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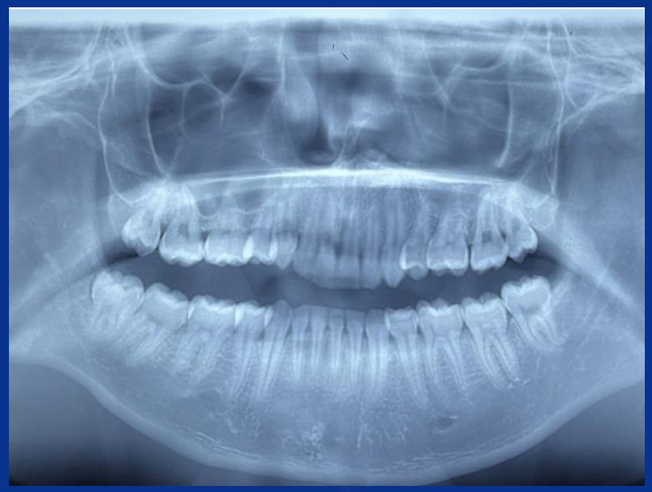

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REVIEW

The benefit of chitosan adding as a reinforcement material for polymethyl methacrylate provisional fixed dentures

Dara Aidilla, Ricca Chairunnisa, Syafrinani

Keywords: Chitosan, Provisional fixed partial denture, Self-cure PMMA

ABSTRACT

Backgrounds: Provisional fixed partial denture (FPD) is an important procedure in prosthetic treatment such as crown or bridge. In particular cases, like crown lengthening as preliminary treatment, implant procedure until osseointegration process, and temporomandibular disorder as an occlusal therapy, the use of provisional FPD will take 3-6 months until the insertion of definitive restoration. Therefore, materials used in making a provisional FPD should be able to preserve the prepared tooth, maintain the periodontal conditions, and have superior esthetic for a long time. Self-cure polymethyl methacrylate (PMMA) is a most commonly used material due to its biocompatibility, high wear resistance, ease of application, and superior esthetic. Nonetheless, unmodified self-curing PMMA has weaknesses due to its degradation process in the oral cavity, which affects its mechanical and physical properties. To overcome this, addition of reinforcement material, namely chitosan, in provisional FPD is necessary. Chitosan is polymer compound obtain through partial deacetylation of acetyl glucosamine through deacetylation of chitin base and modified into magnetic nanoparticles with size 100-400 nm to increase absorption power. The addition of nanotechnology to polymeric materials has shown significant appeal and improved mechanical and physical properties. (IJP 2024;5(2):89-91)

Introduction

Provisional restoration is an important stage of prosthetic treatments withcrowns and bridges. The periodontal tissue usually requires 6 months to heal after certain procedures, such as crown lengthening. A provisional restoration is therefore required to maintain the periodontal's shape and tissue after crown lengthening.[1,2] The same holds true for implant installation, which requires a 3-6 months osseointegration period.[3]

Provisional restoration serves to protect and maintain patient comfort when definitive restoration is made. The success of the treatment phase using provisional restoration , the dentist can gain the patient's trust and favorably influence the final success of the restoration.[1,4] The types of materials that can be used in temporary retortation are PMMA, PEMA, Urethane Dimethacrylat Resin, and Bicacryl Composite. The material that until now has been used is PMMA (polymethyl methacrylate). PMMA is often used because of its easy application and because its price is not too expensive when compared to other materials. PMMA comes in several types, namely heat-cure and self-cure.[5,6]

The most commonly used material for producing provisional restoration s is PMMA. This material has a reduced molecular weight and doesn't require heat for polymerization. A tertiary amine niciator, such as dimethyl-p-toluidin, activated benzyl peroxide, which subsequently creates free radicals chemically, in a self-cure PMMA. Better dimensional stability and adaptation are the primary advantages of PMMA self-cure, and there is minimal shrinkage after polymerization.[6] However, since PMMA self-cure polymerizes to a lower degree than heat-cure PMMA, there are many unreacted monomers, or so-called residual monomers, that could irritate tissues and decrease their mechanical and physical properties. To overcome this, a reinforcing material was added to the self-cure PMMA, increasing its resistance to fractures caused by masticatory loads, discoloration, and long-term use. Chemical substances, metals, or fibers can be utilized as reinforcing materials. However, because natural ingredients are biocompatible and safe for the body, several researchers have created the method of adding them as reinforcement.[7,8]

A naturally existing material called chitosan is derived from the shells of crustaceans like crabs, shrimp, and lobsters. Other microbes, including yeast and fungus, also contain chitosan. Research on chitosan keeps on being established because it has many benefits in biomedical and dental applications. Chitin bases are deacetylated to produce chitosan, a polymeric compound of glucosamine and N-acetyl glucosamine. Chitosan has many advantageous properties, including good biocompatibility, mucoadhesion, non-toxicity, lack of allergic reactions, and lack of carcinogenicity.(9–11) In addition, chitosan also has a high resistance to heat due to its intramolecular hydrogen bonds. Chitosan can be modified both chemically and physically during development to increase its adsorption capacity,

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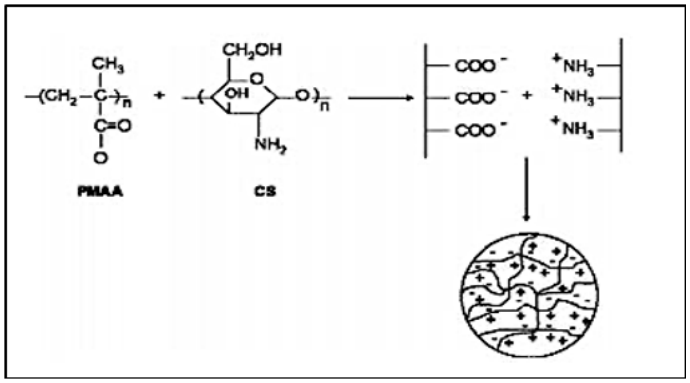

Figure 1. Bond between PMMA and chitosan compounds

selectivity, and use. Such chitosan modifications can be accomplished by combining chitosan with a variety of polymers, both natural and synthetic.[12-14]

Research has shown that nanoparticles are significantly attracted to prosthodontic polymeric materials because of the materials' improved mechanical and physical properties. However, a number of variables, including particle size, polymer particle interface, fabrication method, and particle distribution in the polymer matrix, influence how much of an impact nanoparticles have on the physical and mechanical properties of polymers.[8,9] Chitosan development research is still being explored. The scientists researched further special qualities in chitosan that may be applied in a variety of industries, such as medical, biology, and pharmaceuticals. Many studies use chitosan as an absorbent and modify it chemically and physically by combining it with other polymers.[13] Based on this, the author wants to describe how PMMA is self-curing while chitosan material is being added to the provisional fixed denture material in an attempt to improve its physical and mechanical properties.

Provisional Fixed Dentures

A provisional restoration, according to The Glossary of Prosthodontics, is a fixed or removable dental prosthesis or maxillofacial prosthesis created to improve aesthetics, stability, and/or function for a brief period of time before being replaced by a final dental or maxillofacial prosthesis.[15] Until the insertion of a definitive restoration, provisional restorations perform an important function in dental preparation. Although the final restoration will be done a few weeks after the tooth is restored, provisional restorations should nevertheless satisfy the patients' and dentists' essential needs.[3]

Provisional restoration may be required for a prolonged period of time due to periodontal diseases or the etiology of TMJ problems. Therefore, a provisional restoration must be adequate for maintaining the patient's health. The ideal interim restoration must take into account a number of interrelated factors, which can be classified as biological, mechanical, and aesthetic considerations. The condition of a provisional restoration must be able to protect the pulp, prevent supraeruption and the presence of tipping on the teeth, produce good occlusal function in the patient, easily maintain the patient's OH, the material used must be resistant to occlusal and retentive loads, aesthetically pleasing and can be policed to prevent plaque accumulation.[2,16]

Some materials that can be used for provisional restoration are Polymethyl Methacrylate Resins (PMMA), Polyethyl Methacrylate Resins (PEMA), vinyl ethyl methacrylate resins, butyl methacrylate, epimine, metal, polycarbonate materials, bis-acryl composites, bis-GMA composites, and Urethane Di Methacrylate Resins (UDMA). However, a commonly used material for provisional restoration is PMMA acrylic resin.[5]

Polymethyl Metachrylate (PMMA)

In 1843, Redtenbacher published the first description of PMMA, an odorless acrylate acid polymer. However, PMMA's development in biomedicine occurred gradually over a period of time. In 1937, PMMA was first introduced in powder form for the fabrication of denture bases. Later, in the 1940s, PMMA became an important biomaterial for dental laboratories and clinics.[17]

The properties obtained by PMMA, such as easy to process, acceptable mechanical properties, aesthetics, cost-effectiveness, and relatively lower toxicity, have replaced the basic materials of artificial teeth used previously, namely, gold, porcelain, aluminum, and others. In the late 20th century, PMMA gained popularity for the fabrication of a variety of dental and maxillofacial prostheses, including obturators, dentures, provisional crowns and bridges, in addition to being the base material for dentures. However, this material has gluttons, such as exothermic polymerization, high polymerization shrinkage, and low wear resistance.[5]

According to Anusavice (2013), the types of akrilik resins are:[18] Hot polymerized acrylic resin (Heat-Activated Denture Base Resin); This material is used by almost all denture base manufacturers. This material is available in powder and liquid form and requires thermal energy (heating) for polymerization. A water bath or microwave can be used to heat the material; Chemical-Activated Denture Base Resin. The terms self-cure, cold-cure, autopolymerization, swapolimerizing resins are frequently used to describe acrylic resins that require chemical activation. This material polymerizes by chemical activation. In self-cure PMMA, tertiary initiator amines such as dimethyl-p-toluidine are added, which after polymerization activates benzyl peroxide and produces free radicals. Activation is chemical and does not require the application of thermal energy. Therefore, it can be done at room temperature. This material is frequently utilized today because the quick and simple manufacturing process makes it simpler for dentists to do provisional restorations.

PMMA self-cure

Self-curing PMMA was first introduced in 1945 in Germany. The advantages of using this type of material over other types of PMMA polymers include easy application; a fast manufacturing process; biocompatibility with oral tissue; allergy-freeness; low density and molecular weight; stable color for acceptable aesthetics; minimal depreciation; a stable polymerization cycle with an acceptable end result; and long-term functionality.[17,19]

This material consists of powder and liquid, where acrylic resin powder, benzoyl peroxide, fibers, and colorants are contained in the powder. And the self-cure PMMA liquid contains methyl metacrylate, hydroquinone, ethylene glycole, and what distinguishes

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it from pmma heat-cure is the addition of a tertiary amine activator. Before this material polymerizes, there are multiple phases that occur when powder and liquid are mixed. At the initial stage, physical changes occur. The mixture of this material will feel grainy or sandy. Then the monomer will mix with the polymer. Part of the polymer chain will be dispersed in the monomer liquid so that the viscosity increases. The number of polymer chains increases during the dough stage. The dough is plastic and easy to mold during this stage.[17] Benzoyl peroxide and tertiary amines react to generate free radicals as the powder and liquid are mixed. When a substance transitions from the grainy stage to the dough stage, free radicals are created. Inhibitors in liquids eliminate these free radicals. The polymerization reaction occurs as a result of chemical changes that take place when the inhibitor is depleted during the dough stage. The dough material stiffens and thickens. The material warms up as a result of this reaction, which also produces heat. As the polymerization process is finished, the material solidifies and becomes rigid.[17,20]

PMMA self-cure has a limitation in that its degree of polymerization is less than that of PMMA heat-cure, resulting in a higher proportion of monomers that do not react or are termed monomers, while the remaining monomers will irritate tissue. This weakness results in a drop in mechanical and physical qualities. Self-cure PMMA resins have various physical and mechanical properties, such as an elastic modulus of 1.63–3 MPa, impact resistance of 8.3 KJ/m2, flexural strength of 79 MPa, water absorption of 2.5%, and a density of 1.19 g/cm3.[19,21]

Chitosan

One of the biomaterials currently under research is chitosan, which has been found to be safe for usage in humans as well as to offer a number of medical benefits. Chitosan is frequently used in biomedical applications due to its distinct properties, which include good biocompatibility, biodegradability, mucoadhesion, non-toxicity, does not cause immunological reactions, and does not cause cancer. In dentistry, chitosan is widely used for bone and tissue regeneration, as an antimicrobial in toothpaste, and as an antifungal in denture bases. In vitro studies established significant results of chitosan denture base composites in antifungal, antioxidant, antimicrobial, and some mechanical properties.[22]

Chitosan is composed of three elements: carbon, hydrogen, and nitrogen. Acidic solvents, including acetic acid, formic acid, lactic acid, citric acid, and hydrochloric acid, can dissolve chitosan. A number of acidic solvents must be included in order for chitosan to dissolve in water, methanol, acetone, and other mixtures. Chitosan is insoluble in water, alkalis, and dilute mineral acids except under specific circumstances. Chitosan's solubility is influenced by the molecule's weight and degree of deacetylation.[10]

In its development, chitosan is modified in the magnetic form of chitosan nanoparticles with a particle size of 100-400 nm to increase its absorbency. The distribution of nanoparticles inside the polymer matrix, the matrix's relative crystalline or amorphous properties, the interaction of the fillers with the polymeric matrix, and other factors all affect how nanoparticles affect the physiomechanical properties of nanocomposites. Chitosan is a polycationic polymer with the functional groups "amino" and "hydroxyl" as its active components. In addition, due to its intramolecular hydrogen bond, chitosan has a high resistance to heat. Chitosan can be modified both chemically and physically to increase its adsorption capacity, selectivity, and applicability. Such chitosan modifications can be accomplished by combining chitosan with a number of different polymers, both natural and synthetic.[10,18]

Chitosan-PMMA self-cure

In the polymerization process, a reaction between methyl methacrylate, glycol dimethacrylate, and heat produces a cross-link into poly (methyl methacrylate). Chitosan, which has basic characteristics and has NH2, forms the first chain in this intermediate bond. While acrylic resin, or PMMA, contains COOH and has acidic characteristics. The final result of the COO (-) + NH3 bond can be NH3 because NH2 from chitosan captures (H) from COOH in PPMA. This bond can occur because, in general, chitosan is alkaline and has the ability to absorb components from PMMA, which is acidic and more likely to readily release them.[12,22]

Discussion

PMMA has been altered to improve its mechanical (impact strength, cyclic fatigue, flexural strength, and wear resistance), physical (thermal conductivity, water absorption, solubility, and dimensional stability), and biological properties. These modifications have involved chemical or mechanical reinforcement using additives (fibers, nanofillers, nanotubes, and hybrid materials) (antimicrobial activity, biocompatibility).[18]

In 2021, Felycia analyzed the effect of chitosan coating on the transverse strength and water absorption of hot polymerized acrylic resin dentures. Hot polymerized acrylic resin dentures' bases' transverse strength and water absorption are both affected by chitosan coating. Chitosan coating can prevent water absorption and prevent hot polymerized acrylic resins from decreasing its transverse strength.[10]

Chitosan nanoparticles (Cs/NPs) were investigated by Abdillah M. et al. in 2020 to see how these would affect thermoplastic resin materials' flexural strength, impact strength, fracture toughness, water absorption, and solubility. The flexural strength, impact strength, and fracture toughness of thermoplastic resins are all decreased by the incorporation of Cs/NPs. Meanwhile, the modified thermoplastic resin's solubility and water absorption were increased.[9]

Investigated the effectiveness of a mixture of acrylic resins, chitosan, and acrylic acid as an anti-Candida albicans denture material. The results showed that the chitosan and acrylic resin combination significantly inhibited the growth of Candida albicans.[11]

The addition of high-molecular chitosan in the form of nanogels has an effect on the acrylic resin's base material's mechanical strength and color stability. The values of impact strength, transverse strength, and discoloration of the acrylic resin's base material after the addition of chitosan nano gel at different percentages of 0.25 percent, 0.50 percent, 0.75 percent, 1.0 percent, and 1.5 percent can be seen to significantly vary. The best consistency that can be used as a strengthening material is the addition of chitosan nanogel at 1%.[18]

A comprehensive overview of the preparation, application, and major breakthroughs of chitosan biomaterials. GIC material modified with the addition of chitosan results in an increase in GIC bonding strength. In this case, chitosan has the advantage of having the highest antibacterial activity and the highest compressive and

flexural strength.[12]

In order to significantly improve biocompatibility without affecting other implant properties, Tanikonda et al. discussed several applications of chitosan in the field of chitosan electrodeposition dentistry in combination with calcium phosphate in Ti6Al4V implants. It has been reported that electrolytically precipitated calcium phosphate is initially octacalcium phosphate, which is then transferred to apatite carbonate. This is due to chitosan being present, which affects how calcium phosphate forms and crystallizes, preventing octacalcium phosphate from converting to carbonate apatite and causing a drop in crystallinity. Chitosan concentration increases have a detrimental effect on coating thickness and surface roughness.[13]

The effect of differences in Ch concentrations on flexural strength (FS), fracture toughness (FT), impact strength (IS), and surface roughness (Ra) on hot polymerization DBR. The addition of chitosan to the acrylic resin of the denture base increases the flexural strength, fracture toughness, and impact strength of the denture base resin. The flexural strength, toughness of the fracture, and the highest impact strength are obtained at the addition of 5% of the chitosan weight to the resin of the denture base. Surface roughness decreases with chitosan concentrations and increased surface roughness is observed at the addition of chitosan 5% to the resin of the denture base.[14]

Conclusion and Suggestion

The effect of differences in Ch concentrations on flexural strength (FS), fracture toughness (FT), impact strength (IS), and surface roughness (Ra) on hot polymerization DBR. The addition of chitosan to the acrylic resin of the denture base increases the flexural strength, fracture toughness, and impact strength of the denture base resin. The flexural strength, toughness of the fracture, and the highest impact strength are obtained at the addition of 5% of the chitosan weight to the resin of the denture base. Surface roughness decreases with chitosan concentrations and increased surface roughness is observed at the addition of chitosan 5% to the resin of the denture base.[14]

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REVIEW

Accuracy of Cut-Out-Rescan Method in Digital Impression Literature Review

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Keywords: Accuracy, Cut-out-rescan, IOS, Mesh holes, Workflow

ABSTRACT

The process of fabricating fixed dentures starts with an impression of the anatomical structure of the teeth. Currently, the use of an intraoral scanner (IOS) for digital impression has improved due to its rapid workflow. One of the advantages of IOS is the availability of the cut-out-rescan method, which involves rescanning unscanned areas (mesh holes) without the need to repeat the entire impression procedure. This method is recommended to assist in the digital workflow of fixed denture fabrication, by performing a cut-out on the prepared tooth, rescan, and merge it with the initial scan (pre-preparation scan). The accuracy of the cut-out-rescan method is measured based on trueness and precision. The aim of this literature is to describe the accuracy of the cut-out-rescan method in digital impression. Rescanning procedure influenced the accuracy of the definitive scan. The number and diameter of mesh holes influenced the scanning accuracy of IOS. The higher the number and diameter of the rescanned area, the lower the accuracy of the IOS. The narrow anatomical structure of teeth such as the anterior teeth also made the rescanning process more difficult. Nonetheless, the use of the cut-out-rescan method is quite practical and makes it easier for clinicians to perform digital workflow as there is no need to repeat impression procedure to obtain a definitive virtual cast. Clinical workflow becomes quicker by the elimination of physical casts, thus reducing clinical expenses. (IJP 2024;5(2):93-97)

Introduction

The initial stage in fabricating dentures always involves taking an impression of the teeth and surrounding tissues. This stage is fundamental in ensuring the precision of the model created, which ultimately determines the accuracy of the final denture.[1] Conventional impression materials generally exhibit excellent dimensional stability and precision and have been successfully used in the fabrication of fixed dentures for decades. However, various factors such as temperature variations, length of time between impression making and pouring, and disinfection procedures can result in material distortion and affect accuracy. In addition, laboratory steps for denture fabrication such as waxing, investing, casting, or pressing processes, can introduce dimensional errors and affect the adaptation of the definitive restoration.[2]

Recent technological developments have introduced digital impression using intraoral scanners (IOS) offer several advantages such as easy repeatability of impressions, direct visualization of models, better time efficiency, and chairside denture production with computer-aided design/computer-aided manufacturing (CAD/CAM). In addition, it also shortens working time and minimizes patient discomfort. Furthermore, digital impression has demonstrated accuracy similar to conventional impression for short-span edentulous cases such as single tooth restorations or multiple tooth loss per quadrant.[2,3]

The process of obtaining 3D mesh geometry involves following the manufacturer's instructions closely. However, it is not uncommon for certain areas to remain unscanned, leading to the formation of mesh holes. These areas will usually be rescanned after the initial scanning process is complete.[4,5] One of the advantages of IOS is the availability of the cut-out-rescan method, which involves rescanning unscanned areas (mesh holes) without having to repeat the impression procedure from the beginning.1 This method is recommended to assist the digital workflow in a fixed denture cases, by cutting out the prepped tooth area, rescanning it, and then reuniting it with the initial scan (pre-preparation scan).[5-7] This technique proves advantageous for both the operator and patient, as it facilitates the visual examination of the scan area that requires correction, resulting in a quicker clinical workflow process.[1]

When measuring the accuracy of IOS scan results, two factors are taken into account: trueness and precision. Trueness pertains to the IOS' ability to accurately capture the 3D geometry of an object, preserving its original dimensions as much as possible. Meanwhile, precision indicates the consistency of the scan results when the IOS is utilized repeatedly under similar circumstances.[8,9] The rescanning procedure may compromise the accuracy of the final virtual model.4 There is little research on the cut-out-rescan method despite several factors that influence its accuracy, including the number, dimensions, and location of mesh holes.[4-7,10] The aim of this literature

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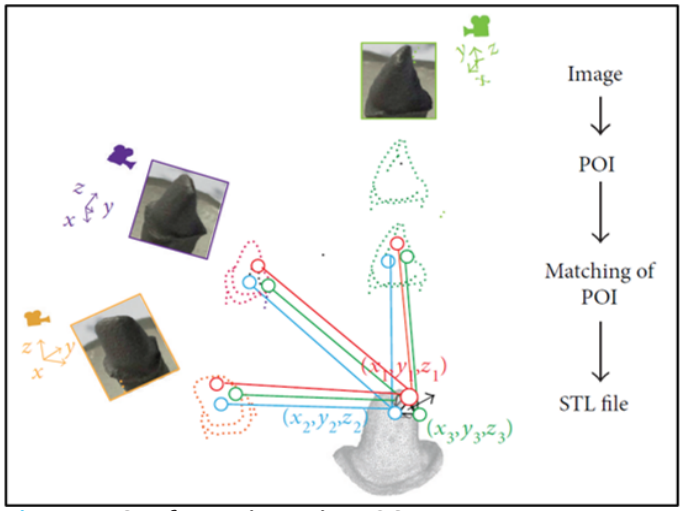

Figure 1. STL formation using IOS

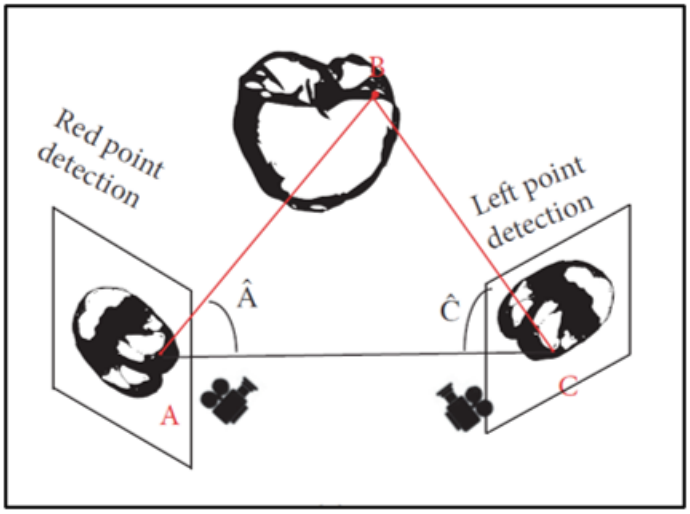

Figure 2. Triangulation

is to describe the accuracy of the cut-out-rescan method in digital impression.

Literature Studies

Intraoral Scanner (IOS)

IOS records a digital impression of tooth structure and surrounding tissues in the patient's mouth to obtain a digital impression.10 IOS comprises a handheld camera, computer, and software to accurately capture an object's three-dimensional geometry. The most commonly used digital format is either open STL (Standard Tessellation Language) or locked STL-Like. These formats describe triangulated surfaces where each triangle is defined by three points and a surface, but there is a proliferation of other file formats that record the colour, 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 calculated based on the camera's distance to the object, as shown in figure 1.[11,12]

Indication

Digital impression are used in the prosthodontic field to design and create different types of dental restorations, such as single-tooth crowns, endodontic crowns, resin onlays and inlays, veneers, fixed partial dentures, removable partial denture frameworks, implant bridge posts and cores, temporary restorations, and digital smile design (DSD). In orthodontics, IOS can help with diagnosis and treatment planning, creating orthodontic aligners, custom-made orthodontic devices, and retainers. Additionally, IOS can be used for guided implant surgery.[13]

Contraindication

Contraindications include long-span fixed partial dentures, long-span implant-supported fixed partial dentures, and complete removable dentures. Common contraindications include the patient's inability to sit still and restricted access such as in cases where the scanner head is too large or if there is interference from the tongue or orthodontic appliance. It is important to control bleeding before scanning to obtain adequate images.[13]

Technology

There are various types of IOS technologies such as triangulation, confocal, Optical Coherence Tomography (OCT), Accordion Fringe Interferometry (AFI), Active Wavefront Sampling (AWS), stereophotogrammetry.[11,14] The concept of triangulation involves using the positions and angles of two viewpoints to calculate the location of a triangular point or object (as shown in figure 2). Meanwhile, confocal imaging is a method that involves capturing both focused and unfocused images at a specific depth to identify areas of image sharpness that can be used to determine the distance of the object. This distance is then correlated with the focal length of the lens, as demonstrated in figure 3.[11] OCT is an interferometric imaging technique that provides cross-sectional images of the subsurface microstructure of a target object, such as biological tissue figure 4. AFI technology uses laser light and utilizes interference patterns created from multiple laser sources, to produce a perfectly focused and highly accurate fringe pattern on the target object figure 5.[14] 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 figure 6. Stereophotogrammetry analyses the image algorithmically to estimate all coordinates (x, y, and z) figure 7.[11]

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.[8,9] The best trueness

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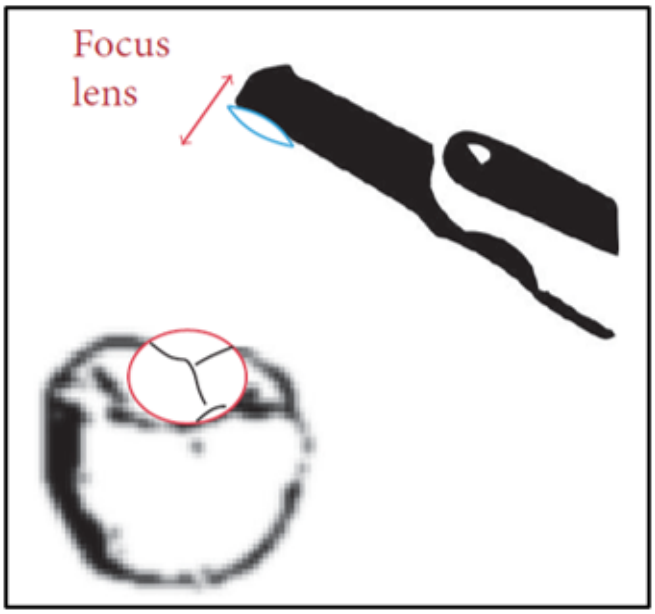

Figure 3. **Confocal**

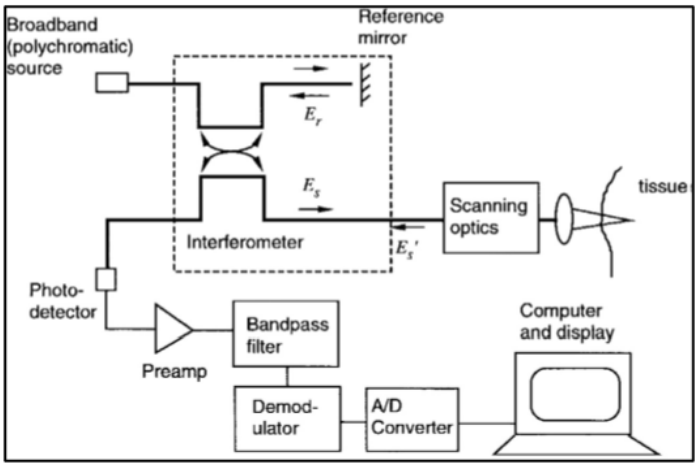

Figure 4. **Diagram of the OCT system**

value is achieved through a single continuous scan without interruption, while the best precision value is achieved through rescanning.[10] There are many factors that affect the accuracy of iOS, which will be described below.

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.[11]

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, there is no significant difference in the effect of powder on scanning accuracy.[11]

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 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.[15]

Scanning path/strategy

To enhance the accuracy of the virtual model, the scanner head is moved in a specific direction, which is called the scan path. For best results, the object being scanned should be positioned in the center of the acquisition area. The operator should maintain a stable distance and keep the gear centered during recording, following the movement trajectory. Depending on the scanner and technology, the camera should be held between 5 and 30 mm away from the scanned surface.[11,16]

Scanning distance

The distance between the scanner head and the surface of the object being scanned has an impact on the accuracy of digital impression. Their study revealed that using the Medit i700 IOS, scanning distances of less than 5mm or greater than 15mm resulted in lower accuracy. The most accurate results were achieved with a scanning distance of 10mm between the scanner head and the object surface.[17]

Disadvantage

Like any new technology, there is a learning curve, and those who are not experts may need more time to capture digital

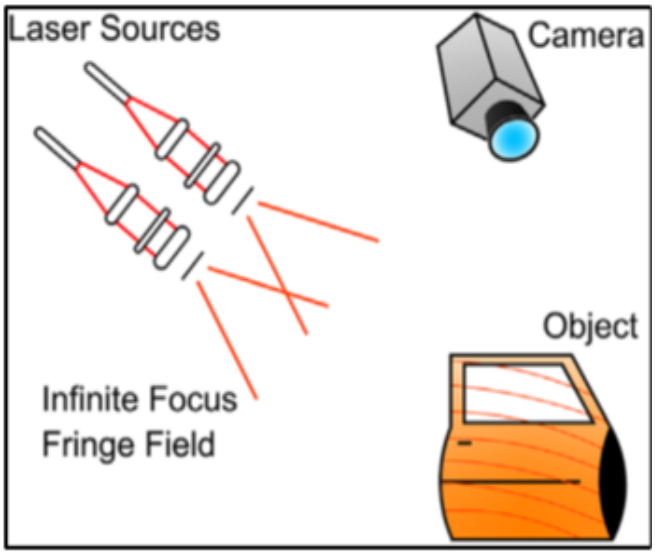

Figure 5. **AFI working principle**

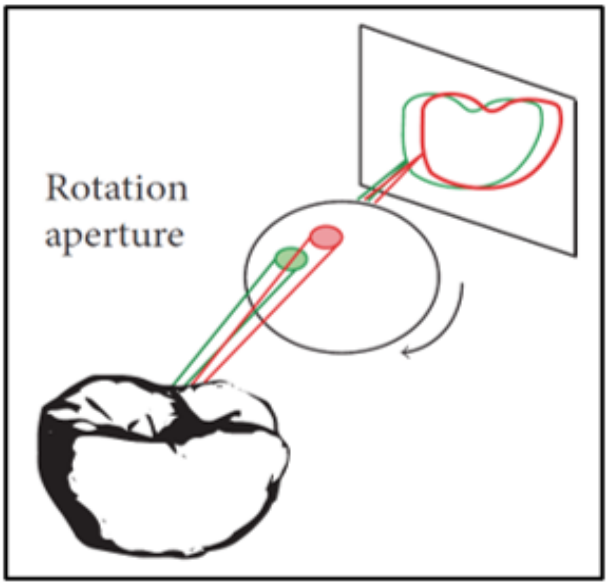

Figure 6. AWS working principle

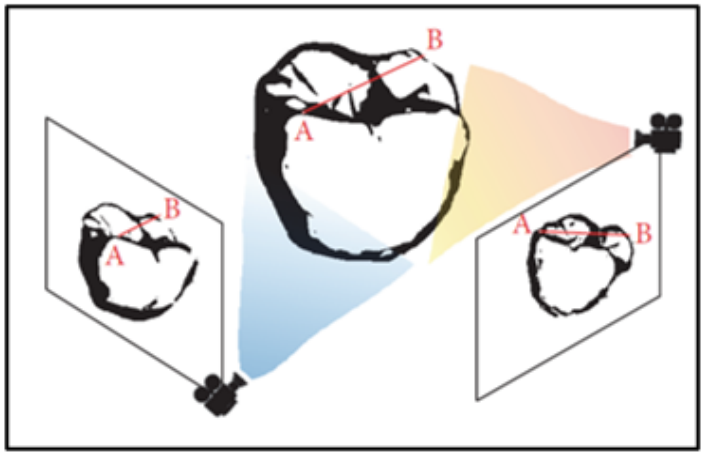

Figure 7. Stereophotogrammetry

images. In addition, IOS technology has some drawbacks, such as the inability to detect the margins of teeth prepared subgingivally and the high initial investment cost.[13]

Advantage

Digital impression offers several benefits, such as eliminating the need for impression materials, which reduces the risk of choking and provides greater patient comfort. This method also reduces the time required for casting and enables visualization of scanned areas that need correction, as the positive image of the tooth preparation is immediately visible on the computer screen. Moreover, the IOS can record not only the prepared tooth but also adjacent teeth, the entire dental arch, and simulated movements in the virtual articulator. This feature enhances communication between the clinician, patient, and dental technician.[1,13]

In addition, no tooth model needs to be disinfected except the tips of the IOS head. It is easier to store and dental restorations can be done on the same day as scanning using CAD/CAM technology. Eliminating the use of tooth models can help reduce material costs.[18] One of the other advantages of IOS is the availability of the cut-out-rescan method, which involves rescanning unscanned areas (mesh holes) without the need to repeat the impression procedure from the beginning.[1]

The rescanning procedure is a common procedure performed to record the area of mesh holes with IOS to complete the 3D representation of the scanned surface geometry.[6] Digital intraoral scanning provides options that cannot be applied when using conventional impression, including the possibility of modifying the virtual 3D display on the computer screen using cutting out and snipping tools. This application is useful for correcting specific areas; for example, if the preparation part of the image is covered by blood or saliva. The damaged surface can be cut out, gingival management improved, and the area can be rescanned.[7]

When IOS is to be used to produce a definitive virtual model for short-span denture fabrication, it is recommended to perform a digital workflow consisting of cut-out and rescanning procedures on the prepared teeth. The first step involves performing a scan procedure with the IOS to obtain an initial or pre-prepared model. The second step is a cut-out procedure on the area to be prepped, then followed by a rescanning procedure on the prepped tooth. This allows the IOS software to produce two STL data sets that are superimposed on each other with the same orientation on the x, y, z axis.[7,10] Several studies have analysed the accuracy of this cut-out-rescan method in terms of the number, dimensions, and location of mesh holes.[4-7,10]

Discussion

The digital workflow protocol for tooth-supported denture fabrication requires the creation of mesh holes on the initial digital scans. Subsequently, the area is to record the tooth preparation so that it can be unified with the initial scan. Moreover, this process also helps identify areas that require improvement and makes corrections easier to implement.[5] The rescanning procedure may compromise the accuracy of the final virtual model. Therefore, definitive restorations may have contact, interproximal, or occlusal fit discrepancies. The study found that rescanning three small mesh holes resulted in higher trueness and precision values compared to rescanning one large mesh hole. This highlights the significance of the rescanned mesh-hole's dimension in ensuring accurate definitive scanning. This can be explained by the smaller mesh stitching around three small mesh holes compared to a single large mesh hole.[4]

Research conducted shows that the cut-out-rescan procedure has a significant effect on IOS accuracy. The number and size of mesh holes in the scanning area, as measured by the IOS tested (TRIOS 4 wireless system (v. 21.2.0) from 3Shape A/S in Copenhagen, Denmark) have a direct effect on IOS accuracy. Specifically, when the scanning area contains more and larger mesh holes, the accuracy of IOS measurements decreases. Interestingly, the study found that there was no significant difference in accuracy between groups with one, two, or three mesh holes of the same diameter. However, there was a significant difference in accuracy between groups with mesh holes of 2, 4, and 6 mm in diameter.

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These findings align with previous research by Gomez-Polo and colleagues, which found that mesh hole diameter has a greater impact on IOS accuracy than the number of mesh holes present.5 Contrarily, the study revealed that the diameter of the mesh holes and the location of the cut-out-rescan teeth did not affect the accuracy of IOS tested (TRIOS 4, wireless, v. 21.2.0; 3Shape A/S). The results of these studies are difficult to compare due to variations in research protocols, scanned surfaces, and measurement methods.[6]

Research conducted that singlescan has the best trueness value, while rescan has the best precision value. The singlescan action showed the lowest precision value due to the presence of unscanned areas, especially in the proximal region, causing variability between scans. The study was conducted on the posterior arch because the proximal lateral area is difficult to reach by the IOS tip (Medit I700; Medit, Seoul, South Korea) and sometimes unknowingly leaves mesh holes during the scanning procedure.[10] The accuracy of rescanning is affected by the expansion of the initial scan and rescan areas. In contrast to Faur's suggestion, Reich et al found that the anterior dental area has a smaller, steeper, and narrower anatomical structure compared to the posterior dental area. This makes the superimposition procedure more challenging when rescanning the anterior dental area.[7]

Conclusion and Suggestion

The use of the cut-out-rescan method is quite practical and makes it easier for clinicians to perform digital workflow as there is no need to repeat impression procedure to obtain a definitive virtual cast. Clinical workflow becomes quicker by the elimination of physical casts, thus reducing clinical expenses. Several factors such as the dimensions, number and location of mesh holes affect the accuracy of the cut-out-rescan method.

There is very little research on the accuracy evaluation of the cut-out-rescan method, so there is a need for further research on this method with different types of IOS, different scanning location areas and teeth, diameter and number of mesh holes.

