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Implant-supported crown as an alternative for missing teeth

[1]Michael Josef Kridanto K, [1]Harry Laksono, [2]Birgitta Dwitya Swastyayana Subiakto
[1]Staff of Prosthodontic Dentistry Department
[2]Post Graduate Student of Prosthodontic Dentistry Department
Faculty of Dental Medicine, Universitas Airlangga
Surabaya, Indonesia
Corresponding author: **Michael Josef Kridanto K**, email: **josef_310563@yahoo.com**

ABSTRACT
The use of dental implants to support fixed or removable restoration is widely used as treatment modality. The advantages are increased retention, chewing ability, and easy access to oral hygiene procedures. A missing tooth that needs to be replaced completely can be restored using an implant-supported crown. The aim of this study is to rehabilitate maxillary partial edentulous with implant supported crown. A 66-year-old male patient came to the clinic, wanted to replace partial edentulous after extraction of 13 and 14, needed fixed restoration in order to eat and chew well, and expected high aesthetic result. This patient had experienced using implants to replace teeth loss in other regions. Patient wanted to have implant treatment with fixed restoration because he had experienced with the same treatment before in another region, so the prosthodontic treatment option was using implant supported crowns. Implant supported crown can be an option to replace partial edentulous.
Keyword: implant supported crown, fixed restoration, dental implant

INTRODUCTION

Dental implants, also known as oral or endosseous implants, have been used to replace missing teeth for more than half a century. Dental implant restoration has been considered to be one of the most reliable methods for treating partial or full edentulism. They are considered to be an important contribution to dentistry as they have revolutionized the way by which missing teeth are replaced with a high success rate. This success depends on the ability of the implant material to integrate with the surrounding tissue. However, this integration is influenced by several factors, such as implant materialS, bone quality and quantity, and the implant loading condition.[1]

Bone graft is frequently accompanied with dental implant surgery. Various types of bone graft materials are used such as the autogenous bone, allogenic bone, xenogenic bone, and synthetic materials. The most frequently used surgical methods for bone grafts are guided bone regeneration (GBR), block bone graft (BBG), sinus lifting via lateral window, and bone-added osteotome technique. GBR procedure needs bone graft materials and a membrane for selective occlusiveness. Bone graft materials can be used solely or mixed together in different proportions.[2] Similar cases of bone defects can be treated differently according to the surgeon's preference.

The aim of this study is to rehabilitate maxillary partial edentulous with implant supported crown.

CASE

A 66-year-old male patient came to the clinic wanted to replace partial edentulous after extraction of 13 and 14. This patient wanted fixed restoration in order to eat and chew well and expected high aesthetic result.

This patient had experienced using implants to replace teeth loss in other regions. In this case, patient lost his canine and first premolar on the right maxilla. Patient wanted to have implant treatment with fixed restoration because he had experienced with the same treatment before in another regions, so the prosthodontic treatment option was using implant supported crowns.

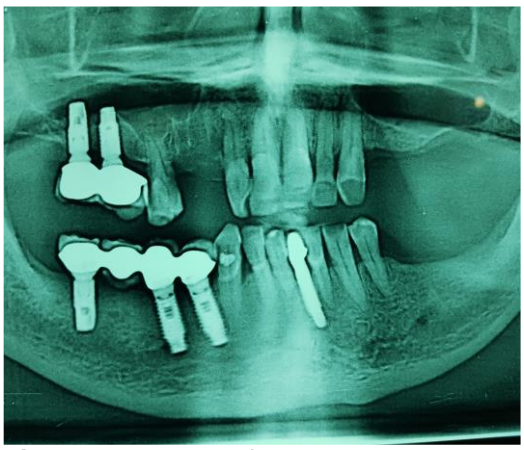


Fig 1 X-ray panoramic

MANAGEMENT

The first stage when the patient came for a consultation was taking X-ray. The X-ray shows a defect due to tooth extraction 13 and 14, which was done by adding bone graft in the area. On the next visit an implant placement Ø 3.3 x 8 mm (Straumann, Switzerland) was followed by bone grafting and membrane (Straumann, Switzerland)

in areas 13 and 14. Then a healing screw was placed to help guide the gingiva in the proper way to heal. Then, wound closure was performed by tension-free repositioning and suturing of the flap.

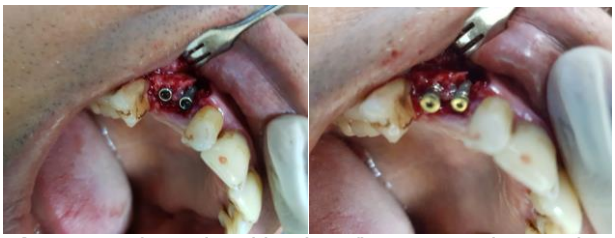


Fig 2A Two bone level implant fixture were inserted at region 13 and 14; **B** bone graft application, wound closure by tension-free repositioning and suturing of the flap

After 6 months, the healing screw was opened and a screw abutment was placed, which is the part that screws into the implant and will support the crown. Once the abutment was placed, we took another impression of the abutment for each replacement tooth. Then the patient got a temporary crown while the tissues continued to heal and form around the artificial tooth as with the natural teeth. The patient wore the temporary crown for four to six weeks. During this time, the permanent crown would be made. Then, the final stage of the procedure was placing the crown. Crowns were screwed into the abutment to this patient.

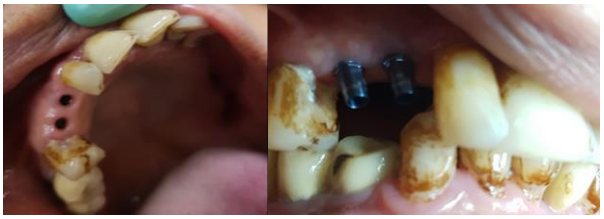


Fig 3A Healing screws were opened 6 months after implants insertion; **B** two cemented abutments were engaged to the implants

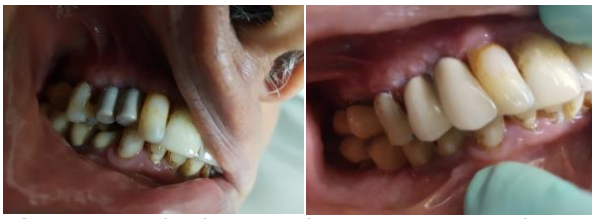


Fig 4A Two plastic protective caps were used to protect the abutments during laboratory process; **B** 2 porcelain fused to metal were chosen as final restorations.

DISCUSSION

Dental implants have been used to replace missing teeth for more than half a century. Dental implant considered to be an important contribution to dentistry by which missing teeth are replaced with a high success rate. This success depends on the ability of the implant material to integrate with the surrounding tissue.

Placement of implants requires sufficient bone volume and biologic quality. Some cases need socket preservation or ridge preservation. In this case, there is resorption of the edentulous ridge post extraction which make socket preservation or ridge preservation necessary.

These procedures involve filling the socket with bone or bone substitute material, with or without membrane. The aim of ridge preservations are filling the socket (wound care), preservation of ridge volume (ridge preservation), and new bone formation (osteogenesis). Dental implant is considered as the most reliable and convenient treatment for partial and full edentulism. Long-term follow-up of the implants showed successful survival rate of over 90 %.[3]

In several studies, 50.3% of the patients required bone graft during implant surgery. The anterior maxillary area required more than 77% bone graft. Because of the high esthetic demands in the anterior maxilla, bone augmentation was performed even though there was no bone fenestration or dehiscence.[3] Autogenous bone graft in exposed threads of the implant was suggested as a golden standard. After autogenous bone graft, xenogenic bone and absorbable membrane were used for additional augmentation for long-term esthetic results. At least 1.5~2 mm of buccal bone is required for esthetic results in the anterior maxilla.[4]

In this case, bone grafting was decided because of the presence of thin labial plate in areas 13 and 14. The indications for GBR are dehiscence or fenestration wound or thin labial plate which was expected to resorb during healing. If the width of the residual alveolar bone in the anterior maxilla was less than 3 mm, BBG was performed. BBG was performed in the anterior maxilla most frequently than in any other sites.[5]

During GBR procedures, xenogenic bone with/without autogenous bone was the most commonly used. The advantages of the xenogenic bone include slow bone resorption during the healing phase and its wide availability. Although there was no bone dehiscence, xenogenic bone was recommended to graft for the augmentation of the labial bone. In this study, absorbable membrane (Straumann, Switzerland) was used for GBR procedure.[5]

In this case, the retention of the restoration relies on the retaining screw. Nevertheless, the restoration can be removed and/or replaced when required, without damage or need a new restora-

tion. The adaptation between the restoration and the underlying implant is usually better than that in the case of its cement-retained counterpart. It can be used when the vertical restorative space is limited as the retention depends on the screw, but is contra-indicated when mouth opening is limited, as the use of the different tools required for screwing and torqueing the screws may not be possible.[2]

However, the use of a screw-retained restoration may be considered when the implant platform is situated deep sub-mucosally, as complete removal of cement is not always possible when a cement-retained restoration is used. The screw type is not indicated when the screw hole is pointed at the labial surface as this compromises the aesthetics. Hence, the implant should be placed in its optimal position and angulation to avoid negative effects on aesthetics, otherwise an angled abutment may provide an acceptable alternative.

So, it was concluded that Implant can replace missing teeth to restore masticatory function and aesthetic for the patient. Bone graft was necessary to augment the defect areas during implant surgery. The success of any implant supported restoration is dependent on the interaction between the patient and the dental personnel. Maintaining good oral hygiene and committing to regular check-ups are the responsibility of the patient.

REFERENCES

1. Zupnik J, Kim S, Ravens D, Karimbux N, Guze K. Analysis. J Periodontol 2011;82:1390–5.
2. Warreth A. Dental implants : an overview. Dent Updat 2018; 44: 596–620.
3. Ribeiro CG, Bittencourt TC, Ferreira CF, Maria N, Picorelli S. An alternative approach for augmenting the anterior maxilla using autogenous free gingival bone graft for implant retained prosthesis. J Oral Implantol 2014;XL(2):183–7.
4. Chen ST, Buser FD, Dent PM. Esthetic outcomes following immediate and early implant placement in the anterior maxilla — a systematic review. Int J Oral Maxillofac Implant 2014;29(1):187–95.
5. Cha H, Kim J, Hwang J, Ahn K. Frequency of bone graft in implant surgery. Maxillofac Plast Reconstr Surg [Internet]. 2016;38(19):2–5. Available from: http://dx.doi.org/10.1186/s40902-016-0064-2.

Anterior repositioning splint treatment consideration for cases of disc displacement with reduction

[1]Steven Alexander Tjang, [2]Ira Tanti
[1]Prosthodontic Residency Program
[2]Prosthodontic Department
Faculty of Dentistry, Indonesia University
Jakarta, Indonesia
Corresponding author: **Ira Tanty**, email: **iratanti@ymail.com**

ABSTRACT
The focus of this literature review is to explore the process of disc displacement with reduction (DDWR) and how the treatment using anterior repositioning splint (ARS) can positively affect patients who are diagnosed with DDWR. The use of MRI as the gold standard of TMJ study allows current researcher to re-consider the common theory whereby DDWR ultimately progresses into disc displacement without reduction or other advanced internal derangement process. The use of ARS can produce resolution of pain in patients who are experiencing DDWR with joint pain. However, the use of ARS is shown to be effective on short term only, and its use must be accompanied by other modalities such as physical self-regulation (PSR). The lack of gold standard for the treatment of DDWR prompts healthcare worker to provide patients with conservative treatment before offering more advanced and sur-gical procedure, both of which carries additional unwanted risk. Overall, the use of ARS is shown to be very effective and non-invasive.
Keywords: disc displacement with reduction, anterior repositioning splint, TMD

INTRODUCTION

Temporomandibular disorder (TMD) is a group of conditions that involve masticatory muscles, temporomandibular joint (TMJ) and the surrounding structures. Generally, the term intercapsular disorders involves muscles of mastication, whilst intracapsular disorder involves temporomandibular joint complex. From the myriads of intracapsular disorder variations, disc displacement with reduction (DDWR) conditions comprises of 41% of the diagnoses of TMD that is often founded by clinician.[1] Observation of the condition of DDWR under magnetic resonance imaging (MRI) show articular disc position located more anteriorly than normal during maximum intercuspation. During mouth opening, articular disc will return to a normal position, whereby the returning motion of condyle to normal position from anterior position creates the clicking sound. DDWR can be accompanied with pain or without pain. A recent publications show 31% of patients has no signs of painful condition.[2]

Correlation between pain and TMD is still a matter of debate. Okeson explained that intracapsular disorder can occur on patients with orthopedically unstable TMJ as well as unfavorable masticatory force. However, not all orthopedically unstable TMJ will lead to intracapsular disorder, and therefore therapy is not always indicated.[1] The high prevalence of DDWR among general population causes confusion for both patient and clinicians in terms of the risk factor associated with the progression on DDWR. A literature review is important to determine whether DDWR treatment will be needed and/or the degree of treatment that can be provided for patient.[2]

The use of anterior repositioning splint (ARS) has been known as one of the treatment alternatives for DDWR with a good success rate. A short-term use of ARS has been shown to be able to reduce painful symptom associated with DDWR. However, several researchers found that the long-term use of ASR can cause relapse to DDWR, making articular disc condition return to a state before treatment.[2,3]

This literature review will revisit DDWR, its progression, the need to alleviate the condition and ultimately to determine whether the use of ARS can become a routine procedure to treat and resolve DDWR that often becomes patient's chief complaint.

METHODS

Focused questions

Using patient, intervention, comparison, outcome (PICO) format, the following criteria were framed for this literature search, that is P: patients with DDWR that seeks treatment for their condition due to the presence of pain and/or clicking sound; I: patients instructed to use ARS as a form of treatment for DDWR; C: comparing the position of articular disc within TMJ complex before, during and after treatment with or without the use of ARS. Pain and clicking evaluation before

and after treatment with ARS compared to without the use of ARS. Comparisons performed using MRI; O: effectiveness of ARS with the following outcome that is pain resolution, clicking sound resolution and resolution in disc position within the TMJ complex.

Search strategy method

Using electronic search of three databases, MEDLINE (Via PubMed), Cochrane Library and Scopus, was performed to identify the relevant literature. Articles that are published in the last 10 years, from January 2010 to December 2019, were considered. The following combination of keywords was applied ((ARS [All Fields] OR anterior repositioning appliance [All Fields]) AND (DDWR [All Fields] OR TMD [All Fields] OR TMJ dysfunction [All Fields] OR TMJ disease [All Fields]) AND (MRI [All Fields] OR MRI [All Fields])).

Additionally, manual search of relevant articles was performed. Articles published between the year 2010 through the latest, which is 2019, was performed in the following journals: Journal of Cranio-Maxillofacial Surgery, Journal of Oral Rehabilitation, Scientific Reports, Journal of Applied Oral Science.

Inclusion and exclusion criteria

The following inclusion criteria were applied: any case series, prospective, retrospective, cohort studies, controlled clinical trials, or randomized clinical trials with five or more patients included, full text in English, and a minimum of patient follow-up performed after treatment.

The following exclusion criteria were applied: in vitro studies and animal studies

RESULT

Using the search strategy, 14 articles from Cochrane Library, 6 articles Scopus, and 5 articles from MEDLINE via PubMed. Using the inclusion and exclusion criteria, 6 articles were selected to be part of inclusion criteria.

Article by Liu et al evaluated the effect of bite position when different splint treatments are used to a sample of 37 subject with a mean age of 18.8 $\pm$4.3 years old. Maximum intercuspation was used as control, while ARS is being compared with stabilization splint. Measurement using MRI is performed by determining the disc-condyle angle during the use of the splint. In this study it was shown that ARS improves relationship between disc condyle more than stabilization splint and control. However, it is also shown that transitory posterior movement of the disc also occurred. Here the author mentioned that as soon as ARS is no longer being used, articular disc will return to its displaced position. The long term effect of continual use of ARS is not being investigated.

