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INDONESIAN JOURNAL OF PROSTHODONTICS

REVIEW

Assessment of stress distribution and displacement of complete dentures on flabby ridge with multiple occlusion schemes using finite element analysis

Nanda Iswa Maysfera, Ariyani, Ismet Danial Nasution*

Keywords: Displacement of complete denture, Finite element analysis, Flabby ridges, Occlusion schemes, Stress distribution.

ABSTRACT

Loss of teeth and supporting tissues, which are functional components of the stomatognathic system, significantly affects masticatory function. Flabby ridges are one of the soft tissue anomalies in the edentulous. The main choice of treatment for edentulous patients with flabby ridges issues is a complete denture (CD). Flabby ridges cause problems with the retention and stabilization of the CD which causes displacement of the denture base during function. Lingualized and linear occlusion schemes were used to overcome the stabilization of CD by reducing stress distribution in the flabby ridge area when obtaining masticatory load. Assessment of stress distribution and displacement of CD can be analyzed using Finite Element Analysis (FEA). This paper describes the use of FEA to assess the stress distribution and displacement of CD on flabby ridges by simulating axial and oblique forces in lingualized and linear occlusion schemes. The use of FEA for assessing stress distribution and displacement of CD in flabby ridges with multiple occlusion schemes has advantages in terms of accuracy and flexibility. (IJP 2024;5(1):1-5)

INTRODUCTION

The stomatognathic system is a complex system with several functional components that work together. Stomatognathic components consist of teeth, bones, joints, ligaments and other supporting tissues.[1] According to the Glossary of Prosthodontic Terms, the stomatognathic system is a combination of several structures involved in speech, mastication, swallowing, and parafunctional functions.[2] Disruption one of the functional components of the stomatognathic system, such as tooth loss, will affect masticatory function, impacting quality of life and nutritional intake. Demographic data on the elderly population indicate demand to rehabilitate edentulous patients has remained high for decades.[3] According to the 2018 National Basic Health Research Report, the proportion of edentulous cases is 2.6 percent for people aged 55 to 64, and 9 percent for people aged 65 and up.[4] Edentulous rehabilitation with complete dentures (CD) is generally considered acceptable because it provides the desired aesthetics as well as occlusal support for mastication and allows the patient to speak normally.[3,4]

The use of CD on flabby ridges will affect retention and stabilization. Flabby ridge is a condition in which the alveolar ridge is easily moved due to bone replacement with fibrous tissue. It is most common in the maxillary anterior, especially when the mandible still has natural anterior teeth and the maxillary ridge is weak underpressure from the mandibular anterior natural teeth.[5,6] The amount and pattern of pressure applied to the oral mucosa is an important aspect of denture treatment that affects CD stabilization and retention.[7] One method for achieving CD retention and stabilization is to use a lingualized and linear occlusion scheme, which aims to achieve an even stress distribution and reduce the occurrence of displacement in the CD.[3,8,9] The number of occlusal contacts was significantly reduced with the lingualized and linear occlusion schemes compared to the conventional occlusion scheme. The masticatory pressure applied to the mandibular alveolar ridge with this occlusion scheme is directed towards to

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Figure 1. Lingualized occlusion.

Figure 2. Lingualized occlusion during lateral movement.

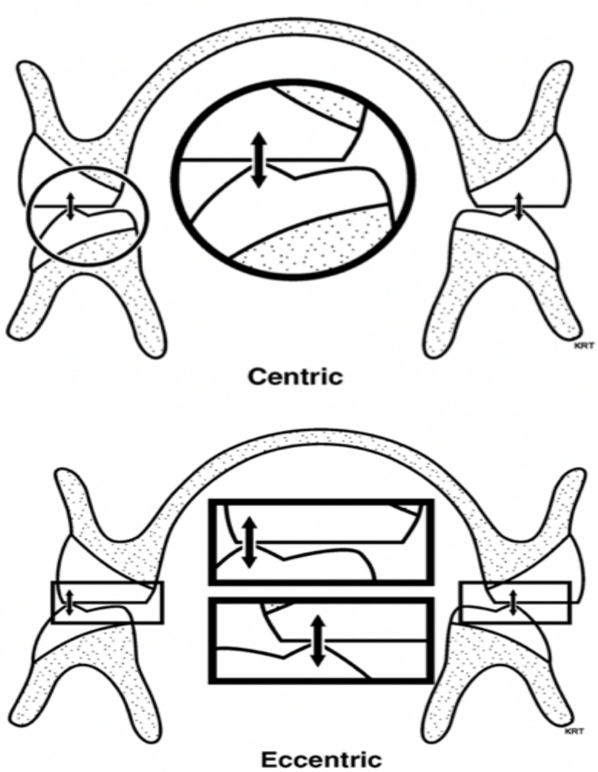

Figure 3. Linear occlusion in centric and eccentric relations.

the center of the ridge, increasing the stability of the mandibular denture and avoiding crossbites.[10]

Finite Element Analysis (FEA) is an important research tool in dental research for biomechanical analysis. This method has the advantages of being non-invasive, allowing visualization of overlapping structures, and allowing the determination of material properties of anatomic craniofacial structures. This method can determine the magnitude, location, and direction of an applied force in addition to assign theoretically measurable stress points. Furthermore, because it has no effect on the physical properties of the material being analyzed, it can be repeated as many times as necessary.[11] The use of FEA is expected to improve understanding of the stress distribution and displacement of complete dentures with flabby ridge in different occlusion schemes.[7,12]

LITERATURE STUDIES

The Effect of Edentulus on Mastication

Definition

According to the Glossary of Prosthodontic Terms, mastication is the process of chewing food for swallowing and digestion.[2,13] The masticatory system is a complex and interconnected system of muscles, bones, ligaments, teeth, and nerves.[14] Masticatory performance is affected by factors such as the number of natural teeth, occlusal strength, and tongue pressure.[15] It is known that the number of teeth below 20 teeth can affect the efficiency, performance and masticatory ability.[13]

Flabby Ridges

According to the Glossary of Prosthodontic Terms 9 (GPT) flabby ridge is defined as excessive movable tissue.[2,17] Historically, the flabby ridge in the maxillary anterior region was a feature of the 'combination syndrome' as identified by Kelly in 1972. The combination syndrome occurs in patients with full maxillary edentulous antagonizes the mandibular Kennedy Class I partial dentition.[5,18]

Flabby ridges caused by uncontrolled tooth extraction, excessive occlusal load on the residual maxillary ridge, unstable occlusal relationships, and flabby tissue often accompanied by atrophic and knife edge ridges.[17,19] The mucosa of the flabby ridges is highly mobile and loses its attachment to the periosteal tissue that covers the bone. Flabby ridge provides limited support for CD. Masticatory pressure can cause displacement of the denture and loss of peripheral seal.[17]

Flabby Ridges Classification

Stefanescu C et al. classify the flabby ridges as follows:[19]
By location: Upper frontal edentulous ridge (very often); Upper fronto-lateral edentulous ridge (often); Maxillary tuberosity (rare); Lower frontal edentulous ridge (very often); Lower fronto-lateral edentulous ridge (rare); Retromolar pad (often).

Based on the structure: Hyperplasic, keratinized, with high antero-posterior and supero-inferior thickness; Atrophic, thin, small antero-posterior thickness and increased supero-inferior length; Apparently histological normal appearance at inspection, but with increased mobilityin all directions.

Flabby Ridges Management

Various managements of flabby ridges have been proposed,

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both surgical and non-surgical procedures. Surgical procedures to remove flabby ridges include pre-prosthetic treatment. Surgical procedures on a flabby ridge usually result in the loss of a portion of the vestibular area which can affect the stability of the denture. Either a ridge augmentation procedure using bone graft or platelet rich fibrin (PRF) can be performed but the prognosis is questionable. The implant procedure may also be considered as part of the flabby treatment plan. However, both augmentation and implant procedures have many factors to consider, such as patient age, history of systemic disease, surgical risks and complications, and implant failure.[9,19]

Non-surgical management is a prosthodontic approach. In the principle of prosthodontics, of course, the use of an unfavorable ridge is still better than nothing. The treatment of flabby edges with various printing methods and materials is frequently discussed in various literatures.[19] Determining the best occlusion scheme is also important for achieving denture stability in cases of flabby ridges. Lingualized and linear occlusion are frequently used to maximize the stability, esthetics, and function of the CD in cases of severe alveolar ridge resorption and flabby ridges.

Occlusion Scheme

The occlusal scheme is defined as the shape and arrangement of the occlusal contacts in natural teeth and dentures. The occlusal scheme determines the pattern of occlusal contact between opposing teeth during centric relation and the functional movement of the mandible The amount and direction of the force transmitted through the denture base to the residual ridge is determined by the quantity and intensity of this contact. That is why the occlusal scheme is an important factor in the design of complete denture prostheses.[20] Over the years a number of occlusion concepts have been developed for complete dentures. The main goal is to keep the load on the bone within physiological limits. Lingualized and linear occlusion are the two most popular occlusion schemes for complete dentures with flabby ridges.[21]

Lingualized Occlusion

This concept was introduced by Alfred Gysi in 1927 and SH Payne in 1941: 'cusp-to-fossa occlusion' and Pound: 'lingualized oclusion'. Lingual occlusion can be defined as, a form of denture occlusion in which the maxillary lingual cusp articulates with the mandibular occlusal surface in centric working and non-working side mandibular positions (Fig.1).[8,20,22] Indications of a lingualized occlusion scheme are severe alveolar resorption, class II jaw relations, complete dentures on flabby ridges againts removable partial dentures and patients with parafunctional habits. Aesthetic results can be achieved by anchoring the anatomical upper posterior teeth in lingual occlusion. During lateral movement, the contact that occurs on the working side is only between the lingual cusps of the maxillary and mandibular posterior teeth, on the balancing side there is contact between the palatal cusps of the upper denture and the lingual inner curve of the buccal cusps of the lower denture, as occurs in the conventional concept of occlusion (Fig.2).[22,23]

Advantages of Lingualized occlusion

The vertical force of masticatory pressure is concentrated at the mandibular ridge; Cusp shape is more aesthetic than non-anatomical tooth shape; It can be used in patients with various conditions; Better food bolus penetration; Additional stability is obtained during parafunctional movements with balanced occlusion; It is easier to adjust the occlusion; Can be used in Class II, Class III, and crossbites.[23]

In general, it can be said that there are no contraindications to the use of lingualized occlusion. This occlusion scheme is used in patients who expect esthetics but minimize pressure during mastication and parafunctional movements as a result of severe ridges resorption and flabby tissue or abnormal jaw relationship and large spaces between the ridges.

Linear Occlusion

The occlusal adjustment of the denture was made on the basis of a horizontal plane without anterior overlap (overbite = 0) using the maxillary posterior denture elements with nonanatomical occlusal surfaces and in contact with the occlusal surfaces of the mandibular posterior denture elements which had a straight, long and shaped shape. narrow occlusal surface resembling a line (Fig.3).[3,20]

Linear occlusion consists of the following basic parameters; Zero-degree teeth (flat plane) are in line with the bladed teeth (line contact) where the blade is in a straight line just above the crest of the ridge; The maxillary teeth are arranged in a monoplane with relation to the occlusal plane; There was no interference with the anterior teeth during protrusive or lateral movements.[24]

According to Gronas and Stout, linear occlusion has the potential to generate the smallest lateral forces. In linear occlusion, the bladed teeth are placed on the jaw that requires the most stability. Because the lower jaw usually requires denture stability, the blade teeth in this occlusion scheme are placed on the lower jaw. In the centric and eccentric relation, the occlusive force between the blade teeth and the zero degree teeth occurs in the vertical direction (Fig. 3). The location of masticatory pressure on the mandible does not change significantly in different occlusion positions. Because there is little contact area between the plane and the blade teeth, denture displacement is reduced due to low frictional resistance.[24]

Stress Distribution and Displacement

Dentures depend on the mucosa and residual ridges for support, so it is critical to minimize excessive residual ridge resorption by distributing the occlusal load evenly. In the absence of natural teeth, mechanoreceptors and proprioceptive functions are maintained through continuous stimulation of the denture base and oral mucosa. As an outcome, the pattern of intraoral pressure within the oral cavity is determined by acceptable functional behaviors like mastication, swallowing, and speech, as well as parafunctional behaviors like bruxism.[7]

Mucosal capacity continuous load from denture is a variable that depends on the level and duration of mechanical load during denture wear, there is limited knowledge about the physiological parameters for oral mucosal pain threshold. In particular, the Pressure Pain Threshold (PPT), is a major area of concern in denture treatment because it is the maximum pressure before pain is experienced by the patient.[7] The pressure pain threshold (PPT) in the lower edentulous area was reported to be 630 kPa.[12]

Occlusal forces in the range of 65-110 N, generated on premolars and molars, have been shown to be sufficient to pro-

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cess most foods.[25] The masticatory efficiency depends not only on the stability of the denture but also on the compression of mastication against the mucosa under the denture. Chewing and swallowing as the most frequently performed activities tend to occur in a vertical direction.[6] However, movement in the lateral or oblique direction has the most damaging effect due to displacement of the denture so that the masticatory load is distributed unequally over the entire supporting tissue, with the area receiving greater stress than the other areas.[12]

Alveolar bone resorption will occur at an unpredictable rate after natural teeth are extracted and will severely destabilize the complete denture if the alveolar ridges move excessively (>2 mm) or are of a soft consistency under light stress.[26] In mandibular dentures there is a large displacement of the mucosa during the transmission of masticatory pressure especially when oblique forces are applied in relation to the occlusal surface. Denture displacement is kept to a minimum during the masticatory process by using an appropriate occlusion scheme. Clinical trials have shown that denture displacement increases with the size of the food piece.[12]

Transmission of occlusal forces in mastication is only possible if the mandibular denture is in a stable condition when in contact with the maxillary denture on the non-working side. During in vivo studies of the masticatory process, significant denture displacements have been reported up to 1 mm, despite the articulations being balanced. Stabilization is achieved by various occlusion schemes selected by the dentist according to the intraoral situation.[12]

Finite Element Analysis (FEA)

Finite element analysisis a numerical method to get a solution to a problem accurately by analyzing modeling simulations.[27]

The advantages of using FEA: Modeling and treatment can be free-form according to the preferences of the researcher; Mesh modeling is a combination of several elements; Processing can be done in one program; The original structure and the model have identical conditions.

Studying the stress distribution due to this occlusal configuration is important to understand the phenomenon of load transfer not only but also to improve denture design. Available methods for studying stress analysis include photoelasticity, finite element analysis (FEA), and strain measurement. The application of FEA to assess the biomechanical properties of dentures, bones and teeth has grown rapidly over the last decade as it offers the ability to model complex geometries, evaluate internal stress states of various components and other mechanical quantities. FEA is also very effective for comparison studies where one can examine the effects of one or more parameters of interest through simulation without the need to create multiple physical constructs or prototypes.[28]

DISCUSSION

According to Pai et al flabby ridges can be defined as movable soft tissue located in the superficial area of the alveolar ridge.[29] The flabby ridge mainly occurs when the edentulous ridge is opposed to the natural teeth and is considered a feature of the combination syndrome when it occurs in the anterior maxilla (Lynch and Allen, 2004; Kelly, 1972).[26] Flabby ridges are easily displaced under occlusal forces due to poor support, resulting in impaired denture retention as a consequence of loss of peripheral seal (Pai et al. 2014).[29]

According to MacEntee, support for CD is significantly impaired if the flabby ridges has a displacement of more than 2 mm under masticatory forces.[30] According to a study (Chong 1983), displacements on the working side and balancing side can reach as high as 1.4 and 1.6 mm, respectively. The balancing side shows a marked tendency to dislodge and slide on the foundation (Miyashita et al. 1998) where this displacement occurs under masticatory loads.[25] The use of lingualized and linear occlusion schemes is indicated for flabby ridges because vertical forces are directed more concentrated on the mandibular alveolar ridge, which provides more stability to the denture.[10]

Abduo's (2013) systematic review concluded that bilateral balanced or lingualized occlusion schemes were equally acceptable to patients in terms of mastication, aesthetics, comfort, and speech processing. Improved denture quality significantly affects masticatory performance, occlusal strength and patient satisfaction.[31] Based on the research results, Hasan A et al (2015) consider the two most functionally efficient occlusion schemes, namely lingual and linear occlusion. In the lingualized occlusion scheme, the premolars and molars were arranged and modified so that only the lingual cusps of the maxillary posterior teeth were in contact with the central fossa of the mandibular posterior teeth. The linear occlusion scheme was defined as the pin-point contact of the cusp tips of the bladed mandibular teeth against the maxillary teeth that had no cusps.[22]

According to Fatihallah A, the tension generated in the lingualized occlusion scheme is much less than that produced in the bilateral balanced occlusion scheme, this may be because the number of occlusal contacts is reduced so that there is only one centric stopper between the upper and lower antagonist teeth in the case of the lingualized occlusion scheme.[32] The clinical study conducted by Hameed et al. it was found that based on the results of the radiographic evaluation, linear occlusion resulted in less resorption of the alveolar ridge than lingualized occlusion.[21]

The FEA study conducted by Hasan A (2015) showed that the maximum stress of the linear occlusion scheme was 365 MPa, 62% higher than the lingualized occlusion scheme (224 MPa) in the overdenture implant. A similar pattern was observed in the denture and tooth bases; the linear occlusion scheme resulted in a higher von-mises stress (189 MPa) than the lingualized occlusion scheme (124 MPa).[21] On the other hand, the stress distribution analysis with FEA conducted by Hasan M showed that in dentures, the maximum and minimum stresses for bilateral balanced occlusion and lingualized schemes were not significantly different.[28]

Zmudzki J et al. conducted an FEA study on the distribution of denture stress on the mandible with a load of 100 N in the vertical direction and 141 N in the 45° oblique direction with direct contact and delayed contact on the non-working side.[12] As a result, the direction of the oblique load provides greater stress distribution and displacement, especially on the non-working side with delayed contact. Quantitative assessment of the stress distribution and displacement of the denture showed that the occlusion scheme has an important role in maintaining the stability of the CD under stress despite good adaptation of the CD base and mucosa and shape of the ridge. There has been no research on the stress distribution and CD displacement on flabby ridges on various occlusion schemes, so more research is required.

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CONCLUSION

FEA can be used effectively to assess the stress distribution and displacement of complete dentures on the flabby ridge with lingualized and linear occlusion schemes. Lingualized and linear occlusion schemes on flabby ridges can increase denture stabilization because occlusal forces are more concentrated on the ridges so that they can be distributed well and also reduce horizontal force during eccentric movement due to minimal occlusion contact, reducing CD displacement on the flabby ridges.

SUGGESTIONS

There has been no research on the stress distribution and CD displacement on flabby ridges on various occlusion schemes, so more research is required.

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INDONESIAN JOURNAL OF PROSTHODONTICS

REVIEW

Re-establishment of an occlusal vertical dimension: Aliterature review

M.Faizal Fachry,* Irfan Dammar

Keywords: Restorativ treatment, Vertical dimension, Parafunctional habits

ABSTRACT

Determination of the correct Occlusion vertical dimension (OVD) is one of the factors that dentists need to pay attention to in important dental procedures. One of the most important strategies of restorative care is the assessment andre-establishment of the occlusal vertical dimension. Tooth attrition causes changes in facial morphology dimensions and OVD decreases. The occlusion vertical dimension (OVD) was the height of the lower third of the face as measured from the point of subnation to gnathion at the maximum intercuspation position. One of the factors that affect a person's occlusion vertical dimension is the presence of tooth abrasion, attrition and tooth loss. One way to improve a patient's occlusion vertical dimension is by rehabilitative action with restorative treatment by making crowns for teeth experiencing anterior attrition. Tooth attrition causes changes in facial morphology dimensions and occlusion vertical dimension decreases. Determination of the correct occlusal vertical dimension is one of the success factors in rehabilitation treatment, because if it is not restored properly, the guard teeth will decrease, damage to the teeth, muscles, TMJ, swallowing and can occur speech disorders. (IJP 2024;5(1):6-8)

INTRODUCTION

According to the Glossary of Prosthodontic Terms, the vertical dimension is the distance between two anatomical signs, namely the upper half of the face and the lower half of the face. This anatomical sign is a point on the tip of the nose and tip of the chin, where one of the points is on movable tissue and the other point is on immovable tissuel.

The occlusion vertical dimension (OVD) is the height of the lower third of the face measured from the point of subnation to the gnathion at the maximum intercuspation position, while the vertical dimension of rest is the height of the lower third of the face measured between two anatomical points when the mandible is in a physiological resting position. It is determined by muscle relationships, using the lower jaw physiological resting position as a guiding factor. Knowledge of the physiological resting position is very important in determining the vertical dimension of adequate occlusion.[1-3]

The centric relation can be defined as the relationship between the maxilla and the mandible in which the condyle is in a non-tense position and lies posteriorly in the fossa glenoid.

The presence of tooth loss results in the influence of a number of factors, including: location, number of missing tooth elements, interdigitation, condition of the periodontal tissue and tongue. In addition to these things, there are also other influencing factors, namely: age, ability to adapt to changes due to tooth loss and neuromuscular tolerance.[4-8]

Some of the consequences that occur due to tooth loss that is not replaced area decrease in the support of the alveolar bone periodontal tissue, attrition, tooth loss and TMJ dysfunction, loss of mastication efficiency, tooth shift and changes in the occlusalarch.[1-6]

Occlusal and incisal attrition may occur during deglutition (physiological wear) and may be exacerbated by parafunctional activities such as habitual bruxism

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and clenching (pathological wear). Glossy tooth surfaces and circumscribed facets are clearly reliable signs of attrition and are usually consistent with the presence of a facet on the antagonist/opposite tooth during eccentric occlusion, especially in the anterior antagonist tooth. Such facets are usually seen on the functional (occlusal and incisal) surfaces of the teeth, but can also affect the buccal and palatal surfaces of teeth anterior to the mandible and maxilla when there is deep vertical overlap.[4]

Preventive measures are one of the ways to rehabilitate teeth so that they can restore the occlusion vertical dimension. Based on this, the authors are interested in studying more deeply about how to re-establish the vertical dimension of occlusion and its rehabilitation measures.[7]

LITERATURE REVIEW

The jaw relationship is also known as the vertical dimension, the vertical dimension is the vertical distance between the upper and lower jaws that can give a normal expression to a person's face.

The vertical dimension in patients with partial tooth loss is the vertical relationship between one tooth and another when the tooth is in occlusion. In a patient who has lost a tooth in one arch and has practically lost the vertical dimension, this situation must be redefined in various ways so that it is the same as the vertical dimension when the teeth are still complete.[8,9]

To find out whether the vertical dimension is correct, it can be seen from phonetics and aesthetics.

Rest position vertical dimension; It is an upper jaw relationship in which the muscles of opening and closing the mouth are in balance. This vertical dimension was measured when the mandible was in a state of physiological rest.

Occlusion vertical dimension; AIn a relationship of the mandible to the maxilla, the teeth or the occlusal rim are occluded.

This vertical dimension is measured when the toothis in centric occlusion.

Gelbier and Copley and Cawson, dental attrition is defined as the gradual wear and tear of the occlusal surfaces of the teeth associated with masticatory movements. that occurs physiologically as a result of mastication.[9]

When the teeth contact, then when it occurs tooth wear occurs. The more frequent contact occurs, the greater the wear. The wear and tear caused by the contact of the teeth is called attrition. Attrition of this tooth can occur in the incisal, occlusal and proximal to the tooth. Considering that the enamel is so hard and that the teeth facing each other do not come into contact very often due to the presence of saliva as a lubricant, wear is usually limited when the teeth have been in the oral cavity for sometime.[10]

Somethings that need to be considered in restoring the vertical dimension of occlusion are how much the decrease in the vertical dimension of occlusion, changes in facial aesthetics and the condition of the TMJ.

Measurement of Decrease in Occlusion Vertical Dimension

How to measure vertical dimension: Rest position vertical dimension; Determine two points on the patient's face parallel to the median line, namely on the chin and above the lips/nose. Measurements were made using rollers and calipers.

The patient is asked to count from one to ten and maintain the position of his jaw at a count often, at which time the distance between the two points is measured.

Then the patient is asked to say a few words that end in "S" and the distance between the two points is measured again.

Then the patient was asked to swallow and in a relaxed state the third measurement was taken. If the distance between the three measurements is the same, this is the vertical dimension of the resting position.

Occlusion vertical dimension; Measurements were taken after the occlusal rim was placed in the patient's mouth.

The maxillary occlusal rim is inserted, then pay attention to the patient's facial shape whether it is in accordance with the patient's normal expression.

Then insert the lower jaw occlusal rim, the patient is asked to stop the upper and lower jaws in a centric occlusion state, measure the distance between the two points again, it will decrease 2-4 mm from the vertical dimension distance of the resting position. The called vertical dimension of occlusion.[12]

Facial Aesthetics

The determinants of facial aesthetics are the sagittal profile, facial appearance, lip morphology and tooth appearance. Examination of the sagittal profile may reveal pseudoprognathia which is a sign of decreased occlusion vertical dimension and mandibular closure. The cephalometric results showed that worn teeth caused a reduction in arch width and gonial angle, thus showing a pseudoprognathic appearance.

The state of TMJ

Examination of the TMJ before restoring the vertical dimension is important in the form of examination of joint pain, mandibular movement and the presence or absence of clicks. A comprehensive examination and treatment approach needs to be carried out, especially in patients with TMJ disorders, because TMJ symptoms are often detected because they are masked by patient discomfort during the adaptation period to the occlusion vertical dimension before permanent restoration.[10]

DISCUSSION

Bruxismis a parafunctional habits of grinding teeth, or the habit of grinding teeth involuntarily in addition to chewing movements of the mandible, thereby triggering occlusal trauma. The cause of bruxism is not specifically known, but several influencing factors are morphological factors such as tooth occlusion, psychosocial factors such as stress and certain personality characteristics, pathophysiological factors (disease, trauma, genetics, smoking, alcohol, caffeine consumption, drugs and sleep disturbances and snoring).[14]

Rehabilitation of patients with tooth wear in the occlusal area is a complex and challenging treatment in dentistry. Teeth are prone to wear and tear due to functional activity. However, this condition can be exacerbated in cases of posterior tooth loss because the chewing load will be concentrated on the remaining anterior teeth resulting in impaired occlusion and parafunctional habits such as bruxism.

When the mandible alternately moves laterally, the teeth

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Figure 1. Vertical dimension measurement tool called Willis bite gauge

are subjected to great horizontal stresses, increasing the likelihood of damage to the tooth structure to the periodontal tissues. Bruxism also occurs in an eccentric position, resulting in an unequal distribution of pressure but only on a few teeth, does not conflict with functional activities where the mandible is in a centric position for occlusion. Wear of teeth due to parafunctional habits is associated with development of tooth sensitivity, decreased clinical crown height and possible changes in the occlusion vertical dimension. Loss of tooth structure does not directly result in loss of vertical dimension, so to determine whether there is a change in the occlusion vertical dimension, various aspects need to be considered such ashow the posterior teeth are occluded, the degree of tooth wear, phonetic evaluation of hissing sounds, interocclusal distance and facial appearance. An increase in the vertical dimension of occlusion causes the teeth not to contact when making a hissing sound, difficulty in closing the lips and difficulty swallowing accompanied by pain, whereas if the vertical dimension of occlusion decreases, it shows a decrease in the face during occlusion, disturbances in the TMJ, excessive lip contact and angular cheilits.[15]

The first step in cases of excessive wear in the anterior region consists in reshaping the occlusal vertical dimension, which must be done to restore the height of the lower third of the face and create an interocclusal space to allow reconstruction of the occlusaland anterior teeth.

Proper prosthetic rehabilitation planning should not link the re-establishment of the occlusal vertical dimension with the creation of a new denture with the risk of the patient not adapting to the new conditions of the vertical dimension. Inpatients with excessive tooth wear, rehabilitation of restoring the vertical dimension of the occlusion by means of a fixed

CONCLUSION

Attrition of the teeth due to functional and parafunctional activities can lead to changes in the morphological dimensions of the face and a decrease in the vertical dimension of occlusion correct is an important factor in the success of rehabilitation treatment, because the reduction invertical dimension of occlusioncause tooth decay, muscle disorders, TMJ, digestion, and phonetic dysfunction. Rehabilitationvertical dimension of occlusioncurrently tend to use fixed dentures because they have better aesthetics, adaptation and functional improvement in patients. The use of removable dentures shows that there are complaints that often become complaints that arise due to the use of removable dentures.

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REVIEW

The role of laser power and frequency on metal surfaces of adhesive bridge in increasing the bond strength of resin cement

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Keywords: Adhesive bridge, Laser, Surface treatment, Resin cement.

ABSTRACT

Adhesive Bridge is a fixed denture that is attached to the tooth structure, especially the enamel, which has been etched to achieve micromechanical retention. Among other things, adhesive bridge attachment depends on, one important factor is the adhesive bond between the etched enamel and the retained metal. To increase the retention of adhesive bridges, variations of micromechanical surface treatment on metal can be carried out in the form of chemical or electrical etching, air particle abrasion (sandblasting), primary metal, tin plating, silica coating, and lasers. Lasers with different energies, strengths, frequencies, wavelengths, durations and distances can create a thin layer of porous oxide which increases the bonding strength of resin cement for adhesive bridges. The role of laser power and frequency as well as the selection of the right type of resin on the metal surface of the adhesive bridge can increase the bonding strength of the resin cement on the adhesive bridge. The selection of the type of surface treatment such as laser and the right type of resin cement can affect the bond strength of the resin cement on the adhesive bridge. (IJP 2024;5(1):9-13)

INTRODUCTION

Adhesive bridges or resin bonded fixed dentures is the type of denture relies heavily on the bond between the resin cement and the tooth and metal surfaces. An adhesive bridge comprises of a pontic that is fixed to the abutment teeth with the support of a metal wing retainer.[4] Adhesive bridges have the advantage that they require minimal preparation and can maintain more healthy tooth structure than conventional bridges and require minimal clinical time.[4]

Adhesive bridges are indicated in cases where the abutment teeth are in healthy condition, without caries and restorations and there is sufficient enamel for adhesion procedures, fixed retainers after orthodontic procedures, tooth splinting, and in cases where the patient is afraid of anesthetic needles.[5] Adhesive bridges are contraindicated in cases where the abutment teeth do not have adequate enamel for adhesion, the abutments are small or peg shaped, the abutments are malposition and mobile, and in patients who are allergic to cement and proper cementation procedures.[13] The main functions of resin cement materials are to provide adequate adhesion between the restorative material and the tooth, seal the exposed dentin during preparation, and fill the space created between the tooth and the restorative material. The success of a restoration is influenced by the adhesion that occurs between the restoration and cement.[14]

The development of cement materials in dentistry is increasing. Currently, there are two groups of resin cements on the market, namely conventional resin cements that require bonding materials, namely total etch resin cements, and self-etch resin cements, and resin cements that do not require bonding materials (self-adhesive resin cements). The application of resin cement is preceded by the application of bonding materials, in total-etch or self-etch systems.[13,23] The multi-stage application technique of resin cement with this bonding material is quite complex and sensitive, therefore it can affect the effectiveness of the attachment of the restoration to the tooth.[15] One of the major changes in recent years has been the development of resin cements that do not require the application of a bonding agent to attach the restoration. Resin cements that do not require a bonding agent have various names

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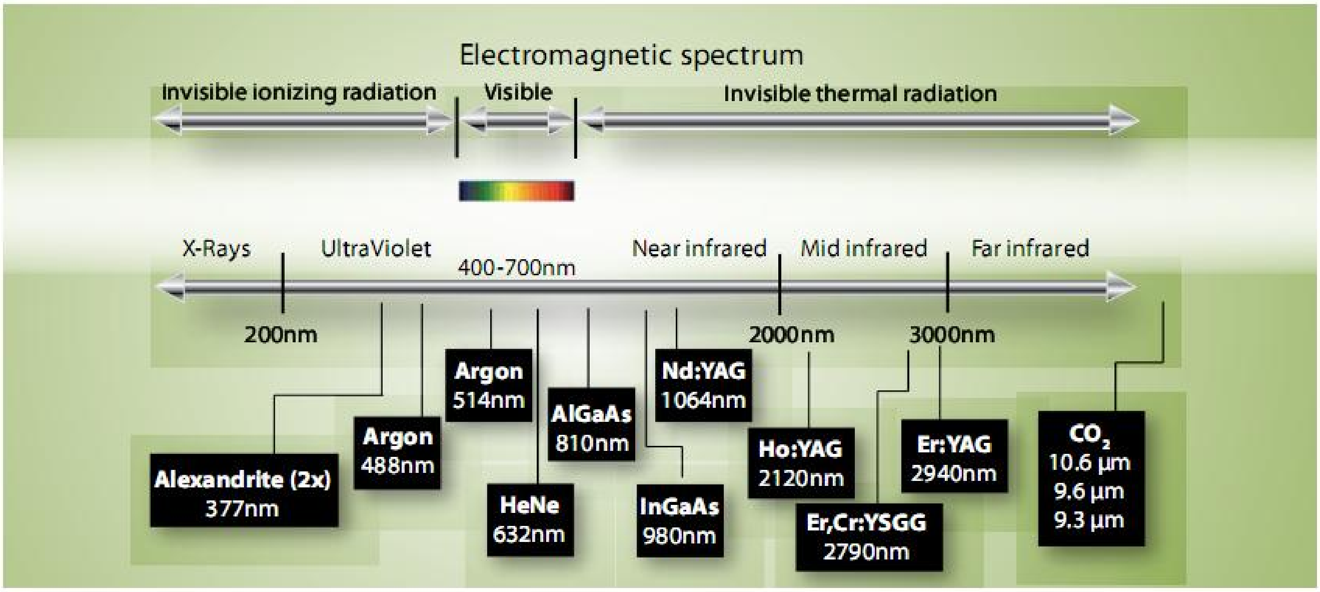

such as all-in-one resin cement, universal resin cement or self-adhesive resin cement.[13]

Self-adhesive resin cements were introduced to overcome several problems conventional resin cement systems. The aim of developing this cement was to combine the ease of use of conventional cements with micromechanical advantages.[16] Sandblasting with Al2O3 particles is the most commonly used method to obtain micromechanical retention. These particles have different sizes. Preparation with 50μm Al2O3 particles resulted in the highest shear bond strength of Ni-Cr metal.[17]

Previous studies on adhesive bridges have used different methods to improve retention such as using perforated retainers or fabricating micromechanical features to improve retention by using electrochemical etching or particle roughening. Studies show that micromechanical retention features are more efficient than macro-mechanical retention. Various surface treatment methods have been tried to improve the retention and resistance of fixed prostheses. The most common method used is sandblasting with alumina particles. An alternative to conventional surface treatment methods is laser.

With the application of lasers, it is possible to carry out the treatment of many soft tissue conditions and in prostheses which are often a challenge in prosthodontics. Lasers can affect the overall aesthetics of the result, and provide an easier method of handling. Before using a laser, it is very important to understand how this system works, the steps involved, and the precautions to be taken (e.g., eye protection), and troubleshooting steps.[21]

LITERATURE STUDIES

Adhesive bridge

An adhesive bridge is a fixed denture that is attached to the tooth structure, especially the enamel, which has been etched to achieve micromechanical retention of the luting material from the resin.[22] An adhesive bridge consists of one or two pontics supported by thin metal retainers that are placed lingually and proximally to the abutment teeth. Adhesive bridge attachment depends, among other things, on the adhesive bond between the etched enamel and the retention metal.[3] Some other names of adhesive bridges that are often used by several authors include Rochette bridge, Maryland bridge, Minimal-preparation bridge, Direct bonded retainer, Resin bonded fixed partial denture, Resin bonded prosthesis and Resin retained cast metal prosthesis.

Factors Affecting the Success of Adhesive Bridges

Dentures are made to restore occlusal stability and enhance oral, cosmetic, and dental function. According to certain research, adhesive bridges have a 5-year success rate of 87.7%.[4] The effectiveness of adhesive bridge restoration can be affected by a number of things. The factors related to the patient, the choice of the abutment teeth, the adhesive bridge design (such as wing retainer coverage), aesthetic considerations, the design of the pontic, and the adhesive bridge materials (such as full porcelain, metal porcelain, and fiber-reinforced resin composite). The success of adhesive bridges is also influenced by clinical procedures including abutment preparation and cementation. For example, wax up coping, casting, porcelain application, porcelain firing, and metal surface treatment are some of the processes employed in the lab. A combination of macro-, micro-, and chemical treatments on metal parts as surface treatment can help in increasing the retention of metal surfaces in adhesive bridges.

Resin Cement

Resin cements, also known as adhesive resins, are resins containing adhesives such as 10-methacryloyloxydecyl dihydrogen phosphate (MDP), organophosphate, or 4-methacryloxyethyl trimethylate anhydride (4-META); In dentistry, resin cement describes the adhesive material used to attach fixed dentures and veneers to metal.[22] Resin cement is the newest type of cement for attaching restorative materials indirect with teeth. The advantages of resin cement are it has the following properties like higher mechanical strength compared to conventional cement and insoluble in liquid in the oral cavity so that the marginal margins are closed better. Resin cement, also known as bonding cement, is cement that has the property of adhering to the interior of the restoration and to the abutment tooth structure.

According to ISO 4049 adhesive resin cements are classified into 3 classes based on their polymerization activation, namely chemical activation without irradiation (self-cured, class 1), with irradiation (light-cured, class 2), and activation chemically and with or without irradiation (dual-cured, class 3).[23] Dual-cured resin cements are attractive as luting agents because of the development of resins for fillings, the advantages of acid etching techniques for bonding resins to enamel and the potential for bonding to dentin by organic or inorganic acid treatment. Some cements are made for general use and some for specific uses, such as cementation of ceramic crowns and fixed dentures.[12]

Content of Resin Cement

Resin cements use monomers that are aromatic or aliphatic acrylates. Bis-GMA, urethane dimethacrylate (UDMA) and triethylene glycol dimethacrylate (TEGDMA) is a dimethacrylate commonly used in dental composites.[12] Bis-GMA (bisphenol A Glycidyl Methacrylate) and UDMA (Dimethacrylate Urethane) developed by Foster and Walker to make monomers with lower viscosities, such as the free hydroxyl Bis-GMA and UDMA (Ilie & Hickel, 2011). Bis-GMA is the most commonly used monomer polymer for resins composites on teeth. To improve Bis-GMA processing performance, usually added extra monomer polymers such as UDMA and TEDGMA to reduce the viscosity of the resin cement. Uses of Glycidyl Methacrylate (Bis.) matrix GMA is to form strong cross-linked polymers in composite materials and control the consistency of the composite resin. Bis-GMA plays an important role in reducing volumetric shrinkage, increasing composite reactivity and increase the conversion rate to some extent. Small polymerization shrinkage, high fatigue resistance, high fracture resistance, resistance to pressure, low heat conduction coefficient, and meet the aesthetic requirements of the teeth several important characteristics for the desired composite.[15]

Resin Cement Bonding Mechanism

The use of a dentin bonding agent prior to resin cement application is critical to success, unless the enamel has been prepared. Several mechanisms for bonding to the dentin surface include: tagging of dentinal tubules, bonding to precipitates on pre-manipulated dentin, chemical incorporation with inorganic components, chemical incorporation with organic componentc, production of dentin layers by impregnation with resins.[18] Resin cement is polymerized through a chemical mechanism, hydrophilic monomers that have polymerized will enter through the collagen layer into the dentin apatite that has been demineralized by etching. Adhesion of the dentin to the resin cement is achieved by primary infiltration of the resin into the mineralized portion of the dentinal tubule, resulting in an interlocking mechanical bond. The resin cement cementation procedure requires several steps. First the acid is applied to remove the smear layer, the dentinal tubules are exposed and demineralization occurs with a thickness of 2-5 microns of dentin. The acid then dissolves and the apatite mineral extract normally coats the collagen fibers of the dentinal matrix and opens a 20-30 m deep channel around the collagen fibres. The cement will achieve mechanical retention by the entry of hydrophilic monomers into the channel.[19]

The adhesive resin will form a hybrid layer. This hybrid layer is a structure formed on mineralized hard tooth tissue then infiltrated by monomer and will be followed by a monomer polymerization process. This hybrid zone indicates resin penetration into the intertubular dentin as deep as 5-10 m and the formation of micromechanical interlocking with dentinal collagen.[8] Meanwhile, according to Smith (2007) the attachment of cement to metal is more of a mechanical retention. The mechanical retention is obtained from the surface roughness of the metal restoration. The liquid cement fills the roughness. After hardening, cement acts as a bond between the two surfaces (dentin and metal).[6,8]

Surface treatment

Surface treatment is a treatment process that is applied to change the properties / characteristics of the metal on the metal surface. Variations of micromechanical surface treatment on metals in the form of chemical or electrical etching, air particle abrasion (sandblasting), primary metal, tin plating, and silica coating have been investigated and are intended to increase the adhesive strength of restorations on cement. Surface treatment of the metal adhesive bridge retainer aims to increase the retention between the adhesive bridge retainer and the resin cement. On adhesive bridges, macro mechanical, micromechanical, and chemical surface treatment can be carried out.