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REVIEW

The role of shoulder and chamfer margin design on the fracture resistance of zirconia crown

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Keywords: Chamfer, Fracture resistance, Margin design, Shoulder, Zirconia

ABSTRACT

In recent years, zirconia all-ceramic restorations are widely used in crown and bridge treatment due to their superior mechanical properties and aesthetics. Zirconia is the strongest ceramic material, thus it is the treatment of choice for posterior dental restorations. One factor that affects the fracture resistance of zirconia restoration is the margin design. The shoulder and chamfer are the recommended margin design to obtain maximum fracture resistance from zirconia restoration. Shoulder is recommended because it has greater fracture resistance while chamfer is more conservative and able to withstand maximum masticatory load. However, there is still a difference of opinion regarding the fracture resistance of zirconia crown with shoulder and chamfer margin designs. This literature review aims to discuss the role of chamfer and shoulder margins design on the fracture resistance of zirconia crown. The shoulder margin design results in a wide ledge, space for adequate restoration contours and maximum aesthetics that provide resistance to occlusal forces and minimizes stress that can cause fracture. The chamfer margin design on zirconia crown has a difference in the rounded internal angle of the preparation resulting in better force distribution, better marginal fit and more resistance to fracture compared to the shoulder margin design. Chamfer margin design is more conservative and resistant to fracture due to better marginal fit which distribute stress more evenly. (IJP 2024;5(2):98-101)

Introduction

All-ceramic zirconia restorations have been widely used in recent years for crown and bridge restorations due to their superior mechanical and aesthetic properties. Zirconia is the strongest ceramic material so it is a treatment option in posterior tooth restorations. However, fractures remain a complication for all ceramic restoration in clinical practice.[1-3]

Margin design is one of the factors which have been widely investigated concerning its impact on fracture resistance of all-ceramic restoration. The most common margin designs used for all ceramic restoration include chamfer, deep chamfer, chamfer with collar, round end shoulder & shoulder.[4] Shoulder and chamfer are recommended designs to achieve maximum fracture resistance from zirconia restoration. Shoulders are indicated for planning aesthetic restorations but require more preparation of the tooth structure than other design margins.5,6 The wide ledge provides resistance to occlusal forces and minimizes stresses that might lead to fracture.6 On the other hand, chamfer is also the best choice that can also provide space for sufficient material thickness for restoration strength and can form precise axial anatomical contours and has good adaptability. The preparation of margin design chamfers requires precision at the time of preparation to avoid leaving a lip of unsupported enamel.[5,6]

Some studies have shown different results regarding the effect of shoulder and chamfer margin design on zirconia crown fracture resistance. Evaluated the effect of chamfer and shoulder margin design on the fracture resistance of the Inceram all-ceramic crown and reported that the strength of the shoulder margin design was better. On the other hand, the study showed that the fracture resistance of the chamfer design margin is higher. Then the study of Sadan et al. reported that the margin design of the shoulder and chamfer have the same fracture resistance value.[7]

Therefore, this literature review aims to discuss the effect of different margin designs, chamfer and shoulder, on zirconia crown fracture resistance.

Literature Studies

Zirconia

Dental ceramics have been applied as restorative materials for decades due to their superiority to other materials in terms of properties and their natural tooth mimicking ability. Zirconia has been introduced and widely used for load bearing as dental crowns, fixed partial dentures (FPDs) and dental implants.1,2 Zirconia was suggested as the first candidate for full contour monolithic restorations due to its significant advantages, such as excellent mechanical properties, superior to those of other ceramic systems, esthetic performance comparable to that of metal-ceramic restorations, radiopacity, low corrosion potential, good chemical properties, volumetric stability and elastic modulus values comparable to steel. According to in-vitro

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studies, zirconia restorations exhibit flexural or bending strength values of 900–1200 MPa and resistance to fracture of 9–10 MPa.10 With the advances in digital technology, intraoral scanners and CAD/CAM, it has become possible to create dental restorations digitally with easy processes and designs and high accuracy.[19]

Yttria-stabilized tetragonal zirconia polycrystal (Y-TZP) is widely used in dentistry due to its superior mechanical properties, similar to ceramic metal crowns and considered the golden rule in fixed prostheses. Zirconia is classified as a polycrystalline ceramic. Zirconium oxide crystals can be categorized into three crystallographic phases: monoclinic (m) at room temperature, has weak mechanical properties; tetragonal (t) at temperatures between 11700C – 23700C, characterized by the best mechanical properties; and cubic (c) at temperatures above 23700C and exhibiting average mechanical properties. Since phase (t) has the most excellent mechanical properties, it will be stabilized at room temperature by the addition of stabilizers/dopants (magnesium, calcium or yttrium). In dentistry, yttrium has been found to have the best mechanical properties for stabilizing zirconia.[20]

Regarding the fabrication of monolithic zirconia crowns, the marginal areas are areas of minimal thickness that frequently lead to the easy fracture of the crown. The source of the failure originating in the margin of the zirconia restoration may relate to the margin design, as well as the thickness of the margins. Several investigations have been carried out with regard to the effect of the margin design on the load-bearing capacity of zirconia restoration in relation to occlusal thickness and wall thickness.12 Other factors including restoration thickness, occlusal load, the patient's oral habits like bruxism, and the cement type also influenced the ultimate strength of restoration.[7,11]

Margin Design

Margin design is one of the factors which have been widely investigated concerning its impact on strength of all-ceramic restoration.[7] Margin failures may be related to the design and thickness of the crown margins. Multiple studies have been performed in order to evaluate the effect of margin design on load at fracture, but the results are inconclusive. Several studies find that the margin design has an effect on the fracture resistance, while others see no such effect.

The fracture pattern of crowns fractured during clinical use demonstrates fracture origins in the cervical margin of the crown and often occur at the proximal area of the crown, where the finish line curves toward the occlusal surface over the gingival papilla. Clinical recommendations for margin design are based on previous experiences with all-ceramic crowns and also on the design of metal-based crowns.

It is not evident whether these recommendations are optimal for the modern high-strength zirconia restorations. Most manufacturers of dental ceramics advise dentists to remove up to 0.5–1.5 mm of tooth substance to make room for a bilayer ceramic crown. A preparation depth of 1.5 mm increases the risk of negative effects on tooth vitality. Based on mechanical properties, zirconia crowns can probably be made using a minimal invasive slice preparation technique, as suggested by some manufacturers and in scientific papers. However, it is still uncertain which design provides optimal balance between crown strength and tooth vitality.[8]

The most commonly used margin designs for all-ceramic restorations include chamfer, deep chamfer, chamfer with collar, round end shoulder & shoulder.[4] Shoulder and chamfer are the most widely used designs for zirconia crown. The shoulder has long been the finish line of choice for the all-ceramic crown. The wide ledge provides resistance to occlusal forces and minimizes stresses that might lead to fracture of the porcelain. It produces the space for healthy restoration contours and maximum esthetics. However, it does require the destruction of more tooth structure than any other finish line. The sharp, 90-degree internal line angle associated with the classic variety of this finish line concentrates stress in the tooth and is conducive to coronal fracture. The shoulder generally is not used as a finish line for cast metal restorations.[6]

Some studies shown that zirconia crown with chamfer margin design has increased fracture resistance. Chamfer is a concave extra coronal margin design that provides greater angulation than the knife-edge design and a smaller width than the shoulder design. The advantage of chamfer design is more conservative, has clear margins and easy to identify. Chamfer is the best for providing the bulk needed for strength while still allowing good adaptation.6 Various studies have different results regarding the effect of the type of margin design on the fracture resistance of zirconia crowns. Evaluated the effect of chamfer and shoulder marginal designs on the fracture resistance of Inceram all-ceramic restorations and concluded that the strength created by the former is higher. In a different study by the same researcher, the same margin designs were assessed on zirconia cores and chamfer margin was found to have more increased the restoration strength than shoulder margin. On the other hand, carried out a study on the effects of 50° chamfer and 90°shoulder margin designs on the fracture resistance of Procera all- ceram cores (with 0.4mm thickness) and reported that shoulder margin design is more resistant than chamfer.

Fracture Resistance

All-ceramic restorations have been widely applied in prosthodontics as metal-free restorations because of their good esthetics and excellent biocompatibility. However, fractures remain a complication for all-ceramic restorations in clinical practice. Fracture resistance depends on the elastic modulus of the abutment, the properties of the luting agent, tooth preparation design, surface roughness and restoration thickness. The tooth preparation design is an especially important factor in determining the strength of all-ceramic crowns. Additionally, the elastic modulus of restoration materials is an important factor in crack initiation and propagation within a dental ceramic. The stress in all-ceramic crowns during mastication has been reported to be higher near the cervical margin than on the occlusal surface. During clinical use, cracks may be induced from the occlusal surface to the thin margin. However, little is known regarding the influence of a margin design with zirconia on the fracture resistance of all-ceramic crowns.[9]

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Some investigations into the fracture resistance of all ceramic restorations were carried out by applying an occlusal load, either longitudinally or obliquely, on anatomical crowns until fracture, indicating that the fracture was possibly influenced by the design of the margin in the restoration.[12] It has been reported that monolithic zirconia crowns exhibit fracture resistance that can withstand occlusal loading, even with a limited thickness, when compared to conventional ceramic materials. It is well known that the marginal accuracy is one of the key factors affecting the long-term prognosis of a prosthesis.[13]

Discussion

In the literature, data showed that differences in the margin design clearly affect the fracture resistance of the crown restoration. Most studies of fracture resistance in single crown restorations have shown that the cervical area has high stress. The best choice of margin design for zirconia crown is still uncertain.

That chamfer finish line design has the greatest stability for posterior all ceramic crowns. The effect of finish line design on fracture resistance of composite-reinforced ceramic restorations and demonstrated that the fracture resistance of chamfer finish line design samples was significantly higher than shoulder finish design. That for long lasting restorations in posterior region it is advisable to make a chamfer with collar preparation.

The effect of two marginal designs (shoulder and chamfer) on the fracture resistance of all ceramic restorations, INCERAM. The mean value of fracture resistance for the chamfer samples were 610.18 ± 58.79 N and 502.72 ± 105.83 N for the shoulder samples. This study reveals that the chamfer margin has more fracture resistance than shoulder margin. A chamfer margin could improve the biomechanical performance of posterior single crown alumina restorations. This may be because of a much better marginal fitness in chamfer margin that happens because of a curve in the chamfer finishing line and that causes a better spread in the load. However, we do not have such a condition in a 90o in shoulder margin that have sharp endings. d = D cos b and d = D sin a. D is vertical discrepancy between the restoration and tooth and d is horizontal discrepancy between the restoration and tooth. In addition we know that horizontal discrepancy is more important than vertical discrepancy, which is the real gap between the restoration and teeth. The lower horizontal discrepancy makes better fitness between the restoration and teeth. In chamfer margin horizontal discrepancy < vertical discrepancy. But in the shoulder margin horizontal discrepancy = vertical discrepancy. In this situation we have the worse marginal fitness in addition there is not a strong unity between the restoration and teeth that makes a lower fracture resistance than the chamfer margin does. Furthermore, in chamfer finishing line we have an angled cut of enamel that makes the higher width of enamel in exposure to etch and bonding, so we have strong bonding and unity between the restoration and teeth that makes higher fracture resistance than shoulder margin because as we know in this finishing line we have the lower width of enamel that is important in the bonding of the restoration and teeth.

The effect of two marginal designs namely deep chamfer and shoulder margin design on the fracture resistance of monolithic zirconia crowns. Results showed that the highest fracture resistance values were recorded with Deep chamfer finish line. That zirconia crowns made for a chamfer preparation fracture at significantly higher loads than similar crowns made for a slice preparation design. Heavy chamfer margins provided a stronger and more durable zirconia crown than light chamfer margin. Nevertheless, both heavy and light chamfer margins were capable of withstanding a fracture load that is higher than the maximum masticatory force of humans.

The fracture resistance of chamfer and shoulder margins under a cyclic load of Inceram crowns. The mean ± standard deviation for the resistance of fracture came out to be 610.1880±58.79526 N for chamfer margin and 502.7270±105.83233 N for that of shoulder margin. Fracture resistance of the two groups are more than biting forces so we could use both marginal designs successfully in the posterior all ceramic crowns. But there is a statistically significant difference between the two groups that reveals that the chamfer margin has more fracture resistance than shoulder margin. This may be because of a much better marginal fitness in chamfer margin that happens because of a curve in the chamfer finishing line and that causes a better spread in the load.

Marginal accuracy and fracture resistance between deep chamfer and shoulder margin. Mean values of marginal accuracy after cementation for deep chamfer 40.38 ± 9.47 μm and shoulder margin groups 77.4 ± 14.3 μm. The mean value of fracture resistance for deep chamfer 1874 ± 723 N and shoulder margin 1069 ± 288 N. They concluded that deep chamfer margin shows better fracture resistance than shoulder margin for zirconia copings. They suggested that this could be because of a curve in the chamfer finish line that causes a better spread in the load. However, such a condition does not exist in a 90º shoulder margin that has sharp endings. The deep chamfer margin showed better marginal accuracy than the shoulder margin for zirconia coping restoration. It is because the deep chamfer used in this study, apparently facilitated the escape of cement early in the cementation process & thus offered a better seal.

The resistance to fracture under a cyclic load applied to chamfer margin and shoulder margin Procera® All Ceram cores. The mean values of fracture resistance for the chamfer samples were 406.10 ± 67.271 N and 643.90 ± 32.912 N for the shoulder samples. The results of this in vitro study indicate a relationship between the cervical thickness of the alumina cores and their fracture resistance. A shoulder margin could improve the biomechanical performance of posterior single crown alumina restorations.

The effects of five different preparation design (shoulder-less, slight and pronounced deep chamfer, beveled and non-beveled shoulder) on the fracture resistance of zirconia copings with a wall thickness of 0.4 mm. They observed the maximum fracture resistance in shoulder preparation, and also recommended the slight chamfer only for endodontically treated teeth with thin wall.

Evaluated and compared the fracture resistance of monolithic zirconia crowns with two preparation designs, shoulder margin

design and feather-edge margin design. Teeth were randomly divided into two groups (n = 20), according to the material used: Group A monolithic traditional zirconia (IPS e.max ZirCAD LT A3, W89335, Ivoclar Digital, Liechtenstein, Germany) and Group B monolithic translucent zirconia (IPS e.max ZirCAD MT Multi A3, X29480, Ivoclar Digital, Liechtenstein, Germany). They were further subdivided into two subgroups (n = 10) according to the type of margin design: subgroup A1 and B1 shoulder margin design and subgroup A2 and B2 feather-edge margin design. Even though all the tested crowns fractured at a higher level than the maximum occlusal forces s (850 N), the shoulder margin design was better than the feather-edge margin design. They found that monolithic traditional zirconia with shoulder margin design has higher fracture load than monolithic traditional zirconia with feather-edge margin design in both groups. It might be because the stress distribution pattern in the shoulder margin design as the circumferential shoulder withstands occlusal forces and results in less concentration of stress on axial walls. Furthermore, an increase in the crown margin and axial wall thickness lead to fracture at a higher load.

Evaluate the effect of two marginal designs (shoulder 90°, shoulder 135°) on the fracture resistance of zirconia copings. The mean value of fracture resistance for shoulder 90° finish line design were 368.3±109.4 N and for shoulder 135° finish line design were 518.4±115.5 N. They concluded that marginal design of zirconia cores significantly influences their fracture resistance. The two marginal designs (shoulder 90°, shoulder 135°) had clinically acceptable fracture resistance. A 135° shoulder finish line design can improve the fracture resistance of the zirconia crowns. Several factors might have contributed in increasing the fracture resistance of zirconia restoration with 135° in comparison with those with 90° shoulder finishing lines including the presence of sharp internal angle in 90° shoulder margin. Internal angle of 135° shoulder was wider than 90° shoulder and subsequently stress may be less concentrated. Presence of slope in 135° shoulder margin and better marginal fit can be considered as the second contributing factor. 135° shoulder margin consists of inclination, thus the vertical distance between the die and margin inclination area is less than in 90° shoulder. Consequently, die support better fits on zirconia core in margin area and the force would be more evenly distributed. Therefore, the fracture strength of crown complex with 135° shoulder margin is higher.

That rounded shoulder margins and deep chamfer margins combined with monolithic zirconia crowns, potentially have optimal geometry to minimize occlusal force. Sadan et al. (2005) proposed that chamfer and shoulder margin design are considered to be adequate for the tooth.

Conclusion and Suggestion

It is concluded that shoulder and chamfer finish line design still the main choice in fixed partial denture. Wide ledge of shoulder design provides resistance to occlusal forces and gives space to healthy restoration with maximum esthetic but it is less conservative of tooth structure and stress concentration at 90° internal angle of finish line hence conducive to coronal fracture. Chamfer finish line has concave form. It provides greater angulation than knife edge and less width than shoulder. Chamfer are more conservative with distinct margin and easy to identified and also improve biomechanical performance compared to preparation with a shoulder finish line. The choice of margin design has an influence on the fracture resistance for a long-term crown restoration. Careful planning of the margin design and selection of restorative materials is important before treatment. Based on the data, it can be concluded that the chamfer margin design is more conservative and resistant to fracture because it has better marginal fittings so that it can distribute pressure more evenly.

The optimal design margin to achieve fracture resistance of zirconia crowns still varies, especially with the rapid development of zirconia. Therefore, further research is needed to determine the optimal margin design to achieve the best fracture resistance in zirconia crown restorations.

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REVIEW

The use of hydrofluoric acid as a surface treatment material on bond strength in repair system of lithium disilicate – Literature Review

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Keywords: Bond strengt, Hydrofluoric acid, Lithium disilicate, Surface treatment

ABSTRACT

Lithium disilicate is a glassy ceramic material that mimics the aesthetics and strength of natural tooth structure, making it very popular in recent years. Lithium disilicate has good flexural strength, translucency, and high mechanical strength of up to 360±60 MPa which is superior to feldspathic porcelain or leucite-reinforced glass ceramic. These excellent properties make it suitable for both anterior and posterior use. Naturally, ceramic materials are inherently brittle and tend to fracture easily in repetitive function. There are several methods of fracture treatment, one of which is repair. Composite resin is frequently used for ceramic repair as a simple and fast solution. The bond strength of ceramic repairs on lithium disilicate using hydrofluoric (HF) acid is higher compared to other methods. Hydrofluoric acid that has been used as a surface treatment for lithium disilicate is 4% and 5% HF acid. This article reviews the effect of HF as a surface treatment material on bonding strength between lithium disilicate and composite resin. The application of hydrofluoric acid in ceramic surface promotes the reaction with the glass matrix that contains silica and form hexafluorosilicates. This glass matrix is selectively removed and the crystalline structure is exposed. As a result, the surface of the ceramic becomes rough and this roughly etched surface helps to provide more surface energy prior to combining with the silane solution. Silane coupling agent forms a chemical covalent bond between silica on the lithium disilicate surface and composite resin. This bond will increase the micromechanical interlock. (IJP 2024;5(2):102-106)

Introduction

Metal-ceramic restoration has been widely used for decades as a gold standard, for either single restoration or bridges, but nowadays, ceramic restoration without metal layer has been considered as a restoration with more optimum aesthetic value therefore increasing its demand.[1-7] Ceramic materials, especially lithium disilicate and zirconia, are being used extensively for the fabrication of crowns and bridges.[8] Lithium disilicate (Li2O5Si5) is a glassy ceramic with an average flexural strength of 400 Mpa and a favourable translucency, making it suitable for both anterior and posterior use. Lithium disilicate has many advantages over the traditional metal materials, macromolecule materials, and older ceramics. These include high mechanical and flexural strength, good wear resistance and excellent aesthetics.[9]

Lithium disilicate has a unique structure that helped improve the fracture toughness and increase its flexural strength.[10] Retrospective studies on success rates of lithium disilicate ceramic restorations from between three to ten years of follow up, showed survival rates (i.e. restorations that had remained in place without complications) of over 95%, with the monolithic crowns having less reported structural problems than layered crowns.[9] Overall cumulative survival probability of lithium disilicate restorations for up to years was 85.08%.[11] However, ceramic in nature is a brittle material that highly susceptible to be cracked, which leads to chipping and fracture of the restoration.

Ceramic fractures are often considered an emergency and become a challenge for dentists. Ceramic fractures can occur from several factors, namely intra-ceramic defects, pressure from parafunction, contamination during manufacture, improper planning, endodontic factors, differences in thermal coefficient expansion of core and veneering ceramic, inadequate tooth preparation and trauma.[12-15] Fractures of ceramic are classified into small chipping, moderate chipping and severe chipping. Small chipping can be treated with polishing, moderate chipping can be repaired with resin composites and grade 3 chipping led to replacement of the entire restoration.

Replacing the fractured ceramic restoration is however not feasible, because it costs more and is less conservative of the natural tooth structure. Restoring crown and bridge restorations cannot be done in the patient's mouth, takes a long time, and requires more complex skills and tools. Removing a bridge or crown restoration is an unpleasant experience for the patient and tiring for the dentist. That is why replacing all restorations is not considered as the best solution because of the high costs and difficulties.[2,13,14] Therefore, a direct repair of such restorations has to be considered as a more viable option. The repair procedure involves surface treatment of the fractured ceramic interface to create roughness through mechanical means to increase

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Table 1. Comparison of various surface roughening methods on ceramics

Type of Ceramic	Diamond Burs	HF Acid Etching	Sand blasting	Triboche-mical Silica Coating	Lasers	Recommended Method
Feldspathic Porcelain e.g. IPS Classic (Ivoclar Vivadent, Inc., Amherst, New York), VITA Mark II (Vident, Brea, California)	Effective	Most effective	Effective	Long term low stability	Low bond strength	HF Acid Etching
Lithium Disilicate based Ceramic e.g. IPS e.max Press, Ivoclar Vivadent, Inc., Amherst, New York	Effective	Most effective	Reduces bond strength	n/a	Low bond strength	HF Acid Etching
Leucite-Reinforced Glass Ceramic e.g. IPS Empress, Ivoclar Vivadent, Inc., Amherst, New York	Effective	Low bond strength	Effective	Effective	Low bond strength	Sand blasting with alumina particles
Glass-infiltrated Aluminium oxide Ceramic e.g. In-Ceram Alumina; Vita Zahnfabrik, Bad Säckingen, Germany	Ineffective	Ineffective	Effective	Most effective	Low bond strength	Tribochemical Silica Coating
Densely Sintered Aluminium Oxide Ceramic e.g. Procera All-Ceram, Nobel Biocare, USA, Inc., Yorba Linda, California	Ineffective	Ineffective	Effective	Most effective	Low bond strength	Tribochemical Silica Coating
Zirconia based Ceramics e.g. In-Ceram Zirconia (Vita Zahnfabrik, Bad Säckingen, Germany), Cercon (Dentsply, York, PA, USA), Lava (3M ESPE, St. Paul, Minnesota)	Ineffective	Ineffective	Effective	Most effective	Low bond strength	Tribochemical Silica Coating

surface area, such as air abrasion; laser irradiation or chemical means to increase the wettability for bonding, by acid etching with hydrofluoric (HF) acid and bonding with silane coupling agents. The treated surface is then ready to receive an adhesive composite resin material to restore the defect.[16]

The resin composite adheres well to dental ceramics when the substrate surface is mechanically prepared and a silane coupling agent applied.[13] The standard protocol for the treatment of vitreous ceramic is etching with HF acid followed by application of silane coupling agent.[4,5,17-19] HF acid dissolves the glassy surface on the ceramic matrix so that the crystalline structure is exposed, and silane coupling agent acts as hybrids of inorganic-organic compounds that create strong microscopic bonds between the two materials.[19-21] Although HF acid is the suggested pretreatment for ceramic, this etchant is very toxic and may lead to accident in practice and also weakening the ceramic surface.[12,17,22] The purpose of this literature review is to review the effect of HF as a surface treatment material on bonding strength between lithium disilicate and composite resin.

Literature Studies

Repair System of Lithium Dislicate

Lithium Disilicate Repair Technique

Lithium disilicate repair technique is divided into 2 types, namely direct and indirect. Indirect repair is carried out in the laboratory using porcelain without removing the restoration first. Meanwhile, direct repair is a technique that is carried out directly in the mouth on damaged restoration by applying composite resin. The advantage of the indirect technique is more aesthetic because it is made through laboratory procedure. Disadvantages of indirect technique require additional time and cost. Some of the advantages of the direct technique include shorter time required, lower cost and easy application. While the disadvantages are lower strength, quality of use and lack of aesthetics.[23]

A possible classification and treatment recommendation for a chipped ceramic restoration was published by Heintze and Rousson. A chipping grading scale comprising three grades was established according to the treatment that followed the chipping as: small veneer chippings receive grade 1, moderate veneer chipping receive grade 2 and severe
chipping receive grade 3. Grade 1 chippings can be treated with polishing, grade 2 chippings can be repaired with resin composites and grade 3 chippings led to replacement of the entire restoration. The criteria for replacement (grade 3) are the fracture surface extends into a functional area and repair is not feasible, recontouring will result in a significant unacceptable alteration of the anatomic form from the original anatomy, recontouring will significantly increase the risk of pulp trauma by the generation of heat, repair with a resin composite will result in esthetic changes that are unacceptable to the patient.[24]

The direct repair procedure using composite resin is carried out in several stage, including examination of the fracture classification. Isolation of the fracture part using a rubber dam. Form a bevel on the ceramic fracture suffix using a low-speed green stone bur. Apply HF acid to the porcelain surface, rinse with water and dry. Application of silane material on ceramic surfaces. The bonding material was applied to the ceramic fracture surface and then light cured. The application of the composite resin restorative material using incremental technique and light cured each layer. Finishing and polishing using a disc bur with conventional method.[25] The success of ceramic repair by direct technique is clinically determined by the intact bond between ceramic and composite resin. This complete bond is achieved by chemical and mechanical bond. Chemical bonding is obtained form the application of silane, while

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mechanical bonding is obtained from the surface treatment.[26-28]

Surface Treatment

Surface treatment is divided into mechanical methods, chemical methods and combination. Mechanical methods include airborne particle abrasion and diamond rotary bur grinding, chemical methods involve etching the ceramics with acid. Several surface treatment methods that have been carried include diamond bur, air abrasion, laser and acid etching. Clinical application of the adhesive method on ceramic requires surface treatment to optimize the adhesion of the composite resin to the ceramic.[29] Surface treatment on ceramic is performed to produce mechanical retention which can increase the bond strength of ceramic repair from the roughened ceramic surface.[30] This surface roughness results in a micromechanical bond between the ceramic and the repair material obtained from the surface treatment. This makes surface treatment procedure important in determining the success of intraoral repair.[31]

Acid etching provides a clean surface by increasing the capacity for micromechanical retention and, as a consequence, increasing potential bond strength.[32] Acid etching on dental ceramics was several types of acid, such ad orthophosphoric (OP), sulfuric, nitric, ammonium hydrogen difluoride, acidulated phosphate fluoride (APF) and HF acid are recommended as surface treatment materials for ceramic restoration. The most commonly used acid etching is HF acid.[33] HF acid is an organic acid capable of etching the surface of glass. HF acid reacts with silicon oxide (SiO2) in the glass phase of ceramics, resulting in surface microporosity, which allows the formation of mechanical interlocks with the composite resin.[32,34]

HF acid is considered a relatively weak acid from a chemical point of view because of its low tendency to dissociate into H+ and F- ions. This does not mean that HF is harmless. Quite the opposite; HF has the ability to easily penetrate skin tissue (often without causing external burns) due its low dissociation potential. These conditions can cause extensive internal tissue damage, as well as alter blood calcium levels (due to CaF2 formation), which can lead to cardiac arrythmias. The use of HF during intra-oral repair procedures, exposes the patient to a high risk of acid damage, in particular, soft tissue. Thus, specific protocols should be followed including isolation of the rubber dam, careful use of a triple air water syringe, removal of excess acid and use of a high volume aspirator to maximize preventive measures.[32]

HF acid with a concentration of 5% is the type commonly used in etching lithium disilicate restorations and intraoral repair of fractures. HF acid can be safely used in dental procedures within this concentration range, including intraoral repairs, with caution and reasonable care when used. Recommended HF etching time is in the range of 20 seconds to 20 minutes, depending on acid concentration and type of ceramics.[32,34] The use of composite resin to repair fractures in ceramic has been introduced in various methods. Micromechanical retention of composite resin can be obtained from all surface treatment methods performed on ceramic surface. However, etching porcelain using HF acid is a commonly used procedure. The use of HF acid to achieve a clean microretention surface before bonding or repairing ceramic can be produced. This is because the acid can dissolve the glass matrix on the ceramic, thereby creating a mechanically retentive surface. Several selections on surface treatment methods on ceramic surfaces that provide effective results can be seen in table 1.[30]

Surface treatment using HF acid to obtain adequate adhesion between ceramic materials and composite resin is acceptable. Etching of ceramics also has the potential to significantly increase the bond strength of composite resin. Generally, ceramic consists of a glass matrix phase and a crystalline phase. HF acid as an acid that selectively dissolves the glass matrix in ceramic so as to increase the porosity of the surface, it is high energy, microretentive and provides a large surface area for the bonding of composite resin. In principle, these conditions are the same as enamel surface after etching with phosphoric acid. The hydroxyl groups are also exposed after etching using HF which are important for chemical bonding through the solute-pairs present in the silane.[35]

Silane Coupling Agent

Silanes are a class of organic molecules that contain one or more silicon atoms (3-methacryloxypropyl trimethoxy silane), which act as a wetting agent and help to form covalent chemical bonds at the involved interfaces. Single-bottle silanes that are pre-hydrolysed typically consist of 1% to 5% silane in a water/ethanol solution with added acetic acid to achieve the desired pH of 4 to 5. They perform optimally if left for 5 minutes.

Silane hydrolysis creates terminal hydroxyl groups on each silane molecule. These hydroxyl groups react directly with corresponding hydroxyl groups on the surface of glass ceramic through the oxidation of SiO2. A condensation polymerization reaction creates bonds between the silane and porcelain when the opposing hydroxyl groups interact with one another via hydrogen and covalent bonding. Clinically, the surface of the porcelain should appear matte after silane application and drying. The treated surface is then ready to receive an adhesive composite material to restore the restoration defect.[9]

Lithium Disilicate Repair Material

Different techniques for repairing fractured ceramic restorations:

Acrylic resin

The attempt for repairing of fractured ceramic used for making denture teeth started early as a trial for preparing the fractured denture teeth. Older techniques utilize acrylic resin as a repairing material for fractured ceramic restorations, these techniques includes: fabrication of a pin only with an acrylic resin veneer cemented to the labial surface, directly formed acrylic resin facing which are cemented to place and the use of Nuva-Fil to replace fractured porcelain.[36]

Glass ionomer cement

Glass ionomer cement may be used for ceramic repairs. This material is opaque and can be matched to a variety of tooth shades. Its characteristic of local fluoride release presents the advantage of increased resistance to the onset of carious lesions.[37]

Resin composites

Because of their physical, mechanical and optical properties, hybrid resin composites and their variations are best suited for ceramic repairs. Resin composite systems that offer opaque and translucent resins, in addition to the basic shades, should preferably be used to reestablish esthetics after ceramic repair.37 There are several mechanical properties of composite resin as repair system of lithium disilicate, one of which is bond strength. According to The Glossary of Prosthodontic Terms, the definition of bond strength is the force required to break a bonded assembly with failure

occurring in or near the adhesive/adherent interface. Interfacial bond strength is a key factor influencing the overall mechanical properties of composites. Bond strength tests are relatively easy to perform and can be done without expensive equipment.[38]

Discussion

The fracture of ceramic restorations can severely compromise the esthetics and function of the restorations, affecting their longevity. In most clinical trials, the failure of ceramic restorations was related to chipping of the veneering layer. Where applicable, the intraoral repair completed with resin composites is a conservative minimally invasive approach with a very good cost-to-benefit ratio. This type of repair is associated with reduced cost, treatment time, and increased longevity of the restoration for the patient.[23] Depending on the type and size of the fracture, different substrates may be exposed, requiring different treatment methods involving etching agents, adhesion promoters and/or sandblasting to ensure good adhesion of intraoral repair material to the ceramic surface. These treatments can promote mechanical interlocking, chemical bonding, or both.

The acids that are used as ceramics etchants are the HF acid, the acidulated phosphate fluoride (APF), and the ammonium hydrogen difluoride. The hydrofluoric acid is the most frequently used acid, which when applied onto the ceramic surface reacts with the silica matrix creating silicon tetrafluoride and molecules of water that are released.[39] A scanning electron microscope analysis has shown that ceramic surface etched with 4% APF for 2 min has irregular etching pattern with pores. An insignificant effect of APF may be explained by low concentrations of HF acid and available fluoride ions. However, when the application time of 1.23% APF gel (clinically used as a topical fluoride for reduction of the incidence and progress of caries) was prolonged up to 60 min, increasing in surface roughness was detected, with numerous pores and deposits of particles in the form of precipitate or degradation material in the glassy matrix. The strongest immediate bond was achieved by etching of the ceramic surface with HF acid (23.7 Mpa).[39]

As ceramic materials are rich in silica, hydrofluoric acid interacts with the microstructure of this material, creating a porous surface that aids in mechanical retention of the resin composite used in the intraoral repair technique. This approach favors the bonding procedure and increases the repair longevity. However, hydrofluoric acid needs to be carefully used intraorally due to possible damage to soft tissues and therefore the use of proper isolation is essential.[23]

Etching with acid has multiplied effect on ceramic: cleansing the bonding surface by removing the unwanted oxides, debris and grease, increasing the roughness thus increasing the bonding area and wettability of the ceramic surface and create micro retention that can be easily infiltrated with uncured flowable composite. This will significantly increase resin-ceramic bond strength.[21] The use of medium-grain diamond burs can produce roughness values comparable to those of hydrofluoric acid but it does not provide sufficient bond strength to be an alternative to acid etching.[4] This is because the acid etching creates more hydroxyl groups on the surface and increases micro-mechanical retention.[18]

A study comparing the difference in shear bond strength between ceramic repair systems using grinding and universal primers with those using etching HF acid and silane on lithium disilicate showed that the shear bond strength achieved in acid etching and silane group was higher than the grinding group. The manufacturer of IPS e.max Press (EMX; Ivoclar Vivadent, Schaan, Liechtenstein), a commercial brand that presents ±70 vol% of lithium disilicate crystals dispersed in an amorphous vitrous phase, recommends that EMX should be etched with a 4.8% HF concentration for 20 seconds. However, several clinical reports and in vitro studies, published from 2011 to date, have reported different HF concentrations and etching periods on lithium disilicate ceramic, such as 10% for 15 seconds, 10% for 20 seconds, 9.6% for 30 seconds, 9.5% for 60 seconds, 4.8% for 60 seconds, 5% for 20 seconds.[40]

That etching with 5% HF for 20 seconds can be recommended for lithium disilicate and leucite-reinforced CAD/CAM ceramics. However, for pressed lithium disilicate ceramic, 10% HF for 60 s showed significantly higher bond strength.[41] On the contrary, the highest shear bond strength values were obtained with surface treatment with 9% HF and not affected significantly by the conditioning time (20 s or 90 s). They assumed that surface treatment with 9% HF for only 20 s will provide better bonding strength than using 5% HF acid for 20 s, as per the manufacturer recommendation.[42] That optimal bond strength to lithium disilicate is achieved by exposure at least 20 s of 5% HF acid followed by a coat of silane. If an additional silane step is not taken prior to applying a universal adhesive, the use of 9.5% HF for 60 s can increase bond strength.43 Sunfeld et al suggested to clinically use previously heated 1% or 2.5% hydrofluoric acid instead of higher concentrations when etching to lithium disilicate glass-ceramic.[44] The 10% HF acid concentration and exposure time from 20 to 40 s showed the best results.[45]

Over-etching on the etched ceramic surface is clearly visible as "white residue". Sometimes, due to the large amount of residue deposits, it can be very broad covering the ceramic surface. This is related to the concentration of HF acid, time and type of ceramic. The condition cannot be removed by air/water spray and wiping with acetone-soaked cotton. Cleaning can be done by placing it in ethanol followed by ultra-sonication. It takes 15 minutes of ultrasonication to release the white residue. The etching efficiency of HF depends on the concentration, etching time, temperature, and dilution of the acid solution. A consensus regarding the most suitable etching protocol for glass ceramics is not clear, especially for lithium disilicate glass ceramics.[40]

Conclusion and Suggestion

It is concluded that the use of HF acid as a surface treatment material in increasing the bond strength of lithium disilicate and composite resin is an option that can be considered because the material is quite easy to obtain in the market, affordable and easy to apply. The right time and concentration of HF acid to obtain maximum bond strength between lihium disilicate and resin composite is also concerning. The selection of the right time and concentration in the application of HF acid as a surface treatment material is necessary in repair system of lithium disilicate.

Further research is needed on the effect of time and concentration of HF acid as a surface treatment material in lithium disilicate repair system to obtain maximum increase in bond strength between lithium disilicate and composite resin, so that the minimum application time is obtained with the right concentration of HF acid.

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INDONESIAN JOURNAL OF PROSTHODONTICS

REVIEW

Strain distribution on shortened dental arches complete denture using finite element analysis

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Keywords: Complete denture, Finite element analysis, Shortened dental arches, Strain distribution analysis

ABSTRACT

Prosthetic management for edentulism could be challenging with the Inadequate interocclusal space due to enlargement of the maxillary tuberosity, causes difficulties in artificial tooth placement. Hence, reducing numbers of artificial teeth is indicated which is in line with the shortened dental arches (SDA) concept. The SDA concept could provide good occlusal and mandibular stability, comfort in mastication and appearance. An increase in strain distribution value in the anterior region of the mandible was found in the SDA due to partial changes of the occlusal load distribution pattern. Strain distribution can be analyzed using Finite Element Analysis (FEA). This literature review aims to analyse the strain distribution on SDA complete denture using finite element analysis. The SDA concept was aimed at preserving the anterior and premolar regions. Masticatory ability is correlated with the number of teeth and is impaired if there are less than 20 teeth. Based on FEA, the increase in strain distribution value in the SDA concept is due to changes in occlusal load distribution pattern, masticatory muscle activity and tissue morphology that is susceptible to stress. Nevertheless, the strain value in SDA models were of lower intensity than the yield reported to cause deterioration effects. In maxillary complete denture, the highest strain value was found at the incisal and labial frenal notches. Strain distribution on shortened dental arches using finite element analysis shows a satisfactory masticatory ability and an increase in the value of stress distribution in the anterior region of the mandible. (IJP 2024;5(2):107-110)

Introduction

Prosthetic management of edentulism can be challenging with the presence of limited interocclusal space. This condition is caused by prolonged edentulous state which create extrusion of opposing teeth combined with alveolar extrusion such as maxillary tuberosities overgrowth.[1] In result, inadequate interocclusal space makes difficulty in complete denture fabrication especially on the artificial teeth placement. Surgical intervention like maxillary tuberosities reduction could solve the problem. However, there are times when surgery is not judicious.[2] Hence, reducing numbers of artificial teeth in complete denture fabrication is indicated which is in line with the shortened dental arches (SDA) concept.

SDA is defined as having an intact anterior region but a reduced number of occluding pairs of posterior teeth.[3] This concept was aimed at preserving the anterior and premolar region. Masticatory ability is correlated with the number of teeth and is impaired if there are less than 20 teeth and this statement are supported too by the World Health Organization whom indicates that a functional, aesthetic, natural dentition has at least 20 teeth.[3]

Finite element analysis (FEA) is one of the research tools that has become increasingly popular in dental research for biomechanical analysis due to its simplicity and reproducibility. It allows simple measurements to be made on models with complex geometries, provides information about the state of overall stress in the models, and enables quantitative study of the effect of force application.[4] FEA have been successfully applied to analyse the effects of different occlusal forces on tooth positioning and occlusal stability on complete dental arch.[5] Knowing that there are still lack of studies on SDA complete dentures, the use of FEA may improve understanding of the stress distribution on the SDA complete dentures. This literature review aims to discuss the strain distribution on SDA complete denture using finite element analysis.