Chantaracherd investigated more about the

Table 1 The 6 journals selected to be part of inclusion criteria

Author	Findings on pain resolution	Findings on clicking resolution	Findings on change in discal recapture after the use of ARS
Liu et al[5]	No information on pain	ARS resolve clicking sound, but the sound returns after no longer using ARS	Disc recapture was more significant in the use of ARS when compared to control and SA (stabilization appliance)
Chantaracherd et al[4]	Using characteristic pain intensity (CPI), ARS is statistically significant up to 3 months after treatment end	ARS use has no impact on clicking sound	No information on discal position
Ma et al[6]	Statistically significant reduction in joint pain	Statistically significant reduction in joint clicking	Disc recapture was statistically significant in younger subject (early adolescent) but not in older (late adolescent)
Litko et al[8]	Statistically significant in joint pain	No information in joint clicking, but patient with limited mouth opening show sign of improvement.	No information on disc recapture, but correlation is made between the severity of disc displacement with restriction in mouth opening.
Xie et al[7]	No pain is reported after the use of ARS	No information in joint clicking	No information in disc recapture, but in adolescent patient it shows mandibular asymmetry for patient who does not receive ARS after 6 months follow up
Chen et al[3]	Pain resolves after treatment with no recurrence	Joint clicking sound completely disappeared during observation period	Disc recapture is shown from the time of ARS use and up to 6 months post-treatment. After that period, disc recapture only appears in 40.6% of subject

conventional pathway of the progression of DDWR to disc displacement without reduction (DDWoR). The use of ARS is shown to alleviate pain in patient with DDWR, but patient without pain that do not use ARS is also shown to remain stable for years after observation. It seems that the progression of DDWR to DDWoR, as we previously believed, is not an absolute theory, because some people, especially older people, can experience DDWR without progressing to degenerative disease. Therefore, in this cross sectional studies there is not association between TMJ intra-articular status and TMD impact.

Ma et al tries to determine the efficacy of ARS in DDWR patient with class II occlusal relationship in 91 subjects with mean age of 15.7 years old. The observation was performed using MRI and images were taken before treatment (T0), after bite registration (T1), at the end of treatment (T2), and 12 months after treatment (T3). In this study it was shown that the efficacy of ARS decreases over time. However, from clinical and MRI findings it can be concluded that ARS is an effective treatment modality in DDWR, especially for patients in early puberty.

Litko et al analyses the degree of DDWR with restriction in mouth opening; 191 patients: 148 women and 43 men ages 14-60 years old, that are diagnosed with DDWR were treated and found that the severity of DDWR from sagittal is statistically significant predictor in mouth opening. The association of disc displacement and TMJ internal derangement were made in this journal, and no clicking is mentioned during the trial.

Xie et al studies how DDWR affects mandibular asymmetry in adolescent patient. In this self-control longitudinal study, craniofascial growth were recorded at least 6 months in 40 patients ages 10-20 years, and found that if DDWR is not treated, then the severity of mandibular asymmetry during growth increases. There is no mention on joint pain and clicking associated with DDWR.

The study by Chen et al examines the short and long term effect of ARS on disc condyle by metric analysis by Draze-Enazmann Disc condyle angle using MRI. 32 TMJ were studied and MRI image were taken before the study, immediately post-insertion and 6 months after treatment. The study found that ARS has a good short term effect on disc condyle complex with relatively lower efficacy in long term of 6-months observation period.

When comparing results between the articles, many heterogenities of results are shown in terms of subject choice, methods of assessment, and factors to be considered. Some articles, such as Ma et al and Xie et al uses subject ages 12-18 years old to assess the treatment of DDWR on a subject that are still undergoing growth stage. This can produce different result when compared to older subject who are no longer growing. Moreover, some subjects use questionnaire as a form of assessment in terms of improvement, such as Chantaracherd et al and Litko et al, whereas other researchers use MRI as the gold standard of TMJ assessment. These differences need to be taken into account when analyzing the results that they have.

In general, these articles have similarity in conclusion especially 1) the use of ARS is an effective modality to treat DDWR. Results is statistically significant during and post-treatment. However, after 6 months, some patients have their condition relapsed back into DDWR. Therefore longitudinal studies are needed to further assess the efficacy of ARS; 2) the lack of treatment of DDWR does not lead into further disc derangement disorder such as DDWoR or other degenerative disorder. These chains of causality must be investigated further.

DISCUSSION

Disc displacement with reduction

DDWR is known to be the most common internal derangement of TMJ condition in the majority of the population.[6] When teeth occlude, articular disc is positioned more anterior than normal, and often reduced to normal position during mouth opening. This condition is thought to be caused by biomechanical pressure that the condyle receive against mandibula, which can cause progressive change in function and form. Various factors that potentially play a role in increasing the risk of DDWR can be summed into microtrauma and macrotrauma. Macrotrauma, such as automobile accident or a physical hit to lower jaw, can be easily found out during anamnesis. Microtrauma, however, can be undetected when examined with an inexperienced clinician. One of the example of microtrauma is bruxism[2], and orthopedic instability that can happen in tooth arrangement that are unstable. It can also happen to Angle class II division two which is often found to have positive correlation with DDWR. Other condition, such as hypoxia reperfusion injury is also another form if microtrauma whereby overloading joint overtime can cause soft tissue degradation. Damage to collagen fibril causes reduction in collagen network, and secretion of synovial fluid from

articular disc creates a more tender disc. This condition is also known as chondromalacia. When this condition left untreated, articular disc adhesion can occur at the superior compartment of articular disc, which contributes to DDWR.[1]

The progress of DDWR can be explained through elongation of discal collateral ligament. Thinning of the posterior border of articular disc can also cause to displace articular disc anteriorly, which shifts condyle position to a more posterior position, closing in to retrodiscal tissue. This could potentiate into DDWR with painful symptoms due to aggravation of retrodiscal tissue. When patient opens their mouth, the motion of mouth opening cause changes in articular disc position.[2,9]

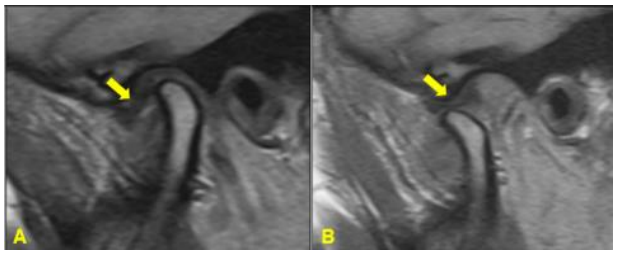


Figure 1 DDWR; **A** during maximum intercuspation, articular disc (yellow arrow) is located more anteriorly in its relation with TMJ's condyle fossa complex; **B** during maximum mouth opening position, articular disc returns to normal position, where it articulates well in between condyle and articular eminence.[2]

The prevalence of DDWR is higher among women than men. It is speculated that the joint laxity of women's joint articulation along with higher intra-articular pressure is one of few probable causes of this discrepancy when compared to men. Furthermore, there are positive correlation between an increase in age and an increase in prevalence which is thought to be caused by the change in articularis disc dimension along with advancing age.[2] Other researcher have found that an estrogen receptor within women's TMJ complex allows them to speculate that changes in metabolic function due to fluctuation in women's estrogen level can cause changes in flexibility of TMJ's ligament.[6] These findings are thought to contribute to the increasing number of women who suffers from DDWR when compared to men.

It has been suggested that DDWR would be the first stage of disc displacement, and its progress to DDWoR, retrodiscitis or other intracapsular disorder is inevitable. However, such speculations is not consistent to all conditions and types of DDWR. Researchers have found that, from the study of 155 TMJ patient with DDWR, 93.5% of them would not have this condition progresses; only 6.5% of these patients, or six TMJ, that progresses into DDWoR. The condition of DDWR can continue to remain unchanged as long as patient has an adaptive capacity to withstand clicking. The most common findings of adaptive capacity are in a form of retrodiscal fibrosis, where bilaminar zone of TMJ created fibrotic structures as an evidence of adaptive capacity of articular disc. This conditions can be stimulated through the use of occlusal splint (Fig 2).[2,6,9]

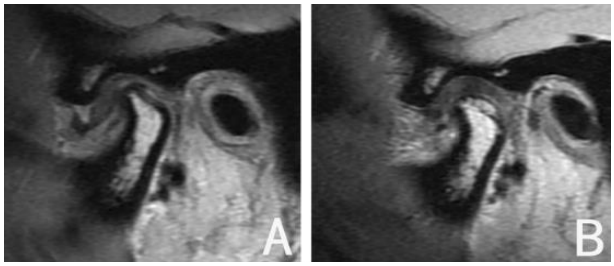


Figure 2A The condition of DDWR within TMJ complex before treatment, viewed using MRI; **B** TMJ complex after treatment with occlusal splint. Bone apposition can be seen in posterosuperior region of the condyle and the formation of retrodiscal fibrosis within the retrodiscal tissue.[6]

TMJ complex to confirm DDWR can be examined using MRI as the gold standard.[2,5,8–10] MRI can accurately show the morphology and the articular disc position in relation to the bone structures within TMJ. The specificity value is around 88-90% with sensitivity value between 78-83.3%.[2,3,5] Several techniques available to analyze articular disc position in relation to condyle and fossa. One of the more common technique is the Draze-Enazmann method. Point C is designated as the centric point within the condyle head, while Point D is the middle point within the posterior margin of posterior articular disc. Line 1 can then be created from point C and be made perpendicular to Frankfort Horizontal plane. Line 2 can be made by joining point C and D. when Line 1 and 2 are examined, the angle made between these two lines is known as disc-condyle angle. The normal value of this angle is between -15° and +15°. When the value is larger than +15°, then it is an indication of DDWR condition being positive (Fig 3).[3,5]

Ultrasonography can be used as an alternative way to examine the condition of DDWR. This technique has specificity value of 66.7% and sensitivity of 78.6%. The drawbacks of USG is the lack of standardized examination technique, so it's accuracy varies in each examination when compared to MRI.[2]

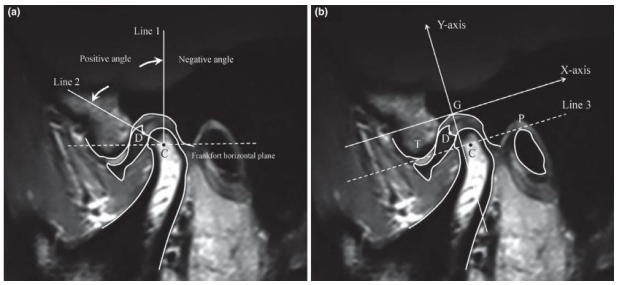


Figure 3A Examination of DDWR using MRI and Draze-Enazmann method. Point C is the centric point of the condyle head, while point D is the middle point of the posterior margin of articular disc. Line 1 can be made from point C and be made perpendicular to Frankfort Horizontal plane, while Line 2 is made by joining point C and D. between Line 1 and 2, it will create an angle known as disc-condyle angle; **B** coordinate measurement of articular disc position and condyle head.[3,5]

Aside from the advancement of technology, manual examination remains preferred examination method of choice is most TMJ dysfunction case. According to the Diagnostic Criteria for TMD (DC/TMD),[11,12] examination of DDWR must meet at least one of these criteria: 1) in the last 30 days, any TMJ noise(s) present with jaw movement or function, or 2) patient report of any noise during the exam.

During the examination, patient must experience at least one of the following: 1) clicking, popping, and/or snapping noise during both opening and closing movement, detected with palpation during at least one of three repetitions of jaw opening and closing movement, or 2) clicking, popping and/or snapping noise detected with palpation during at least one of three repetition of opening or closing movement, and 3) clicking, popping, and/or snapping noise detected with palpation during at least one of three repetition of right or left lateral, or protrusive movement(s).

The use of imaging is the reference standard for this diagnosis. The use of panoramic imaging provides 34% sensitivity value and 92% specificity value.[11,12] However, other research found that the methode proposed using DC/TMD only provides 44% sensitivity value and 46-57% specificity value in evaluating DDWR.[2]

According to Jeffrey Okeson, DDWR should have the following criteria: 1) there is a single joint sound during opening and closing movement in one or both TMJ. Joint sound does not include reciprocal sound or crepitation sound; 2) can have association with joint pain; 3) normal mandibular motion, with maximum mouth opening more than 40 mm when measured from incisal edge of upper central incisive against lower central incisive tooth.

Anterior repositioning splint

Fabrication of ARS was first proposed by Farrar in 1970.[3] The purpose of ARS is to return association between disc-condyle-fossa complex into normal position. When mandible is positioned more anterior dan maximum intercuspation (MI) by using ARS, this provides stability to TMJ. The use of reverse incline on ARS in the anterior maxillary region will provide guidance to occlude in a more anterior position (Fig 4).[6]

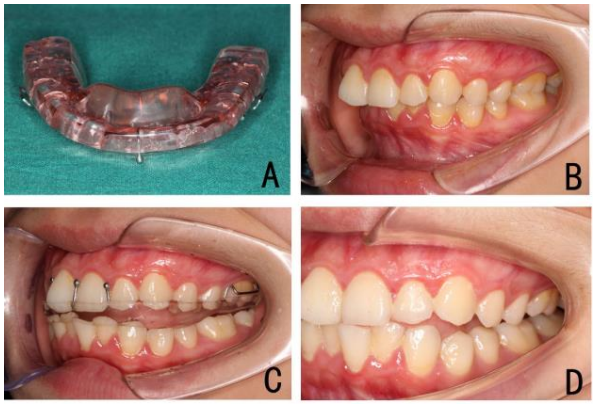


Figure 4A Full coverage ARS on anterior maxilla using the reverse incline plane bite block on palatal as guidance so that mandibula can be positioned more anterior; **B-D** occlusal re-establishment after the use of ARS. [6]

The treatment mechanism of ARS as a mode of therapy is still debatable. Two theories emerge that are generally acceptable among researcher. One of them is the '*recapturer*' theory who stipulates that as condyle is placed more anteriorly, the relationship between disc-condyle-fossa allows articular disc to recapture a normal relationship by guiding condyle to occlude along the posterior slope of articular eminence through periodic modification of ARS. With repeated use for short period of time, articular disc can stimulate bone apposition along the posterosuperior area of condyle and/or creating fibrotic structures along the retrodiscal tissue (figure 5).[3,6,9] Another theory proposes that after the use of ARS, clinician must restore the whole dentition so that mandibula will return to therapeutic position, which is a position that locates condyle more anteriorly. This is known as the '*rebuilders*'.[3] Okeson stated that the '*recapturer*' theory is more acceptable because fibrotic structure along the retrodiscal tissue can remove pain symptoms that is associated with DDWR. Furthermore, mandibular position would be able to return back into a musculoskeletally stable position, when compared to rebuilders that maintains therapeutic position more anterior than muskuloskeletally stable position.[1,9]

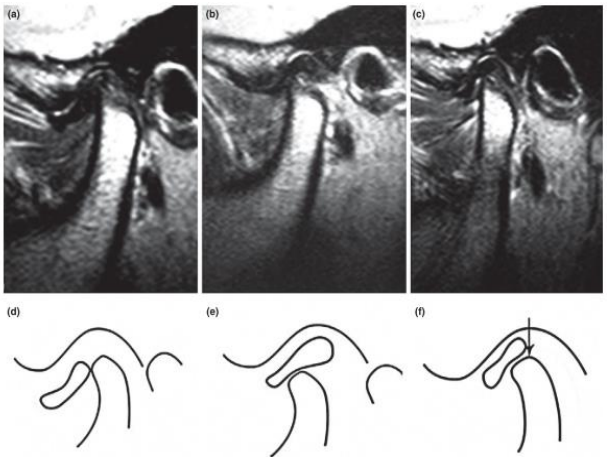


Figure 5 (A) DDWR before treatment. (B) DDWR after placement of ARS, where articular disc is recaptured to a more normal position in maximum intercuspation where loading of the joint is transferred within the thin intermediate zone between condyle and fossa. (C) Fibrotic structure is made as an adaptive response to the use of ARS after 6-8 weeks. Retrodiscal tissue does not elicit joint pain because of its fibrotic structure. (D-F) A diagrammatic representation of A-C, respectively.[3]

Primary indication of the use of ARS is to treat DDWR as well as disc displacement with intermittent locking on mandibula. The use of ARS has also been shown to be able to treat single clicking or reciprocal clicking joint that can be accompanied with pain. Patient with retrodiscitis can find some relief using ARS.