Macro mechanical Surface Treatment; Surface treatment of adhesive bridges in macro mechanical way was first made by Rochette. Rochette bridges formed perforations on metal wing retainers as additional retention for resin materials. Then macro mechanical surface treatment on adhesive bridges can also be found on Virginia bridges in the form of results from the use of the lost salt technique.

Micro mechanical Surface Treatment; Micro mechanical surface treatment of adhesive bridges can be found on Maryland bridges. On the Maryland bridge, surface treatment was carried out with electrolysis etching using 3.5% nitric acid and an electric current of 250mA/cm2 for a period of time.

Laser

A laser consists of three main parts, namely the energy source, the amplifier medium and the optical cavity or resonator. In order for amplification to occur, energy is delivered to the laser source by a pumping mechanism of energy through a strobe flash lamp, electric current, or electric coil. This energy is then delivered to the active medium in an optical resonator, and then produces spontaneous photon emission. Further, the amplification obtained by stimulated emission acts as a reflected photon through a reflective medium in an optical resonator before being ejected through the coupler path. In the case of dental lasers, laser light is delivered to the target tissue via fiber optic cables, hollow wave guides or articulated arms. The wavelength and other properties of the laser are determined primarily by the composition of the active medium, which can be a gas, a crystal, or a solid semiconductor.[21,25]

Dental laser: argon laser

Argon laser, an active medium in the form of argon gas, produces light with two wavelengths, blue light with a wavelength of 488 nm which is commonly used to initiate polymerization of restorative composite materials. Blue-green light with a wavelength of 514 has maximal tissue absorption

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consisting of pigmented molecules such as hemosiderin and melanin. Both wavelengths produced by the argon laser have poor absorption in non-pigmented and hard tissues. This type of laser is often used to control bleeding during gingival surgery, and to detect cracks and damage to the tooth surface using the transillumination technique.[7]

Erbium laser

Currently, the erbium laser is the type most often used in dentistry. The types of erbium lasers that are often used are the Er:YAG and Er, Cr:.YSGG types. The Er:YAG (2940 nm) laser has YAG as the active medium, while Er, Cr:YSGG (2790 nm) has solid yttrium, scandium and garnet as the active medium. Both wavelengths show the highest absorbance level in hydroxyapatite and the highest absorbance in water compared to other systems. Since bones and teeth are composed of large amounts of hydroxyapatite and water, the erbium laser can be used in hard tissue removal. For such applications, as the moisture content of the tooth evaporates, removal of the surrounding soft tissue can be carried out with minimal thermal effect on the pulp.[7]

Neodymium-doped yttrium aluminum garnet (Nd: YAG) laser

With YAG doped crystals and neodymium as the active medium, it is the first laser system created specifically for dental applications. Unlike CO2 and Er:YAG lasers, which absorb in water and tissue with a greater pigment content, this laser has a wavelength of 1,064 nm. Because of the substantial coagulation layer, Nd:YAG has a long-lasting hemostatic effect. In addition to surgical uses, this kind is also employed in the removal of soft tissue, and researchers have looked into nonsurgical sulcus debridement. This technique is safe to use for applications in soft tissue surgeries since it only affects the hard tissues of the teeth, which have a close structural relationship to the teeth. Numerous studies have used the Nd:YAG laser to modify the ceramic's surface prior to bonding. Before bonding, this laser has been recommended as an efficient approach for surface roughening and wettability. The Nd:YAG laser has been used for zirconia under various power and irradiation settings.[1]

Laser Parameter

Recently, dental practitioners using lasers in the fields of cavity preparation, dentin caries treatment cream, surface conditioning, and also indirect restoration surface treatment, the recommended laser in this case is the use of the erbium:yttrium aluminum garnet laser (Eh: YAG).[11,24] Due to the synchronization of wavelengths and absorption peaks and because of the good absorption by the OH groups in hydroxyapatite, the erbium:yttrium aluminum garnet (Er:YAG) laser is often used in dentures with ceramic materials. Carbon dioxide (CO2) lasers are commonly used intraoral especially in soft tissue and hard tissue applications. Since the ceramic completely absorbs all long CO2 lasers, the CO2 laser is particularly suitable for surface treatment of ceramic materials. CO2 laser etching can represent an effective method for surface conditioning of zirconia, improving micromechanical retention and increasing strength.[11]

In order to achieve desired results, it will be essential to choose the appropriate laser processing parameters, which directly determine the produced surface topography and microscale surface roughness. The principle for increasing bond strength is surface roughening to enable micromechanical interlocking. For the strengthening and durability of the restoration, all the parameters such as such as pulse, power, and duration are very important. It is evident that surface roughness tends to increase and become more variable in high energy laser scenarios, while it tends to stay low and become less variable in low energy laser situations. However, more laser exposure under low energy settings causes the roughness to increase; in contrast, more exposure under high energy conditions results in a smoothing effect. This could be explained by the fact that consecutive exposures at different scan angles tend to homogenize the roughness profile when more material is melted with a higher laser energy during a single pass.[20]

DISCUSSION

Adhesive bridges are dentures with minimal intervention. The main criterion for the success of an adhesive bridge is the occurrence of a strong and permanent bond between the tooth surface and the metal surface. One of the factors that cause the most failure of adhesive bridges is the failure of the adhesion of the adhesive bridge between metal and resin cement.[3]

Laser technology has been considered in almost all areas of dentistry. Several recent investigations studied the effect of laser irradiation on the resin bond strength of ceramic restorative materials. It has been reported that compared to conventional sandblasting and acid etching techniques, there is no significant difference associated with the application of Er:YAG or Nd:YAG lasers for bonding resin cement to dental porcelain, so laser surface treatment of porcelain may be as effective as conventional methods.[9]

Abraham et al. concluded that the laser irradiated ceramic surface was more effective due to the low surface energy and rough surface created by the laser beam. When the ceramic surface treated with an Nd:YAG laser is observed under a scanning electron microscope (SEM) (×200 magnification), the surface pattern shows areas that appear to be liquid with the presence of pores and craters, a water droplet-like pattern thereby increasing the surface undercut which enhances adhesion.[10] On the other hand, the surface morphology with sandblasted regions results in a surface with irregularities with no visible defects on the surface. Moslehifard et al. made similar observations on the surface of a nickel-chromium alloy treated with an Nd:YAG laser. They concluded that during laser energy discharge, surface changes were observed at the time of the laser micro blast action resulting in the formation of craters and pores. The deposition of the droplet is possible due to the cast material's proximity to the laser point application. All features of the laser etched onto the surface contributing to increased retention are due to mechanical micro-cutting.[26]

Surface roughness increased significantly in the laser sandblasted polished surface sequence based on the study by Ghoveizi et al. The sandblasting roughness was significantly increased compared to the specimens with polishing treatment.[27] This is because each particle size collides with the surface, the appearance of the particles leaves a mark on the surface, and at this time, it is not only affected by the particle size, but also the particle injection pressure significantly. It is confirmed that the bond strength between the porcelain and the metal alloy increases due to the increased contact area compared to the polished sample. Also, the Ni-Cr and Ni-Cr-Ti specimens

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using the FS laser surface treatment had a higher Ra value (mean surface roughness) than the polished samples. Especially the microporosity pores will play a role in increasing the adhesive strength. Therefore, the results of the roughness test can determine the effect of the interfacial bond strength between porcelain and metal alloys.[28]

CONCLUSION

Adhesive bridges or resin bonded fixed dentures have been known for more than 40 years ago. The adhesion resistance of this type of denture relies heavily on the bond between the resin cement and the tooth and metal surfaces. An adhesive bridge consists of a pontic anchored to the abutment teeth using a metallic wing retainer made of metal. The drawback of the adhesive bridge is the lack of success rate of the adhesive bridge. The main cause of failure of adhesive bridges is debonding or detachment of dentures due to masticatory forces.

One of the main factors in bonding adhesive bridge restorations to resin-based cements is their surface roughness. Surface treatment on metal wing retainers and the type of resin cement used can affect the bond strength of the adhesive bridge. Therefore, different methods have been used to create this roughness, including sandblasting and laser treatment. Laser is the best part in increasing the surface roughness of the metal on the adhesive bridge in increasing the adhesive strength of the resin cement on the adhesive bridge.

SUGGESTIONS

In today's digital world, patients interact almost instantly with social media and internet so they have a better understanding in diagnosis and treatment options. They are more likely to accept recommendations for treatment, and they are definitely willing to invest in a procedure that they value and as long as it is comfortable for them. If the patient's experience with the laser is positive, then it will invite more references in using it. In short, lasers can enable dentists to make better quality dentistry. Awareness of the different laser wavelength types and laser parameters will encourage clinicians to explore a wider range of research. Courses at various levels of intensity, subject matter and complexity about lasers will be promoted more frequently at scientific conferences in dentistry.

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REVIEW

Benefits of eggshell reinforcement in water sorption and color stability of heat-cured polymethyl-methacrylate provisional fixed partial dentures

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Keywords: Color stablity, Eggshell, provisional fixed restoration, PMMA, Water sorption

ABSTRACT

Oral rehabilitation procedures such as crown lengthening, implants for anterior teeth, and endodontic procedures with limited tooth structure require provisional restoration for a long time. The material used in fabricating provisional fixed partial dentures is polymethyl-methacrylate (PMMA). PMMA is divided into heat cured and self-cured based on the polymerization. Heat-cured PMMA has better mechanical properties than self-cured PMMA. Despite its advantages, however, there are also some disadvantages, such as high water sorption, low color stability, and wear of use. Research on the use of eggshells as reinforcement in denture bases has been conducted. However, the use of eggshells in provisional fixed partial dentures has not been done yet. Eggshell, as an environment byproduct waste material, is composed of 95% calcium carbonate ($CaCO_3$), magnesium, potassium, and other inorganic components, can be used as alternative natural reinforced materials for PMMA provisional restoration. To describe use of provisional restoration for a long time, PMMA as provisional restoration material, as well as the merit of eggshell as natural reinforcement material in water sorption and color stability of heat-cured PMMA provisional fixed partial dentures. Eggshell, which is composed of calcium carbonate, can be converted into hydroxyapatite as a reinforcement in long term provisional restoration, could improve the physical properties of heat-cured PMMA, such as water sorption and color stability. (IJP 2024;5(1):14-17)

INTRODUCTION

According to the Glossary of Prosthodontic Terms, provisional or interim or transitional prosthesis or restoration is a fixed or removable dental or maxillofacial prosthesis designed to enhance esthetics, stabilization and/or function for a limited period of time, after which it is to be replaced by a definitive dental or maxillofacial prosthesis.[1] Fixed denture prosthesis (FDP), as in post-tooth preparation; especially involving multiple teeth, either full or partial closure, in crown lengthening, implants, and certain cases of endodontic restoration, such as post use, provisional FDPs are used for a relatively long period of time (6-12 weeks), whereas provisional FDPs are designed to test esthetics, phonetics and function before being replaced by a definitive restoration.[2-6]

Provisional FDP must have characteristics that are similar to the form and performance of the anticipated permanent restoration, including good marginal adaptation, sufficient strength to bear masticatory loads, longevity, and color stability with prolonged use.[3,7-8] Different kinds of polymers are regularly employed as provisional FDP materials, with polymethyl-methacrylate (PMMA) being the most widely utilized form.[7-10]

PMMA has the benefits of being easy to manipulate, inexpensive, available in various colors, and aesthetically pleasing.[9] However in addition to its benefits, PMMA also has a number of drawbacks, such as the tendency to release heat when it cures, its porosity, shrinkage, susceptibility of fracture, wear with use, water absorption, and poor color stability.[9,10]

The quantity of monomer residue in the denture has an impact on water absorption. The water absorption property occurs due to the molecular polarity, which causes expansion of PMMA and affects the dimensional stability. According to ISO 20195-1, the PMMA water absorption value should be less than 32 g/mm3.[10] PMMA not only absorbs water but also has a poor color stability that is affected by both intrinsic and external factors.[10-12] Due its porous nature and lack of flexural strength, PMMA is susceptible to fracture when subjected to occlusal loads and should be taken into consideration for long-term use.[13]

In order to strengthen PMMA for long-term use and overcome the limitation of PMMA, reinforcement materials are frequently

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added to PMMA.[14] Both synthetic and natural materials may be utilized as reinforcement.[15] Natural materials, namely eggshell, have a high CaCO3 content (90.9%), making them a viable source for biocompatible biomaterials.[14,16] Additionally, using eggshell has other benefits including being inexpensive, simple to get, and making environmentally friendly products.[14]

The purpose of this article is to explain the benefits of eggshell reinforcement in water sorption and color stability of heat-cured polymethyl-methacrylate provisional fixed partial dentures.

LITERATURE STUDIES

Provisionl Fixed Partial Dentures (FDPs)

Provisional or temporary dentures, according to the Glossary of Prosthodontic Terms, are fixed or removable restorations intended to enhance the appearance, stability, and/or function of the teeth for a brief period of time before being replaced by permanent restorations.[1] In dentistry, temporary/provisional/interim restorations are frequently utilized while teeth are being prepared and while waiting for permanent restoration.[2]

The Role of FDPs

Provisional FDP is designed to protect the tooth or abutment from the oral environment, maintain contact with the adjacent and antagonistic teeth, monitor patient comfort and satisfaction, allow adjustments to be made as needed, support function and esthetics for a certain period of time, which will later be replaced by definitive prostheses.[2-6] Provisional FDP focuses on protecting the pulp, maintaining the health of the periodontal tissues, promoting tissue healing to achieve an acceptable profile, evaluate oral hygiene procedures, preventing abutment migration, managing the patient's psychological needs, providing an adequate occlusal scheme, and assessing the maxillomandibular relationship; therefore, provisional FDP should be taken into account similar in shape and purpose to the patient's intended, long-term rehabilitation.[4]

Provisional FDP Terms

Numerous short- and long-term applications of provisional FDP are possible, including the construction of long- and short-span bridges, endodontic treatments, crown lengthening, and comprehensive oral rehabilitation techniques such implant placement and occlusal splinting.[7,12] According to Shillingburg, provisional fixed dentures must meet the requirements in the form of being able to protect the pulp, prevent supraeruption or tipping of the tooth, provide a good occlusive function for the patient, easy to clean, can withstand occlusal loads, retentive, aesthetically pleasing, can be polished to prevent plaque accumulation as well as the surrounding areas, and the margin area does not interfere with the gingival tissue which can stimulate gingival pathology.[7] Biological, physical, and mechanical factors must be taken into account when choosing materials for provisional FDP. These factors include material biocompatibility, strength, stiffness, repairability, polymerization's ability to release heat, shrinkage, marginal integrity, and color stability.[17] Notably in long span fixed partial dentures (FPD), long-term oral rehabilitation, and in patients with parafunctional habits, materials for provisional fixed dentures must have sufficient strength to withstand masticatory loads.[7] FDPs used in the aesthetic field must have good color stability, which is influenced by the patient's tions, in addition to the resin's chemical properties. The color stability of the material is crucial for maintaining the patient's aesthetics and psychological impact in comprehensive oral rehabilitation procedures like all-on-4 implants, where provisional FDP is only replaced after 4-6 months.[18] There is no single material that meets all of the requirements for the construction of provisional FDPs.[16] However, commonly used and accepted materials are polymethyl methacrylate (PMMA), polyethyl methacrylate, polyvinyl (ethylmethacrylate), bisphenol A-glycidyl methacrylate resins, bis-acryl composite resins, and light-cured urethane-dimethacrylate resins.[7,10,17]

Polymethyl-methacrylate (PMMA)

Various types of polymers are commonly used for various dental applications, of which the most commonly used material is polymethyl methacrylate (PMMA). Based on its polymerization properties, PMMA is divided into self-cured, light-cured and heat-cured. Light-cured PMMA has slightly inferior mechanical properties to conventional PMMA, its use is limited to the manufacture of physiological impression trays and full denture base plates. Compared to heat-cured PMMA, self-cured PMMA has a lower polymerization rate, leaving more residual monomer, which can affect mechanical properties such as strength, hardness, and discoloration of the denture. Heat-cured PMMA has better mechanical properties. The main objective of the heating cycle is to obtain a higher degree of polymerization and reduce the monomer residue on the denture.[10] PMMA has several advantages, including its ease of manipulation, low cost, availability in a variety of colors, and aesthetics.[9] In addition to the benefits of using heat-cured PMMA, this PMMA material has several drawbacks, including porosity, shrinkage, easy to fracture, absorbing liquid, low color stability, and wear over time.[9,10]

Water absorption and color stability of PMMA

Water absorption occurs in PMMA in a humid environment. This is due to the nature of PMMA, which absorbs water. Water absorption occurs as a result of the separation of weak polymer chains, which results in a diffusion process involving water molecules.[19] Water absorbed by PMMA acts as a plasticizer, allowing softening, discoloration, and a decrease in PMMA mechanical properties such as hardness, transverse strength, and fatigue threshold, resulting in dimensional changes in PMMA. Furthermore, extrinsic and intrinsic factors influence the color change in PMMA. Extrinsic factors influence color adsorption and absorption from exogenous materials, such as oral hygiene, surface roughness of restorations, diet, and regular consumption of various beverages such as coffee, tea, soft drinks, and alcohol; while intrinsic factors are influenced by characteristics of the resin itself, such as incomplete polymerization, the presence of residual monomers, and the presence of porosity in PMMA[10-12]

Reinforced Materials

Various studies have been conducted in an attempt to overcome PMMA's shortcomings, such as by adding reinforcing materials.[20] Reinforcing materials can be derived from synthetic or natural materials. Natural materials have the advantages of being inexpensive, dense, renewable, biocompatible, and versatile.[15] Natural reinforcing materials that can be added to PMMA include pistachio shells, bamboo, coir, husks, crab shells, shrimp shells, egg shells and so on.[15,21,22] The combination of two or more materials to obtain superior material properties forms a composite. Matrix as a polymer resin is merged with a filler as a reinforcement medium to form the composite polymer matrix.[23] Due to the combination of the most desirable properties of the component materials, composite materials produce better and unique properties. Particle-reinforced composite polymer matrices are commonly used, resulting in a simpler and less expensive preparation method than fiber-reinforced polymers.[24]

Chicken Egg Shell

Chicken eggshell is a type of kitchen waste. In many countries, eggshell is wasted, which has a negative impact on the environment.[16,25] Eggshell waste can be recycled, reused, and distributed to make a valuable product.[18] Eggshell has been used as a calcium and trace element source, as well as a source of magnesium, boron, copper, manganese, sulphur, and zinc.[14,25] Eggshell is a material that is easily obtained and can be used as a filler material that is affordable and relatively simple to process into a variety of different products.[24]

Structure of Eggshell

Three layers make up a fresh eggshell: a ceramic-like frothy cuticle layer on the outside, a spongy middle layer, and an inner lamellar layer that makes up 11% of the weight of the entire egg.[23] Eggshell has the potential to function as a biocompatible biomaterial due to its high calcium carbonate content (94%), also known as calcite.[14,21,25] In the inner layer of the cuticle, hydroxyapatite (HAp), which resembles tiny needles, coexists with calcite, the most stable form of $CaCO_3$. Calcite is a component that improves the mechanical properties and strength of eggshell-based hydroxyapatite.[22]

$Ca_{10}(PO_4)_6(OH)_2$, often known as hydroxyapatite (HAp), is a bioactive and biocompatible substance. HAp can be produced from a variety of biological calcium sources, including eggshell, snail, crab, and other shells.[22] In terms of hardness, density, and cell culture, HAp synthesized from eggshell has better sintering ability than HAp synthesized from other sources. The fact that eggshell HAp resembles human hard tissue contributes to its high quality.[25]

DISCUSSION

Heat-cured acrylic is created by combining heat activation and compression molding of PMMA, resulting in a homogeneous mixture of materials that is bubble-free and has a higher resistance than other materials.[10] Heat-cured acrylic is recommended for periods longer than one month due to its hardness and functional stability.[26] Karadi HR et al. (2017) investigated the addition of nanohydroxyapatite filler on heat-cured PMMA acrylic base. According to the research, adding 2% Hap nanoparticles increased impact strength and surface hardness, but there was no visible change in water absorption. Comparing the filler group to the control group, surface roughness enhanced, but it remained within the range of values less than 2μm.[27]

Hartini VO et al. (2021) investigated chitosan as a coupling agent in the addition of rice husk nanocellulose material to heat-cured PMMA material. The results of the PMMA study with the addition of 3% chitosan had the lowest water absorption (15.54 ± 3.48 m/mm3). PMMA without chitosan had the lowest water absorption value at 32.85 ± 4.82 m/mm3. There was a significant difference in the water absorption of the two groups ($p<0.05$).[19] Perchyono VT et al. (2019) looked into the surface roughness and color stability of bisacrylic resin with chitosan and nanodiamond reinforcement. According to the study, both chitosan and nanodiamond on bisacrylic resin improved color stability ($p=0.007$).[28]

Kohli et al. (2017) compared the discoloration of PMMA and bis-acrylic provisional FPD in artificial saliva, artificial saliva and tea, artificial saliva and coffee, artificial saliva and orange juice, and artificial saliva and cranberry juice before, after, and after 1 month of immersion. According to the findings, the color change increased with the length of immersion time. PMMA withstands discoloration better than bis-acrylic resins. The artificial saliva and coffee solution showed unacceptable discoloration after 1 month of immersion.[11] Kontanidis A et al. (2019) investigated the discoloration of provisional FDPs of PMMA resins with silica reinforcement and found that the addition of 0.25% silica (SiO_2) nanoparticles affected the optical properties of PMMA resins without being clinically apparent.[29]

Onwubu SC et al. (2017) investigated eggshell as an abrasive, where 50-nm and 0.3-μm particles were shown to produce good polishing surfaces.[16] Abdulrahman et al. (2020) used calcium carbonate from eggshell to produce hydroxyapatite, which is used in bone and dental treatment. He stated that the use of hydroxyapatite from eggshell and nanohydroxyapatite can reduce treatment costs in bone repair or bone replacement and reduce waste to protect the environment.[23]

In the study by Lubis M et al. (2017), the denture bases mechanical properties were improved by the incorporation of 10% Chicken Eggshell material. The modulus of elasticity (MOE) and modulus of rapture (MOR) of the biocomposite increased with the addition of eggshells, from 1,933 GPa to 2.124 GPa at 10% filler and 46,864 MPa to 48.311 MPa at 20% filler.[14] According to Lubis M et al. (2021) studies, the addition of chicken eggshell nanoparticles to the acrylic resin denture base improved the mechanical properties of the biocomposite base. The Modulus of Elasticity (MOE) and Modulus of Rapture (MOR) increased, reaching maximum values of 2,571 GPa and 48.859 MPa, respectively. When compared to the addition of 30% filler, the addition of 10% filler is desirable.[21]

Al-Bahar ZJH et al. (2014) extracted hydroxyapatite from chicken eggshell in their study. Hydroxyapatite is produced by heating $CaCO_3$ in chicken eggshell material to 900°C and then adding H_3PO_4 (phosphoric acid). The mechanical strength of the denture base significantly increased when chicken eggshell hydroxyapatite was added to heat-cured acrylic resin.[30] Fouly A. et al. (2021) investigated the effects of adding hydroxyapatite to PMMA nanocomposite for making denture bases. Hydroxyapatite nanoparticles having weight fractions -

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of 0, 0.2, 0.4, 0.6, and 0.8 % were employed in the study. The findings demonstrated that the stiffness, compressive yield strength, toughness, ductility, and hardness of PMMA nanocomposite will increase with increasing hydroxyapatite content.[31]

Abdullah AM et al. (2020) using treated eggshell powder with PMMA. PMMA wear was reduced by approximately 57% with an increase in the fraction of treated eggshell powder of up to 5% wt. Additionally, it was discovered in this investigation that when the eggshell concentration in PMMA composites increased, the flexural modulus value gradually increased.[23]

CONCLUSION

Provisional FDPs made of heat-cured PMMA must be strong enough to support occlusal loads and aesthetically pleasing during use for long periods of time. Various attempts have been made to overcome the drawbacks of the long-term use of PMMA, such as the addition of reinforcing materials to improve the physical and mechanical properties of FDP's materials. It is reasonable to anticipate that adding eggshell to the FDP reinforcement of heat-cured PMMA will improve color stability and reduce the water absorption nature.

SUGGESTIONS

Further research on the addition of eggshell reinforcing material is required to determine the relationship between physical properties like water absorption and color stability in heat-cured PMMA.

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REVIEW

Role of laser power and focus diameter in increasing retention of metal porcelain fixed dentures with short clinical crowns

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Keywords: Fixed denture, Laser, Shear bond strength, Short clinical crown, Surface roughness.

ABSTRACT

In teeth with short clinical crowns that will be used as a support for metal porcelain fixed dentures, the problem that often occurs is that the dentures easily fall off after being installed. Surface treatment is one of the efforts to increase retention. Advances in laser technology provide advantages in increasing microstructural and wear resistance on the metal surface of the crown that will be used as abutment teeth. In addressing the retention problem of short clinical crowns, modification of tooth preparation, casting, and proper cementation procedures need to be considered. Improving the mechanical properties by surface treatment of the dental crown to be cemented by modifying the strength and focus of the laser diameter can play a role in surface roughness and shear bond strength. The use of lasers to increase microstructural and wear resistance in teeth with short clinical crowns can minimize the failure of making metal porcelain fixed dentures. (IJP 2024;5(1):18-23)

INTRODUCTION

In teeth with short clinical crowns that will be used as metal porcelain fixed dentures, the problem that often occurs is that the dentures easily fall off after being installed. A short clinical crown in this case is defined as a crown wall height of less than 2 mm in tooth preparation that will be used as a fixed denture abutment.[1] Aesthetic success and adequate dimensions in short clinical crowns that will be used as abutments are difficult to determine. If done, complex planning and procedures are needed.[1,2] Factors that play a role in the success of fixed dentures are biological, mechanical, and aesthetic factors.[3] According to Prasad (2017) 27 % of failure of fixed partial denture is retention, which is influenced by improper preparation, short proximal walls, lack of resistance form, surface area, surface roughness of the material to be cemented, and the cementation material.[1-4]

Improving the mechanical bond and chemical bonding between the tooth and the restorative material with a surface treatment procedure before the cementation procedure can be performed to increase retention and resistance.[4-5] Advances in laser technology in improving surface treatment procedures provide advantages in increasing microstructural, friction, fatigue, wear resistance, and reducing corrosion on the metal surface of the crown to be used as abutment teeth.[7] It is known that surface treatment uses an laser produces a more stable surface than using other techniques commonly used in surface treatment procedures.[5] Surface treatment using laser is known to increase microhardness and wear resistance on metal surfaces as well as surface roughness which affects the surface roughness and shear bond strength of clinical crowns of fixed dentures.[7]

The purpose of this paper is to examine the role of strength and focal diameter of laser surface treatment on retention in the manufacture of metal porcelain fixed dentures with short clinical crowns.

LITERATURE STUDIES

Successful Factor in Preparation Fixed Partial Denture

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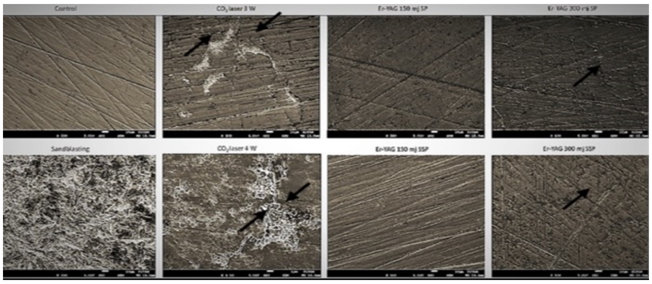

Figure 1. Surface roughness using sandblasting and laser (measurement with SEM).

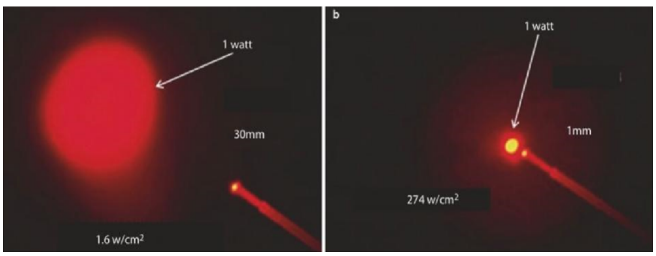

Figure 2. Laser.

Visible light systems[18]
- Argon laser—488 nm/514 nm
- Frequency double Nd:YAG laser/Potassium titanyl phosphate (KTP)—532 nm
- Low level lasers
  - Photobiomodulation—600-635 nm
  - Caries detection—655 nm

Infrared systems
- Diode lasers—800-1064 nm
  - Aluminium Gallium Arsenide—810 nm
  - Gallium Aluminium Arsenide—940 nm
  - Indium Gallium Arsenide—980 nm
  - Indium Gallium Arsenide Phosphate—1064 nm
- Neodymium doped Yttrium Aluminum Garnet (Nd:YAG lasers)—1,064 nm
- Erbium—Chromium doped Yttrium Scandium Gallium Garnet (Er:Cr:YSGG)—2,780 nm
- Erbium doped Yttrium Aluminium Garnet (Er:YAG lasers)—2,940 nm
- Carbon dioxide (CO_2 lasers)—9,300 nm and 10,600 nm.

Figure 3. Classification of the laser beam.

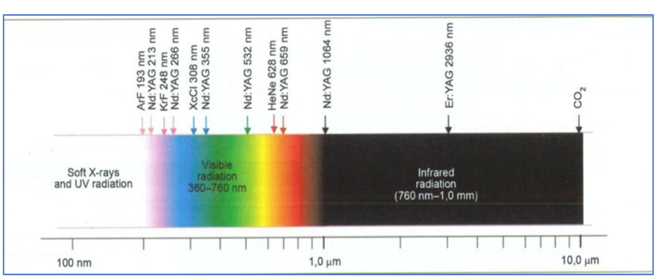

Figure 4. Classification of laser beam by power.

Table 1. Comparison of laser surface treatment and sandblasting.

Testing specimens	Bonding load	Bonding strength (MPa)
Laser textured Ni-Cr	38.245	80.316*
Sandblasted Ni-Cr	36.529	74.230*
Laser textured Ni-Cr-Ti	37.673	77.206*
Sandblasted Ni-Cr-Ti	37.625	76.393*

*Mean value were not significantly different (P>0.05)

Several principles that determine the success in making fixed dentures so that restorations become retentive, and last a long time, including.[3] Biological considerations: factors affecting oral tissue health which include conservation of tooth structure, avoidance of over contouring, supragingival margins, harmonious occlusion, and protection against tooth fracture; Mechanical considerations: factors affecting the integrity and durability of restorations; Aesthetic considerations: factors that affect the patient's appearance.

Mechanical considerations are the factors that determine the retention and resistance of a fixed denture.[3] In short clinical crowns as abutments, and mechanical factors in this case retention are difficult to obtain and become a problem that can hinder the success of making fixed dentures.

Short Clinical Crown

A short clinical crown was defined as a tooth with a crown height of less than 2 mm, on parallel walls remaining after occlusal and axial reduction. The causes of short clinical crowns are diseases and abnormalities in the teeth (caries, erosion, dental malformations), trauma (broken teeth, attrition), iatrogenic factors (reduction of excess teeth, large endodontic access openings), disharmony eruption, exostosis, and genetic variations. in the shape of the teeth. Things that must be considered before performing treatment on short clinical crowns include consideration of dental arch position, periodontal considerations, crown-root ratio, and occlusion. feasibility of endodontic treatment, and aesthetics.[1]

Treatment for short clinical crowns includes changes to the tooth preparation design and placement of retention features, additional forms of resistance, The addition of a foundation to the teeth, surgical crown lengthening, orthodontic eruption, endodontic treatment, and placement of removable partial denture overlays. An appropriate comprehensive treatment plan is needed to address the problems posed by short clinical crowns. The addition of a clinical crown can be done by placing a subgingival margin, but if the restoration margin exceeds the biological width, it can interfere with the health of the periodontal tissue. To evaluate the clinical crown height, visual examination, radiographic examination, and analysis of diagnostic models are required.[1] Adequate clinical crown height is required to increase retention in the fabrication of fixed dentures.[12]

Factors affecting crown retention and resistance form in short clinical crowns were crown lengths, degree of occlusal convergence, axial surface area, and the relationship between axial wall height and tooth preparation area. Secondary forms of retention and resistance can come from the manufacture of boxes, grooves, or pins placed on the abutment tooth structure.[1,8] Crowns on short tooth preparations have a greater displacement tendency than tall crowns in the axial wall region.[8]

Factors that can affect retention are grouped into three categories, namely the modification of the tooth preparation, casting procedure, and cementation procedure.[6] In the modification of the tooth preparation, the things that affect the surface area, the height of the crown of the prepared tooth, the convergence of the preparation walls, the texture of the surface of the prepared tooth, intracoronary retentive device.

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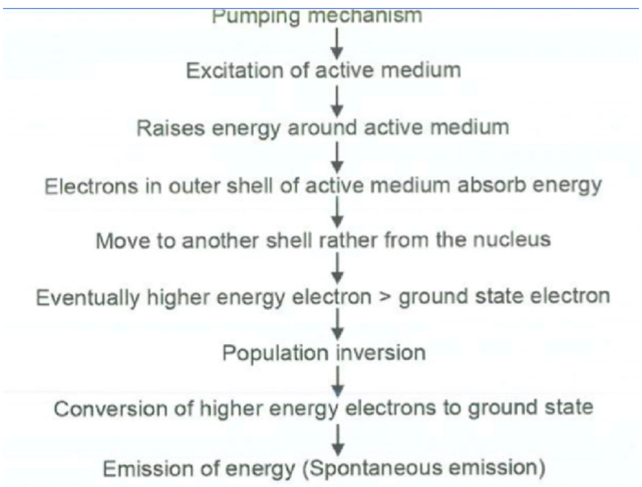

Figure 5. Laser beam production procedure.

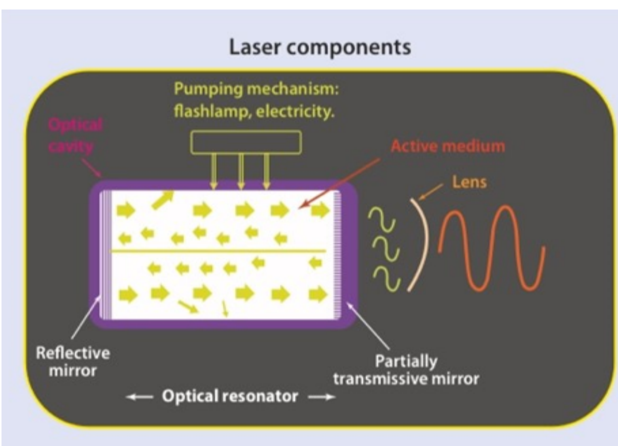

Figure 6. Laser tool projection.

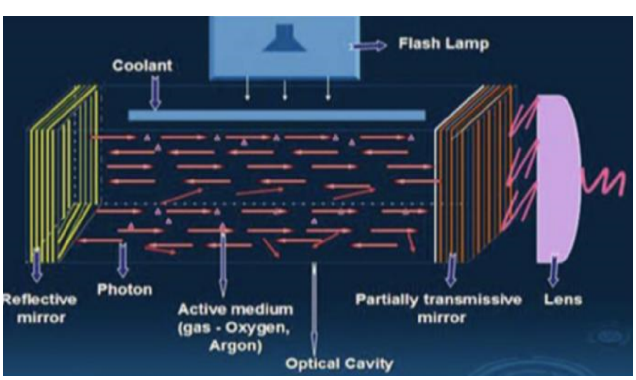

Figure 7. The basic components of a typical laser cavity.

The retention denture crown casting procedure includes the relative adaptation factors of the casting material to the prepared tooth surface, the internal surface texture of the casting, the effect on the retention of each of the restored and cemented castings together, and the strength properties of the cast metal material. While in the cementation procedure, retention is influenced by the type of cement, the casting surface variations in cement viscosity, setting force, duration of force, the time lapse between procedures cementing and removal of denture crowns, angle unseating force, the magnitude of force release (magnitude of the lever arm of the unseating force), the magnitude of the compressive strength, shear strength, surface roughness.[6] Surface treatment procedures before the cementation procedure alone are known to increase the retention of 64% of castings.[5-6] Surface roughness in the surface treatment procedure before cementation itself is known to increase the retention of 64% of the casting.[5-6]

Surface Treatment

Surface treatment in the manufacture of dentures is a procedure to change the mechanical properties of a restorative material which will later be used as a clinical crown in manufacturing dentures. There are several methods commonly used in surface treatment, including hydrofluoric acid etching, airborne particle abrasion, and using diamond burs and lasers.[5] With advances in laser technology, it is used as an alternative in increasing the surface roughness and increasing the mechanical bond between the clinical crown surfaces of dentures and teeth.[5-7] In the laser surface treatment procedure used is erbium; yttrium aluminum garnet. (Er: YAG) because it has good wavelength synchronization and absorption.[10,15] Laser works by using parameter control including laser power, focus diameter, pulse direction, and pulse frequency. The presence of parameters is the key to success and laser control works by increasing the mechanical and metallurgical properties of the surface area.[7,16,17]

The surface treatment procedure using sandblasting air abrasion in terms of surface roughness produces a rougher surface area than the use of a laser. However, the sandblasting procedure produces a uniform surface roughness and some particles can contaminate the metal surface Figure 1.[9] The following are the results of the SEM surface area examination after surface treatment using sandblasting and laser.

The bonding strength of metal using a laser has advantages over sandblasting. Surface treatment using sandblasting has a rougher surface but lower bonding strength Table 1. The following is a comparison table of bonding load and bonding strength of laser and sandblasting surface treatment.