Literature Studies

Complete Denture

Complete denture is a fixed or removable dental prosthesis that replaces the entire dentition and associated structures of the maxillae or mandible.[6] The foundation of complete denture is made up of bone and covering soft tissues. The denture base rests on the mucous membrane, which serves as a cushion between the denture base and the supporting bone. The goal on fabricating complete denture includes maximizing the extension of the denture base increases surface area and spreads the "pressure" of mastication and tooth contacts during swallowing over a greater surface area. These involve capturing the anatomical landmark of both maxilla and mandibula, compromising two areas: stress-bearing (or supporting) area and peripheral (or limiting) area.[7]

The maxillary tuberosity is one of the maxilla anatomical

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Table 1. Number of occluding pair of teeth required based on age

Age	Functional Level	Occluding Pair
20-50	I - Optimal	12
40-80	II - Suboptimal	10 (SDA)
70-100	III - Minimal	8 (ESDA)

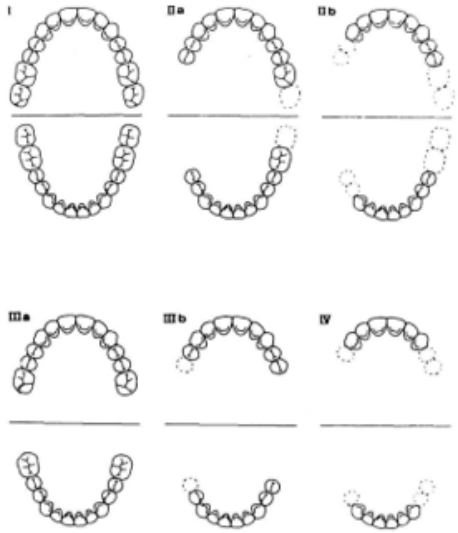

Figure 1. Schematic representation of SDA Classification

landmarks which offer considerable support on denture as it consists of dense fibrous connective tissues with minimal compressibility.[7] It is located in the posterior inferior extension of the maxillary bone, bounded mesially by the last erupted molar and maxillary sinus, and distally by the pterygopalatine fissure and pyramidal process of the palatine bone.[8]

Enlarged maxillary tuberosities, which may consist of soft tissue, bone or both, may be caused by combination syndrome or so called Kelly's syndrome and extrusion of maxillary posterior teeth and alveolar associated with an untreated Kennedy class 1 type of mandibular dentition.[7,9]

Excesses in the area of the maxillary tuberosity may encroach on the interocclusal space and decrease the overall freeway space needed for proper prosthetic function.[10] When the maxillary tuberosities are so large that they prevent the correct location of the occlusal plane, require the omission of some teeth, or prevent the correct distal extensions of the denture bases.[7] Surgical intervention like maxillary tuberosities reduction could solve the problem. However, there are times when surgery is not judicious, especially on elderly and medically compromised patient.[2] Hence, reducing numbers of artificial teeth in complete denture fabrication is indicated which is in line with the shortened dental arches (SDA) concept.

Shortened dental arches (SDA)

The term 'shortened dental arches' (SDA) was first used in 1981 by the Dutch prosthodontist Arnd Kayser for a dentition with loss of posterior teeth.11 The SDA is defined as having an intact anterior region but a reduced number of occluding pairs of posterior teeth. This concept was aimed at preserving the anterior and premolar region.[3]

SDA has been classified into five classes:[1] IIa – asymmetrical (3–4 pre-molars and 1–2 molars); IIb – asymmetrical (2–3 pre-molars and 1 molar); IIIa – symmetrical (3–4 pre-molars and 2 molars); IIIb – symmetrical (3–4 pre-molars); IV – extremely shortened (0–2 premolars and no molars).

Table 1 suggests minimum number of occluding pair of teeth required based on age and other factors to provide satisfactory levels of oral function.[12]

Masticatory ability is correlated with the number of teeth and is impaired if there are less than 20 teeth. Kayser estimated the minimum number of teeth needed to satisfy functional demands of modern man:[11] Biting: 12 front teeth + 4 premolars; Mastication: 8 premolars + 4 molars; Speech: 12 front teeth; Aesthetics, 12 front teeth + 4 premolars in the maxilla; Mandibular stability: 12 front teeth + 8 premolars + (4 molars in some cases).

SDA may be appropriate for patients meeting the following criteria:[12] Progressive caries and periodontal disease confined mainly to the molars; Good long term prognosis for the anterior teeth; Financial and other limitations to dental care.

The contraindications of SDA include:[12] Severe maxillomandibular discrepancy (e.g. Severe angle class II and class III relationship); Anterior open bite; Parafunctional habits; Pre-existing craniomandibular dysfunction; Marked pathological tooth wear; Marked reduction in alveolar bone support (e.g. advanced periodontal disease); Patient below 50 years of age.

Probable advantages of SDA are:[12] Simplification of extensive restorative management; Easier maintenance for both the patient and the dentist; Simplification of oral hygiene maintenance; Good prognosis for the remaining teeth, if the patient learns to maintain his/her own dentition.

The prognosis on SDA depends on:[12] Maintenance of good oral health; The maxillomandibular jaw relationship; The age of the patient; The periodontal status of the anterior and premolar teeth; The adaptive potential of the TMJ; Occlusal stability.

The SDA concept could provide good occlusal and mandibular stability, comfort in mastication and appearance. Sufficient adaptive capacity in subjects with SDA achieved when at least four occlusal units are left (one unit corresponds to a pair of occluding premolars; two units correspond to a pair of occluding molars).[11]

The World Health Organization too indicates that a functional, aesthetic, natural dentition has at least 20 teeth, provided a strong support by suggesting that the SDA concept was a possible clinical alternative in certain conditions.[11]

Strain distribution

Strain, or the change in length per unit length, is the relative deformation of an object subjected to a stress. Strain may be either elastic, plastic, elastic and plastic or viscoelastic. Elastic strain is reversible where the object fully recovers its original shape when the force is

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removed. Plastic strain represents a permanent deformation of the material while viscoelastic materials deform by exhibiting both properties (viscous and elastic characteristic) and a time dependent strain behavior.[13]

Strain distribution analysis allow further understanding of transmitted stress to the underlying structures to denture bases where excessive stress may result in denture failure such as denture bases deformation.[14]

Various methods can be used to study stress distribution in dentures such as brittle lacquer coatings, strain gauges, photoelasticity, holography, mathematical equations, and finite element analysis (FEA). Among all these methods, FEA has become increasingly popular for stress analysis due to its improved simplicity and reproducibility.[4]

Finite element analysis

Finite element analysis (FEA) is one of the research tools that has become increasingly popular in dental research for biomechanical analysis due to its simplicity and reproducibility. It allows simple measurements to be made on models with complex geometries, provides information about the state of overall stress in the models, and enables quantitative study of the effect of force application.[4] FEA have been successfully applied to analyse the effects of different occlusal forces on tooth positioning and occlusal stability on complete dental arch.[5]

Discussion

The FEA method has been established as a standardised scientific procedure for qualitative assessment of the stress distribution in various structures, and it has been used to evaluate the stress distribution underneath the complete denture in the residual alveolar bone.[15]

FEA study on conventional maxillary complete denture by Cheng et al showed that the highest tensile and compressive strains were found at the incisal notches and labial frenal notches, respectively. These results agreed with the findings of Matthew and Wain using brittle lacquear coating found that crack lines in anterior palate of intaglio surface originated from the tip of the incisal notch. The high tensile strain concentration at the incisal notch is likely to be the cause of denture fracture during clinical service. One of the most likely reasons on crack initiation and propagation in incisal notch which result faster rate of denture fracture is the repeated high occlusal load by the opposing natural dentition. On the other hand, Hargreaves observed that a deep labial frenal notch was the cause of midline fracture due to high tensile strain and labial frenectomy is advised to reduce the strain concentration.[4]

Literature indicates that masticatory ability closely correlates with the number of teeth and is impaired when there are fewer than 20 uniformly distributed teeth in the mouth.[3] In the study of dentate a shortened dental arch does not affect masticatory efficiency and might be suggested as an alternative treatment. This statement is further supported by the research of Iegami et al where in complete denture wearers, the absence of second molars also did not affect masticatory efficiency, despite the reduction in occlusal area.[1]

In terms of number of occluding pair of teeth and mastication in dentate subject, it was concluded that SDA with intact premolar regions and at least one occluding pair of molars provided sufficient chewing ability. The chewing ability deteriorated with a decrease of occluding pairs of teeth, especially for hard foods. Subjects with extreme SDA (0 to 2 occluding premolars) complained of severely reduced chewing ability.11 Likewise, subjects with asymmetric arches and unevenly distributed teeth reported greater masticatory difficulty than subjects with more complete dental arches.[3]

FEA study in dentate subject revealed that shortening the dental arch partially changed the pattern of occlusal load distribution and increased stress and strain in the anterior mandibular segment as the occlusal loading shift anteriorly. A location of the areas of higher stress despite associated with the loading position, site and the morphology of the material or tissue is also susceptible to stress. Nevertheless, the strain value in SDA models were of lower intensity than the yield reported to cause deterioration effects.[16,17]

Conclusion and Suggestion

The SDA concept is an example of problem-oriented approach and could be implemented in complete denture fabrication to manage reduced interocclusal space caused by enlarged tuberosities without the need of surgical intervention. With the minimum of 20 occluding units, it could provide good occlusal and mandibular stability, comfort in mastication and appearance. FEA study in dentate subject revealed that shortening the dental arch partially changed the pattern of occlusal load distribution and increased stress and strain in the anterior mandibular segment.

The use of FEA can improve understanding and help describing how the strain distribution on the denture base, and the result allow the outlook of possible risk of SDA complete denture bases complications in the future. Knowing that there is still limited study conducted on SDA complete denture, therefore, more studies are needed to assess stress distribution on SDA complete denture for the application on theoretical and clinical scopes.

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REVIEW

Analysis of Stress Distribution on Knife-Edge with Various Occlusion Schemes Using

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Keywords: Finite element method, Knife edge, Occlusal schemes, Pressure-pain threshold, Stress distribution

ABSTRACT

Edentulism is an oral health problem that has an impact on quality of life because it causes a loss of balance in the stomatognathic system with disruption of mastication. The impaired masticatory function can be exacerbated from knife-edge conditions, thus the masticatory load received by the mucous in the form of stress distribution becomes greater. One of the efforts to reduce stress concentration is to modify the occlusion concept and anatomical shape of the artificial teeth. However, measuring the stress distribution on edentulous mucous with various occlusion schemes was difficult with in vivo and in vitro tests due to inability to represent the complex system of stomatognation. In silico test with A) can be a solution because the modeling simulation is obtained from CT-scan or digital design. This paper discusses the stress distribution analysis on knife-edge condition with various occlusion schemes using FEM. Stress distribution that exceeds the mucous pressure-pain threshold during denture function will cause poor mastication performance. This paper discusses the analysis of stress distribution under knife-edge ridge conditions with various occlusion schemes using FEM. Stress distribution that exceeds the mucous pressure-pain threshold during denture function will cause poor mastication performance. The use of Lingualized or Monoplane occlusion schemes can be a solution because they use semi-anatomical and non-anatomical artificial teeth to reduce the load passed on the cusp and also minimize resistance during lateral movement. The advantages of FEM in obtaining accurate modeling and flexibility in testing allow analyses that are difficult to perform in in vivo and in vitro, FEM measure stress distribution and its relationship with pain on knife-edge ridge base on various occlusion schemes in complete dentures. (IJP 2024;5(2):111-115)

Introduction

The Stomatognathic System is composed of static structures (mandibular, maxilla, dental arches, TMJ and hyoid bone) and dynamic structures (masticatory, supra and infrahyoid muscles and tongue, lips and cheek muscles) that act together[1] as they are balanced and controlled by the central nervous system performing the stomatognathic functions: suction, breathing, swallowing, speech and chewing.[1] Teeth have an important role in mastication and phonetics. Disruption of one of the components of the stomatognathic system, such as loss of all teeth, can result in an imbalance in its function. Decreasing masticatory, phonetic, and aesthetic functions result in diminishing general health and quality of life of the patient.[2]

Edentulism or full edentulous, is the loss of all natural teeth in the oral cavity. Edentulism results in reduced height of the lower third of the face, vertical dimension, disorders of mastication, social and psychosocial problems, aesthetics, and phonetics that affect on a person's quality of life.[3-6] Oral rehabilitation using complete dentures is required to improve mastication in fully edentulous patients. Complete dentures help restoring mastication, phonetic, and aesthetic hence a person can return to normal interactions. Mastication is the first step in the digestive process, when food is reducing into smaller particle and lubricated with saliva then formed into a cohesive mass called as a food bolus.[7]

In patients who wear ill-fitting dentures, it can result in changes to the alveolar ridge changes shape significantly in both the horizontal and vertical axes following a predictable pattern. As resorption continues from the labial and lingual aspects, the crest of the ridge becomes increasingly narrow ultimately becoming knife-edge. As the process continues, the knife-edge becomes shorter and even eventually disappears, leaving a low well rounded or flat ridge. Eventually, this too resorbs, leaving a depressed ridge.[8]

The priority of prosthetic rehabilitation in edentulous patients is to restore the function of the stomatognathic system with optimal retention and stability of the complete denture.[9] The success of complete denture depends on the condition of the alveolar ridge. The magnitude and direction of masticatory load applied to the denture will be distributed on the oral mucosa under the denture base. An effort to manage Knife-ridge is to modify the impression technique that can minimize pressure on the alveolar mucosa and modify by the type of occlusal schemes, such as using a lingualize occlusion to decreasing lateral force, There is some evidence that Lingualize Occlusion is beneficial for patients with severely resorbed ridges in terms of mastication and stability.[9,10]

The influence in the bone structure of the residual ridge can be a cause of chronic pain under the denture, especially when performing masticatory movements. When the knife-edge ridge is

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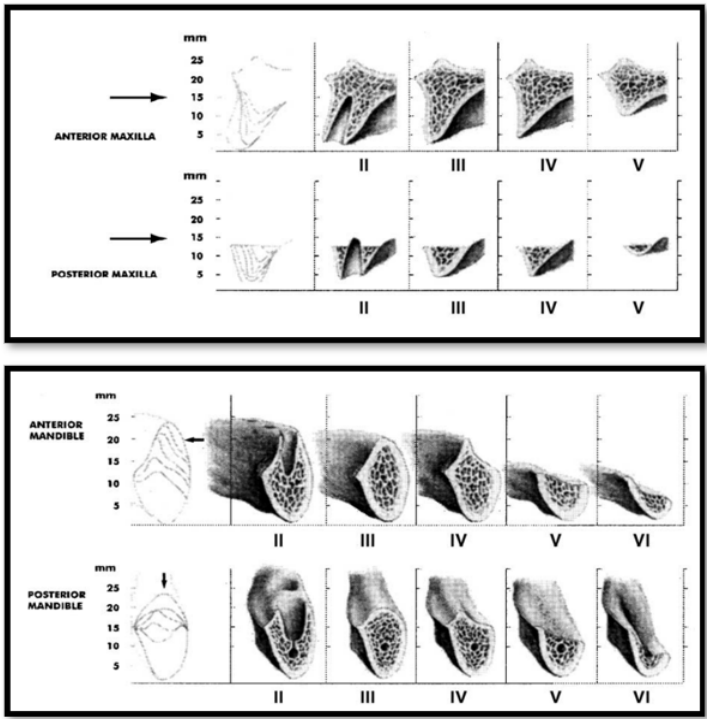

Figure 1. **Cawood and Hawell classify the residual ridge**

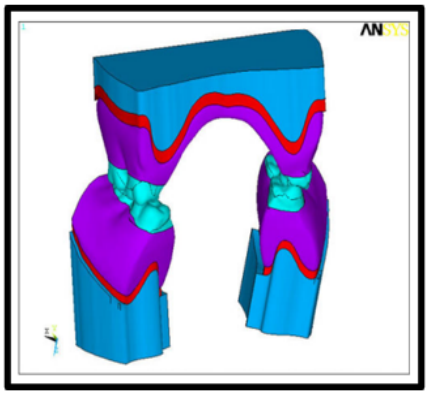

Figure 2. **FEM model of maxillary and mandibular complete denture in first molar region showing the underlying mucosa and alveolar bone**

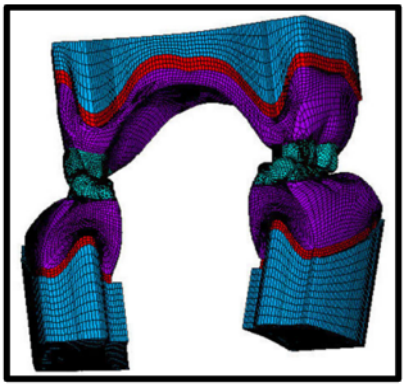

Figure 3. **F3D FEM model of maxillary mandibular complete denture with mesh**

given a load, the existing mucosa will be wedged between the base of the denture and bone, which will then cause pain.[11]

Masticatory function in complete denture wearers can be objectively assess by measuring masticatory performance. Masticatory performance is a measurement of food particle distribution under standard test conditions and demonstrates the comprehensive capabilities required for mastication. Masticatory performance can be measured with conventional methods such as sieving and mixing ability methods. Conventional methods of measuring masticatory performance require a large number of samples in the study. Digitally, finite element method (FEM) can be used to measure masticatory performance of complete denture wearers using only one sample related to stress distribution and displacement of the alveolar ridge against masticatory load.[12]

Base on the research use a finite element to build a model of the mandible, including the TMJ from the commercial software Abaqus FEM, to simulate the process of mastication cycle.[13]

This paper aims to discuss the use of FEM in the measurement of stress distribution on the Knife-Ridge of complete dentures with various occlusal schemes.

Literature Studies

Knife Edge Ridge

The Knife-edge ridge is included in one of the compromised ridges due to the process of resorption ridge. A knife-edge ridge is a ridge with sharp bones and is a problem that often occurs in edentulous patients. The knife-edge ridge formed because of the rapid resorption of the labial and lingual sides of the anterior lower jaw.[14]

Teeth may be lost due to several reasons tooth decay, periodontal problems, and tooth injury being the most frequent causes of tooth loss. When tooth loss occurs the alveolar ridge undergoes a series of changes that lead to different shapes of ridges, thus forming residual ridges.[15,16]

The size of residual ridge is reduced most rapidly in the first six months, but resorption of bone continues throughout the life at a slower pace that leads to changes in bone form and structure.[17,18] Maxilla resorbs superiorly and posteriorly; however, mandibular resorbs in inferior and anterior directions. The anterior mandibular resorbs four times faster than the anterior maxilla. Cawood and Hawell classify the residual ridge to basic six classes: Class I - dentate; Class II -immediately post extraction; Class III- well-rounded ridge form, adequate in height and width; Class IV - knife-edge ridge form, adequate in height and inadequate in width; Class V flat ridge form, inadequate in height and width; Class VI - depressed ridge form, with some basilar loss evident.

Moreover they found that the Pattern of bone loss varies with sites. Anterior mandibular bone loss is vertical and horizontal (from the labial aspect). Posterior mandibular bone loss is mainly vertical. Anterior maxilla - bone loss is both vertical and horizontal (from the labial aspect). Posterior maxilla - bone loss is both vertical and horizontal (from the buccal aspect).[20]

Masticatory Performanc[22] Masticatory performance is an achievable measure of food distribution under standard test

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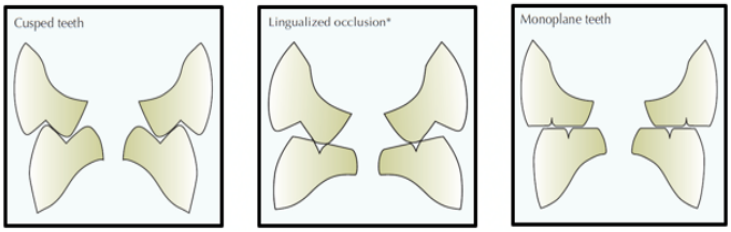

Figure 3. Tooth Molds and Occlusal Concepts

conditions and demonstrates the comprehensive capabilities required for mastication. Conventional masticatory performance measurement can be done by two methods:

Comminution method

These method use food that has been crushed into smaller particles. Smaller particle size indicates better mastication performance. Can be divided into four methods: A sieving method that assesses the fragmentation and particle size distribution by single or multiple sieves or through several types of optical scanning and digital image analysis; Gummy jelly (GJ) method which involves measuring the extraction of glucose released from gummy jelly after chewing; the amount of glucose released is related to the degree to which the test food is fragmented; The fuchsin bead method which uses encapsulated fuchsin beads as food to assess masticatory performance. The fuchsin dye was released into the capsule when the beads were chewed, and the concentration of the dye released, which was proportional to the masticatory performance and was measured by a spectrophotometer; Colorimetric methods that assess food fragmentation tests by the release or binding of dyes from solution. The dye concentration is assessed by a spectrophotometer, which is proportional to the masticatory performance.

Mixing ability

To assess masticatory performance, the mixing ability method used two-colored gum or wax and color-changing gum. The color change that occurs in the gum or wax determines the value of masticatory performance.[22]

Finite Element Method (FEM)

FEM is a numerical method to get a solution to a problem accurately with modeling simulations to be analyzed mathematically. The continuous structure is divided into different elements, retaining the properties of the original structure under study. Each element is described by a different equation and solved by a mathematical model.[23]

FEM can analyze stress and strain as a result of external pressure, temperature changes and other factors. It is therefore not possible to measure stress and strain in human tissues in response to external stresses. This method is very useful for examining the mechanical aspects of biomaterials in human tissue. The results can be examined with software related to the FEM to look at the various parameters and identify the analysis of their implications.[23]

The advantages of FEM are: Minimize animal research; Non-invasive; Can visualize superimposed structures; Easier analysis of material properties of craniofacial structures and geometries; The direction and magnitude of the pressure can be located precisely; Theoretical measurement of the load point; Static and dynamic analysis can be performed; Research can be done repeatedly.; Time efficiency

The limitations of the FEM, are: Researchers need to understand material properties well; Errors in inputting data can result in errors in output; Requires a lot of input data.

Occlusal Schemes

Reduced the mucosal area of denture support on the knife ridge, requires treatment by minimizing the load that the cusp will receive and reducing resistance during movement to prevent pain.[24] One of the efforts can be made is to arrange the occlusion schemes other than bilateral balanced occlusion schemes, for example lingualized or monoplane occlusion.[25,26]

The bilateral balanced occlusion scheme uses anatomical factors to give a more natural appearance and good masticatory efficiency. The lingualized occlusion scheme uses anatomical factors in the maxilla and non-anatomical factors in the mandibular to make the premolar area still looks natural. The monoplane occlusion scheme uses non-anatomical factors throughout so that lateral movement reduces stress on the mucosa.[25]

This difference in the shape of the artificial teeth helps in reducing the load that will be transmitted to the periphery and also minimizes resistance during movement, but the impact is reduced masticatory efficiency, less aesthetic appearance, and modifications to the annulus that need to be made.[25-27] This becomes even more apparent when the occlusion scheme chosen is a monoplane with an entirely non-anatomical.

Discussion

The resorption that occurs on the margins of the edentulus is a consequence of tooth extraction and long-term denture use.[29,30] A systematic review conducted by Pham et al on several studies measuring the resorption rate on the posterior mandibular of patients with complete denture users, found that the average resorption on the posterior mandibular ranged from 0.01-2.4 mm per year. This figure has a very large variation and is different from that proposed by Laing and Zarb who stated that this resorption ranges from 0.1-0.2 mm per year. This difference is thought to be due to the occlusion scheme used, of which there were only seven studies that used bilateral balanced.

A study conducted by Alsaggaf and Fenlon[31] even found that patients who used a denture for more than 5 years experienced significant residual resorption when compared to the group who did not use a denture. This contradicts Wolf's Law, which states that the edentulus will atrophy if not used a denture.[32] The author believes that other factors play a role so that resorption in denture users is more significant, one of which is the possibility that the load distributed by the denture is uneven that it exceeds the tolerance threshold of the underlying mucosa.

The concept of occlusion is still an interesting discussion regarding prosthodontic efforts to produce a stable denture. Bhambhani et al[33] in their systematic review stated that in the BBO occlusion scheme, the deflective contact of the anatomical form of the annulus can cause the denture to become unstable. Similarly, in a randomised clinical trial study patients with BBO occlusion scheme dentures tend to avoid some foods that cause discomfort due to frequent denture instability, although in the assessment of masticatory efficiency no difference was found compared to other occlusion schemes.[34]

Studies related to the comparison of various occlusion schemes in denture users are based on mastication efficiency or mastication performance, which is subjectively assessed by patients when using a denture and without using standardised test foods. In

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addition, the inability of patients to crush food due to low resilience can be expected due to the load received exceeding the mucosal tolerance threshold, which cannot be detected by mastication performance assessment.[35]

Other in vitro studies were conducted directly on the denture, but modelling of the edentulus plate could not represent the complex native conditions, making it inadequate to study the stress distribution in oral structures.[36]

Assessed the stress distribution by FEM on the mucosa under the denture base with 33^0, 20^0, and 0^0 cuspal teeth. Cross-sections of the denture were graphed and normal bone contours were obtained from CT results, with a load of 50 N. The stress values revealed that greater stress values were observed in the 20^0 and 33^0 cuspal teeth than in 0^0 teeth. The shortcoming of this study is the use of two-dimensional FEM testing so that the resulting stress distribution is only assessed at a certain point that does not necessarily receive the largest load when functioning.[37]

How the shape of the posterior cuspal teeth with inclinations of 0^0, 20^0, and 33^0 resulted in different stress distributions under the tissues of a complete denture when it received a masticatory load of 100N in the vertical direction. The results showed that inclinations of 20^0 and 33^0 produced greater stress distribution values than 0^0, while between 20^0 and 33^0 showed no significant difference. This was expected because different inclinations would cause a change in the load direction and the greater the inclination, the less the contact area with the antagonist. However, this study did not include the variable oblique load direction to represent lateral movement, which is most prone to cause interference with denture retention and stabilisation.[37] The research about knife edges is limited to impression techniques, while the selection of occlusion schemes has not been carried out on knife edges.

Conclusion and Suggestion

The treatment of edentulus cases, especially on knife ridge, requires a deeper understanding of how the occlusion scheme can play a role in maximizing the patient's masticatory performance while maintaining the condition of the mucosa and the underlying alveolar bone from pain and further resorption. The utilization of FEM with simulated modeling obtained is similar to the original condition, so it can help describe how the stress distribution received by the mucosa under the denture base and conduct further analysis related to pain and possible resorption risks that can occur.

Several studies related to the utilization of FEM in assessing the stress distribution on the mucosa under the denture have focused on normal residual ridge conditions and bilateral balanced occlusion schemes, more studies need to be conducted related to crowding conditions with various occlusion concepts, so that it can be applied theoretically and clinically.

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INDONESIAN JOURNAL OF PROSTHODONTICS

REVIEW

Utilization of robusta coffee bean extract (Coffea canephora) as an alternative herbal in applied dentistry

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Keywords: Applied dentistry, Coffea canephora, Herbal medicine, Oral health, Robusta coffee

ABSTRACT

Background: Indonesia is a major producer of Robusta coffee, which has variations in chemical qualities such as caffeine, polyphenols, flavonoid compounds, tannins, alkaloids, and chlorogenic acid. Research shows that Robusta coffee bean extract has potential in dental applications. The importance of Robusta coffee as an agricultural commodity and source of active ingredients with health benefits, especially in dental care. Objectives: This literature review aims to evaluate the effectiveness of Robusta coffee as oral herbal medicine. An electronic search was carried out on PubMed, Science Direct, and Google Scholar with manual search from 2018 to 2024 following the PRISMA 2020 guidelines. The review incorporated studies related to the utilization of Robusta coffee bean extract that can be applicable for oral health care. Conclusion: Robusta coffee bean extract has significant potential as an active material in dental health care, with clear antibacterial, antioxidant, and wound-healing abilities. Robusta coffee bean extract-based products as oral herbal medicine can give significant advantages to oral health. Further research is needed to optimize its use in health products. (IJP 2024;5(2):116-118)

Introduction

Indonesia is a major producer of coffee, with Robusta coffee being the dominant type.[1] The chemical quality parameters of Robusta coffee in western Indonesia have been studied, with variations found in caffeine, sucrose, total fat, and fatty acid.[2] Quality evaluation of Robusta coffee in Jambi Province has identified promising clones with good flavor and high productivity.[3] Robusta coffee beans are therefore Indonesia's natural wealth with the best quality in Southeast Asia.[4]

A series of studies have demonstrated the potential of robusta coffee bean extract in dental applications. A gel containing 40-50% robusta coffee bean extract increased the number of fibroblasts, aiding wound healing after gingivectomy.[5] Toothpaste with 12.5-50% robusta coffee bean extract can inhibit the growth of Aggregatibacter actinomycetemcomitans and Treponema denticola, bacteria associated with periodontal disease.[6,7] Further research supports these findings, showing that robusta coffee bean extract at concentrations of 1-3% inhibits the growth of Porphyromonas gingivalis, another periodontal disease-causing bacterium.[8] These studies collectively suggest that robusta coffee bean extract has potential as an alternative herbal ingredient in dental care.

Overall, this study underscores the importance of robusta coffee not only as a major agricultural commodity but also as a source of active ingredients with significant health benefits. Robusta coffee bean extract shows great potential in various medical and health applications, especially in the field of dental health. Thus, further development and continued research is essential to optimize the use of robusta coffee in health products.

Literature Studies

The studies included in this literature review were selected based on predetermined inclusion and exclusion parameters. Studies included in this study were chosen according to these inclusion criteria: Research publications that discuss the utilization of robusta coffee bean extract (Coffea canephora) as an alternative herbal ingredient in applied dentistry; Published in the period 2018-2024; Registered in PubMed, ScienceDirect, and Google Scholar. The exclusion criteria used are: Review studies; Published before 2018; Not available as free full-text journals.

The PICOS criteria are used in the search of literature with population (P) criteria used for patients with oral cavity diseases. Intervention (I) criteria used is Robusta coffee as the selected herbal medicine treatment. Comparison (C) criteria used is other herbal medicine treatments. Outcome (O) criteria used is the potential of Robusta coffee in managing oral diseases and about the study (S) used is In vitro and In vivo design.

The review was conducted by PRISMA 2020 guidelines figure 1. The initial stage of literature search in 3 electronic databases (PubMed, ScienceDirect, and Google Scholar) using the keywords "(Robusta Coffee OR Coffea canephora) AND Herbal Medicine" and manual searches resulted in 158 studies. In the second stage, 98 duplicated articles were removed and resulted in 110 articles. The next stage was the title and abstract screening with 86 articles not meeting the PICOS and inclusion-exclusion criteria, resulting in 24

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Table 1. Literature review results

No	Title	Author/Year	Study Design	Outcome
1.	Inhibition of Robusta Coffee Bean Extract (Coffea Canephora) against Porphyromonas gingivalis Bacteria (in vitro)	Dianastri, R.N., et al./ (2021)	In vitro	Robusta coffee bean extract at concentrations of 1-3% inhibits the growth of Porphyromonas gingivalis, another periodontal disease-causing bacterium.
2.	Anti–Peri-implantitis Bacteria's Ability of Robusta Green Coffee Bean (Coffea Canephora) Ethanol Extract: An In Silico and In Vitro Study	Nugraha, A. P., et al./ (2023)	In vitro	Robusta Green Coffee Bean ethanol extract has high antioxidant ability against A. actinomycetemcomitans (Aa), P. gingivalis (Pg), F. nucleatum (Fn), and P. intermedia (Pi). 50% RGCB ethanol extract may act as strong anti–peri-implantitis bacteria
3.	Inhibition of Toothpaste Containing Robusta Coffee Bean Extract (Coffea canephora) Against the Growth of Aggregatibacter actinomycetemcomitans Bacteria In Vitro	Farahdila, N.A., et al./ (2024)	In vitro	Toothpaste with 12.5-50% robusta coffee bean extract can inhibit the growth of Aggregatibacter actinomycetemcomitans and Treponema denticola, bacteria associated with periodontal disease.
4.	Antibacterial power of toothpaste containing robusta coffee bean extract (Coffea canephora) against Treponema denticola: An experimental laboratory study.	Perdana, M.D., et al../ (2024)	In vitro	Toothpaste containing robusta coffee bean extract at concentrations of 12.5; 25; and 50% has antibacterial power against Treponema denticola.
5.	Antioxidant, antimicrobial and healing properties of an extract from coffee pulp for the development of a phytocosmetic	Dos Santos, É.M., et al./ (2024)	In vitro	Robusta green bean coffee, had the best results in FRAP antioxidant assay, total phenolics, higher chlorogenic acid content, antibacterial activity against Staphylococcus aureus, and less cytotoxic potential, that showed desirable antioxidant, antimicrobial and healing properties
6.	Effectiveness of Robusta Coffee Bean Extract Gel (Coffea canephora) on Increasing the Number of Fibroblasts in Post-Gingivectomy Wound Healing	Rahmadani, N., et al./ (2022).	In vivo	A gel containing 40-50% robusta coffee bean extract increases the number of fibroblasts, aiding wound healing after gingivectomy.
7.	Coffee pulp: From a by-product of coffee production to a potential anticariogenic mouth rinse! An in vivo study	Bollamma, P. B. K., et al./ (2023)	In vivo	Coffee pulp extract-based mouth rinse showed a statistically significant reduction. It can be a potential anticariogenic agent that offers few advantages over chlorhexidine.
8.	Inhibiting the growth of periopathogenic bacteria and accelerating bone repair processes by using robusta coffee bean extract	Sari, D. S., et al../ (2023)	In vitro & in vivo	Robusta coffee bean extract with a concentration of 12.5-50% has a growth inhibitory effect on P. gingivalis, A. actino-mycetemcomitans, and S. viridans

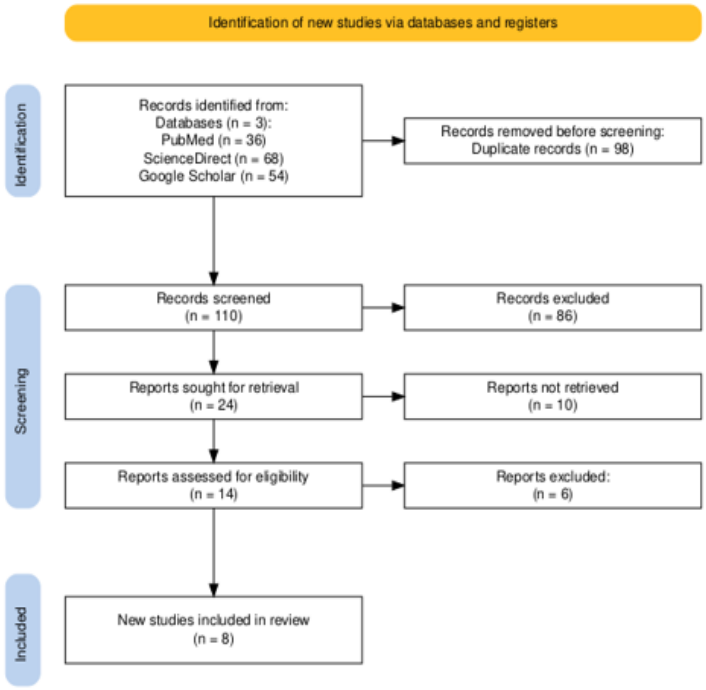

Figure 1. PRISMA 2020 guidelines

articles being reviewed full-text. 10 studies did not have full-text available and six studies were excluded. Eight suitable studies were found and used in this literature review.

The table below table 1 shows some research results regarding the potential of robusta coffee (Coffea canephora) as an alternative herbal material in applied dentistry.

All eight studies resulted in significant results on the efficacy of robusta coffee as a potential treatment for oral health care problems. Studies by Dianastri, et al., 2021; Nugraha et al., 2023; Farahdila, et al., 2024; Perdana et al., 2024; Dos Santos et al., 2024; and Sari et al., 2023 studied that robusta coffee green bean extract has the potential to fight oral cavity bacteria (P. gingivalis, A. actinomycetemcomitans, F. nucleatum, P. intermedia, S. aureus, S. viridans, and T. denticola) because it contains active compounds, such as phenolics, higher chlorogenic acid, also higher potential as antioxidant and antibacterial activity. As well as studies conducted by Rahmadani et al., 2022 and Bollamma et al., 2023 studied that the gel and coffee pulp from robusta coffee extract have been shown to significantly aid in wound healing and have anticariogenic properties. With this ability against oral cavity bacteria, this coffee can be a herbal medicine for oral diseases including periodontal diseases, peri-implantitis, and also healing properties.

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Discussion

The reviewed studies collectively underscore the significant potential of Robusta coffee bean extract (Coffea canephora) and its by-products as effective agents in the treatment and prevention of various oral health issues. Notably, the antibacterial properties of Robusta coffee extract have been consistently demonstrated across multiple studies, with findings indicating its inhibitory effects on key oral pathogens such as Porphyromonas gingivalis, Aggregatibacter actinomycetemcomitans, Fusobacterium nucleatum, and Treponema denticola. These pathogens are closely associated with periodontal diseases and peri-implantitis, making the extract a promising natural alternative to conventional treatments. Furthermore, the antioxidant and wound-healing properties of Robusta coffee extract, highlighted in studies by Dos Santos et al. (2024) and Rahmadani et al. (2022), reveal its potential to reduce oxidative stress and enhance tissue regeneration, particularly in post-gingivectomy wound healing. The incorporation of Robusta coffee extract into oral hygiene products, such as toothpaste and mouth rinses, as demonstrated by Farahdila et al. (2024) and Bollamma et al. (2023), further suggests its practical application in everyday oral care. These findings advocate for the continued exploration of Robusta coffee extract as a viable herbal medicine for oral health, with future research needed to optimize formulations, understand underlying mechanisms, and confirm efficacy through clinical trials. The broad-spectrum benefits of Robusta coffee extract, including its antibacterial, antioxidant, and healing properties, position it as a promising candidate for enhancing oral health outcomes and developing new, effective oral care products.

Conclusion and Suggestion

The results of this study indicate that robusta coffee bean extract holds significant potential as an active herbal ingredient in dental health care due to its pronounced antibacterial and wound-healing properties. These findings suggest that robusta coffee bean extract could play a valuable role in oral care by effectively combating harmful bacteria and promoting the healing of oral tissues. Incorporating this extract into oral care products could provide a safe and effective alternative to traditional treatments, offering a natural and accessible option for enhancing oral health outcomes. As further research validates these benefits, robusta coffee bean extract could become a key component in developing advanced oral hygiene solutions.

Further research and development into robusta coffee bean extract as an oral herbal medicine could greatly benefit oral health. By studying the bioactive compounds in robusta coffee beans, we may uncover new therapeutic properties that can help prevent and treat common oral health issues. This exploration could lead to innovative oral care products with natural ingredients, offering an alternative to traditional treatments and promoting more effective and sustainable oral hygiene solutions.