ARS commonly use hard acrylic and adapted on one of the jaws, usually the maxilla. Maxilla is the preferred choice because it is easier to make reverse incline ramp on a more stable occlusal surface when compared to mandible which is more mobile. A 2 mm thickness is often enough to provide an adequate strength to the appliance. The incline ramp will guide mandible to a more anterior position. Appliance will be used and its efficacy will be evaluated. If symptoms do not improve, then patient's condition will be re-evaluated.

When ARS fails to relieve symptom, there is a possibility that the etiologic factor has not been addressed. Pain can come from TMJ complex, or better known as intracapsular pain, or it can also come from muscle, also known as intercapsular pain or myogenous pain. When pain comes from muscle, then symptom relieve can progress slowly, because of protective co-contraction muscle response that can cause uncomfortable muscle tension which can sensitize joint. Repeating diagnostic procedure becomes important for clinician to be able to better determine etiologic factor of each individual patient.[1,9]

Success rates is one factor that needs to be considered to determine the efficacy of the use of ARS. According to Okeson, joint sound cannot be the determining factor of ARS's success, because long term studies have indicated that more than 50% of patients after ARS treatment will have returning joint sound. Moreover, when factors that determine success includes the reduction of joint sound and pain resolution, the success rate of ARS treatment is only 28%. However, if we modify the factors to only the resolution of pain, then the success rate increases into 75% over an observation period of 2.5-5 years.[13] Joint sound has been found to be more resistant to repair when compared to pain resolution after the use of ARS.

The use of MRI has become the golden standard to evaluate articular disc position prior, during and after the insertion of ARS. This observation is to help us determine whether joint sound can become the cause of DDWoR. The findings are summarized on table 1, and it can be concluded that ARS can become a viable treatment on joint pain to patients with DDWR, and joint sound does not determine the failure of ARS treatment; only 6% of patient with joint pain and DDWR that progresses into other internal derangement condition such as DDWoR or joint locking.[1–3,9] the use of ARS gives opportunity for retrodiscal tissue to adapt and form fibrotic structure to allow TMJ to function without joint pain while maintaining a more anterior positioned articular disc.

The use of ARS should meet the following criteria during insertion: 1) ARS must adapt well with the corresponding natural teeth so that retention and stabilization of splint can be maintained well. Retention should be examined by palpating the splint in patient's mouth; 2) in a protruded mandible position, all mandibular teeth must contact evenly, where mandibular cusp have some contact with the occlusal surface of ARS; 3) the protruded position that is made from the splint must resolve symptoms during opening and closing of mouth at the new position; 4) during retruded mandible position, reverse incline ramp must contact the opposing teeth. As mandible elevates, splint must guide mandible to therapeutic mandibular position; 5) ARS must be polished to have an even surface.

Post-insertion instruction varies among researcher; some pointed out that the use of ARS should be use for 24 hours, and only removed during eating and brushing teeth. Ma *et al* recommend creating a 5 mm thick ARS to remove reciprocal clicking, where occlusal grinding was per-

formed to reduce ARS thickness 1 mm for every 4-6 weeks in the posterior region to induce vertical eruption of patient's teeth and achieve occlusal plane levelling. Patient will use ARS for 1-3 months, and deemed successful when joint clicking and pain did not return after 1-3 months post-treatment.[6] According to Chen *et* al, the use of ARS should have at least 3 months of use for 24 hours, and continues by wearing ARS only at nighttime.[3]

Okeson suggest that the use of ARS should be limited on nighttime only. Daytime use reserves to condition where patient cannot tolerate joint pain during working hours, and the use is limited to resolving the pain only. When the pain resolves, the use of ARS should be discouraged, as to prevent changing mandible's position more anteriorly. In addition, patients were instructed with physical self-regulation (PSR) regimen to aid in TMJ treatment. The goal of PSR is to make patient conscious of their condition, also known as cognitive awareness, in terms of spatial position of their mandible so that patient can reduce non-functional contact and excessive muscle activity actively to aid in TMD joint pain management. PSR involves proprioceptive practice and relaxation techniques.[9]

Treatment becomes tricky when patient's main complaint is a very loud joint sound. For the majority of patients, patient's education is the treatment of choice. There is no standardized treatment of TMJ joint sound, so healthcare practitioner must perform conservative treatment as treatment of choice through education, PSR, occlusal splint, and muscle exercises of the jaw. Invasive treatment is rarely indicated during DDWR because of the many risk associated with invasive surgical procedure.

When the use of ARS does not improve pain tolerance, healthcare workers need to consider two possibilities. One is that the adaptive process of retrodiscal tissue in inadequate in creating fibrotic structure to allow this tissue withstand functional load. In this case, the use of ARS must be lengthened to provide opportunity for the structure to adapt. However, if pain is caused by orthopedic instability, then patient may have returning symptoms after treatment with ARS. In this case, dental treatment needs to be administered so as to attain orthopedic stability. The treatment is seldom needed, however.

Invasive treatment can be considered when conservative treatment did not produce the intended result. Persistence of symptoms is one sign that indicates failure of ARS addressing the problem. Treatment options that can be considered are arthrocentesis, arthroscopy and surgical treatment. Arthrocentesis is a treatment of injecting therapeutic substance such as hyaluronate acid or corticosteroid with the intention to flush away algogenic substance that adheres in the articular disc, notable the superior joint space of the articular disc. Furthermore, the procedure also modifies intracranial pressure, which relieves pain. The use of arthrocentesis is indicated with closed lock TMJ, rheumatoid arthritis or adhesion. The use of arthrocentesis for DDWR is seldom indicated.[14] Arthroscopy treatment uses arthroscope to directly observe superior joint space so as to identify and eliminate adhesion on joint. However, invasive treatment often is accompanied with elevated risk, such as extravasation of synovial fluid, facial nerve lesion, eye lesion, pre-auricular hematoma, intracranial perforation, and other risks. These risks needs to be addressed so that patient can receive for benefit having this treatment performed that the risk.[9]

It was concluded that the purpose of the treatment of DDWR should be to reduce intracapsular pain, and not necessarily returning articular disc position to a normal position. The use of ARS is another non-invasive treatment modality that can be offered to DDWR's patient so that the use of ARS will allow adaptive response by eliciting fibrotic structure on retrodiscal fossa and returning articular disc to a more normal position of disc-condyle-fossa. Variation exist regarding the post-treatment instruction, but most afree that the use of ARS should only be on a short-term basis to reduce the risk of a more permanent unintended occlusal change. Adaptive response occurs between 8-10 weeks, and most patients experience relieve of pain. The lack of gold standard for the treatment of DDWR prompts healthcare provider to opt for conservative treatment before considering advancing to a more invasive procedure.

REFERENCES

1. Okeson JP. Joint Intracapsular Disorders: Diagnostic and Nonsurgical Management Considerations. Dent Clin North Am. 2007;51(1):85-103.
2. Poluha RL, De La Torre Canales G, Costa YM, Grossmann E, Bonjardim LR, Conti PCR. Temporomandibular joint disc displacement with reduction: A review of mechanisms and clinical presentation. J Appl Oral Sci. 2019;27:1-9.
3. Chen HM, Liu MQ, Yap AUJ, Fu KY. Physiological effects of anterior repositioning splint on

temporomandibular joint disc displacement: a quantitative analysis. J Oral Rehabil. 2017;44(9):664-672.
4. Chantaracherd P, John MT, Hodges JS, Schiffman EL. Temporomandibular joint disorders' impact on pain, function, and disability. J Dent Res. 2015;94(3):79S-86S.
5. Liu MQ, Lei J, Han JH, Yap AUJ, Fu KY. Metrical analysis of disc-condyle relation with different splint treatment positions in patients with TMJ disc displacement. J Appl Oral Sci. 2017;25(5):483-489.
6. Ma Z, Xie Q, Yang C, Zhang S, Shen Y, Abdelrehem A. Can anterior repositioning splint effectively treat temporomandibular joint disc displacement? Sci Rep. 2019;9(1):8-15.
7. Xie Q, Yang C, He D, et al. Will unilateral temporomandibular joint anterior disc displacement in teenagers lead to asymmetry of condyle and mandible ? A longitudinal study. J Cranio-Maxillofacial Surg. 2016;44(5):590-596.
8. Litko M, Berger M, Szkutnik J, Różyło-Kalinowska I. Correlation between direction and severity of temporomandibular joint disc displacement and reduction ability during mouth opening. J Oral Rehabil. 2017;44(12):957-963.
9. Okeson JP. Management of Temporomandibular Disorders and Occlusion 8th Edition. 8th ed. Missouri: Elsevier Inc; 2020.
10. Kumar Rg, Gajapathi B, Ibrahim Mm, Karthik P, Rangarajan V, Yogesh P. Concepts of occlusion in prosthodontics: A literature review, part I. J Indian Prosthodont Soc. 2016;15(3):200.
11. Schiffman E, Look J, Anderson G, et al. DC/TMD for clinical and research application. 2014;28(1):6-27.
12. Okeson JP. Reliability and validity of the DC/TMD Axis I. J Oral Facial Pain Headache. 2018;32(1):19-21.
13. Okeson JP. long term treatment of disk interference disorders of the temporomandibular joint with anterior repositioning occlusal splints. :611-616.
14. Monje-Gil F, Nitzan D, González-Garcia R. Temporomandibular joint arthrocentesis. Review of the literature. Med Oral Patol Oral Cir Bucal. 2012;17(4).

The effect of aluminum oxide on heat polymerized acrylic resin denture base material to flexural strength and color stability

Desy Praningrum, Dwi Tjahyaning Putranti
Department of Prosthodontics
Faculty of Dentistry, University of Sumatera Utara
Medan, Indonesia
Corresponding author: **Desy Praningrum, email**: **desypraningrum571@gmail.com**

ABSTRACT
Purpose: The purpose of this study was to determine the effect of aluminum oxide addition on heat polymerized acrylic (HPA) resin denture base to flexural strength and color stability. **Method**: This study was carried out on HPA resin samples without and with the addition of aluminum oxide with a concentration of 0.5%, 1.5%, 2.5%. A bar-shaped sample sized 65 x 10 x 3 mm was used for flexural strength testing and circular-shaped sample with a diameter of 50 mm x 1 mm (no. 80) was used for color stability testing; 24 samples for flexural strength test and 24 samples for color stability test. All samples were immersed in distilled water for 48 hours at 37˚C in an incubator. A universal testing machine was used to test flexural strength and a portable colorimeter was used for color stability testing. **Conclusion**: The addition of 0.5% aluminum oxide significantly increase the flexural strength and has good color stability.
Keywords: heat polymerized acrylic resin, aluminum oxide, flexural strength, color stability.

INTRODUCTION

Denture base is a part of denture that rests on soft tissue and does not include the artificial teeth.[1] Denture base material is divided into two groups, metal and nonmetal.[2,3] Non-metal denture base, namely resins, can be classified into two groups based on their thermal reactions, namely thermoplastics and thermosets.[4,5] Thermosets are resins which, once formed, cannot be reshaped by heating, and cannot be recycled. The examples of this resins were acrylic resins.[2-5]

Acrylic resin is the most widely used materials for the manufacture of dentures.[5] Heat polymerized acrylic (HPA) resins were the denture base materials which bear the polymerization process by applying heat. This material has many advantages such as easy to process and polish, aesthetically affordable, and low toxic, but it also has low mechanical properties, resulting in frequent denture base fractures. According to ADA specification no. 12 (ISO 1567), flexural strength of the HPA resin was 65 MPa.[6] The HPA resins have good aesthetics, because of its translucent colors and they are close to gingival colors. The degree of color change was determined by a colorimeter or spectrophotometer that has a standard; if the value of ΔE is more than 3.7 then the color is unstable.[7-9]

Several studies have linked the use of reinforcing materials with the strength of HPA resin denture base and found a significant influence. The addition of reinforcing material in the form of metal oxide to HPA resin can affect the physical, mechanical and biological properties of the denture base. Metal oxide which will be added to the HPA in this study was aluminum oxide (Al_2O_3). Aluminum oxide was chosen because it is a biocompatible material, has a low density and it is lightweight.[10,11]

The purpose of this study was to determine the effect of aluminum oxide addition on HPA resin denture base to flexural strength and color stability.

METHOD

This experimental laboratory with post test only with control group design used samples of HCA resin without addition of aluminum oxide and with the addition of aluminum oxide (Beta Diamond Products) with three different concentration groups: 0.5%, 1.5% and 2.5%. The number of samples for each group is 6, so the total sample for 8 groups is 48 samples.

The size of custom made model of metal used for flexural strength tests according to ISO 1567 is (65 x 10 x 3 mm) ± 0.5 mm[12] and for color stability test according to ADA no. 80 is circular in diameter (50 x 1 mm) ± 0.5 mm (Fig. 1).[9]

This study was carried out by making samples (Fig.2), measuring flexural strength, and color stability. Samples was made through the process of making molds, filling acrylic in molds, curing, and finishing. The finishing is done by polishing and immersing the samples in distilled water at 37^{0}C for 48 hours in an incubator.

Measurement of flexural strength is carried out using the Universal Testing Machine, Tensilon AND RTF-1350 (Fig.3A). The sample is marked at both ends and the measuring area is mea-

sured and placed between the pulling plates. Before the test takes place, the instrument was first calibrated with a pointer at exactly zero. The device was then turned on, the number indicated by the measurement on the tool is recorded as an F value after the sample has fracture (MPa).

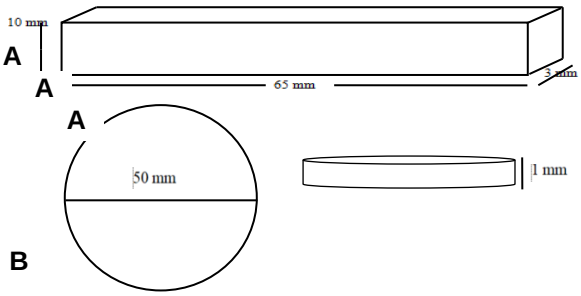


Fig.1 Size of the sample **A** of flexural strength; **B** of color stability

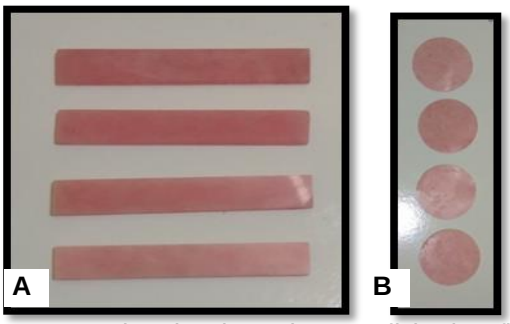


Fig 2 Samples that have been polished **A** flexural strength test; **B** color stability test

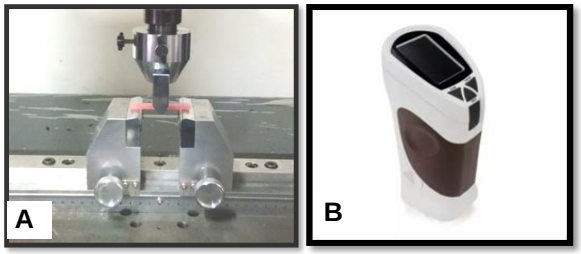


Fig 3A Flexural strength test using Universal Testing Machine; **B** portable Colorimeter CS-10

Color stability measurements were carried out by means of the color of the sample measured before and after aluminum oxide addition using Colorimeter CS-10 (Fig 3B). The colorimeter was set to measure mood and placed perpendicular to the sample surface. The instrument was held in a direction against 90^0 surface center of the sample and the test button was pressed until the machine beeps to indicate completion of the measurement and the results were displayed on the display device. The results were displayed in L*a*b format. Each reading was repeated three times by the researcher to get identical and sequential readings achieved and then averaged values were recorded.

RESULT

The mean value and standard deviation of flexural strength in this study were analyzed using univariate tests. The mean value and standard deviation of HPA resin denture base without the addition of aluminum oxide was 89.09 ± 0.12 MPa, with the addition of 0.5% aluminum oxide concentration was 102.93 ± 0.27 MPa, with the addition of 1.5% aluminum oxide concentration was 111.95 ± 0.20 MPa, with the addition of 2.5% aluminum oxide concentration was 122.03 ± 0.25 MPa (Table 1).