In some cases, excessive surface roughness in the use of sandblasting can cause fractures, especially in the transgranular and intergranular interface areas in porcelain.[9] To overcome this problem, it is necessary to have a surface modification using a laser which produces a better surface and can increase the strength of the matrix and affect the bonding strength.[9]

Laser

A laser is a device that produces a very narrow and intense beam of light energy (electromagnetic radiation) through a process called emission stimulation. Albert Einstein is the developer of the laser theory. He was the first to coin the -

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term “Stimulated Emission” in his publication “Zur Quantentheorie der Strahlung”, published in 1917 in the “Physikalische Zeitschrift”.[9-11] Laser is an acronym for Light Amplification by Stimulated Emission of Radiation. In prosthodontics, the use of lasers has advantages, namely more precise results, faster healing time, has advantages in coagulation factors, besides that the laser also has convenience in use for patients efficiently delivering wavelengths.[10,11]

Currently, many laser systems are available for dental use including Neodymiumdoped: Yttrium Aluminum-Garnet (Nd: YAG), carbon dioxide (CO2), and semiconductor diode lasers which have been approved by the United States Food and Drug Administration for the treatment of soft tissues in the oral cavity.[9-14]

Laser Type and Classification

The types of laser beams can be classified as follows[13]

Laser Components

Lasers are straight and always the same regardless of the type of equipment. The laser consists of an active amplifying medium in the optical cavity (resonator) and a pumping source (energy source). The optical cavity consists of two mirrors placed on either side of the laser medium. Due to this arrangement, the photons generated from the stimulated emission will form a continuous avalanche process. As long as the pumping energy maintains the population inversion in the active medium, more stimulated photons are generated thereby generating energy. The energy is absorbed and emitted in the resonator and with the help of the mirror, is reflected and resonates within this space, and finally produces a laser beam. The light energy is converted into heat energy, which is cooled locally.[9,12]

The following is the procedure for the formation of a laser beam and the projection of light from a laser device: The laser component consists of Figure 6.

Active medium: the core of the laser device, can be in the form of crystal crystals (Er; YAG), solid semiconductor (diode laser), or gas canister (CO2 laser); Pumping mechanism: the transmitter source can be a flash, an electrical circuit, or a coil. Where the excitation source pumps energy around the active medium and generates electrons which absorb energy and convert it into lower energies, then produce progressive amplification of the emitted energy emitting a laser beam; Optical resonator: consists of two mirrors placed at each end of the laser chamber which are placed parallel or opposite. These mirrors are called optical resonators because they reflect waves and allow laser light to be projected from the laser emitting device.

The basic unit of energy is called the photon. The photon waves generated by the laser can be defined by measuring the velocity (the speed of light), the amplitude includes the speed of the light intensity in the wave, the total height of the wave from the top of the peak to the bottom of the vertical axis (the greater the amplitude, the greater the laser work), the wavelength (the distance between two corresponding points on the wave on the horizontal axis).[12,13]

Laser Characteristics

There are several characteristics of the laser.[12] Monochromacy: the laser has one specific color/single wavelength Collimation: has a spatial boundary that ensures a constant size of the beam emitted from the laser device; Coherency: the light waves produced by the laser device have identical waveforms. Efficiency: low average power can be used to perform specific functions.

Benefits of Laser in Prosthodontics

Other benefits of lasers used in prosthodontics.[14] Complete denture: Prototyping and CAD/CAM (Computer-Aided Design and Computer Aided Manufacturing) technology; occlusion analysis with CAD/CAM; analysis of printing accuracy using a laser scanne; Fixed partial denture: tissue management; crown preparation; Removable partial teeth: laser welding; Dental implants: soft tissue Surgery; implant surface debridement; implant surface treatment; Maxillofacial: sintering with CAD/CAM technology in the manufacture of wax pattern maxillofacial prosthesis.

Advantages and Limitations of Using Lasers

The advantage of using lasers is that they are efficient in reducing processing time, more precise results can be achieved, minimal heat input, chemical cleanliness, and surface treatment procedures are effective in improving mechanical properties, microhardness, and wear resistance.[7] While the limitations of using lasers are the need for additional training and education for the clinical use and type of laser, the high costs involved in equipment purchase, technology application, and equipment investment, more than one laser may be required as different wavelengths are required for different procedures.[14]

DISCUSSION

The manufacture of fixed dentures with short clinical crowns for gaining retention and resistance is difficult and a factor of greatest failure of the restoration.[1,2] several factors must be considered in increasing the success of fixed dentures with clinical crowns including the design of the tooth preparation, the addition of additional retention in the form of pins and groove casting procedure as well as proper cementation procedure.[3] According to Sharma et al. (2012) when the clinical dimensions of the denture crown are inadequate, the success of the tooth will be high both aesthetic and biological imitation is difficult to achieve.[1] A proper treatment plan is required complex and appropriate procedures to increase the success of treatment in the short clinical crown. Meanwhile, according to Shujaulla et al. (2020) the main failures in the manufacture of fixed dentures are poor denture design, inadequate tooth preparation, and poor biomechanical application.[18] There is a difference in retention in the manufacture of crowns with a height of 2.5 mm and 3.5 mm. The higher the clinical crown height, the greater the retention obtained.[19]

Short clinical crowns that can complicate the mechanical preparation of abutments in the manufacture of fixed dentures are caused by several things, including; caries, erosion, dental malformations, trauma factors such as tooth fractures, attrition, iatrogenic (excessive reduction of teeth after endodontic treatment), disharmony eruptions, exostosis, and genetic factors. The over-preparation of short clinical crowns can reduce the supporting structures of the teeth and harm the supporting tissues. The prosthodontist must maintain the concept of minimal tooth preparation, slope the tooth preparation wall parallel to 6^0, eliminate, undercuts and must

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have a one-way attachment to the fixed denture abutments. The presence of other factors that can cause fracture of the short clinical crown should also be considered, such as parafunctional trauma and bruxism. Pressure on mastication and habit parafunction can lead to a short clinical crown with poor retention of the manufacture of fixed dentures is easy to fall off and fractures occur after being installed.[1]

Treatments that can be performed on short clinical crowns include placement of the subgingival margin in tooth preparation, orthodontic treatment, and crown lengthening procedures to obtain an adequate height for the crown of the tooth to be prepared. However, chronic inflammation of the gingiva due to preparations that exceed the biological width at the time of placement of the subgingival margin and inadequate interocclusal space in orthodontic treatment can make it difficult to increase the height of the clinical crown length in some cases. Although crown lengthening procedures are more effective in increasing the height of short clinical crowns, it may take at least 6-12 weeks for periodontal tissue to heal before restorative procedures can be performed. There are anatomical limitations inadequate tooth furcation and proximal areas are difficult for reduction of bone in the apical area of the tooth to be crown lengthened and abutment tooth preparation.[5]

In an abutment preparation procedure for the manufacture of fixed denture restorations, the denture crown must have adequate height while reducing the incisal and occlusal areas to achieve retention. Meanwhile, in short, in clinical crowns, the presence of inadequate height during preparation for abutment teeth can hinder the success of making dentures so complex procedures are needed, namely modifying tooth preparation, casting, and proper cementation procedures to obtain mechanical retention and chemical bonding in tooth fabrication. fixed denture with a short clinical crown.[1,5,6]

To improve the biomechanics of chemical bonding, the roughness of the intaglio metal surface of the fixed denture crown is needed. The mechanical and chemical bond formed between the metal surface and the tooth is obtained by modifying the strength with a surface treatment procedure. The surface treatment procedure is known to significantly increase the surface roughness and shear bond strength.[1,5,7,20-23] Many methods are used in carrying out surface treatment procedures, one of which is using a laser.[7,24]

Laser is a straight beam exposure produced from a device that is generated from an energy source through a resonator. Optical consists of two pieces of glass that reflect light that comes from exposure to energy sources that are reflected through a resonator Figure 7. According to Khansaa et al. (2011) mechanical test trial laser surface treatment done with different powers 2.7, 3.3, and 4.3 watt, laser power 4.3 watt obviously improve the mechanical properties on CK45 steel compared with other watt power and decreased far from the surface.[7] Lasers have highly intensive, monochromatic, coherent, and highly polarized light waves. Laser procedures work include laser surface melting, surface alloying, cladding, and amorphization processes.[17,25,26] According to Aziz et al. (2020) the effect of laser parameters such as laser energy, and focus diameter has an influence on the microhardness of the metal surface in the surface treatment procedure.[7] Laser surface treatment is effective in increasing the bond strength - of metal surfaces with ceramic materials in alloy recycling procedures.[24] There are effects on corrosion, yield strength, surface hardness, and flexural strength which affect changes in mechanical properties in the form of macrostructural and porosity in metal alloys seen in the scanning electron microscope (SEM) procedure.[7]

Surface treatment increases the bond strength between the metal crown and the cementitious material. However, several journals state that there is no significant difference in surface roughness with metal-ceramic on bond strength. It was also reported that the presence of intaglio surface roughness can reduce the bond strength of the metal-ceramic surface.[27,28]

CONCLUSION

The use of lasers to improve mechanical properties such as microhardness and wear resistance on teeth with short clinical crowns can minimize failure in the manufacture of fixed metal dentures with short clinical crowns. Laser has advantages compared to the use of other methods commonly used in surface treatment procedures.

Some parameters can be used to generate energy including strength and focal diameter. Lasers have the advantages of using low power in the heat treatment procedure, being fast in the cooling process, and producing a clean and uncontaminated surface area to increase the surface roughness and shear bond strength of the metal surface of the clinical denture crown.

SUGGESTIONS

Surface treatment procedures using lasers must be accompanied by clinical examination, diagnostics, and appropriate treatment plans and must take into account other factors considered in increasing retention, especially in short clinical crowns. To avoid any risks that may occur when using lasers, doctors should have knowledge and training before using laser tools.

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REVIEW

The role of intraoral abrasion pressure with alumunium oxide on the bond strength of resin cement in adhesive bridge restorations

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Keywords: Adhesive bridge, Adhesive resin cement, Intraoral abrasion, Alumunium oxide, Water airborne abrasion.

ABSTRACT

Adhesive bridge is a fixed denture with minimal abutment preparation attached with resin cement. Exposure of the dentin during preparation in the posterior region causes frequent detachment of the adhesive bridge. This is due to the presence of fluid and changes in the smear layer on the dentinal tubules, to increase bond strength, the intraoral abrasion method was developed. Intraoral abrasion is a mechanical technique using air and water sprays to produce tooth surface roughness while increasing bond strength without damaging the tooth structure. One of the intraoral abrasion materials used is aluminum oxide (Al2O3). One of the operating parameters of intraoral abrasion that can affect bond strength between resin cement and the tooth surface is pressure. Optimal intraoral abrasion pressure with Al2O3 and the right type of resin cement aims to create tooth surface roughness while increasing the bond strength of resin cement in adhesive bridge restorations. The success of adhesive bridges, especially in the posterior area, cannot be separated from the role of optimum intraoral abrasion pressure on the tooth surface. The correct use of intraoral abrasion pressure can increase the bond strength of resin cement on the tooth surface while reducing tooth structure damage. (IJP 2024;5(1):24-28)

INTRODUCTION

An adhesive bridge is a fixed denture with minimal preparation of the enamel of the abutment teeth attached with adhesive resin cement.[1] The success of an adhesive bridge restoration is influenced by several factors. The condition of the abutment teeth and the cementation procedure are factors that often lead to the failure of restoration attachment to adhesive bridges. Restoration attachment failure occurred due to exposure of dentin during the preparation of posterior abutments. Exposure to dentin causes a reduction in the adhesive strength of resin cement on the tooth surface. This is due to the presence of dentin composition that can affect the bond between the resin cement and the tooth surface.[2-4]

The cementation procedure for adhesive bridge restorations uses conventional and latest-generation resin cement. Conventional resin cement is divided into two which are total etch and self etch. The total-etch system can cause discoloration of the marginal tooth structure and post cementation procedure sensitivity.[5] So that a one-step system cement was developed, known as self-adhesive resin cement. However, self-adhesive resin cement has lower adhesive strength to enamel and dentin than conventional resin cement.[6] Currently, a pre-treatment procedure on the tooth surface is being developed before the cementation procedure known as the intraoral abrasion technique.[6-9]

Intraoral abrasion is a procedure that sprays abrasive particles at high speed to form roughness and lift debris on the tooth surface with the spray of water and air. Some of the operational parameters are nozzle size, pressure, time, distance, flow, and contact angle. One of the important parameters in this technique is pressure. This is supported with a study by Chan Te Huang et al; 2019, where intraoral abrasion with a pressure of 60 psi or ± 4 bar can increase the adhesive strength of conventional and self-adhesive resin cement on enamel or dentin.[9] However, there is no study to determine the optimal parameter values in the restoration procedure of adhesive bridges.

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LITERATURE STUDIES

Adhesive Bridge

An adhesive bridge is a fixed denture that is attached to the enamel after an etching procedure with the aim of increasing the bond strength of the resin cement by a micromechanical method.[1-2]

Factors affecting the success of an adhesive bridge

Some of the success factors for restoration are case selection, adhesive bridge design, and clinical expertise.[3-7]

Selection of patient cases; Some factors in terms of patient case selection that must be considered.

General factors of the patient; Common factors for the patient are age, systemic history, patient preference, oral hygiene, and the number of teeth to be replaced. This is related to the indication of an adhesive bridge to replace a missing tooth and a young patient with a large pulp chamber.

Selection of abutment teeth; One of the factors in the selection of abutment teeth should consider the endodontic treatment history, the condition of the periodontal tissues, and the enamel structure present in the abutment crowns as retainer support and guiding plane.

Occlusal factors; The pontic must not be forced during excursive movements of the mandible is a concern in relation to occlusal and occlusal guidance. The existence of guidance from natural teeth can reduce damage to the abutment teeth.[8]

Aesthetic; The aesthetics of an adhesive bridge is determined by the metal retainer, porcelain coating, and also soft tissue. Metal connectors can be seen on the incisors which are slightly translucent giving them a grayish appearance. This problem can be overcome by using a block of opaque resin cement.

Pontic design; The most commonly used pontic design is the modified ridge lap. This design provides a great aesthetic result and oral hygiene.

Adhesive bridge design; The design factor of adhesive bridges with cantilevers has a higher success than fixedfixed bridges. Clinically, the fixed-fixed design in cases with large edentulous spaces is of great interest to clinicians because of limited contact during excursive movement and intercuspation only on retainers. A review study in which 11 cases of an adhesive bridge with a cantilever design that used a conventional design using two abutments had advantages in terms of strength, better aesthetics, reduced gingival tissue damage, easy cleaning, and more economical cost, and less attachment failure.[3,6,9,10]

Table 1. Shear bond strength values using 50 μm Al2O3 after pre-treatment using intraoral abrasion technique and without intraoral abrasion technique.

	Adhesive System	Without intraoral abrasion (MPa)	With intraoral abrasion (MPa)
Enamel	Etch-and-rinse	28.4 ± 6.7	30.4 ± 4.5
Dentin	Etch-and-rinse	27.3 ± 5.2	24.9 ± 9.8
	Self-etch	22.8 ± 7.2	23.9 ± 3.6

Clinical expertise; In terms of expertise, the clinician should consider the limitations of abutment preparations that are limited to enamel or minimal preparation, or no preparation at all. In an in vitro study, the preparation of 20 premolars resulted in 11.06 mm^2 of dentin exposure, or about 16.15%. Meanwhile, the preparation of the groove in the proximal area of up to 1 mm caused the dentin to be exposed at the gingival margin. This causes adhesive bridge restorations to often fall off, especially in the posterior area. The detachment of the adhesive bridge in the posterior area because the cement attachment to the dentin is lower than the enamel.[9,11]

Retention of abutment teeth in the posterior region through 0.5 mm axial preparation, formation of grooves, boxes, and rest seats will cause the dentin to be exposed. Exposure to dentin will cause dentin sensitivity and caries to cause attachment failure.[13] This is due to the low content of inorganic elements and the homogeneity of the dentin structure. The high fluid content in the dentinal tubules and changes in the smear layer cause the adhesive strength of dentin to be not as good as enamel. In terms of clinical expertise as a prosthodontist, errors in cementation procedures can lead to attachment failure. Therefore, it is important for clinicians to know the contents and techniques of cementation procedures with resin cement.

Cementation of adhesive bridge restoration; The success of an adhesive bridge restoration cannot be separated from the type of resin cement that will be used in the cementation procedure. The main ingredients are bisphenol-a-glycidyl methacrylate (Bis-GMA) resin and other methacrylate modified from composite resins.[16-18]

Advantages and disadvantages of resin cement; The disadvantages of previous resin cement are that they are easy to degrade and lack adhesion when used for a long time. Panavia resin cement (Kuraray Co. Ltd, Osaka, Japan) showed high adhesive strength. This is due to the formation of chemical bonds between the phosphate group of the cement monomer and the oxidant layer on the metal retainer. The advantages of resin cement compared to other types of cement are higher compressive/ tensile/ bonding strength, low solubility, and better aesthetics.[15] Disadvantages are the inability to release fluoride, relatively high film thickness, high sensitivity of dentin, high cost, and particle residue left during the cementation procedure.[19]

Resin Cement Classification; Resin cement is divided into conventional cement and the latest generation figure 1.[17,20,21] Conventional cement is total etch and self etch, while the latest generation cement is self-adhesive.

Polymerization; Based on the polymerization, resin cement is divided into light cured, self cured, dual-cured. Self-cured and dual-cured resin cement can be used in all types of cementation procedures. Meanwhile, light-cured resin cement is only limited to porcelain veneers and glass-ceramic restorations, which allow light to penetrate through porcelain. Several studies reported that dual-cured resin cement without light activation reduced adhesive strength and microhardness. It is advisable to carry out light polymerization on the entire restoration margin.[17]

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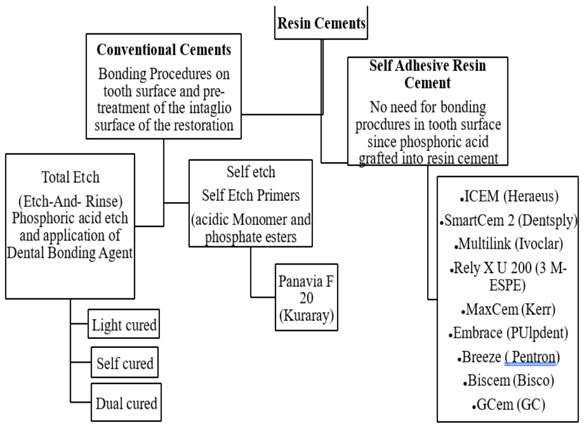

Figure 1. Classification of resin cement.

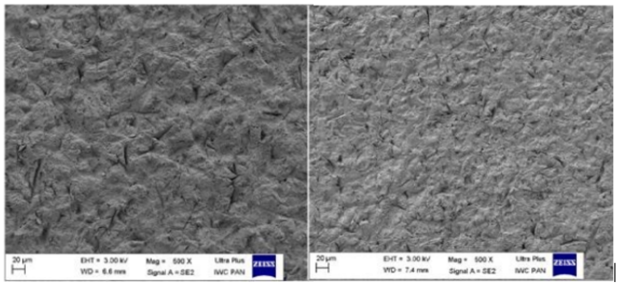

Figure 2. Effect of intraoral abrasion with A2O3 on the enamel surface, A. 50 μm, B. 29 μm with parameter distance: 4-5 mm, contact angle: 60^0, and pressure: 70 ±2 psi using SEM.

Attachment mechanism; Based on the attachment mechanism, resin cement is divided into total-etch, self-etch, and self-adhesive.[17] The 3 steps in total-etch are: acid etching, irrigation, and drying; bonding agent application, cured; resin cement application, cured. Meanwhile, in selfetching resin cement, the first step is a combination of acid etching and bonding agent application in one stage, followed by the application of resin cement. Total etch and self-etch resin cement is known as conventional resin cement. Self-adhesive cement is cement using universal bonding which can be used in total-etch and self-etch systems.

Surface treatment; Attachment to dentin is very challenging because it contains 50% minerals, 30% collagen, and 20% water. Adhesion to dentin must maintain moisture in the mineral and organic structures (especially collagen). Most of the dentin layer is protected by a "smear layer" which can prevent adhesives from entering the dentinal structure. Therefore, a mechanical modification technique of smear layer on dentin is currently being developed to form a hybrid layer so that maximum adhesion occurs between resin cement and dentin.[2,20] One technique that has developed a lot is intraoral abrasion. Pre-treatment on the tooth surface consists of chemical and mechanical. Chemically is the use of acidic materials such as polyacrylic acid or phosphoric acid. The application of 37% phosphoric acid can cause the opening of dentinal tubules and the lifting of some of the hydroxyapatite layer on the enamel surface by 80 μm. A study suggests using polyacrylic acid is better than phosphoric acid.[2] The pre-treatment procedure is mechanically known as air abrasion or water air abrasion or intraoral abrasion.

Intraoral abrasion; Intraoral abrasion is a mechanical technique using a spray of abrasive particles at the speed of an air or water thrust known as intraoral abrasion. This technique aims to form a surface roughness while removing debris on the tooth surface while increasing the adhesive strength of the restoration.[7,23-25] Intraoral abrasion uses several types and sizes of particles of different materials. In adhesive bridge restorations, this technique aims to maintain the enamel or dentin surface free from contamination prior to etching and primer application prior to cementation procedures to increase bond strength. This technique uses materials such as bioglass, aluminum oxide, and sodium bicarbonate or baking soda.[22,26] One material that is often used is aluminum oxide (Al2O3), available in sizes 29 μm, 50 μm, and 90 μm.

According to Rafael et al., Al2O3 has advantages because it produces surface roughness while increasing the adhesive strength. This is because Al2O3 does not affect the diameter of the dentinal tubules so the sensitivity of the dentin is reduced.[23] An intraoral abrasion study with Al2O3 resulted in higher adhesion strength than the use of a pumice or hand instrument prior to cementation with a self-adhesive resin material.[19]

The air abrasion technique with Al2O3 measuring 27 and 50 μm forms an irregular and amorphous dentin surface on the smear layer.[29]

Operating parameters

In the intraoral abrasion procedure there are several operational parameters:

Nozzle; The nozzle size consists of 0.4, 0.6, and 0.8 mm. The smaller the nozzle size, the greater the flow velocity. On the other hand, the larger the nozzle size, the greater the effect of strength and accuracy on surface roughness. Therefore, it is recommended to use clinical nozzles with a size of 0.8 mm, as the best surface treatment measure because the results of the spray material will be scattered and not concentrated at one point.

Time; Time as a parameter in the intraoral abrasion procedure shows that increasing can result in increased damage to the enamel crystal layer. It is therefore recommended that the intraoral abrasion procedure be limited to 3 seconds per tooth. This is supported by a study by Garcia LR et al; 2014 where sandblasting with low pressure in a short time will reduce enamel damage compared to the use of 37% phosphoric acid.[6]

Distance; Different spacing settings will affect the amount of damage to the enamel. In the sandblasting technique with Al2O3, the amount of enamel damage with its effect on the bond strength can be controlled by the operator. Olsen et al said that the adhesive strength of the adhesive material will be significantly reduced if sandblasting is carried out at a distance of 5 mm from the enamel.[25,27] Meanwhile, according to D'amario et al, intraoral abrasion Al2O3. 50 μm, with a pressure of 2 bar for 10 seconds and a distance of 5 cm can increase the adhesive strength of total-etch resin cement on the tooth surface after a tensile test.[26] So it is not known exactly how much distance is right to increase the adhesive strength of a restoration.

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Flow; Tepedino M et al said that the use of aluminum oxide as pretreatment with a pressure of 3 bar with the minimum flow, 5 bar with the medium flow, and 7 bar with maximum flow had no significant effect on the bond strength between adhesive resin cement and dentin surface after tensile test.[28]

Contact angle; In a recent study by Szersze´n M, spraying air particles as a pre-treatment with a contact angle of 60° and a pressure of 70 ± 2 psi or 5 bar in a cementation procedure using adhesive resin cement materials will increase the adhesive strength of fixed restorations. This is because the effect of microparticle jets will cause changes in topography, structure shape, and bond strength between dentin and prostheses using self-adhesive resin cement figure 2.[27]

Pressure; The magnitude of the pressure as a parameter of intraoral abrasion will increase the surface roughness of the teeth. In a study by Chan Te Huang et al; 2019, where intraoral abrasion using 50 µm Al2O3 with a pressure of 60 psi or ±4 bar can increase the adhesive strength of conventional and self-adhesive resin cement on enamel or dentin table 1.[9]

DISCUSSION

Based on a systematic review, the success rate of adhesive bridge restoration for 5 years was 87.7% lower than that of conventional fixed dentures which reached 90%. Meanwhile, according to Balasubramaniam; 2017, the success rate of this restoration with 5year durability reached 83.6% and 10 years reached 64.9%. The failure that often occurs in adhesive bridges is the occurrence of debonding or loss of fixed dentures by 77%. Another failure is the occurrence of fractures or broken porcelain by 13%.[13] This is due to the lower bond strength of dentin compared to enamel. Therefore, a pre-treatment of the tooth surface with intraoral abrasion was developed to reduce the failure rate of attachment to restorations with adhesive bridges.

A study by H. Milly et al, 2014; air abrasion with bioglass and 29 µm aluminum oxide on enamel surface damage with a pressure of 1 to 4 bar produced a non-significant difference.[29,30] Baraba et al., said that sandblasting with air-driven and low speed produces kinetic energy that creates microscopic dentin surface roughness to increase the bond strength.[31] Meanwhile, according to Rafael et al., 2016, intraoral abrasion aims to maintain the diameter of the tubular orifice and intertubular dentin so that it can affect the increase in adhesive strength. Intraoral abrasion Al2O3.50 µm, with a pressure of 2 bar for 10 seconds and a distance of 5 cm can increase the adhesive strength of the total etch resin cement on the tooth surface after the tensile test.[23] Tepedino M et al, 2021 using pressures of 3, 5 and 7 bar of intraoral abrasion Al2O3, 50 m with different flow velocities where there are differences in the adhesive strength of the total etch resin cement.[28] Then a study by Chan-Te Huang et al., 2019, intraoral abrasion Al2O3, 50 m with a pressure of 60 psi or 4 bar on total resin cement etch can increase the adhesive strength of the enamel to reach 30.4 ± 4.5 Mpa; and in dentin which it reaches 24.9 ± 9.8 MPa; while the self-etch resin cement reached 23.9 ± 3.6 Mpa. This supports the previous study conducted by De Souza-Zaroni et al of 4 bar can increase the adhesive strength of cement to 31.82 MPa of self-etch resin on enamel compared to conventional resin cement.[7] In a recent study by Szersze n, M, particle blast with a contact angle of 60° and a pressure of 70 ± 2 psi or 5 bar before cementation procedure using aluminum oxide with adhesive resin cement will increase the adhesive strength of the fixed restoration. Therefore, spraying of particles with air as a pre-treatment is the recommended procedure for cementation of fixed restorations using adhesive resin cement.[27]

CONCLUSION

The success of the adhesive bridge, especially in the posterior area, cannot be separated from the role of intraoral abrasion pressure on the tooth surface. The intraoral abrasion procedure has several operating parameters, namely nozzles, pressure, time, distance, flow, and contact angle. One of the operating parameters in the Al2O3 intraoral abrasion technique that plays an important role is pressure. The use of optimal intraoral abrasion pressure from Al2O3 can increase the bond strength between resin cement and the tooth surface while reducing tooth structure damage. Several previous studies have identified the role of intraoral abrasion on surface roughness and its effect on the adhesive strength of resin adhesive cement. However, its role in the restoration of adhesive bridges is not yet clear.

SUGGESTION

The intraoral abrasion technique is currently very developed in the field of dentistry. This intraoral abrasion technique on the tooth surface has previously been developed in the field of orthodontics and conservation. In the field of prosthodontics, this technique is generally limited to metal surfaces which is known as sandblasting. As a clinician, it is necessary to know the exact operational parameters of the restoration to be performed. Errors in determining operational parameters in the intraoral abrasion technique will affect the success of an adhesive bridge restoration. This cannot be proven because there are no studies conducted. Therefore, it is necessary to study the role of pressure as one of the operating parameters in the intraoral abrasion technique with Al2O3 material and how it affects the adhesive strength of resin cement in adhesive bridge restorations.

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REVIEW

The role of tooth preparation modification on retention and resistance in short abutment

Steven Tiopan, Ariyani,* Haslinda Z. Tamin

Keywords: Short abutment, Retention, Resistance, Tooth preparation modification.

ABSTRACT

The parameters for the long-term success of fixed dentures are retention and resistance. Fixed denture treatment for short abutments requires modification of tooth preparation to increase retention and resistance. The proximal area of the preparation can be modified to increase retention by adding grooves, boxes, and frustums. To increase resistance, proximal modifications in the form of adding grooves and boxes, and cervical angle of convergence modification can be used. To analyze retention and resistance based on convergence angle and tooth preparation modification on short abutment. In abutment with ideal convergence angle, addition of grooves and boxes will causes the cement-restoration interface to increase. The frustrum-shaped preparation will convert the retention value from the shear strength of the cement material into the compressive strength of the cement material. In abutment with compromised convergence angle, proksimal modification in the form of grooves and boxes, as well as reducing the convergence angles in the cervical region will result in paralleling of axial walls and increase the resistance. In cases of a short abutment with an ideal convergence angle, the highest retention is obtained by modifying the proximal area with a frustum shape. Meanwhile, if the convergence angles are compromised, reducing the convergence angle in the cervical region would be the most effective method to improve the resistance. (IJP 2024;5(1):29-33)

INTRODUCTION

Fixed prosthodontic treatment can provide a great satisfaction for patients and dentists. To achieve the best treatment outcomes, careful consideration is required from the initial patient history, at the stage of treatment, and the follow-up care. Failure in fixed prosthodontics can occur at any time, and the diagnosis and treatment for the failed restoration are usually complex and difficult. Therefore, it is important to know in advance if there are any indications of possible restoration failure. Failure in fixed prosthodontic treatment can be classified into three categories: biological failure, mechanical failure, and aesthetic failure.[1] According to research done by Zavanelli et al (2018), the most common types of mechanical failure are failures caused by loosening of the prostheses (57.14%), followed by fractured ceramics (28.57%), and fractures of abutments (14.29%).[2]

Failure to achieve the ideal preparation form in terms of the occluso-cervical height and the convergence angle of the abutment to support retention and resistance of the fixed restoration can lead to mechanical failure. Fundamental principles for tooth preparation must be followed to achieve predictably successful prosthodontic treatment. The preservation of tooth structure and periodontium, achieving retention and resistance form, maintaining marginal integrity, preserving structural durability, and aesthetic considerations are the principles of tooth preparation.[3,4] Some common causes of short occluso-cervical height of the abutment are caries, trauma, iatrogenic factors, and eruption disharmony.[5]

Clinically acceptable taper range for a preparation recommended by Rosenstiel et al is 5-22°, however, for abutment with an occluso-cervical height of 3 mm, the taper is restricted to a maximum of 10° to obtain an adequate form of resistance.[4] According to a survey by Abdulla et al. (2018), the average convergence angle that

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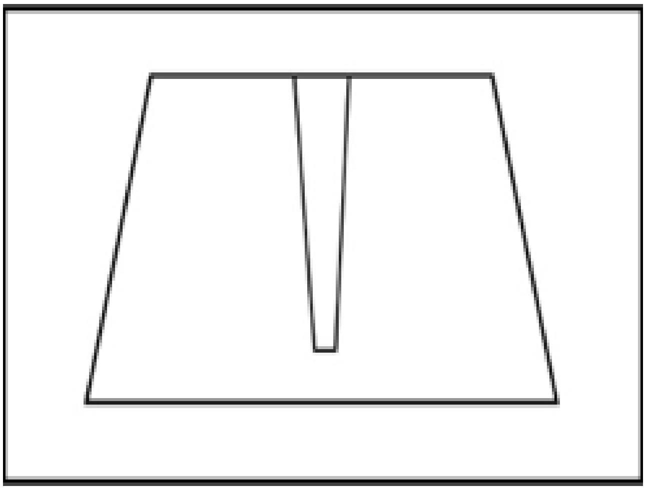

Figure 1. Groove Preparation.

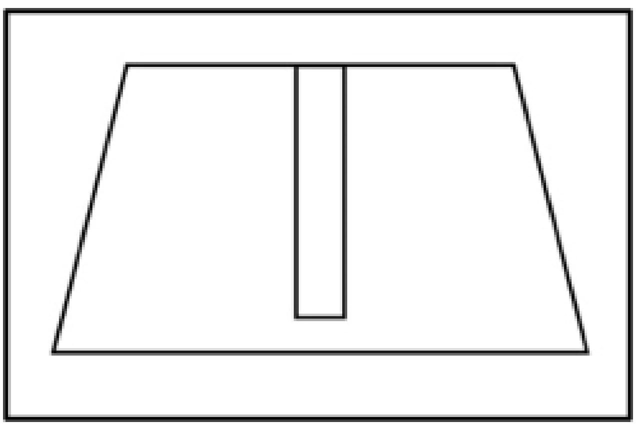

Figure 2. Box Preparation.

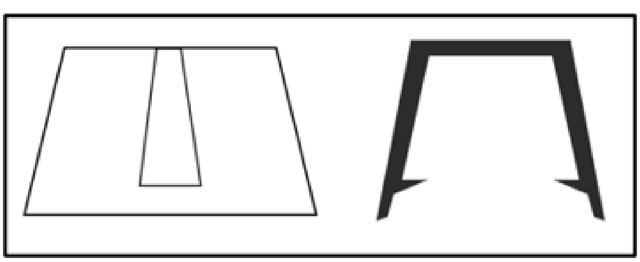

Figure 3. Frustum Preparation and The Internal Metal Protrusion.

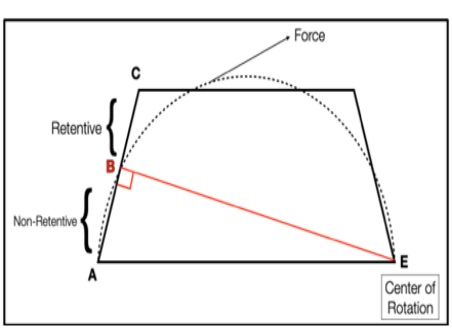

Figure 4. Method Lewis and Owen.

can be achieved by practitioners is 28.6°, which is higher than the recommended limit.[6] A study by Al-Moaleem et al. (2015) also reported that the convergence angle of preparation that can be achieved by specialist practitioners ranged from 22.91° to 38.21°. He concluded that the recommended taper and convergence angle are clinically difficult to achieve.[7] Another study by Ghafoor et al. (2012) reported that the average convergence angle that can be achieved by practitioners is 23.7° ± 8.9°.[8] To overcome the inadequate preparation form, modifications can be made to the tooth preparations in the proximal or cervical area to increase the retention and resistance.

The goal of this article is to determine the role of tooth preparation modification and the correlation between preparation modification and convergence angle in short abutment in increasing the retention and resistance.

LITERATURE STUDIES

According to the Glossary of Prosthodontic Terms, a fixed dental prosthesis is any prosthesis that is securely fixed to a natural tooth or teeth, or to one or more dental implants/implant abutments; it cannot be removed by the patient.[9]

In order for restoration to last a long time, a preparation must take into account biological, mechanical and aesthetic factors. Biological factors include the health of the tissues of the oral cavity and teeth, avoiding overconturing, supragingival-made margins, harmonious occlusion, and tooth protection against fractures. Mechanical factors include factors that affect the integrity and durability of the restoration. Aesthetic factors, are factors that affect the appearance of the patient.[4]

An ideal preparation form is required to support retention and resistance. Factors can affect retention and resistance in terms of tooth preparation are the convergence angle and the height of the abutment.[3,4]

Short Clinical Crown

Common causes of a short clinical crown are caries, erosion, tooth malformations, dental fractures, attrition, iatrogenic factors at the time of dental preparation, and the presence of disharmony of tooth eruptions such as insufficient passive eruptions and a mesially tipped tooth. The ideal height of the preparation wall for a crown restoration is a minimum of 4 mm.[5,10]

Some methods for dealing with teeth with short clinical crowns include creating the restoration margin in the subgingival area without interfering with the biological width. The biological width consists of 1 mm of epithelial attachment and 1 mm of connective tissue attachment. Any disturbances in the biological width can lead to chronic inflammation, alveolar bone loss, gingival recession, and the formation of periodontal pockets. Chronic inflammation caused by biological width violations can interfere with aesthetics and periodontal health.[5]

Other option when manage a short clinical crown is the use of restoration materials to fill the existing voids, undercuts, and irregularities in the preparation. For non-vital teeth, pre-fabricated post and casting post can be

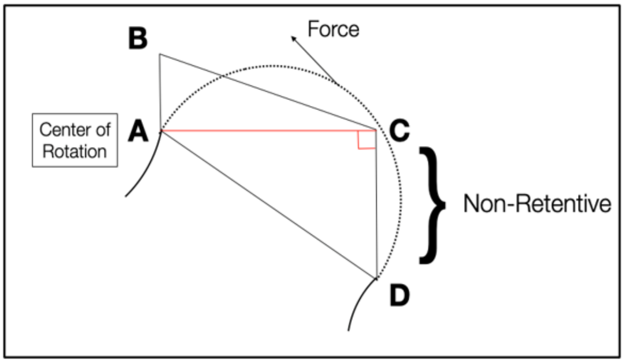

Figure 5. The resistance form of a tilted molar.

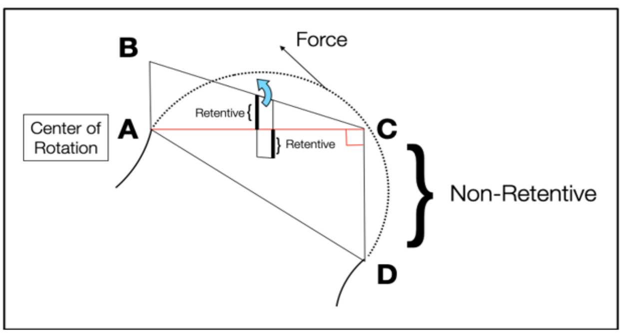

Figure 6. The Resistance Form of a Tilted Molar after Adding Groove.

used. Surgical crown lengthening treatment, can be performed on teeth with short occluso-cervical height, to obtain additional tooth structure, preventing violations of biological width, and for aesthetic reasons, in cases where the gingival contours are not the same, or in the case of gummy smile. Contraindication of this treatment are teeth with fractures that are no longer restored, teeth with a poor crown-root ratio caused by short roots or bone resorption, teeth with exposed bifurcations,and patients with systemic diseases and poor OH, which can interfere with the healing process. Teeth with short occluso-cervical height can also be treated with orthodontic eruption procedure, where the teeth are given a force to pull the teeth upwards. The purpose of this treatment is to maintain bone health, the biological width, and aesthetics. The simplest and most economical treatments for managing teeth with a short occluso-cervical height are endodontic treatments accompanied by the use of a removable overlay denture.[5]

The main factors of retention and resistance are related to the surface area, height of the preparation, the convergence angle, and the surface texture of the prepared tooth. The secondary factor relates to the modification of the preparation in the proximal region or in the cervical region. In the case of a short abutment, preparation modification needs to be done due to the compromised retention and resistance.[5]

Retention

According to the Glossary of Prosthodontic Terms, retention is a quality found in dental prostheses that serves to withstand forces of dislodgment along the path of placement.[9] The magnitude of the dislodging force can influence the retention of a restoration. Generally, this force appears when chewing sticky foods or when chewing gum. This force depends on the sticky consistency of the food, the surface area, and the texture of the restoration. Retention in a fixed prosthodontic depends on the geometric shape of the preparation rather than the adhesion force. Cement is only effective if the restoration has one path of withdrawal. If one of the walls in the preparation is over tapered, the shape of the preparation will not be cylindrical and the cemented restoration material will have more than one path of withdrawal. In such cases, the cement particles will tend to lift away from the preparation rather than slide along the preparation, and the retention obtained is only from the limited adhesion force of the cement.[4]

A taper that is too small may result in unwanted undercuts, while a taper that is too large may result in a lack of retention. The recommended convergence between opposing walls is 6°.Surface area plays a role when the restoration has a limited path of placement. Retention of a restoration depends on the length of the sliding contact between the teeth and restoration. Crowns with tall axial walls will be more retentive than those with short axial walls, and because of the greater diameter, molar crowns will be more retentive than premolar crowns of similar taper.[4]

To reduce retentive failure caused by cohesive failure of the cement, sharp occluso-axial line angles should be rounded to minimize these stresses. Types of preparation can effect the retentive value, retention of a complete crown is more than double that of partial-coverage restorations. Roughening of the internal surfaces of the restoration can increase the retention. The use of air abrasion has been shown to increase retention by 64%. The types of material used for the restoration appear to affect the adhesion with selected luting agents. Base metal alloys such as nickel, cobalt, and chromium have better retention values than less reactive metals with high gold content.[4]

Adding preparation modification in the form of grooves or boxes to increase the surface area between cement materials and restoration is another method to increase retention figure 1 and 2. Further studies have been made by AlShaarani F et al (2019), which reported that preparation modification in the form of proximal frustum with or without internal metal protrusion, can increase the retention of the restoration in case with a short abutment figure 3. The role of the frustum preparation, along with the internal metal protrusion inside the restoration will convert the retention value which is usually seen from the shear strength of cement material into the compressive value of the cement material which have a higher value.[11]

Resistensi

According to the Glossary of Prosthodontic Terms, resistance form is a feature of a tooth preparation that enhance the stability of the restoration and resists dislodgment

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along an axis other than the path of placement.[9] A crown with insufficient resistance form preparation will easily roll off the die, whereas a crown with adequate resistance form will prevent movement.