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INDONESIAN JOURNAL OF PROSTHODONTICS

CASE REPORT

Improved retention of ocular prosthesis with modified shallow socket impression technique

Andri Sinulingga, Putri Welda Utami Ritonga,* Haslinda Z. Tamin

Keywords: Custom ocular tray, Enucleation, Ocular prosthesis, Post enucleation

ABSTRACT

TBackground: The long-term use of a custom ocular prosthesis that is not replaced could cause a shallow socket. These changes affect the size of the socket. In fact, the custom ocular prosthesis becomes loose. Objectives: Modify the impression by duplicating the old custom ocular prosthesis as a special tray for obtaining an accurate impression of the socket and reducing clinical visits. Case Report:. A 42-year-old woman came to Dental Hospital Universitas Sumatera Utara with the chief complaint that the custom ocular prosthesis was easy to fall off and painful during movement. She has worn the ocular prosthesis for over 30 years, fabricating it five times. However, the last ocular prosthesis lasted for 10 years. The definitive impression was prepared by duplicating the custom ocular prosthesis, and this special tray was modified by adding a rod with a light body material due to its low viscosity. As a result of using the special tray, a more accurate impression can be made due to the small size of the rod. Conclusion: The impression technique with a modified tray from the duplicated old custom ocular prosthesis can record the eye socket in detail and produces a retentive custom ocular prosthesis. (IJP 2024;5(2):119-123)

Introduction

Eye loss has a major impact on the patient's physical and psychological. These conditions can also affect a person's social and professional life.[1] Eye loss can be caused by trauma, injury and congenital defects. Rehabilitation in this case is quite challenging because it must produce the same visualization in color, shape, contour and orientation to get a realistic appearance.[2,3] Cosmetic rehabilitation with specially made prosthetic can provide social acceptance for the individual and reduce the problems caused.[1]

Enucleation is the removal of the entire eyeball after the extraocular muscle and optic nerve have been transected.[3,4] This is the last procedure most often performed when the patient has intraocular malignancy, trauma, and painful eye blindness. After enucleation, the orbital volume is lost because the orbital tissue that once supported and protected the natural eye is no longer useful and tends to shrink. Cosmetic abnormalities arising from loss of orbital volume after eye enucleation include enophthalmos, upper eyelid ptosis, deepening of the superior sulcus, backward tilt of the ocular prosthesis, and drooping lower eyelid, i.e. ectropion. These symptoms, which are summarized in 'post-enucleated socket syndrome,' can appear separately or in combination and vary in severity.[1,5,6]

Implant is the most common method of replacing lost volume in the socket after evisceration or enucleation.6 Although an implant is the best option, this treatment is expensive and cannot be done by everyone. Fabrication using a custom ocular prosthesis with various fabricating modifications can be the best alternative treatment option. It because the technique of making a custom ocular prosthesis able to duplicate the anatomy of the eye socket well.[4] Thus, the results in an ocular prosthesis is more precise, well adapted and more aesthetically pleasing.[7] These results provide a better cosmetic appearance and long-term comfort, because the use of a custom ocular prosthesis allows an even distribution of space in the socket.[1]

One of the successes in fabricating a custom ocular prosthesis is the accurate impression of the anatomic area of the eye socket.[3,4] Miller argues that the use of a custom ocular prosthesis is necessary as a tray in certain situations. This method involves the attachment of a solid suction rod to the patient's existing custom ocular prosthesis.[3] The use of the old custom ocular prosthesis as a custom impression tray because the shape of the intaglio surface has not undergone significant changes to the socket. This case report will describe the prosthetic correction of post-enucleation syndrome by modifying a custom ocular prosthesis as a custom tray.

Case Report

A 42-year-old woman came to the Dental Hospital Universitas Sumatera Utara with the main complaint of loose, detached, and uncomfortable ocular prosthesis. The patient has worn the custom ocular prosthesis for 10 years. The patient had to press her ocular prosthesis

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Figure 1. Clinical examination, A. While the old custom ocular prosthesis is used and the patient is asked to look forward, B. when closing the eyes, C. eye sockets of patients without ocular prosthesiss

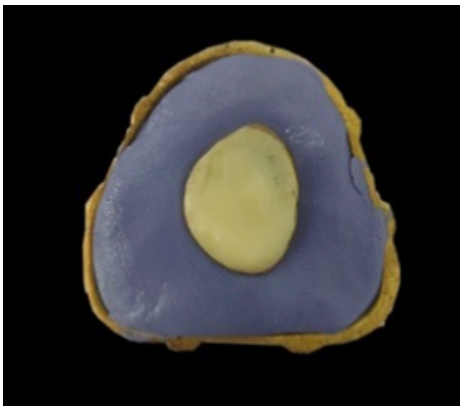

Figure 2. Duplication of the old custom ocular prosthesis

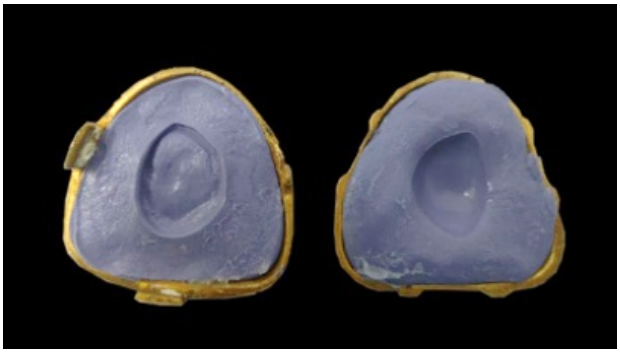

Figure 3. Triangulation

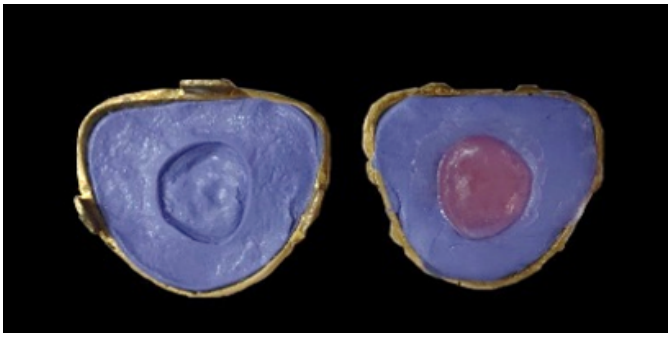

Figure 4. Duplicate using self-cure

to maintain it from falling out of the eye socket. The patient feels pain in the head region when pressing the ocular prosthesis, so the patient always takes analgetics. Patient also feels discomfort during daily usage of ocular prosthesis.

The cause of the loss of the left eyeball was due to being shot by a toy gun at the age of 9 years. The surgery was performed twice. The first surgery was performed to remove the entire eyeball, and the second surgery was performed to remove the cicatricial tissue that interfered with the retention and stabilization of the custom ocular prosthesis. During these 30 years, the patient has made 5 different custom ocular prosthesis. From the clinical examination, the patient was diagnosed with post-enucleated left anophthalmic socket. The size of the old custom ocular prosthesis looks large and protrudes when in use. This condition also makes it difficult for the eyelids to close. The prosthesis is not retentive and often slips out of the socket during use.

Anatomical impressions were not performed, custom impression tray were made using the patient's old custom ocular prosthesis. A custom tray was made by duplicating the old ocular prosthesis using a putty (Putty I-SiLTM Vinyl Poly Siloxane Impression Material, Spident CO., LTD, Korea) figure 2. The impression model was obtained from the impression figure 3. The impression was poured with self-curing acrylic (Self Curing Vertex®, Vertex-Dental B.V., Netherland) to duplicate the old ocular prosthesis to be used as a custom impression tray figure 4. Making the handle of an impression tray using self-cured acrylic by forming it in the shape of a rod and attaching it to the duplicated ocular prosthesis. The intaglio edge of the ocular prosthesis surface was reduced by ± 2 mm.

A custom impression using a vinyl poly siloxane light body (Light Body I-SiL vinyl poly siloxane impression material, Spident CO., LTD, Korea) figure 5, Petroleum jelly (Vaseline Repairing Jelly, A Unilever, Indonesia) was applied on skin around the left eye to avoid the impression material attaching to the eyelashes. The impression tray was coated with an adhesive tray (Extreme Adhesive, Medicept UK LTD, United Kingdom). The impression material is applied to the eye socket and on the surface of the impression tray. The impression tray is gently inserted into the eye socket to prevent forming bubbles in the mold. The patient was asked to close and move the eye in all directions, so that the impression material flows across the surface of the eye socket. The impression was checked to make sure all parts were recorded figure 6.

Making a physiological model by pouring the mold using a type IV plaster (Snow Rock Die Stone Gold, DK Mungyo, Korea). The next stage is making the scleral wax pattern and try in sclera wax. The mold was poured with wax (Anchor Brand Teeth Modeling Wax, Indonesia). The wax pattern is inserted into the patient's eye socket. Modify the size and shape according to the socket until the palpebral fissure and anterior curvature of the eye are similar to the contralateral eye. This trial of the scleral wax pattern was aimed to evaluate size, comfort, superior and inferior palpebrals support, and eye movements figure 7.

After the trial of the scleral wax pattern was obtained, it was continued by determining the color of the sclera using a shade guide. The curing was carried out using heat cure acrylic (Acrylic Denture Materials, Tricodent, England). The acrylic resin sclera was tried in the

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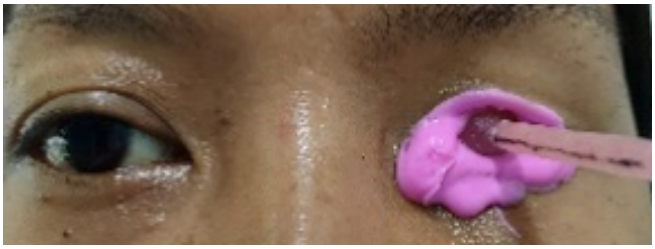

Figure 5. **Custom impression**

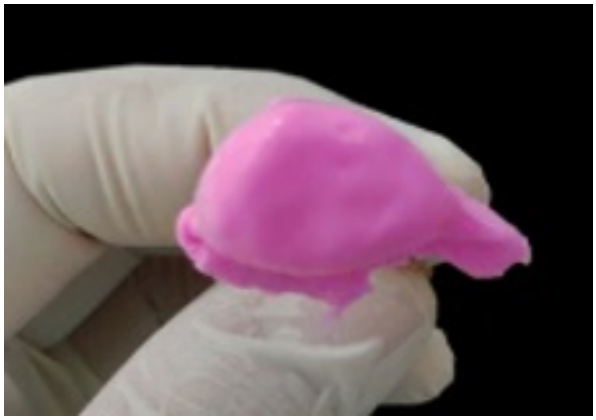

Figure 6. **The result of impression**

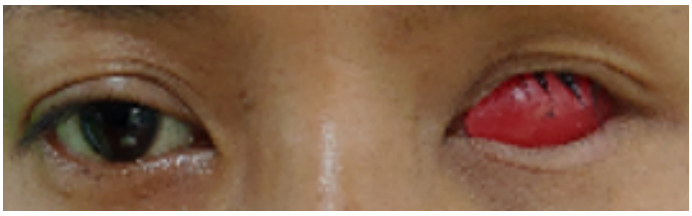

Figure 7. **Try in of the sclera wax**

Figure 8. **try in of the acrylic sclera**

aye socket to evaluate color, size, comfort, superior and inferior eyelid support, and eye movement figure 8.

Determination of the location of the iris using the pupillary distance ruler (PD ruler) figure 9A, after try in the sclera, instruct the patient to look forward with distraction technique. Positioning the instrument on the patient by placing the notch on the bridge of the nose and adjusting it to accommodate the eye within the ocular opening. The patient was asked to hold the eye position in a normal conversational gaze. Measure the orientation, pupillary distance, and medio-lateral dimensions of the original iris on a graded scale until a consistent measurement is achieved. Then the measurement was transferred to the sclera pattern by marking it using a marker as the midpoint of the pupil which becomes the midpoint of the iris figure 9B. Using a drawing compass, a circle the size of a 12 mm circle is formed. The marked circles are darkened using a marker figure 9C.

Iris coloring uses water color printing paper that has been shaped in a circle with A diameter of 12 mm according to the patient's eye figure 10. The coloring was done with oil paints (reeves oil colors) using a 0.00 size brush. After coloring was done, coat the iris with monopoly syrup to prevent air trapping during curing, which causes color distortion of the iris.

Investing the iris on the sclera, a hole was made in the acrylic sclera according to the area of the marking that had been done. A hole was made as deep as 4 mm as a place for the iris to be placed. Reducing the thickness of the 2 mm thick facial surface by following the adjusted convex shape. Next, the iris was made into the sclera, by placing the iris into the hole that has been formed. Making blood vessels in the sclera with red threads. The sclera was placed back in the flask, to which CMS (Apollon Sep, Yamahachi Dental MGF., CO, Japan) was applied first. Clear liquid and powder PMMA were mixed after entering the dough stage and put into the mold. Then it was pressed and the excess was removed after that it cured for approximately 1 hour. Then, finishing and polishing were done figure 11.

The important thing that must be considered when insertion of the custom ocular prosthesis is adaptation of the ocular prosthesis into the eye socket figure 12, the ocular prosthesis can support the eye socket without pain and the ocular prosthesis movement can follow the movement of the eye muscles. Post-insertion instructions are placement and removal of the ocular prosthesis with clean hands, the ocular prosthesis is removal at night and soaked with antibacterial solution and periodic follow-up every year at the prosthodontist.

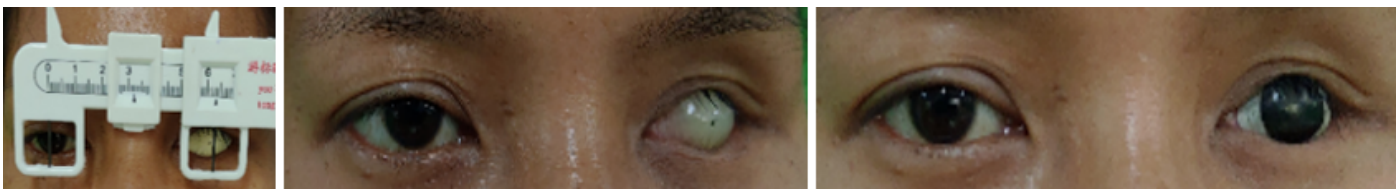

Figure 9. **AFI working principle**

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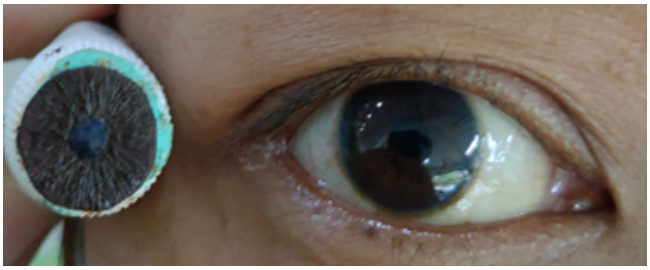

Figure 10. **Iris Coloring**

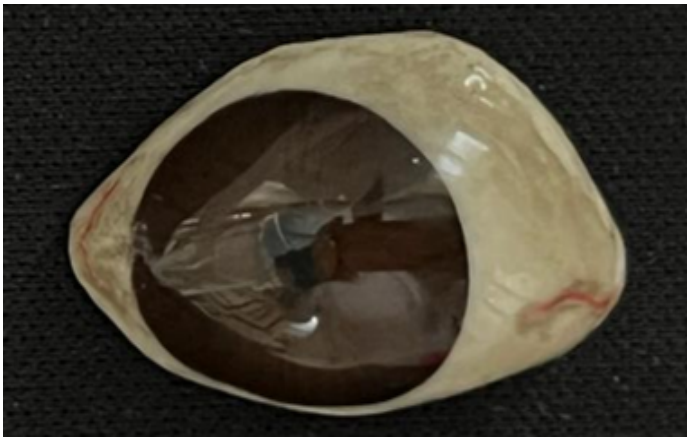

Figure 11. **Custom ocular prosthesis**

Discussion

Enucleation surgery can lead to various complications including wound dehiscence, postoperative infection, implant migration or extrusion, and most importantly, post-enucleated socket syndrome. According to the literature, post-enucleated socket syndrome is a relatively frequent complication following enucleation. Volume loss due to removal of the eyeball is a major cause of post-enucleated socket syndrome. The management of post-enucleated socket syndrome can be surgical or conservative treatment.5 The conservative treatment is the fabrication of a custom ocular prosthesis because the results obtained are very satisfactory, both in terms of aesthetics and retention.

Custom ocular prosthesis is a good option when reconstruction with surgery or the use of implants is not possible or affordable.[2] A custom ocular prosthesis made of acrylic resin is a substitute for the eyeball. Currently there are three types of acrylic resin prosthesis in use; stock ocular prosthesis, prefabricated ocular prosthesis modified by various methods, and custom ocular prosthesis made from eye socket impression.[6,7] The most commonly used is the custom ocular prosthesis creation technique.[7] Disadvantages of stock ocular prosthesis range from incompatibility to infection of the soft tissue of the eye socket. In comparison, custom ocular prosthesis made of acrylic resin are more precise because they can mimic the color, shape, size, and movement of the natural eye.[6,9] giving a symmetrical and realistic appearance to the patient's face.9 It is thus aesthetically superior due to the adjustment and impression of the tissue in the socket obtained before the ocular prosthesis is made.[1,7]

In the case of a shallow eye socket, the main challenge is to obtain an adequate impression to improve the retention. Allen has described in the literature how to deal with various socket deformities using a modified impressions technique.[1] In this case, a one-step impressions technique was carried out, without performing anatomical impressions because the old custom ocular prosthesis was duplicated to create a custom impression tray as introduced by Miller.[2-4] This reduces the number of patient visits to the clinic. To get an accurate impression of the socket, polyvinyl siloxane impression material with light body consistency is used.[10]

The old custom ocular prosthesis was duplicated to make a custom impression tray and modified by adding a rod to the facial surface. The purpose of the duplication is to obtain an impression of the old custom ocular prosthesis, so that the impression can be made using the duplicated custom ocular prosthesis without damaging or changing the old prosthesis. The old custom ocular prosthesis can be used while waiting for the new custom ocular prosthesis to be fabricated. The addition of the rod on the custom impression tray worked as a handle to maintain the stability of the tray during movement. The rod can be adjusted to smaller sizes, making it easier to record the inner palpebral of the socket during closing.

Another challenging and critical procedure in the fabrication of an ocular prosthesis is to paint the iris and to position the iris in an ideal symmetrical position.[2] The iris was painted using oil painting. According to Fernandes, oil painting has excellent chromatic stability and is significant to be used in artificial iris painting for ocular prosthesis polymerized by microwave energy, regardless of color, when compared to other paintings.[11] Positioning of the iris is using the PD ruler. The PD ruler has range from 20 to 40 millimetres, which helps in obtaining precise and accurate orientation of the iris. Moreover, it requires less chair side, less skill, easy to obtain and an inexpensive device. This is really advantageous over visual assessment it can be considered easier than the graph grid method because graph cutting and positioning is difficult and time consum-

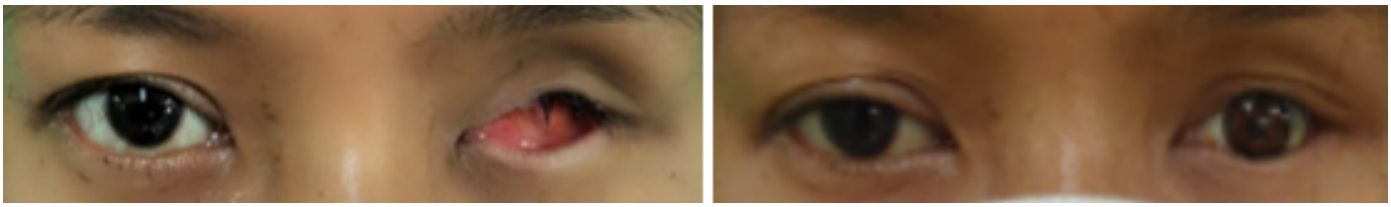

Figure 12. **A. before insertion of the custom ocular prosthesis, B. After insertion of the custom ocular prosthesis**

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ing. Adjusting the scale for a distance between pupil is also a time-consuming and relatively difficult procedure.[9]

Conclusion and Suggestion

The reduced or loss of volume due to enucleation poses a challenge to prosthodontists in achieving a retentive ocular prosthesis when implants are not the treatment of choice. An accurate impression is critical to the success of this particular ocular prosthesis. The purpose is not only obtaining the retention of the prosthesis, but also the ability to restore an aesthetic appearance, a symmetrical face, and comfort to the patient. Thus, the custom ocular prosthesis increases the patient social acceptance, self-confidence, and overall quality of life. This case report describes how to achieve the retention in a custom ocular prosthesis by utilizing the patient's old custom ocular prosthesis as a custom tray.

The difficulty encountered in this impression technique was the possibility of inadequate amount of impression material during the impression procedure. The impression material could not be placed in bulk because of the flat surface of the impression tray. Another disadvantage of this technique was the absent of escape holes in the design of the custom impression tray, which resulted in excessive pressure on the eye socket, which could compromise impression accuracy. The authors suggested the use of escape holes as a place for excess impression material to flow and the use of a syringe to carry the impression material directly into the eye socket.

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INDONESIAN JOURNAL OF PROSTHODONTICS

CASE REPORT

Obturator with hollow bulb after hemimaxillectomy – A Case Report

Cynthia Gunawan,[1] Fransiscus Wihan Pradana,[2] Endang Wahyuningtyas,[3] Intan Ruspita[3]*

Keywords: Definitive obturator, Hollow bulb, Surgical obturator

ABSTRACT

Hemimaxillectomy will create oro-nasal communication which can affect the function of swallowing, masticatory, speech, aesthetic and psychological. This case report describes a method of prosthodontic management of maxillary defects using an obturator prosthesis with a hollow bulb. A 15-year-old male patient was diagnosed with central giant cell granuloma, therefore hemimaxillectomy was performed by ENT doctors at RSUP Dr. Sardjito. He has a surgical obturator that was inserted by a prosthodontist immediately after the surgery. Three weeks after surgery, soft tissues were ready to be made an interim obturator. Seven months later, he came to RSGM Prof. Soedomo with a complaint the old obturator is difficult to adapt. Intraoral examination revealed a large palate defect in the right palate durum segment (Aramany's class II type maxillary defect) and half of the right maxilla is missing. A definitive obturator using metal combination acrylic with a hollow bulb was made to cover the maxillofacial defect and replaced missing teeth. That prosthesis can cover the defects of the maxilla so the patient can speak well, and the function of masticating and swallowing can be restored. (IJP 2024;5(2):124-127)

Introduction

Central giant cell granuloma (CGCG) was an uncommon, benign tumor that was also aggressive and destructive in its localized area. Surgical excision or resection with a continuity defect, enucleation, or aggressive local curettage are possible treatments.[1] Surgical resection such as hemimaxillectomy results in several problems that cause difficulties in mastication, swallowing, speech, aesthetics, and psychologies.[2] This surgery also forms an opening or a relation between the antrum and nasopharynx, known as a maxillofacial defect.[2,3] This defect can be categorized into three groups: acquired, congenital, and developmental. Acquired defects are the most common maxillofacial defects that are the result of trauma or of disease and its treatment, congenital defects are present from birth, and developmental defects occur because of some genetic predisposition.[4]

The maxillofacial prosthetic is known as a large removable prosthetic discipline that can be divided into maxillary prostheses and mandibular prostheses. Obturator prosthesis is a type of maxillary prosthesis that use to repair those defects.[4] This prosthesis aims to the separation of the oral and nasal cavities; hence the defect can be restored.[5]

The management of neoplasm usually involves radical surgical resection, chemotherapy, and radiotherapy. Partial surgical resection of the maxilla is known as hemimaxillectomy. Prosthodontic management for neoplasm can be divided into three phases: Pre-operative construction or surgical obturator; Post-operative modification or interim obturator; Definitive obturator.

Figure 1 Aramany classified the partially defect post maxillectomy into 6 groups, such as Class I (Midline resection), Class II (unilateral resection with retaining the anterior teeth on the contralateral side), Class III (central resection that involves the hard palate and may the part of the soft palate, without involving the remaining teeth), Class IV (the defect involves both sides of the maxilla and crosses the midline), Class V (bilateral posterior resection), Class VI (anterior resection).[4,6]

This case report describes a prosthodontic rehabilitation of a patient with CGCG of the right maxilla using a surgical obturator, interim obturator with a hollow bulb, and metal framework combina-

Case Report

A 15-year-old male patient came to the Oral Health and Dental Clinic RSUP Dr. Sardjito on September 2021 with diagnosed central giant cell granuloma post mass extirpation followed by a hemimaxillectomy. He was referred from the ENT Clinic for a consultation about a surgical obturator. Pre-surgical extraoral examination revealed an asymmetrical face with visible swelling on the right side but the pain is absent figure 2 . Intraoral examination showed a large mass inside the right palatal defect, and missing teeth 17,16,15,14,13,12 figure 3. The treatment plan included extirpation of the mass followed by hemimaxillectomy to be performed by ENT doctors and surgical

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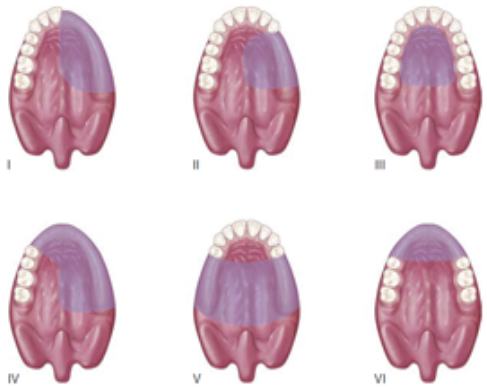

Figure 1. Aramany classification system for maxillectomy defects

Figure 2. Extraoral frontal view, Presurgery, 3 weeks presurgery, 7 months postsurgery

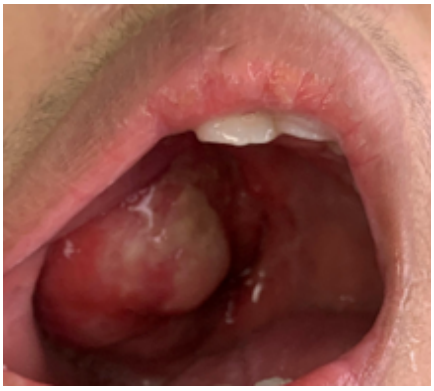

Figure 3. Intraoral preoperative condition

obturator placement by a prosthodontist.

At the first visit, patient history was taken and an impression of the maxilla and mandibula was performed using a perforated stock tray with irreversible hydrocolloid impression material. The negative impression was modified and filled with a dental gips stone. A modified working model was used to design and fabricate the surgical obturator figure 4A. The design was formed like an essix retainer using thermoforming foils material that covers the entire surface and left maxillary teeth, with perforation on the labial and left buccal flange area for suturing or fixation figure 4B.

Surgery was scheduled 1 month later. After the mass was removed, the maxilla was imprinted using a perforated stock tray with polyvinyl siloxane impression material (to make an individual custom tray). The surgical obturator was fitted and sutured at three sites of the anterior mucosa region figure 5.

Two days after surgery, the patient was checked to make sure there was no discomfort from the surgical obturator and educated patient about how to clean the oral cavity and scheduled for control to the Oral Health and Dental Clinic. One week later, the patient come to control and unstitched the surgical obturator.

Three weeks after surgery, the patient was examined, and the healing of soft tissue was well enough for the replacement of the interim obturator. Clinical intraoral examination presented quite good oral hygiene; large palate defect in the right palate durum segment (Aramany's class II type maxillary defect); half of the right maxilla is missing from region 17 to 12 missing teeth 17,16,15,14,13,12; unstable occlusion; slightly posterior crossbite; and anterior overjet 5 mm figure 6. The preliminary impression was made using the individual custom tray with irreversible hydrocolloid impression material, and the cast was poured figure 7.

The working model was sent to the dental laboratory to customize an interim obturator. The design of the interim obturator was using a round stainless-steel wrought wire (diameter 0.7mm) C-clasp for teeth 24,25,26; an acrylic hollow bulb to close the palatal defect; artificial teeth with light contact (with the opposing teeth) figure 8. This procedure takes 1 month long with 4 times visits until it is inserted. During the insertion time, a soft liner was added to the posterior side of the prostheses, then the patient was educated on how to clean the obturator and counseled that chewing on the defective side is not allowed. One week after insertion, the patient was scheduled to control and there is no complaint about pain or discomfort felt.

Seven months later, he came to RSGM Prof. Soedomo with a complaint the old obturator is difficult to adapt and loosen. Intraoral examination showed quite good oral hygiene; no fresh complications; decreased size of the defect. Extraoral examination showed a curved profile, an asymmetrical face, and slight lack of lip support. At this visit, preliminary impressions of maxilla and mandible were recorded with hydrocolloid irreversible impression material with metal stock perforated trays. The impressions were poured with dental gips stone and casts were obtained figure 9A. For the design of the framework, double akers clasp was selected for teeth 26,27; Y-clasp for tooth 11, modified palatal type of major connector (half plate – half mesh) figure 9B.

One week later, the framework was tried in the patient's mouth to assess the fit with supporting structures, and bite rim blocks were attached to the framework figure 10A. Centric jaw relation was recorded and the casts were mounted on an articulator figure 10B. The artificial teeth were arranged and the prosthesis was tried to confirm the occlusion with the mandibular teeth, aesthetic appearance, and support for the underlining tissues figure 11. The prosthesis was sent to the dental laboratory to process with acrylic, add the hollow bulb to close the defect, finished, polished, and inserted. The patient received post-insertion instruction on how to take care of and use the obturator.

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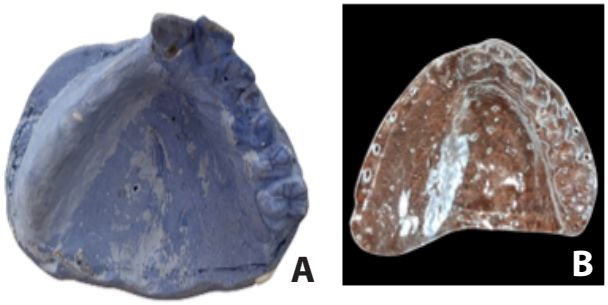

Figure 4. **A. Modified working model, B. Surgical obturator**

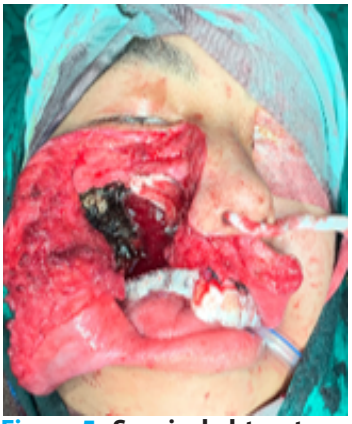

Figure 5. **Surgical obturator was inserted immediately after surgery**

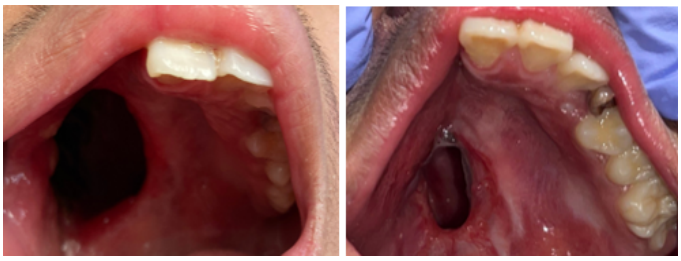

Figure 6. **Intraoral view; 3 weeks postsurgery, 7 months postsurgery**

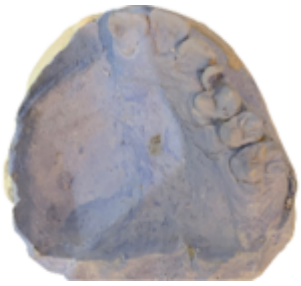

Figure 7. **Working model for interim obturator**

Discussion

Most patients with maxillary defects post maxillectomy require a surgical obturator, interim obturator, and definitive obturator.[7] Typical goals of removable maxillofacial prostheses are well-supported, minimal movement under function, maximum engagement of the remaining teeth to control the retention, minimal movement under function, and placement of artificial teeth to facilitate tooth-tissue contact during normal functional contacts.[4]

Bulb extension is very important for removable maxillary prostheses because of using the hollow bulb reduces the weight of an obturator. Another consideration for using the hollow bulb is to aid speech resonance; reduce the weight on the unsupported side; increase physiological function, decrease the unnecessary stress on the surrounding tissues and teeth; decrease the pressure on the surrounding tissues aid in swallowing; easy to clean the internal surface from saliva and mucous crust; and there are no accumulated nasal secretions which can lead to foul-smelling.[8]

The history and clinical examination of the patient in this case report showed maxillary defects classification Class II Aramany, which was rehabilitated by a surgical obturator, interim obturator with a hollow bulb using the acrylic material, metal framework combination acrylic with hollow bulb for definitive obturator.

The surgical obturator is a maxillofacial prosthesis that recovers and preserves function to an acceptable level during the early stages of healing. This obturator is inserted immediately at the time of surgery. It may act as a barrier between the oral cavity and nasal cavity; hence per-oral contamination can be avoided.[8-10]

In this case, the interim obturator was constructed three weeks following the operation. Artificial teeth were added with light contact with the opposing teeth. The addition of artificial teeth to an interim obturator (fabricated 3-4 weeks after surgery) showed a bigger percentage of speech intelligibility (95.60%) than an immediate obturator that was inserted on the second day post-operative (94,10%).[5] An initial focus on improvement in swallowing and speech to help boost the rehabilitation process significantly. The patient is prohibited from using the defective side for chewing to prevent prosthesis movement.[4]

The definitive obturator was constructed until the defect site is completely healed and stable. This may take 3 to 6 months after surgery depending on the prognosis of the tumor, size of the defect area, recovery period, and existence or absence of teeth.[4,8,10] The chosen material for this phase obturator was metal framework because the bracing component, maximum extension to the muco-buccal fold, the extension of the labial flange can improve the stabilization, retention durability and longevity of the prosthesis.[11,12] Aramany's class II type maxillary defect is similar to a Kennedy class II which a single, unilateral defect is located posterior to the remaining teeth. Therefore, a tripodal design can be used.[12]

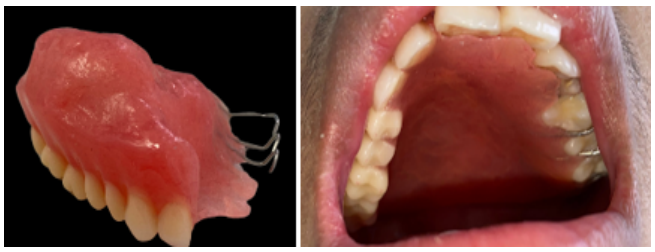

Figure 8. **The interim obturator acrylic with hollow bulb; Before insertion, after insertion**

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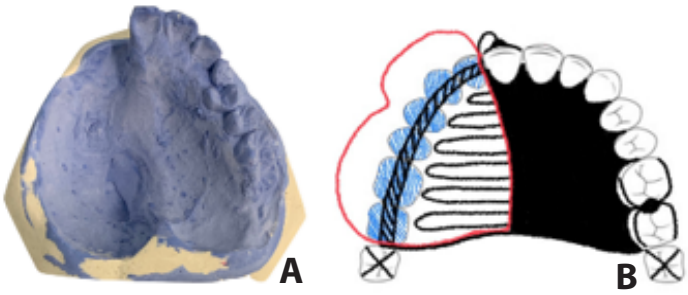

Figure 9. A. Working model for definitive obturator, B. Design for definitive obturator

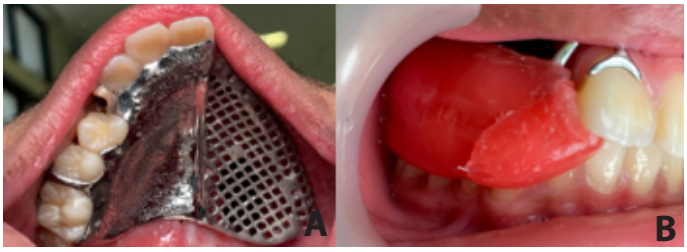

Figure 10. A. Try in the metal framework, B. Record the centric jaw

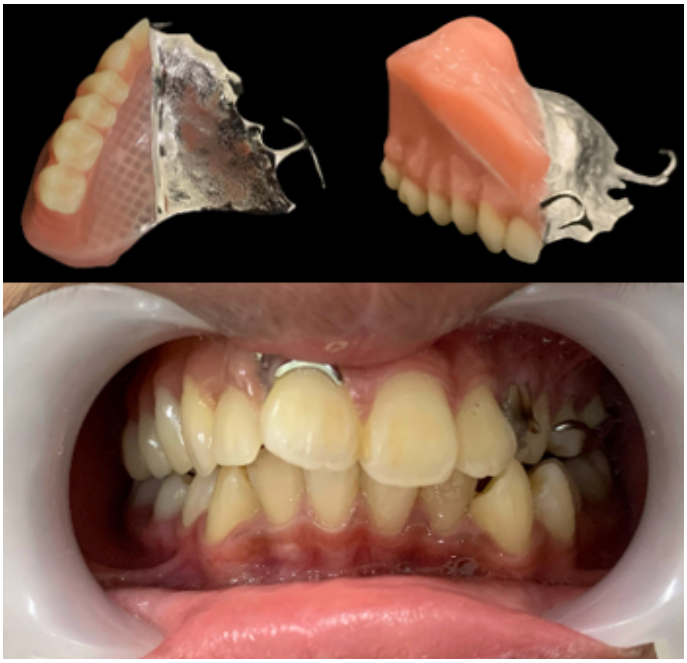

Figure 11. Metal framework combination acrylic with hollow bulb, definitive obturator was inserted.

Conclusion and Suggestion

Patients post hemimaxillectomy with maxillary defects suffer from a lot of psychological trauma. Hence, we as a prosthodontist should try to restore the function of the oral structures and regain the lost form of peri-oral structures. The maxillary prostheses such as surgical obturators, interim obturators, and definitive obturators with hollow bulb modification improve the function of masticatory, swallowing, aesthetic, comfort, and psychological. The patient suggested maintaining oral hygiene, prosthesis hygiene, and regular checkups

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INDONESIAN JOURNAL OF PROSTHODONTICS

CASE REPORT

Case management of young patients with temporomandibular Osteoarthritis joint disorders using stabilization splint,self-therapy, and chondroitin sulfate-glucosamine supplements

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Keywords: Chondroitin sulfate-glucosamine, Cone beam computed tomography, Osteoarthritis, Stabilization splints, Temporomandibular joint disorder

ABSTRACT

Introduction: Osteoarthritis (OA) is a disorder of the temporomandibular joint which results in permanent changes to TMJ. Scissors bite and bad habits are one of the etiological factors of OA. OA causes deviation when opening the mouth, limitations of mouth opening, and joint crepitus sounds. Use of stabilization splints (SS), physical therapy, and consumption of chondroitin sulfate-glucosamine supplements aimed at reducing joint pain, relaxing TMJ muscle, and preventing joint damage. Case report: A 22-year-old female patient came to North Sumatera of Dental Hospital with complaints stiff jaw when opening her mouth, especially in the morning. Complaints of pain occurred since skelling treatment 3 years ago. Clinical examination showed scissors bite and a habit of chewing on the right side. Palpation of the right anterior temporalis muscle revealed familiar pain and joint crepitus sound. Based on DC/TMD assessment, the patient had OA where the mouth opening is 35 mm without pain and 38 mm with pain accompanied by a left deviation of 1.5 mm. On CBCT examination there was flattening on the TMJ surface. Treatment is carried out by using SS every day and consuming chondroitin sulfate-glucosamine supplements once a day accompanied by self-therapy. Self-therapy is carried out alone by practicing opening and closing the jaw for 15 minutes every day. After 6 months is obtained without assisted mouth opening of 36 mm to 41 mm. There is no pain on palpating muscles but there is still a crepitus sound when opening and closing the mouth. Conclusion: Treatment of OA with SS, self-therapy, and consumption of Chondroitin Sulfate-Glucosamine supplements is effective in reducing TMJ joint pain and muscle stiffness through chondroitin stimulation mechanism so that prevents further degenerative processes. (IJP 2024;5(2):128-131)

Introduction

Osteoarthritis (OA) is a disorder of the temporomandibular joint characterized by a destructive process on the surface of the articular disc between the condyle and the fossa, causing an increase in joint load. Sustained stress causes thinning of the layers of the articular surface (chondromalacia) and subarticular bone. Progressive degeneration in OA will cause erosion of the cortical layer. Erosion of the articular eminence is the loss of attachment to the surface of the articular eminence. Osseous changes in the TMJ can be clarified by CBCT images.