Table 1 Value of HPA resin denture base flexural strength without and with the addition of aluminum oxide with concentrations of 0.5%, 1.5%, and 2.5%

No	Flexural Strength (MPa)			
	Without Aluminum Oxide	Addition of Aluminum Oxide		
		0.5%	1.5%	2.5%
1	88.97*	102.55*	111.85	121.94
2	89.23	102.74	111.75	121.99
3	88.97	103.20	112.16	122.38**
4	89.07	103.25**	112.03	121.95
5	89.24**	102.81	111.74*	121.67*
6	89.06	102.97	112.18**	122.26
	$\bar{x}$ =89.09	$\bar{x}$ =102.92	$\bar{x}$ =111.95	$\bar{x}$ =122.03
	SD=0.12	SD=0.27	SD=0.20	SD=0.25

Description: * Smallest ** Biggest

Average value and standard deviation of the color stability of HPA denture base in this study were analyzed using univariate tests. The mean value and standard deviation of the color stability of HPA resin denture base without the addition of aluminum oxide was 0 ± 0.00 with the addition of 0.5% aluminum oxide was 3.28 ± 0.25, with the addition of 1.5% aluminum oxide was 7.30 ± 0.37. with the addition of 2.5% aluminum oxide was 9.37 ± 0.25 (Table 2).

The effect of aluminum oxide addition with concentrations of 0.5%, 1.5%, and 2.5% on HPA resin denture base on flexural strength and color stability in this study was analyzed using the one-way Anova-test. Previously, normality data was tested using the Saphiro-Wilk. After that,the data homogenity was performed using Levene test to find out that the data is truly homogeneous.

The one-way ANOVA test results gained significance with p = 0.0001 (p <0.05), then H_0 is rejected and Ha accepted. This means that

there was a significant influence in the addition of aluminum oxide with a concentration of 0.5%, 1,5%, and 2.5% in the heat polymerized acrylic resin denture base flexural strength. (Table 3)

Table 2 The value HPA resin denture base acrylic without and with the addition of aluminum oxide with concentrations of 0.5%, 1.5%, and 2.5%

No	Color Stability (values)			
	Without Aluminum Oxide	Addition of Aluminum Oxide		
		0.5%	1.5%	2.5%
1	0	3.15	7.14	9.34
2	0	2.84*	6.87*	9.84**
3	0	3.44	7.96**	9.14*
4	0	3.47	7.33	9.22
5	0	3.28	7.42	9.42
6	0	3.49**	7.11	9.24
	$\bar{x}$=0	$\bar{x}$=3.28	$\bar{x}$=7.30	$\bar{x}$=9.37
	SD=0	SD=0.25	SD=0.37	SD=0.25

Specification: * Smallest ** Biggest

Table 3 The effect of the addition of aluminum oxide with concentrations of 0.5%, 1.5%, and 2.5% on the HPA resin denture base flexural strength (Anova test)

Group	Flexural Strength		p
	n	$\bar{x}$ ± SD	
Without reinforcing materials	6	89.09 ± 0.12	
Aluminum 0.5%	6	102.92 ± 0.27	0.0001*
Aluminum 1.5%	6	111.95 ± 0.20	
Aluminum 2.5%	6	122.03 ± 0.25	

Note: * significant

Table 4 The effect of the addition of aluminum oxide with a concentration of 0.5%, 1.5%, and 2.5% on HPA resin denture base color stability (Anova test)

Group	Color Stability		p
	n	$\bar{x}$ ± SD	
Without reinforcement material	6	0.00 ± 0.00	
Aluminum 0.5%	6	3.28 ± 0.25	0.0001*
Aluminum 1.5%	6	7.30 ± 0.37	
Aluminum 2.5%	6	9.37 ± 0.25	

Description: * Significant

The one-way ANOVA test results gained significance with p was 0.0001; less than 0.05. This means that there was a significant influence in the addition of aluminum oxides with concentrations of 0.5%, 1.5%, and 2.5% in HPA resin denture base color stability (Table 4).

The difference in the effect of the addition of aluminum oxide with a concentration of 0.5%, 1.5%, and 2.5% on the HPA resin denture base material of the flexural strength and color stability was tested by LSD; it showed a difference in the influence of flexural strength between the test group (p was 0.0001) (Table 5). The test showed a difference in the effect of color stability between the the group (p was 0.0001) (Table 6).

DISCUSSION

Table 1 shows the flexural strength of HPA resin denture base samples with the addition of aluminum oxide with a concentration of 0.5%, 1.5%, and 2.5% were greater than the samples

Table 5 The difference in the effect of aluminum oxide addition with a concentration of 0.5%, 1.5%, and 2.5% in the HPA resin denture base flexural strength (LSD)

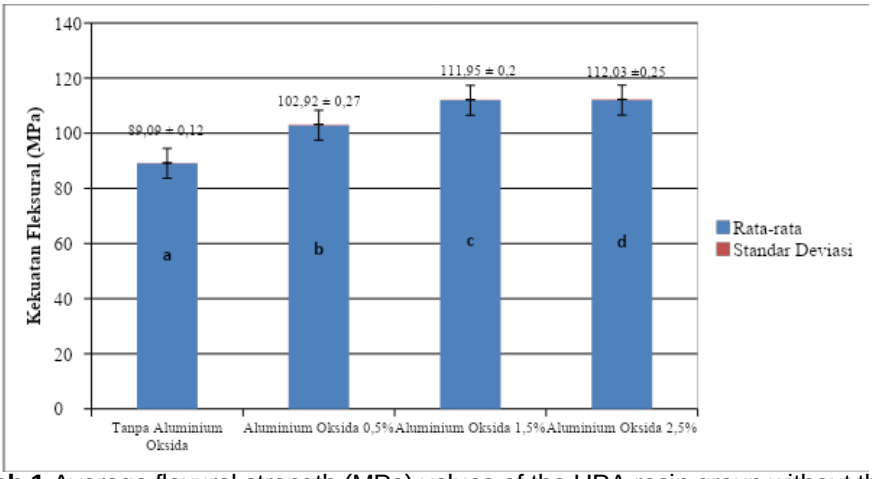
Group		Mean diference	p
Group aluminum oxide 0.5%	Aluminum oxide 1.5%	-9.02	0.0001 *
	Aluminum oxide 2.5%	-19.11	0.0001 *
Aluminum oxide group 1.5%	Aluminum oxide 0.5%	9.02	0,0001 *
	Aluminum oxide 2.5%	-10.08	0,0001 *
Aluminum oxide group 2.5%	Aluminum oxide 0.5%	19.11	0,0001 *
	Aluminum oxide 1.5%	10.08	0.0001 *

Description: * Significant

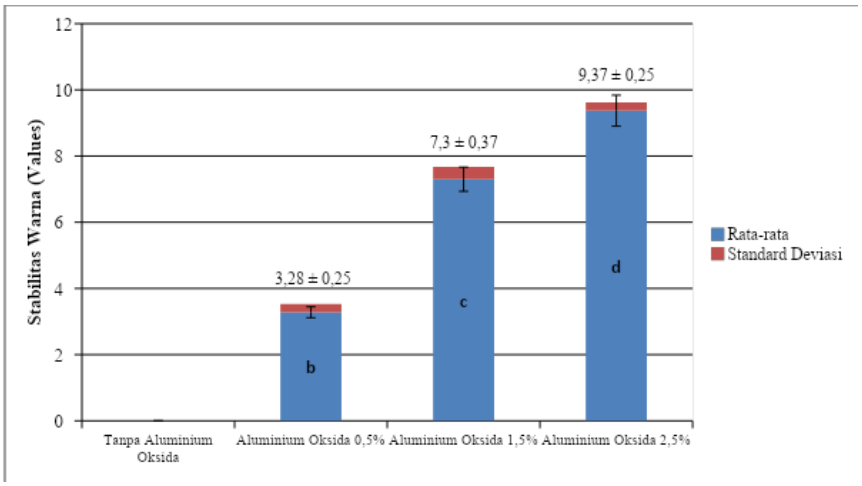
Table 6 The difference in the effect of aluminum oxide addition with a concentration of 0.5%, 1.5%, and 2.5% in the HPA resin denture base color stability (LSD)

Group		Mean diference	p
Group aluminum oxide 0.5%	Aluminum oxide 1.5%	-4.03	0.0001 *
	Aluminum oxide 2.5%	-6.09	0.0001 *
Aluminum oxide group 1.5%	Aluminum oxide 0.5%	4.03	0,0001 *
	Aluminum oxide 2.5%	-2.06	0,0001 *
Aluminum oxide group 2.5%	Aluminum oxide 0.5%	6.09	0.0001 *
	Aluminum oxide 1.5%	2.06	0.0001 *

Description: * Significant



Graph 1 Average flexural strength (MPa) values of the HPA resin group without the addition of aluminum oxide and with the addition of aluminum oxide concentration of 0.5%, 1.5%, and 2.5%; vertical lines indicate standard deviations; different letters indicate significant differences.



Graph 2 Average value of the color stability (values) of HPA resin without the addition of aluminum oxide and with the addition of aluminum oxide concentration of 0.5%, 1.5%, and 2.5%; vertical lines indicate standard deviations; different letters indicate significant differences.

without aluminum oxide addition. According to ADA specifications no. 12 the flexural strength value of HPA resin was 65 MPa. The flexural strength increase with increasing aluminium oxide concentration. This study was in line with Pentapati et al who add aluminum oxide at concentrations of 5%, 10%, and 15% in HPS resins. The 15% aluminum oxide concentration can increase the flexural strength without side effects. The greater concentration, the greater flexural strength is also obtained.[13] Increasing value of flexural strength in the sample with the addition of aluminum oxide can occur due to various factors including good adhesion between the polymer matrix of acrylic resin and aluminum oxide.[14] This good adhesion occured because aluminum oxide can be chemically bonded with the -COOR group of HPA resin polymer. Aluminum oxide will form crosslinking with HPA resin. The formation of crosslinking will increase the denture base resistance to fractures. This formation of crosslinking will also cause an increase in the surface shift strength between aluminum oxide and the polymer matrix, there by reducing the cracking of material and increase the flexural.[15]

Table 2 shows that the HPA resin denture base sample which was added aluminum oxide with a concentration of 0.5%, 1.5%, and 2.5% experienced a change in color when compared to the HPA resin sample which no aluminum oxide is added. Discoloration of the sample occurs because a white aluminum oxide powder is mixed with a HPA resin powder which causes a change in color. The higher concentration of alu-

minum oxide mixed in the HPA resin powder, the whiter the base material produced. Color stability has a standard if the ΔE value is more than 3.7, so the color is unstable or not aesthetic, so it is not recommended to be applied to the patient's mouth. And based on this study the value of ΔE is relatively stable on the addition of aluminum oxide with a concentration of 0.5%. The results of this study are in line with research from Sahin, et al. They added nano zirconium dioxide with a concentration of 1% to HPA resins. In his study, it was found that the value of ΔE was less than 3.7 for the color stability test so that it was classified as stable and within acceptable clinical limits.[16]

Based on the data in Table 3 from the results of the one-way Anova test, there was a significant influence in the addition of aluminum oxide to the HPA resin denture base flexural strength p was 0.0001; less than 0.05. The results of this study are similar to the results of research conducted by Pentapati, et al who use aluminum oxide with concentrations of 5%, 10%, and 15%. His research states that the addition of aluminum oxide with concentrations of 5%, 10%, and 15% has a significance value of p was 0.0001. It shows that the addition of aluminum oxide with a concentration of 5%, 10%, and 15% to the HPA resin causes an increase in flexural strength.[13]

Based on the data in Table 4 from the results of the one-way Anova test, there is a significant influence in the addition of aluminum oxide to the HPA resin denture base material on color stability p was 0.0001; less than<0.05). The results of this study are similar to Sahin, et al. They added nano zirconium dioxide with a concentration of 1% to the HPA resin which can change color, but not significantly. The addition of nano zirconium dioxide with a concentration of 1% to the color stability has a significant value of p was 0.713.[16]

Statistical analysis based on table 5 shows that there is a significant difference to the addition of aluminum oxide with a concentration of 0.5%, 1.5%, 2.5% against the flexural strength of HPA resin denture base between the tested groups.The aluminum oxide addition group with a concentration of 2.5% showed a higher flexural strength than the aluminum oxide addition group with a concentration of 1.5% and 0.5%. This occured because the addition of aluminum oxide to HPA resin with different concentrations of 0.5%, 1.5%, and 2.5% will affect the amount of crosslinking formed. The more concentrations of aluminum oxide added to HPA resin will cause more crosslinking to form and the better the flexural strength produced.[14,15]

The results of statistical analysis based on table 6 show that there is a significant difference in the effect of adding aluminum oxide with concentrations of 0.5%, 1.5%, and 2.5% on the color stability of HPA resin denture base between the tested groups. The aluminum oxide addition group with a concentration of 2.5% showed a higher increase in color stability compared to the aluminum oxide addition group with a concentration of 1.5% and 0.5%. This occurred because the white aluminum oxide powder is mixed with a HPA resin powder which causes a change in color. The higher the concentration of aluminum oxide mixed in the HPA resin powder, the whiter the base material produced.[16]

The flexural strength and color stability increased after the addition of aluminum oxide. The addition of aluminum oxide groups with concentrations of 0.5%, 1.5%, and 2.5% significantly increased the flexural strength of denture base. The addition of aluminum oxide group with a concentration of 0.5%, 1.5%, and 2.5% also significantly affects the color stability, and which still has good color stability is also still within the acceptable clinical limit is the aluminum oxide addition group with a concentration of 0.5%, so the addition of aluminum oxide with 0,5% concentration increase flexural strength and still have good color stability. It can be concluded that aluminum oxide has been proven to be used to increase flexural strength with good color stability on a HPA resin denture base. If it is associated clinically it will withstand excessive mastication loads, can be used for a longer time, and for colors that are aesthetic.

REFERENCES

1. McCabe JF, Walls AWG. Bahan Kedokteran gigi. Sunarintyas S, Mustaqimah DN. Mustaqimah DN Jakarta: EGC; 2017.p.30-4.
2. Manappali JJ. Basic Dental materials. 3rded. New Delhi.: Jaypee Brothers; 2010.p.381-403.
3. Rahn A, Ivanhoe J, Plummer K. Textbook of complete dentures. 6th ed. Beijing: People's Medical Publishing House; 2009.p.8-9.
4. George A, Kumar G, Pillay S, Rao S, Sangur R. Basic dental material. 2nd ed. New Delhi: Jaypee Brothers Medical Publisher; 2003.p.13-7, 100-26.

5. Anusavice K, Shen C, Rawls H. Philip's science of dental materials. 12th ed. Philadelphia: Elsevier; 2012.p. 4, 48-63.
6. Sakaguchi RL, Powers JM. Craig's restorative dental materials. 12th ed. Philadelphia: Elsevier Mosby; 2006: 514-26.
7. Padiyar N, Kaurani P. Colour stability: An important physical property of esthetic restorative materials. IJCDS 2010; 1(1): 81-4.
8. Sagsoz NP, Yanikoglu N, Ulu H, Bayindir F. Color changes of polyamide and polymethyl methacrylate denture base materials. Open Journal of Stomatology 2014; 4: 489-96.
9. Dhir G, Berzins DW, Dhuru VB, Periathamby AR, Dentino A. Physical properties of denture base resins potentially resistant to candida adhesion. J Prosthodont 2007; 16(6): 465-72.
10. Arora P, Singh S, Arora V. Effect of alumina addition on properties of polymethyl methacrylate – A comprehensive review. Int J Biotech Trends Technol 2015; 9(1): 1-7.
11. Yadav N, Elkawash H. Fleksural strength of denture base resin reinforced with aluminium oxide and processed by different processing techniques. J Adv Dent Res 2011; 2(1): 33-6.
12. Vojdani M, Bagheri R, Khaledi AAR. Effect of aluminium oxide addition on the fleksural strength, surface hardness, and roughness of heat-polymerized acrylic resin. JDS 2012; 7: 238-44.
13. Pentapati L, Srinivas K, Shakar R, Swetha V, Krishna M. Effect of addition of aluminium oxide on flexural strength and hardness of acrylic resins. IOSR-JDMS 2017; 16(3): 1-6.
14. Gad M, Founda S. PMMA denture base material enhancement: a revier of fiber, filler, and nanofiller addition. Int J Nanomedicine 2017; 12: 3801-12.
15. Rashid H, Sheikh Z, Vohra F. Allergic effects of the residual monomer used in denture bace acrylic resins. Eur J Dent. 2015; 9(4): 614-9.
16. Sahin Z, Ergun G. The assessment of some physical and mechanical properties of PMMA added different forms of nano-ZrO_2. J Dent Oral Health 2017: 1-10.