Retention and resistance form depend on taper. The relationship between taper and retention is in the form of a curved graph, where as the taper gets smaller, the retention will increase. On the other hand, the relationship between taper and resistance is in the form of whether the resistance form is achieved or not achieved in a preparation. The limiting taper value can be determined mathematically with the formula:[12]

The H dan B refer to the height and base of the preparation, the convergence angle is twice this value. The minimally acceptable taper guidelines for preparation for each tooth group can be determined by implementing the formula. The total occlusal convergence were 58° for incisor, 66° for canines, 20° for premolar, and 16° for molars. Hence, resistance form for anterior teeth is much easier to achieve than for posterior teeth, which are shorter and broader with a lower height-to-base ratio. Achieving the required taper for adequate resistance form will be a challenge in posterior teeth. According to Shillingburg, the recommended total convergence angle increases from the anterior teeth (10°) to the posterior molar teeth (22°). Clinically, resistance form is difficult to obtain in molar tooth preparations. Since the most common loose restorations are restorations on molars, preparations made on molars must be done carefully to achieve adequate form resistance.[12,13]

The method for evaluating resistance form proposed by Lewis and Owen is carried out by drawing a perpendicular line on the AC side from the center of rotation E on the opposite margin figure 4. The intersection between the Lewis line and the AC side is point B, and all areas above point B (section BC) are resistive, and all areas below point B (area BC) are non-resistive.[12]

Several methods to increase the resistance form include crown lengthening, shoulder preparation, adding a proximal box or groove, occlusal isthmus, and pins or posts. In the case of tilted molars, the addition of grooves will restrain rotational forces that appear on one side of the groove wall figure 5 and 6.[12]

DISCUSSION

The most common mechanical failure of fixed denture restorations is the dislodgement of a prosthesis, caused by inadequate retention and resistance form in a tooth preparation. Factors that play a role in retention and resistance are the dimension of the teeth and the convergence angle of the preparation.[2,12]

Restoration of a molar with a short occluso-cervical height using a full coverage crown is a challenge in fixed dentures due to the lack of retention and resistance forms in the preparation. Several studies have been conducted to find methods to increase retention and resistance in short occluso-cervical teeth for fixed denture restorations.

In terms of retention, preparation modification that can be done is by making proximal grooves and boxes. According to a study by Vinaya et al. (2015), which aimed to evaluate the retention of full fixed denture restorations in teeth with inadequate height, it was reported that the addition of the proximal groove provides greater retention when compared to proximal boxes.[14] This was further investigated by Shetty et al. (2020), who compared the effect of adding grooves on the retention of fixed dentures in teeth with a height of 3.5 mm, reporting that the addition of two proximal grooves on the mesial and distal sides resulted in higher retention compared to the addition of a proximal groove or conventional preparation.[15] In the study of AlShaarani et al. (2019), which compared the addition of retention of the proximal groove preparation and the proximal frustum preparation on the mesial and distal sides, it was stated that there was a significant increase in retention in the proximal frustum preparation compared to the groove. The proximal frustum preparation is reported to be the preparation modification that can provide the highest retention, but some limitations of the frustum preparation are that it needs more teeth preparation than the groove and box. It is indicated for abutments that have undergone endodontic treatment, abutments with small pulp chambers, and abutment teeth restored with posts and cores. In addition, when manufacturing the final restoration, special skills are needed from laboratory technicians to be able to produce restorations with an internal metal protrusion.[11]

A study to increase the resistance by Proussaefs et al. (2004), who investigated the effectiveness of the preparation modification by comparing grooves and boxes and reducing the angle of convergence of the cervical region in abutments with a height of 2.5 mm and a convergence angle of 20°, concluded that the groove and box preparation were not effective, and that the preparation modification that could significantly increase the resistance was by reducing the angle of convergence in the cervical region.[16]

This is contrary to the study of Lu et al. (2008), who examined the effect of groove preparation on increasing resistance in abutment teeth with a height of 3mm and a convergence angle of 50°, and reported that the addition of two grooves could significantly increase resistance.[17] This was later opposed by Huang et al. (2015), who investigated the effects of proximal grooves and abutment height of a posterior fixed restoration with a convergence angle of 20°, reporting that groove preparation only increased resistance in abutments with a height of 4mm, whereas in abutments with a height of less than 4mm, the addition of a groove had no significant effect.[10]

This was further investigated by Arora et al. (2016) on abutment teeth with a height of 2.5 mm and a convergence angle of 22°, who reported that the proximal groove did not significantly increase resistance. The proximal box preparation modification could significantly

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increase resistance, but the most effective method to increase retention is to reduce the angle of convergence in the cervical region.[18]

CONCLUSION

Short abutments can affect retention and resistance. It is necessary to make modifications to the preparation to overcome these problems. Based on the existing literature, it can be concluded that in the case of short abutments with an ideal convergence angle, the highest retention is obtained by adding the frustum preparation, while for short abutments with a compromised convergence angle, the most effective method to increase resistance is by reducing the convergence angle in the cervical region.

SUGGESTIONS

For achieving the required retention and resistance form, the height of the abutment teeth and the angle of convergence of the preparation play an important role. In the literature that uses groove, box, and frustum preparations with the goal of increasing retention of the short abutment teeth, the convergence angle used is 10°, which is the most optimal angle to obtain the resistance form, but it is still clinically difficult to achieve by clinicians. Regarding the literature related to resistance, there is still conflicting research between authors on the effectiveness of the groove and box preparations in short abutment.

Further in vivo studies are recommended to analyze the role of modified preparations on retention and resistance using samples with a convergence angle that can represent the daily clinical situation found in the dental clinic.

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REVIEW

Potential color change in ceramic-based restorations

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Keywords: Ceramics, color change, Lithium disilicate, Thermocycling, Zirconia

ABSTRACT

Ceramic materials are among the materials used in restorative dentistry. They are widely used for restoration in esthetically demanding areas. Consequently, this material requires excellent color stability on top of adequate strength and good biocompatibility to achieve prosthodontic treatment success, especially in the aesthetic aspect. Lithium disilicate and zirconia are two popular ceramic materials used in dentistry mainly due to their translucency and strength. This scoping review aims to evaluate the potential for ceramic materials, mainly lithium disilicate and zirconia, to change colors after thermocycling with or without the staining process. Thermocycling is a laboratory method used to simulate daily oral use in relatively short periods. Twelve (12) articles extracted from 172 articles in 3 database resources based on the inclusion and exclusion criteria (journal articles in English from 2017-2021 that evaluate the color change in ceramic materials after thermocycling with or without staining process) are reviewed for the color change of several ceramic restoration materials. All materials generally show color change; lithium disilicate and zirconia-reinforced lithium silicate show the slightest color change compared to zirconia, feldspathic, or hybrid ceramic materials. Glazed materials offer better color stability compared to polished materials. Several staining solutions significantly contribute to the color change: coffee, tea, and wine. The thickness of materials and adhesive cement may also contribute to the color change of ceramic materials. In conclusion, all materials show color change after the thermocycling process; however, only hybrid ceramics show a level of color change that is above the tolerated limit. (IJP 2024;5(1):34-43)

INTRODUCTION

The ongoing development of dental materials has made it possible to fabricate strong yet also aesthetic restoration materials. As the demand for the use of tooth-colored restorative materials especially in prosthetic dentistry increased, this development is a welcomed one.[1] Ceramic-based materials are the material of choice that has major advantages in the aesthetic aspects; Apart from that, this material also shows good biocompatibility and physical characteristics that continues to improve.[2,3] Also, by utilizing the CAD/CAM technology, it is possible to make the ceramic restoration with the minimum possible thickness, thereby reducing the amount of tooth structure that must be removed.[4]

Initially, there were still concerns regarding the physical strength of the latest ceramic-based materials which have a fairly thin thickness (1 mm or less). However, it is revealed that in general, the latest ceramic materials can be fabricated with a thickness of up to 0.5 mm and still have a fracture strength limit that is above everyday occlusal loads.[5] Ceramic-based indirect restorative materials can generally be divided into 2: silicate ceramics and oxide ceramics. Lithium disilicate is an example of a silicate ceramic material and zirconia is an example of an oxide ceramic material. Both are the main materials of choice for indirect restoration in areas that have a high level of aesthetic needs and have been widely researched with quite satisfactory results, both from an aesthetic, biological and mechanical perspective.[6]

One of the main reasons of tooth restoration replacement especially in anterior teeth, is discoloration of the restoration.[13,14] Therefore, color stability is an important factor to ensure that the restoration's aesthetics value can last a relatively long time so that the restoration does not need to be replaced within a short period after cementation. Various ceramic-based indirect restoration materials (including lithium disilicate and zirconia) are known to

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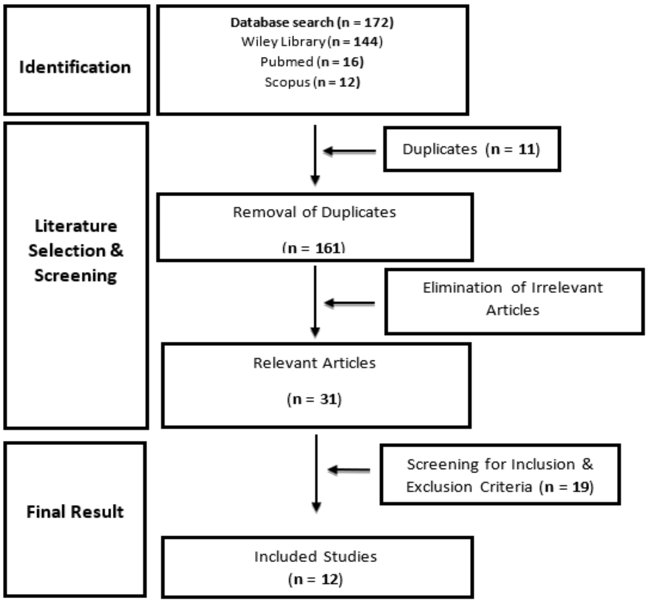

Figure 1. Literature Search Flow.

Table 1. Comparison of laser surface treatment and sandblasting.

Inclusion Criteria	Exclusion Criteria
Articles published from January 2017 - November 2021	Articles published before January 2017 with languages other than English
English articles	Case reports, finite element analysis (FEA) studies, systematic reviews, meta-analyses, clinical trials, or literature reviews articles
Articles that are available as full text	Articles that do not have a full-text version
Articles in the form of in vitro studies	
Articles that evaluate and discuss the effect of thermocycling process with/without staining process on the color stability of ceramic-based restorative materials	

have different physical properties so it is estimated that the color stability of these materials will also show different results. Several methods have been used to maintain the stability of the restoration color, i.e., through polishing and glazing processes on the surface of the materials.[11,15,16]

Several studies have tried to evaluate the color stability of ceramic materials. Color stability testing can be done by simulating the effect of oral environment daily use on the materials through a thermocycling process to evaluate changes in the structure and color of the material by using the microscopic and spectrophotometry analysis. Apart from thermocycling, the use of solutions such as coffee, tea, or soft drinks are also commonly used in several studies to evaluate the color stability of ceramic materials.[12,14,17,18] However, the studies above still provide quite diverse results and further information regarding the potential for changing the color of ceramic materials has not yet been widely discussed. So based on this, this paper aims to evaluate in more detail the potential for color changes of ceramic-based indirect restoration materials that have undergone a thermo-cycling process with/without a staining process. It is hoped that the information obtained regarding the potential for color changes from ceramic-based indirect restoration materials in this paper will be useful for fellow clinicians.

LITERATURE STUDIES

This paper is written as a scoping review that summarizes and examines the results of previous studies that have been carried out in relation to a particular topic or field of science. The stages carried out in preparing a scoping review consist of determining study questions, determining the type of relevant study, selecting studies based on predetermined keywords, collecting data in a chart, and preparing a report on study results in the form of a summary. The format of the scoping review will be based on Arksey's stage framework and the Preferred Reporting Items for Systematic Review Extension for Scoping Review (PRISMA-ScR) guidelines.[19,20]

The research question in this scoping review paper is "What is the potential for color changes in ceramic-based restoration materials after the thermocycling process with/without staining process?" The population chosen is ceramic-based restoration materials. The concept used in this paper is the stability of the color of the restoration material, while the context is the change in color of the restoration material before and after thermocycling treatment and/or staining process as a representation of daily use in oral environment.

A search for literature relevant to the research questions in this scoping review was carried out using the internet. Three source databases were used: PubMed, Wiley Library, and Scopus. The keywords used to search for literature were ("Color Stability" OR "Colour Stability" AND "Ceramic" OR "Lithium Disilicate" OR "Zirconia" AND "Thermocycling"). All articles were in English with full text available related to dentistry and published in the last 5 years (2017-2021). The inclusion and exclusion criteria can be seen in table 1.

The literature search flow can be seen in figure 1. Literature search on PubMed, Wiley Library, and Scopus produced a total of 172 articles, of which 144 articles were obtained from Wiley Library, 16 articles from PubMed, and 12 articles from Scopus. From this, irrelevant articles were filtered based on reading the title and abstract; 130 articles were eliminated based on selection of irrelevant titles and abstracts, leaving 42 articles. After that, there were 11 articles that were duplicated from the three sources; these were also eliminated and thus leaving 31 articles. The remaining literature was then further selected regarding articles that met the inclusion and exclusion criteria that had been set for this scoping review by reading the full text articles. Based on inclusion and exclusion criteria, 19 articles did not meet the inclusion and exclusion criteria. The final results of the screening obtained 12 articles which will be reviewed in this scoping review.

A summary of the literature results used in this paper can be seen in table 2 and table 3. Table 2 presents the demographic

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Table 2. Demographic data of the included studies.

Author (year)	Research purpose	Samples	
Palla et al (2017)	To evaluate the color changes in various lithium disilicate material after thermal cycling and immersion in beverages	288 lithium disilicate (A2) specimens with a thickness of 1 mm:	IPS e-max CAD IPS e-max CERAM IPS e-max Press w/ glazing IPS e-max Press w/o glazing
Elter et al (2021)	To evaluate the color stability of various ceramic materials after thermocycling and coffee immersion	80 labial veneers (A2) (thickness 0.2-0.4 mm) from various ceramics cemented on cow teeth (light cure and dual cure cementation):	Lithium Disilicate (CAD) Nano-ceramic Resin Feldspathic Ceramic Leucite-reinforced Feldspathic
Seyidaliyeva et al (2019)	To evaluate the color stability of ceramic hybrids, composites, and lithium disilicate after thermocycling and immersion in various drinks	180 specimens of anterior tooth restoration material (Hybrid ceramic, lithium disilicate, composite resin; A3 HT) with a thickness of 2 mm:	Hybrid Ceramic Lithium Disilicate (CAD) Composite Resin Layered Zirconia
Aljanobi and Al-Sowygh (2020)	To evaluate the effect of thermocycling on the color stability of various ceramic restoration materials	48 specimens of various ceramic restoration material (A2) with a thickness of 1 mm:	Layered High Translucency - Zirconia Lithium Disilicate CAD ZLS
Ashy et al (2021)	To evaluate the color stability of high translucency monolithic zirconia and lithium disilicate materials cemented on premolars after the thermocycling process	40 specimens of 1 mm ceramic restorative material (A1) cemented with light cure or dual-cure resin cemen:	Lithium Disilicate (CAD) Monolithic Zirconia
Haralur et al (2019)	To assess the effect of thermocycling and immersion with drinks and mouthwash on the color stability of monolithic zirconia, bilayered zirconia, and lithium disilicate	90 specimens of ceramic restoration materials with a thickness of 2 mm:	Lithium Disilicate (Press) Monolithic Zirconia Bilayered Zirconia
Cakmak et al (2021)	To evaluate the effect of coffee thermocycling on color stability of zirconia reinforced lithium silicate (ZLS) ceramic	30 specimens of Zirconia-reinforced Lithium Silicate (ZLS) material with a thickness of 0.8 mm and 1.5 mm. Cementation with A2, A3, and Tr auto-cure resin cements	
Yuan et al (2017)	To evaluate the effect of thermocycling on the color stability of CAD-CAM ceramic restoration materials	180 specimens of ceramic-based restoration materials with a thickness of 4 mm and underwent glazing process after fabrication:	Lithium Disilikate (CAD) Zirconia
Aldosari et al (2021)	To evaluate the color stability of ceramic materials that have been thermocycled and immersed in coffee	96 specimens of CAD/CAM restoration materials with a thickness of 2 mm which are subsequently divided into glazed and polished groups:	Hybrid Ceramic ZLS Feldspathic Ceramic
Al Amri et al (2020)	To evaluate and compare the translucency and color stability of hybrid ceramic materials compared to conventional ceramic materials	80 specimens of CAD/CAM materials with a thickness of 1 mm which are polished after fabrication:	Lithium Disilicate Nano-ceramic resin 1 Nano-ceramic resin 2 Hybrid Ceramic Polymer 1 Hybrid Ceramic Polymer 2
Abdalkadeer et al (2020)	To evaluate the effect of Cola drinks and the surface treatment on the color stability of porcelain veneers with different thicknesses	96 ceramic-based material specimens with a thickness of 1 mm and 0.6 mm which are subsequently divided into glazed and polished groups:	Zirconia Lithium Disilicate CAD Lithium Disilicate Press
Al Moaleem et al (2020)	To evaluate and compare the effect of khat on surface roughness and color changes in ceramic-based materials	70 ceramic material specimens with a thickness of 2 mm which are subsequently divided into glazed and polished groups:	Feldspathic Metal Ceramic - (PFM) Feldspathic Ceramic Zirconia

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Table 3. Evaluation of color stability of various ceramic materials

Author (year)	Treatment method	Results and summaries
Palla et al (2017)	- Water thermocycling (5-55^{0}C) for 21.900 cycles (simulation of 3 years of use in oral environment) - Immersion of the specimens in coffee, tea, and red wine solutions for 54 hours (simulation 3 years of use) - Color changes were measured based on spectrophotometric color parameters analysis	- IPS CAD showed a color change value (ΔE) < 1 in all - treatment methods - IPS Press material w/ glazing showed a ΔE value > 1 (1.39) after the thermocycling process and a ΔE value < 1 after the immersion process in all drinking solutions - IPS CERAM material shows a ΔE value >1 after thermocycling (1.61) and immersion in coffee (1.31); for immersion in other solutions the value is <1 - IPS Press material w/o glazing showed the highest ΔE >1 after immersion in tea (4.99), wine (1.85) and coffee (1.1) - CAD materials show better color stability
Elter et al (2021)	- Storage of specimens in distilled water (37^{0}C) for 24 hours - Thermocycling for 5.000 cycles (5-55^{0}C) in distilled water with a dwell time of 30 seconds - Immersion of the specimens in 37^{0}C coffee solution for 3 weeks (changed every 2 days) - Color change measurements were based on spectrophotometric color parameters analysis	- All materials showed a ΔE value <3.3 after the thermocycling process - Changes in material color after the thermocycling process and immersion in coffee showed significant differences between groups; nano-ceramic resin (ΔE = 13.67); lithium disilicate (ΔE = 4.2); feldspathic ceramic (ΔE = 5.76); leucite-reinforced feldspathic (ΔE = 3.77). All materials showed ΔE value of > 3.3 (tolerated limit value) - Light cure resin cement shows a lower degree of color change in ceramic materials compared to dual-cure
Seyidaliyeva et al (2019)	- Thermocycling for 10.000 cycles (6.5-60^{0}C) with 45 seconds dwell time - Storage of specimens for 4 weeks (37^{0}C) in a container containing 60 ml of red wine, cola, black tea, curry and water - Post-immersion polishing process for all specimens - Color change measurements were based on spectrophotometric color parameters analysis	- The thermocycling process showed a ΔE value < 0.8 on all materials - The ΔE value at 4 weeks of immersion: hybrid ceramic 4.5; composite resin 5.0; lithium disilicate 3.0 (ΔE>1.8 - tolerated limit value) - Polishing process àThe ΔE value for hybrid ceramic and composite resin >0.8 but <1.8; lithium disilicate showed a ΔE value <0.8 - Red wine caused the highest discoloration of all materials and showed ΔE value >1.8 (hybrid ceramic 11.6; resin composite 13.2; lithium disilicate 5.9) - Lithium disilicate was a material with minimal color changes compared to other materials, including after polishing process
Aljanobi and Al-Sowygh (2020)	- Thermocycling 10.000, 30.000, and 50.000 cycles, simulating 1, 3, and 5 years, respectively (5-55^{0}C and 30 seconds dwell time) - Color change measurements were based on spectrophotometric color parameters analysis	- Lithium disilicate à significantly higher translucency parameters compared to other materials in all thermocycling phases - All materials showed gradual color change as thermocycling time progresses; ZLS was the material with the lowest level of color change, followed by lithium disilicate - Zirconia (conventional and high translucency) à highest color change compared to lithium disilicate and ZLS - All materials, when compared with the established clinical tolerance threshold (ΔE = 3.3), showed color change below this value
Ashy et al (2021)	- Thermocycling for 3.000 cycles (5-50^{0}C and 15 seconds dwell time) - Color change measurements were based on spectrophotometric color parameters analysis	- Zirconia and lithium disilicate à statistically significant color change after thermocycling; The average ΔE value was 3.59, this value was still below the specified tolerance limit value of 3.7 - The color change of lithium disilicate (ΔE 3.67-3.99) was greater than zirconia (ΔE 3.22-3.49) regardless of the type of cement used - The type of resin cement did not affect the color change; however, it was found that the dual-cure cement (b*=5.2) showed a significantly yellower color compared to the light-cure cement (b*=4.2)

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Table 3. Evaluation of color stability of various ceramic materials

Author (year)	Treatment method	Results and summaries
Haralur et al (2019)	- Thermocycling for 3.000 cycles in distilled water (5-55^{0}C) - Immersion of the specimens in solutions of tea, coffee (15 grams each in 250 ml of water), and 0.2% chlorhexidine mouthwash for 7 days at an average temperature of 37^{0}C - Color change measurements were based on spectrophotometric color parameters analysis	- Lithium disilicate showed ΔE values of 1.788 (coffee), 2.241 (tea), and 1.588 (chlorhexidine); monolithic zirconia showed ΔE values of 5.602 (coffee), 5.192 (tea), and 4.866 (chlorhexidine); bilayered zirconia showed ΔE values of 4.299 (coffee), 2.191 (tea), and 1.438 (chlorhexidine), respectively - Lithium disilicate color changes were generally lower compared to both type of zirconia materials for all groups especially in coffee immersion group - Bilayered zirconia à color changes were lower on tea and chlorhexidine immersion compared to lithium disilicate, but the difference was not significant - The clinical tolerance limit value of ΔE was set at 3.5 à lithium disilicate was the only material that showed a ΔE value below 3.5 for all immersion groups
Cakmak et al (2021)	- Thermocycling for 5.000 cycles (5-55^{0}C and 30 seconds dwell time) in 1 tablespoon of coffee solution - Color change measurements were based on spectrophotometric color parameters analysis	- The thermocycling process reduced translucency in all ZLS samples (both 0.8 mm and 1.5 mm thickness) regardless of the cements used - A material thickness of 0.8 mm showed a higher degree of translucency than 1.5 mm; This thickness also caused significantly greater color changes although the value was still below the determined tolerance threshold value (ΔE<1.77) - The color of the cement did not significantly affect the final color of the material that has been thermocycled; Cement color mostly affected the color of ZLS before thermocycling at both thicknesses - Regardless of all treatment, color changes in all specimens were still below the tolerance threshold value
Yuan et al (2017)	- Thermocycling for 6.000, 12.000, and 18.000 cycles (5-55^{0}C and 30 second dwell time) in distilled water, simulating 5, 10, and 15 years of use, respectively - Color change measurements were based on spectrophotometric color parameters analysis; surface roughness analysis was carried out using Interferometry Microscopic analysis	- Thermocycling process for 18.000 cycles (simulation of 15 years routine oral use) à significant changes in surface roughness on both materials; however, there was no correlation between roughness and color change - Lithium disilicate showed better color stability than zirconia in all thermocycling cycles - Both lithium disilicate and zirconia showed color change values below the specified clinical tolerance limits (ΔE=2.6) after thermocycling treatment
Aldosari et al (2021)	- Immersion of the specimens in hot coffee solution (30 g, 1 liter of 100^{0}C water) and cold coffee solution. The solutions were changed every day - Thermocycling process on the specimens for 5.000 cycles (5-55^{0}C) for 30 days - Grouping the specimens into glazed and polished groups - Color change measurements were based on spectrophotometric color parameters analysis; surface roughness analysis was carried out using SEM analysis	- Hybrid ceramic showed the highest roughness (0,51) in the glazing group while feldspathic ceramic material showed the highest roughness (0,79) in the polishing group. Overall, the hybrid ceramic (0,59) showed the highest roughness regardless of the surface treatment performed - Hybrid ceramic showed the highest color change (ΔE = 3.07) compared to ZLS (ΔE = 1.96) and feldspathic ceramic (ΔE = 2.65) - The glazing process generally provided a lower level of surface roughness than the polishing process and thus providing lower color change value - The color changes that occurred in the three materials were still below the clinically acceptable color change threshold (ΔE<3.7)
Al Amri et al (2020)	- Phase 1 thermocycling for 5.000 cycles (5-55^{0}C and 30 seconds dwell time) - Immersion of specimens in a coffee solution (15 grams, 250 ml hot water) and distilled water - Phase 2 thermocycling for 5.000 cycles - Color change measurements were based on spectrophotometric color parameters analysis	- Nano-ceramic resin specimens showed the highest translucency among the material specimens, followed by lithium disilicate; hybrid ceramic specimens showed the lowest translucency - Translucency did not show significant changes in all specimens after phase 1 thermocycling except for hybrid ceramic 1 - Hybrid ceramic 2 shows significant changes in translucency after immersion and thermocycling phase 2

Table 3. Evaluation of color stability of various ceramic materials

Author (year)	Treatment method	Results and summaries
		- The largest color change occurred in the nano-ceramic resin group (1 and 2) after immersion in the coffee solution and thermocycling - Color changes in lithium disilicate were found to be minimal (0.29) compared to nano-ceramic and hybrid ceramic resin materials; nano-ceramic resin showed the greatest color change (2.45)
Abdalkadeer et al (2020)	- Immersion of the specimens in Cola solution for 4 weeks - Thermocycling for 10 cycles every day for 4 weeks (5-55^{0}C, total 400 cycles) - Color change measurements were based on spectrophotometric color parameters analysis	- The specified ΔE tolerance limit value is 4.2 for all samples - ΔE value for specimens with a thickness of 0,6 mm à zirconia glazed (1.79) & polished (4.41), lithium disilicate Press glazed (1.88) & polished (5.3), lithium disilicate CAD glazed (1.62) and polished (4.81) - ΔE value for specimens with a thickness of 1 mm à zirconia glazed (2.39) and polished (4,39), lithium disilicate Press glazed (2.0) and polished (4.7), lithium disilicate CAD glazed (1.55) and polished (4.32) - Materials that underwent the polishing process showed color changes above the specified tolerance limits - Lithium disilicate CAD showed the least color change for both material thicknesses, especially for the glazed group - The color change between the 2 material thicknesses within each material is not significantly different
Al Moaleem et al (2020)	- Immersion of the specimens in khat solution for 30 days - Thermocycling for 100 cycles every day for 30 days (5-55^{0}C, total 3000 cycles) - Color change measurements were based on spectrophotometric color parameters analysis; surface roughness was measured using a profilometer device	- Surface roughness in the polished group (PFM 1,18; feldspathic 1,93; zirconia 2,23) > glazed group (PFM 0,83; feldspathic 1,26; zirconia 1.32) for all materials - Both glazed and polished groups showed that the lowest color change was found in feldspathic materials (0.28 and 0.73) followed by PFM (0.56 and 1.34) and zirconia (1.58 and 2.52) - All materials showed significant changes in surface roughness and color changes after immersion and thermocycling process

data of the articles (name of authors, publication year, research purpose, and samples) while table 3 presents the treatment methods and research results. All research articles used in this scoping review are in vitro studies with a cross-sectional design.

DISCUSSION

The success of fixed prosthodontics treatment depends, in part, on its ability to restore function and aesthetics to the patient. The operator's ability to match the color of the fixed prosthesis to the adjacent teeth is one of the criteria for the success of the treatment in achieving its aesthetic function. Not only that, the color of these restorations, especially for ceramic-based materials such as zirconia and lithium disilicate, is also expected to last as long as possible to maintain optimal aesthetic function.[13] On the basis of this, several studies have tried to evaluate the potential for color change (color stability) on ceramic restoration materials that have been given various treatments such as thermocycling and immersion in several commonly used daily solutions. This scoping review paper aims to summarize and present the results of previous research regarding the color stability of ceramic-based restoration materials that have undergone a thermocycling process with/without immersion in staining solution. A total of 12 articles that had met the inclusion and exclusion criteria were reviewed, all of which are in vitro studies; The literature discussed shows that there are variations in treatment methods for ceramic materials as well as the types of ceramic materials studied.

The thermocycling process is used as a method for simulating the oral condition and its influence on the materials. Oral environment regularly experiences temperature changes and through the thermocycling process, the specimens are exposed to temperatures that have extreme differences which are repeated until a predetermined cycle. It is hoped that through this thermocycling process, thermal stress simulations can be obtained on materials that are aging through daily use in the mouth in a relatively short period.[12] However, until now there is no standard regarding the number of thermocycling cycles, time, and temperature that can be used, although there is general agreement regarding the use of temperatures between 5^{0}C and 55^{0}C which corresponds to fluctuations in oral cavity temperature.[23] All studies apply a thermocycling process with a temperature range between 5^{0}C and 55^{0}C, but there are variations in dwell time and number of cycles performed.

Nine studies evaluate lithium disilicate material,[1,3,6-8,13,21-24] 3 studies used ZLS (zirconia-reinforced lithium silicate) material,[612,21,22] 6 studies used zirconia material (monolithic and layered),[6,7,13,18,21,24] 3 studies used feldspathic ceramic materials,[8,12,18] and 4 studies used polymer-based materials (composite resin, hybrid ceramic, and nano-ceramic resin).[1,8,12,23] In particular, 1 study specifically studied the effect of lithium disilicate processing methods (CAD, CERAM, and Press with/without glazing) on the color stability.[3] All studies applied a thermocycling process to the research samples, but there were variations in the number of cycles carried out, with a range between 400 to 50,000 cycles , and dwell time in the range of 15-45 seconds. It should also be noted that not all studies wrote the dwell time applied to the thermocycling process. In regards to the immersion process, 3 studies did not carry out the immersion process, 8 studies carried out the sample immersion process in coffee, tea, wine, cola, mouthwash or curry solutions, and 1 study carried out immersion process in khat solution. The differences in the 12 articles discussed are factors for consideration related to variations in research results.

For lithium disilicate materials, two studies[3,24] compared the color change in variations of lithium disilicate materials fabrication (CAD, Press, and CERAM) and examined the effect of the glazing process on the color stability of lithium disilicate. Lithium disilicate fabrication from CAD technique shows the lowest level of color change compared to other fabrication types (Press or CERAM) after the thermocycling and coloring process. Lithium disilicate fabricated using the Press technique and did not undergo a glazing process shows the highest level of color change and is declared unacceptable clinically.[3] CAD type lithium disilicate has the best color stability because the material structure is quite stable and does not change easily after going through the thermocycling process. This good structural quality was also confirmed in the study through X-Ray XRD and infrared FTIR analysis. The glazing process aims to provide an additional layer on the surface of the ceramic material, so that the rough surface can become smooth.[3,24,26] This could be the reason why the materials that did not undergo a glazing process show the highest level of color change. Rough surfaces can increase the risk of water penetration which can then dissolve the silica components in lithium disilicate, resulting in decreased crystallinity and increased adsorption of color pigments. Seyidaliyeva et al in their research found that lithium disilicate material still experienced color changes and its potential was higher when immersed in several solutions compared to other materials studied. However, it is estimated that the color change that occurs is an external color change because the polishing process can return the color of the lithium disilicate back to before the solution immersion process was carried out.[1]

Zirconia material was evaluated in 6 studies[6,7,13,18,21,24] and gave varied results, although in general lithium disilicate showed equal or better color stability than monolithic or layered zirconia. The high potential for color change in zirconia material when compared to lithium disilicate is most likely caused by the zirconia crystal density that is not as good as that of lithium disilicate, causing more coloring pigments to penetrate. This occurs due to the low-temperature degradation (LTD) effect that occurs when zirconia is exposed to a wet environment. The LTD phenomenon is known to degrade the zirconia crystal structure from a tetragonal to a monoclinic structure, resulting in an increase in the material wear rate and an increase in surface roughness.[6,18,27] This surface roughness was also confirmed in several studies which found that zirconia materials, either standard or high translucency, has a larger surface particle size and a rougher texture compared to lithium disilicate and ZLS through SEM micrographic analysis.[18,21,28] However, all studies also concluded that the color changes that occur in zirconia materials are still below the clinical tolerance threshold, especially for the glazed materials . The results of these studies are also in accordance with the study by Subasi et al which stated that there was no significant difference in color changes between CAD-CAM monolithic ceramic-based materials after the thermocycling process.[29]

An exception was found in the study by Ashy et al which found that lithium disilicate material showed a greater color change (ΔE) compared to zirconia material in cementation scenarios with resin cement (both light cure and dual cure) although this difference was not statistically significant. However, the same study also noted that the differences in results were likely caused by variations in specimen preparation, simulation methods, and differences in the material composition used in each study.[7] This was also shown in the study by Haralur et al who used various staining solutions to examine potential color change between lithium disilicate, monolithic zirconia, and layered zirconia. Immersion of the materials in tea solution and chlorhexidine mouthwash showed the lowest level of color change in layered zirconia material, but this difference was not significant when compared to lithium disilicate.[13] In their research, Haralur et al used Press type lithium disilicate followed by a glazing process. Based on a study by Palla et al and Abdalkadeer et al, litihium disilicate Press showed greater color changes compared to lithium disilicate CAD and zirconia.[3,24]

Layered zirconia material shows better color stability which is thought to be due to the material's higher resistance to LTD. This higher resistance is reported to be due to having a higher crystal density and smaller crystal size making it more resistant to crystal transformation compared to monolithic zirconia. Not only that, microleakage that occurred due to the thermocycling process are not exposed because the zirconia is protected by the porcelain that coats the material.[13,30]

Polymer-based materials were evaluated in 4 studies.[1,8,12,23] Elter et al, Al Amri et al, and Aldosari et al evaluated nano-ceramic resin and hybrid ceramic materials, while Seyidaliyeva et al evaluated the color change in composite resin and nano-ceramic resin materials. All studies found that polymer-based materials showed the highest levels of color change compared to other materials including lithium disilicate. The results of these studies are also in accordance with previous research by Gawriolek et al which evaluated color changes in composite resin materials. This material's susceptibility to color changes is caused by the internal characteristics of resin-based materials which can experience imperfect polymerization, tend to be more porous, and easily absorb water so that it is easier to capture color pigments over time.[31] Not only that, the surface of the composite resin material also tends to become rougher than ceramic-based materials when the thermocycling process is carried out, so it is easier to catch color pigment particles over

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time if polishing is not carried out regularly. Routine polishing of resin-based materials is a vital control step to prevent permanent color changes. However, this polishing cannot return the color of the material back to its original color because over time internal discoloration will still occur.[1,32] Hybrid ceramic and nano-ceramic resin materials also did not show promising results due to the physical properties of polymer-based materials that have been described above although it gives slightly better results compared to composite resin; overall nano-ceramic resin showed higher color change but better translucency.[8,23]

Porcelain-based materials were studied in 3 studies.[8,12,18] Elter et al evaluated the color change in feldspathic ceramic and leucite-reinforced feldspathic ceramic and found that leucite-reinforced material provided better color stability when compared to other materials including lithium disilicate although in their study all materials showed color change that was above the clinical tolerance threshold after the thermocycling process and immersion in coffee solution were carried out. Additionally, the difference in color change with lithium disilicate was also found to be insignificant. It was also showed that feldspathic ceramic materials showed significantly greater color changes than leucite-reinforced materials. Most likely this is caused by the surface treatment process carried out on the sample material. Elter carried out a polishing process on all research samples. The polishing process based on a study by Aldosari et al showed greater surface roughness on feldspathic ceramic materials compared to the glazing process. This surface roughness is likely to have an influence on the color stability of the feldspathic ceramic material compared to leucite-reinforced feldspathic material. The addition of leucite components can provide a microstructure with less empty space so that it is more resistant to color changes.[3,8,12] The study by Al Moaleem et al used 2 types of feldspathic ceramic: CAD/CAM feldspathic and low-fusing feldspathic that will be fused to metal coping (PFM). It was found that low-fusing feldspathic showed lower surface roughness and thus better color stability. Al Moaleem et al proposed that this was due to the material having stable surfaces especially compared to zirconia.[18]

The ZLS is a modified material from lithium disilicate which combines zirconia crystals into a silicate glass matrix from lithium disilicate. Adding zirconia crystals aims to improve the mechanical characteristics of lithium disilicate so that it has better physical characteristics without reducing the aesthetic quality provided by lithium disilicate.[22] In this review, a total of 3 studies[12,21,22] used ZLS material to evaluate its color stability. The study of Aldosari et al and the study of Aljanobi and Al-Sowygh showed that the level of color change of the ZLS material was significantly below that of other materials after the thermocycling process including lithium disilicate in the study of Aljanobi and Al-Sowygh. However, it should also be noted that the translucency level of ZLS is still below lithium disilicate. The main composition of ZLS, which is still dominated by lithium disilicate, also helps the resistance of ZLS to discoloration because the material surface is relatively smooth compared to other materials such as zirconia and hybrid ceramic. The glass matrix plays a role in maintaining bonds between the ceramic particles, providing a protection to water infiltration.[12,21] The study by Cakmak et al specifically only examined ZLS material but with different thicknesses. In this study, a thickness of 0,8 mm showed a greater color change compared to a material thickness of 1,5 mm.[22] This result was in accordance with a previous study by Kandil et al which found that ZLS material with a thickness of under 1 mm showed a significant color change after immersion in coffee solution.[33] However, Cakmak et al also concluded that the color change that occurred in ZLS material with a thickness of 0.8 mm after the thermocycling process in coffee solution was still clinically acceptable.[22]

It was also found that several staining solutions, especially drinks, also influence color change parameter in ceramic-based materials. In this review, 9 studies examined the effects of various types of drinks other than water on temporary color changes in ceramic materials, although there were 4 studies[8,12,22,23] that only used coffee solution as the coloring solution. Based on studies by Palla et al, Seyidaliyeva et al, and Haralur et al, it is known that red wine, tea and coffee are the 3 main drinks that can significantly change the color of restoration materials over time.[1,3,13] These results are also in accordance with previous studies which found that these three types of drinks could significantly change the color of ceramic restoration materials. Specifically for red wine, it is estimated that the alcohol content in red wine plays a role in the degradation of the surface of the material, making it easier for water to penetrate and dye particles to enter/stick. Resin-based materials are very susceptible to color changes due to the influence of this alcohol.[8,34,35] Specifically for coffee drinks, which is one of the most favorite drinks in Indonesia above tea,[36] all studies show that coffee drinks can cause significant color changes. on restorative materials, specifically nano-ceramic resins, composite resins, and monolithic zirconia. However, for ceramic materials, a study by Seyidaliyeva et al showed that the discoloration disappeared after polishing the ceramic material. It is very likely that if routine polishing is carried out, the color of the restoration material that has been changed by drinking coffee (and other drinks) can be returned to its original color.[1]

On the other hand, cola solution was evaluated in 2 studies[1,23] and both provided quite contradicting results. Abdalkadeer et al showed that when immersed in cola solution, it would cause a color change in materials that is well above the tolerated threshold value, meanwhile Seyidaliyeva et al showed a relatively minimal change in material color. This is found after comparing the polished group in Abdalkadeer et al study with Seyidaliyeva et al study which only use a polishing process after material fabrication. This difference may be due to variation in color change measurement device or the difference in material thickness used in both studies. However, both studies also agreed that cola immersion may increase the surface roughness of the materials due to its acid content (phosphoric acid) and thus glazing may be more effective in preventing the color change given the fact that glazing process provide smoother surface than polishing process.[12,23] Finally khat was evaluated in one study by Al Moaleem et al.[18] Khat is a plant that regularly used for chewing in some middle-east countries. It is also known that khat may alter the surface of the enamel and thus also may increase the surface roughness of several restorative materials. In their study, Al Moaleem found that khat indeed caused the color change in materials tested, however the changes were found to be lower than that of natural teeth. They also concluded that more studies need to be conducted in order to clarify this finding.