The condyle is covered with connective tissue containing mesenchymal cells and differentiates into chondrocytes which we know as fibrocartilage. Fibrocartilage is a secondary tissue consisting of perivascular osteogenic cells whose outer cell matrix is denser than hyaline bone cartilage. Osteogenic cells contain fibrous connective tissue that binds glycosaminoglycans (GAGs) and type I collagen fibers. Collagen, which is part of fibrocartilage, can withstand mechanical loads. The tensile strength of the cartilage bone causes the width of the tissue due to osmotic pressure. The occurrence of OA triggers the release of cytokines and increased growth factors in the synovial fluid in the TMJ. Cytokines can trigger the inflammatory process and the occurrence of synthesis accompanied by the release of proteases. This causes depletion of collagen and cartilage bone which causes symptoms in OA.[1-3]

The etiology of OA is multifactorial. OA can be caused by trauma, parafunction, systemic disease, and joint loads that are too large when the TMJ is functioning.[1-4] Degenerative changes occur due to TMJ remodeling disorders. Remodeling is a biological response to TMJ stress. This is important for the balance between joint function and occlusion. Excessive load for a long time accompanied by a lack of TMJ adaptation causes remodeling disorders. The initiation and progression of OA are due to the overload of the TMJ. Mechanical factors due to trauma cause changes in the articular disk, cartilage degradation, and the occurrence of inflammation and pain. Parafunction causes dislocation of the articular disc and articular eminence which will cause friction, unstable occlusion, and excessive functional load. Light loads will cause asymptomatic bone remodeling due to the adaptability of the TMJ when it functions. However, if the load received is greater than the adaptability of the bones accompanied by a habit of chewing on one side for a long time, it can exacerbate OA conditions.

Clinical characteristics in OA are characterized by a limited mandibular opening accompanied by pain in the joint.[1-8] The history of patients with OA is characterized by unilateral pain when mandibular

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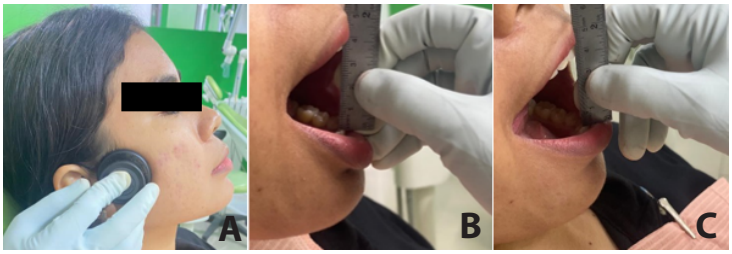

Figure 1. A. Photo of TMJ crepitus examination, B. Examination of opening mouth without pain: 35 mm, C. Examination of opening mouth with pain: 38 mm

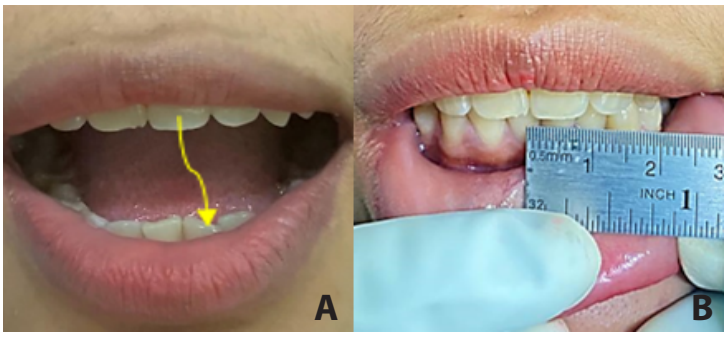

Figure 2. A. Deviation to the left, B. Midline shift 1.5 mm to the left

movement occurs. The pain may be constant and worse, especially in the morning or at night. Symptoms of OA are specifically accompanied by a crepitus sound caused by friction between the bone surfaces. However, patients can also adapt so that they do not cause symptoms. This is because when the load is reduced, the TMJ will adapt even though changes in bone morphology continue to occur. This adaptive stage is known as osteoarthrosis. Korean health institutions report an increase in the number of patients diagnosed with OA at the age of 50 years and over. 10 In a study by Ju et al, the ratio of experiencing OA can occur in patients aged 10-20 years.11 Cases of young patients are rarely found because this age is still in the phase of development of occlusion and craniofacial bones.[6] However, the prevalence of several studies says that crepitus can be experienced in young patients around 12.5%.[5,8-12]

OA treatment according to the severity can be combined with the use of corticosteroids, hyaluronic acid, or chondroitin sulfate-glucosamine supplements.[3,4] The advantage of this supplement as a natural product is that it does not cause side effects. Chondroitin sulfate-glucosamine supplements have been clinically tested for their effectiveness in reducing TMJ joint pain. This is due to the stimulation mechanism of chondroitin where sulfur can cause a reaction in cartilage bone to prevent the TMJ degeneration process from occurring.[3,4,13]

OA treatment is divided into 3 groups, namely conservative treatment (patient education, analgesics, splint therapy, and physiotherapy), non-invasive surgical procedures (intra-articular injections, arthrocentesis, astroscopy), and surgical procedures (arthroscopic procedures and TMJ surgery). SS protects the TMJ joint from overload and relieves muscle tension. The use of this tool helps the clinician to find out the area that is the center of the pain. SS therapy in patients caused by occlusion disorders such as scissors bite will reduce pain.[13] Several studies say that decreased TMJ function due to OA can be prevented due to the osseous bone remodeling process in the temporal TMJ which can still occur at a young age. Patients who experience recurrent symptoms can combine treatment using SS with self-therapy.[14] Use of a Stabilization Splint (SS) combined with self-therapy and supplements can relax stiff muscles.[5,9,15] Muscle relaxation will reduce the difficulty of opening and closing the TMJ joints.[11,12]

Case Report

A 22-year-old female patient came to the Dental and Oral Hospital of the University of North Sumatra with complaints of stiffness in the jaw joint when opening and closing her mouth when she wakes up. The patient has a habit of chewing on the right side. The patient complained of pain for the first time after skelling treatment due to opening the mouth for too long ± 3 years ago. This causes the jaw to be locked so that it is difficult to open or close the mouth.

Palpation of the masticatory muscles did not reveal pain except for the right anterior temporalis muscle when opening and closing the mouth where there was familiar pain and a crepitus sound in the jaw joint. On examination of the mouth opening, there was a mouth opening of 35 mm without pain and 38 mm of pain figure 1A - figure 1C. When opening the mouth there is a deviation of 1.5 mm to the left and a midline of 1.5 mm to the left figure 2A and figure 2B. When examining the movement of the joint to the right 8 mm there was no pain but when moving to the left 9 mm there was a crepitus sound accompanied by pain in the right side of the TMJ joint. So based on the DC/TMD examination these conditions can be diagnosed as Degenerative Joint Disorders with Osteoarthritis figure 3.[16]

Intraoral examination and panoramic photo analysis showed no dental restorations but there are bucoversion of teeth 18, 28, 38, and 48. This could lead to scissors biting. Examination of overbite and overjet about ± 3 mm. Features of intraoral examination figure 4A - figure 4G.

Panoramic radiographic images showed flattening of the left condyle figure 5A and figure 5B. This is confirmed by a 3D image of the jaw joint with CBCT figure 6A - figure 6B. In the 3D view of the jaw joint when opening and closing it was found that there was an image of the condyle not reaching the articular eminence. This causes joint movement disorders which are characterized by limited mouth opening.

On the first visit, primary impression was carried out using an irreversible hydrocolloid (Hygedent USA). After that, it was followed by making final cast model using type IV plaster material (Hard Stone THS-S Type 4, TST, Taiwan). Occlusal registration was performed with bite registration material (blue-mousse VPS, USA) according to the patient's centric occlusion, lateral movement right, left, and protrusive figure 7.

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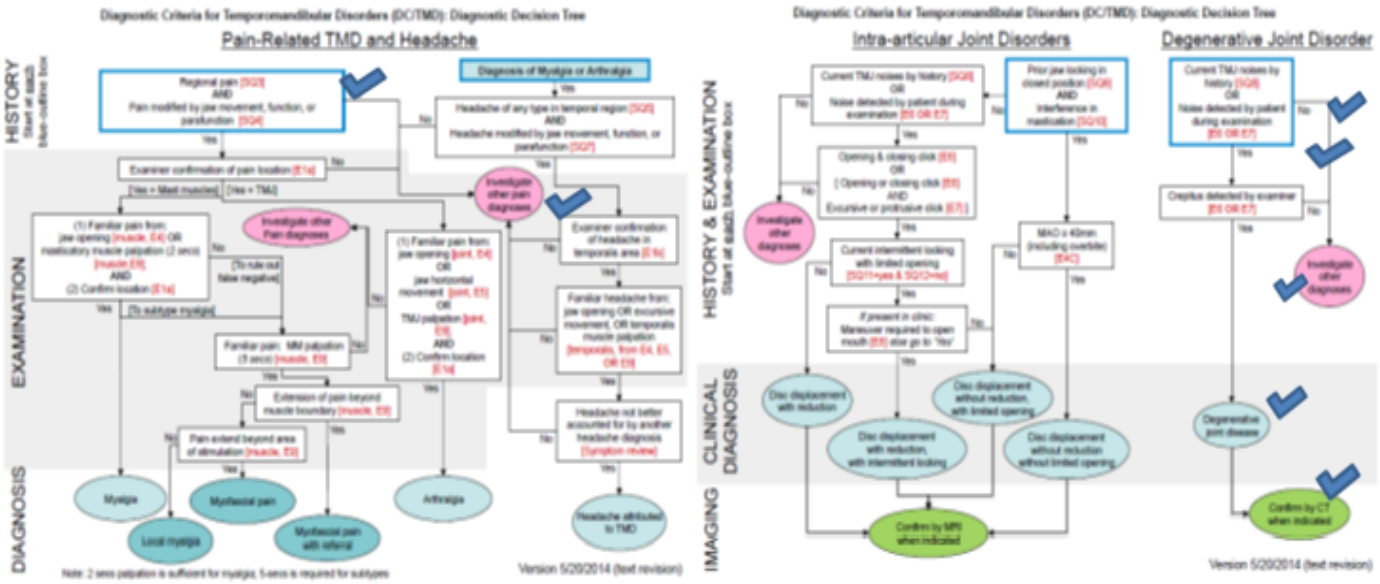

Figure 3. Diagnostic criteria for temporomandibular disorders (DC/TMD): diagnostic decision tree

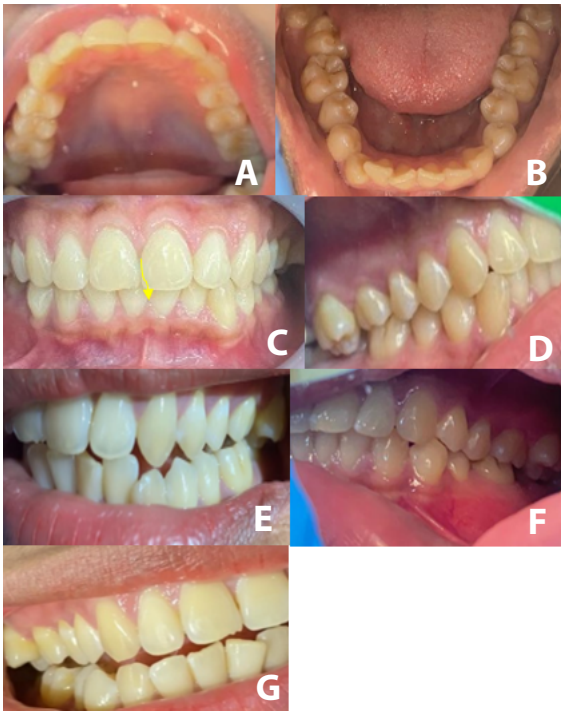

Figure 4. Intraoral condition, A. Maxilla, B. Mandible, C. Front view, D. Right lateral, E. Left lateral and F and G. Dynamic occlusion relationship

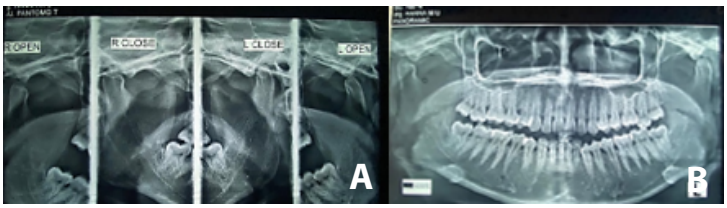

Figure 5. Radiographic examination, A. Of the TMJ in the closed and open positions, B. Panoramic

After obtaining the bite height, final cast model was mounting on a semi-adjustable bioart articulator. Wax patterns are made by increasing the height by 2 – 4 mm to obtain a mutually protected occlusion (canine guidance). After everything is appropriate then flasked and dewaxed of wax pattern figure 8A. Next was packing the wax pattern with clear acrylic resin (Heat Curing Vertex®, Vertex-Dental B.V., Netherlands) for the manufacture of SS. The results of SS insertion were checked again with articulating paper to obtain mutually protected occlusion (canine guidance) during centric and eccentric occlusion figure 8B.

Patients were instructed to use the device every day. Patients are advised to reduce the habit of chewing on one side to reduce pain. Self-therapy is recommended to be done alone by the patient in the morning when he wakes up. Self-therapy is done by opening and closing the mouth straight in front of the mirror every day for 15 minutes. Patients were also instructed to take chondroitin sulfate-glucosamine supplements once a day. Then the patient was instructed to come for control once a month. Control splint use is done after 1 week, 2 weeks, and every month thereafter. At the visit after 6 months, the patient reported a decrease in symptoms of pain and stiffness in the muscles when opening and closing the mouth, especially in the morning. Unassisted mouth opening from 36 mm to 41 mm. Palpation of the muscles found no pain when opening and closing the mouth but there was still a crepitus sound in the right joint. Control after 6 months figure 8C and figure 8D.

Discussion

The occurrence of Osteoarthritis (OA) in the temporomandibular joint based on pathophysiology, epidemiology, and severity shows different signs and symptoms. OA treatment can be done both invasively and non-invasively.[4,7] The use of non-steroidal

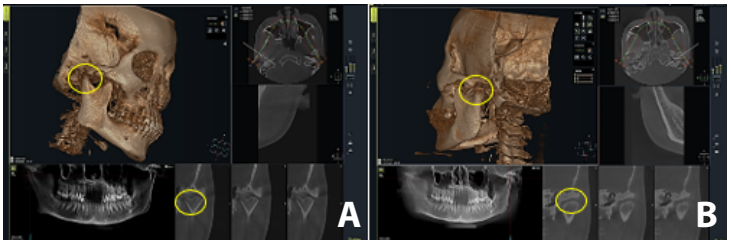

Figure 6. CBCT examination, A. Right and B. Left

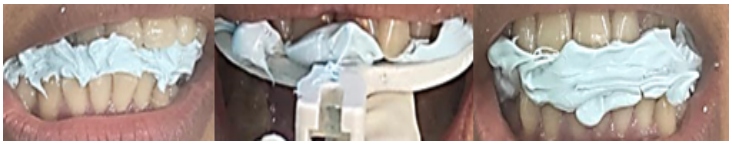

Figure 7. Occlusal regristration of centric occlusion and lateral movement

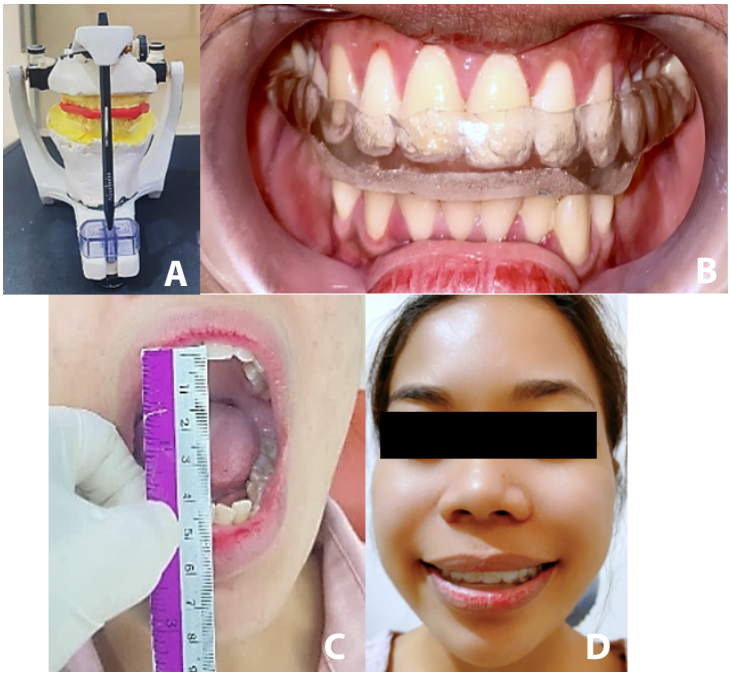

Figure 8. A. Wax pattern making, B. Use of a stabilization splint, C and D. Control after 6 months

anti-inflammatory drugs (NSAIDs) and analgesics are generally given to reduce pain, but long-term consumption can cause problems in the gastrointestinal tract and kidney.[4]

Chondroitin sulfate-glucosamine supplements can relieve TMJ joint pain. This supplement aims to be anti-aging, antioxidant, prevent the development of bacteria, increase immunity, and stimulate hormone production. Several studies say that taking glucosamine chondroitin sulfate supplements for 3 months as an anti-inflammatory will reduce joint stiffness and sound in joints.[13] This occurs due to a stimulation mechanism of chondroitin where sulfur can react in the TMJ cartilage so that it can cause remodeling of the TMJ.[3,4,14]

OA treatment can be combined using a stabilization splint (SS) and self-therapy. Ok. et al said that the use of SS for ± 11 months can stimulate bone remodeling in the anterior part of the condylar head thereby reducing the occurrence of bone resorption in the glenoid fossa. This can be evaluated based on the lack of symptoms and superimposed features on CBCT before and after treatment. Pficer et al said that OA treatment with SS and self-therapy showed a significantly high success rate in less than 3 months, while Milojević et al said that optimal results can be obtained after 6 months of treatment.[9,15] The purpose of using SS and self-therapy is to reduce bone resorption, especially in the mandibular fossa of the TMJ.11 This tool is effective in reducing pain, improving quality of life, and patient comfort, especially when opening the mouth.[9,11,15]

Conclusion

OA does not only occur in old age but can also be experienced by young patients due to bad habits and trauma. The effectiveness of chondroitin sulfate-glucosamine supplements has a higher success than medication with analgesics but it is not clear how the side effects on the body are so further research is needed.[3,4,13] Use of stabilization splints (SS), self therapy combined with supplements chondroitin sulfate-glucosamine is the treatment with the least risk of all treatment options but further studies are still needed based on the degree of severity in the diagnosis of OA.[5,7,9]

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INDONESIAN JOURNAL OF PROSTHODONTICS

CASE REPORT

Prosthetic rehabilitation of a post evisceration patient with Non-Fabricated ocular prosthesis: A case report

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Keywords: Eye prosthesis, Ocular rehabilitation, Phthisis bulbi

ABSTRACT

The disability associated with the loss of eye can cause significant physical and emotional problems in sufferers. Rehabilitation of patients with eyeball loss requires an eye prosthesis that can restore optimal cosmetic and psychological function. Eye prostheses can be made from non-fabricated acrylic resin. In this case report, a 23-year-old female patient came to the RSGM Prof. Soedomo, Faculty of Dentistry, Gadjah Mada University with complaints of missing left eye since 8 years ago with a diagnosis of phthisis bulbi. The results of the clinical examination showed that the conjunctiva was in good health and there was no infection. The treatment in this case was the manufacture of non-fabricated ocular prostheses made of acrylic resin. Custom-made ocular prostheses provide satisfactory results thereby improving psychology and emotional as well the social aspect. (IJP 2024;5(2):132-134)

Introduction

The loss of an eye impairs visual function and also results in noticeable physical deformity.[1] It may be caused by a congenital defect, trauma, and necrotizing tumor known as phthisis bulbi. It is characterized by small, shrunken, non-functional eye, leading to esthetic disfigurement of the face, which significantly affects the individual physical, psychological, emotional, and social well-being in severe.[2] The surgical procedure is evisceration, enucleation, or exenteration. When surgical site is fully healed and dimensionally stable, fabrication of an ocular prosthesis may be undertaken. Patient with evisceration defects can be treated with non-fabricated ocular prothesis.[1,3]

The ocular prosthesis is an artificial eye used to improve the appearance of a person who has lost an eye due to injury or disease.[4] The ocular prosthesis can be classified as stock shell and custom-made prosthesis or non-fabricated ocular prosthesis. The materials are lightweight, durable and resistant to moisture and bacteria.[5] In this case report, a custom-made eye prosthesis was chosen over the prefabricated one as it has better fit, adaptation, and patient comfort.

Case Report

A 23-years-old female reported to the Department of Prosthodontics, RSGM Prof.Soedomo FKG UGM with the chief complaint of the appearance of the old prosthesis. She presented with evisceration performed eight years which was diagnosed phthisis bulbi.

On objective examination, the eye socket was normal; there was no irritation; and there was no infection figure 1. The eyelid muscles were still in good condition, the patient could open and close the eyelid. The eye socket was deep enough to allow good retention of the eye prosthesis.

The informed consent was provided by the Prosthodontics Specialist Universitas Gadjah Mada, RSGM, and given to the patient. The patient agreed to select a custom ocular prosthesis made of acrylic resin.

The patient's eye socket applied a thin layer of Vaseline, prior to making an impression using hydrocolloid irreversible for making a custom tray extraoral 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 an eye model. The custom tray was finished, polished, and tried in the patient's socket, and minor adjustments were made figure 3.

An impression of the socket was made using light body consistency addition silicone elastomeric impression material. The patient was instructed to look in front at the level of the eyes during the impression was made. The impression was invested with die stone to obtain the final cast figure 4.

The baseplate wax was melted into the mold to fabricate a sclera wax pattern. A sclera wax pattern was fitted and adjusted in the

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Figure 1. **Pre-treatment**

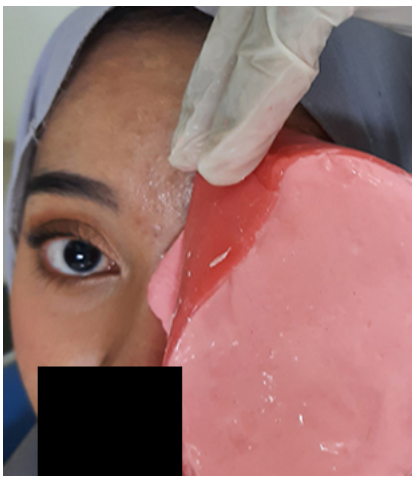

Figure 2. **Impression for custom-made tray extraoral**

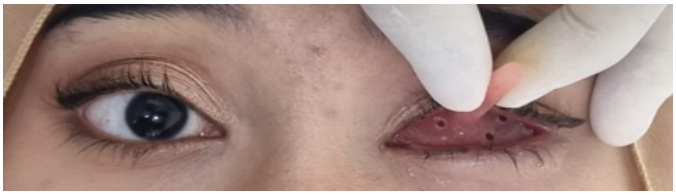

Figure 3. **Try in a custom-made tray**

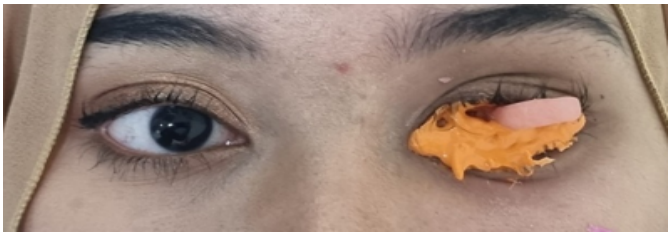

Figure 4. **Final impression**

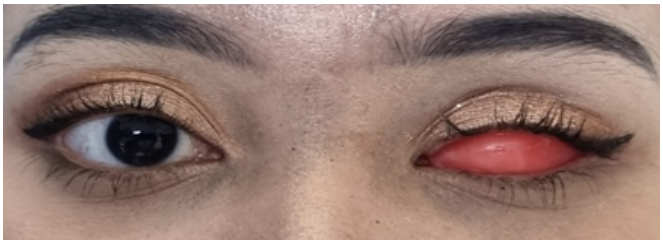

Figure 5. **Slera wax pattern try in**

socket area until contour of the eyelid was achieved figure 5. The patient was asked to perform all movements of the sclera wax pattern. Then shade of the sclera portion was selected using the Vita classical shade guide. The scleral portion of the natural contra lateral eye was matched to obtain the shade of the scleral portion of the prosthesis.

The final sclera wax pattern was invested in a flask using die stone. The flask was put in boiling water for 5 minutes. After the dewaxing procedure, packing and curing were done with the selected shade of heat cure tooth-colored acrylic resin, incorporated with red nylon fiber to simulate the blood vessels of the contralateral natural eye. Then, acrylic sclera was tried in the socket area figure 6.

The size of the iris was determined and marked on the prosthesis using the natural eye as a guide. The patient was instructed to sit up straight, with the prosthesis in the patient's socket eye, apply a caliper. The iris diameters usually range from 10 mm, 10.5 mm, 11 mm, 11.5 mm, and 12 mm. After the position of the iris and pupil were achieved, acrylic sclera was sent to the laboratory for iris coloring, polishing and finishing figure 7.

The final step was the insertion of the eye prosthesis. The result was ascertained from the satisfied look on the face of the patient. The patient was given instructions of prosthesis wearing and home care protocol figure 8.

Discussion

The disfigurement caused by the loss of an eye has a physical and emotional problem. Most patients experience significant stress caused by the loss of eye and societal reactions to the facial impairment. Replacement of the lost eye as soon as possible after healing from eye removal is necessary to promote physical and psychological healing for the patient and to improve social acceptance.[7]

Ocular prostheses may be prefabricated or custom-made.[8] Differences between prefabricated and custom-made ocular prostheses are quite significant. The prefabricated prosthesis has several disadvantages, for example, poor fit, constant tissue irritations due to bacterial growth in the accumulated fluid in tissue prosthesis interface and compromised esthetic outcome.[9] Custom-made ocular prostheses is preferred to increase stability and aid in movement as the contour of the socket defect is taken into consideration. Ocular prosthesis using acrylic resin has various advantages such as—non-brittle, better adaptation, more comfortable, better esthetics, longer serviceability, and easy to repair or polish.[10,11]

Impression techniques using custom or stock trays to carry impression materials into the defect interferes with complete closure of eyelids and functional molding of the material by various ocular movements. Defect socket can be recorded in full detail using the dimensionally stable light body consistency of polyvinyl siloxane impression material.[12] The retention of the ocular prosthesis must be considered in addition to aesthetics so that the patient feels comfortable and calm when wearing the prosthesis. In the present case, retention of the ocular prosthesis was obtained by anatomical

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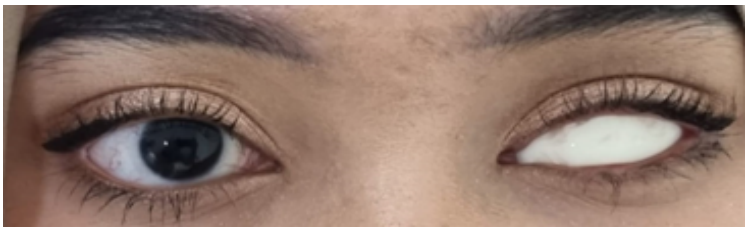

Figure 6. **Acrylic sclera try in**

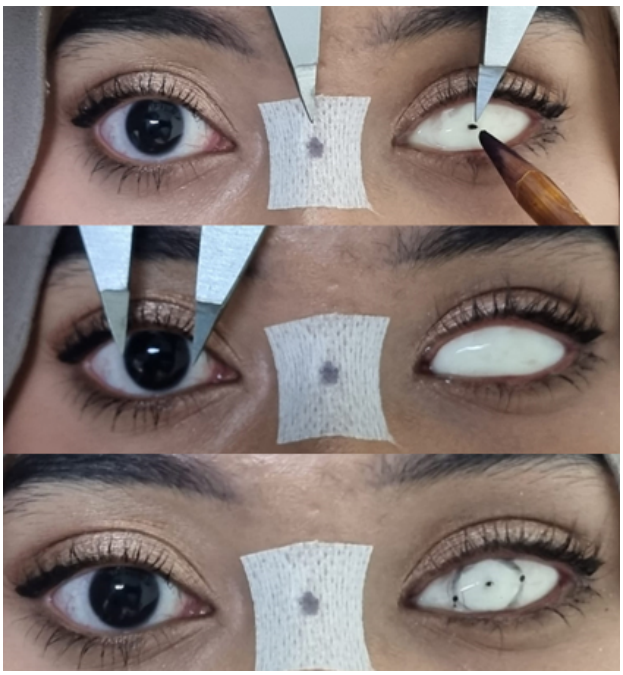

Figure 7. **Positioning of iris disc**

Figure 8. **Insertion of ocular prosthesis**

undercuts.[13] When used daily, the prosthesis must be removed regularly to maintain tissue health and hygiene. The prosthesis may be cleaned with a mild soap or baby shampoo, and with wet hands, gently wash the prosthesis between fingers. All soap must be rinsed from the prosthesis and hands before using the prosthesis.[14]

Conclusion

Custom-made prosthesis allows infinite better fit and satisfaction. The procedure used in this case is cheaper, affordable, and can be carried out in a small clinical set-up. The prosthodontist has an important role by fabricating a well-crafted ocular prosthesis and also rehabilitating the patient on the emotional as well as the social aspect.

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INDONESIAN JOURNAL OF PROSTHODONTICS

CASE REPORT

Prosthetic rehabilitation of nasomaxillary defect with TAD retained surgical obturator followed by hollow bulb definitive obturator and immediate lower denture

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Keywords: Definitive obturator, Hollow bulb, Maxillofacial prostheses, Surgical obturator

ABSTRACT

The integrity and functionality of the oral cavity may be compromised by nasomaxillary defects, such as speech, mastication, deglutition, and esthetics. Early prosthodontic rehabilitation can improve quality of life and lessen the psychological harm caused by the surgical treatment. A 70-years-old female patient was referred to the Department of Prosthodontics RSUP Dr. Sardjito Yogyakarta with chief complaints of nasal obstruction, and right-side swelling of the face. Extraoral examination revealed facial asymmetry due to swelling of the right buccal region. On intraoral examination, showing a large, firm mass extending from right palate to the midline. A multidisciplinary approach with ENT is required for the surgical treatment. A surgical obturator was made before the surgery, and immediately inserted after with TAD as a retention device. Three months later, a hollow bulb obturator and immediate lower denture was fabricated so the functional capabilities of speech, mastication, deglutition, and esthetics can be restored.. (IJP 2024;5(2):135-137)

Introduction

Nasomaxillary defect rehabilitation with obturator has been defined as holistic treatment care to achieve highest possible result in enhancing postoperative quality of life.[1] The Glossary of Prosthodontic Terms defines an obturator as "a maxillofacial prosthesis used to close a congenital or acquired tissue opening, primarily of the hard palate and/or contiguous alveolar/soft tissue structures".[2] Construction protocol of obturator consists of three phases as follows: surgical obturator, interim obturator, and definitive obturator.[3]

Surgical obturator is the first prosthesis that is inserted at the time of surgery to prevent wound contamination. Interim obturator prosthesis is usually placed during the healing phase of the defect. It has to easily modifiable by lining material to be better adaptable to surgical wound changes during healing. The definitive obturator is fabricated when soft tissues healing completely, approximately three to four months after surgery.[3,4]

In large defects, obturator needs to extend vertically and horizontally to engage the surgical defect, therefore the size and weight of the obturator will increase. The unfavorable weight of the prosthesis is a problem for definitive obturators, as it compromises the retention, stability, and support. Hollow bulb obturators are designed to minimize the weight of the prosthesis.1 This case report describes a prosthodontic rehabilitation of patient with nasomaxillary defect using a surgical obturator, followed by definitive hollow bulb obturator and immediate lower denture.

Case Report

A 70-years-old female patient came to the Department of Prosthodontics RSUP Dr. Sardjito Yogyakarta on February 2022 referred by the ENT clinic with diagnosed Sinonasal Cyst on the right maxillary palatal region. Extraoral examination revealed asymmetrical face due to the extensive swelling of the right buccal region with absent pain figure 1. On intraoral examination, showed a large firm mass extending from right palate to the midline suppressing teeth 16,15; radix 21,22,26; and several teeth are missing figure 2A and figure 2B. Surgical resection by the ENT doctors and restoration of the defect with surgical obturator by prosthodontist was planned.

Presurgical impression of the maxilla and mandible was made using a perforated stock tray and irreversible hydrocolloid impression material. Diagnostic casts were prepared, and the area to be resected was modified on the duplicate cast. The surgical obturator was fabricated with the modified duplicate cast using thermoforming foils material with perforation on the palate and buccal flange area for fixation.

Surgical procedure was performed and the remaining teeth on the maxilla was extracted. The surgical obturator was inserted with two pieces TAD (Temporary Anchorage Device) on the palate as retention devices figure 3.

Three days after surgery, patient was examined if there is

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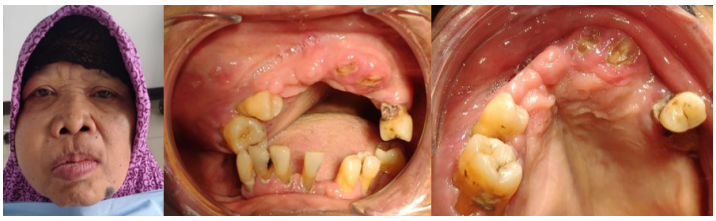

Figure 1. **Extraoral frontal view; Intraoral frontal view; Intraoral Occlusal View**

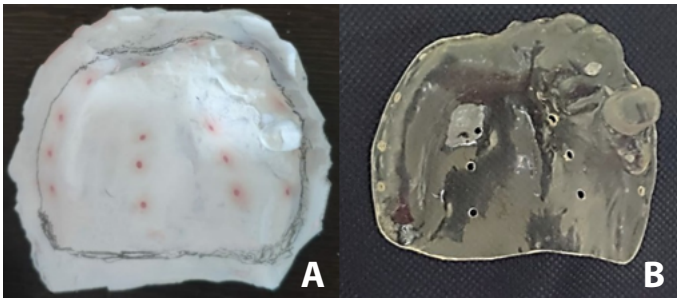

Figure 2. **A. Modified Duplicate Cast, B. Surgical Obturator**

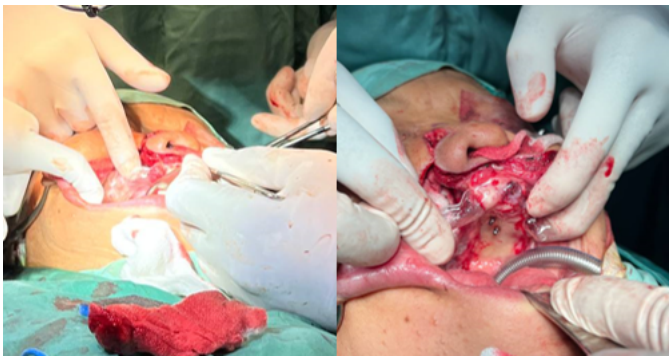

Figure 3. **TAD and Surgical Obturator Insertion**

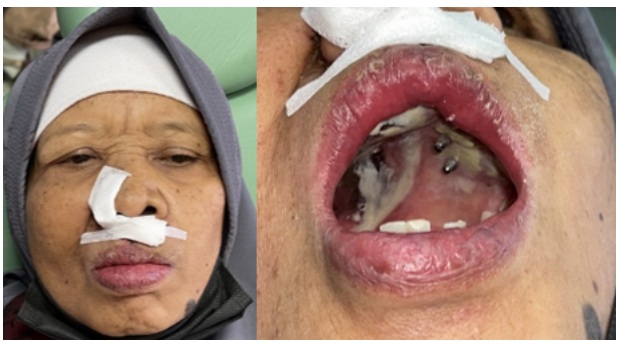

Figure 4. **1 week post surgery**

any discomfort or pain from the surgical obturator and oral hygiene instructions was given. Regular follow up every week was done to clean the defect area around the surgical obturator figure 4.

After 2 months, intraoral examination showed complete healing of the soft tissues but third grade mobility on tooth 31, 41, 42 was found figure 5. The treatment plan was to make a definitive hollow bulb obturator and immediate partial lower denture on teeth 31, 41, 42.

The TAD and surgical obturator were removed. Then a primary impression with irreversible hydrocolloid impression material was made with the stock tray on both arches. Master cast was obtained using this impression. The design for the definitive obturator was acrylic full denture with close hollow bulb to close the palatal defect, as for the lower denture was acrylic partial denture using a round stainless-steel wrought wire (Diameter 0.7mm) C-clasp on teeth 32 and 37.

Acrylic base plate was made to fit the cast, then tried in intraorally and jaw relation including median line, canine line, and laugh line was recorded on the bite rim. Teeth arrangement followed by try in was done and the denture was packed and processed at the dental laboratorium.

The finished hollow bulb obturator was inserted and the partial lower denture was inserted immediately after extraction on teeth 31, 41, 42 and post instructions regarding care, hygiene and maintenance were given to the patient figure 6, figure 7 and figure 8. Patient scheduled to control 1 day and 7 day later.

Discussion

Prosthetic rehabilitation of post-maxillectomy patient is frequently a challenging case for prosthodontists. The most common issues are the lack of retention, stability, and support.[5] In this case, the patient was fully edentulous on the maxilla. TAD (Temporary Anchorage Device) was used as a retention device for the surgical obturator because it can directly insert into the bone through the gingiva with a handheld driver and can be loaded immediately as it gains its anchorage through mechanical gripping of bone instead of osseointegration. TAD is a titanium-alloy mini-screws often used by orthodontist that range from 6-12 mm in length and 1.2-2 mm in diameter.[6]

The main objective of the treatment of maxillectomy defect is to give a prosthetic obturation that recreate an anatomical barrier between oral cavity and sinonasal cavity. Hollow bulb obturator prostheses are widely used alternative to surgical reconstruction because of its simplicity to fabricate and maintain. The hollow bulb makes the prosthesis lighter, have better retention and more comfortable.[1,7]

Due to mobility on tooth 31, 41, 42 an immediate lower denture was planned. Immediate denture is a dental prosthesis that is fabricated to replace the missing teeth and inserted immediately after the extraction of the remaining teeth. Once the healing period has been completed, the immediate denture can be relined to adjust the tissue changes occurring during the healing period.[8]

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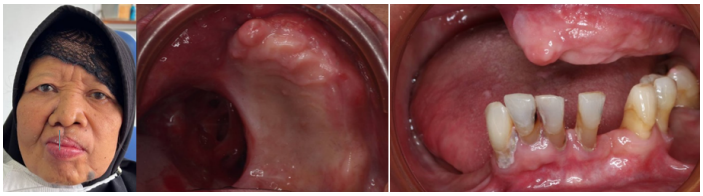

Figure 5. **2 months post surgery**

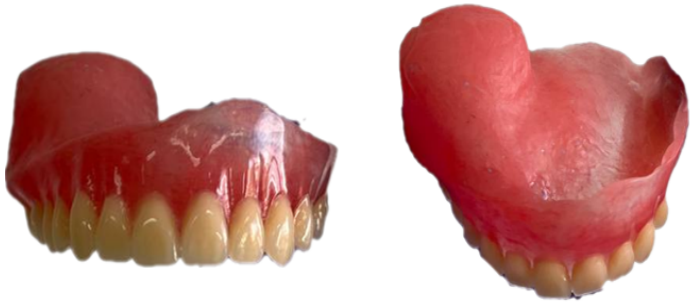

Figure 6. **Hollow Bulb Obturator**

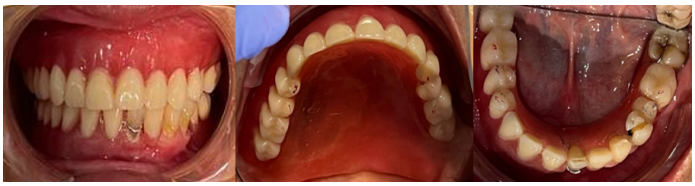

Figure 7. **Hollow Bulb Obturator and Immediate Lower Denture After Insertion**

Figure 8. **Extraoral view, A. Pre Surgical Treatment, B. Post surgical treatment and prosthetic rehabilitation**

Conclusion and Suggestion

First priority of prosthodontist on maxillectomy patient should be to preserve and restore the function of speech and the lost oral structures because of the defect. Treatment planning must be personalized for each patient and special attention must be used when taking impressions and fitting the obturator. Hollow bulb obturator restores the lost hard and soft tissues along with speech, mastication, and esthetics of the patient.