Color stability of denture acrylic base after cleaning with rosella flower extract toothpaste

Mohammad Dharma Utama, Eri Hendra Jubhari, Bahruddin Thalib, Ike Damayanti Habar, Irfany
Department of Prosthodontics
Faculty of Dentistry, Hasanuddin University
Makassar, Indonesia
Correspondence author: **Mohammad Dharma Utama**, email: **mohdharmautama.umi@gmail.com**

Background: The efficacy of rosella flowers as an antibacterial contains anthocyanin pigment which acts as an antioxidant, vitamins and minerals that are useful for the body so it needs to develop products other than drinks and food; one of them as herbal disinfectant for complete denture acrylic base. **Objective**: To determine the color stability of the complete denture base after cleaning with various concentrations of rosella flower extract. **Method**: This time series study with pre and post with control group design was carried out using 5 complete dentures cleaned with rosella flower extract toothpaste with a concentration of 2.5%, 5%, 10% and control, and assessed its color on the surface of the polished and intaglio surface. The value is processed into the formula ΔE * ab = [(ΔL *) 2 + (Δa *) 2 + (Δb *) 2] 1/2 then analyzed using the Kolmorogrov test and t-test. **Result**: Rosella flower extract toothpaste at concentrations of 2.5%, 5%, and 10% did not show significant differences in color changes (p> 0.05). **Conclusion**: There were no significant differences in color changes at all concentrations after the acrylic base was cleaned with rosella flower extract.
Keywords: toothpaste, rosella flower extract, complete denture, discoloration

INTRODUCTION

Denture is an appliance to replace the surface of mastication and the surrounding structures of the upper and lower jaws. Denture material that is widely used in Indonesia is acrylic.[1-3]

Two disadvantages of acrylic are high porosity and surface roughness so that the surface of the denture base that is not polished that is the part that faces the supporting tissue is more easily attached to the rest of food. If the base is not cleaned adequately it will become a place for microbes develop.[4]

Maintenance of denture cleanliness can be performed using denture cleaning agents. The use of natural ingredients in the health world tends to increase from year to year, included in the field of dentistry. The advantage of natural ingredients is the minimal side effects or safe for the body. Rosella is one of the natural ingredients used as drinks, food and medicine for the body. The efficacy of this flower is as an antibacterial, contains anthocyanin pigment which acts as an antioxidant, vitamins and minerals that are useful for the body. Knowing the many benefits of rosella, it is necessary to develop other products besides drinks and food, that is rosella flower extract which can function as an herbal disinfectant for acrylic dentures.[5,6] The dark pink color of rosella flowers might affect the color of acrylic dentures, because this material can absorb liquid.

The aim of this article is to obtain data regarding the color stability of the acrylic base of removable denture after cleaning with extract of rosella flower as toothpaste.

METHOD

This time series study was design as pre and post with control, and in situ. The sample size was 20 of 5 samples for each concentration. The population was patients who attended the Clinic of Prosthodontics at Hasanuddin University, Makassar.

The samples are parts of the population that meets the inclusion and exclusion criteria. Inclusion criteria are patients who use full denture shortly after insertion, agrees to participate in this study, the patient is willing to not consume food and drinks that can affect the color of dentures, such as carbonated drinks; while exclusion criteria were patients using metal frame full denture, patients using partial denture flexidenture, patients using fixed dentures, and patients suffering from denture stomatitis, *Candida albicans*, and HIV-AIDS.

The toothpaste of rosella flower is maked by extracting it at concentrations of 2.5%, 5%, 10% and non-rosella extract as control group; the toothpaste was made in the Laboratory of Pharmaceutical, Hasanuddin University. Before brushing using this rosella flower extract paste on acrylic denture, the sample was photographed and the L *, a *, b * values were calculated with the CIELab system using the

Adobe Photoshop® program. The same measurement is also carried out on the sample after the denture brushed to see the color changing.

The data were collected and analyzed by the Kolmogorov Smirnov test to know the data normality and then tested by independent t-test with a significance level of 0.05.

RESULT

Based on this study, it was obtained statistical data showing color changes from the first week to the fourth week after brushing the denture.

Table 1 Mean data of color changing of denture base after brushing with extract of rosella flower at all concentrations in the first to fourth week.

Types	Mean (cm^{-1})			
	Week I	Week II	Week III	Week IV
Extract	1.76	1,82	1,86	1,63

The t-test at each concentration for a month (Table 2) on the polished surface shows that after the use of rosella flower extract and control for a month showed insignificant color changes both in the first week to the fourth week; p-value more than 0.05).

DISCUSSION

This study using rosella flower extract as the denture cleanser. This formula was prepared in several concentrations, namely 2.5%, 5%, and 10%. This statement is consistent with Maruapey[7] study which showed effectivity of rosella flower extraxt in inhibiting plaque formation, inhibiting the growth of bacterial colonies and *Candida albicans* colonies in acrylic resin dentures that were highest cleaned or brushed with rosella flower denture cleaning extract at a concentration of 10%; p-value less than 0.05), and lowest in extracts with a concentration of 2.5%; p-value was less than 0.05). The active ingredient of rosella is flavonoid.

Table 2 Data of color changing on the polished surface at each concentration (t-test).

Polished surface	Times	Mean (cm^{-1})			p-value
		Before	After	difference	
Toothpaste of extract of rosella flower 2.5%	Week 1-2	1.25	0.68	0.56	0.178
	Week 1-3	1.25	0.96	0.28	0.224
	Week 1-4	1.25	1.25	0.00	1.000
Toothpaste of extract of rosella flower 5%	Week 1-2	1.51	1.41	0.10	0.595
	Week 1-3	1.51	1.80	-0.29	0.406
	Week 1-4	1.51	1.29	0.22	0.100
Toothpaste of extract of rosella flower 10%	Week 1-2	2.39	2.12	0.27	0.532
	Week 1-3	2.39	2.51	-0.12	0.764
	Week 1-4	2.39	2.21	0.18	0.560
Control	Week 1-2	1.31	1.31	0.00	1.000
	Week 1-3	1.31	1.31	0.00	1.000
	Week 1-4	1.31	1.31	0.00	1.000

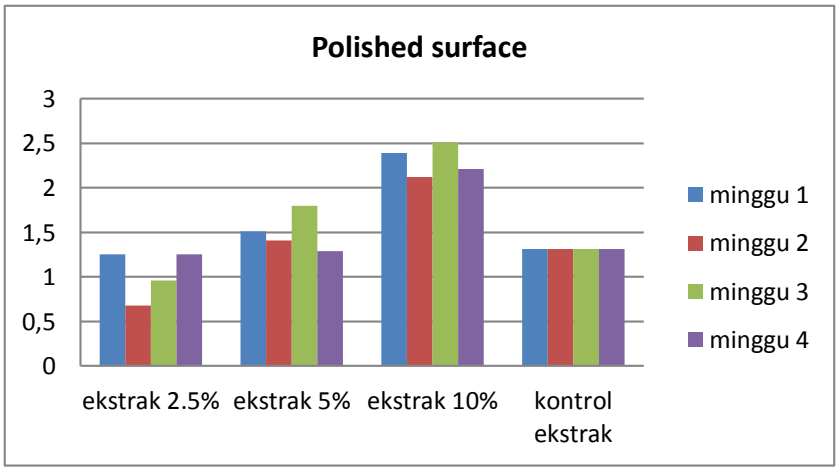


Figure 1 Color changes on polished surface in the 1st-4th week using toothpaste of extract of rosella flower paste at concentrations of 2.5%, 5%, 10%, and control.

Table 3 Color changes on intaglio surfaces at each concentration (t-test)

Polished surface	Times	Mean(cm^{-1})			P
		Before	After	Difference	
Toothpaste of extract of rosella flower 2.5%	Week 1-2	1.74	1.59	0.15	0.515
	Week 1-3	1.74	1.13	0.61	0.127
	Week 1-4	1.74	1.51	0.23	0.228
Toothpaste of extract of rosella flower 5%	Week 1-2	2.20	2.39	-0.19	0.127
	Week 1-3	2.20	2.43	-0.23	0.466
	Week 1-4	2.20	2.05	0.16	0.820
Toothpaste of extract of rosella flower 10%	Week 1-2	1.45	2.20	-0.75	0.089
	Week 1-3	1.45	2.35	-0.89	0.224
	Week 1-4	1.45	1.66	-0.21	0.661
Control	Week 1-2	1.25	1.25	0.00	1.000
	Week 1-3	1.25	1.41	0.16	0.157
	Week 1-4	1.25	1.56	0.31	0,102

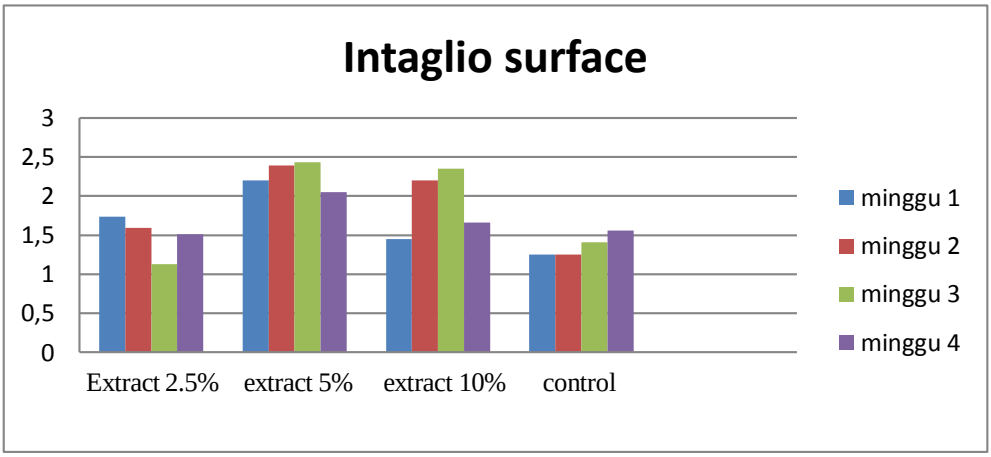


Figure 2 Color changes on intaglio surface color in the 1st-4th week using toothpaste of extract of rosella flower paste at concentrations of 2.5%, 5%, 10%, and control.

The antifungal and antibacterial effects produced by rosella calyx in this study were probably caused by rosella calyx *(Hibicscus sabdariffa L)* contain several flavonoid compounds that is anthocyanin, gossypeptin3-glucoside, flavonol glucoside hibiscritin, flavonoid gossypeptin, delphinidine cogidine 3-monoglycine-monoglycine-monoglycine-monoglycine-monoglycine-3-glucoside onoglucoside; vitamin C, protein, carbohydrates, beta-carotene and antioxidants. It is expected that besides being a denture cleaner, it should also not cause discoloration on the acrylic denture base. The principle of measurement in this study is to see whether there is a change on the color of acrylic denture base due to use of rosella flower extract.

Color changes can be assessed using the CIELab System which is a color model designed to resemble the perception of human vision using three components, namely L* as luminance or the lighting, and a* and b* as opposite color dimensions. The design of this application system uses the CIELab system. This color model was chosen because it was proven to provide better results than the RGB color model in measuring the similarity of color traits in the image. The L * a * b * color model can also be used to make more accurate color balance corrections and to adjust the contrast of lighting that is difficult and impossible for RGB color models.[8]

In the comparison of color change extract concentration of 5% and 10% on the polished and intabglio surfaces, it shows the intaglio surface is more likely to change color than the polished surface. This is in line with the statement that rough surfaces or shafts can affect the stability of acrylic color because it can cause more water absorption and food coloring.[9] Po-

rosity can result from evaporation of unreacted monomers and low molecular weight polymers, when the resin temperature reach or exceed the boiling point of the material, but this type of porosity does not occur uniformly along the affected resin segment.[8]

The existence of this insignificant color change could have been due to the contact time was not enough so that the natural dyes in rosella flower extract toothpaste, namely anthocyanin pigment, had not diffused into acrylic and caused significant color changes in acrylic resins.[1] This anthocyanin pigment is one of the pigments contained in the extract of rosella flower petals and this pigment gives the extract a red color. The stability of this pigment depends on the pH of the pigment; it is more stable under acidic conditions or at low pH conditions. The level of degradation of anthocyanin pigments increases as the temperature rises. Thermal degradation causes loss of anthocyanin pigment which is present in rosella flower extract.[8]

According to Anusavice, the color changes that occur in the resin can vary, that is caused by several factors, including the sample size, microporosity of the sample and the length of contact between materials. The wider the sample size, the greater the physical changes in the material can occur. Microporosity determines the occurrence of porous regional color particles. The more porosity the accumulation of dyes absorbed through the diffusion process will also increase.[9]

Ingredients that cause discoloration on a denture basis include synthetic or natural dyes or substances that can be obtained from food and beverages. Discoloration in acrylic is not only caused by the use of rosella flower toothpaste but also because of the daily food and drinks consumed by denture users such as tea, coffee, cola drinks changes the acrylic color to darker. This is due to the accumulation of color pigments attached on the surface and the absorption of particles adhesion that enters the pores of acrylic resin, so that the color absorbed is more than the color that is reflected. Researchers urge patients who are sampled not to consume foods and drinks that cause research to be ambiguous, but if the patient has difficulty carrying it out, then they can remove the denture when taking it.[10]

It was concluded that toothpaste of rosella flower extract does not cause discoloration on the base acrylic denture and there is a color difference between the intaglio and polished surface of the denture base after the use of rosella flower extract toothpaste.

REFERENCES

1. Depkes RI. Petunjuk pemeliharaan kesehatan gigi dan mulut keluarga. Jakarta; 2000. p. 1-15.
2. Haryanto AG. Terminology dalam ilmu geligi tiruan sebagian lepasan. Jakarta: Hipocrates; 1991.p.12.
3. The Internat Journal of Geriatic and Geriontology 2010; 6(1): 8-15
4. Shibata N, Suzuki A, Kobayashi H, Okawa Y. Chemical structure of the cell-wall mannan of Candida albicans serotype-A and its difference in yeast and hyphal Forms. Biochem J 2007: 365-72.
5. Pannuti M. Clinical effect of an herbal dentifrice on the control of plaque and gingivitis. Pesqui Odontol Braz 2011: 323-33.
6. Tanjong A. Pengaruh konsentrasi ekstrak bunga rosella (*Hibiscus sabdarifa L)* terhadap koloni *Candida albicans* yang terdapat pada plat gigitiruan. [skripsi] 2011.p.52.
7. Maruapey AM. Penggunaan pasta pembersih gigitiruan bunga Rosella (*Hibiscus sabdariffa* L.) dalam menghambat pertumbuhan bakteri dan Candida albicans pada gigitiruan. [tesis]. Makassar: Universitas Hasanuddin; 2013.p.57
8. Optel Vision. Definition of Cielab color space. [serial online] 2011; 1-2: [internet]. Available from: RL:http://www.optelvision.com/documents/optel-vision-explanation-on-cielab-color-space.pdf. Diakses 12 desember 2012.
9. Anusavice KJ. Sifat kimia resin sintetik. Dalam: Buku ajar ilmu kedokteran gigi. Ed.10. Alih Bahasa Budiman JA. Jakarta: EGC; 2004. hal. 176-96.
10. Lestari WA. Pengaruh lama perendaman plat gigitiruan akrilik dalam ekstrak bunga Rosella terhadap kekuatan transversa plat gigitiruan. [skripsi] Makassar: Universitas Hasanuddin; 2013. p. 47

Comparison between endocrown fracture resistance with post core crown

[1]Yohanes Paulus Krisna, [2]Ira Tanti
[1]Prosthodontic Residency Program
[2]Prosthodontic Department
Faculty of Dentistry, Indonesia University,
Jakarta, Indonesia.
Corresponding author: **Ira Tanti**, Email: **iratanti@ymail.com**

ABSTRACT
The concept of minimally invasive restoration has been more approached lately, with the aim of preserve the remaining tooth structure especially after endodotic treatment. Endocrown is one type of restoration that might be the solution. Endocrown is made of glass-ceramic material, defined as a single restoration that uses pulp chambers as a retention and resistance form, margin of preparation is above the gingiva in order to preserve tooth structure. Endocrown was initiated by Pissis in 1995 and popularized by Bindl and Mörmann in 1999. According to late research, crown endocrown has higher fracture resistance than post-core crown. Although the literature on endocrown is still limited, empirical evidence leads to positive view for the use of this restoration.
Keywords: endocrown, fracture resistance, postcore

INTRODUCTION

Dental rehabilitation after endodontic treatment which has extensive caries damage is still a challenge. First, most of the tooth structure has been lost, so the rest of the structure provides minimal retention and resistance form. Second, even though the remaining tissue structure is minimal, sometimes additional preparations are still needed to form margins for the restoration material. Third, the use of metal post or fiber post can weaken the root structure because of the preparation of a root canal widening. These three things become the dentist's dilemma in making decisions.