Apart from the type of drink, several factors such as material surface treatment, material thickness, and cement type may also influence the material color changes to some degrees. Surface treatment is known to influence the surface roughness of the material. Studies by Palla et al, Aldosari et al, Al Moaleem et al, and Abdalkadeer et al found that materials subjected to the glazing process showed minimal surface roughness and thus also showed minimal levels of color change.[3,12,18,24]

For the material thickness, regardless of the translucency parameter, the material with a higher thickness will indicate a more minimal degree of discoloration. However, the thickness of the material will also affect the level of translucency and clinically this has the consequence of removing more tooth tissue.[22] Despite the results, it was also found that the color change was not significantly different between two different material thickness.[22,24]

Cement type independently does not significantly influence material color changes based on 2 studies[7,8]; material color changes are mostly influenced influenced by the physical characteristics of the material, the roughness of the material surface, and the type of staining solution exposed to the material. However, both studies also noted that light cure type cement was slightly better in terms of color stability compared to dual cure cement; specimens cemented with dual cure cement showed yellower color parameters after the thermocycling process. These results are also in accordance with several previous studies which found that dual cure cement showed greater discoloration. It is very likely that the effect of the amine accelerator content undergoing oxidation plays a role in this yellow color change.[37,38]

There are several limitations to this scoping review. The details of the thermocycling process, especially the number of cycles used and their daily use equivalence, still vary. Apart from that, not all of them use the same staining solution so they may give different research results. Also, several specimen details such as the thickness of the material and the brand of material used vary quite widely between the studies examined in this review. This could influence the results of research related to changes in material color. The existence of these factors in the literature reviewed in this scoping review could potentially cause confusion in the results of the study. Several variables such as cement type and material thickness were only evaluated in 2 studies each, so definite conclusions cannot be drawn regarding the influence of these variables on the color stability of ceramic-based restoration materials. In addition, all of the studies are in vitro studies, most of which are cross-sectional studies. The results of the studies discussed in this scoping review cannot necessarily be fully applied to clinical conditions in patients, considering that there are many variables that have not been precisely measured in this study, such as the number of drinks consumed, oral health conditions, material exposure to the oral environment, and others.

CONCLUSION AND SUGGESTION

Based on the 12 studies reviewed in this paper in relation to the evaluation of the potential for color changes (color stability) of ceramic-based restoration materials that have undergone a thermocycling process with/without additional staining processes, it can be concluded that: Lithium disilicate-based materials (including ZLS) generally have better color stability (lower potential for color change) compared to other ceramic materials (zirconia and feldspathic) and polymer-based materials (including hybrid ceramic); The thermocycling process causes an increase in the surface roughness of the material, changes in the crystal structure of the ceramic, and changes in the translucency of the material, causing statistically significant color changes among the materials studied, however, the changes are still within the tolerable clinical limits; Wine, tea, and coffee may cause significant discoloration of ceramic materials, significantly higher than other type of drinks; Glazing process on the ceramic surface may significantly lower color change potential compared to the polishing process; The surface roughness of lithium disilicate-based materials is lower compared to other restoration materials reviewed in this paper; The thickness of the restoration may influence the discoloration; restorations with a thickness of more than 1 mm show relatively minimal discoloration on ceramic materials with high translucency; The use of light-cured resin cement shows slightly less color changes compared to dual-cured resin cement; dual-cure cement shows a yellower color, although this difference is not statistically significant.

Considering the limitations of this scoping review, it is suggested that further investigations are needed in regards to the effect of material thickness and type of resin cement to the ceramic color changes. Also, more studies from more databases may be collected so a uniform data may be collected and thus more robust conclusion can be pulled.

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REVIEW

Accuracy of various scanning strategies in partial edentulous with digital impression

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Keywords: Digital impression, Intra oral scanner, Precision, Strategy scanning, Trueness.

ABSTRACT

Digital impression of partial edentulous in removable partial denture requires special attention, based on Kennedy's classification, amount of tooth loss and position will affect the accuracy of digital impression. Factors affecting accuracy of intra oral scanner are handling and learning, powdering, lighting, scanning distance, and scanning strategy. The scanning strategy is a certain movement when scanning to improve the accuracy of the virtual model. The accuracy of the scanning strategy in digital impression can be assessed based on trueness and precision. This literature review aims to explain the various scanning strategies on partial edentulous on digital impression accuracy. Most IOS manufacturers recommend specific scanning strategies. In removable partial dentures, it was found that modified scanning strategies were more accurate than the manufacturer's recommended scanning strategies in some clinical situations. For cases in Kennedy Class IV and Class III maxillae the scanning strategy from occlusal to palatal and then to buccal proved to be more accurate. In Kennedy's Class I maxilla, the T-R (Teeth-Ridge) strategy was more accurate than the M (Manufactured) and R-T (Ridge-Teeth) strategies with reduced seesaw effect and high stabilization of the partial removable denture framework. This requires special strategies that depend on the IOS system. The scanning strategy affects the accuracy of digital impression, where the manufacturer's recommended scanning strategy is not necessarily better than the modified scanning strategy. In addition, the location and case of tooth loss also affect the scanning strategy. (IJP 2024;5(1):44-49)

INTRODUCTION

Since the eighteenth century, conventional impression techniques have been used to record the three-dimensional geometry of dental tissues. Problems with conventional impression are usually volumetric changes in impression materials and dental stone expansion caused by deficiencies and properties of impression materials, errors in storage of impression materials, errors during impression, and errors in the process chain (disinfection, storage, transport, model fabrication). To overcome these difficulties, impression with IOS (intra oral scanner) was developed for dental practice.[1,2]

Hassiny et al. surveyed 1072 respondents from 109 different countries. More than three-quarters of the survey group (78.8%) used IOS in their daily practice, while 21.17% did not. Regarding the period of IOS usage, of the 78.8% (n=845) respondents who used IOS daily, 17.9% (n=151) used IOS for more than 5 years, 12.9% (n=109) for 3 to 5 years, 34.3% (n=290) 1 to 3 years, 25.3% (n=214) less than 1 year, and 9.6% (n=81) less than 1 month.[3]

Impression of partial edentulous in removable partial denture manufacturing with digital impression (Intra Oral Scanner) requires special attention. Based on Kennedy's classification, tooth loss and position, and hard and soft tissue support will affect the accuracy of digital impression.[4] Factors affecting accuracy of intra oral scanner are handling and learning, powdering, lighting, scanning distance, and scanning strategy.[1] Scan strategy means that the scanner head is moved in a specific direction so as to improve the accuracy of the virtual model. Scan strategy means that the scanner head is moved in a specific direction so as to improve the accuracy of the virtual model.[1] A prerequisite for intraoral scanning is the accuracy of the resulting

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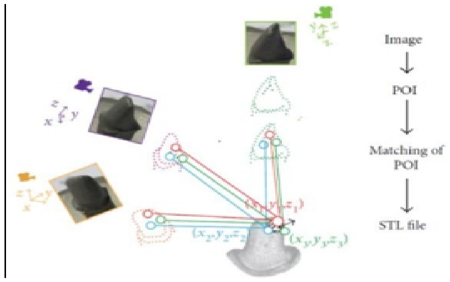

Figure 1. STL formation using IOS

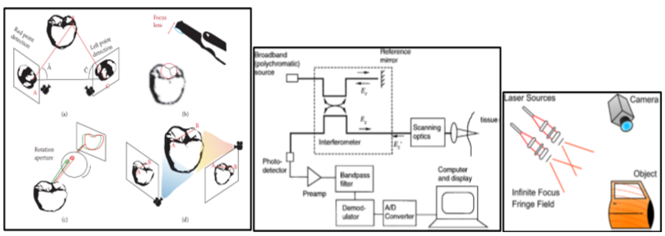

Figure 2. Determining the distance to an object. A. Triangulation: the distance BC can be determined based on the formula $BC = AC \times \sin(\hat{A}) / \sin(\hat{A} + \hat{C})$, B. Confocal: the distance to the object is determined according to the focal distance, C. AWS requires a camera and an off-axis that moves on a circular path around the optical axis and results in rotation of the points of interest, D. Stereophotogrammetry is a technology that generates files by algorithmically analyzing multiple images, E. OCT system diagram, F. AFI working principle.

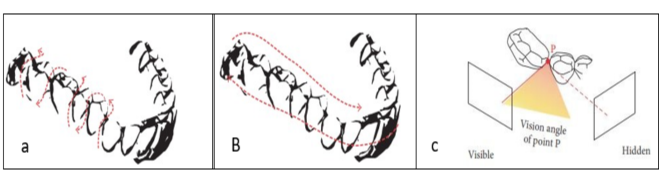

Figure 3. A. One-way scanning (S motion on vestibular, occlusal, and lingual surfaces, B. Linear movement on the occlusal-palatal surface followed by the buccal surface, C. Proximal surfaces cannot be scanned if the scanning strategy is not adjusted.

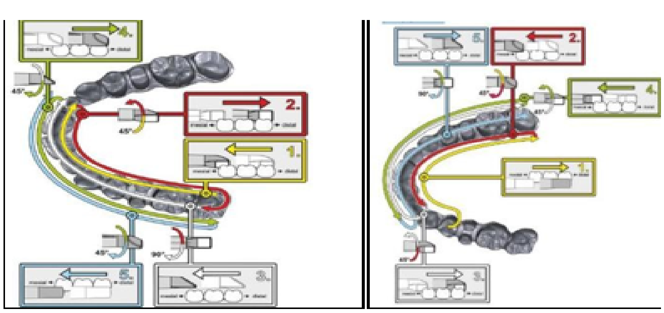

Figure 4. Scanning strategy Triangulation and Confocal (Omnicam) Technology A. Stage 1, B. Stage 2.

virtual impression. The accuracy of the scanning strategy in digital impression can be assessed based on trueness and precission.[5-7]

Various scientific analyses have shown the influence of scanning strategy on the accuracy of data capture, both in vitro and in vivo. Capturing structureless areas and areas with steep slopes, such as the anterior mandibular area, often proves difficult. This requires specialized strategies that are system-dependent. Rather than relying solely on technical specifications, it is also important for users to try out the scanning system they are interested in.[8]

The aim of this study was to elucidate various scanning strategies on partial edentulous on digital impression accuracy.

LITERATURE STUDIES

Intra Oral Scanner (IOS)

IOS is a device for recording the surface of tooth structures and surrounding tissues directly in the patient's mouth to obtain digital impressions.[9] IOS consists of a handheld camera, computer and software. IOS can record with precision the three- dimensional geometry of an object. The most widely used digital formats are open STL (Standard Tessellation Language) or locked STL-Like. These formats describe triangulated surfaces where each triangle is defined by three points and surface normals . However, there is a proliferation of other file formats that record the color, transparency, or texture of dental tissues (such as Polygon File Format, PLY files). Regardless of the type of scanning technology used by the IOS, all cameras require light projection to record individual images or videos and are compiled by the software after acquiring POIs (Points of Interest). The first two coordinates (x and y) of each point are evaluated on the image, and the third coordinate (z) is then calculated depending on the distance to the technological object of each camera, as described in figure 1.[1,10]

Indications and Contraindications of IOS

In the field of prosthodontics, IOS indications are: resin inlays/onlays, zirconia copings, single-tooth restorations in lithium disilicate, zirconia, all ceramic, frameworks and partial dentures in zirconia (4-5 elements), crowns with single implants, implant bridges (4-5 implants), implant-supported bars (≤4 implants), posts and cores, removable partial dentures, Digital Smile Design, and obturators.[11]

Contraindications of IOS in prosthodontics: long span/or full arch fixed partial denture (6-8 elements), implant supported partial fixed denture (6-8 elements), implant supported long span/or full arch fixed partial denture (6-8 implants), and removable full denture.[11]

Advantages and Disadvantages of IOS

Some of the advantages of using IOS in dental practice are real visualization, selective repetition, selective capture of relevant areas, no need to disinfect and clean dental impressions and impression trays, preparation/restoration analysis options, no model wear, rapid communication and availability, archiving, economical use of materials, chairside, virtual cutting tools, virtual follow-up, true-to-life representation, possibility of data fusion, and reduced patient discomfort.[8,11]

Besides the many advantages of using IOS, there are some disadvantages, including: Learning Curve, unable to obtain static and dynamic occlusion, high cost, difficulty in detecting marginal lines on prepared teeth, and requires a scanning strategy.[8,11]

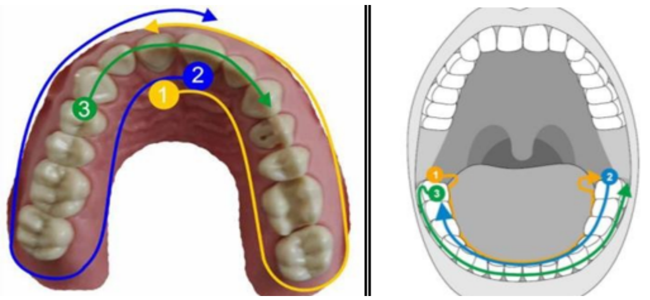

Figure 5. A. Procedure of the triangulation technology scanning strategy (Primescan) for the upper jaw, and B. For the lower jaw.

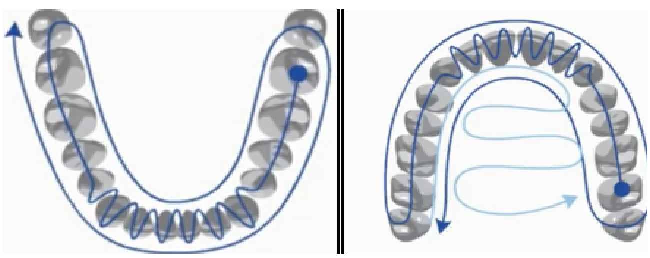

Figure 6. A. Scanning strategy of confocal technology (TRIOS) of the mandible, and B. Of the maxilla.

IOS Technology

There are various types of IOS technologies such as triangulation, confocal, Active Wavefront Sampling (AWS), Stereophotogrammetry, Optical Coherence Tomography (OCT), and Accordion Fringe Interferometry (AFI).[1,12] Triangulation is based on the principle that the position of a triangular point (object) can be calculated by knowing the positions and angles of two viewpoints. Confocal imaging is a technique based on acquiring focused and unfocused images of a selected depth so as to detect areas of image sharpness to infer the distance of the object correlated with the focal length of the lens. AWS is a surface imaging technique, which requires a camera and an off-axis aperture module, where the module moves on a circular path around the optical axis and produces POI rotation. Stereophotogrammetry estimates all coordinates (x, y, and z) through algorithmic analysis of the image. OCT is an interferometric imaging technique that provides cross-sectional images of the subsurface microstructure of a target object, such as biological tissue. AFI technology uses a laser beam and utilizes interference patterns created from multiple laser sources, to produce a perfectly focused and highly accurate fringe pattern on the target object.

rotation of the points of interest. (d) Stereophotogrammetry is a technology that generates files by algorithmically analyzing multiple images. (e) OCT system diagram (f) AFI working principle.[1,12]

IOS Accuracy

The accuracy of IOS scan results is measured based on trueness and precision. Trueness is defined as the ability of the IOS to capture the 3D geometry of an object that is closest to its original dimensions, while precision indicates the reproducibility of the IOS scanning results under the same conditions.[5-7] The accuracy and precision of digital impressions using IOS depend on the operator, the equipment used and calibration, the time elapsed between measurements, and the environment (temperature, humidity, etc.).[10]

Factors that affect accuracy

Handling and Learning

While digital impression is more convenient and faster than conventional impression, mastering the use of IOS technology takes time and experience. Each IOS has specific technology and different scanner head size and weight. For example, it has been reported that clinicians prefer to use Trios over iTero even though both IOSs use confocal technology.[1]

Shimmel et al conducted an in vitro study and determined: The accuracy of IOS for partially and fully edentulous arches is high, and experience with IOS has little influence on scanning accuracy.[13]

Powdering

Dental tissues such as enamel or restoration surfaces have many reflective surfaces that may interfere with POI matching due to overexposure. To solve the problem, the operator can change the orientation of the camera or install a polarizing filter to even out the light distribution. In addition, the use of 20-40 μm powder coating is sometimes required during the image capture process to avoid reflections. However, the use of powder can cause discomfort for the patient and the scanning time becomes longer due to saliva contamination, requiring cleaning and reapplication. So far, no significant difference has been found on the effect of powder on scanning accuracy.[1]

Lighting

Ambient lighting conditions affect IOS accuracy and the use of different IOS technologies results in different scanning accuracy. Therefore, lighting conditions need to be adjusted to the IOS technology system used. From research conducted by Revilla- Leon et al (2019), iTero IOS has better accuracy when using seat lighting of 10,000 lux and a room of 1003 lux. CEREC Omnicam has better accuracy with conditions without lighting, while TRIOS 3 is more suitable with room lighting conditions of 1003 lux.[14]

Scanning distance

The distance between the scanner head and the scanned object surface affects impression accuracy. According to Rotar et al (2022), a scanning distance of less than 5 mm or more than 15 mm will negatively affect the impression accuracy with the IOS used (Medit i700). A scanning distance of 10 mm between the object and the scanner head produces the best accuracy.[15]

Scanning strategy

Scan strategy means that the scanner head is moved in a specific direction so as to improve the accuracy of the virtual model. The scanned object should be positioned in the center of the acquisition area to depict the optimal scope around the object. The operator should also maintain a trajectory of movement, always keeping a stable distance and the gear centered during recording. The camera should be held between

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5 and 30 mm away from the scanned surface depending on the scanner and technology.[1,16]

For IOS using confocal technology, when scanning the entire arcade is required, different strategies are described by the manufacturers. One is a linear motion on the entire palatal occlusal surface followed by the buccal surface. The other procedure consists of S-movements on the vestibular, occlusal, and lingual surfaces of each tooth in sequence. The first strategy seems to limit spatial distortion by completing the image capture at the starting position, thus avoiding the overall one-way error, but the linear movement of the vestibular scanning may not be precise on the interproximal area. These technical observations lead practitioners to adjust their clinical protocols in difficult areas such as the interproximal zone, tooth preparation, central incisors with high arches, and axis changes around canines. However, imaging areas with steep slopes, such as the anterior mandibular area, is often associated with difficulties in image processing.[1]

Effect of Scanning Strategy

Different IOS manufacturers have proposed different scanning strategies based on the technology used. The scanning strategy refers to the specific path followed by the IOS head along the scanned object. Although the actual impact of the scanning strategy is not fully understood, variations in accuracy have been reported depending on the scanning strategy used. In addition, the effect of scanning strategy on the accuracy of digital scanning is reported to vary depending on the IOS used.[5,17-21]

Most IOS manufacturers recommend specific scanning strategies for their systems, but those strategies are usually described for dentate arches. Different scanning strategies and techniques for scanning edentulous and partial edentulous arches have been described, but accuracy analysis is still lacking.[5]

Strategy Scanning Recommendations from the Manufacturer

There are several recommended scanning strategies from several IOS technologies, namely: triangulation and confocal technology (Omnicam), triangulation technology (Primescan), and confocal technology (TRIOS).[22]

Triangulation and Confocal (Omnicam) Technology[22,23]

The following scanning strategy is divided into two stages.

Stage 1, : (1) Start as shown above, on the occlusal surface of the right terminal tooth, and scan occlusally. Tilt the scanner by 45° in the palatal (oral) direction and aim from distal to mesial. (2) Tilt the scanner another 45° in the palatal (oral) direction and move it distally. (3) Tilt the scanner by 90° to the occlusal surface and move it mesially. (4) Tilt the scanner 45° buccally and move it back distally. (5) Then tilt the scanner another 45° buccally to a total of 90° and move it mesially again.

Stage 2, namely: (1) Start by placing the device on the occlusal surface of the premolar tooth, which has already been scanned, and point the scanner in the palatal (oral) direction with a mesial tilt of up to 90° across the lingual surface of the front teeth in a distal direction towards the terminal premolar tooth. (2) Tilt the scanner slightly by 45°, so that the scanner is only tilted by 45° in the palatal (oral) direction moving from the distal and posterior parts mesially to the front teeth. (3) Once you reach the front tooth area, point the scanner 45° to the buccal side and tilt the scanner by 45° from mesial to distal direction. (4) When you reach the distal part, tilt the scanner by another 45° (90° in total) to the buccal side and point the scanner from the distal part back to the mesial direction. (5) Once you reach the front tooth area, tilt the scanner in the occlusal direction and point the scanner mesial to the occlusal surface right to the rear distal molars.

Triangulation Technology (Primescan)[24,25]

The triangulation technology scanning strategy (primescan) was divided into maxilla and mandible. Procedure 1 for the maxilla includes: (1) Start with the mouth surface of the anterior teeth and move the scanner toward the mouth along the quadrant. Move the scanner past the distal teeth to the vestibular side and trace the first quadrant to the anterior teeth. Gently tilt the scanner by approx. 30° in the coronal- apical direction. (2) Move the scanner as shown under (1) for the second quadrant. (3) Then scan the anterior teeth from cuspid to cuspid in the coronal apical direction. Ensure that both the labial surface and the oral surface are visible. Extend this third scan to a location where you can see the scanning hole.

Procedure 2 for the mandible includes: (1) Start occlusally at the distal tooth, tilt the scanner approx. 60° towards the mouth and move it orally along the dental arch to the opposite distal tooth. (2) Move the scanner occlusally from the distal tooth across the entire dental arch back to the other side. (3) To complete scanning, tilt the scanner approx. 60° buccally and move it buccally along the entire dental arch.

Confocal Technology (TRIOS)[25,26]

The confocal technology scanning strategy (TRIOS) is divided into the mandible and maxilla. The lower jaw starts from the occlusal, lingual and buccal surfaces. The maxilla starts from the occlusal, buccal, lingual and then palatal surfaces (if required).

Modification of Scanning Strategy in Some Studies

Jamjoom et al. conducted an in vitro study with six scanning strategies and two ios on maxillary and mandibular edentulous arch typodonts. The six scanning strategies were a). BOP (Buccal-Occlusal-Palatal), b). POB, c). OBP, d). OPB, e). ZZ-P, and f). ZZ. The POB scanning strategy produces a virtual model with the highest accuracy and the ZZ strategy the lowest compared to others.[5] Chang et al. suggested that the recommended scanning strategy for maxillary Kennedy Class I is the TR (Teeth-Ridge) strategy due to the reduction of the seesaw effect and high stabilization of the RPD frame compared to the M (Manufactured) and RT (Ridge-Teeth) strategies.[16] Muller et al. suggested that scanning strategy B (occlusal-palatal first, buccal return) might be recommended because it provides the highest trueness and precision in full-arch scanning and therefore minimizes inaccuracies in the final reconstruction compared with strategy A (buccal surface first, occlusal-palatal return) and strategy C (one-way S-type).[27] Saidan et al. recommended a scanning strategy for Kennedy Class IV maxillary jaws from occlusal to palatal then finally to buccal because it produced the highest trueness value compared to the other seven groups (Kennedy Class I, Class II, Class I modification 2, Class II modification 1, Class III, Class III, and Class III modification 1).[28]

DISCUSSION

Muller et al investigated scan strategies influence accuracy digital impression. Saidan et al said that different partially edentulous conditions affected the trueness of the scan generated from the selected intra oral scanner.[28] Digital impression of partial edentulous in removable partial denture requires special attention; Kennedy classification, amount of tooth loss

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and position, and hard and soft tissue support will affect the accuracy of digital impression. Therefore it is necessary special scanning strategies for Kennedy Classification Class I,II, III, and IV.

In some studies, it was determined that the scanning plane affects the accuracy of IOS. Mizumoto et al in their study found that the accuracy and precision of digital scanning of the non-toothed maxillary arch, regardless of the suturing or unsuturing of the palate and the position of the implant had a significant effect on its trueness.[19] Various scientific analyses have shown the influence of scanning strategy on the accuracy of data capture, both in vitro and in vivo.[8] Different IOS manufacturers have proposed different scanning strategies based on the technology used. Most IOS manufacturers recommend specific scanning strategies for their systems, but those strategies are usually described for dentate arches. Different scanning strategies and techniques for scanning edentulous arches have been described, but accuracy analysis is still lacking.[5] Zarone et al investigated the effect of different scanning strategies on the accuracy of intraoral scanning in vitro and concluded that scanning strategy has a significant impact on scanning accuracy, in particular, when anatomical landmarks are well-defined.[18] The scanning strategy also depends on the IOS system used, Medina et al. investigated the impact of scanning strategy on the accuracy of four IOS systems and different results for other systems.[29]

Some studies explained digital impression in edentulous partials is only indicated in Kennedy Classifications III and IV, but some studies have been conducted in Kennedy Classifications I and II with modified scanning strategies and the impression accuracy is not significantly different from other classifications. In the Kennedy Class I maxillary condition, the modified scan strategy is better than the recommendations, in the Chang et al study suggesting that the recommended scan strategy for Kennedy Class I maxillary is the TR (Teeth-Ridge) strategy due to the reduction of seesaw effect and high stabilization of the maxilla. The RPD framework was compared with the M (Manufactured) and RT (Ridge-Teeth) strategies.[16] Saidan et al. recommended a scanning strategy for Kennedy Class IV maxillary jaws from occlusal to palatal then finally to buccal because it produced the highest trueness value compared to the other seven groups (Kennedy Class I, Class II, Class I modification 2, Class II modification 1, Class III, Class III, and Class III modification 1).[28]

CONCLUSION

The scanning strategy affects the accuracy of digital impression, where the manufacturer's recommended scanning strategy is not necessarily better than the modified scanning strategy. In addition, the location and case of tooth loss also affect the scanning strategy.

SUGGESTIONS

Further research is needed on scanning strategies in partial

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REVIEW

The benefits of adding eggshells to the porosity and flexural strength of temporary fixed denture in long-term-use

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Keywords: Eggshell, Flexural strength, Polymethyl methacrylate, Porosity, Temporary fixed denture.

ABSTRACT

Temporary fixed partial dentures (FPD) are worn for a limited time before definitive FPD, but in some cases like crown lengthening procedures, supra structure implant, temporomandibular disorders, and endodontic treatment, require long-term temporization. Polymethyl Methacrylate (PMMA) which is commonly used for temporary fixed dentures has weaknesses, namely porosity, low value of flexural strength and impact, low abrasion resistance, ease of fracture, shrinkage after polymerization, and leaves monomer residue, so modification is needed with the addition of reinforcing materials. Reinforcement like fiber filler is difficult to absorb resin monomers causing space between the surfaces of fiber and polymer matrix thereby reducing the mechanical strength of the resin. Eggshell is a natural source of calcium, has the potential as a biocompatible material with an economical price, and is easy to obtain as an alternative material for PMMA reinforcement. This paper discusses the long-term use of temporary FPD, PMMA as a temporarily fixed material, and the benefit of eggshell waste to porosity and flexural strength of PMMA materials. The addition of eggshell to PMMA for temporary fixed restoration could decrease porosity and increase the flexural strength of PMMA material because it contains calcium carbonate so that it could be used for the manufacture of provisional fixed restoration which requires long-term use. (IJP 2024;5(1):50-54)

INTRODUCTION

The placement of temporary dentures is an important part of the procedure fixed denture treatment. A temporary fixed partial denture (FPD) is a fixed denture designed to improve aesthetics, stability, or function over time limited before being replaced with a definitive denture. Temporary FPD is temporarily used for assessing the effectiveness of the therapeutic plan, and the form, and function of the definitive FPD.[1]

Temporary FPD is usually immediately replaced with definitive FPD, but in certain conditions such as in treatment crown lengthening, the procedure of implant superstructure, endodontic treatment, and treatment of temporal mandibular disorder need a longer period of 2 to 6 months or until a definitive prosthetic can be administered to the patient.[2-8]

Temporary FPD is designed for the complex oral environment. In clinical conditions, temporary FPD will accept various forces during mastication including compression, tension, and shear force. Maximum pressure the occlusal pressure can reach 900 N in adult posterior teeth and the pressure mastication is between 100-300 N. Maximum frequency of occlusal pressure can occur up to 3000 times per day, it is a consideration that temporary FPD has a large load for a long time and repeatedly in daily use, so a material with adequate flexural resistance is needed.[9] Temporary FPD also should not dissolve in oral fluids. Many materials are commonly used for the fabrication of temporary FPD, one of which is polymethyl methacrylate (PMMA).

PMMA material has limitations and it could cause problems. These include easy to fracture, low abrasion resistance, low flexural resistance, and porosity. These limitations could interfere with biofunctionality temporary FPD, especially when it is used for a long time.[10]

Porosity will decrease restoration strength and make

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of microorganisms to the restoration surface.[11] Low flexural strength will cause denture wear and fracture because of occlusal force during its function. Damage can also occur while adjustment during the process of the treatment period so in some situations temporary FPD is needed to be repaired.

To overcome the limitations of PMMA, reinforcing material is needed. Many reinforcing materials, both synthetic and natural, are used as reinforcement PMMA. Reinforce materials such as fiber or polyethylene fibers are difficult to absorb resin monomers, resulting in space between the fiber and matrix surfaces and reducing resin strength.[12,13] Eggshell is known as waste that is easily obtained in large quantities and has the potential as a PMMA reinforcement material because it has 90% calcium content.[12]

This paper aims to discuss the long-term use of temporary FPD, PMMA as a temporary FPD material, and the benefits of adding eggshell to the porosity and flexural strength of temporary fixed denture in long-term use.

LITERATURE STUDIES

Temporary Fixed Partial Denture

Temporary FPD protects the pulp, maintains health periodontal, accelerates the tissue healing process, evaluates hygiene procedures, avoids displacement of abutment teeth, improves aesthetics and phonetics, presents an adequate occlusion scheme, evaluates intermaxillary relationships with patients, improves the patient's social life, and the diagnostic function as a prototype the outcome of the treatment that the patient will receive.[2-6] To make temporary FPD function optimally, it must qualify for the biological, aesthetic, and mechanical requirements.[2,3,7,8] Biological requirements can protect the pulp, prevent enamel fracture, maintain periodontal health, occlusal compatibility, and tooth position. Aesthetic requirements that must be owned by temporary FPD have color and can be manipulated so that its shape can resemble real natural teeth close together. The mechanical requirements are resistance to fracture, ability to withstand occlusal forces in the oral cavity when it functions and must be retentive, manipulated, and reassembled without damage, smooth surface so that it will be advantageous both aesthetically and biologically, good margins, tensile strength, and adequate dimensional stability, and easy to repair.[2-4,6,7,14]

Type of Temporary Fixed Partial Denture

Based on the method of making temporary FPD is divided into custom and preformed.[7,14] Custom temporary FPD is made according to the patient's teeth condition before preparation or on a modified diagnostic model, whereas preformed temporary FPD is currently available on the market. When temporary FPD installation is preformed, it needs readjustment to the patient's dental condition.[2,14] The technique of fabrication of temporary FPD could be direct, indirect technique and a combination of techniques from direct indirect. Advantages of indirect technique are occlusal and aesthetic adjustments can be made at the articulator, there is no contact of oral tissues with monomers, avoiding the prepared tooth from heat during the resin polymerization process, good marginal fit, reduce inhalation hydrocarbons volatile by the patient. The disadvantage of this technique increases the processing time, requires a laboratory process, and potentially increases the cost of processing. The direct technique has the advantages of being cheaper and easier to perform, but the drawback of this method is the residual monomer polymerization left behind can cause inflammation of the tissue, and heat of reaction exothermic irritation could irritate the pulp causing pain and discomfort to patients, poor marginal margin adaptation.[2,4,6-10] Combined direct and indirect technique is a hybrid technique that combines laboratory work with intra-oral relining.[4]

Temporary Fixed Partial Denture Material

Temporary FPD could base on metal or resin material. Resin-based materials used in manufacturing temporary FPD such as polymethyl methacrylate (PMMA), polyethyl methacrylate (PEMA), polyvinyl methacrylate (PVMA), bis acrylic resin, and VLC urethane dimethacrylate.[4]

Polymethyl Methacrylate (PMMA)

The advantages of PMMA are its low density, aesthetics, economical, easy to handle during manufacture and repair, manufacture of embrasure larger ones with smaller contact points between adjacent teeth will be beneficial for periodontal tissue as well as better aesthetic appearance, easier to apply in humid areas suitable for intra-oral conditions, and has better color stability than bis acrylic.[3-5,7,14,15] Heat-cured PMMA has a higher degree of polymerization, produces less residual monomer, higher flexural strength, and fracture resistance than self-cured PMMA. According to Supichaya, et al. (2018) the flexural strength after artificial aging proses with thermocycling 5000 cycles, heat cured PMMA has higher flexural strength value compared to acrylic self-cured and bis-acrylic materials.[16] These advantages make PMMA widely used in dentistry, however, PMMA also has some limitations.

The limitations of PMMA are porosity, easy to fracture, low value of flexural strength, impact as well as low resistance to abrasion, shrinkage after polymerization, leaving monomer residue, the exothermic reaction of polymerization which can irritate the pulp and periodontal tissues, discoloration when usage, marginal inaccuracy, and external contour non-integrity of temporary FPD.[3,7,10] This weakness will interfere it function especially when used long-term.

Temporary Long-Term Use of Temporary FPD

Indications for long-term use of temporary FPD when implant procedures require a healing process, crown lengthening procedure which takes 3-6 months, temporomandibular disorder therapy requires occlusal adjustment and endodontic treatment. This duration use is related to tissue healing procedures, monitoring patient comfort and satisfaction, and making any necessary adjustments.[4,10,16-18] In long-term use of temporary FPD problems can be encountered, including a decrease in mechanical strength associated with a value of porosity and low flexural strength of PMMA materials.[16]

Porosity and flexural Strength PMMA

Porosity is a complex phenomenon caused by various factors such as laboratory techniques, methods, and polymerization materials. All related factors with laboratory techniques that affect the porosity value, as known as the ratio of powder and liquid, mixing process of powder and liquid, pressing, flask cooling, and controlled polishing time.[19] Porosity creates

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space within the matrix which will cause a stress point so that the restoration breaks while performing its function in the oral cavity. Porosity is also detrimental in the biological aspect, increasing the attachment of microorganisms to restoration surface.[11] There are two types of acrylic resin porosity, gaseous porosity or internal porosity and contraction porosity. The porosity formed in the thick part and away from the heat source is called gaseous porosity or internal porosity. Gaseous porosity formed due to evaporation of the remaining unreacted monomer to form air voids called porosity.[19]

Flexural strength, also known as modulus of rapture or transverse strength is the resistance of PMMA after polymerization to vertical load is applied to the test rod supported at both ends until the rod break. Flexural strength can describe as the resistance of objects in receiving masticatory load. Temporary FPD must have resistance to occurrence of fractures and permanent deformities.[10,16]

Fractures are caused by the distribution of surface cracks, flexural strength, impact, and inadequate fatigue resistance. During function and parafunctional movements, fractures can occur due to pressure concentration, especially in the area connector, or on a blank area. Fractures of the cervical region are caused by inadequate preparation so that the restoration walls are too thin. The fracture that occurs results in a temporary disruption of the function of the restoration, causing discomfort to the patient, and harming the prepared tooth, and the periodontal tissues.[6] To overcome the problem due to the weakness of PMMA, modifications were made to improve PMMA properties by adding PMMA reinforcing material.

PMMA Reinforcing Materials

To improve the mechanical properties of PMMA, especially in long-term use, several reinforcing materials have been used such as the addition of fiber fillers like carbon fiber, glass fiber, and polyethylene fiber. The fiber material is difficult to absorb the monomer resin, which causes spaces between the polymer matrix and can cause a decrease in the mechanical strength of the resin material.[12,13] The mechanical properties of PMMA materials are affected by shape, size, and distribution of filler particles in the matrix.[20] In addition to reinforcing materials in the form of metals, synthetics, and chemicals, there are also PMMA reinforcing materials that come from nature. Natural materials used to strengthen the mechanical properties of PMMA such as nano cellulose from rice husk, chitosan, and eggshell.[21]

Eggshells as a Reinforcement Material

According to statistical data from the Ministry of Animal Husbandry and Animal Health Agriculture In 2019, the average egg production from 2015 to 2019 in Indonesia reached 3,953,411.4 tons.[22] Eggshells contain calcium ($CaCO_3$ 90.93%) and other microelements such as magnesium, boron, copper, iron manganese, sulfur, and zinc. Another advantage possessed by eggshells is that they are easy to find in large quantities and low prices.[18,23] Eggshell be converted from eggshell waste to hydroxyapatite form.[23] Eggshell is expected to be the best natural source of calcium with 90% absorbable.[24]

In the field of dentistry, egg shells have been used as a denture base acrylic mixture to increase the strength of the denture base, for direct pulp capping, as a tooth remineralization material after the etching process, and add shear bond strength with bulk composite, as an ingredient polishing agent for denture bases, as an additive in toothpaste, and procedures bone graft.[12,21,25-28]

Eggshell is a biocompatible material that will not only in improving the mechanical and physical properties of PMMA as temporary FDP material but also as an environmentally friendly material.