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INDONESIAN JOURNAL OF PROSTHODONTICS

CASE REPORT

Tooth-supported overdenture retained with metal medium copings: A case report

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Keywords: Medium coping, Overdenture, Tooth-supported

ABSTRACT

Overdenture is removable denture used to replace missing teeth and cover or rest on one or more remaining natural teeth in the mouth. The concept of overdenture is a positive means for delaying the process of complete edentulism and helps in reducing bone resorption. Selection of teeth to be retained by looking at periodontal tissue and history of dental caries. Tooth-supported overdenture using coping can be made with short coping, medium coping, or long coping. Metal copings can be used on teeth that have decreased alveolar bone support but are still strong, also covering dentin tubules. On this report, A 62-year-old man patient reported having the chief complaint of difficulty in chewing food and speaking due to missing teeth in the upper and lower arch. This case report describes prosthodontic rehabilitation of a mandibular partially edentulous arch with tooth-supported overdenture using metal medium copings which aim to provide sensory response with further stability and retention to the denture. The patient was satisfied with the treatment outcome. For elderly edentulous patient with few remaining teeth, a tooth-supported overdenture is one of the best and most practical, feasible, and comfortable treatment alternatives. (IJP 2024;5(2):138-140)

Introduction

Overdenture is removable dental prosthesis that covers and rests on one or more remaining natural teeth, the roots of natural teeth, and/or dental implants. Residual ridge resorption is a continuous process and the resorption is even at a faster rate without the natural tooth support. Tooth-supported overdentures are considered as a part of preventive prosthodontics. Restored retained abutments teeth are frequently endodontically prepared and used as abutments for an overdenture. The objective is to distribute stress concentration through retained abutments and denture-supporting soft tissues. Tooth-supported overdenture using coping can be made with short coping, medium coping, or long coping. Metal copings can be used on teeth that have decreased alveolar bone support but are still strong, also covering dentin tubules. Patients with natural dentition, complete denture and overdenture were compared based on masticatory performance, then the result was the overdenture patients had a chewing efficiency one-third higher than the complete denture patients.[1] A timely planned tooth-supported overdenture has been a proven mainstay of preventive prosthodontics therapy as it attempts to conserve the few remaining natural teeth/roots and reducing alveolar bone resorption. There are advantages of the tooth-supported overdenture such as gives secured prosthesis support, economical, good proprioceptive response, and improves the retention and stability of the dentures. Tooth-supported overdenture is favourable as they provide psychological, biological, and functional advantages to the patient.[2] This case report describes prosthodontic rehabilitation of a mandibular partially edentulous arch with tooth-supported overdenture using metal medium copings which aim to provide sensory response with further stability and retention to the denture.

Case Report

A 62-year-old man came to the Prosthodontics Department of RSGM Prof. Soedomo wanted to have dentures because he had difficulty in chewing food and speaking due to missing teeth in the upper and lower arch. Intra oral examination revealed the loss of several teeth in the upper jaw (17, 16, 15, 14, 13, 12, 22, 23, 24, 25, 26, 27) and also in the lower jaw (37, 36, 35, 34, 32, 31, 41, 45, 46, 47) figure 1A - figure 1D. 11 have been installed short metal coping and 21, 33, 42, 43, 44 had already got the root canal treatment. The patient had been to the dentist last month for tooth extraction, also scaling and root planning. The patient had previously used a maxillary overdenture. The patient had no history of systemic disease. The patient had no history of allergies. The patient was not under the care of a doctor or taking regular medication. The patient was managed with maxillary tooth-supported complete overdenture (short metal coping on 11 and bareroot on 21) and mandibular tooth-supported complete overdenture (medium metal coping on 33, 43 and bareroot on 42, 44). The

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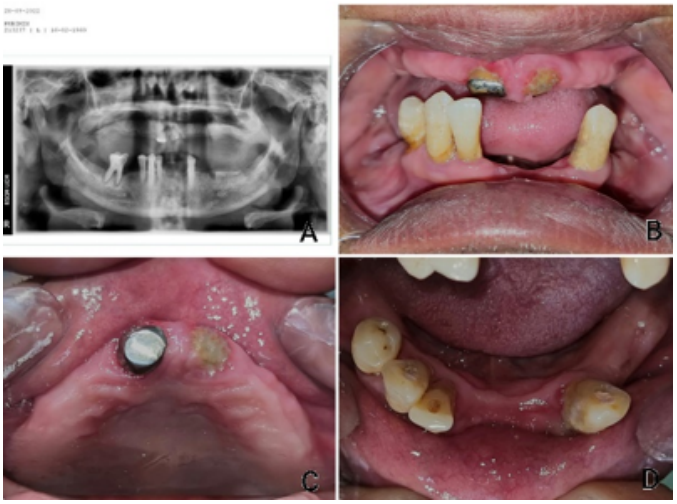

Figure 1. A Panoramic radiograph; B, C, D intra oral condition

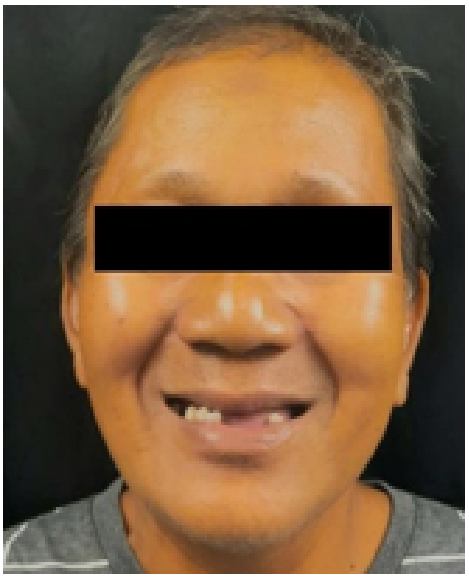

Figure 2. Pre-treatment frontal view

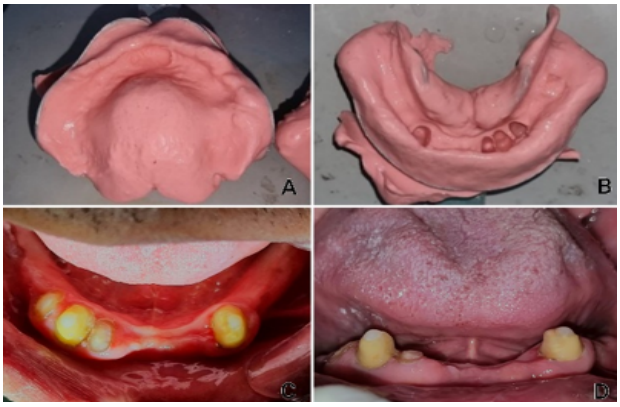

Figure 3. A, B The impressions of maxilla and mandibula to fabricate study model; C, D Preparation of 33, 42, 43, and 44

patient was agreed to get the treatment figure 2.

At the first meeting, making impression of maxilla and mandibula figure 3A and figure 3B to fabricate study model (to design the denture and also to make the individual tray) and matched tooth colour with shade guide. Next step was teeth preparation figure 3C and figure 3D. 42 and 44 were prepared equivalent to the gingival margin. 33 and 43 were prepared and leaving 3 mm height from gingival margin. Applied Glass Ionomer Cement (GIC) to cover the surface of all prepared teeth. Making impression of mandibula to fabricate work model (to make the metal medium copings). All copings were fit after trying in. All metal medium copings were cemented with GIC figure 4A and figure 4B.

Individual tray had no problem after trying in. Making impression of maxilla and mandibula with individual tray figure 4C and figure 4D to fabricate work model (to make the overdenture baseplate). The overdenture base plates were retentive and stabile when it tried in. The base plates were not dropped off when trying in and also when using to talk or other mouth movement. Bite rim was made by wax on base plates. Trying in the bite rims to the patient and recording Maxillo Mandibular Relationship (MMR) figure 5A. Measuring vertical dimensions and determining centric relations. Creating the median line (by drawing a line from the philtrum to determine the median line), the canine lines (this line will determine the mesiodistal width of the anterior teeth), and the laugh line (made at 2/3 of the length of the maxillary incisors) figure 5A. Doing fixation both bite rims then taking out the bite rims from patient mouth. Bite rims were transferred to the articulator. Arranging the anterior teeth in articulator figure 5B then trying in to the patient. Overjet, overbite, median line, canine lines, laugh line, and phonetics had been appropriate and good after trying in to the patient. Continuing arranging the posterior teeth figure 5C then trying in to the patient. Retention, stabilization, occlusion, phonetics, and aesthetics were appropriate and good after trying in to the patient. Next step was processing the denture in laboratory. Subjective and objective examinations must be done after doing overdenture insertion. Patient had no complaint after overdenture insertion figure 5D. Patient said there was no problem in retention, stabilization, occlusion, phonetic, and aesthetic when using the denture. The patient was satisfied with the treatment outcome. Instructions to the patient: patient was taught how to wear and remove the dentures, maintaining denture cleanliness, removing dentures at bedtime and soaking them in clean water in a closed container, immediately contacting the dentist if there were complaints or pain, and doing control on the scheduled time. Patient had no complaint on the control day figure 6.

Discussion

Edentulism is considered a major public health problem worldwide, despite the advancement in preventive dentistry. Various studies have reported that there is a continuous resorption of the residual alveolar ridge in completely edentulous patient with complete denture and this continuous resorption may lead to serious prosthodontic problem and difficulties both for the patient and the dentist.[2] Preserving the remaining natural teeth have an excellent effect on retention and stability of dentures. It also gives the patient a great

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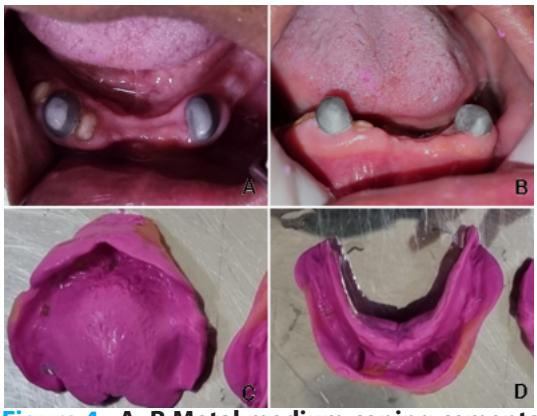

Figure 4. **A, B Metal medium coping cementation; C, D The impressions to fabricate work model**

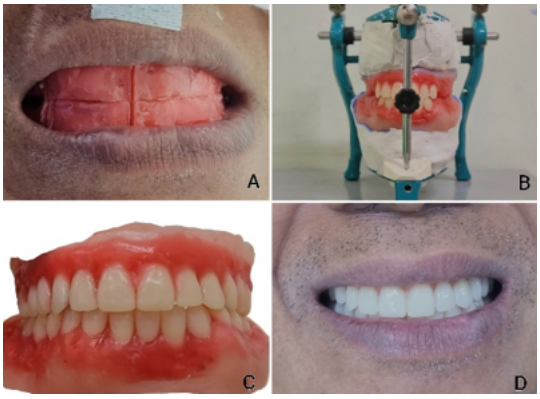

Figure 5. **A. Trying in the bite rims and recording Maxillo Mandibular Relationship (MMR), B. Arranging the anterior teeth, C. Arranging the posterior teeth, D. Insertion**

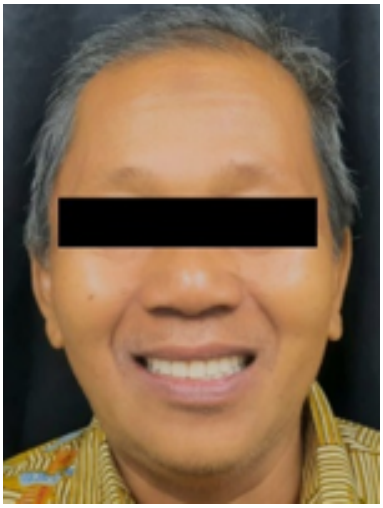

Figure 6. **Frontal view on control day**

psychological satisfaction. Tooth-supported overdenture accomplishes three important goals. It maintains the abutment as a part of the residual ridge which in turn provides more support than a conventional complete denture. When the teeth are retained, alveolar bone integrity is maintained as they support the alveolar bone. With the preservation of the teeth there is also preservation of the periodontal membrane.[3] Root canal therapy is a necessary phase of preparation for the selected teeth.[4] In the following case report, we have used metal medium copings which are comparatively economical solutions as the interarch space were limited. Abutments were prepared in dome shape contour and received cast copings. These dentures provide mainly the preservation of alveolar bone, maintenance of proprioception and stability of prosthesis. Oral hygiene instructions must be given to the patient and reinforcement of the same has to be done. Recall examinations with radiographs at regular intervals of 6 months or less will maintain the prosthetic, restorative, and periodontal status of the patient at acceptable levels, which in turn leads to the success of the overdenture therapy. Regular fluoride gel application can also be advised for proper maintenance of abutment tooth.[5]

Conclusion and Suggestion

Overdenture has proven innumerable advantages and applications compared with conventional complete denture. Overdenture are a good and economic treatment option for patients who have healthy abutment teeth. Tooth-supported overdenture with metal medium coping is a simple and cost-effective alternative treatment. Use of overdentures has been favoured often because of mechanical advantages. The retained tooth provides dentures with good stability and support with slow rate of alveolar resorption. For edentulous patients with few remaining teeth, a mandibular tooth-supported overdenture is one of the best and most comfortable treatment alternatives. Patient education determine the treatment results and the patient's post prosthetic quality of life.

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INDONESIAN JOURNAL OF PROSTHODONTICS

CASE REPORT

Custom-Made of ocular prosthesis for post enucleation: A Case Report

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Keywords: stom-made ocular prosthesis, Enucleation, Rehabilitation

ABSTRACT

Ocular prosthesis is part of a whole rehabilitative treatment plan after surgery. Stock ocular prosthesis, are premade, come in a range of colours and sizes with a right and left standard shape, and inexpensive to manufacture. The disadvantage is not being able to fit completely in the eye socket. To address this issue, the patients require a suitable prosthesis to enhance their living standards. A 75-year-old male patient came to RSGM UGM Prof. Soedomo using a stock ocular prosthesis. Complained that his ocular prosthesis loose and uncomfortable. The treatment plan was making custom-made ocular prosthesis using acrylic resin. The treatment procedure comprises minting the individual eye by using an individual tray; making the model of wax sclera followed by trying on the wax sclera pattern to the patient eye socket and continuing the acrylic resin process of sclera followed by trying on the eye socket, and then determining the location and iris diameter to draw the iris and pupil. The final step is inserting the ocular prosthesis into the patient's eye socket. One week after insertion, the patient felt comfortable and has no complaints. Ocular prosthesis help improve the patient's quality of life. (IJP 2024;5(2):141-144)

Introduction

The lost of an eye through accident, from disease or from congenital causes is a major event that impacts on person's self-image and well-being. It also requires changes in routine associated with wearing and maintaining a prosthetic eye or scleral shell prosthesis.[1,2] The loss of eyeballs may lead to problems in function, psychology, and aesthetics. Loss or absence of the eyeballs can be caused by a congenital abnormality or trauma that requires surgical intervention.[3] Replacement of the missing eyeballs may be necessary to improve physical and psychological healing for the patient and to increase social acceptance.[1]

There are two types of prosthetic eye, stock and custom-made. Unlike custom-fit prosthetic eyes, stock eyes, wheter made from glass or PMMA, are premade and come in a range of colours and sizes with a right and left standard shape. The main advantage of stock prosthetic eyes is inexpensive to manufacture, provide large of selection, do not need to be fitted or adjusted by an ocular prosthetist. This is an important consideration in countries whose populations do not have access to custom-fit PMMA prosthetic eyes because of cost. The chief advantage of custom-fit PMMA prosthetic eyes is that they can be moulded and coloured for individual patients. This greatly improves the patient's prospects for receiving a comfortable and aesthetically pleasing prosthesis with optimum motility.

The purpose of this article is to describe the rehabilittion treatment with a custom-made ocular prosthesis.

Case Report

A 75-year-old male patient came to RSGM UGM Prof. Soedomo using a fabricated ocular prosthesis. The patient's history was a traffic accident 30 years ago. The patient had to undergo enucleation surgery. The patient complained that his prosthesis was loose and had become discoloured.

On objective examination, the eye socket was normal; there was no irritation; and there was no infection. The eyelid muscles were still in good condition, so the patient could open and close the eyelid. The eye socket was deep enough to allow for retention of the eye prosthesis figure 1. The first visit was for anamnesis, objective examination, and to take a photo of the patient's profile. The diagnosis was of loss of the left bulbus oculi due to trauma. The treatment plan was to make a customized ocular prosthesis with acrylic resin.

The patient was asked to close his eyes. Afterwards an irreversible hydrocolloid impression material was poured around the eye figure 2. Then the cast was filled with dental stone figure 3. The hardened stone was used as a working model to make individual trays using a self-curing acrylic resin figure 4.

A light body polyvinyl siloxane impression material was injected into the eye socket, to which an individual tray was attached figure 5. The patient was instructed to move his eye to the right and then to the left, then up and down, and finally, in a circular motion, to

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Figure 1. **Pre-treatment**

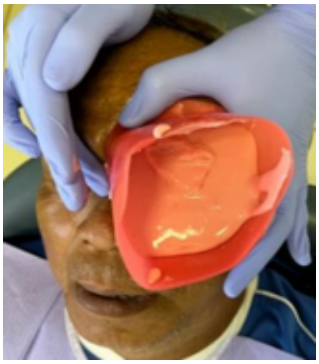

Figure 2. **Study Model Impression**

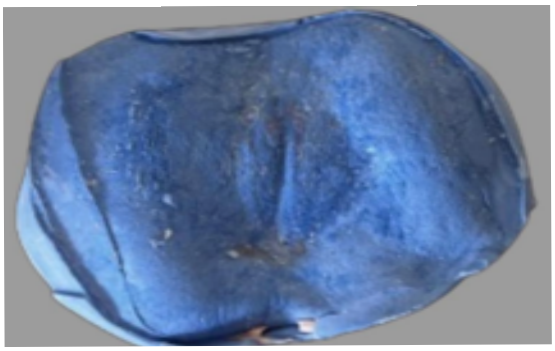

Figure 3. **The cast filled with dental stone**

obtain a functional impression of the defect. After the material was set, the impression was removed from the socket and it was examined for completeness or any voids figure 6. Boxing of the impression was done, and the cast was poured in three parts to get a split cast by using type III dental stone figure 7.

A wax pattern was fabricated by allowing molten modelling wax to flow into the mold figure 8. Afterwards, the wax pattern was tried in the patient's eye socket, and the patient was asked to move his eye to the left and right to check for comfort, stability, and retention figure 9. Furthermore, the sclera colour was recorded using photography of the patient's real eye figure 10. The smoothed sclera wax pattern and sclera colour notes were sent to the laboratory for packing.

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, and the patient was asked to move his eye to the left and right to check for comfort, stability, and retention. Afterwards, the iris and the pupil were designed based on the other eye using a pencil. The iris diameters usually range from 10mm, 10.5mm, 11mm, 11.5mm, and 12mm2 . The iris distance measurement figure 11 and iris diameter was designed by direct measurement using a sliding caliper figure 12. Then design the diameter and midpoint of the iris figure 13 The acrylic sclera is tried on again on the patient figure 14 and then sent to the laboratory for iris colouring.

The prosthesis was inserted into the eye socket, and it was evaluated for aesthetics and patient comfort. The patient was educated to insert and remove the prosthesis figure 15.

Discussion

Ocular defects constitute an important maxillofacial deficiency which requires prosthetic replacement.[3] A few methods have been used, such as stock ocular prosthesis, modifying stock ocular prosthesis, and customized ocular prosthesis.[4] A stock ocular prosthesis has disadvantages such as a cavity gap, which can lead to an accumulation of tears and mucous secretion, creating heaviness in the cavity and resulting in the dislodgement of the prosthesis from the cavity. Moreover, the aesthetics are also compromised, as the shades of the sclera and the iris do not exactly match those of the contralateral eye.[4] Whereas the customized ocular prosthesis has advantage in

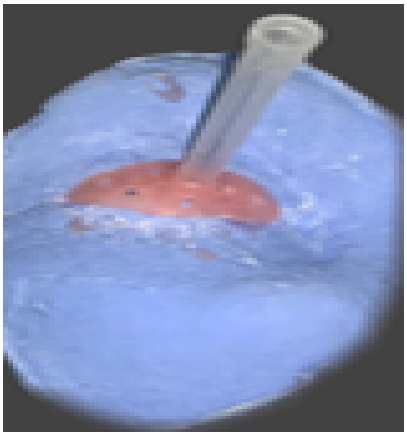

Figure 4. **Individual tray using self-cured acrylic resin**

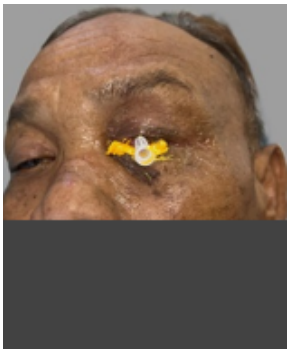

Figure 5. **A light body polyvinyl siloxane impression material was injected into the eye socket**

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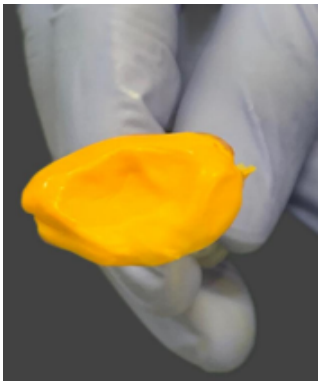

Figure 6. **Functional Impression**

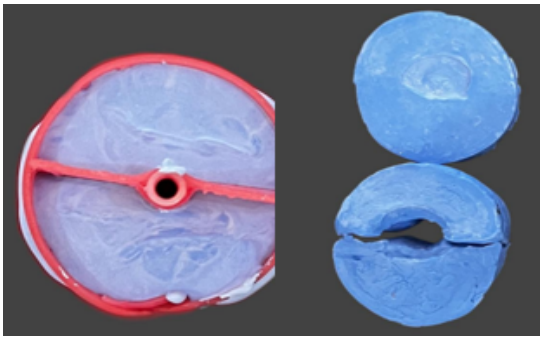

Figure 7. **Work Model**

Figure 8. **Wax pattern sclera**

Figure 9. **Wax sclera try-in**

resemblance of size and colour of the contralateral eye. This can help to maintain pressure balance around the eye socket, thus reduce the incidence of the conjunctival abrasion and ulceration. The customized ocular prosthesis provides more aesthetic results because the iris and the sclera are custom fabricated and painted. The iris painting is one of the important steps in the fabrication of a custom-made ocular prosthesis. This technique is complex, it increases the treatment time, and it requires artistic skills, which are necessary in the iris painting. Moreover, the age, systemic conditions and financial constraints may limit their use.

The protocol for managing mucoid discharge associated with prosthetic eyes suggests that prosthetic eyes should not be removed and cleaning more frequently than monthly and not less frequently than 6 monthly. Cleaning removes surface deposits, reduce the wettability of the prosthesis and reduce the ability of socket fluids to lubricate. Pine et al. suggest that prosthetic eye should be left undisturbed for at least one month. The socket and eyelid hygiene is maintained with daily washing and/or showering as it is with the sighted eye. If an episode of inflammation occurs, clean the socket without removing the prosthesis by syringing it with tepid eye wash solution or sterile saline.

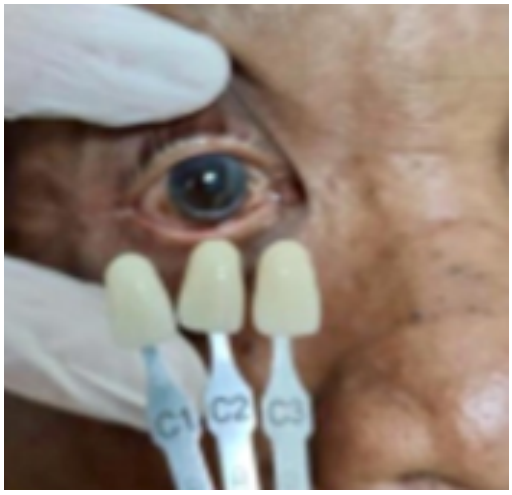

Figure 10. **Recording the colour of sclera**

Conclusion and Suggestion

Ocular prosthesis is part of a whole rehabilitative treatment plan after surgery. The key of effectively rehabilitating patients with ocular defects is giving professional treatment with attentive and sensitive care. The use of customized ocular prosthesis can provide a good aesthetic result in the rehabilitation of patients. Additionally, it can help them reintegrate into society by enhancing their psychological well-being.

In addition to helping a minimal intervention strategy in the rehabilitative treatment plan after surgery, the adoption of a customized stock ocular prosthesis can provide an acceptable aesthetic outcome.

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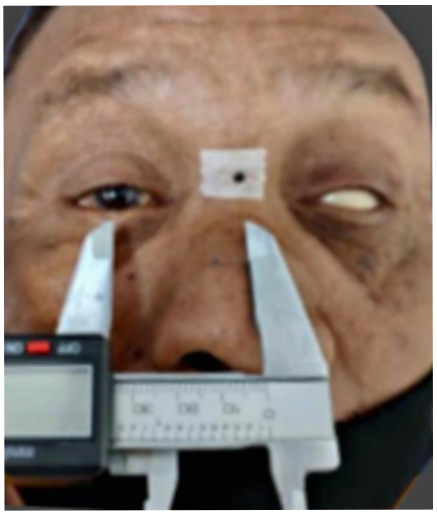

Figure 11. The iris distance measurement

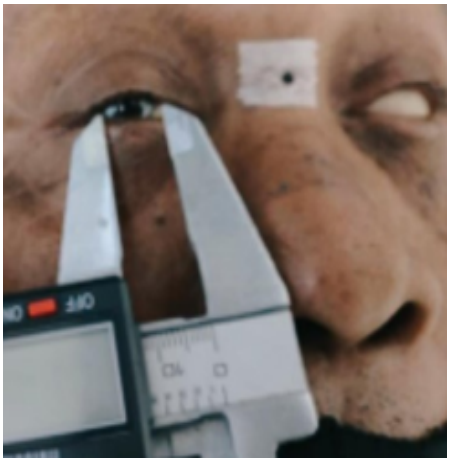

Figure 12. The iris diameter measurement

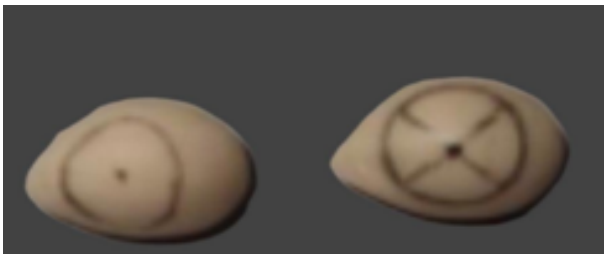

Figure 13. The iris diameter and midpoint design

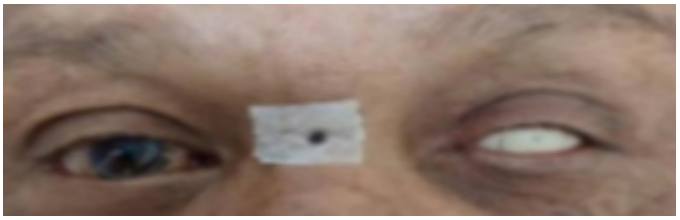

Figure 14. The acrylic sclera try-in

Figure 15. Insertion

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INDONESIAN JOURNAL OF PROSTHODONTICS

CASE REPORT

Acupressure gua sha and massage with kutus-kutus oil accompanied using a stabilization splint in patients with temporomandibular disorder

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Keywords: Acupressure, Gua sha, Massage, Stabilization splint, TMJ disorder

ABSTRACT

Background: The most common temporomandibular disorder (TMD) is characterized by disc displacement with reduction (DDWR). Despite its typical signs such as clicking, DDWR has complex symptomatic characteristics, thus; conservative treatment including occlusal splint and physical therapy are commonly performed. Physical therapy, such as acupressure using acupuncture points and massage, is an alternative to DDWR treatment. Objectives: This paper aims to explain the DDWR treatment using stabilization splints and acupressure therapy using gua sha accompanied by a massage with Kutus-Kutus oil. Case report: A 36-years-old male patient arrived at USU Dental Hospital with complaints of clicking right jaw and feeling pain in zygomatic and mandibular area. The patient has been experiencing pain under stress and during periods of high activity for the past six months. This pain is often accompanied by clenching of the jaw, particularly when the patient is worried or concentrating, and the patient tends to sleep on one side. Upon clinical examination, a sound was detected in the right temporomandibular joint (TMJ). The patient was able to open their mouth to a width of 34 mm without experiencing pain, although there was a noticeable deviation to the right. No pain was reported in the joint area during mouth opening. Radiographic examination revealed that the right and left mandibular condyles were positioned anterior to the articular tubercle. For symptomatic treatment, stabilization splints were used in conjunction with physical therapy, which included acupressure gua sha and massage with Kutus-Kutus oil. The use of a stabilization splint caused the patient to experience discomfort during clenching, which gradually led to the cessation of this detrimental habit. This intervention helped to reduce pain and eliminate the clicking sounds associated with TMJ disorder. Conclusion: the combined use of acupressure gua sha, massage with Kutus-Kutus oil, and a stabilization splint can effectively alleviate the pain and clicking symptoms in patients with TMJ disorder. (IJP 2024;5(2):145-151)

Introduction

Temporomandibular disorders (TMD) are a collective term for conditions involving pain and dysfunction of the temporomandibular joint (TMJ) that involve the masticatory muscles and related structures.[1-3] Most TMD involves either muscle or skeletal structures, or both. It is estimated that 8-15% of women and 3-10% of men currently suffer from TMD. About 60-70% of the general population has at least one sign of TMD dysfunction, but only one in four people are aware of these symptoms and seek examination from a dentist.[5,6] TMD is the second most common musculoskeletal condition (after chronic lower back pain) that results in pain.[7] It is generally recognized that pain-related TMD is most often observed in the adult population between the ages of 18 and 45, with a prevalence rate of up to 25%.4 Pain-related TMD can affect an individual's daily activities, psychosocial function, and quality of life.[7]

Temporomandibular disorders (TMD) can be classified into: complex condylar disc derangement: disc displacement, disc displacement with reduction (DDWR), and disc displacement without reduction (DDWOR); structural mismatch of the articular surface: disc, condyle or fossa deviation, adhesion, subluxation, spontaneous dislocation; Inflammatory conditions of the TMJ: synovitis/capsulitis, retro discitis, and arthritism; Inflammatory disorders in related structures: temporal tendonitis and inflammation of the stylomandibular ligament.[2] Patients often consult with dentists for TMD associated with pain. Diagnostic criteria for TMD with simple, clear, reliable, and valid operational definitions for history taking, examination, and imaging procedures are needed to make a physical diagnosis. In addition, the assessment of habits from pain-related behavior and psychosocial function is an important part of the diagnostic process.[7,8] Diagnostic Criteria (DC/TMD) both Axis I and Axis II simultaneously will provide evidence-based criteria that doctors can use when assessing patients, and will facilitate communication related to consultation, referral, and prognosis.[2,7,8] Its etiology is multifactorial, involving several factors such as parafunctional habits like bruxism and clenching, jaw trauma, degenerative joint disease, postural changes, TMJ anatomy, hormonal changes, and instability of the maxillomandibular relationship. Research shows that emotional factors (stress, anxiety, depression) also play a significant role in TMD.[2,5,9]

TMD is characterized by symptoms such as muscle pain, clicking sounds, deviation or limitation in mouth opening, restricted mandibular movement, myofascial pain, palpable trigger points (TPs), and related headaches.[2,5,9,10] Among various clinical issues, manstudies focus on TMD-related pain, which can disrupt daily activities like

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Table 1. Examination results of muscles and functional manipulation related to TMD and TMJ examination

Examination	Regio	
	KA	KI
Temporalis	Ant: 0 Med: 1 Post: 1	Ant: 0 Med: 0 Post: 0
Tendon temporalis	1	0
Lateral pterygoid	2	0
Masseter	Superior: 1 Middle: 0 Inferior: 0	Superior: 0 Middle: 1 Inferior: 0
Regio submandibula	0	0
Sternocleidomastoideus	Posterior: 1 Anterior: 2 Clavicle: 1	Posterior: 0 Anterior: 1 Clavicle: 0
Splenius Capitis	-	-
Trapezius	0	0
Maximum Mouth Opening without Pain (mm)	34mm	34mm
Maximum Mouth Opening with Pain (mm)	42mm	42mm
Maximum Mouth Opening with Operator Assistance (mm)	56mm	56mm
Lateral Movement	5mm	10mm
TMJ Pain	2	0
TMJ Sound	Opening: Clicking Closing: Clicking	Opening: - Closing: Clicking
Headache	-	-
Tinnitus	-	-
Occlusion	Right: Class I Angle (molar relationship); Class I Angle (canine relationship) Left: Class I Angle (molar relationship); Class I Angle (canine relationship) Overbite: 2 mm Overjet: 3 mm	
Midline Deviation at Maximum Opening	Deviation to the right at maximum mouth opening	

Figure 1. Front and side view of the facial profile

eating and speaking. This pain is often mild and temporary, but for some individuals, it can become chronic and persistent. Factors like bruxism (teeth grinding), clenching, specific oral habits, body pain complaints, being female, and various psychological factors have been identified as risk indicators for pain-related TMD.[2,5,11] Various types of therapy are performed to treat the symptoms of TMD dysfunction. Therapy can be reversible such as occlusal splints and physical therapy, or irreversible therapy such as occlusal adjustment, orthodontic treatment to surgical procedures.[12] Occlusal splints are removable occlusal devices made of plastic or metal that are used by patients temporarily to change the occlusal contact and mandibular function pattern that are placed on the occlusal and incisal surfaces on one of the jaw arches, which can produce proper occlusal contact with the teeth on the opposite jaw arch.[2,12,13] O treat TMD symptoms, therapies can range from reversible options, such as occlusal splints and physical therapy, to irreversible treatments like occlusal adjustment, orthodontic interventions, and surgery. Occlusal splints, which are removable devices made of plastic or metal, are worn temporarily to modify occlusal contact and mandibular function. These devices are placed on the occlusal and incisal surfaces of one jaw arch, ensuring proper occlusal contact with the opposite jaw. Stabilization splints, a specific type of occlusal splint with a flat surface, permit the muscles to position the condyle into the centric relation without interference from the teeth's inclines. Stabilization splints are favored as a treatment option for their reversibility, non-invasive nature, cost-effectiveness, and notable efficacy.

TMD has complex symptoms, leading to the use of conservative treatments such as patient education, pharmacotherapy, and physical therapy. Additionally, relaxation techniques and acupressure serve as complementary therapies for TMD patients experiencing pain.[9] In the field of dentistry, acupressure has been validated for addressing various chronic orofacial disorders. Evidence from randomized controlled trials (RCTs) highlights the analgesic benefits of acupressure for managing postoperative pain from diverse dental procedures and other chronic conditions. The literature suggests acupressure's superiority over placebo, positioning it as a viable option in dental practice for pain relief and the treatment of dental and TMD-related issues.

Gua sha, a technique from Chinese medicine, is recognized for its pain relief capabilities, achieved by scraping the skin to eliminate blood stagnation at the surface. Beyond its use for pain, gua sha addresses conditions like the flu, respiratory issues, and musculoskeletal (MS) and joint pain. The potential mechanisms through which gua sha alleviates MS pain include: Enhancing local microcirculation to alleviate distal myalgia; Mitigating pain via the activation of serotonergic, noradrenergic, and opioid systems; and reducing the direct impact of pain on nociceptors and their connections within the spinal cord.[14-16]

To mitigate pain associated with TMD, massage therapy emerges as a viable treatment strategy. It engages the pain gate mechanism, effectively reducing pain perception. Additionally, this therapy activates the parasympathetic nervous system and enhances muscle flexibility. Beyond these benefits, massage therapy boosts local blood flow and the production of endogenous opioids, which

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diminishes pain perception and fosters both tonic and relaxation effects. These outcomes are particularly relevant in the management of TMD.[17]

Kutus-kutus oil can be used in massage therapy. Kutus-kutus oil is a herbal spice oil made from 69 different herbal plants that are processed in a special way using traditional methods. This results in a herbal oil that helps the healing process and is safe and comfortable to use daily. This oil is made from natural active ingredients such as neem leaves, purwoceng, ashitaba, star anise, and others, which are believed to have benefits in reducing pain and also providing a relaxing effect.[18] This paper aims to explain the treatment of temporomandibular joint disorder disc displacement with reduction using stabilization splint and acupressure with gua sha accompanied with massage therapy with kutus-kutus oil.

Case Report

A 35-year-old male patient came to the Prosthodontics clinic of RSGM USU with a complaint of a sore right jaw and sometimes felt pain in the front of the ear. The pain was felt when stressed and too much activity in the past 6 months. The patient said that he had a habit of grinding his teeth when stressed and focused and slept on one side with his cheek on his hand. The patient felt a sound when opening his jaw. On clinical examination, the patient was instructed to open and close his mouth slowly to detect clicking sounds with palpation in the preauricular area. The clicking sound was detected by a stethoscope on the right jaw joint when opening and closing the mouth. The mouth opening was recorded by measuring the distance between the left side of the upper and lower central incisors, and the mouth opening distance without pain was 34 mm, with pain 42 mm, and assisted opening 56 mm.