Elderton and Simonsen state when a tooth receives a restoration, it enters a 'restorative cycle of death'.[1] A restoration will be defective at some time will be replaced by another bigger restoration, and finally the tooth will be extracted. The concept of minimally invasive restoration has been more approached lately, with the aim of preserving the remaining tooth structure, especially after endodontic treatment. Meanwhile, according to in-vitro and in-vivo studies, post was not proven to have a significant effect on the success of long-term treatment of tooth after endodontic treatment. It weakens the structure of the remaining tooth through preparation and enlargement of the root canal.[2,3] Alternative restoration treatment which is more minimally invasive, minimal preparation and preserves the remaining tooth structure is needed. One of the alternative restoration solutions is a crown with internal extension into pulp chamber, and is known by the name endocrown.[4]

Endocrown restoration was first introduced by Pissis in 1995 under the name monoblock porcelain technique. The term endocrown (endodontic adhesive crown) itself only began in 1999 by Bindl and Mörmann.[5] A characteristic of endocrown using porcelain crowns that cover the entire tooth surface is by extending the internal side of the restoration into the pulp chamber. Its macromechanical retention is obtained from the pulp wall and the micromechanical retention is obtained through adhesive cement. The stress distribution on the endocrown is more evenly distributed compared to the post-core crown, because the endocrown crown is a single unit. However this will be greatly influenced by the type of crown material used.[6] The use of endocrown to date is still being debated. Although the evidence of clinical studies leads to the positive side, its empirical evidence is less than the use of post-core crown. Therefore the use of endocrown as restoration is still on the decision of the clinician who work on it. In this article, this paper aims to compare whether endocrown is better than a post core crown in fracture resistance.

METHOD

This paper is compiled based on the problems, interventions, comparisons, results (PICO) model, whether tooth with root canal treatment (P) restored with endocrown (I) compared post and crown (C) has better fracture resistance (O)?

Data collection were screened on March 31, 2020 from Pubmed, EBSCO and Scopus using the search strategy as follow: ((endocrown) AND ((zirconia post) OR (metal post) OR (cast post) OR (fiber post))) AND ((fracture resistance) OR (strength)). Data were extracted into csv. files from

each search engine combined into the same sheet in Excel 365 (Microsooft Corporation, Redmond, WA, USA). Duplicate were eliminated by sorting the same DOI. This article exclusion will be carried out twice, the first based on the title and abstract and the second exclusion is based on the methodology (Fig. 1).

RESULTS

A total of 55 relevant articles were identified and 13 of these are duplicate. The remaining 42 articles are examined based on title and abstract, 10 studies were excluded because they did not meet the eligibility criteria, 25 more articles were exluded based on method. Thus, 7 remaining articles will be discussed in this paper (Table 1).

Each remaining articles are in-vitro studies which investigating fracture strength and were published between 2015 and 2020. The sample size ranged from 30 to 105 teeth by study. Two studies analyzed endocrowns in anterior teeth, while five studies in posterior teeth. All studies evaluated lithium disilicate endocrown and fiber post with lithium disilicate restoration, except two studies, one using composites rather than ceramics for crown restoration combined with fiber post and another use glass-ceramic combined with fiber post (Table 2). Load testing methods between studies are varies and some of them are not decribed in full. Two studies did not write the standard deviation results.

The result within studies are varies. There is no uniformity among the study states that tooth with endocrown is better than post and crown, including the type of fracture that occurs (Table 3). Favorable fracture is a type of fracture where the tooth can still be considered for restoration, while unfavorable fracture is the contrary (more than cementoenamel junction). However, most of the studies states endocrown has better fracture resistance than post and crown.[7-10]

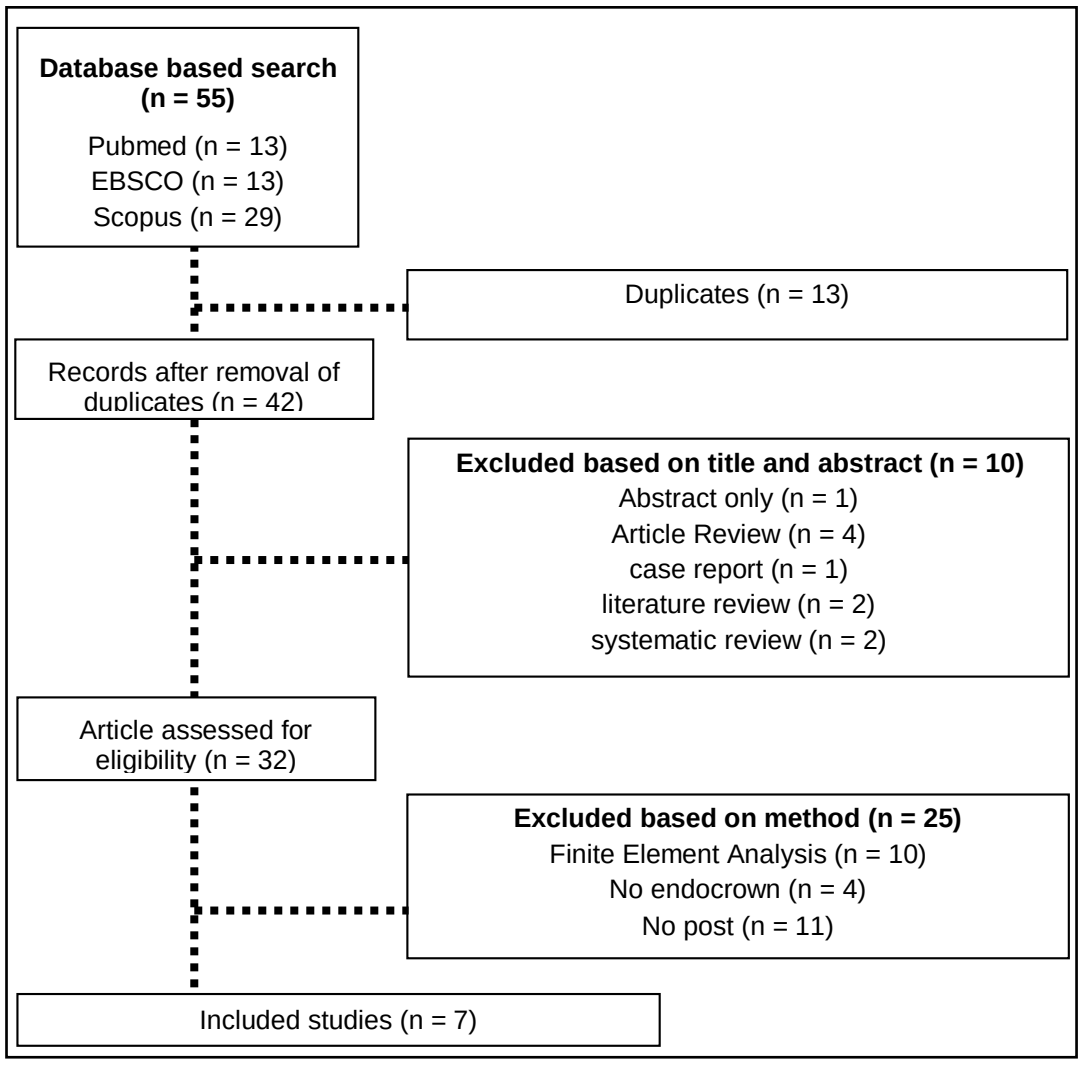


Fig. 1 Data collection workflow

Tabel 1 Demographic data of the included studies.

No	Author	Article title	Year	Purpose	No of teeth (per group)	Type of Teeth
1	Schmidlin PR[11]	Fracture resistance of endodontically treated teeth without ferrule using a novel H-shaped short post	2015	Evaluate the fracture resistance and failure type of modified H-designed intradental short retention preparation for CAD/CAM restorations, in cases where no ferrule is possible.	40 (10)	Premolar (single root)
2	Guo J[12]	A comparison of the fracture resistance of endodontically treated lower premolars restored with endocrowns and glass fiber post-core retained conventional crowns	2016	Evaluate the fracture resistances and failure modes of endodontically treated lower premolars restored with endocrowns and conventional post-core retained crowns	30 (10)	Lower Premolar
3	Atash[8]	Comparison of resistance to fracture between 3 types of permanent restorations subjected to shear force: An in vitro study	2017	Compare resistance to fracture between endocrown and conventional post and core restorations when subjected to shear force.	30 (10)	Lower Premolar
4	Koglu GM[7]	Fracture strength of CAD/CAM fabricated lithium disilicate and resin nano ceramic restorations used for endodontically treated teeth	2017	Evaluate and compare fracture strength and failure modes of endocrowns, zirconnia post, and fiber post supported restorations and predict the clinical outcomes of six different prostheses used for endodontically treated teeth.	60 (10)	Upper central incisor
5	de Kuijper M[13]	Fracture strength of various types of large direct composite and indirect glass ceramic restorations	2019	Investigate the mechanical behavior of severely compromised endodontically treated molars restored by means of various types of composite buildups, full-contour lithium disilicate crowns (with or without post) or a lithium disilicate endocrown	105 (15)	Third Molar
6	Alghalayini S[9]	Fracture load of nano-ceramic composite material for anterior endocrown restorations	2020	Evaluate ability of nano ceramic composite endocrown to withstand occlusal forces when used in the anterior region	80 (10)	Upper central incisor
7	Sedrez-Porto JA[10]	Which materials would account for a better mechanical behavior for direct endocrown restorations	2020	Investigate the mechanical performance and fracture behavior of endocrown restoration prepared using different composite materials and following a direct technique.	63 (7)	Lower First Molar

DISCUSSION

The goal of tooth restoration after endodontic treatment is to restore the function of the tooth. As another goal is to maintain the tooth and its restoration as long as possible. In some cases, after endodontic treatment tooth will require post-core crown restorative treatment. However, based on recent research, the use of post does not guarantee durability of the tooth. Root fracture and leakage are two things that can make a failure in the restoration with a post. Metal post are considered too rigid so they can make the tooth become fractured.[7] An alternative option is to use fiber post. These fiber post are assessed to have a lower modulus of elasticity than the metal post and resemble dentin. It is expected to have a better distribution of masticatory forces and fracture resistance.[7,12] But apparently both types of post are still unable to maintain teeth after endodontic treatment. According to Atash, et al. the failure of a metal post is centered on the risk of an unfavorable fracture, that is a fracture that makes the root unmanageable.[8] In contrast to metal post, failures that occur in teeth with fiber post are more focused on crown restoration, so it can be said to be more beneficial. However, this does not rule out the possibility that fiber post can cause root fractures, even with a smaller percentage of probability.[8] Based on studies conducted by Magne, post is considered to weaken the structure of the tooth, especially the root canal, making fracture vulnerable.[14]

Tabel 2 Groups evaluated with fracture strength (N) and standard deviation (SD).

No	Author	Testing methods	Groups	Materials	Fracture strength (N) Mean (±SD)
1	Schmidlin PR	UTM with a 5 mm steel sphere at 30° and a cross-head speed of 1 mm/min	1. H-post (glass-ceramic) 2. H-post (LiDi) 3. Endrocrown 4. Control (Fiber post + 2 mm ferrule)	1. Glass-ceramic crown (IPS Empress CAD) 2. Lithium disilicate ceramic (e.max CAD) 3. Glass-ceramic crown 4. Fiberpost + Glass-ceramic crown	1.547 ± 232 2.1044 ± 501 3.592.4 ± 147 4.890 ± 125
2	Guo J	Load test with UTM a 5 mm steel sphere at 45° and a cross-head speed of 1 mm/min	1. Intact teeth (GI) 2. Endocrown (GE) 3. Conventional post-core sup-ported crown group (GC)	1. – 2. IPS e.max CAD (Lithium disilicate) 3. RTD Post #1.2 + IPS e.max CAD	1.997.1 ± 166.3 2.479.1 ± 180.6 3.510.1 ± 191.0
3	Atash R	Instron 5585 test machine and a cross-head speed of 1 mm/min	1. All ceramic endocrown 2. Glass fiber post + composite resin core + ceramic crown 3. cast post and core + ceramic crown	1. Ceramic crown (IPS e.max) 2. Glass fiber post (3M ESPE)+Com-posite resin core (3M ESPE Filtek Supreme XTE) + ceramic crown 3. Non-precious metal (Wirobond C Co-Cr) + ceramic crown	1.1717.17±481.13 2.1091.11±179.03 3.1068.82±201.90
4	KOĞLU GM	UTM with a 2 mm steel sphere at 45° and a cross-head speed of 1 mm/min	1. zirconia post/resinnano-ceramic crown (ZrRNC) 2. fiber post/resinnano-ceramic crown (FbRNC) 3. zirconia post/lithium disilicate ceramic crown (ZrLDS) 4. fiber post/lithium disili-cate ceramic crown (FbLDS) 5. resin-nano-ceramic endocrown (EndoRNC) 6. lithium disilicate ceramic endocrown (EndoLDS)	1. Zirconia post (IncorisTZI) + Resin nano ceramic (Lava Ultimate, 3M ESPE) 2. Glass fiber posts (Ika-Dent, Kutno, Poland) + Resin nano ceramic 3. Zirconia post + Lithium disilicate (IPS e.max CAD, Ivoclar Vivadent) 4. Glass fiber post + LiDi 5. Resin nano ceramic 6. LiDi	1.893.43 2.764.63 3.580.02 4.646.78 5.869.04 6.915.91
5	de Kuijper M	Fracture test: loaded using 8 mm ball-shaped at oclusal plane (1 mm/min)	1. Control (no prepn) 2. Glass fiber reinforced composite (GFRC) 3. Microhybrid composite (C) 4. Microhybrid Composite + post (CP) 5. Lithium disilicate full contour crown (LDS) 6. Lithium disilicate full contour crown and glass fiber post (P-LDS) 7. Endocrown (EC)	1. – 2. Microhybrid composite (GC Essentia Universal)+ GC Ever X Posterior at central pulp 3. Composite resin (Clearfil AP-X Posterior) 4. Fiber post (Rely X Fiber post red) + Core buildup (Clearfil FC Core Plus Dentin) + Composite resin 5. Composite resin + IPS e.max CAD 6. Fiber post + Core buildup + IPS e.max CAD 7. IPS e.max CAD	1.1890 ± 774 2.1823 ± 911 3.2192 ± 752 4.1830 ± 590 5.3217 ± 1052 6.2694 ± 665 7.2425 ± 993

(cont) Tabel 2 Groups evaluated with fracture strength (N) and standard deviation (SD).