DISCUSSION

After aging heat cured acrylic has highest strength and hardness value, compared with autopolymerization acrylic material and bis acrylic (Antonio, et al. 2017). There is no significant difference between strength self-cured acrylic and bis-acrylic. The highest strength of heat-cured acrylic due to the process experienced by this material significantly affects the strength of acrylic. Heat-cured acrylic through a process of heat activation and compression molding (flasking), creating a homogeneous mixture of materials, and bubble-free with high resistance higher than other materials. Because of their hardness and functional stability heat-cured acrylic are recommended for periods longer than 1 month. Self-cured acrylic is suggested uses of FPD 1-3 units with minimum thickness of 1 mm, and using cooling techniques when polymerizing, or used on teeth non-vital to prevent the risk of overheating. Bisacrylic used for a short period of time up to 15 days.[29] According to Anil K Gujjari, et al. 2013, bis-acrylic has higher flexural strength than PMMA after immersion for 7 days. The difference in strength between PMMA and bis-acrylic is derived from different monomer compositions. Bis-acrylic has multifunctional monomers that increase strength through cross-linking with other monomers. The addition of inorganic fillers can increase the strength and microhardness. [30]

Abbas Ibrahim Husain (2020) conducted research on the use of particles eggshell as a mechanical property reinforcement of PMMA, eggshell powder increased the tensile strength of PMMA material at concentrations of 1% and 2%, then tensile test decreased at 3% and stabilized at the addition of 4% powder eggshell. Flexural strength increases in increments of 1-3%, but begins at 3% the flexural value decreases, this proves that there is a bond limitation between eggshell powder and composite materials. From this research, it is stated that, the benefits of adding egg shells have a good effect on the mechanical properties of PMMA, but not exceeding 2% eggshell concentration.[31] Maulida Lubis, et al. (2021) conducted research on the effect of nanoparticles eggshell as filler in acrylic resin biocomposite denture base. Flexural strength significantly increased with the addition of 10% then decreased at concentrations of 20% and 30%. The addition of more than 10% eggshel nanoparticles causes saturation to occur which will cause a decrease in the strength of the sample. The addition of 30% filler reduces the strength value due to particle concentration higher filler will increase the interaction between the filler particles which produces agglomerates. Agglomerates that occur due to high concentration. The filler material for the composite structure is not homogeneous, stress points occur in the matrix which will cause cracks.[32]

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Aseel M Abdullah, et al. (2019) researching on impact strength, modulus flexural, and wear rate from PMMA already given as reinforcing material for eggshells powder. They mix PMMA ingredients with untreated eggshells (UTESP) and treated eggshell (TESP) with ratios 1, 2, 3, 4, and 5 wt%.[33] It was found that there was an increase in modulus flexural along with increased addition of eggshell powder with TESP. Modulus flexural value TESP is higher than UTESP. Crack propagation can be converted into a good bond between the PMMA matrix and eggshell particles related to the natural properties from eggshell particles bound to PMMA. Addition of powder eggshell in PMMA reduce wear rate of PMMA.[33]

Ronaldo Triputra, et al. (2019) doing research regarding the effectiveness of adding hydroxyapatite to decrease the porosity of the base heat cured acrylic resin. The test was carried out in the control group, group 1 with the addition of 2% hydroxyapatite concentration, group 2 with the addition of 5% hydroxyapatite, group 3 with the addition of 10% hydroxyapatite. In control group results obtained an average porosity of 8.53%, in the group 1 test the average porosity is 7.75%, group 2 is 4.47% and group 3 is 5.53%. From result, their research found that the residual monomer after polymerization which binds to hydroxyapatite can reduce the porosity of the acrylic resin. According to the results of the study, it was found that the addition of too many particles (in groups 2 and 3) can cause material defects, thus causing deposition of particles in the resin, and the addition of excessive particles when reaching the saturation point of the matrix will cause discontinuity of the resin matrix. The addition of hydroxyapatite has a role in reducing the porosity of the resin plate acrylic heat cured.[19] M Lubis, et al. (2019) who made observations with SEM of 1500 times magnification on a PMMA denture base treated with reinforcement in the form of eggshell nanoparticles, it is stated that not occur space void on the addition of 10% eggshell nanoparticles, but at the addition of 30% eggshell nanoparticles has a fractured surface structure that coarse and many voids formed in the sample.[12]

CONCLUSION

Long-term use temporary FPD in cases of temporomandibular disorder treatment, crown lengthening procedure, supra structure implant procedure, and endodontic treatment, takes a long time to heal and requires adjustment occlusal so that a strong temporary FPD is needed for optimal function until definitive FPD can be achieved by patient. Heat-cured PMMA has the value of flexural strength and durability better fracture resistance compared to self-cured PMMA and PMMA light polymerization, PMMA also has more strength after repair so good that it becomes an option for long-term temporary FPD.

Porosity occurs in dentures due to the presence of non absorbable monomer residues adsorbed after the polymerization process. The gaps between the polymer matrix surface as well because of temporary FPD fracture. Adequate flexural strength is needed to withstand complex masticatory forces without permanent deformity and avoid temporary FPD waste in the form of micro powder/nanoparticles can be an alternative to PMMA reinforcing biocompatible materials to improve strength flexibility and porosity at a low price and easily available and friendly environment.

SUGESSTION

The addition of reinforcing materials from eggshell waste at certain concentrations to reduce porosity and increase the value of the flexural strength of PMMA materials in order for optimal function of temporary FDP requires further research.

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ORIGINAL ARTICLE

Influence of immersion in heat-cured resin acrylic in chitosan solution to hardness, transversal strength and modulus of elasticity

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Keywords: Chitosan, Hardness, Heat-cured acrylic, Modulus of elasticity, Transversal strength.

ABSTRACT

Heat-cured acrylic resin is a commonly used material for removable denture bases but has a low mechanical strength. Heat-cured acrylic resin used as a denture base must be kept clean by immersing the denture in a cleaning agent. Denture cleaning materials on the market generally come from chemicals. Immersion of heat-cured acrylic resin as denture base in chitosan solution can inhibit the growth of Candida albicans better than oxygenizing denture cleaning solution. Biologically, chitosan is safe because it has biocompatible and biodegradable properties. To determine the effect of immersion of heat-cured acrylic resin in chitosan solution on hardness, transverse strength, and modulus of elasticity. 25 acrylic resin plates measuring 65x10x2.5mm divided into five groups. Each group was immersed in a solution of 1%, 2%, 3% chitosan, distilled water, and 1% ascorbic acid, then tested for transverse strength using the Universal Testing Machine. The values of transverse strength and modulus of elasticity were calculated using the formula. Hardness test pre and post-test used 15 acrylic resin plates measuring 12mmx12mmx3mm were divided into five groups with each group immersed in 1%, 2%, 3% chitosan solution, distilled water, and 1% ascorbic acid. Statistical analysis used one-way ANOVA for each test. The only significant difference was the modulus of elasticity between the immersion groups. The value of transverse strength, modulus of elasticity, and hardness was higher in the group with a 3% chitosan solution, with no difference statistically in transverse strength and hardness between groups. There was a significant difference in the effect of elastic modulus from the immersion of heat-cured acrylic resin in solution distilled water and 1% ascorbic acid as a control and 1%, 2%, and 3% chitosan solutions with ascorbic acid as a solvent. (IJP 2024;5(1):55-58)

INTRODUCTION

Acrylic resin is a polymer used in the manufacture of removable partial dentures and full dentures.[1,2] Based on the polymerization, acrylic resins are divided into three classifications: heat-cured acrylic resin, self-cured acrylic resin and light-cured acrylic resin.[3] Heat-cured acrylic resin is often used because it is non-toxic, non-irritating, insoluble in oral fluids and esthetics, easy to manipulate and repair, and has minimal dimensional changes.[4] Heat-cured acrylic resin has good enough strength to be used as a base for full and partial dentures but often fractures.[5,6] Transverse strength and modulus of elasticity of acrylic resin is one of the properties that affect the material's resistance to fracture.[5]

Acrylic resin is a material with a low level of hardness and elasticity and can be abraded. Heat-cured acrylic resin generally improve the weakness of the acrylic resin denture base material so that its mechanical properties increase for long-term use by adding reinforcing materials. The addition of reinforcing materials can be in the form of chemicals, metal, or fibre.[7] However, nowadays, using natural materials is more desirable because it does not cause side effects on the body. One of the uses of these natural ingredients is to use chitosan.[8]

Research by adding other materials to acrylic resin has been carried out by mixing chitosan into heat-cured acrylic resin before heating but did not produce significant changes. The addition of chitosan has a high viscosity value, making it difficult for chitosan to diffuse and decrease its mechanical strength.[9] The lower the molecular weight of chitosan and the lower its viscosity, the more easily chitosan is absorbed into the acrylic resin.[10] In

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Table 1. Mean and standard deviation of hardness.

Group (VHN)	Mean ± SD Before	After
Aquades	18.769±1.040	19.196±1.290
Ascorbic Acid 1%	18.281±0.629	19.630±0.678
Chitosan 1%	18.850 0.493	19.860±1.639
Chitosan 2%	19.013±0.496	19.854±1.532
Chitosan 3%	19.223±1.355	20.151±0.788
Total	18.827±0.890	19.738±1.232

Table 2. One Way ANOVA of hardness.

	Sum of Squares	df	Mean Square	F	Sig.
Between groups	3.976	4	0.994	0.419	0.794
Within Groups	94.918	40	2.373		
Total	98.894	44			

*p<0.05

Table 3. Mean and standard deviation of transversal strength.

Group	Aquades	Ascorbic Acid 1%	Chitosan 1%	Chitosan 2%	Chitosan 3%
Mean±SD	128.46 ±23.03	138.05 ±12.87	117.11 ±15.03	136.24 ±12.75	143.72 ±10.35

Table 4. One-Way ANOVA of transversal strength.

	Sum of Squares	df	Mean Square	F	Sig.
Between groups	2118.69	4	529.673	2.22	0.103
Within Groups	4771.077	20	283.554		
Total	6889.767	24			

*p<0.05

Table 5. Mean and standard deviation of modulus easticity.

Group	Aquades	Ascorbic Acid 1%	Chitosan 1%	Chitosan 2%	Chitosan 3%
Mean±SD	2102.15 ±209.14	2371.42 ±276.48	1736.51 ±225.31	2095.97 ±300.66	2499.17 ±216.89

Table 6. One-Way ANOVA of modulus elasticity.

	Sum of Squares	df	Mean Square	F	Sig.
Between groups	1732598.12	4	433149.531	7.023	0.001
Within Groups	1233587.74	20	61679.387		
Total	2966185.87	24			

*p<0.05

research on the toxicity test of resin mixtures. Acrylic resin with chitosan as antifungal denture material stated that the greater the concentration of chitosan, the smaller the average value of absorbance and cell viability, acrylic resin with chitosan at concentrations of 0.5%, 1%, and 2% was not toxic.[11]

Chitosan is chitin's main derivative, which can be isolated from various living things such as shrimp, crabs and several other animals. Chitosan is a copolymer of D-glucosamine and N-acetyl-D-glucosamine with B-(164) bonds, obtained by enzymatic deacetylation of the polysaccharide chitin. Removing the acetyl group of chitin increases its solubility, so chitosan is used more than chitin. In addition, chitosan is non-toxic, biocompatible and biodegradable, so it is safe to use.[8] Chitosan is insoluble in water and most organic solvents but soluble in acids with a pH of less than 6.5. The solvents usually used to dissolve chitosan are formic acid, acetic acid, lactic acid, and glutamic acid.[12]

Chitosan can be dissolved in ascorbic acid, and the best chitosan solubility is found at 1%.[8] Ascorbic acid, or vitamin C, is a water-soluble and the most unstable vitamin. Vitamin C is stable in the dry state but in the form of a solution and is easily oxidized, especially by the influence of oxygen, light, and pH. Vitamin C is safe for the body and is used in carbohydrate metabolism and synthesizing proteins, lipids, and collagen. Unlike fat-soluble vitamins, vitamin C is not stored in the body and is excreted in the urine.[13]

MATERIAL AND METHODS

Preparation of 1% ascorbic acid solution

Mix 1 gram of ascorbic acid powder into 100 ml of distilled water, then stir with a magnetic stirrer for about 4 minutes until it is completely mixed and there are no deposits.

Procedure for making chitosan solution

A 1% chitosan solution was prepared by mixing 1 gram of chitosan powder in a 1% ascorbic acid solution, then stirred using a magnetic stirrer for about 30 minutes until all the chitosan powder was dissolved and there was no precipitate. For 2% and 3%, the same procedure was carried out only with different concentrations of chitosan powder, namely 2 grams and 3 grams, respectively.

Hardness Test

Fifteen heat-cured acrylic specimens measuring 12mmx12mmx3mm were divided into five groups. Group 1: 3 specimens immersed in aquadest/distilled water solution; Group 2: 3 specimens immersed in 1% ascorbic acid; Group 3: 3 specimens immersed in 1% chitosan solution; Group 4: 3 specimens immersed in 2% chitosan solution; Group 5: 3 specimens immersed in 3% chitosan solution.

All specimens were soaked for 10 minutes for each group, then dried and tested for hardness using a Shimadzu Micro Vickers Hardness Tester type HMV-G21ST (E, 230V) with an HVO load of 0.25 (245.2mN)/10 seconds. Each specimen carried out five different test points and averaged. Data analysis was carried out using a paired sample T-test to determine the difference between groups before and after immersion. The data were tested again using one-way ANOVA statistical analysis to compare the averages of more than two groups unrelated to the significance level of $p<0.05$.

Transversal Strength Test

Twenty-five acrylic plates with dimensions 65 x 10 x 2.5 mm were divided into five groups, five pieces each and soaked in the same way with the hardness test. The transversal strength test was carried out using the Universal Testing Machine (UTM), with the three-point bending method using the Shimadzu Autograph AGS-X Series, Japan. The load cell used in this study is 5 kN with a speed of 50 mm/min. Statistical analysis using One Way ANOVA test using SPSS software version 25 to compare the mean of each group.

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RESULTS

The mean and standard deviation of hardness, transversal strength and modulus of elasticity of the five groups are as follows: All groups were tested for normality with the Shapiro Wilk test and showed normal results ($p>0.05$), which continued with the One-Way ANOVA test.

DISCUSSION

Immersion of heat-cured acrylic resin in each treatment group, namely the distilled water group, 1% ascorbic acid solution, 1% chitosan solution, 2% chitosan solution and 3% chitosan solution, all experienced an increase in hardness when compared to the hardness value before immersion. Immersion of heat-cured acrylic resin in a solution can affect its physical properties. Based on the study's results, it was found that heat-cured acrylic resin before and after immersion in various solutions experienced an insignificant increase in hardness because the chitosan solution could penetrate the microporosity cavity of acrylic resin and affect the intermolecular bonds. The longer the immersion time, the more solution particles will penetrate the microporosity cavity of the acrylic resin.[14] This is due to the heat-cured nature of acrylic resin, which can absorb water slowly over a certain period, with the absorption mechanism through the diffusion of water molecules according to the law of diffusion. The diffusion coefficient of water on the heat-cured acrylic resin is generally 1.08×10^{-12} m2/sec at 37°C. [15,16] In the results of this study, the hardness of heat-cured acrylic resin after immersion in several concentrations of chitosan showed an increase in hardness with increasing concentration. This result follows previous studies that discussed the effect of adding chitosan nano gel to the mechanical properties and colour stability of heat-cured acrylic resin denture base materials. The study stated that adding chitosan to heat-cured acrylic resin showed an increase in hardness and modulus of elasticity, which affected the fracture toughness of heat-cured acrylic resin. Chitosan has mechanical properties 2-3 times stronger than heat-cured acrylic resin.[17] The concentration of chitosan is directly related to the viscosity; the higher the viscosity, the friction between the particles in the chitosan solution increases and is more attached. The addition of chitosan to the denture base can reduce water absorption.[18]

The heat-cured acrylic resin group immersed in 3% chitosan solution has the highest average transversal strength and modulus of elasticity. The lowest average was the heat-cured acrylic resin group immersed in 1% chitosan solution. The standard transversal strength of acrylic resin used as a denture base should not be less than 65 MPa, and the modulus of elasticity ranges from 2000-2400 MPa.[4,19] In this study, there was an increase in the average transverse strength and modulus of elasticity of heat-cured acrylic resin immersed in chitosan solution. The increase started from 1% chitosan concentration, 2% chitosan concentration, and 3%. The highest average transversal strength and modulus of elasticity were in chitosan solution with a concentration of 3%. However, the average modulus of elasticity of heat the average modulus of elasticity of heat cured acrylic resin, which should equal 2400 MPa. The increase occurred in line with the increase in the concentration of chitosan, where the higher the chitosan concentration, the transverse strength and modulus of elasticity increased. Increasing the concentration of chitosan can cause more chitosan content in the solution, which results in physical and chemical interactions in binding molecules.[17]

The heat-cured acrylic resin contains polymethyl methacrylate and a small amount of ethylene glycol dimethacrylate, both of which will form a functional group in the form of an ester group so that it easily absorbs the solution.[20] This causes chitosan to penetrate macromolecules of heat-cured acrylic resin and affect its chemical bonding.[4] Chitosan has elements NH2 and NH3+, and polymethyl methacrylate from heat-cured acrylic resin has elements of COOH.[9] Bonds occur between polymer chains where CH3 in heat-cured acrylic resin will bind to chitosan polymer chains, namely -OH. In addition, the carbonyl group C = O in the poly (methyl methacrylate) chain will also bind to NH2 in chitosan.[17] The hydrogen bonding reaction between chitosan and acrylic resin can affect the hardness value of the denture plate so that a strong bond will occur. Another possibility that can occur is the presence of ionic bonds between NH3+ chitosan and CH3COO−.[21]

The transversal strength and modulus of elasticity of heat cured acrylic resin immersed in 1% ascorbic acid solution had higher values than 1% chitosan solution. This value is thought to occur because the acid compound contains a lot of H+ ions which can lower the surface tension of the heat-cured acrylic resin so that the molecules in the solution easily enter between the acrylic resin molecules and diffusion occurs faster.[21] Denture bases exposed to acid solutions for a long time can experience a decrease in transverse strength.[22] However, the results of this study did not show a decrease in transverse strength and modulus of elasticity after immersion in 1% ascorbic acid solution. This result is because the acrylic resin has good resistance to weak acids, one of which is ascorbic acid.[23]

CONCLUSION

There was no significant effect on the hardness of heat cured acrylic resin before and after immersion in distilled water, 1% ascorbic acid solution, and chitosan solution with ascorbic acid solvent at concentrations of 1%, 2% and 3%, but there was an increase in hardness with increasing chitosan concentration.

There was no significant difference in the transversal strength effect of heat cured acrylic resin immersion in aquadest solution and 1% ascorbic acid as control and 1%, 2%, and 3% chitosan solution with the ascorbic acid solvent. However, there was an effect of a different modulus of elasticity.

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INDONESIAN JOURNAL OF PROSTHODONTICS

ORIGINAL ARTICLE

Knowledge, attitude, and implementation toward denture adhesive among Indonesian Dental Students and Dentists

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Keywords: Attitude, Dental students, Dentist, Denture adhesive, Implementation, Knowledge.

ABSTRACT

Increased exposure of denture adhesive commercially may have impact on how denture wearers use this material without dentist's prescription. Dentists need to know the proper use of denture adhesive so that they can educate public the indication and contraindication to avoid side effects. The aim of this study was to assess knowledge, attitudes, and implementation toward of denture adhesive among dental students and dentists. The questionnaire was made through expert discussion and psychometric test to determine the validity and reliability of the questionnaire was tested on 146 subjects consist of 73 dental students and 73 dentists in Jakarta. Test retest reliability was tested on 30 subjects. Univariate analyze were carried out on knowledge, attitudes, and implementation of each group of respondents. The 29 items of questionnaires were consist of three domains of knowledge (23 items), attitude(3 items) and implementation (3 items). Convergent validity was confirmed by correlation coefficients ranged from 0.327 to 0.355 for knowledge, attitude, and implementation domain. Internal consistency showed Cronbach alpha values from 0,669 to 0,859. The interclass correlations were ranged form 0.821-0.923. Significant differences between dental students and dentists were found for implementation domain toward denture adhesive. In this study, 87.7% dental students and 80.8% dentists were already know about denture adhesive. But 78.1% dental students and 39.7% dentists have never applied this material. Questionnaire knowledge, attitude, and implementation toward denture adhesive in Indonesian has a good validity and reliability value, especially in knowledge and implementation domain. The majority of respondents in the dental student and dentist groups already know about indications and contraindications toward denture adhesive. (IJP 2024;5(1):59-65)

INTRODUCTION

The use of additional products in removable denture treatment such as denture adhesive can help to improve retention.[1] The Glossary of Prosthodontic Terms ninth edition defined denture adhesive as a material used to adhere denture to oral mucosa.[2] Some research says that improving denture fitness, chewing ability, and the main reason for using denture adhesive is confidence while using removable denture.[3,4]

The application of denture adhesive must be considered according to its indications and contraindications. This material can be used in patient who experience xerostomia, patient with neuromuscular disease such as Parkinson's disease, or when using temporary denture if needed.[5,6] Denture adhesives are not recommended for long-term use to repair loose or fractured denture, because this material cannot be a substitute for relining or rebasing procedures that should be performed.[5-7]

Coates (2000) reported that 67.1% patient had never tried, 32.9% had tried denture adhesive but only 10 (6.9%) currently used it.[3] Denture adhesive that are sold commercially through the media and advertisement contribute to the use of this material without being prescribed by dentists or self-prescribed.[6,7] Therefore, knowledge and attitude of dentists about denture adhesives give a very important role to provide education to patient about indication, contraindication, how to use, frequency of use, and how to clean the material from mucosa and denture base to prevent problems in the future.[7,8]

Study on knowledge and attitudes regarding denture adhesives was previously conducted in Saudi Arabia. Study by Al Taweel et

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Table 1. Charachteristics of the participant.

Charactristics (N=146)	Dental student N(%)	Dentists N(%)
Gender		
Male(30(20.5))	15(10.27)	15(10.27)
Female(116(79.5))	58(39.73)	58(39.73)
Age		
15-24 years old	73(50)	3(2.05)
25-44 years old	-	62(42.47)
45-64 years old	-	8(5.5)
≥ 65 years old	-	-
Profession		
Dental student	73(50)	-
Dentist	-	73(50)
General practitioner	-	56(38.36)
Resident	-	10(6.85)
Specialist	-	7(4.79)
Dental practice experience (dentists)		
0-10 years	-	53(72.6)
11-20 years	-	13(17.8)
21-30 years	-	6(8.2)
>30 years	-	1(1.4)
Removable denture cases have been handled (dentist)		
Nothing	-	3(4.1)
1-5	-	24(32.9)
6-10	-	16(21.9)
11-20	-	12(21.9)
21-30	-	6(8.2)
31-40	-	-
41-50	-	3(4.1)
≥ 51	-	9(12.3)
Average denture cases handled in a month		
Nothing	-	20(27.4)
1-4	-	51(69.9)
5-10	-	1(1.4)
> 11	-	1(1.4)

al. (2016) described that 93% of the respondents already knew and 85.5% had been taught about denture adhesives in undergraduate education.[9] Study by Sadamori et al (2005) with a Pilot Study used a questionnaire to compare the knowledge of Japanese and Indonesian dentists regarding denture adhesive.[4] From this study, it was found that dentists in Japan obtained more information about denture adhesives and used denture adhesive more than dentists in Indonesia.[4] Study by Hong et al. (2008) also conducted a questionnaire survey research on dental students and dentists in China regarding denture adhesive and provided an illustration that 73% of the respondents did not know and had not been taught about this material either from books, television, or lectures.[10]
Based on the description that has been explained above, the author wants to conduct research to investigate the knowledge, attitudes, and implementation of denture adhesive among professional students and dentists and their practice in Indonesia.

MATERIAL AND METHODS

This study received ethical approval form Ethics Commission from Faculty of Dentistry, Universitas Indonesia on November 3, 2022 with protocol number 94/Ethical Approval/FKGUI/XI/2022. The research was carried out in November-December 2022. The new measuring tool in the form of a questionnaire was made in accordance with the objectives and research methodology so that relevant questionnaire items were obtained to be able to objectively assess knowledge, attitudes, and implementation of denture adhesive among dental student and dentist.

The development of the questionnaire included item development, pilot testing, and psychometric validation.[11] The item development is also generated through expert discussion to review and to add another items, reduce items, as well as to get suggestion to get better content validity.[12] This questionnaire is self-administered and uses a five-scale Likert response. The domain of knowledge and attitudes uses a scale of 1: Strongly disagree; 2: Disagree; 3: Undecided; 4: Agree; 5: Strongly agree, whereas the implementation domain using a scale of 1: Never; 2: Rarely; 3: Sometimes; 4: Often; 5: Always. Trial was conducted to 20 people consist of 10 dental student and 10 dentist to assess respondent's interpretations using the preliminary questionnaire. Then a survey was conducted to test psychometric validation using Pearson or Spearman tests. Meanwhile, the discriminant validity test used the unpaired T test or Mann-Whitney. The reliability tests tested were internal consistency and test and retest.

RESULTS

Item Development

Questionnaire items were collected through literature study to find materials that could be used as items that are in accordance with the main objectives based on reference books and previous research. Most of the items used are new items taken based on reference books and have not been used in previous research. Some of the items refer to questionnaires used in previous studies, including Slaughter et al. (1999), Sadamori et al. (2005) and Hong et al. (2008), Al Taweel et al. (2016), Hatim et al. (2011) to build a construct that can assess knowledge, attitudes, and implementation of denture adhesive among dental students and dentists.[4,9,10,13,14] A list of 31 draft items was produced. Questionnaire was designed in Indonesian and have three domains, knowledge, attitude, and implementation. Each domain is grouped based on certain sub-domains. The knowledge domain consists of 20 items and have sub-domains regarding awareness, preparation, purpose, indications, contraindications, advantages, and disadvantages of using denture adhesive. The attitude domain consists of 5 items about consideration, recommendation, and education. The implementation domain consists of 3 items about prescription and application. Expert review was conducted by inviting two experts in removable denture and research methodology. There were some suggestions made by the expert. Some question were added, reduce, and rearrange the language to avoid multiperception.

A total of 20 participants were interviewed using the preliminary questionnaire which has been corrected based on expert review. At the trial stage, there was not much feedback

Table 2. Questionnaire items of knowledge domain and percentage distributions of answers

No.	Item	Subject	Response(N(%))				
			1	2	3	4	5
Q1	Saya mengetahui mengenai denture adhesive	DS	-	1(1.4)	8(11.2)	41(56.2)	23(31.5)
		D	-	1(1.4)	13(17.8)	33(45.2)	26(35.6)
Q2	Saya pernah mempelajari mengenai denture adhesive	DS	1(1.4)	5(6.8)	22(30.1)	29(39.7)	16(21.9)
		D	2(2.7)	7(9.6)	17(23.3)	34(46.6)	13(17.8)
Q3	Denture adhesive memiliki sediaan dalam bentuk pasta	DS	-	1(1.4)	7(9.6)	33(45.2)	32(43.8)
		D	-	1(1.4)	5(6.8)	36(49.3)	31(42.5)
Q4	Denture adhesive memiliki sediaan dalam bentuk bubuk	DS	5(6.8)	12(16.4)	25(34.2)	17(23.3)	14(19.2)
		D	6(8.2)	15(20.5)	29(39.7)	17(23.3)	6(8.2)
Q5	Saya mengetahui bahwa penggunaan denture adhesive sesuai indikasi membantu mendapatkan retensi dan stabilisasi gigi tiruan	DS	-	2(2.7)	3(4.1)	35(47.9)	33(45.2)
		D	1(1.4)	-	3(4.1)	41(56.2)	28(38.4)
Q6	Denture adhesive dapat digunakan pada pasien dengan gangguan neuromuskular dengan gerakan lidah, bibir, dan pipi yang tidak dapat dikontrol	DS	-	2(2.7)	15(20.5)	32(43.8)	24(32.9)
		D	-	3(4.1)	7(9.6)	39(53.4)	24(32.9)
Q7	Pasien yang mengalami gangguan pada kelenjar saliva atau hipofungsi kelenjar saliva, seperti xerostomia dapat diindikasikan menggunakan denture adhesive	DS	1(1.4)	7(9.6)	25(34.2)	20(27.4)	20(27.4)
		D	2(2.7)	2(2.7)	14(19.2)	36(49.3)	19(26.0)
Q8	Denture adhesive dapat digunakan untuk pasien yang tidak memiliki dukungan struktur anatomi yang adekuat seperti pasien pasca bedah maksilofasial atau memiliki celah palatum	DS	1(1.4)	4(5.5)	16(21.9)	27(50.7)	15(20.5)
		D	2(2.7)	3(4.1)	15(20.5)	38(52.1)	15(20.5)
Q9	Denture adhesive dapat digunakan pada periode tertentu setelah pemasangan gigi tiruan immediate untuk meningkatkan kenyamanan, retensi, dan fungsi gigi tiruan	DS	-	2(2.7)	15(20.5)	35(47.9)	21(28.8)
		D	1(1.4)	3(4.1)	10(13.7)	40(54.8)	19(26.0)
Q10	Denture adhesive dapat digunakan pada tahap penentuan hubungan rahang dan percobaan gigi tiruan malam	DS	9(12.3)	16(21.9)	32(43.8)	10(13.7)	6(8.2)
		D	8(11.0)	20(27.4)	19(26.0)	17(23.3)	9(12.3)
Q11	Pasien yang mengalami alergi terhadap material denture adhesive tidak dapat menggunakan denture adhesive	DS	-	3(4.1)	15(20.5)	29(39.7)	26(35.6)
		D	2(2.7)	1(1.4)	6(8.2)	29 (39.7)	35(47.9)
Q12	Penggunaan denture adhesive sebaiknya disarankan pada pasien sesuai indikasi, memiliki kebersihan mulut baik, dan dapat menjaga OH-nya	DS	-	3(4.1)	6(8.2)	32(43.8)	32(43.8)
		D		-	4(5.5)	29(39.7)	40(54.8)
Q13	Denture adhesive tidak dianjurkan pada gigi tiruan yang longgar akibat proses pembuatan yang tidak baik	DS	-	3(4.1)	14(19.2)	25(34.2)	31(42.5)
		D	2(2.7)	3(4.1)	8(11.0)	19(26.0)	41(56.2)
Q14	Denture adhesive tidak dapat menyelesaikan masalah pada gigi tiruan yang fraktur atau kehilangan sayap	DS	-	3(4.1)	12(16.4)	26(35.6)	32(43.8)
		D	-	-	6(8.2)	27(37.0)	40(54.8)
Q15	Denture adhesive yang digunakan sesuai indikasinya dapat membantu meningkatkan fungsi mastikasi dan fonetik	DS	-	-	7(9.6)	33(45.2)	33(45.2)
		D	-	-	3(4.1)	35(47.9)	35(47.9)
Q16	Denture adhesive yang digunakan sesuai indikasinya dapat membantu meningkatkan kepercayaan diri pasien saat menggunakan gigi tiruan lepasan	DS	-	-	10(13.7)	33(45.2)	30(41.1)
		D	-	-	3(4.1)	34(46.6)	36(49.3)
Q17	Kandungan seng (Zn) yang berlebih pada denture adhesive dapat menyebabkan toksisitas	DS	-	1(1.4)	35(47.9)	27(37.0)	10(13.7)
		D	-	1(1.4)	37(50.7)	25(34.2)	10(13.7)
Q18	Pembersihan denture adhesive yang kurang baik dalam jangka panjang dapat memicu pertumbuhan jamur Candida albicans pada mukosa maupun basis gigi tiruan	DS	-	2(2.7)	8(11.0)	25(34.2)	38(52.1)
		D	-	-	1(1.4)	32(43.8)	40(54.8)

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Table 2. Questionnaire items of knowledge domain and percentage distributions of answers

No.	Item	Subject	Response(N(%))				
			1	2	3	4	5
Q19	Pemakaian denture adhesive secara self-prescribed dalam jangka panjang dapat menyebabkan resorpsi tulang alveolar	DS	-	6(8.2)	39(53.4)	16(21.9)	12(16.4)
		D	2(2.7)	5(6.8)	38(52.1)	19(26.0)	9(12.3)
Q20	Pengaplikasian denture adhesive pada gigi tiruan lepasan dilakukan sesuai dengan petunjuk pemakaian produk	DS	-	-	6(8.2)	33(45.2)	34(46.6)
		D	-	-	1(1.4)	34(46.6)	38(52.1)
Q21	Perlekatan denture adhesive yang baik memerlukan lapisan tipis merata di seluruh permukaan basis gigi tiruan dengan mukosa	DS	-	2(2.7)	11(15.1)	46(63.0)	14(19.2)
		D	1(1.4)	5(6.8)	5(6.8)	39(52.4)	23(31.5)
Q22	Kemampuan retensi dari denture adhesive berkisar antara 3 sampai 12 jam tergantung bentuk sediaan yang digunakan dan variasi kasus	DS	-	-	27(37.0)	34(46.6)	12(16.4)
		D	-	-	17(23.3)	44(60.3)	12(16.4)
Q23	Denture adhesive pada gigi tiruan dan mukosa perlu dibersihkan setelah pemakaian	DS	-	-	12(16.4)	25(34.2)	36(49.3)
		D	-	-	2(2.7)	27(37.0)	44(60.3)

Table 3. Questionnaire items of attitude domain and percentage distributions of answers

No.	Item	Subject	Response(N(%))				
			1	2	3	4	5
Q24	Saya akan mempertimbangkan penggunaan denture adhesive pada pasien sesuai indikasi	DS	-	-	5(6.8)	45(61.6)	21(28.8)
		D	-	-	4(5.5)	37(50.7)	32(43.8)
Q25	Saya merasa perlu mempelajari lebih lanjut mengenai penggunaan denture adhesive	DS	-	-	1(1.4)	22(30.1)	50(68.5)
		D	-	-	1(1.4)	22(30.1)	50(68.5)
Q26	Saya akan merekomendasikan penggunaan denture adhesive kepada pasien yang sesuai indikasi dengan instruksi penggunaan yang tepat	DS	-	-	4(5.5)	35(47.9)	34(46.6)
		D	-	-	2(2.7)	35(47.9)	26(49.3)

Table 4. Questionnaire items of implementation domain and percentage distributions of answers

No.	Item	Subject	Response(N(%))				
			1	2	3	4	5
Q28	Saya pernah meresepkan denture adhesive pada pasien yang sesuai indikasi	DS	57(78.1)	7(9.6)	2(2.7)	3(5.5)	3(4.1)
		D	29(39.7)	13(17.8)	7(9.6)	18(24.7)	6(8.2)
Q29	Saya pernah mengaplikasikan denture adhesive untuk stabilitas basis galangan gigit pada tahap pembuatan gigi tiruan	DS	57(78.1)	7(9.6)	2(2.7)	4(5.5)	3(4.1)
		D	48(65.8)	16(21.9)	4(5.5)	4(5.5)	1(1.4)
Q30	Saya pernah membiarkan pasien menggunakan denture adhesive walaupun tidak indikasi dan sudah diberi edukasi penggunaan yang tepat	DS	61(83.6)	4(5.5)	5(6.8)	1(1.4)	2(2.7)
		D	53(72.6)	9(12.3)	5(6.8)	6(8.2)	-

from the participants, and generally speaking, the subjects had grasped the questionnaire items. There was a multiperception on one item of the knowledge domain but that was resolved by changing the language arrangement. To prevent multiperception, some language rules need to be altered. The questionnaire was then finalized with input from the trial results so that the psychometric test could proceed.

Psychometric Test

Psychometric test reliability was taken by analyzing 146 answered questionnaire subjected to reliability and validity testing. Of the 146 participants consist of 73 dental students and 73 dentists (56 general practitioners, 10 residents, and 7 specialists), 30 were collected from male participants (20.5%) and 116 were collected from female participants (79.5).

Majority of the participants was 15-24 years old (32.05%). According to profession, half of the participants, 73 subjects (50%) are dental students and another half of the participants, 73 subjects (50%) are dentists. The participants' work experience was dominated by the 0-10 year group (53 (72.6%) participants). Majority of the dentists, 24 subjects (32.9%) had treated 1-5 removable denture. Majority of the dentists (69.9%) also handles 1-4 denture cases per month Table 1.

Reliability test

Reliability test internal consistency measured by Cronbach's alpha. Cronbach's alpha coefficient in knowledge domain was 0.859 (good reliability), in attitude domain was 0.669 (questionable reliability), and in implementation domain was 0.739 (good reliability implementation). Before these result came out, there are 2 item from attitude domain that has been deleted, those are "Saya akan merekomendasikan perbaikan atau pembuatan gigi tiruan baru daripada penggunaan denture adhesive" and "Saya akan memberi edukasi kepada pasien

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yang menggunakan denture adhesive secara mandiri tanpa rekomendasi dokter gigi/self-prescribed". Those item was deleted to increase Cronbach's alpha value from 0.440 (unacceptable reliability) to 0.669 (questionable reliability).

The interclass correlation coefficient (ICC) was evaluated as part of test and retest reliability. A total of 30 respondents completed to answer questionnaire twice, in different time periods, with one week span. After deleting 2 items, the analysis's findings indicate that the knowledge domain's ICC value is 0.923 (excellent reliability), the attitude domain's ICC value is 0.836 (good reliability), and the implementation domain's ICC value is 0.821 (good reliability).

Validity test

The convergent validity test is carried out by comparing thee total score of knowledge or attitude with the global question. Question "Menurut Anda, seberapa jauh Anda sudah mengetahui mengenai penggunaan denture adhesive pada perawatan gigi tiruan lepasan?" used as a qlobal question to assess knowledge by respondents, the question "Beri penilaian bagaimana sikap Anda terhadap penggunaan denture adhesive pada perawatan gigi tiruan lepasan" used as a global question of attitude. Spearman test in the knowledge domain shows that the r-value is 0.355 and p-value is 0.000 ($p<0.05$) indicating that there is statistically significant moderate correlation between the total knowledge score and the respondent's self-assessment of knowledge about denture adhesive. Spearman test in attitude domain shows that the r-value is 0.327 and p-value is 0,009 ($p<0.05$) indicating that there is statistically significant moderate correlation between the total knowledge score and the respondent's self-assessment of attitude towards denture adhesive as removable denture treatment in clinical practice.

Discriminant validity was tested by comparing the mean value of each item and the total mean between two groups (dental students and dentists). Independent T test in knowledge domain shows a p-value of 0.243. Mann-Whitney test shows p-value of attitude domain is 0.624 and p-value implementation domain shows a 0.000. Based on the results of the discriminant validity test, there are no significantly different in knowledge and attitude domain in this questionnaire ($p\geq0.05$) between dental students and dentists groups, while the implementation domain could differ significantly ($p<0.05$) between dental students and dentists groups.

Univariat analyses

The majority of respondents in the dental student and dentist groups already know about denture adhesive paste preparations, intended use, indications and contraindications, as well as advantages and disadvantages of denture adhesive table 1. Some items show doubts from professional student and dentist respondents so that the level of knowledge of professional students and dentists is not yet known, as in item Q4 "Denture adhesive memiliki sediaan dalam bentuk bubuk", 34.2% dental students and 39,7% of dentists answered undecided. Item Q17, "Kandungan seng (Zn) yang berlebih pada denture adhesive dapat menyebabkan toksisitas," received skeptical responses from 50.7% of dentists and 47.9% of dental students. Participants already have a strong understanding of this information, which includes preparations, indicators, indications, advantages, and downsides, according to the results of a high score that is near to the maximum value of knowledge.

The majority of respondents have a positive attitude towards the use of denture adhesive in removable denture treatment. Based on the mean and mean values, the majority of dental students and dentists have shown a positive attitude in using the appropriate denture adhesive.

Table 4 showed item Q7 "Saya pernah meresepkan denture adhesive pada pasien yang sesuai indikasi", 78.1% of dental students and 39.7% of dentists answered never. Item Q28 "Saya pernah mengaplikasikan denture adhesive untuk stabilitas basis galangan gigit pada tahap pembuatan gigi tiruan", 78.1% of dental students and 65.8% of dentists answered never. Based on the mean and mean values, there is a difference in the implementation of denture adhesive between dental students and dentists with the majority of respondents have never applied denture adhesive in dental clinical practice.