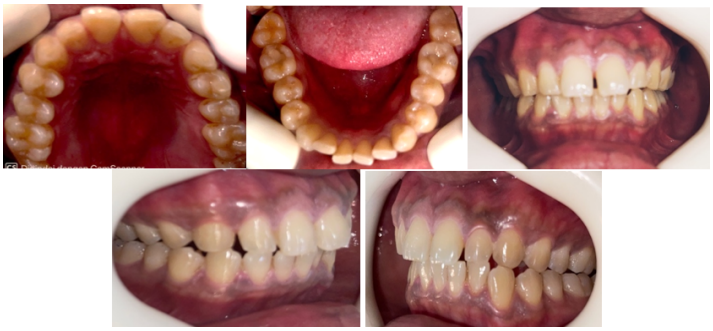

Figure 2. Intraoral examinations

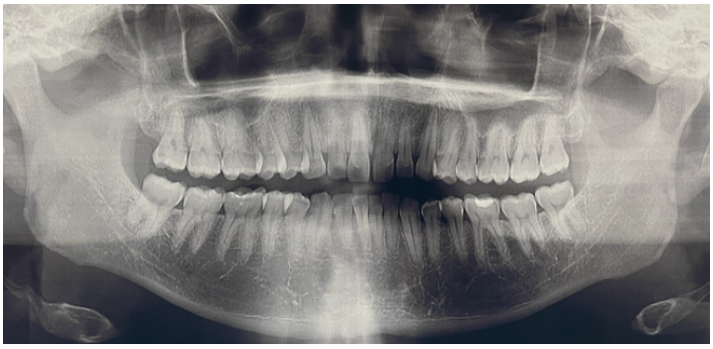

Figure 3 Panoramic radiography

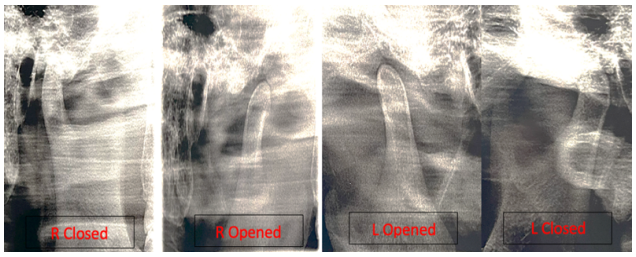

Figure 4. TMJ radiography image

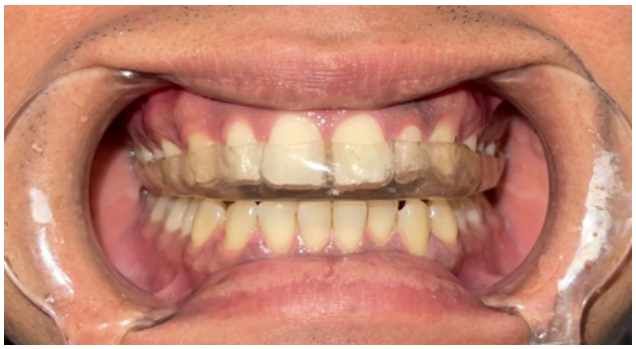

Figure 5. Stabilization splint placement

Several questions were directed to the patient based on the Diagnostic Criteria for Temporo-Mandibular Disorders (DC/TMD) to gather the temporomandibular joint (TMJ) health history with the aim of assisting in classifying the type of temporomandibular disorder (TMD) during examination of the muscles around the face, neck, and TMJ. Extraoral examination showed symmetry in facial shape figure 1. In Axis I examination, palpation was performed on extraoral and intraoral muscles. Palpation was done on extraoral muscles (such as masseter, temporal, sternocleidomastoid, posterior stylohyoid, medial/suprahyoid/digastric anterior pterygoid, splenius capitis, and trapezius) and intraoral muscles (such as temporal tendon, and lateral pterygoid area) related to TMD, noting scores according to DC/TMD criteria (0: no pain; 1: mild pain; 2: moderate pain; 3: severe pain). Additionally, various vertical movements were examined (such as maximum mouth opening with and without assisted pain, and without pain; lateral left and right excursive movements; protrusive movements; and examination of the lower jaw median line and mouth opening pattern). Palpation examination for TMJ pain was also conducted, including intra-auricular and extra-auricular palpation, as well as joint sound examination. Based on Axis II examination, the Anxiety questionnaire yielded a score of 7, indicating moderate anxiety (scores 6-9). The patient's health questionnaire with physical symptoms yielded a score of 11, indicating moderate physical symptoms (scores 10-15). Meanwhile, the Oral Cavity Behavior questionnaire yielded a score of 18, indicating the presence of bad habits in TMD patients (scores 17-24).

Intraoral examination figure 2 and panoramic radiographic analysis figure 3 revealed the following dental findings: teeth 13-12, 11-21: diastema; teeth 11, 21, 31, 41: distolabiotorsiversi; tooth 42: lingioversi; tooth 32: mesiolinguotorsiversi; teeth 36, 46: composite

Table 2. Acupressure points to be targeted

Location	Point	Anatomical Position	Indications
Facial	Jiache (ST6)	On the cheek, 1 cun higher than the anterior angle and above the mandible, on the prominence of the masseter muscle	Relaxation of facial muscles, facilitating jaw movement
	Xianguan (ST7)	Distal part of the zygomatic bone, anterior side of the mandibular condyle process, at the posterior border of the masseter muscle	Improvement of hearing function and TMJ. Reduction of muscle spasms and pain
	Tinggong (SI19)	In the anatomical depression formed when opening the mouth, located anterior to the tragus, between the TMJ and tragus	Reduction of pain, muscle spasms, trismus, TMJ motor disorders, and toothache
	Ermen (TE21)	Superior part of the cavity before the tragus and above the mandibular condyle when the mouth is open	Toothache and pain, TMJ arthritis, headache
	Yintang	Midline of the face, midpoint between the eyebrows	An extra point that calms the mind
	Trigger Points	Trigger points in any palpable area of the body	Relaxation and pain reduction

Figure 6. Gua Sha image

restorations; teeth 13, 23: attrition. The patient's periodontal condition was good. Based on the panoramic radiograph, the condyle size on the left side was equal to that on the right side, with no impacted teeth, no pathological abnormalities, and a curved antegonial line suggestive of clenching habit figure 3. From the TMJ radiographic images figure 4, it was observed that during mouth closure, both the right and left mandibular condyles were positioned within the glenoid fossa. During mouth opening, both the right and left mandibular condyles were located anterior to the articular tuberculum. Based on the occlusal classification, molar relationship on the right and left sides was Angle Class I; canine relationship on the right and left sides was Angle Class I; with an overbite of 2 mm and an overjet of 3 mm. Deviation to the right occurred during mouth opening. The results of the aforementioned examinations are presented in table 1.

Based on the examination results above, the patient's diagnosis is Disc displacement with reduction (DDWR) accompanied by myofascial pain and arthralgia et causa due to bad habits of clenching and sleeping facing only one side. On palpation of the masticatory muscles, there was pain in the intraoral muscles (lateral pterygoid) on the right side, masseter, temporalis and temporalis tendon. On palpation of the extraoral muscles, there was pain in the sternocleidomastoid muscle in the posterior ear and cervical neck area on the right side. At the time of palpation of the extra-auricular area on the right side, there was pain. On opening the mouth, there was a clicking sound on the right TMJ. There was a consistent deviation to the right when opening and closing the mouth. The first treatment, called phase one treatment, performed on the patient includes: Communication: discuss the anatomy related to the clicking sound so that the patient is not anxious and the patient experiences a reversible disorder that may be related to bad habits such as clenching, and sleeping facing one side and supporting the cheek on the hand; Physical therapy: Reduce bad habits such as clenching that are often done by patients. Physical therapy in the form of acupressure using gua sha and massage with kutus-kutus oil with kneading, friction, stretching movements; Occlusal splint use: in this case, the stabilization splint is the choice of phase I treatment because there is no limitation of mouth opening and locking of the jaw when opening and closing the mouth.

The benefits of using a stabilization splint are: Reducing the TMJ load when functioning; Repositioning the lower jaw to the normal position; Restoring the balance of the tone of the chewing muscles; Eliminating clicking; Eliminating various complaints and symptoms of TMJ joint dysfunction.

The procedure for making a stabilization splint is as follows: Taking a working bite with an increased vertical dimension during centric relation position; Surveying on the model to obtain the height of tooth contour that will be waxed up and determining the areas that need blocking out; Mounting the model accompanied by increasing the working bite on a semi-adjustable articulator; Waxing up is done on the upper jaw model covering the height of the tooth contour surface according to the survey results to make it more aesthetic and retentive, without exceeding the gingival margin as it may cause irritation, and the splint surface is made flat; Processing the stabilization splint using clear heat-polymerized acrylic resin; Placing the stabilization splint with attention to adaptation and retention; the thickness of the splint must match the freeway space; occlusal contact in centric relation position and canine guidance occlusal scheme; instructing the patient to wear the splint for 24 hours. The stabilization splint is

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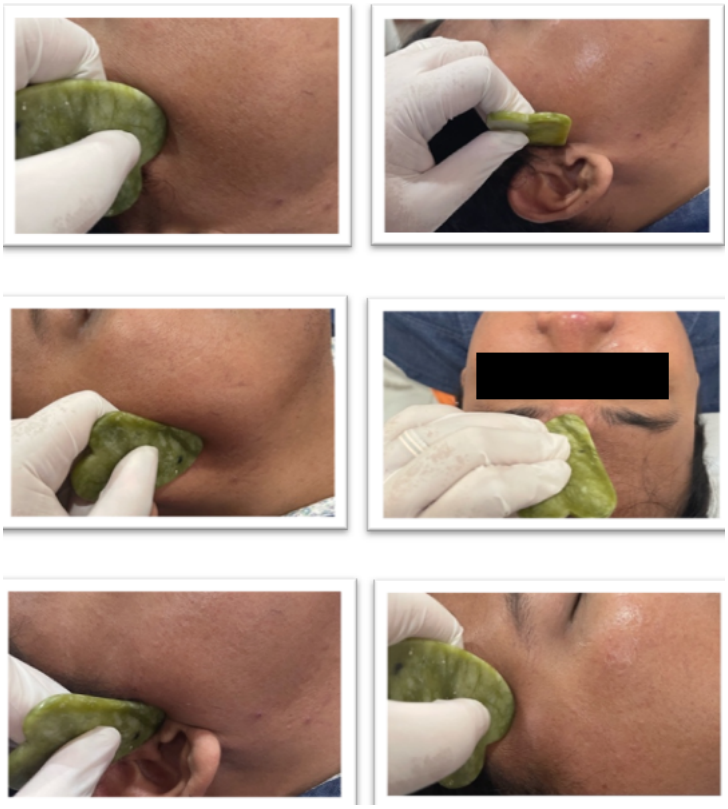

Figure 7. Acupressure procedure using gua sha: A. ST7 point, B. SI 19 point, C. ST 6 point, D. Yintang point, E. TE21 point, F. Trigger point

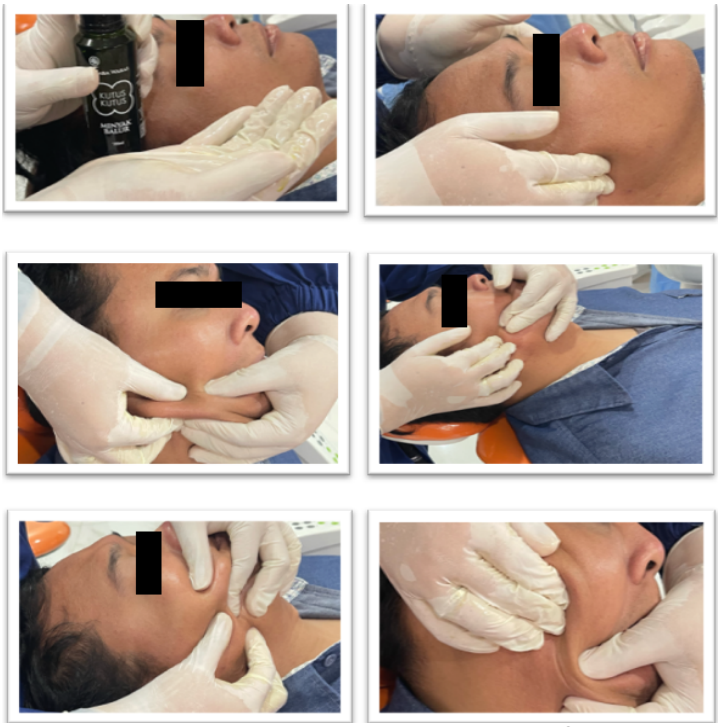

Figure 8. Massage procedure: A. Application of Kutus-Kutus oil, B. Kneading, C. Friction, D. Stretching, E. Stretching on the neck area, F. Cross stretching

used for a minimum of 2 months and worn at all times except during meals figure 5; The patient is instructed to attend a follow-up appointment one week after splint insertion, and an examination is conducted to determine post-placement complaints including: Examination of complaints regarding splint insertion, whether there is traumatic occlusion on the stabilization splint using articulating paper; Examination of clicking sounds; Examination of deviation during mouth opening and closing; Follow-up appointment 2 weeks after placement to reassess complaints from the first appointment and subsequent appointments until patient complaints disappear.

The physical therapy performed involves acupressure using gua sha. Gua sha acupressure is conducted using a special stone or tool called a gua sha tool. The special gua sha stone, typically made of porcelain, is gently rubbed on the area around the face down to the neck. Figure 6 The technique of rubbing or massaging the facial area with the gua sha tool is aimed at promoting blood flow and energy circulation, known as "chi" in Chinese culture.

The massage technique with Kutus-Kutus oil involves the following steps:[17] figure 7 the massage is performed in a quiet room, positioning the patient in a supine position to ensure comfort; The area to be massaged is cleaned with 70% alcohol to reduce skin oiliness; The massage techniques include effleurage, kneading, friction, and stretching; Kutus-Kutus oil is applied to the area being massaged; Starting with effleurage and kneading movements, use the second and third fingers to perform circular motions on the masseter muscle region to stimulate muscle relaxation and warm-up the muscle area; Then, perform an intraoral massage with light pressure followed by friction and stretching movements for 8 seconds, with a 2-second rest phase for each muscle during the massage. This procedure is repeated 5 times for each muscle to reduce muscle tension and achieve relief at trigger point areas; The massage is carried out on the myofascial region, neck, face or head; Extramuscular and intramuscular techniques are applied to these regions, performing 3-5 release techniques at each location; Instruct the patient to practice diaphragmatic breathing for relaxation, reducing the sympathetic nervous system effects during the massage procedure.

The examination results after 2 weeks showed that, based on subjective assessment, there was a decrease in pain in the jaw joint area, and upon waking, the patient no longer felt stiffness. The habit of teeth clenching was obstructed by the use of a stabilization splint, making the patient consciously remember not to engage in such behavior. According to objective examination, mouth opening without pain increased, from 34 mm before treatment to 46 mm at the 8-week check-up after the splint was applied. This indicates the effectiveness of using the stabilization splint along with gua sha acupressure and massage with Kutus-Kutus oil in reducing pain in Temporomandibular Disorder (TMD) cases.

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Discussion

The main purpose of a stabilization splint is to normalize the tone of the masticatory muscles and at the same time distribute occlusal forces evenly. The principle of the stabilization splint is to increase patient awareness and relax the muscles. Alternative names for the stabilization splint include the superior repositioning splint, the Tanner appliance, the Michigan splint, the Fox appliance, or the centric relation appliance. The stabilization splint is a hard acrylic splint that plays a role in reducing abnormal muscle activity and achieving neuromuscular balance.[2,12,19] The stabilization splint is effectively used to protect teeth from abrasion due to parafunctional activities such as bruxism and clenching, eliminate occlusal disturbances, stabilize the relationship between teeth and the jaw joint, restore vertical dimension, reduce the load on the temporomandibular joint, and distribute the load in cases of clenching which significantly affects the reduction of pain.[12]

There are about 74 publications on the use of acupressure in dentistry, and 17 of them are randomized controlled trials (RCTs). Nine trials reached this level; of these, four investigated the use of acupuncture in postoperative pain management and four in temporomandibular disorders (TMD). The four trials that included TMD demonstrated some benefits comparable to occlusal splints. Three of the postoperative pain management trials found that acupressure was effective.[9] According to Naik et al., acupressure can be used to manage various disorders in dentistry. It can offer new hope for patients suffering from conditions that cannot be managed with conventional treatment modalities. Some conditions where acupressure can be effectively used include toothache and gag reflex, jaw joint pain, TMJ clicking and locking, chronic muscle pain or spasms, facial pain, headaches (migraine, tension headaches), and xerostomia (dry mouth).[9]

Chapman and his team have found that the pain threshold for toothache in response to acupressure significantly increases. This method can alleviate tooth pain by stimulating nerves located in the muscles, leading to the release of endorphins and other neurohumoral factors (e.g., neuropeptide Y, serotonin). It changes the perception and processing of pain in the brain and spinal cord, reduces cardiovascular reflexes induced by tooth pain (associated with the adrenergic system), increases the release of adenosine, which has antinociceptive properties, affects the activity of the limbic-paralimbic-neocortical tissue, reduces inflammation by promoting the release of immunomodulators and vascular factors, and improves local microcirculation, which helps to dissolve swelling.[16]

A clinical trial conducted by Shen et al evaluated the effectiveness of acupressure for myofascial pain in the jaw muscles. Twenty-eight patients over 18 years old, diagnosed with chronic myofascial pain in the jaw muscles, received pressure therapy. General head and neck pain ratings were collected before and after treatment on a numerical scale. Mechanical pain stimulus on the masseter muscle was given before and after the procedure and assessed on a visual analog scale to measure pain tolerance levels. Patients who received acupressure experienced reduced jaw pain, neck pain, and also an increase in pain tolerance in the masseter muscle.[9]

Gua Sha is a traditional healing technique widely used in Asia, Asian immigrant communities, and by acupuncturists and practitioners of traditional East Asian medicine around the world. Gua Sha is generally considered effective for acute or chronic pain and for mild to severe conditions such as colds, flu, fever, and respiratory issues like asthma, bronchitis, and emphysema; functional internal organ issues, as well as musculoskeletal problems (from fibromyalgia to severe tension, spasms, or injuries), and is indicated for any case of persistent recurring pain. Gua Sha can be used as a form of self-care or family care at home as well as in clinical practice.[20]

Physical therapy and its combinations have been proven effective in reducing pain and improving mandibular function. Temporomandibular Disorders (TMD) are the primary cause of non-dental orofacial pain in patients, with the most common type being myogenous, characterized by myofascial pain. Myofascial pain is a significant symptom presented in more than half of the patients seeking treatment, with a prevalence of 31-76%. To alleviate this pain, massage therapy can be employed because it activates the pain gate mechanism. However, this therapy is less studied despite its promising results.[17]

The Kutus-Kutus oil used in this case is a herbal balm oil produced by PT. Tambar Waras and created by its inventor, S. Bambang Pranoto, from raw materials initially gathered from the kitchen and yard of his home in Gianyar Regency, Bali. The choice of Kutus-Kutus oil for treatment in this case is due to its active ingredients which include:[18] Coconut Oil: This oil has antibacterial, antifungal, and antiviral effects. Moreover, its high emollient or moisturizing content can make the skin moist and more elastic; Ashitaba Leaves: Ashitaba leaves (Angelica keiskei) have long been used by Japanese and Korean communities as an herbal medicine or tea. Some studies have revealed that ashitaba leaves possess anti-inflammatory and antioxidant effects; Agarwood: Agarwood (Aquilaria spp.) is beneficial as an antiallergy, anti-inflammatory, pain reliever, anticancer, and antibacterial agent. This plant also acts as an antioxidant, mosquito repellent, and laxative; Purwoceng: Purwoceng is known for its antibacterial, antifungal, and analgesic properties; Neem Leaves: This herbal plant also has antibacterial, antioxidant, and anti-inflammatory properties, and is capable of inhibiting cancer growth. Neem leaves are also believed to be good for maintaining the health of liver and nerve organs, as well as aiding in the wound healing process; Black Seed (Nigella sativa): Some research indicates it has the potential to address several health issues, such as hypertension, diabetes, asthma, high cholesterol, and cancer. Black seed also has diuretic, antibacterial, anti-inflammatory, and analgesic effects, and is beneficial for boosting immunity and digestive health; Turmeric: Turmeric is known for its anti-inflammatory, antihypertensive, antidiuretic, antifungal, antibacterial, and antioxidant properties. It is also suspected to improve appetite and address disorders of the gallbladder, liver, and digestion; Lemongrass: In traditional medicine, lemongrass is commonly consumed as herbal medicine, applied to the skin, or inhaled as aromatherapy. Lemongrass oil in Kutus Kutus oil is also beneficial as an antifungal and anti-inflammatory agent.

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Conclusion

Dentists should clearly understand that occlusal splints do not cure but rather provide an initial treatment within a comprehensive management approach for Temporomandibular Disorders (TMD). The combination of physical therapy as supportive care can influence the success of the treatment. Acupressure therapy using gua sha and massage with Kutus-Kutus oil can be an alternative supportive treatment option because the treatments offered can produce a relaxation effect and are relatively comfortable for patients.

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INDONESIAN JOURNAL OF PROSTHODONTICS

CASE REPORT

Management of TMD in patient with canted occlusal and asymmetry

Fitrya Dyah Wijayanti,[1] Ira Tanti[2]*

Keywords: Disc displacement, Facial asymmetry, TMJ internal derangement

ABSTRACT

Facial asymmetry can disturb not only appearance but also function. The most characteristic of the TMJ internal derangement (ID) is the disc displacement in patient with face asymmetry. To report the successful treatment of TMJ ID in class 2 malocclusion with canted occlusal plane and facial asymmetry. A 22-year-old male patient came refer by the Orthodontics Department with chief complaints of slanted jaw and bite, soreness, tension in front of right ear region. History of closed lock on his right jaw and had clicking on his left. He's a daytime bruxer. Clinical examination showed visible canting in the occlusal plane, reciprocal clicking in the left TMJ, limited movement and deviation when opening and closing the mouth. Based on panoramic x-ray, the left mandibular ramus was longer than the right. The DC-TMD diagnosis is disc displacement with reduction on the left and disc displacement without reduction without limited opening on the right TMJ. A stabilization appliance (SA) was fabricated for him. Patient was instructed to do jaw exercise, and physical-self regulation (PSR). Patient was also told that emotional stress, and bad habit should be reduced. After 4 months using the SA, and doing the jaw exercise and PSR, the patient showed significant improvement. Soreness and tension had disappeared, and facial asymmetry was getting better. Patient then was referring to Orthodontic Department to treat his malocclusion. SA, jaw exercise and PSR were a good treatment choice to manage the TMJ ID. (IJP 2024;5(2):152-156)

Introduction

Facial asymmetry can disturb not only appearance but also function. Temporomandibular disorder is a multifactorial condition with muscle hyperactivity as an important contributing factor, along with stress, arthrogenous factors, parafunctional habits and structural issues in the anatomy of the joint.[1] Temporomandibular joint disorders (TMD) were first introduced in an article written by James Costen in 1943.[2] Some of the hallmarks of TMD include Temporomandibular joint (TMJ) pain, limitation of mandibular movement, and TMJ sounds.[3] Scientific findings at that time showed that occlusion conditions affected the function of the masticatory muscles.[2] In the 1950s, a hypothesis was proposed that malocclusion caused abnormalities in the masticatory muscles and played a role in the occurrence of TMD.[2] The division of TMD is divided into three categories, namely derangement of the condyle-disc complex (disc displacement with reduction, disc displacement without reduction, disc displacement with intermittent locking), structural incompatibilities of the articular surfaces (deviation, adherences/adhesion, subluxation, luxation),and inflammatory joint disorder (synovisitis/capsulitis, retrodiscitis, osteoarthritis, osteoarthrosis, rheumatoid arthritis, hyperuricemia, traumatic arthritis).[2]

Temporomandibular joint internal derangement (TMJ-ID) is a common problem faced by dentist when treating patients with asymmetry. The most characteristic of the TMJ internal derangement is the disc displacement in patient with face asymmetry.[4-7] Articular disc displacement has known as possessing a cause-and-effect relationship with facial morphology and growth.[4,8,9] Many studies investigate the mechanism of articular-disc displacement, where in general shown increase in friction has been claimed as a major causative factor in displacement of the articular disc. The side with symptoms is directly related to the amount of vertical asymmetry.[4,10] The mandible appears to be shorter on the side with more advanced disc displacement.[4,6]

Differences in bilateral TMJ morphology may represent an anatomic disorder that predispose this patient to TMJ problems.[4,11,12] Biomechanically, vertical dental and skeletal asymmetries of the mandible, such as canting of occlusal and mandibular planes in the frontal dimension due to a difference in the height of the right left ramus, have been considered as important contributors to disturbances in TMJ loading that are related to TMJ ID.[4,13,14]

Repetitive loading with unbalanced and inappropriate direction of stress may cause reactions of the lateral pterygoid muscle and the accessory ligament around the TMJ, tending to increase the stability of the joint. These mechanical strains may cause fatigue and spasm to the muscles and ligaments that finally induce disc displacement.[4,15]

This case report aims to report the successful treatment of TMJ internal derangement in class 2 malocclusion with canted occlusal plane and facial asymmetry.

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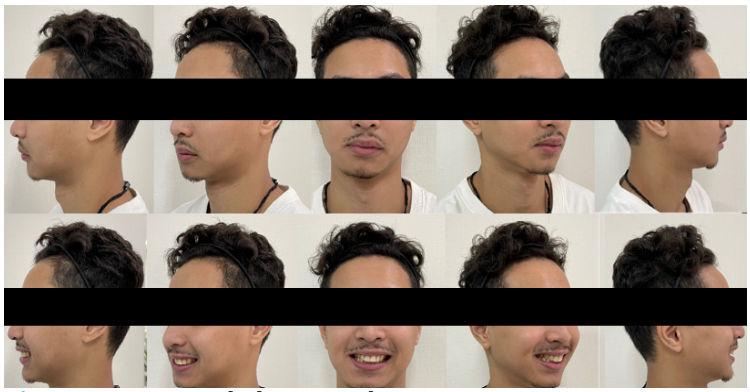

Figure 1. Extra oral photography

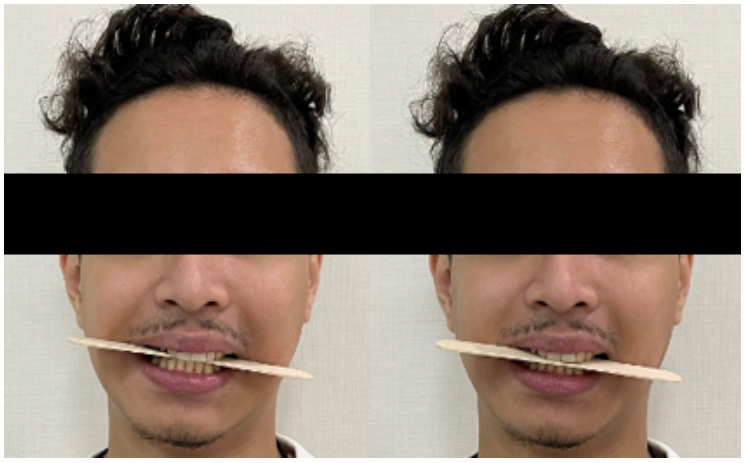

Figure 2. Visible canting

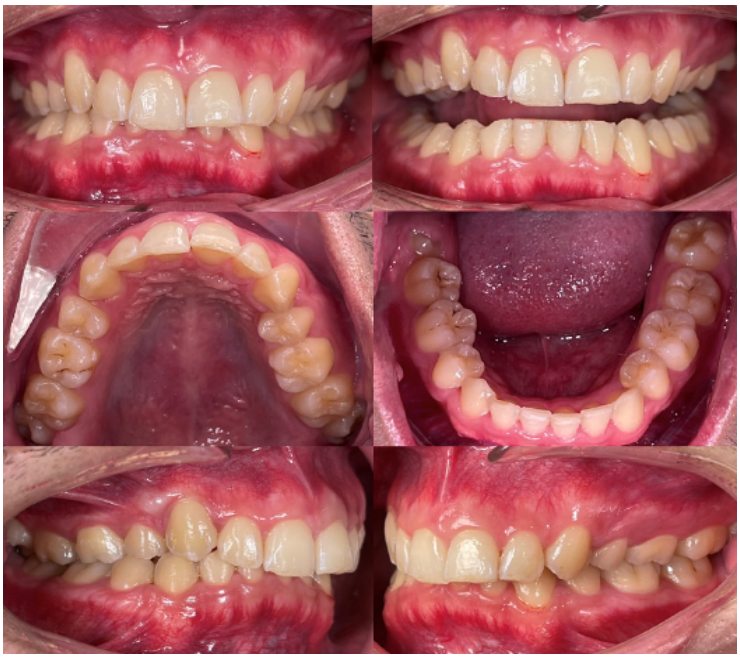

Figure 3. Intra oral examination show the clinical condition of remaining teeth

Case Report

A 22-year-old male patient came to the Prosthodontic clinic, Universitas Indonesia, Jakarta, refer by the Orthodontics department. His chief complaints were slanted bite, slanted jaw, soreness, and tension in front of right ear region after wearing orthodontic fixed braces for 1,5 years when he is in junior high school. Ten years ago, he experienced a closed lock on his right jaw, the dentist only prescribed him an analgetic. He had a limited mouth opening ever since. He had clicking on his left. Besides, he was also a daytime bruxer and history of trauma was denied. Clinical examination showed visible canting in the occlusal plane figure 1 and figure 2, reciprocal clicking in the left TMJ, limited movement and deviation when opening and closing the mouth.

Intraoral analysis showed the patient have a good oral hygiene, 14,24,34,44 missing due to the previous orthodontic treatment, occlusion class II, light occlusal wear, no occlusal interference and slide in centric figure 3. Based on panoramic radiography, it was shown that the left mandibular ramus was longer than the right side figure 4 and from posteroanterior radiography shown there is a midline deviation on the mandible to the right side figure 5. Transcranial radiograph could be seen that the right TMJ is displaced posteriorly in biting position but displaced antero-inferiorly in rest position. Left TMJ showed that there was a condyle hypermobility figure 6.

Result from the Index Temporomandibular Disorder of the patient with total score 2 are Non-Temporomandibular Disorder. Result of the Etiology of TMD showed the overall based on the gender, stress, bad habit, and freeway space examination with total score of 6 are high risk for TMD. According to the DC-TMD symptom and examination questionnaire, the diagnosis is disc displacement with reduction on the left and disc displacement without reduction without limited opening on the right TMJ figure 7.

According to Okeson, the diagnostic algorithm for temporomandibular disorders, the treatment management for the patient are fabrication of stabilization appliance, jaw exercise, physical-self regulation (PSR), reducing emotional stress, reducing bad habit[2] and orthognathic surgical considerations for correcting different mandibular ramus heights.[2,16]

Stabilization appliance (SA) is usually made for the maxilla with the aim of creating an optimal occlusal relationship for the patient. To eliminate orthopedic instability between occlusal and joint positions, thereby eliminating the etiologic factor of TMD (instability). SA can be used in maxilla and mandibula, but SA maxilla is more commonly used. Maxillary SA is more stable and covers more tissue, more retentive and less likely to break. In patients with class II and III jaw relationships, achieving proper anterior contact and guidance is often difficult with mandibular appliance, maxillary appliance is more stable as all mandibular tooth contacts are on a flat surface. SA can help to find the musculo skeletally stable relationship of the

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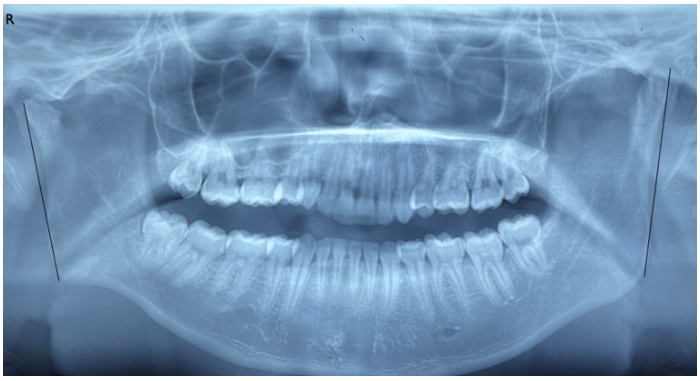

Figure 4. Panoramic radiography showed left mandibular ramus longer than the right side

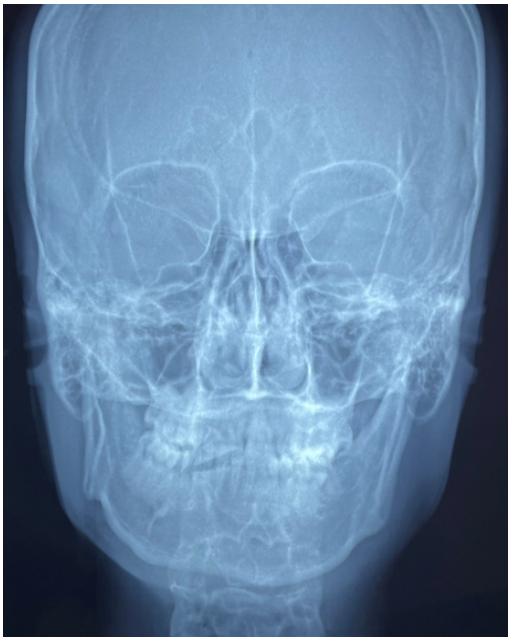

Figure 5. Posteroanterior radiography shown there is a midline deviation on the mandible

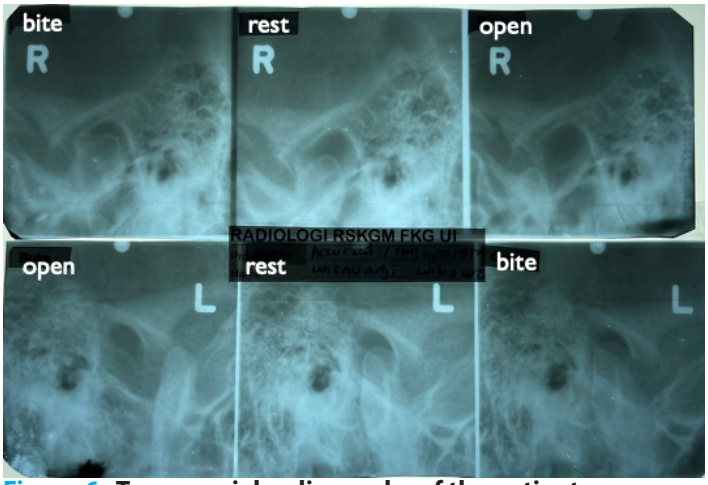

Figure 6. Transcranial radiography of the patient

condyles in the fossa.[2] According to Ooi K et al, horizontal occlusal instability strongly affected the prevalence of internal derangement of TMJ. A causal relationship has been reported between internal derangement of the TMJ and an abnormal facial skeleton, which is characterized primarily by a retrognathic mandible, mandibular asymmetry, and occlusal instability.[1,2,17] fabricating SA for this patient is the right choice to correct the instability that occurred. A leaf gauge is used to assist locating the musculo skeletally stable position. The patient asked to close, and enough leaves are placed between the anterior teeth to separate the posterior teeth slightly. As the patient tries to seat the posterior teeth, the condyles will move to the centric relation position. Care should be taken to assure that the patient does not protrude while closing or that the leaf gauge does not exert a retruding force on the condyles.[5,18] Figure 8. The patient is asked to use it every night for 8 hours a day figure 9.

Patients with dysfunctional jaw movements can often be trained to do passive exercise to avoid these movements by simply watching themselves in a mirror. The patient is encouraged to open on a straight opening pathway. In many instances, if this can be accomplished following a more rotational path, with less translation, disc derangement disorders will be avoided.[2] Repetitive loading with unbalanced and inappropriate direction of stress may cause reactions of the lateral pterygoid muscle and the accessory ligament around the TMJ, tending to increase the stability of the joint. These mechanical strains may cause fatigue and spasm to the muscles and ligaments that finally induce disc displacement.[4,15,19] The patient is instructed to open the mouth slowly. Stop if there is pain. Then the patient is instructed to watch his mouth opening with a mirror until he can make a straight mouth opening path without deviation. Sometimes passive muscle stretching can be assisted with the use of vapocoolant sprays it helps in treating trigger points associated with myofascial pain.[2]

To complete the treatment management, we asked the patient to do the Physical Self-Regulation (PSR). Based on clinical trial by Drs. Bertrand and Carlson included randomization of 44 patients with an average age of 34.6 years and with pain lasting for 52 months into either a group receiving PSR or a group receiving standard dental care (SDC) that included a stabilization appliance. Both treatments resulted in significant decreases in pain intensity and life interference from the pains 6 weeks after treatment was initiated.[2] The PSR approach consists of eight areas of education and training.[2] PSR is a powerful tool in reducing many orofacial pain conditions. There are two issues, however, that must be overcome. The first is because these principles are so simple many patients will not believe they will work. In fact, many clinicians will likely feel the same until they see the success that can be achieved. The clinician needs to convince the patient that she or he can make major improvements in the pain condition if these treatment strategies are followed.

The second issue that must be overcome is the patient must be willing to actively participate in the treatment

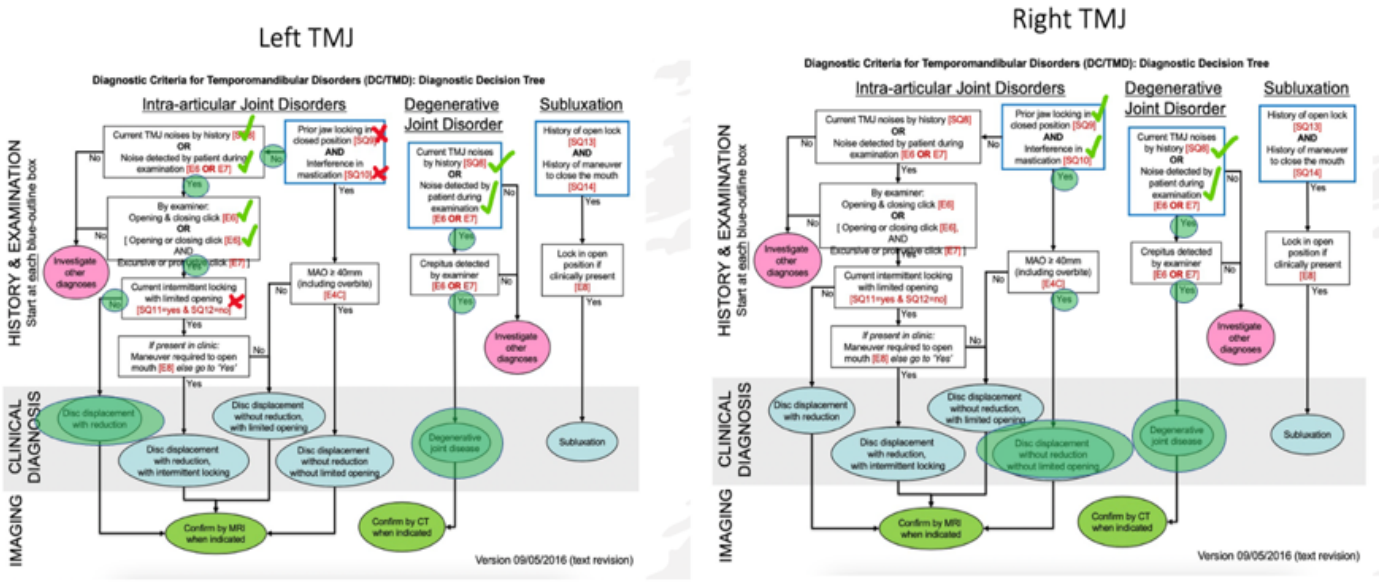

Figure 7. The DC-TMD result of the patient

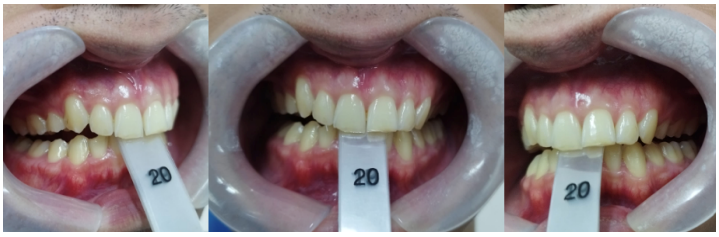

Figure 8. A leaf gauge used to assist locating the musculo skeletally stable position

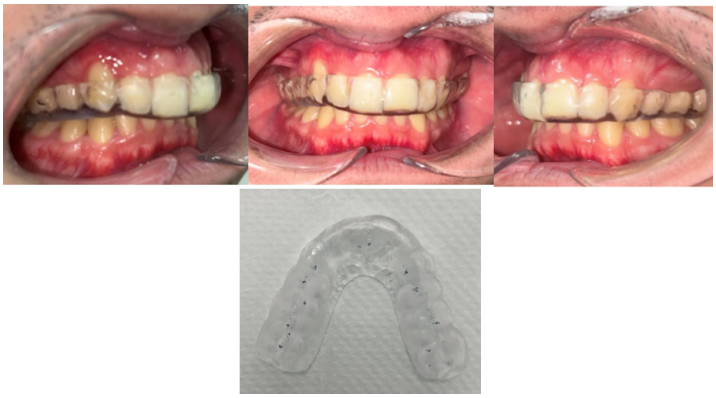

Figure 9. Stabilization appliance of the patient

strategies.[2] PSR works if the patient will actively participate and train.[2,20]

The patient underwent monthly control where each control was carried out an examination of subjective and objective complaints, palpation of the masseter, temporal muscles and TMJ to check if there's any pain. Occlusion and articulation traces on the stabilization appliance were also checked with articulating paper at every control where thick traces which meant heavy contact were reduced to get balanced occlusion pressure on all teeth figure 10. After 5 months using the SA, and doing the jaw exercise and PSR, the patient showed significant improvement. Soreness and tension disappeared, and facial asymmetry was getting better figure 11. Patient then was referring to orthodontic department to treat his malocclusion.