No	Author	Testing methods	Groups	Materials	Fracture strength (N) Mean (±SD)
6	Alghalayini S.	Compressive static load with load on the palatal surface just above the cingulum at a 130º and a cross-head speed of 1 mm/min	Post, core and crown restoration (control) 1. IPS e.max 0.5 mm above CEJ 2. IPS e.max 2 mm above CEJ 3. Lava Ultimate 0.5 mm above CEJ 4. Lava Ultimate 2 mm above CEJ Endocrown restoration 5. IPS e.max 0.5 mm above CEJ 6. IPS e.max 2 mm above CEJ 7. Lava Ultimate 0.5 mm above CEJ 8. Lava Ultimate 2 mm above CEJ	Post: RelyX Fiber Post (3M ESPE) Crown: IPS e.max (Ivoclar) / Lava Ultimate (3M ESPE)	1.627.9 2.449.1 3.1073.8 4.1019.6 5.667.2 6.421.7 7.1130.8 8.1119.1
7	Sedrez-Porto JA	Universal testing machine, cross-head speed of 1 mm/min	1. Control (sound tooth) 2. Endocrown (E.max) 3. Endocrown (Z350) 4. Endocrown (Z350_SBMP) 5. Endocrown (Z350_SBU) 6. Endocrown (Bulk-Fill) 7. Post-retained restoration (GFP_Z350) 8. Post-retained restoration (GFP_Z350_SBMP) 9. Post-retained restoration (GFP_Bulk_Fill)	1. – 2. IPS e.max lithium disilicate 3. Conventional resin composite (Filtek™ Z350 XT) 4. Filtek™ Z350 XT + SBMP (Scotchbond™ Multi-Purpose Adhesive) 5. Filtek™ Z350 XT + SBU (Scotchbond™ Universal Adhesive) 6. Filtek™ Bulk Fill 7. White Post DC + Filtek™ Z350 XT 8. White Post DC + Filtek™ Z350 XT + SBMP 9. White Post DC + Filtek™ Bulk Fill	1. 2149.9 ± 543.3 2. 1748.5 ± 559.3 3. 2292.3 ± 716.8 4. 2546.3 ± 216.8 5. 2583.7 ± 612.2 6. 3363.1 ± 123.9 7. 2451.6 ± 484.5 8. 2774.0 ± 578.8 9. 2861.2 ± 424.1

Studies in vivo also said that it is better to have teeth with ferrules without post than teeth with post, but without ferrules.[3] Types of post, either metal or fiber, have no significant difference in these studies.[3] This shows that post is not mandatory after endodontic post treatment tooth. Then the question arisen, if without a post, is it better to do a core build-up and then restore it with a crown? All the way through in-vitro research by Magne, core build-up cannot always maintain restoration and remaining teeth. The higher core build-up will result in a lower survival rate, based on this reason, Magne suggested the use of endocrown restoration.[2] Endocrown is a restoration that is a single unit between the crown and the core. Although the literature on endocrown is still limited, empirical evidence leads to a positive point for the use of this restoration. Endocrown is known as a minimally invasive type of restoration, which maintains as many healthy tooth structure as possible.[9] The success of endocrown is in the ability of adhesion of restoration material to the tooth surface. However, the use of appropriate materials can also affect the success of a restoration.[13] Each material has a different modulus of elasticity, it is recommended that a good restoration material should have a modulus of elasticity close to enamel & dentin.[7] The closer the modulus of elasticity between the teeth and the restorative material, the more even the spread of the load. Composite resin material as an alternative in

T abel 3 Groups evaluated with fracture type

No	Study	Groups	Number of favorable fractures	Number of unfavorable fractures	Unfavorable Fracture description
1	Schmidlin PR	a. H-post (glass-ceramic) b. H-post (LiDi) c. Endrocrown a. Control (Fiber post + 2mm ferrule)	a. 90 % b. 70 c. 100 % d. 50 %	a. 10% b. 30% c. 0% d. 50%	Tooth/root fracture that would necessitate tooth extraction
2	Atash R	a. All ceramic endocrown b. Glass fiber post + composite resin core + ceramic crown b. cast post and core + ceramic crown	a. 3 b. 6 c.1	a. 7 b. 4 c. 9	a. 2 loosening b. restoration fracture, root unbroken c. restoration fracture, root unbroken
3	Guo J	a. Intact teeth (GI) b. Endocrown (GE) c. Conventional post-core supported crown group (GC)	a. 7 b. 4 c. 4	a. 3 b. 6 c. 6	Non-repairable fractures below the level of bone simulation
4	KOĞLU GÜNGÖR, Merve	c. zirconia post/resin-nano-ceramic crown (ZrRNC) d. fiber post/resinnano-ceramic crown (FbRNC) e. zirconia post/lithium disilicate ceramic crown (ZrLDS) f. fiber post/lithium disilicate ceramic crown (FbLDS) g. resin-nano-ceramic endocrown (EndoRNC) d. lithium disilicate ceramic endocrown (EndoLDS)	a. 10 b. 10 c. 10 d. 10 e. 0 d. 3	a. 0 b. 0 c. 0 d. 0 e. 10 d. 7	Root fracture
5	de Kuijper M	a. Control (no preparation) b. Glass fiber reinforced composite (GFRC) c. Microhybrid composite (C) d. Microhybrid Composite + post (CP) e. Lithium disilicate full contour crown (LDS) f. Lithium disilicate full contour crown and glass fiber post (P-LDS) g. Endocrown (EC)	a. 4 b. 10 c. 1 d. 1 e. 5 f. 4 g. 3	a. 11 b. 5 c. 14 d. 14 e. 10 f. 10 g. 12	a. Fracture >1mm below CEJ 1; Root fracture 10 b. Fracture >1mm below CEJ 4; Root fracture 1 c. Root fracture 14 d. Fracture >1mm below CEJ 3; Root fracture 11 e. Fracture >1mm below CEJ 1; Root fracture 9 f. Root fracture 10 g. Fracture >1mm below CEJ 1; Root fracture 11
6	Alghalayini S.	Post, core and crown restoration (control) a. IPS e.max 0.5 mm above CEJ b. IPS e.max 2 mm above CEJ c. Lava Ultimate 0.5 mm above CEJ d. Lava Ultimate 2 mm above CEJ Endocrown restoration e. IPS e.max 0.5 mm above CEJ f. IPS e.max 2 mm above CEJ g. Lava Ultimate 0.5 mm above CEJ c. Lava Ultimate 2 mm above CEJ	a. 80% b. 40% c. 60% d. 0% e. 60% f. 100% g. 80% c. 40%	a. 20% b. 60% c. 40% d. 100% e. 40% f. 0% g. 20% d. 60%	Fracture extend beyond the cemento-enamel junctions
7	Sedrez-Porto JA	a. Control (sound tooth) b. Endocrown (E.max) c. Endocrown (Z350) d. Endocrown (Z350_SBMP) e. Endocrown (Z350_SBU) f. Endocrown (Bulk-Fill) g. Post-retained restoration (GFP_Z350) h. Post-retained restoration (GFP_Z350_SBMP) i. Post-retained restoration(GFP_Bulk_Fill)	a. 85.7% b. 28.6% c. 28.6% d. 71.4% e. 42.9% f. 71.4% g. 14.3% h. 42.9% i. 28.6%	a. 14.3% b. 71.4% c. 71.4% d. 28.6% e. 57.1% f. 28.6% g. 85.7% h. 57.1% i. 71.4%	Root fracture

making endocrown crowns can be considered. According to Sedrez-Proto JA et al., endocrown crowns with composite resins have a mechanical ability that resembles conventional crown restorative materials such as glass-ceramics, but is better because the resin composite endocrown are considered to be able to protect the remaining tooth structure than e.max restoration materials.[10]

When used for anterior teeth, endocrown has no better fracture resistance and post and crown restoration.[13] The same finding for premolar teeth was also stated by Guo, et al.[12] However, endocrown for anterior teeth produce more unfavorable fracture than post.[13] This might be because endocrown is considered like a short post.

Answer the PICO question, according to most studies, tooth with root canal treatment restored with endocrown has better fracture resistance compared than post and crown. However, endocrown does not provide better protection against fractures that occur compared to post and crown.

REFERENCES

1. Aurélio M, Carvalho D. Current options concerning the endodontically-treated teeth restoration with the adhesive approach Partial restorations versus full Preserving the coronal structure. 2018;32:147-158.
2. Ao PM, Bruzi CG. Influence of no-ferrule and no-post buildup design on the fatigue resistance of endodontically treated molars restored with resin nanoceramic CAD/CAM crowns. 2014:595-602. doi:10.2341/13-004-L
3. Naumann M, Schmitter M, Frankenberger R, Krastl G. "' Ferrule Comes First . Post Is Second !"' Fake News and Alternative Facts ? A Systematic Review. *J Endod*. 2017. doi:10.1016/j.joen.2017.09.020
4. Einhorn M, Duvall N, Wajdowicz M, Brewster J, Roberts H. Preparation ferrule design effect on endocrown failure resistance. 2019:237-242. doi:10.1111/jopr.12671
5. Derleme E, Sevİmlİ G, Cengİz S, Oruç MS. Endocrowns: review. 2015;49(2):57-63.
6. Sedrez-porto JA, Luiz W, Oliveira D, Fernandes A, Münchow EA, Pereira-cenci T. Endocrown restorations : A systematic review and meta-analysis. *J Dent*. 2016;52:8-14. doi:10.1016/j.jdent.2016.07.005
7. Güngör MB, Bal BT, Yilmaz H, Aydin C, Nemlİ SK. Fracture strength of CAD / CAM fabricated lithium disilicate and resin nano ceramic restorations used for endodontically treated teeth. 2017. doi:10.4012/dmj.2016-017
8. Atash R, Arab M, Duterme H, Cetik S. Comparison of resistance to fracture between three types of permanent restorations subjected to shear force : An in vitro study. 2017:239-249. doi:10.4103/jips.jips
9. Article O. Fracture load of nano-ceramic composite material for anterior endocrown restorations. 2020; 23 (1):1-9. doi:10.14295/bds.2020.v23i1.1853
10. Sedrez-porto A, Aldrighi E, Sergio M, Pereira-cenci T. J Mechanical Behavior of Biomedical Materials Which materials would account for a better mechanical behavior for direct endocrown restorations? 2020;103 (December 2019). doi:10.1016/j.jmbbm.2019.103592
11. Patrick R, Schmidlin PR, Fh D, Deabreu D. Restorative dentistry fracture resistance of endodontically treated teeth without ferrule using a novel H-shaped short post. 2015;46(2):97-109. doi:10.3290/j.qi.a32634
12. Guo J, Wang Z, Li X, Sun C, Gao E, Li H. A comparison of the fracture resistances of endodontically treated mandibular premolars restored with endocrowns and glass fiber post-core retained conventional crowns. 2016:489-93.
13. Haumahu D, Schepke U. Fracture strength of various types of large direct composite and indirect glass ceramic restorations. doi:10.2341/18-111-L
14. Magne P, Lazari PC, Carvalho MA, Johnson T DBCA. Ferrule-effect dominates over use of a fiber post when restoring endodontically treated incisors : an in vitro study. Oper Dent. 2017;42:396-406. doi:10.2341/16-243-L

Implant–supported crowns insertion in patient receiving chemotherapy

[1]Michael Josef K.K., [1]Harry Laksono, [2]Cindy Karina Hartono
[1]Staff of Prosthodontic Dentistry Department
[2]Post Graduate Student of Prosthodontic Dentistry Department
Faculty of Dental Medicine Airlangga University
Surabaya, Indonesia
Corresponding author: **Michael Josef K.K**., Email: **josef_310563@yahoo.com**

ABSTRACT
The clinical results of a case demonstrating dental implant insertion in a patient receiving chemotherapy is the focus of this report. A 74-year-old male patient came on his own accord because five units of porcelain long bridge in his right mandibular region were loosened. The one abutment tooth had a severe problem due to the periodontal problem (tooth 47), and teeth 43 and 44 were treated with root canal treatment, intrapulp post and porcelain crowns. After insertion of the fixture bone level implant, the patient is diagnosed with lymphoma and chemotherapy is performed for treatment. Clinically, the implants had no mobility, with no apparent exudate or bleeding upon probing 1 year after. At the time second procedures were performed, the dental implants had provided support for the abutments. One of the abutments was changed with anatomic abutment due to realignment of prosthesis position. Finally, three crowns porcelain fused to metal were used as final restorations and harmonized occlusion was achieved. The following is a discussion of the purposes and technique used for the insertion of these dental implants.
Keywords: dental implants, dental porcelain, dental abutments, crowns, lymphoma

INTRODUCTION

A dental crown is a restoration that replaces the top part of the tooth. A single tooth that needs to be completely replaced can be restored utilizing an implant-supported crown. The crown is usually porcelain, which gives a natural look to the restoration. It is supported by a titanium “root” and post, implanted into the jawbone. The implant cements that artificial tooth, ensuring that the crown and teeth are firmly fit and avoiding position shifting. An implant-supported crown looks such as the natural form, size and color with the teeth and provides a wonderful smile.[1]

A dental implant is indeed a titanium post (like some kind of teeth root) that is located under the gum line and puts the artificial tooth in the jawbone in it. A healthy gums and enough bone to support implants is necessary before placing an implant. Many implants have three parts: the implant in bone, the abutment (or connector) which holds the tooth, as well as the crown tooth. The crown is like a tooth and looks like the others around. The abutments are made from various materials, usually titanium, but also gold or zirconia. The crown is applied to the abutment using a special type for dental cement. Well-constructed dental implants connect with the tooth and the abutment very closely. This is necessary for the implant's long-term maintenance.[2]

Implant placement in patients with malignant disease and benign tumors presents special difficulties. Patients with cancer can have oral toxic effects in the form of antineoplastics agents. One of the treatments for patient with cancer is chemotherapy. The goal of treating cancer with chemotherapeutic agents would be to prevent cancer cells from multiplication, invading, metastasizing, and ultimately killing the patient. While some local and systemic causes might be contraindications to treatment by dental implants, the successful rate of dental implants for patients that have received chemotherapy remain unclear.[3] This case report describes a patient undergoing chemotherapy for lymphoma with successful survival of dental implants inserted in the mandibula.

CASE

A 74-year-old male patient came on his own accord because five units of porcelain long bridge in his right mandibular region were loosened. The one abutment tooth had a severe problem due to the periodontal problem (tooth 47).

Patient wanted to have implant treatment with fixed restoration because he had experienced with the fixed restoration before in another region, so the prosthodontic treatment option was using implant supported crowns.

MANAGEMENT

The abutment, teeth 43 and 44 were treated with root canal treatment, intrapulp post and porcelain crowns. Three bone level dental

implant fixtures were inserted in 45, 46, 47 regions.

After insertion of the fixture, the patient was diagnosed with lymphoma and chemotherapy was performed for treatment. The implants were checked after 1 year following insertion.

Fig 1 Five units porcelain long bridge were loosened.

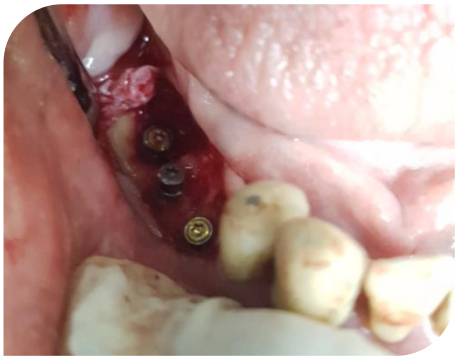


Fig 2 Three bone level dental implant fixtures were inserted.

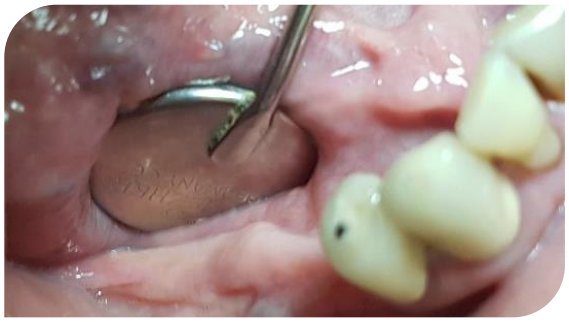


Fig 3 Clinical intra oral examination 1 year after insertion

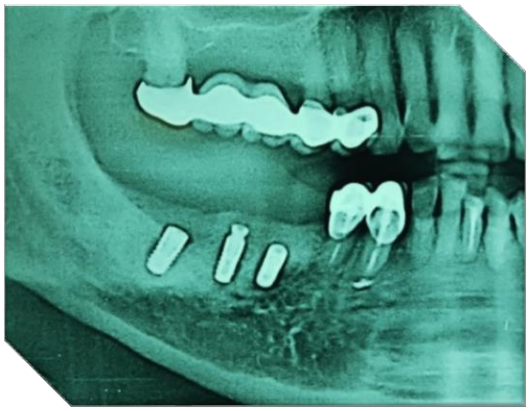


Fig 4 Radiograph examination 1 year after insertion.