DISCUSSION

Participants of this study were 73 dental students and 73 dentist in Jakarta met inclusion and exclusion criteria. Similiar study by Hong et al (2008) with 57 respondents consisted of 31 dental studentsand 26 dentists in China. Other study by Sadamori et al. (2005) involved 43 dentists from Japan and 65 dentists from Indonesia. Differences in number of sample each study can be influenced by differences in the minimum sample size formula used. The respondents who were involved in this study were mostly female, namely 116 (79.5%) people, while the number of male respondents was 30 (20.5%) people. Hong et al. (2008) involved 30 male and 29 female respondents, while another study, namely Sadamori et al. (2005) involved 57 male respondents and 51 female respondents. The respondents' work experience was dominated by the 0-10 year group, namely 53 (72.6%) respondents. The majority of denture cases that have been handled by dentists have handled 1-5 denture cases, namely 24 (32.9%) respondents with the majority handling 1-4 dentures per month. This illustrates that the majority of the dentists in this study were dentists with little length of practice and work experience.

A questionnaire is a measurement tool to collect information about knowledge, beliefs, attitudes, and behavior objectively.[15] Several previous studies, such as Slaughter et al. (1999), Sadamori et al. (2005), Hong et al. (2008), Al Taweel et al. (2016), and Hatim et al. (2011) discusses knowledge and attitude regarding denture adhesive in english and report each item descriptively. The questions used in those study are subjective and not including validation and reliability value. As a result, the objective of this study is to develop a measuring tool that can be used to assess the knowledge, attitudes, and implementation of dental students and dentists. Therefore, this study aims to obtain a measuring instrument that has validity and reliability values and objectively assess knowledge, attitude, and implementation of dental students and dentists . This is intended as an evaluation material for dentists to educate their patients about how too properly use denture adhesives in daily practice.

According to Scientific Advisory Committee (SAC), there are

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8 criteria to develop and evaluate questionnaire, including (1) content validity, (2) internal consistency, (3) criterion validity, (4) construct validity, (5) reproducibility, (6) responsiveness, (7) floor and ceiling effects, and (8) interpretability.[12] Content validity established through expert discussion by selecting items, adding, and reducing items which which were continued and trial questionnaires had to be carried out to test readability and understanding. difficult to understand so that it can be interpreted properly by respondents.[12]

In order to evaluate knowledge, attitude, and implementation that can be measured (quantified and represent the actual situation, validity and reliability tests are conducted. Validity refers to whether a test or scale has accuracy to measure what it aims to measure.[16] Reliability is a consistency, stability, and trustworthiness of survey results from a questionnaire.[16] Reliability is done to determine the extent to which the results of a measurement process can be trusted.

Before reducing two questionnaire items, the value of Cronbach's alpha in attitude domain was 0.440. There are a number of reasons why the value of Cronbach's alpha has low reliability, a shorter test will be less reliable than a long test. Low Cronbach's alpha can also result from insufficient item interrelationship or has heterogenous constructs.[17] The reliability coefficient of the measurement results can change depending on which questionnaire items are added or removed. In this study, to improve Cronbach's alpha value, 2 items from the attitude domain were eliminated. The final questionnaire has only 3 items in attitude domain. Reproducibility means that the degree of measurement performed on the same subject is stable over an extended period of time (1-2 weeks).[12] This questionnaire can be said to have strong reproducibility because the knowledge domain's ICC value is 0,923 (excellent reliability), the attitude domain's ICC value is 0,836 (good reliability), and the implementation domain's ICC value is 0,821 (good reliability).

Knowledge according to the Oxford Dictionaries means everything and information that is known, understood, and obtained by someone based on experience or education. Knowledge is also interpreted as a level or fact in knowing some information, understanding, or a principle.[18] Based on the results of data processing, 56.2% of dental students and 45.2% of dentists have mostly known denture adhesive materials and 39.7% of dental students and 46.6% of dentists have studied this material. The same thing was shown in the study of Sadamori et al. (2005) which shows that 66% of dentists in Indonesia and 56% of dentists in Japan already know about denture adhesive.[4] Research by Hong et al. (2008) shows something different, 83% of students in China have never heard of denture adhesive.[10] This could be because the respondents in Hong et al. (2008) who were fourth-year dental students had not been exposed to clinical practice, in contrast to the respondents in this study, who had been exposed to 1-2 years of clinical practice. Furthermore, 47.9% of dental students and 56.2% of dentists knew about the purpose of using denture adhesive, it is to obtain denture retention and stabilization. This finding is not in line with the research by Hong et al. (2008) who showed that 13% of dentists and 26% of students in China did not know about the purpose of using denture adhesive.[10] However, this finding was in line with the study of Sadamori et al. (2005) which shows that 65% of dentists in Indonesia and 58% of dentists in Japan know about the purpose of using denture adhesive.[4] Most of the respondents already knew about the indications for using denture adhesive.

For implementation domain, it was found that several respondents, 45 (61.6%) dental students and 37 (50.7%) dentists agreed to consider using denture adhesive in patients according to indications. The majority of respondents also answered that it was necessary to learn more about the use of denture adhesive. As in the study of Sadamori et al. (2005), as many as 58% of dentists in Japan and 52% of dentists in Indonesia have never been taught about denture adhesives. To increase their knowledge, professional students and dentists need to learn more about the use of denture adhesives so they can educate patients about the right indications. This needs to be considered carefully, because commercially available materials that show ease of use and benefits can contribute to the use of these materials without being prescribed by a dentist or self-prescribed.

Limitation of this study is that the convergent validity of implementation domain cannot be assessed because there was no global question included when the data collection is carried out.

CONCLUSION

Questionnaire knowledge, attitude, and implementation toward denture adhesive among dental students and dentists in Indonesian has a good validity and reliability value, especially in knowledge and implementation domain. Improvements and modifications in attitude domain are strongly advised by adding items or making grammatical corrections. The majority of respondents in the dental student and dentist groups already know about denture adhesive.

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INDONESIAN JOURNAL OF PROSTHODONTICS

CASE REPORT

Eyeglass Frame - Supported nasal prosthesis rehabilitation: A case report

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Keywords: Adhesive silicone, Eyeglass frame retention, Nasal prosthesis, Partial rhinectomy

ABSTRACT

Patients with facial defects resulting from neoplasm, congenital malformation or trauma can be restored aesthetically and emotionally with facial prosthesis using different materials and retention methods to restore missing tissues and help patients to overcome social, psychological difficulties, and function. A nasal prosthesis can re-establish esthetic form and anatomic contours for midfacial defects. For successful results, a lot of factors such as harmony, texture, color matching and blending of tissue interface with the prosthesis are important. This clinical report describes the details of a prosthodontic rehabilitation of a 52-years old female patient, who came to RSGM UGM Prof. Soedomo who received partial rhinectomy and complaints of esthetic appearance. The treatment plan was making nasal prosthesis using high temperature vulcanized (HTV) silicone rubber using an eyeglass frame and adhesive silicone. Mechanical devices such as eyeglass frames can provide more retention and support for the nasal prosthesis. One week after insertion, the patient felt comfortable and had no complaints. Nasal prosthesis can cover the nasal defect and help to improve the patient's quality of life. (IJP 2024;5(1):66-69)

INTRODUCTION

After removal of part of the nasal (rhinectomy) due to a tumor or congenital defect, the surgeon and prosthodontist must do everything possible to repair the damage to the facial area. But sometimes, the patient's condition does not allow plastic surgery rehabilitation, so they require a silicone nasal prosthesis that provides good aesthetics, respiratory function and social restoration.[1]

Maxillofacial prosthodontics is a branch of prosthodontics related to the restoration or replacement of stomatognathic and craniofacial structures with prostheses that can or cannot be removed periodically or electively.[2]

The materials used in making this nasal prosthesis are silicon HTV (high temperature vulcanized). Retention of prosthesis in the mid-facial region has been accomplished with engagement of anatomic undercuts, adhesives, eyeglasses and attachment to maxillary obturators, prosthetic connections to endosseous implants. When suitable conditions are provided, mechanical retention obtained by anatomic undercuts is the most advantageous. The advantages of this prosthesis are that the technique is noninvasive, tissue tolerant, aesthetic, comfortable to use, and easy to fabricate and clean. Additionally, these prostheses are often preferred by patients because their weight and cost are low.[3]

CASE REPORT

A 52 years old woman patient, came to RSGM UGM Prof. Soedomo who received partial rhinectomy and complaints of esthetic appearance. The patient wants to have a nose made so that the nasal cavity is closed and not directly exposed to dirty air.

On objective examination, the nasal socket was normal, there was no irritation, and there was no infection figure 1. There is redness around the nasal due to the use of bandages and plastic towels to cover the nasal. The bridge of the nasal, including the nasal bones was not included in the resection.

The informed consent was provided by the Prosthodontics Specialist Universitas Gadjah Mada, RSGM, and given to the patient. The patient agreed to select a nasal prosthesis using silicone rubber yang dilekatkan pada kacamata. Mechanical devices such as eyeglass frames and adhesive materials can provide retention and support for the nasal prosthesis.

Management

The patient's nasal socket applied a thin layer of Vaseline so that the impression material does not stick. A layer of gauze

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Figure 1. Initial appearance of patient`s face

Figure 2. Impression for custom-made tray extraoral

Figure 3. Try in a custom-made tray

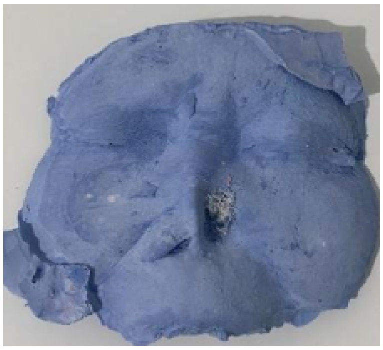

Figure 4. Final impression

was placed over the defect to prevent impression material from entering the nasal cavity. The defect is cast by placing boxing wax, prior to making an impression using irreversible hydrocolloid for making a custom extraoral tray figure 2 The cast was filled with dental stone as a working model. A custom tray was fabricated with polymethyl methacrylate using the contours of a nasal model. The custom tray was finished, polished, and tried on the patient figure 3.

Gauze and pipe were placed over the defect to prevent the molding material from entering the nasal cavity and being able to breathe during the molding process. An impression was made using light body consistency addition silicone elastomeric impression material. The impression was invested with die stone to obtain the final cast figure 4.

The prosthesis is made using wax by printing a model nose that is approximately the same size as the patient's nose with the same procedure as printing the patient's nose. The mold is filled with dental modelling wax. The wax model is tried on on the patient's nose mold and contoured according to the patient's facial profile, the esthetic contours was developed figure 5. The wax pattern adaptation on the patient's face was checked especiallly in the border areas figure 6. In order to get the maximum adaptation with the underlying tissues, functional wax was added to the borders.

A laboratory procedure by placing wax up into a cuvette. The wax is completely dewaxing from the cuvette. The nasal prosthesis was processed using a HTV silicone. The intrinsically colored silicone was done using an acrylic based paint. The color of the silicone is adjusted to the patient's skin color. Materials are processed according to the manufacturer's instructions. The silicone prosthesis was adapted on the patient's face figure 7. Extrinsic coloration was done to further match with the skin tone of the patient figure 8.

After the final contouring and matching, the superior margin at the bridge of the nose was adapted as closely as possible to the point of contact with the eye glass frames. The eyeglasses were used to maximize retention and to mask this margin of the prosthesis. Glass frame was modified in the bridge area. Eyeglasses are attached using a fishing line. The nasal prosthesis is inserted into the patient and added with silicone adhesive for retention. Detailed instructions regarding care and use were provided to the patient.

Control 1 week later and carry out retention and stabilization checks. From the results of the examination, it was found that retention and stabilization were good, there was no irritation, and the patient felt comfortable.

DISCUSSION

Facial defects result in multiple functional and psychosocial difficulties. Surgical reconstruction techniques, prosthetic rehabilitation or a combination of both the methods to restore these facial disfigurements may improve the level of function and self-confidence for patients.[4]

In our case report, the nasal bones and the associated soft tissues were intentionally left intact. This was done to improve the support of the eyeglasses at the bridge of the nose and to increase skin surface contact to enhance adhesive retention of the prosthesis.

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Figure 5. Process wax-up .

Figure 6. Try in wax-up.

Figure 7. Process nasal prosthesis and eyeglass frame attachment.

Figure 8. Insertion of nasal prosthesis attached to eyeglass frame.

When suitable conditions are provided, mechanical retention obtained by anatomic undercuts is the most advantageous. The presence of moisture, mobile soft tissues, or lack of stable tissue support affects the retention; these are disadvantages of anatomic retention.[5]

The nasal prosthesis is made of HTV silicone material. The choice of silicone material is because this material has excellent thermal stability, biologically inert, and color stable when exposed to ultraviolet light. The advantages of HTV (high temperature vulcanized) silicone compared to RTV (room temperature vulcanized) silicone:[6] Fewer chances of air bubble entrapment, since hand mixing of catalyst and pigments with the elastomer, is avoided; Increased tear strength mechanical durability, and chemical resistance; Increased biocompatibility and flexibility.

To get a color that matches the patient's natural face color, this is done by making several samples of a mixture of silicone and dye in different ratios until a suitable color is obtained. Making this nasal prosthesis has difficulties in color adjustment. This is because the edge of the patient's nasal prosthesis borders healthy tissue that has a natural skin color but there is also scar tissue so the skin color is different from normal. This difficulty is overcome by using foundation on both the nasal prosthesis and the patient's facial skin tissue so that there is no color difference.

When reviewing the advantages and disadvantages of each of these materials, it is obvious that no single material is ideal for every patient. Some of the problems inherent in all these materials are.[7]

The continued effect of sunlight and vascular dilation and contraction on the natural tissues, which cannot be duplicated in the prosthesis; The variations of skin tone when the patient is exposed to different light sources (e.g., incandescent, fluorescent, and natural light); Emotional factors which cause color changes in the skin; The inability of the prosthesis to duplicate the full facial movement of the nondefective side; Lack of predictability of the life of the prosthesis, because of the variations among the patients (i.e., secretions, smoking and environment).

CONCLUSION

Facial defects can be rehabilitated using prosthetic rehabilitation so that the patient more comfortably and confidently resumes the regular daily activity. In countries like Indonesia, where cost of the treatment is still a primary concern for the patient, HTV silicone can be used as a material for definitive prosthesis. Mechanical devices such as eyeglass frames and adhesive materials can provide retention and support for the nasal prosthesis.

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INDONESIAN JOURNAL OF PROSTHODONTICS

CASE REPORT

Prosthetic rehabilitation with artificial palpebra of an ocular defect with contracted socket

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Keywords: Contracted sockets, Eye socket, Maxillofacial prosthesis

ABSTRACT

Eyes are one of the most important organs of the body which are set inside the protective orbital bone. Loss of an eye can be caused by congenital defects, trauma, or tumors. The removal of the eyeball (enucleation) may cause a massive impact on the self-image, confidence, and personality of an individual. Acceptable cosmetic results usually can be obtained with an ocular prosthesis which is an artificial maxillofacial prosthesis to replace the lost eye. This paper describes the prosthetic rehabilitation of a 71-year-old male patient with a left ocular defect accompanied by a contracted socket caused by the poorly fitting old prosthesis which results in subpar cosmesis. The soft tissue around the eye is normal, but the palpebral conjunctiva forms an abnormal adhesion to the eye socket. An impression was made using a custom tray and alginate in the defect area, followed by filling the impression with gypsum type 3 to get a working model, from which a wax model was made and adjusted to the patient. Sclera and ocular acrylic prostheses were made on the basis of an adjusted wax model. The prosthesis was then polished and colored according to the contralateral eye, followed by the manufacturing of an artificial palpebra made of silicone for a more aesthetic result. The custom-made eye prosthesis with silicone palpebra is an artistic solution for the treatment of ocular defects with contracted sockets. This technique was able to improve the patient's psychological and emotional status. (IJP 2024;5(1): 70-72)

INTRODUCTION

The human eye is a sense organ which aids in vision and is an important component of the face. The eye consists of sclera, pupil, iris, limbus, collarate, and eye muscles.[1-5] Removal of this organ may be indicated in cases of congenital abnormality, severe trauma, or disease such as an infection, tumor, or malignancy. Contracted socket is the one of the unfavourable complications of anophthalmos which refers to shrinkage of orbital tissue accompanied by a reduction in the volume along with a decrease in the forniceal depth. It eventually results in an inability to sustain a prosthesis which leads to significant functional and psychosocial disability.[2]

Based on Gopal Krishna classification,[2] the grade of the contracted socket of this patient is categorized as grade III where all four fornices (superior, inferior, lateral, and medial) is involved. Patient refused approval for medical treatment to undergo a symblepharectomy surgery due to age and time related factors. Therefore, the alternative management was carried out to improve the patient's aesthetics by making an artificial palpebra on the left eye prosthesis from silicone materials.

Rehabilitation due to eyeball loss can be divided into 2 types, which are orbital implants and eye/ ocular prostheses.[3] Ocular prostheses are also divided into 2 categories, namely fabricated and non- fabricated (customized) prosthesis. The advantage of fabricated eye prostheses is that they require minimal manufacturing time because there are no laboratory stages needed. Fabricated eye prosthesis has 3 sizes and colors.[3] However, this eye prosthesis may cause discomfort and infection due to its lack of fitness in the socket, resulting in a water sac which becomes a place for bacteria to grow. Another disadvantage is the esthetic problems caused by the mismatch in iris color. On the other hand, the customized prosthesis can be adjusted to the existing eye and is more suitable in the patient's orbital socket.[4]

The purpose of this article is to describe the rehabilitation treatment with a customized ocular prosthesis.

CASE

A 71-year-old male patient came to RSGM UGM Prof.

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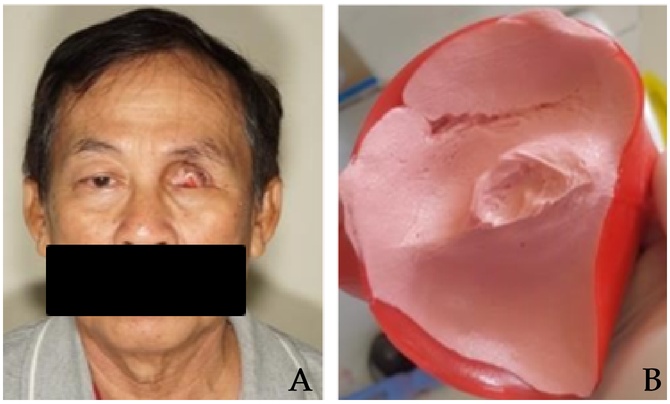

Figure 1. A. Pre-treatment, B. Study model impression

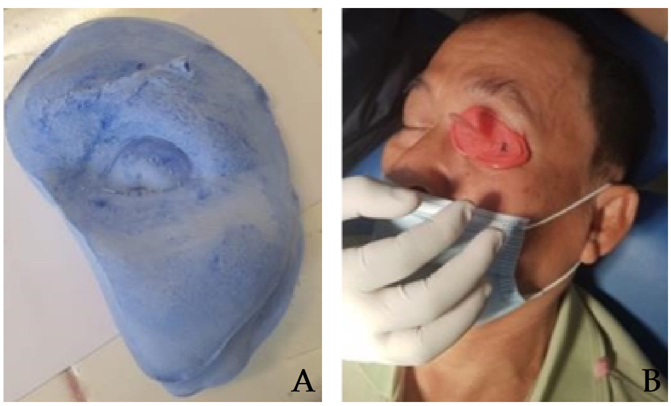

Figure 2. A. Study model, B. Functional impression

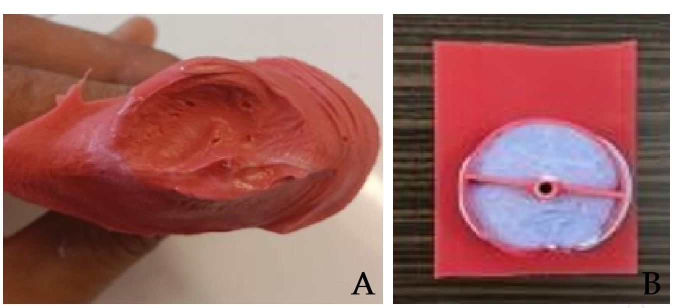

Figure 3. A. Functional impression, B. work model

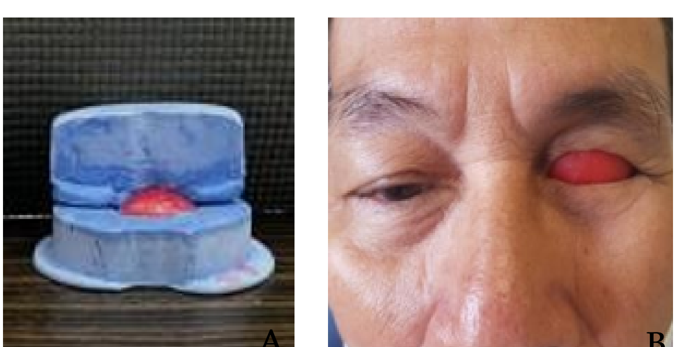

Figure 4. A. Wax pattern sclera, B. wax sclera try-in

Soedomo wearing a fabricated ocular prosthesis. The patient lost his left eyeball due to trauma from a metal bottle cap which occurred 50 years ago and has undergone surgery to remove the eyeball (enucleation). Patient complained that the previous prosthesis looked bulky, disproportionate, thus disturbing the esthetic appearance.

Objective examination was carried out and it was found that there is no eyeball on the left side, no infection and no inflammation. However, the eyelid muscle is pulled inward and is attached to the orbital floor (symblepharon), which is categorized as grade III contracted socket figure 1A. The patient was unable to open and close his left eyelid, thus an artificial palpebra is required to restore the periorbital region. The first appointment was for anamnesis, objective examination, and to collect data of the patient's profile. The diagnosis of this case was anophthalmia bulbus oculi sinistra with contracted socket. The treatment plan was to manufacture non-fabricated ocular prosthesis from acrylic resin with artificial palpebra made of silicone.

Management

The patient was asked to close his eye during individual tray fabrication which used irreversible hydrocolloid impression material around the eyes figure 1B. The impression was then filled with dental stones figure 2A. The hardened stone was used as a working model to make individual trays using a selfcuring acrylic resin.

The Impression Procedure

A light body polyvinyl siloxane impression material was injected into the eye socket, to which an individual tray was attached. The patient was instructed to move his eye muscles to obtain a functional impression of the defect figure 2B. After setting, the impression material was removed from the socket and it was examined thoroughly for any void figure 3A. The impression then was boxed and was poured in three parts to get a split cast by using type III dental stone figure 3B.

The wax sclera try-in

A wax pattern was fabricated by allowing molten modelling wax to flow into the mold figure 4A. Afterwards, the wax pattern was tried in the patient's eye socket to check for comfort, stability, and retention figure 4B. Furthermore, the sclera color was recorded using photography of the patient's real eye. The smoothed sclera wax pattern and sclerea color notes were sent to the laboratory for packing.

The acrylic sclera try-in and determine positioning iris

The patient was instructed to look straight and keep all their facial muscles relaxed. The acrylic sclera was tried in the patient's eye socket to analyze the comfort, stability, and retention figure 5A. After that, the iris and the pupil were designed based on the other eye using a pencil. The diameter of an iris usually range from 10mm, 10.5 mm, 11 mm, 11.5 mm, and 12 mm. The iris diameter was designed by direct measurement using a sliding caliper figure 5B. Then the acrylic sclera was sent to the laboratory for iris coloring.

Ocular Prosthesis Fabrication and Palpebral Wax Contouring

The ocular prosthesis was fabricated and it was evaluated for the morphology and esthetic result figure 6A. The palpebral wax was carved and adjusted to the contralateral eye portion. figure 6B.

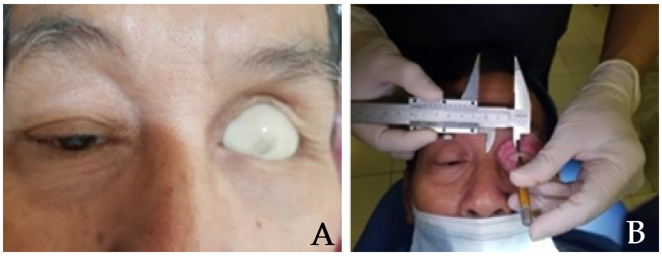

Figure 5. A. Acrylic sclera try-in, B. Iris positioning

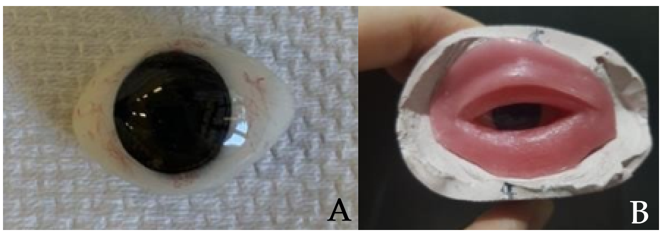

Figure 6. A. Resin sclera fabrication, B. Palpebral wax carving

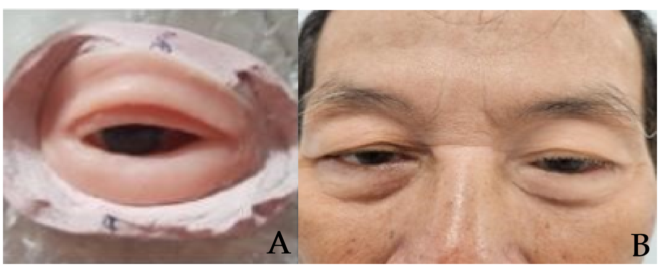

Figure 7. A. Dorsal view of finished prosthesis, B. Orbital rehabilitation (final outcome).

Palpebral wax and silicone try-in

The palpebral wax was tried in around periorbital region. The medical-graded silicone material was mixed, a mix of white, brown, and light red pigment stains were blended into the base color of silicon for intrinsic staining based on shade match with the patient's skin color figure 7A. Silicone was packed and cured at room temperature for 24 h according to manufacturer's instructions. A slit was made on the silicone extending from the medial canthus of the eyelid to the lateral canthus of upper and lower eyelid, and artificial eye lash was inserted between it and adhered for natural appearance figure 7B.

DISCUSSION

The fabrication of a custom acrylic eye provides more esthetic and precise results because an impression establishes the defect contours and the iris and the sclera are custom fabricated. Prosthetic rehabilitation of anophthalmic patient with contracted socket has been explained in this case report. Contracted socket due to eyelid adhesions (symblepharon) had occurred within the last 30 years. This is thought to be because the patient never had control over replacing the eye prosthesis, resulting in a trauma process that caused adhesion to the conjunctival surface of the patient's left eyelid.

The management of symblepharon is symblepharonectomy and surgical reconstruction of the eyelid to improve aesthetics and restore the normal anatomical structure of the eyelid.[1] However, the patient refused approval for medical treatment due to age and time-related factors. Therefore, manufacturing an artificial palpebral on the left eye from silicone material is chosen.

To build the periorbital region medically graded silicone was used, since it had proven desirable material properties including flexibility, biocompatibility, ability to accept intrinsic and extrinsic colorants, chemical, and physical inertness, and moldability.[3] Various methods of auxiliary retention for orbital prostheses include eyeglass and silicone adhesive. The retention of the orbital prosthesis was achieved by adhering the silicone base to the acrylic and to the skin. This technique is a simple, cost effective, and easy way for fabrication and rehabilitation of an orbital defect using silicone prosthesis providing better esthetic and psychological outcome. This article explains some of the basic principles associated with the fabrication of the custom ocular prosthesis with artificial palpebrae made of silicone. A properly fitted and acceptable custom ocular prosthesis has the following characteristics: reconstruct the shape of the defect socket, restore normal palpebral anatomy similar to the natural eye, mimics the colorations and proportion of the natural eye, has a gaze similar to the natural eye.

Making the sclera and painting the iris were adjusted to the opposite eye using photography of the patient's eye. This method might reduce the patient's treatment time because usually the sclera and iris are painted in front of the patient. The advantage of making an eye prosthesis is that it can restore the patient's appearance to that of a normal eye. By restoring the appearance, the self-confidence can be enhanced so that the patient could feel more accepted in social life. The orbital rehabilitation not only restore patient's visual function, but also reduce the psychological trauma caused by an eyeball loss.

Anophthalmic socket with grade III contracted socket may be corrected with modifications to the prosthesis, instead of reconstruction surgery. In this case, manufacturing of artificial palpebra made of silicone which has similar shade with natural skin of the patient and fabricating the acrylic resin ocular prosthesis produced satisfactory results

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CASE REPORT

Prosthodontic presurgical treatment of midline facial cleft in West Syndrome Infant

Detin Nitami,* Dewi Vindani, Lisda Damayanti, Helmi Siti Aminah

Keywords: Midline facial cleft, Modified PNAM, West syndrome

ABSTRACT

Midline facial cleft is extremely rare congenital malformation. It may be associated with other syndromes, including West syndrome (WS), a severe form of epilepsy in infancy. This report presents modified Presurgical Nasoalveolar Molding (PNAM) treatment of midline facial cleft in WS patient. An infant girl born with midline facial cleft, characterized by flat nose due to complete absence of nasal cartilage, columella, and premaxilla. She was also diagnosed with WS, hydrocephalus, and cerebral palsy. PNAM treatment was performed, consisting of feeding plate and extraoral nasal hook. The feeding plate prevented tongue protrusion which could interfere the airway during multiple spasms and trained her to place the tongue in its normal position. The extraoral strapping was retracted across the upper lip and feeding plate was grinded selectively to approximate the lip and alveolar segment concurrently. An elastic band was paired on nasal hook and attached to the forehead to elevate nasal dome and maintain the airway during retraction. After 1 year follow-up, alveolar gap was reduced by 4,5mm, lip segment moved closer to the midline, and bodyweight increased sufficiently. Modified PNAM can help infant with WS breath, increase nutritional intake and mold the alveolar tissue properly. (IJP 2024;5(1):73-77)

INTRODUCTION

Craniofacial clefts are extremely rare congenital malformation compared with the orofacial cleft (cleft lip and/or cleft palate), with prevalence less than 1 per 100.000 births or only 0,4% to 0,7% among cleft population.[1] It is important to distinguish between facial cleft and ordinary cleft lip. The exact etiology of craniofacial cleft is still unclear, but presumably it appears to be as a result of the genetic predisposition, neural crest central disorganization, mutations during craniofacial embryogenesis, and the impact of environmental risk factors, with 4 major category of risk factors: radiation, infection, alcohol and drug use during pregnancy and maternal metabolic imbalance.[2-4]

According to the time of the embryological accident, clinical manifestations are variable. The malformation may concern brain, bone, and soft tissues either together or isolated.[5] In 1976, Tessier described the numeric classification for rare craniofacial clefts into 0 to 14, based on anatomical position of the cleft.[1]

Tessier number 0 is the most common type of rare craniofacial clefts.[4,5] It is a median craniofacial dysgraphia and also referred as midline facial cleft (MFC). MFC can be associated with other congenital defects and central nervous system (CNS) malformations. Patient with MFC presenting agenesis of the premaxilla, may be suspected of being associated with holoprosencephaly (HPE) sequence.[4] Infant with MFC also may be attributed and suffered from epileptic spasms during the neonatal period.[6] Prior to our report, there has no cases reported in the literature regarding MCF patient associated with West syndrome.

West syndrome (WS) is regarded as a subtype of Infantile Spasms Syndrome (ISs) and is the most frequently reported subtype of ISs. WS is a unique and severe form of epilepsy in infancy, characterized by a triad of (1) episodic spasm and occurring in the cluster, (2) characteristic almost continuous interictal epileptic activity with abnormal brain wave pattern on EEG so-called "hypsarrhythmia" and (3) delayed psychomotor development.[7-9] During spasms, acute respiratory compromise can occur when ictal epileptic activity directly affects autonomic control centre, involvement of respiratory centre of the brain stem.[9] Lower heart rate and loss of respiratory rate are commonly observed in WS patient, because of continuous

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adjustment of respiration during interictal spams activity. Both cardiac and respiratory dysfunction have been implicated as possible precipitating causes in sudden unexplained death in epilepsy patients (SUDEP).[9,10] We report here the first case of prosthodontic approach as presurgical treatment using presurgical nasoalveolar molding (PNAM) for infant with the aforementioned conditions.

Presurgical nasoalveolar molding (PNAM) has been widely recognized for a number of years in the early treatment of cleft neonates. The efficacy of PNAM before primary surgical repair has been described. They are the improvement of feeding, eliminate or reduce the risk of aspiration while feeding by providing a separation between oral and nasal cavity, normalizing of tongue position, and resulting presurgical reduction of cleft width.[3,11] The aim of this case report is to describe a modified PNAM treatment approach in MFC with WS infant who has respiratory compromise and feeding problem.

Figure 1. (left) Three days old newborn girl with midline facial cleft; (right) Congenital hydrocephalus clearly seen in this picture. Ventriculoperitoneal shunt was performed at the age of two months.

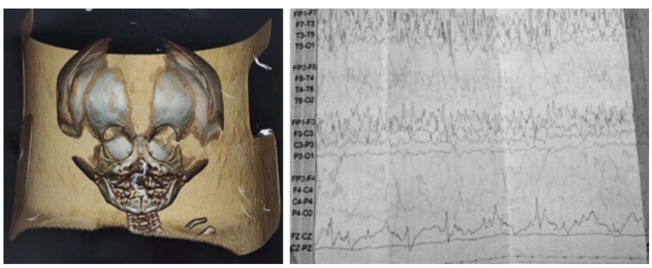

Figure 2. (left) Volume rendering technique (VRT) of head computed tomography (CT) scan demonstrating absence of the premaxilla bone; (right) EEG pattern shows the spike waves and polyspike waves at F7, T3, T5, F8 and T4 especially at left hemisphere. The EEG is abnormal with epileptiform waves.

Figure 3. Frontal view with open mouth shows prolabium-premaxilla-columella complex agenesis in complete hard and soft palate cleft.

Figure 4. A. Individual tray from self-cure acrylic with holes for retention, B. Intraoral impression using putty elastomer material, C. Cast model.

CASE REPORT

An infant girl born at term (40 weeks of gestation) by spontaneous vaginal delivery to a 22-year-old mother with a birth weight 2400grams dan length 41cm. The pregnancy was uncomplicated, but the mother experienced mild nausea and vomiting during the first trimester and light bleeding was reported in the 5th month of pregnancy. According to the parent, the family history was negative for birth defect or genetic disease, and the mother didn't smoke or consumed alcohol. The infant was referred to Dr. Hasan Sadikin general hospital (RSHS) due to her multiple abnormalities. She was treated for two months in the infectious pediatric care unit and then transferred to the non-infectious unit after her condition stable. The clinical diagnostics are then established including cerebral palsy type spastic quadriplegia, congenital hydrocephalus, West syndrome, and midline facial cleft with alobar holoprosencephaly. Figure 1 shows patient with congenital hydrocephalus before ventriculoperitoneal shunt (VP shunt) treatment. The VP Shunt had been performed at the age of 2 months.

Patient had neonatal spasms 5 hours after the birth for 2 minutes. The spasms displayed abnormal movements, intermittent jerks of head and recurrent spasms multiple times in a day followed by a high fever. Episodic spasm continued to recur in her early months of life, consisted of tonic activity of both arms like a forward hugging position with subsequent spread the other limbs. Spasms tend to begin soon after arousal from sleep within 3-5 seconds duration and occur in dozens of clusters, up to 100 spasm per day. Diagnostic work-up such as head computed tomography (CT) scan showed the absence of the premaxilla bone and electroencephalography (EEG) confirmed pattern of hypsarrhythmia, therefore she was diagnosed as having WS (Figure 2). The incidence of spasms slowly decreased over time as she got older, and by the time the patient was 6 months old, spasms became less frequent.

Patient got referred to Prosthodontic department RSHS for feeding treatment of cleft. Clinical features of her cleft were completely absence of premaxilla, columellar and nasal septal cartilage, therefore the nasal dome was flat without any support

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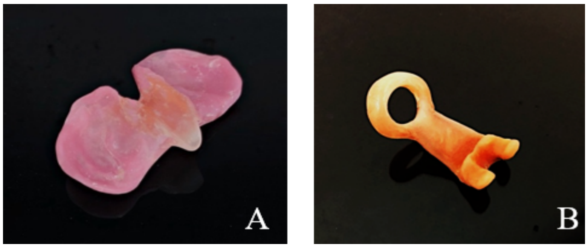

Figure 5. A. Hotz-type feeding plate, B. Extraoral nasal hook.

Figure 6. Feeding plate is placed inside the mouth with a good retention.

Figure 7. Extraoral nasal hook is performed to elevate the flattened nasal dome up during lip retraction.

Figure 8. (left) photo before PNAM treatment, (right) photo after 10 months PNAM treatment. Note the gap of lip segment moves narrower.

as shown in Figure 3. The cleft defect extended to the soft palate. The patient's tongue protruded outward and upward, occupying the cleft most of the time. This activity caused respiratory problems for the patient since her palatum was low.

Intraoral impression was taken at 10 days postnatal using individual infant oral tray and putty impression material (Figure 4). The modified presurgical nasoalveolar molding (PNAM) was then delivered a week after. This PNAM consisted of two separate appliances, the first appliance was a Hotz-type feeding plate and the second appliance was an extraoral nasal hook, as shown in Figure 5. The feeding plate was inserted and the patient's ability to suck milk from the bottle was evaluated (Figure 6). It had taken about 20 minutes to drink 40ml of milk in the first trial of feeding with the appliance. Over time, the ability to drink milk increased and at the next control visit, she was able to drink 60ml of milk in 15 minutes. The weight gain was observed regularly and it was increased sufficiently.

During the onset of multiple spasms, the feeding plate helped pushing the protruded tongue back to its normal position and preventing it to enter the defect area which could interfere the airway. Selective grinding was performed gradually on the feeding plate to approximate the gap of alveolar segment. Strapping was placed across the upper lip to retract the lip closer to the midline. As a consequence of the retraction process, the nasal dome got flatter due to there was no bone to support it. Therefore, an extraoral nasal hook is applied to elevate the nasal passages and maintain the airway during the lip segment retraction. A plaster tape with elastic orthodontic band were paired on the nasal hook and attached vertically on the forehead. Figure 7 shows the procedures described above.

After 1-year follow-up, the 12,5mm alveolar gap reduced to 8mm and the gap between the lips that used to be wide had become narrower, a favorable shape for repair surgery preparation, as shown in Figure 8. Due to patient's unstable conditions, lip surgical repair was performed when she was 14 months old. The repair showed favorable esthetics result and the tissue healed under minimal tension (Figure 9).

DISCUSSION

MFC results from failure of the two medial nasal processes to fuse in the midline.[1,4] It is commonly associated with HPE as a result of failure of cleavage of the embryonic brain. In 1963, DeMyer classification previously used to describe HPE into five categories: (I) cyclopia, (II) ethmocephaly, (III) cebocephaly, (IV) midline facial cleft lip (premaxilla agenesis) dan (V) Facial dysmorphism. DeMyer groups I-III still strongly correlate brain defects, while DeMyer's group IV and V correlate normal or near normal mental development.[1,2] HPE then categorized based on brain morphology. There are three broad categories of HPE: alobar, semi lobar and lobar. Patient in this case is diagnosed with alobar HPE, presenting class IV DeMyer classification: midline facial cleft. In alobar HPE, the brain has not divided at all, usually associated with severe facial deformities and lack of psychomotor development.[12,13] Children with alobar HPE associated with severe facial

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anomalies (cyclopia, ethmocephaly and cebocephaly) have very low survival rate or rarely survive the immediate postnatal period. While those with less severe facial malformation, for example MFC, can survive for months or in a minority of cases, longer than one year.[14]

HPE patients have a strong correlation with epileptic spasm. A retrospective study from Butow and Zwahlen,[6] proposed data of 85 patients with cleft and HPE, 63.0% of them with prolabium-premaxilla-columella agenesis suffered from epilepsy presenting with intermittently compromised airways during epileptic seizures. Our patient also had a complex cleft with prolabium-premaxilla and columella agenesis (class IV DeMyer classification) and she had neonatal spasm and later diagnosed with WS.