There is a difference in the height of the right and left ramus which can cause an imbalance in TMJ loading. This imbalance can cause increased friction on the articular disk. Unbalanced repetitive loading and incorrect direction cause a reaction to the lateral pterygoid musculus and accessory ligaments around the TMJ this causes soreness and tension which can lead to disc displacement.

By using a stabilization appliance with the help of a leaf gauge, it will position the condyle in a Musculo skeletally stable position (CR position) where the condyle head is in the supero-anterior position of the glenoid fossa. After being positioned in the MS position, it is expected that the muscles are relaxed so that the face does not look pulled to the right. According to Okeson, using SA will reduce pressure on the retrodiscal tissue. By adding passive exercise and PSR as treatment management completed the improvement in this patient where the mouth opening and closing movements that were previously deviated became more corrected and reducing bad habit.

Conclusion

The use of SA, jaw exercises and PSR are good treatment options for the management of TMJ internal derangement. Malocclusion patients with TMD symptoms should not be treated with orthodontics immediately. We must eliminate TMD first to prevent it from getting worse.

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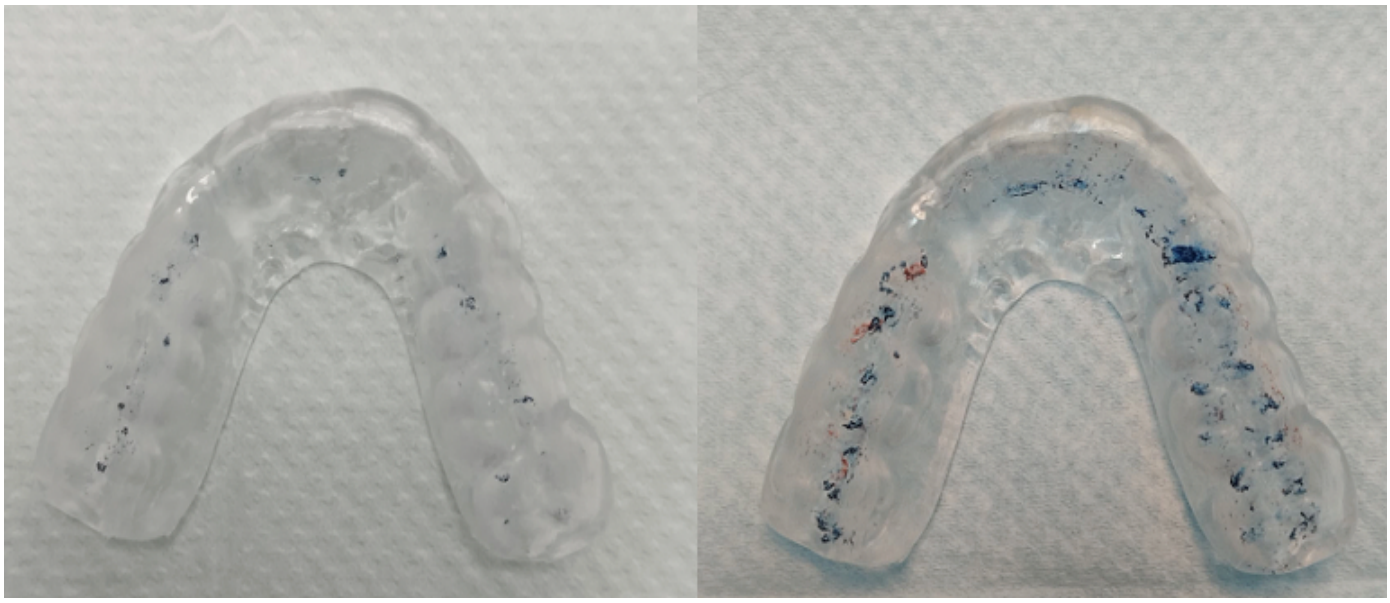

Figure 10. **Occlusion and articulation traces on SA**

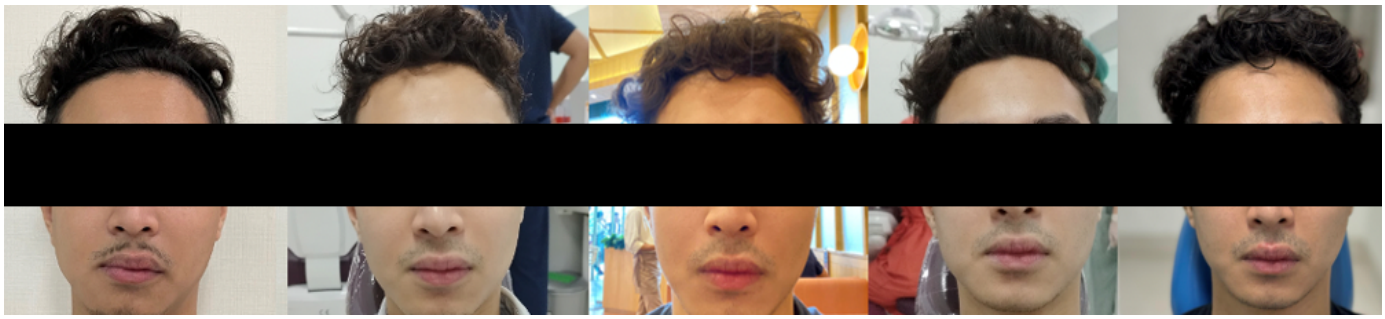

Figure 11. **Patient progression after 5 months treatment**

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ORIGINAL ARTICLE

Disinfection effect of chlorhexidine and castor oil based on usage time on the impact strength of denture base heat polymerized acrylic resin

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Keywords: Castor Oil, Chlorhexidine, Disinfection, Heat polymerized acrylic resin, Impact Strength

ABSTRACT

Heat polymerized acrylic resin is the most frequently used type of acrylic resin because it has several advantages. Heat polymerized acrylic resin dentures must be disinfected to maintain cleanliness and prevent diseases caused by wearing unclean dentures.. The chemical method is a good and easiest method to do by immersing the dentures in a disinfecting solution. The immersion will clean the surface of the denture and reach the undercut area of the denture. Chlorhexidine and castor oil are ingredients that have substances that can clean dentures, but the content in these materials has an influence on the properties of dentures, one of which is mechanical properties. This study aimed to know the effect of disinfection of chlorhexidine and castor oil based on time of use on the impact strength of heat polymerized acrylic resin denture bases with simulations of 3, 4, and 5 years. The sample was tested using a Charpy Impact Tester to determine the impact strength value. This study showed that there was an effect of castor oil on the impact strength of heat polymerized acrylic resin, but the change still above the minimum value, so this can be suggested as a disinfection material. (IJP 2024;5(2):157-159)

Introduction

Tooth loss is a condition of detachment of one or more teeth from their sockets caused by extraction due to caries or periodontal disease, trauma, and systemic diseases tooth loss usually occurs in the elderly and can result in impaired masticatory function, temporo mandibular joint (TMJ) function, and psychological, namely aesthetic and speech function.[1] A denture is a removable replacement for missing teeth and surrounding tissues. Two types of dentures available are complete and partial dentures. Complete dentures are used when all the teeth are missing, while partial dentures are used when some natural teeth remains.[2] One of the components of the denture is the denture base, where these components will be located in the soft tissues of the mouth. Denture base material can be made of metal or non-metal.[3] Heat polymerized acrylic (HPA) Resin is the most commonly used type of acrylic resin to be a denture bases because it has several advantages such as good color stability, non-irritating, non-toxic, good aesthetic quality, low residual monomer economy, small porosity, and easy manufacturing and repair processes. Heat polymerized acrylic Resin also has disadvantages, namely the presence of residual monomers, has microporosity, can absorb water or liquid, easily absorbs food or chemical residues, and is easy to fracture if hit on a hard surface or due to material fatigue due to prolonged use and discoloration after some time in the mouth. To keep denture bases clean, the denture bases must be desinfected. Denture disinfection methods can be divided into mechanical, chemical or combined methods. Mechanical methods with toothbrushes, chemical methods using disinfecting agents in the form of alkaline hydrochloride, alkaline peroxide, chlorhexidine, enzymes, and natural oils, as well as combination methods by combining the two.[4-6]

The chemical method is a good and easy method by soaking the denture in a disinfection solution. The immersion will clean the surface of the denture and reach the undercut area of the denture. A frequently used denture disinfection agent today is chlorhexidine. Chlorhexidine is an antiseptic and disinfectant chemical that is active against various types of bacteria, viruses and fungi such as Candida albicans.[7] Chlorhexidine has fungicidal and fungistatic effects that will cause nucleoprotein coagulation to occur and affect the cell wall causing cytoplasmic components to escape through the cell plasma membrane. Research conducted by Apriasari ML et al (2009) showed that disinfection of dentures with 0.2% chlorhexidine for 5 minutes can suppress the growth of Candida albicans colonies.[8] Castor oil (Ricinus communis) is biocompatible and has bactericidal and fungicidal effects. Castor oil is colorless and odorless. These characteristics together with the detergent action make its use as a denture disinfectant possible. the main component of castor oil is sodium ricinoleate that inhibits the formation of biofilms. According to de Andrade, et al (2012), the detergent action in castor oil against microorganisms is associated with cell wall damage that allows the

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Table 1. Impact Strength Value of Heat Polymerized Acrylic Resin after Disinfection Using Aquades, 0.2% Chlorhexidine, and 10% Castor Oil

No	Impact Stregnth (x 10-3 J/mm2)								
	3 years			4 years			5 years		
	A1	B1	C1	A2	B2	C2	A3	B3	C3
1	21.41**	18.24*	19.02*	17.46*	14.46	17.46**	15.94**	12.29	15.19
2	19.81	18.24	19.02	17.46	13.73*	16.69	15.94	13.01**	15.94**
3	19.81	19.02**	19.02	18.24**	15.94	17.46	15.94	11.59*	13.73*
4	19.02	18.24	19.81**	17.46	15.94	15.94*	15.19*	13.01	14.46
5	19.02*	19.02	19.02	17.46	16.69**	15.94	15.94	13.01	15.19
X ± SD	19.81 ± 0.97	18.54 ± 0.42	19.17 ± 0.35	17.61 ± 0.34	15.35 ± 1.21	16.70 ± 0.76	15.79 ± 0.33	12.58 ± 0.63	14.90 ± 0.84

Table 2. Effect of 0.2% chlorhexidine disinfection and 10% castor oil on the impact strength of hot polymerized acrylic resin denture bases for 3, 4, and 5 years

Duration	group	X ± SD	p
3 years	A1	19.81 ± 0.97	0.030*
	B1	18.54 ± 0.42	
	C1	19.17 ± 0.35	
4 years	A2	17.61 ± 0.34	0.04*
	B2	15.35 ± 1.21	
	C2	16.70 ± 0.76	
5 years	A3	15.79 ± 0.33	0.0001*
	B3	12.58 ± 0.63	
	C3	14.90 ± 0.84	

loss of cytoplasmic components and results in cell death.[9-11] Based on its function, the heat polymerized acrylic resin denture base has strength characteristics, one of which is impact strength. Impact strength is the resistance of a material not to fracture when it gets a large and sudden force in the form of compression, for example falling on a hard surface. The minimum value of the impact strength of a denture base is 5 x 10-3 J/mm2. research on the impact strength of the denture base acrylic resin heat polymerized with disinfection using castor oil has never been done, so the comparison of the results of research used as a reference is research with other materials that have the same compotitions. According to Chairunnisa R and Chailes S (2015) there was a decrease in impact strength caused by immersion of heat polymerized acrylic resin in 0.01% lerak fruit extract (containing phenol) for 2, 3, 4, 5, and 7 days. The longer the soaking time, the lower the impact strength of the heat polymerized acrylic resin.[5,12]

The purpose of this study was to determine the disinfection effect of chlorhexidine and castor oil based on usage time on the impact strength of denture base heat polymerized acrylic resin.

Material and Methods

This experimental laboratory with post test only with control group design used heat polymerized acrylic resin disinfected with chlorhexidine 0,2%, castor oil 10%, and aquadest (control). The number of sample for each group is 5, the total group of disinfection is 9, so the total sample for 9 group is 45 samples. The size of custom made model metal used for impact strength according to ADA specification no.12 is 65 x 10 x 2,5mm.

Samples was made through the process of making molds, filling acrylic in molds, curing, and polishing. After the sample is finished by polishing, the sample will be divide into 9 group which A1, B1, and A3 for 3 years disinfection, A2, B2,and C2 for 4 years disinfection, and A3, B3, and C3 for 5 years disinfection. The "A" group is for aqueadest (control), the "B" group is for chlorhexidine 0,2%, and the "C" group is for castor oil 10%. After the sample divided into each group, every group will be put inside the incubator at 370C for 25, 20, and 25 days (converted from 3, 4, and 5 years). After that, the sample will be cleaned and ready to be tested with charpy impact test machine.

Measurement of impact strength is using charpy impact test machine (HungTA-HT8014). The sample is placed on horizontal posisition on the test placement. After the arm of the tester impact the sample broke into half, the result of energy will be showed on machine and recorded for measurements.

Results

Impact strength values after 3 years of immersion in group A1 were in the interval 19.02 – 21.41 x 10-3 J/mm2 and the mean and standard deviation was 19.81 ± 0.97 x 10-3 J/mm2, group B1 was at intervals of 18.24 – 19.02 x 10-3 J/mm2 and the mean and standard deviation is 18.54 ± 0.42 x 10-3 J/mm2 and group C1 is at intervals of 19.02 – 19.81 x 10 -3 J/mm2 so that the mean and standard deviation is 19.17 ± 0.35

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x 10-3 J/mm2. The Impact Strength value after 4 years of immersion in group A2 has an interval of 17.46 – 18.24 x 10-3 J/mm2 so that the mean and standard deviation is 17.61 ± 0.34 x 10-3 J/mm2, group B2 is at interval interval 13.73 – 16.69 x 10-3 J/mm2 so that the mean and standard deviation is 15.35 ± 1.21 x 10-3 J/mm2 and group C2 is in the interval 15.94 – 17.46 x 10 -3 J/mm2 so that the mean and standard deviation is 16.70 ± 0.76 x 10-3 J/mm2. The Impact Strength value after 5 years of immersion in group A3 has an interval of 15.19 – 15.94 x 10-3 J/mm2 so that the mean and standard deviation is 15.79 ± 0.33 x 10-3 J/mm2, group B3 is at interval 11.59 – 13.01 x 10-3 J/mm2 so that the mean and standard deviation is 12.58 ± 0.63 x 10-3 J/mm2 and group C3 is in the interval 13.73 – 15.94 x 10- 3 J/mm2 so that the mean and standard deviation is 14.90 ± 0.84 x 10-3 J/mm2.

The effect of disinfection of heat polymerized acrylic resin denture base with 0.2% Chlorhexidine and 10% Castor oil on impact strength was analyzed using a one-way ANOVA test. Previously, normality data was tested using Shapiro-wilk to know the data is truly homogenous..

The one-way anova test result gained significance result for all group with p <0,05, which p = 0,030 for 3 years group, p = 0,04 for 4 years group, and p = 0,0001 for 5 years group, then H0 is rejected and Ha accepted. This means there is a significant effect on changes in impact strength on heat polymerized acrylic resin denture bases disinfected with 0.2% chlorhexidine and 10% castor oil based on usage time.

Discussion

Table 1 shows the impact strength values for all HPA resins samples that have been disinfected with 0.2% chlorhexidine and 10% castor oil for 3, 4, and 5 years. group A1 the lowest impact strength value was 19.02 and the highest was 21.41 and the mean value and standard deviation was 19.81 ± 0.97, in group B1 the smallest impact strength value was 18.24 and the highest was 19.02 so that the mean and the group standard deviation was 18.54 ± 0.42, and in group C1 the smallest impact strength value was 19.02 and the largest was 19.81 so that the mean value and standard deviation were 19.17 ± 0.35. Disinfection for 4 years showed a decrease in value where in group A2 the lowest impact strength value was 17.46 and the highest was 18.24 with the mean value and standard deviation at 17.61 ± 0.34, in group B2 the lowest impact strength value was 13.73 and the highest is 16.69 so that the mean value and standard deviation is 15.35 ± 1.21, and in group C2 the smallest impact strength value is 15.94 and the highest is 17.46 so that the mean value and standard deviation in the group is 16.70 ± 0, 76. The 5 year disinfection showed a decrease in value where in group A3 the lowest impact strength value was 15.19 and the highest was 15.94 with a mean value and standard deviation of 15.79 ± 0.33, in group B3 the smallest impact strength value was 11.59 and the highest is 13.01 so the mean value and standard deviation is 12.58 ± 0.63, in group C3 the smallest impact strength value is 13.37 and the highest is 15.94 so the group's mean and standard deviation value is 14.90 ± 0.84. The result shows that the lowest value for each years is from chlorhexidine 0.2% group (B1, B2, and B3), followed by castor oil 10% group (C1,C2, and C3), and the highest value is aquadest (A1, A2, and A3).

Based on the data in table 2 from the results of the one-way anova test, there was a significant influence on disinfection of HPA resin impact strength with chlorhexidine 0,2% and castor oil 10% which p = 0.030 for 3 years group, p = 0.04 for 4 years group, and p = 0.0001 for 5 years group. The result of this study are similar to the results of research conducted by Chailes S who use 0,01% lerak extract (contain Fenol) for soaking HPA resins for 2, 3, 4, 5, and 7 days. Her research shows that the more of time of immersion, the lower value of impact strength.

The variation of impact strength of each sample can due to various factors, including the process of combining the polymer and monomer of HPA resins that cant be done in 1 time for all samples and the process still in manual which causes the sample cant be controlled perfectly.

The decrease of impact strength value for every HPA resins sample caused by the HPA resins sample properties which water absobtion. The disinfection materials

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INDONESIAN JOURNAL OF PROSTHODONTICS

ORIGINAL ARTICLE

Effect of immersion in green tea (camellia sinensis) solution on the transverse strength of heat cured acrylic resin base

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Keywords: Green tea, Heat cured acrylic resin, Transverse strength

ABSTRACT

Objective: To determine the effect of tea solution on the transverse strength of heat cured acrylic resin base. Methods: This study was a laboratory experimental study with post test only with control group design using plate-shaped heat cured acrylic resin samples with a size of 65 mm × 10 mm × 2,5 mm as many as 24 samples. These samples were divided into 6 groups, namely 3 treatment groups immersed in green tea soluble for 3 days, 5 days, and 8 days, and 3 control groups immersed in artificial saliva for 3 days, 5 days, and 8 days. The transverse strength of each group was measured using a Universal Testing Machine (Galdabini). The results were analyzed by Two Way ANOVA test and LSD test. Results: The results of the Two-Way ANOVA test showed a significant difference between immersion in artificial saliva and green tea solution, namely $p = 0,000$ ($p < 0,05$). LSD test results showed significant differences between the three immersion duration groups. Between immersion for 3 and 8 days and immersion for 5 and 8 days, the probability value of $p = 0,000$ ($p < 0,05$) was obtained. While between immersion for 3 and 5 days, the probability value of $p = 0,001$ ($p < 0,05$) was obtained. Conclusion: There is an effect of soaking in green tea solution on the transverse strength of heat cured acrylic resin bases. (IJP 2024;5(2):160-164)

Introduction

Based on Riset Kesehatan Dasar (RISKESDAS) in 2018, 57,6% of oral problems are tooth loss. The percentage of tooth loss in Indonesia is 19%. The characteristic age group of 45-54 years has a percentage of tooth loss of 23,6%. The percentage of tooth loss increases with age. Increased prevalence occurs in the population over 65 years of age. Although the percentage of tooth loss increases, not all individuals who lose teeth use dentures. The percentage of people who use dentures is 1,4%.[1,2]

Tooth loss over a long period of time and not using a denture will result in decreased alveolar bone in the edentulous area, pathological migration of the remaining teeth, decreased masticatory function, impaired speech, aesthetic disturbances, and can affect the temporomandibular joint (TMJ).[3] The many adverse effects of tooth loss make it necessary to use dentures to replace missing teeth, one of which is a removable denture.

The component of a removable denture consists of artificial teeth, clamer, and base. The base of a removable denture can be made from acrylic or metal materials, but the most commonly used is acrylic resin. The denture base plays a role in the stability and retention of the denture. The denture base functions to support the artificial teeth, receive functional forces during occlusion, and then transfer functional forces to support the oral structure in a sustainable manner.[4-6]

Heat cured acrylic resin is widely used because of its advantages, such as transparency, aesthetics, low toxicity, and easy processing, manufacturing, and repair. However, acrylic resin also has some disadvantages, such as easy to absorb liquids, porous, discolored, and easy to fracture. Fractures of denture bases often occur especially in the maxillary midline area. Resistance to fracture depends on the mechanical properties of the material used, one of which is transverse strength.[7,8]

Transverse strength is the strength of a plate supported at each end against a static load. Transverse strength is affected by molecular weight, polymer particle size, residual monomer, porosity, material thickness, load, and moisture content. The transverse strength of acrylic resin is also affected by liquid absorption. The more liquid that penetrates into the base, the more physical changes will occur that will affect the strength and surface structure of the acrylic resin.[7-9]

Tea is a beverage that is often consumed among the public. Per capita tea consumption in Indonesia is around 0.35 kg/year. According to the International Tea Committee (ITC), in terms of green tea consumption, Indonesia ranks 4th among countries in the world. Tea contains three important components, namely caffeine, tannins, and polyphenols. Polyphenols are ingredients that have many health benefits. The highest tea polyphenol content in green tea is 20-30%. A cup of tea contains about 100 mg of polyphenols.[10-14]

When denture users consume tea, the acrylic resin base will

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Figure 1. Transverse strength testing of heat cured acrylic resin plates

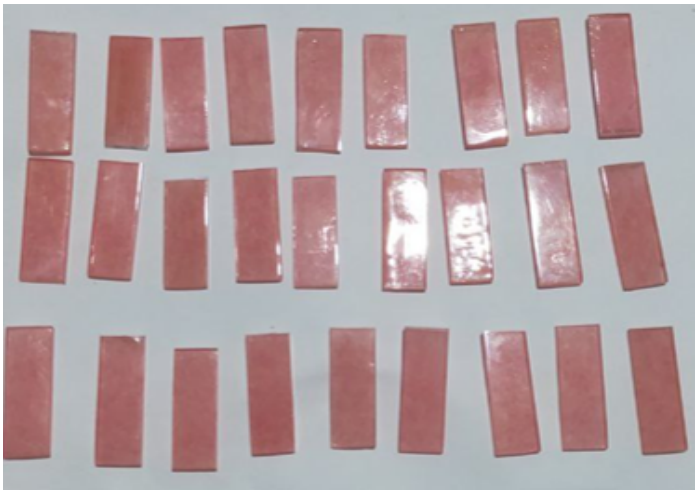

Figure 2. Heat cured acrylic resin plate after transverse strength test

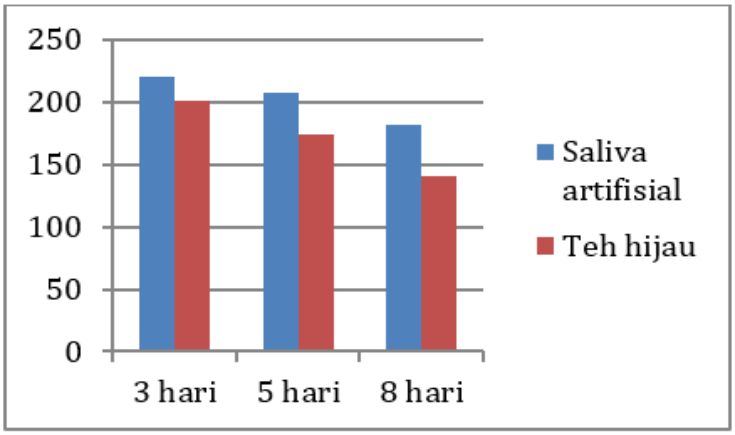

Figure 3. Average value of transverse strength based on immersion duration

come into contact with the tea solution. The polyphenol content then penetrates into the acrylic resin base, breaking the long chain of acrylic resin polymer. As a result, there is a decrease in the intermolecular bonds, thus reducing the strength of the acrylic resin base. Polyphenols can also affect the transverse strength of acrylic resins because they form microporosity that causes chemical damage to the surface of acrylic resins.7,8 Based on this, the authors are interested in examining the effect of immersion in green tea (Camellia sinensis) solution on the transverse strength of heat cured acrylic resin bases.

Material and Methods

This research is an experimental laboratory research with post test only with control group design. This research was conducted from November to December 2023 at Manise Dental Laboratorium Makassar, Oral Biology Laboratory Faculty of Dentistry Hasanuddin University, and Mechanical Engineering Mechanical Laboratory of Politeknik Negeri Ujung Pandang. This study used plate-shaped heat cured acrylic resin samples with a size of 65mm×10 mm×2.5mm as many as 24 samples. These samples were divided into 6 groups, namely 3 treatment groups immersed in green tea soluble for 3 days, 5 days, and 8 days, and 3 control groups immersed in artificial saliva for 3 days, 5 days, and 8 days.

The tools used in this experiment are measuring cup, porcelain cup, petri dish, rubber bowl, spatel, lecron, plaster knife, brush, cuvette, cuvette pressing tool (press), stove, pot, cellophane plastic, polishing tool, caliper (sigmat), clean cloth, incubator (Memmert), and universal testing machine (Galdabini). The materials used in this experiment are heat cured acrylic resin (Huge Denture Base Polymers), base plate wax, type 3 hard cast, soft cast, vaseline, mold seal (CMS), rope, pumice, artificial saliva, water, and green tea (Tong Tji).

Sample making begins with preparing a sample model of the wax base plate with a size of 65mmx10mmx-2.5mm. then the soft cast is mixed with water and stirred until homogeneous, then put into a cuvette and calibrated. After the cuvette is fully filled, the night model is immersed into the cuvette and waited until it hardens. After hardening, the surface of the cast is smeared with vaseline using a brush. The antagonist cuvette was assembled and then filled with the cast mixture until it was full and flat. The lid of the cuvette is installed then pressed using a press tool and then lock the cuvette by tightening the screws and let stand until the cast hardens. The cuvette is tied with string and put into boiling water for 5 minutes to remove the night model. Next, the cuvette is lifted and opened, then the remaining night is cleaned, then the mold surface is smeared with CMS. Powder and liquid heat cured acrylic resin were mixed in a porcelain cup and stirred until they reached the dough stage, then put into the cuvette and covered with

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Table 1. Transverse strength of heat cured acrylic resin plates in each sample group

Sample	Artificial saliva (MPa)			Green tea (MPa)		
	3 days	5 days	8 days	3 days	5 days	8 days
1	233.28	210.24	185.76	204.48	174.24	138.24
2	216	223.2	191.52	187.2	180	144
3	213.12	194.4	178.56	197.28	168.48	151.2
4	218.88	201.6	171.36	216	172.8	128.16
Mean	220.32	207.36	181.8	201.24	173.88	140.4

Table 2. Shapiro-Wilk test results of transverse strength of heat cured acrylic resin plates

Group	Statistic	df	Sig.
Artificial saliva	0.972	12	0.933
Green tea	0.973	12	0.940

Table 3. Two-Way ANOVA test results of transverse strength of heat cured acrylic resin plates

Source	Type III Sum of Squares	df	Mean Square	F	Sig
Soaking type	5885.654	1	5885.654	61.463	0.000
Immersion duration	9989.222	2	4994.611	52.158	0.000
Total	861860.736	24			

Table 4. LSD test results of comparison of mean transverse strength of heat cured acrylic resin plates immersed in green tea solution

Immersion duration (I)	Immersion duration (J)	Mean difference (I-J)	Std. Error	Sig
3 days	5 days	20.1600*	4.89285	0.001
	8 days	49.6800*	4.89285	0.000
5 days	3 days	-20.1600*	4.89285	0.001
	8 days	29.5200*	4.89285	0.000
8 days	3 days	-49.6800*	4.89285	0.000
	5 days	-29.5200*	4.89285	0.000

cellophane. Next, pressing is done so that the excess dough flows out. The cuvette was opened again and the excess ingredients were cut off with a lekron, then the cuvette was closed and a second pressing was done and still covered by cellophane. Then the curing process is carried out, by processing the resin at 74°C for about 2 hours and increasing the temperature of the water bath to 100°C and processing for 1 hour, then removed and left to cool. After cooling, the cuvette was opened and the acrylic plate was removed and then the finishing and polishing process was carried out.

Green tea solution was prepared by dipping 1 green tea bag (2 g) in 200 ml of boiling water (100°C) for 2 minutes in a measuring cup. Then put into Petri dishes as much as 20 ml each and left to cool. The concentration of the green tea solution was 0,01 g/ml or 1%. The 24 samples were divided into 6 treatment groups based on the type and time of soaking. The first three groups as the control group were acrylic plates immersed in artificial saliva for 3, 5, and 8 days. The second three groups were acrylic plates immersed in green tea solution for 3, 5, and 8 days. The assumption of a 3-day soaking period is equal to 1 year of denture wear. The time required to consume green tea is 5 minutes. Suppose that in 1 day it is consumed 2 times, the amount of time required is 10 minutes per day. Thus, the consumption of green tea for 1 year is 10 minutes x 365 days = 3650 minutes = 2,5 days or rounded up to 3 days. Therefore, the three soaking durations were considered as 1 year, 2 years, and 3 years of denture use. The sample baths were kept in an incubator at approximately 37oC, in accordance with the temperature acceptable to the oral mucosa and the green tea solution was changed daily to avoid changes in the solution content.

Measurement of transverse strength using a Universal Testing Machine. The way this tool works is that it will press the center of the plate until it breaks. The monitor will show the maximum load value received by the plate. Furthermore, the value listed on the monitor is then converted into transverse strength using the formula S = 3PL / 2WT2.

Results

This study was conducted to examine the transverse strength of heat cured acrylic resin plate samples after immersion in artificial saliva as the control group and green tea solution as the treatment group. Immersion of the samples was divided into three different time durations, namely 3 days, 5 days, and 8 days. The transverse strength test was conducted by applying a maximum load with a crosshead speed of 3 mm/min to the center of the sample until it broke. The transverse strength testing process can be seen in figures 1 and figure 2.

The maximum load value is then converted into a formula to obtain the transverse strength value. The results of the transverse strength calculation can be seen in table 1 and figure 1.

Table 1 shows the transverse strength values of each sample after immersion in artificial saliva and green tea solution. The results showed a decrease in the average value of transverse strength in each control and treatment group. The highest mean transverse strength value was obtained in the immersion group in artificial saliva for 3 days, namely 220.32 MPa. While the lowest average value of transverse strength was obtained in the immersion group in green tea for 8 days, namely 140.4 MPa.

The transverse strength value data was then analyzed to determine the effect of immersion in green tea solution on the transverse strength of heat cured acrylic resin plates. Before further testing, a normality test was performed using the Shapiro-Wilk test. The results of the Shapiro-Wilk test can be

seen in table 2.

Based on table 2, the probability value p=0.933 was obtained for immersion using artificial saliva and p=0.94 for immersion using green tea solution (p>0.05) which indicates that the data is normally distributed so that it qualifies for ANOVA test to see the difference of several variances. The results of the Two-Way ANOVA test can be seen in table 3.

Based on table 3, the probability value p=0.000 is obtained for the type and duration of immersion (p<0.05) which indicates that there is an effect of the type and time of immersion on the transverse strength of heat cured acrylic resin plates. To determine the average difference in transverse strength in the treatment groups, further tests were carried out with the Post Hoc Test test, namely Least Significance Difference (LSD) which can be seen in table 4.

Based on table 4, there is a significant difference between the three soaking duration groups. Between soaking for 3 and 8 days and soaking for 5 and 8 days, the probability value p=0.000 (p<0.05) was obtained. Meanwhile, between 3 and 5 days of soaking, the probability value of p=0.001 (p<0.05) was obtained. Therefore, it can be said that there is a significant difference in the transverse strength of heat cured acrylic resin plates immersed in green tea solution and artificial saliva for 3, 5, and 8 days.

Discussion

A widely used base material from the past to the present is heat cured acrylic resin. Modifications to heat cured acrylic resins continue to be made to improve their properties, such as impact strength, transverse strength, thermal properties, solubility, and so on. In 2020, it was reported that heat cured acrylic resins are available in powder and liquid form. The powder component contains PMMA, benzoyl peroxide initiator, plasticizers (dibutyl phthalate), opacifiers (titanium and zinc oxide), fibers, and pigments or dyes. While the liquid component contains methyl methacrylate monomer (MMA), ethylene glycol dimethacrylate as a cross-linking agent, and hydroquinone as an inhibitor. Acrylic resin is still used today because of its advantages, such as transparency, aesthetics, low toxicity, and easy processing, manufacturing, and repair. However, acrylic resin also has some disadvantages, such as easy to absorb liquids, easily porous, can change color, and easily fracture.[9,15]

Oral conditions that are often exposed to a lot of fluids can be a factor that affects the decline in mechanical properties of PMMA, one of which is transverse strength. The more liquid that penetrates into the base, it will result in physical changes that will affect the strength of the acrylic resin. In addition, temperature changes associated with food and beverage intake during denture use can affect acrylic resin polymer bonds.[7,8,16]

When denture users consume beverages such as green tea in a warm state, the acrylic resin base will come into contact with the green tea solution. Green tea contains three important components, namely caffeine, tannins, and polyphenols. The higher the brewing temperature of green tea, the higher the total polyphenols produced. The polyphenol content in green tea can penetrate into the acrylic resin base, thus breaking the long chain of acrylic resin polymer. As a result, there is a decrease in intermolecular bonding, thereby reducing the strength of the acrylic resin base. Polyphenols can also affect the transverse strength of acrylic resin because they will form microporosity which causes chemical damage to the surface of acrylic resin.[7,8,10,16]

The results of the study in table 1, show that the transverse strength of the immersion group using green tea solution is lower than that of the immersion group using artificial saliva as a control. This is in line with Rahmi et al research, which states that the presence of polyphenols in tea solutions can degrade the chemical bonds of acrylic resins. Acrylic resin is a polymer in the form of a long polyester, consisting of repeated methyl methacrylate units with low polarity, while phenol is acidic with high polarity. In an acidic atmosphere, the esters hydrolyze to form carboxylic acids and alcohols. The split polyester causes degradation of the chemical bonds of the acrylic resin resulting in a decrease in transverse strength. Islami et al's research also states that phenol in direct contact with acrylic resin will react with PMMA esters. The polymer chain bond of acrylic resin is getting weaker because the compound will enter the surface of acrylic resin and cause acrylic resin to expand. Therefore, the intermolecular bonds decrease, reducing the strength of the acrylic resin.[8,17]

This research is also in line with research conducted by Sujati, which states that polyphenols are chemical substances that have many phenol groups, while phenol is an acidic solution and has a molecular weight smaller than the molecular weight of acrylic resin polymers. Therefore, phenol can be absorbed by the surface of acrylic resin. The chemical absorption of phenol can damage the surface of acrylic resin, in the form of crazing, which is small cracks. This condition is the first sign of fracture of acrylic resin. In addition, the absorption of green tea solution with high polyphenol content, is able to hydrolyze the ester group (COOCH3) on PMMA into free carboxylic groups (COOH). The carboxylate group that is formed then releases a proton (H+) to form a carboxylate anion (COO-). Furthermore, there is repulsion between adjacent carboxylate anions due to space constraints. The solubility will cause a lot of empty space between the polymer matrix, making it easier for bonding between the elements in the liquid and the polymer matrix in that place and breaking the long chain of acrylic resin polymer, causing crazing and decreasing the transverse strength.[7]

The results in table 1 also show that the longer the immersion duration of heat cured acrylic resin plates, the more the transverse strength decreases. The results of statistical analysis in tables 3 and 4 show that there is a significant effect of immersion duration on the decrease in the transverse strength of heat cured acrylic resin plates. In addition to the influence of polyphenolic substances in green tea, the decrease in the transverse strength of heat cured acrylic resin plates is also caused by the ability of heat cured acrylic resin plates in liquid absorption. This is in line with the research of Sundari et al, which states that the ability of water absorption plays a role in the hydrolytic degradation and erosion of

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resin materials by stretching the matrix filler. Polymer-based materials can absorb water into the matrix through a controlled (continuous) diffusion process. The water absorption that occurs will cause solution particles to penetrate and affect the chemical bonds. The longer the immersion duration, the more solution that can penetrate into the microporosity space.[18]

The incoming solvent molecules will break the polymer chains by penetrating and occupying positions between the polymer chains. These polymer chain breaks can weaken the chemical structure, which can result in decreased polymer strength. Based on the matrix degradation theory, the resin immersed in water will absorb water molecules and will penetrate into the intermolecular space of the polymer chain, so that the polar interaction decreases. This causes the distance between polymers to increase, then matrix expansion occurs, then the matrix softens, resulting in a decrease in resin strength.[18]

Transverse strength is highly considered as an indicator of the strength of a material. Poor flexural strength can cause the denture base material to be unable to withstand excessive masticatory loads, causing the denture base to fracture easily. Therefore, high transverse strength is required by a denture base material to withstand masticatory stresses that may result in permanent deformation.[7,18]

The results of the transversal test showed that heat cured acrylic resin plates immersed in green tea solution had poor fracture resistance when compared to immersion in artificial saliva. The polyphenol content in green tea can destabilize the polymer chains in heat cured acrylic resin. While polyphenols are the components responsible for antioxidant activity in tea. Therefore, denture users only need to regulate the frequency of consuming green tea and the cleaning pattern of their dentures so that the impact caused by green tea consumption will not be too great.

Conclusion

The transverse strength value of the heat cured acrylic resin base decreased as the immersion duration increased. Thus, it can be concluded that there is an effect of immersion in green tea (Camellia sinensis) solution on the transverse strength of heat cured acrylic resin base.

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1. The manuscript, written in English. Non-medical foreign terms are used only when necessary and are provided with its translation. Indonesian Journal of Prosthodontics also publishes articles written in academic English.
2. Manuscripts including tables, references and figure legends must be typewritten (double-spaced) using *Microsoft Word* on 210 x 297 mm or size A4 paper with margins of 3 cm. The maximum number of pages is 20.
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