WS is an episodic epileptic spasm that affects individuals during infancy and early childhood. The onset of spasms varies from the first week of life to 3 years of age, with a peak at 6 months of age and in about 80-90% of cases, the spasms manifest within the first year of life.[7,8] In the present case, spasms were present from as early as 5 hours after birth for 2 minutes and associated with violent jerking of the upper limbs. The spasm continue to occur multiple times in a day, followed by a tonic contraction lasting a few seconds (3-5 seconds) with involvement mainly of the muscles of the neck, trunk, and limb. The spasm may appear with episodes of cry or scream and having a peak at 5 months of age. This patient is not achieving physical and mental milestones, she can't even roll over from tummy to back at one year old. She is being subjected to physiotherapy and she also receives routine medication from neuropediatric department for her spasm.

There can be cardiac and respiratory involvement in WS patient. During spasms, acute changes in heart rate and/or respiration can occur, therefore, respiratory dysfunction could be another risk factor for morbidity and mortality in patients with WS.[9] A study by Jansen et al.[9] evaluate respiratory control in 10 patient with WS and 14 control subject. The results show that there is a clear difference in autonomic respiratory control in patients with WS compared to control subject, it is the loss of respiration rate in patients with WS. Case specificity in our patient is that WS is associated with tongue protrusion, moving upward and forward entered and covered the cleft area. Hotz-type feeding plate then was planned to prevent the tongue from entering the defect and interfering the growth of the palatal shelves. It also trained the patient to normalize and place the tongue in the right position. Respiratory issues occurred several times in this patient, including during intraoral impression for PNAM treatment. We took intraoral impression under strict paediatrician supervision and monitor oxygen saturation due to the saturation dropped drastically during the impression process.

The management of cleft in this patient is multicomplex. The greatest obstacle in the reconstruction of the rare craniofacial clefts relates to the extent of soft tissue hypoplasia.[13] In our case, as a presurgical repair treatment, prosthodontic approach is carried out by retracting the lip tissue with extraoral strapping, so that the tissue is moulded closer to the midline, maximizing the aesthetic result of the labioplasty. Unfortunately, in this case, the nasal is flat without any bone

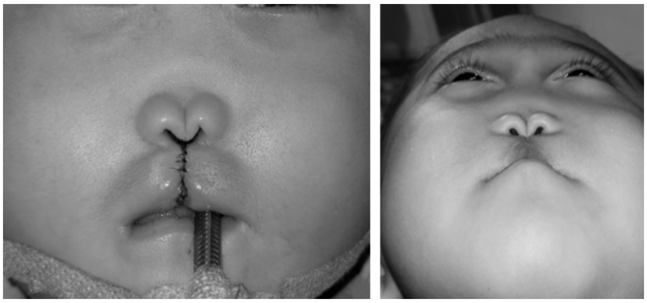

Figure 9. Labioplasty as primary surgical repair result.

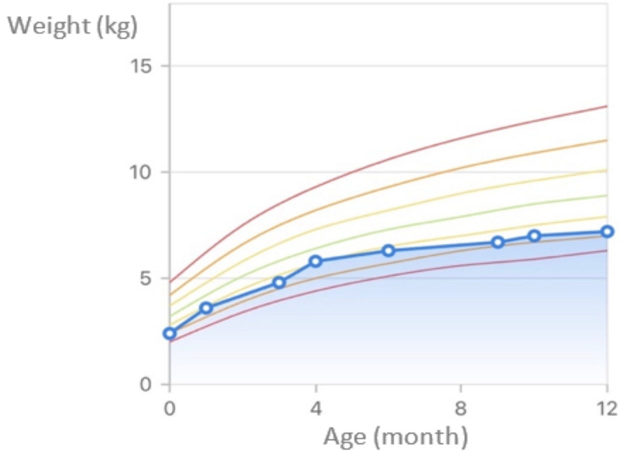

Figure 10. Patient's first year weight chart shows favourable weight gain.

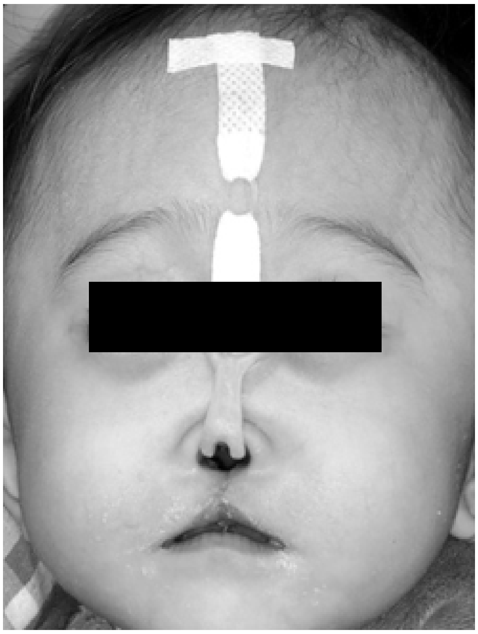

Figure 10. Post labioplasty, patient using extraoral nasal hook to maintain the airway, until the nasal reconstruction in the next surgical phase.

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necessary to be performed. A study by Monasterio et al.[15] compare the effect of nasoalveolar molding with nasal stent and nasoalveolar molding with extraoral nasal elevator in unilateral cleft lip and palate patient. The result showed both methods produced similar result. We used extraoral nasal elevator or nasal hook to simplify the procedure of elevating the nasal dome. Nasal hook was made with a wire lined with resin, paired with elastic band and fixed to the forehead. This simpler way of nasal traction helps to maintain the airway during the lip segment retraction. It is also easier for parent to understand and manage the appliance.

Patient's weight increased favourably, indicate the proper function of PNAM (Figure 10). She had not gain much weight in 5th month to 8th month of age due to her peak spasms and high fever that kept on recurring. However, her weight was regained after that. Not only for facilitate nutritional intake, the feeding plate is also useful for presurgical reduction of cleft width in the alveolus and palate. It provides guidance for the growth of each alveolar segment. In this case, we performed selective grinding of the feeding plate in every routine control visit, and we also performed build up at the under portion of feeding plate to facilitate the jaw development. The 12,5mm alveolar cleft width was reduced to 8mm in one year follow up.

Timing and sequence of cleft reconstruction in MFC with infantile spasm must encompass some criteria: successful weight gain, control of epileptic spasm, presence and the successful wearing of a feeding plate, and one-year survival.[6] It was suggested to perform primary repair surgery in MFC with HPE is not before 12 months of age and a minimum of 5 kg body weight.[6] There is a high risk of postoperative aspiration problem after surgical repair especially in cases with epileptic episodes. In our case, surgery was not performed until the spams completely disappear. The primary labioplasty in this patient was performed at 14 months of age due to patient's unstable condition. The second surgical phase, nasal repair and palatoplasty, is planned to be performed when the patient is 2 years old.

CONCLUSION

The presurgical treatment of MFC with WS has not been reported previously in the literature. Treating patient with these conditions, particularly those with agenesis of facial structures remains a very challenging task and multidisciplinary approach. The prosthodontic approach with PNAM has been expected as an effective treatment for patient with these conditions. It helps the patient to breath better, facilitate nutritional intake so the body weight gain sufficiently and mould the lip and alveolar tissue closer to the midline to provide a more aesthetic primary surgical result.

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CASE REPORT

Immediate surgical obturator and interim obturator for recurrent nasal cavity cancer patient with aramany's class II: A case report

Eugenius Bramianta Wardhana,[1] Franciscus Wihan Pradana,[2] Murti Indrastuti,[1]* Intan Ruspita[1]

Keywords: Aramany's class II, Hollow bulb, Interim obturator, Surgical obturator

ABSTRACT

The maxillary defect can interfere a patient's speech, masticatory, aesthetic and psychologic. To overcome this problem, an obturator prosthesis is needed. This case report focuses on prosthetic rehabilitation for Aramany's class II patient. In January 2022, a woman, 46 years old, was diagnosed with recurrent cavum nasi cancer. She got a subtotal maxillectomy at RSUP Dr. Sardjito. After maxillectomy, the patient was assigned a surgical obturator with vacuum formed retainer material to close the palate gap. One month after the operation, the patient came to Oral Clinic RSUP Dr. Sardjito for evaluation. On the intraoral examination, there was a maxillary defect in Aramany's class II. Resin acrylic obturator with hollow bulb was made as an obturator interim. The obturator insertion showed that the palate gap was tightly closed by the acrylic plate. In this case, the obturator interim successfully helps the patient bring back the function of speech, masticatory, and aesthetics. (IJP 2024;5(1):78-81)

INTRODUCTION

Nasal cavity cancer is a rare condition. The diagnosis is frequently only subsequently suspected because the symptoms of nasal cavity cancer are also frequent signs of many other illnesses, such as chronic rhinitis or sinusitis. Wood dust, nickel, and chemical solvent exposure are risk factors for cancer of the nasal cavity. Smoking cigarettes has also been strongly connected. One of the nasal cavity cancer treatments is a maxillectomy. In some cases maxillectomy can cause maxillofacial defects.[1] Maxillofacial defects may be a result of congenital malformations, trauma or surgical resection of tumors.[2] Multiple issues with deglutition, mastication, pronunciation, aesthetic, and oral hygiene are brought on by palatal defects. The primary objective of rehabilitating these defects is to eliminate the disease and to improve the quality of life for these individuals. Such deformities require a particular prosthesis to create an oro-nasal seal, which the obturator prosthesis can provide.[3]

Aramany's classification is divided into six different groups based on the relationship of the defect area to the remaining abutment teeth. Class I, the resection in this group is performed along the midline of the maxilla. The teeth are maintained on one side of the arch. Class II, the defect is unilateral, retaining the anterior teeth on the contralateral side. The central incisor and sometimes all the anterior teeth to the canine or premolar are saved. Class III, the palatal defect occurs in the central portion of the hard palate and may involve part of the soft palate. The surgery does not involve the remaining teeth. Class IV, the defect crosses the midline and involves both side of the maxillae. There are few teeth remaining which lie in a straight line, which may create a unique design problem similar to the unilateral design of conventional removable partial denture. Class V, the surgical defect is bilateral and lies posterior to remaining abutment teeth. Class VI, it is rare to have an acquired maxillary defect anterior to the remaining abutment teeth.[4]

An obturator is a maxillofacial prosthesis used to close, cover, or maintain the integrity of the oral and nasal compartments resulting from a congenital, acquired, or developmental disease process. The prosthesis facilitates speech and deglutition by replacing those tissues lost and can reduce nasal regurgitation and hyper nasal speech and improve articulation, deglutition, and mastication.[5] The first stage of treatment, known as surgical obturation, comprises the placement of a prosthetic during surgery. During the initial postoperative phase, it largely aids in the restoration

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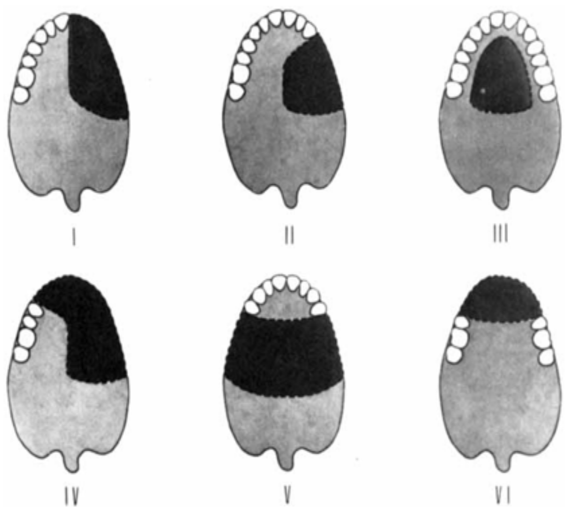

Figure 1. Classification for partially edentulous maxillectomy dental arches

Figure 2. Extraoral condition before subtotal maxillectomy

Figure 3. Surgical obturator insertion

and maintenance of oral functions. The tissue can mend during the second stage, which is referred to as the interim obturator. Typically constructed 2 to 6 weeks following surgery, the interim obturator is kept on hand until the permanent prosthesis is created.[6]

CASE REPORT

A 46 years old female patient was diagnosed with recurrent nasal cavity cancer. The patient had a maxillectomy before in 2002 and using a denture for maxilla. After diagnosed with recurrent nasal cavity, she got a subtotal maxillectomy at RSUP Dr. Sardjito. After maxillectomy, the patient was assigned a surgical obturator with vacuum formed retainer material to close the palate gap.

1 week after subtotal maxillectomy, evaluation conducted to examine post-surgery healing and instruct the patient how to maintain the oral hygiene. 2 weeks after last visit, the condition of post-surgery was good. Intraoral examination showed quite good oral hygiene, dental plaque slightly found, no swelling and no pain around the defect. Therefore, impression was taken with hydrocolloid irreversible. Working model for interim obturator was fabricated and jaw relations were recorded.

Next appointment, try in the bite rim with hollow bulb, teeth arrangement to the patient and a light contact with the opposing teeth was ensured. The purpose of this light occlusion is to not put a heavy load inside the defect. Bite rim made from Cavex modelling wax. After try in, the bite with teeth was delivered to laboratory. The interim obturator was fabricated with heat cure resin.

Interim Obturator with hollow bulb was inserted to the patient on next visit. After the insertion, patient can speak normally again, swallow properly and the aesthetic was good. There was no gap between the obturator and the defect. Occlusion were checked with articulating paper and the occlusion was balance.

On the next visit, evaluation was performed. The patient felt no pain and already used the obturator for eating, drinking and speaking normally. There was no leakage also between obturator and the defect. Patient was instructed to maintain her oral hygiene.

DISCUSSION

Oronasal and oroantral communication is caused by a rapid alteration in the physiological mechanism brought on by a maxillectomy. An obturator is a basic reconstructive procedure that can be used to separate oronasal communication, ease swallowing and mastication problems, support the soft tissues of the face, restore speech, and provide immediate dental restoration without the need for additional surgery.[7] In the aftermath of a maxillectomy, the obturator prosthesis is essential for oral function restoration. Fundamental concepts in prosthodontics, such as wide stress distribution, cross-arch stability with a robust primary connection, and stabilizing and retaining components at precise points within the arch to best avoid dislodging functional forces, should guide the design of every removable obturator prosthesis.[8]

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Figure 4. Extraoral condition 4 weeks after maxillectomy

Figure 5. Interim obturator.

Figure 6. Interim obturator insertion.

Figure 7. Extraoral view after insertion.

Surgical obturator is needed to cover the defect on site of operation. It is a base plate prosthesis that is made from the preoperative impression cast and inserted during the operating room maxilla resection. A matrix is provided by the surgical obturator on which the surgical packing can be positioned. It keeps the packing in the right relationship, ensuring that the skin graft will closely adapt. Additionally, it lessens oral contamination of the site in the immediate aftermath of surgery, which may lessen the likelihood of local infection and allow for an earlier removal of the nasogastric tube. It is a base plate prosthesis that is made from the preoperative impression cast and inserted during the operating room maxilla resection. A matrix is provided by the surgical obturator on which the surgical packing can be positioned. It keeps the packing in the right relationship, ensuring that the skin graft will closely adapt. Additionally, it lessens oral contamination of the site in the immediate aftermath of surgery, which may lessen the likelihood of local infection and allow for an earlier removal of the nasogastric tube.[9]

This Case of maxillary defect included into Aramany's class II design. This patient got the defect because of post subtotal maxillectomy with cavum nasi cancer. There are still a lot of remaining teeth, so the support was still sufficient. After a maxillectomy, an interim obturator prosthesis is necessary to improve aesthetics, deglutition, and speech. Speech and swallowing are typically quickly restored using interim obturators, but over the following three to six months, continual modification and adjusting are necessary because to the constantly changing tissue conformation. Light occlusion is needed to avoid contact with the internal organ inside the defect.[10]

The type of retainer to be used will depend on the number and position of the remaining teeth. Abutment teeth are less stressed when retainers are appropriately made. Therefore, basic design principles like passive placement, encirclement, and stabilization should be used when creating the clasp assembly.

Various materials are used for making obturators such as heat cure resin and light cure resin. In this case, heat cure resin acrylic with hollow bulb was chosen for interim obturator. The patient here had well healed defect so definitive hollow bulb obturator prosthesis was plannedf or rehabilitation.[11] In this case, patient still having chemotherapy. Therefore, definitive obturator still postponed due to defect change.

CONCLUSION AND SUGGESTION

Obturator is needed for patient with maxillary defects to maintain the quality of their life. A good obturator can help the patient to reclaim the functional and psychological needs. Speech, masticatory, and aesthetics of the patient are the most important parts of obturator's success. Interim obturator needs to has a light occlusion to avoid heavy load on organs inside the defect.

In this case, patient suggested to replace the interim obturator to definitive obturator after finish chemotherapy. Prosthesis with metal provides durability, biocompatibility, and longevity of the prosthesis.

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CASE REPORT

Management of lower eyelid laxity with pressure using conformer and custom ocular prosthesis

Dara Aidilla, Ariyani,* Haslinda Z. Tamin

Keywords: Conformer, Lower eyelid laxity, Ocular prosthesis

ABSTRACT

One of the successes in making an ocular prosthesis is sufficient eye socket condition, so post-enucleated patient treatment with lower eyelid laxity is a challenge for prosthodontists due to its difficulty in obtaining the retention of an ocular prosthesis. Long-term use of an ill-fitting ocular prosthesis will cause lower eyelid laxity and irritation due to the movement of the prosthesis that is insubordinate with the eye muscles when it is functioning. This paper represents the management of lower eyelid laxity in a post-enucleated patient with pressure using conformer and custom ocular prosthesis. A twenty-year-old female patient came to Dental Hospital Universitas Sumatera Utara with a red, swollen, and frequent discharge from the eye socket. The custom ocular prosthesis used by the patient often falls out of the socket and she requests a new custom ocular prosthesis. The patient was referred to an ophthalmologist for irritated socket. Then, a definitive impression is made. Two sclera waxes were fabricated in a definitive cast to obtain a conformer and custom ocular prosthesis. Conformer was worn for three weeks to ensure an adequate lower eyelid. Then, a new custom ocular prosthesis was inserted into the socket. Pressing the conformer towards the lower eyelid will stimulate and train the eyelid muscles to move and prevent atrophy, so it can restore the support of the lower eyelid. Lower eyelid laxity can be corrected with a pressure-assisted conformer, resulting in a functionally and aesthetically pleasing custom ocular prosthesis. (IJP 2024;5(1):82-85)

INTRODUCTION

Physical limitations that affect appearance or functionality affect an individual's ability to lead a normal life and encourage individuals to seek treatment that can bring them to their normal state. The loss of eyes is one of the sensory organ losses that has an impact on life. New eyes must be obtained in order for the patient to resume their usual life after eye loss. An ocular prosthesis simulates human anatomy by using prosthetic materials to make it appear as though the eye and its surrounding tissues are healthy and normal.[1,2]

There is a dynamic relationship between the surface of the eye socket and the ocular prosthesis. Properly positioned prosthesis should support the eyelids, restore functioning, and be aesthetically pleasing in addition to restoring the eyes' normal opening. Because the movement of the ocular prosthesis is incompatible with the movement of the eye muscles when functioning, improper ocular prosthesis conditions, also known as ill-filing ocular prosthesis that lasts for a long time, will result in lower eyelid laxity and irritation.[3]

Lower eyelid laxity can be treated using a variety of techniques, both surgical and non-surgical. If none of the non-surgical therapy options have been tried or cannot be used, surgical techniques are used. In the meantime, the non-surgical approach involves altering the ocular prosthesis by emphasizing the eye socket or, alternatively, by minimizing the stress placed on the lower eyelid. This paper describes the treatment of lower eyelid laxity in post-enucleation patients with an emphasis on using conformer and custom ocular prostheses.[2,4,5]

CASE REPORT

A 20-year-old female patient came to Dental Hospital Universitas Sumatera Utara with complaints of red, swollen, and frequently discharged eye sockets. The patient lost his left eye between the ages of 1 year and 8 months due to an infection in his left eye due to measles, so he had to have enucleation surgery. A new custom ocular prosthesis was ordered because the patient's old one, which was constructed

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Figure 1. Condition of the patient's eye sockets

Figure 2. Individual impression

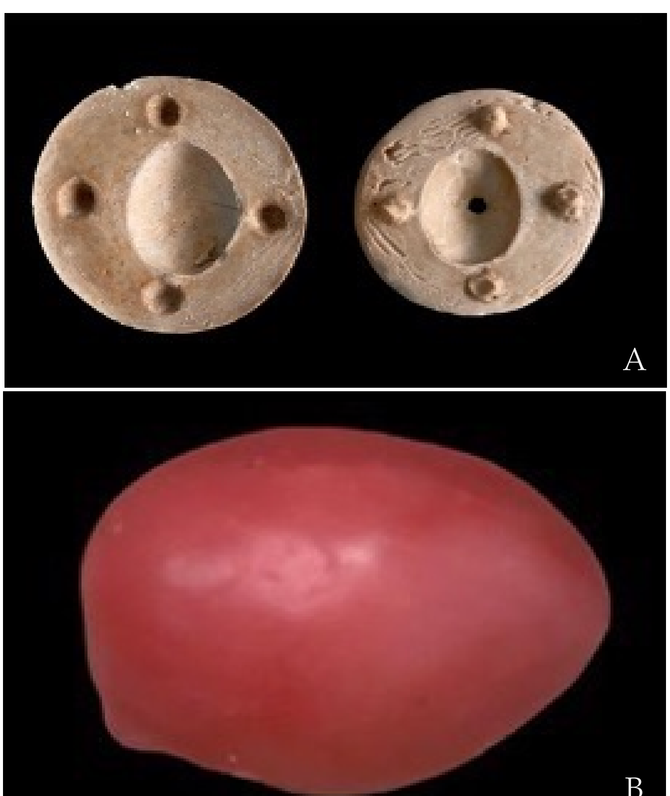

Figure 3. A. Working model, B. Sclera wax.

in January 2020, frequently came loose from its socket. The patient is referred to an ophthalmologist for irritation socket therapy.

Management

After receiving therapy from an ophthalmologist, the condition of the patient's eye sockets improved and continued with the manufacture of a new custom ocular prosthesis. Individual impression trays are created by duplicating the patient's existing customized ocular prosthesis and then perforating the center until it is wide enough for the mixing tip of the light viscosity polyvinyl siloxane impression substance to be set appropriately. To prepare the impression space, the intaglio section of the old customized ocular prosthesis was reduced by 1-2 mm. Vaseline was applied to the patient's eyelashes, and an individual impression was taken using a light viscosity polyvinyl siloxane impression material. The patient was told to move her eyes during the impression in order to get the edge of the eye area.

The master cast is made with a split cast technique, namely by implanting the intaglio surface on a type IV plaster using a plastic cup, and key holes are made on the superior, inferior, medial, and lateral sides before the plaster hardens. From the results of individual printing, a mold will be obtained for custom ocular prosthesis printing.

There will be two sclera waxes produced with this master cast. In order to create conformers from heat-cured acrylic, one of the sclera waxes is cast on the cuvette. The conformer was inserted onto the patient after it had been polished, and its dimensions, comfort, support for the superior and inferior eyelids, and eye movement were all evaluated. For three weeks, the patients were instructed to use the conformer and were observed.

In the second sclera wax, a try in and alignment with the patient's eye socket is carried out. Sclera wax is inserted into the eye socket and adjustments are made to the size and shape according to the patient's anatomy, until the palpebral fissure and anterior curvature of the eye are equal to the collateral eye.

A symmetrical measuring tool was used to perform slices at the next appointment. The patient was told to look straight ahead while the guide points for the vertical and horizontal lines of face symmetry were connected to position the symmetry measurement tool in line with the patient's midline. Next, the sclera wax was marked with the peak's highest point and midway.[6] The determination of the color of the iris is carried out using photos taken with a mobile phone in the sun. After that, Adobe Photoshop is used to alter the image, and photo paper is used for printing. The results of the iris coloring mold are coated with UV resin and cured with a UV lamp.[7]

Try in sclera waxes is done by positioning the midpoint that has been marked on the sclera. After the position of the iris button is correct, do a shake of the ocular prosthesis. Sclera wax and iris buttons that have been passedened are planted into the cuvette. Sclera reduction is carried out by using the putty index as a guideline for placing clear acrylic to get clear lenses on the custom ocular prosthesis. Sclera is re-rubbed using clear acrylic and polishing is carried out using polishing burs and pumice. The installation of a custom ocular prosthesis is carried out on the patient and evaluated for suitability, aesthetics, and coordination of movements with the collateral eye. Post-installation instructions are given to the patient regarding the method of installation and maintenance of the ocular prosthesis.

Figure 4. A. Custom conformer, B. Custom conformer insertion.

Figure 5. Try in sclera wax.

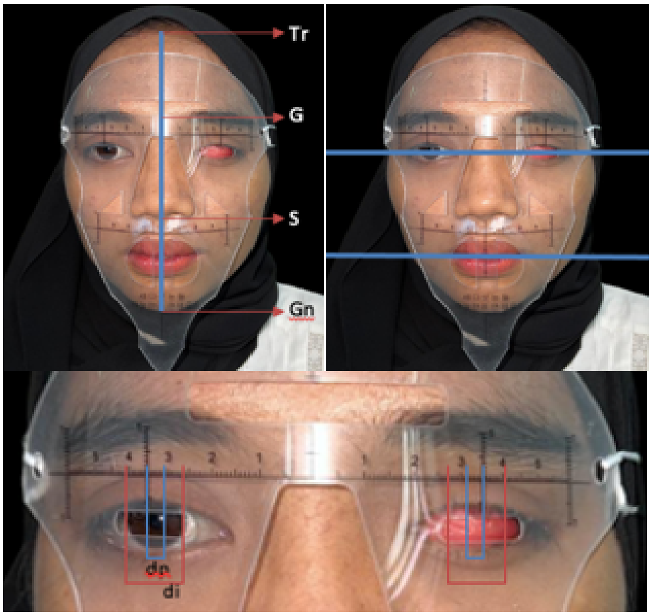

Figure 6. Iris positioning.

DISCUSSION

Lower eyelid laxity is the main factor that causes ectropion of the lower eyelid. The lower eyelid must support an additional load of prosthesis in the otophtalmic socket, which can cause excessive lower eyelid laxity or obvious ectropion. The prosthetic design that minimizes weight and the replacement of the prosthesis that follows the socket change can prevent lower eyelid laxity. Use of a pressure conformer against the socket will train and stimulate the eyelid muscles to move, preventing atrophy and restoring lower eyelid support.[2,4,8]

Several surgical and non-surgical treatment options for patients with lower eyelid laxity are described by Keith et al. (2015). The first non-surgical technique of treatment involves modifying the prosthesis by adding the sclera portion to the anterior and inferior margins in order to produce a negative curve under the iris. The second way involves adding material to the inferior medial and lateral edges of the prosthesis to spread the pressure of the ocular prosthesis to the edge.[2]

According to Raizada K. (2016), managing lower eyelid laxity involves modifying the volume of the custom conformer, namely by removing the anterior apex of the sclera wax and moving it to the upper section of the eyelid to reduce the strain placed on the lower eyelid. The patient is then told to practice winking 25 times per day, and a week of observation follows.[4]

Insertion of conformers minimizes alterations in the socket and prevents the development of scar tissue. Additionally, it enables a clinical evaluation of muscle movement, retention, and eyelid support. If surgery is not an option and scarring has caused the socket depth to decrease, a heat-curable acrylic resin can be added to a custom-made conformer to change its size. The use of stock conformers is not recommended because it requires more complicated adjustments and takes longer.[5,9,10]

After three weeks of observation, the socket can be fixed by using a conformer before a definitive customized ocular prosthesis is made. The manufacture of custom-made conformers that are attached close to the tissues in the socket stimulates and trains the eyelid muscles to move and prevents atrophy in the eye sockets. This can be accomplished more easily since it makes use of the sclera wax that was obtained from earlier printing

CONCLUSION AND SUGGESTION

In order to treat a patient who has lower eyelid laxity brought on by an inadequately fitting ocular prosthesis, it is highly recommended that an eye conformer with pressure be inserted first, followed by the fabrication of a definitive prosthesis. The custom-made conformer maintains the ideal conformation of the orbital cavity. Before a final prosthesis is constructed, any adjustments to size and shape can be made with ease. This method means the definitive ocular prosthesis no longer requires as many fitting adjustments. The advantages and relative ease and simplicity of fabrication can be considered as the first step in the treatment of infected eye sockets.

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Figure 7. Try in sclera wax.

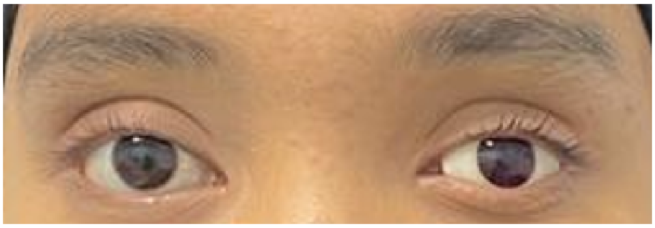

Figure 8. Installation of definitive eye prostheses.

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REVIEW

Challenges in dental education

AnjanaThomas*

Keywords: Dental education, Artificial intelligence, Augmented reality.
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ABSTRACT

Dental education faces numerous challenges that significantly affect the training and preparedness of future dental professionals. This article highlights the primary obstacles and proposes potential solutions to address them. The rapid advancement of technology necessitates continuous updates to curricula, incorporating innovations such as digital imaging, CAD/CAM systems, and laser dentistry. Ensuring faculty and student proficiency in these technologies requires substantial investment in training and resources. In summary, addressing these challenges requires curriculum reform, investment in technology, enhanced clinical training opportunities, financial support mechanisms, mental health initiatives, and adaptable Dental education faces numerous challenges that significantly affect the training and preparedness of future dental professionals. This article highlights the primary obstacles and proposes potential solutions to address them. (IJP 2024;5(1):86-88)

INTRODUCTION

Dental education, like many fields of professional education, is facing significant challenges in the contemporary era. The rapid advancements in technology, shifts in pedagogical methods, evolving ethical considerations, and the need for interdisciplinary collaboration are transforming the landscape of dental education. Additionally, diversity, financial constraints, burnout, and changing student demographics add layers of complexity to the already demanding educational environment. This comprehensive discussion explores these multifaceted challenges, offering a detailed analysis of each aspect and their implications for the future of dental education.

Technological Innovations

Simulation and Artificial Intelligence

The integration of simulation and artificial intelligence (AI) into dental education represents a major advancement but also poses significant challenges. Simulations, such as virtual reality (VR) and augmented reality (AR)[1] allow dental students to practice procedures in a risk-free environment. These technologies can replicate a wide range of clinical scenarios, enhancing students' practical skills and confidence before they treat real patients.

AI, on the other hand, offers diagnostic tools that can analyse radiographs and patient data to assist in treatment planning. AI-driven platforms can provide instant feedback on students' performance, highlighting areas for improvement and offering tailored learning pathways.

However, the adoption of these technologies requires substantial investment in hardware, software, and training for both students and faculty. There is also a learning curve associated with using these technologies effectively. Ensuring that all dental schools have equitable access to these innovations is crucial to prevent disparities in educational quality.

Virtual Teaching and Teledentistry

The COVID-19 pandemic accelerated the adoption of virtual teaching methods, which have become an integral part of dental education. Online lectures, webinars, and virtual classrooms have expanded the reach of dental programs, allowing for more flexible and accessible education. These methods also facilitate the inclusion of guest lecturers from around the world, enriching the curriculum.[2]

Teledentistry, the use of telecommunication technology to provide dental care, is another innovation that has gained prominence. It allows for remote consultations, follow-ups, and even some diagnostic services. Integrating teledentistry into the curriculum ensures that future dentists are prepared to use these technologies in practice.

The challenges associated with virtual teaching and teledentistry include ensuring that all students have access to reliable internet and appropriate devices. There is also a need to develop effective online teaching methodologies that maintain the quality of education and engagement levels. Additionally, teledentistry requires a robust legal and regulatory

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framework to ensure patient privacy and data security.

Pedagogical Innovations

Problem-Based Learning and Flipped Classrooms

Modern pedagogical methods such as problem-based learning (PBL) and flipped classrooms are being increasingly adopted in dental education.[3] PBL encourages students to learn through the exploration of complex, real-world problems,[4] fostering critical thinking and problem-solving skills. Flipped classrooms, where students review lecture materials at home and engage in interactive activities in class, promote active learning and better retention of knowledge.[5]

Implementing these methods requires a shift from traditional lecture-based teaching. Faculty must be trained in these new pedagogies, and the curriculum must be redesigned to support them. There is also a need for appropriate assessment methods to evaluate the effectiveness of these approaches.

Interdisciplinary Collaboration

The importance of interdisciplinary collaboration in healthcare cannot be overstated. Dentists often work alongside other healthcare professionals, and understanding the roles and expertise of these professionals is crucial for comprehensive patient care. Integrating interdisciplinary education into dental programs helps students develop the skills needed for effective teamwork and communication.

However, organizing interdisciplinary education requires coordination between different departments and schools within universities. It also demands a curriculum that accommodates the schedules and learning outcomes of multiple disciplines. Overcoming these logistical challenges is essential to provide a holistic education that prepares students for collaborative practice.

Clinical Training and Quality Assurance

Ensuring Clinical Competence

Quality clinical training is the cornerstone of dental education. Students must gain hands-on experience in diagnosing and treating patients to develop their clinical skills and confidence. This training is typically conducted in teaching clinics under the supervision of experienced faculty.

Ensuring consistent and high-quality clinical training is challenging due to several factors. There is often a high student-to-instructor ratio, which can limit the amount of individual attention each student receives. Additionally, the availability of diverse clinical cases is crucial for comprehensive training. Dental schools must ensure that students are exposed to a wide range of conditions and treatments to prepare them for real-world practice.

Assessment and Accreditation

Accrediting bodies play a vital role in maintaining the quality of dental education. They establish standards for curriculum, faculty qualifications, clinical training, and student outcomes. Regular assessment and accreditation processes ensure that dental programs meet these standards and continuously improve their educational offerings.

Maintaining accreditation involves significant effort and resources. Dental schools must document their compliance with standards, implement changes based on feedback, and demonstrate ongoing improvement. This process can be demanding, but it is essential for ensuring that graduates are well-prepared to enter the profes.

Diversity and Inclusion

Promoting Diversity

Diversity in dental education encompasses not only racial and ethnic diversity but also gender, socioeconomic status, and cultural background. A diverse student body enriches the learning environment, promotes cultural competence, and ensures that the dental workforce reflects the population it serves.

Recruiting and retaining diverse students can be challenging. Outreach and recruitment efforts must be targeted to underrepresented groups, and financial support must be available to make dental education accessible to all. Additionally, creating an inclusive environment where all students feel valued and supported is crucial for retention and success.

Addressing Disparities

Disparities in dental education can arise from various factors, including socioeconomic status, geographic location, and access to resources. Students from disadvantaged backgrounds may face additional challenges in pursuing a dental education, such as financial constraints, lack of mentorship, and limited access to preparatory resources.

Addressing these disparities requires comprehensive support systems. Financial aid, scholarships, and loan repayment programs can alleviate financial barriers. Mentorship and academic support programs can help students from underrepresented backgrounds succeed in dental school. Additionally, partnerships with community organizations can provide outreach and support to aspiring dental students.

Financial Constraints

Cost of Dental Education

The cost of dental education is a significant concern for students and institutions alike. Tuition fees, equipment costs, and living expenses make dental education one of the most expensive professional degrees. High levels of student debt can deter individuals from pursuing a dental career and place financial stress on graduates.

Institutions also face financial challenges in maintaining and improving their programs. Investing in new technologies, facilities, and faculty development requires substantial funding. Public funding for higher education has declined in many regions, placing additional pressure on dental schools to find alternative revenue sources.

Financial Support and Scholarships

Providing financial support to students is essential for making dental education accessible. Scholarships, grants, and low-interest loan programs can help reduce the financial burden on students. Additionally, loan repayment programs for graduates working in underserved areas can incentivize careers in public health dentistry.

Institutions must also seek funding from various sources to support their programs. Partnerships with industry, alumni donations, and research grants can provide much-needed financial resources. Effective financial management and strategic planning are crucial for maintaining the sustainability of dental education programs.

Burnout and Well-being

Student Burnout

The rigorous demands of dental education can lead to high levels of stress and burnout among students.[6] The intense

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workload, high expectations, and competitive environment can take a toll on students' mental and physical health. Burnout not only affects academic performance but also has long-term implications for professional practice and personal well-being.

Addressing student burnout requires a multifaceted approach. Institutions must promote a healthy work-life balance, provide mental health resources, and create a supportive learning environment.[7] Faculty and staff should be trained to recognize signs of burnout and offer appropriate support. Additionally, fostering a culture of well-being and resilience is essential for helping students manage stress.[8]

Faculty Well-being

Faculty members also face significant stress and burnout due to the demands of teaching, research, and clinical responsibilities. Burnout among faculty can impact their effectiveness as educators and their overall job satisfaction. Ensuring faculty well-being is crucial for maintaining a high-quality educational environment.

Institutions should provide resources and support for faculty well-being, including professional development opportunities, counseling services, and a supportive work environment. Encouraging a healthy work-life balance and recognizing the contributions of faculty can also help mitigate burnout.[9]

The New Generation of Dental Students

Characteristics and Expectations

The new generation of dental students, often referred to as Generation Z, brings different characteristics and expectations to dental education. These students are tech-savvy, value diversity and inclusion, and seek meaningful and flexible learning experiences. They are also more likely to prioritize work-life balance and personal well-being.[10]

Understanding the characteristics and expectations of this generation is essential for designing effective educational programs. Institutions must embrace technology, promote a diverse and inclusive environment, and offer flexible learning options. Additionally, fostering a supportive and engaging learning environment can help meet the needs of these students.

Adapting to Change

Adapting to the changing demographics and expectations of students requires a proactive approach. Institutions must continuously evaluate and update their curricula, teaching methods, and support services. Engaging students in the decision-making process and seeking their feedback can also help institutions stay responsive to their needs.

Faculty development is crucial for adapting to these changes. Educators must be trained in new pedagogical methods and technologies to effectively engage and support the new generation of students. Creating a culture of continuous improvement and innovation is essential for staying relevant in a rapidly changing educational landscape.

Ethical Issues in Dental Education

Professionalism and Ethics Training

Ethical issues in dental education encompass a wide range of topics, including patient care, academic integrity, and professional conduct. Training students in professionalism and ethics is crucial for ensuring that they uphold the highest standards in their practice. This training should cover topics such as patient confidentiality, informed consent, and ethical decision-making.

Institutions must also model ethical behavior and create an environment that promotes integrity and accountability. Faculty should serve as role models and mentors, demonstrating ethical behavior in their teaching and clinical practice. Additionally, addressing ethical issues and challenges openly can help students develop a strong ethical foundation.

CONCLUSION

Dental education faces a multitude of contemporary challenges, ranging from technological advancements and pedagogical innovations to issues of diversity, financial constraints, and well-being. Addressing these challenges requires a comprehensive and proactive approach, involving investment in technology, curriculum redesign, support for diversity and inclusion, financial management, and promotion of well-being. Additionally, ethical training and interdisciplinary collaboration are essential for preparing students for the complexities of modern dental practice. By addressing these challenges, dental education can ensure the development of competent, ethical, and resilient dental professionals ready to meet the evolving needs of society.

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