Clinically, the implants submerged in soft tissue, with no apparent exudate or bleeding. The panoramic radiograph shows the bone appeared to be integrated to the surface of the implant, and relatively mature and healthy.

At the time second procedures were performed, the dental implants had provided support for the abutments.

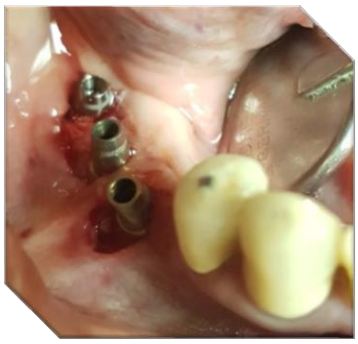


Fig 5 Abutment at second procedures.

Three weeks upon the second operation, the dental implants were in a state of health and functioning in their intended purpose, the mucosa had a full recovery and the impression was done. One of the abutments was changed with anatomic abutment due to realignment of prosthesis position.

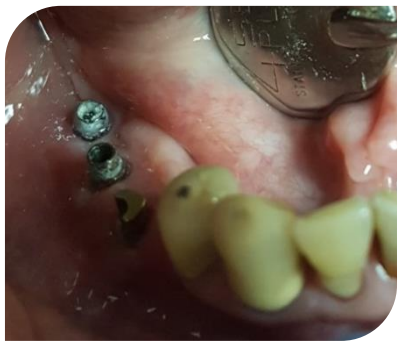


Fig 6 One abutment was changed with anatomic abutment.

Finally, three crowns porcelain fused to metal were used as final restorations and harmonized occlusion was achieved. Panoramic view was taken 6 months after the treatment had fully been accomplished.

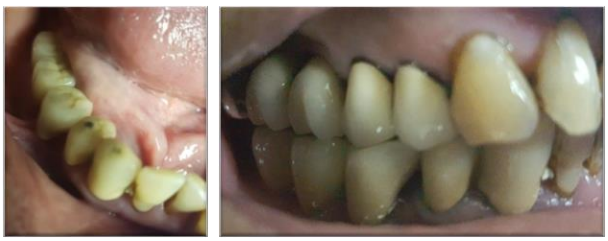


Fig 7 Three crowns porcelain fused to metal.

DISCUSSION

Dental implants were widely used and are regarded to be one of many treatment options which can be used to replace missing teeth. The number of implant-supported therapy choices has been effectively used to substitute a single tooth, various teeth and a totally edentulous jaw. This achievement relies on the capacity of implant material to incorporate into the surrounding tissue.

Cancer patients can suffer oral toxic effects to antineoplastic therapy in the form of chemotherapy. This risk is driven by a variety of variables, including elevated oral mucosal cell turnover rate, oral microflora variety and complexity, or soft tissue trauma during ordinary oral function. Main oral complications of chemotherapy are mucositis, neurotoxicity, susceptible to infections, dental, salivary and taste alterations, and the development of osteonecrosis.

When placing dental implants, it should be known that even a series of metabolic changes occur around the implant, leading to the formation of bone closely linked to the implant surface (osseointegration). Implants can be osseointegrated while the bone and surrounding soft tissues heals and, if chemotherapy is to be given, implants can normally have osseointegrated before the chemotherapy.[4]

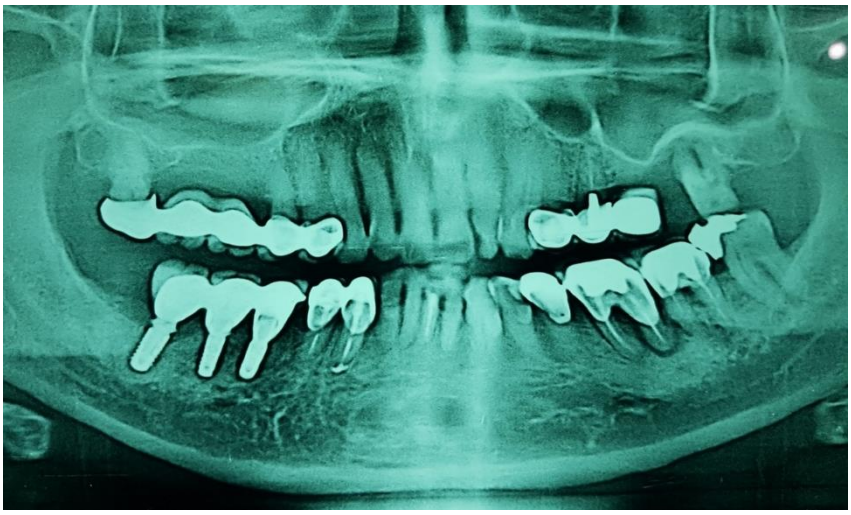


Fig 8 Panoramic radiograph 6 months after treatment.

Table 1 Dental treatment before, during and after chemotherapy[5]

TREATMENT BEFORE CHEMOTHERAPY	TREATMENT DURING CHEMOTHERAPY	TREATMENT AFTER CHEMOTHERAPY
– The dentist should consult the oncologist to determine the current condition of the patient and the type of treatment planned.	– The oncologist should be consulted in order to know the degree of immune suppression of the patient.	– The dentist should consult the oncologist to determine immune competence.
– Exhaustive examination of the oral cavity: discard periapical lesions and/or bone alterations, and the evaluation of periodontal health. – Denture fitting should be checked, with readjustment or removal of those prostheses that prove traumatic. – Radiological study: intraoral (periapical and bitewing) and panoramic.	– Treatment of the complications of chemotherapy (mucositis, xerostomia…).	– Insist on the need for routine systematic oral hygiene. – Use of chlorhexidine rinses and fluorization.
– General prophylactic measures: tartar removal, dental fluorization and rinses with 0.12% chlorhexidine.	– Continued patient reminder of the need to maintain strict dental hygiene is indicated, with the added use of chlorhexidine rinses and fluorization.	
– The patient should be informed of the complications of treatment.	– Analgesics: paracetamol/metamizol. – NO NSAID. – Antibiotics: dose adjustment is required according to the observed creatinine clearance values in patients with kidney problems.	
– Teeth that are non-viable or present a poor prognosis should be removed: o Minor surgery: al least two weeks before chemotherapy. o Major surgery: 4-6 weeks before chemotherapy.	**No elective dental treatment should be carried out.** **ONLY emergency dental care.**	– Elective dental treatment.

NSAID: nonsteroidal antiinflammatory drugs.

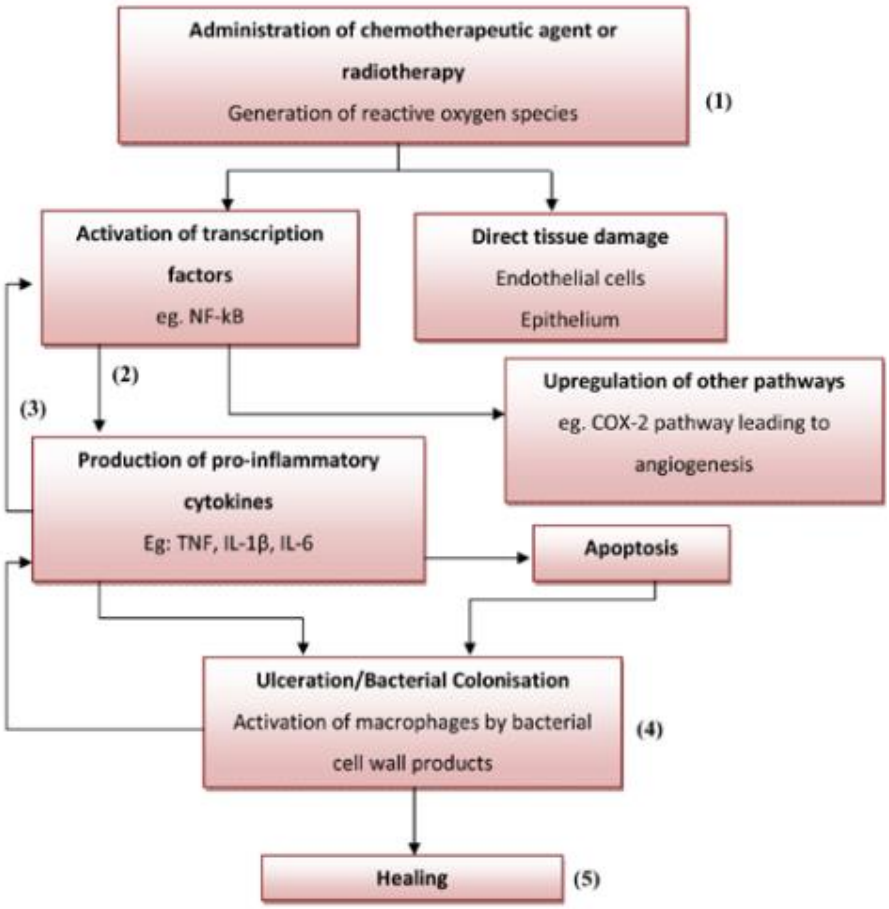


Fig 9 Administration of chemotheraputic agent or radiotherapy.[5]

This table is the guideline for dentist to treat the patient before, during, and after chemotherapy procedure and administration of chemotheraputic agent or radiotherapy.[5]

Implant therapy is not absolutely forbidden to be done in chemotherapy patient. Implant can be done by considering a least four factors, such as patient's health, oral hygiene, chemotherapy standard operating procedure, and approval from the oncologist. A good follow up and communication should be done among patient, dentist, and oncologist.

REFERENCES

1. Rao BHS, Bhat V. Dental implants: a boon to dentistry. Med Health Sci 2015; 3(1): 131-7.
2. Duraccio D, Mussano F, Faga MG. Biomaterials for dental implants: current and future trends. J Mater Sci 2015; 50(14).
3. Aeran H, Nautiyal V, Kumar V, Uniyal S. Implant Supported Overdenture in The Patients with History of Radio and Chemotherapy for The Prostate Malignancy. National J Maxillofac Surg 2015; 6: 200-5.
4. Dantas MVM, Verzola MHA, Sanita PV, Dovigo LN, Cerri PS, Gabrielli MAC. The influence of cisplatin-based chemotherapy on the osseointegration of dental implants: an in vivo mechanical and histometrical study. Clin Oral Implants Res 2019; 30(7): 603-16.
5. Lopez CB, Esteve GC, Perez SMG. Dental treatment considerations in the chemotherapy patient. J Clin Exp Dent 2011; 3(1):31-42.

The effect of polishing agents on the transverse strength of heat cured acrylic resin bases

[1]Tiysha Suraskurmar, [2]Syafrinani
[1]Student at professional stage
[2]Lecturer at Department of Prosthodontic
Faculty of Dentistry, University of Sumatera Utara
Medan, Indonesia
Corresponding author: **Tiysha Suraskurmar,** email: **tiyshasuraskumar@gmail.com**

ABSTRACT
Introduction: Heat cured acrylic resin is frequently used denture base material whereby transverse strength is one of the mechanical properties that must be observed. A rough surface absorbs water, reduces strength of denture bases, thus polishing should be done. Pumice is the most abrasive material used in dentistry. Eggshell and toothpaste can be used as alternative abrasive materials. This study aims to determine the differences in value of transverse strength of HCA resin once polished using pumice, eggshells, and toothpaste. **Method**: This laboratory experimental study using sample sized 65x10x2.5 mm with 30 samples in total for 3 groups. Transverse strength was measured using Universal Testing Machine. The data were analyzed using one-way Anova. **Result**: The comparison ratio of transverse strength between HCA resin after polishing with pumice, eggshells and tooth paste is 93.63 : 118.42 : 105.91 MPa. It shows there were significant differences in transverse strength between groups with significant value p was 0.001 which less than 0.05. **Conclusion**: The value of transverse strength varies according to polishing material used. Eggshell has the highest transverse strength value compared to pumice and toothpaste.
Key words: heat cured acrylic resin, denture bases, transverse strength, polishing materials

INTRODUCTION

Since first polymerized in 1936 by Walter Bauer, heat cured acrylic resin became the most commonly used denture base material because it is inexpensive, ease processing, good color stability and easy to polish.[1,2] One of the characteristics of heat cured acrylic resin that should be observed is the mechanical properties which is the transverse strength.[2] The minimum transverse strength of denture base materials should not be less than 65 MPa.[3] The transverse strength of acrylic resins depends on several factors such as polymer molecular weight, residual monomer level, plasticizer composition, denture base thickness, type of polishing and porosity.[4] Rough surfaces increases water absorption because water acts as a plasticizer until acrylic resin material becomes soft and flexible.[5,6] To get a smooth surface, polishing process should be done. Traditionally, acrylic resin is polished by mechanical procedure using abrasive materials because it produces a smoother base surface. Abrasive material that is often used as a polishing material in the field of dentistry is pumice. Pumice is the powdered form of volcanic rock that has a holey texture.[7] Pumice consists of 60-67% silica, 13-17% alumina, 7-8% sodium oxide-potassium oxide and minimal amount of iron oxide, calcium oxide and titanium dioxide.[8]

Other alternative abrasive materials that can be used as polishing agent are eggshell and toothpaste. The eggshell is the outer part of the egg with a hard and porous texture consisting of 94% calcium carbonate, 1% magnesium carbonate, 1% calcium phosphate and 4% organic matter.[9] Henuset states calcite from calcium carbonate has abrasive properties which can be used to polish the surface of acrylic resins.[10]

Toothpaste is generally used for tooth surfaces and mechanical cleaning of artificial teeth. Toothpaste contains a variety of abrasive substances such as calcium carbonate, dicalcium phosphate, alumina, calcium pyrophosphate, sodium bicarbonate, perlite and silica. Generally, the abrasive material in a toothpaste is around 20-55%.[11] According to Hefferen and Forward, abrasive material is added to toothpaste to remove plaque, stain and food debris.[12] According to Pisani et al, toothpaste has polishing effect on the surface of acrylic resin denture bases because of the silica content.[13]

Based on this, the idea arose to utilize eggshells and toothpaste as a polishing agent for heat cured acrylic resin bases.

METHOD

In this experimental laboratory research, the eggshells were collected from various food outlets, washed under running water and then soaked for 6 hours in 2.5% sodium hypochlorite solution. Eggshells were dried using electric oven (Naberthem, USA) for 6 minutes at 250°C. The eggshells were crushed with a blender and 15 g of sodium lauryl sulfate added to 300 g of eggshell and blended until

homogeneous. The use of ball-mill (Retsch PM 200 Series, Germany) to produce fine particle size was carried out for 60 minutes at a speed of 400 rpm. The powder was then sieved with mesh 100 and continued with mesh 400.

Samples were made from HCA resin of size 65 × 10 × 2.5 mm.[3,5] The total number of sample was 30 and divided into 3 groups: the pumice group, the eggshell group and the toothpaste group. The cuvette containing the mold comes from the parent model which was planted in a cast. The mold was filled with acrylic resin dough then the cuvette was closed, pressed then cured in a water bath. Samples were removed from the cuvette and trimmed with a fraser bur, grinded with 400, 800 and 1200 sandpaper using a rotary grinder and followed by polishing using a rag wheel mounted to polishing motor, using pumice, eggshell and toothpaste. Each sample was polished for 2 minutes, then were immersed in distilled water for 2 days at 37°C in an incubator (Memmert, Germany).

Transverse strength testing was performed using the Universal Testing Machine (Torsee's Electronic System). Data analysis was performed with Univariate test and one-way Anova test.

RESULT

The results show that the value of transverse strength analyzed by the Univariate test whereby the pumice group has a mean value of 93.63 MPa and with a standard deviation of 10.22. The mean value of eggshell group was 118.42 MPa with a standard deviation of 12.66. The mean value of the toothpaste group was 105.91 MPa with a standard deviation of 9.80. Based on the one-way Anova test, there were significant differences in the value of transverse strength in the three groups with a value of p was 0.001, less than 0.05 (Table 1).

Table 1 Anova test results on the value of transverse strength between the pumice, eggshell and toothpaste groups.

Groups	Transverse Strength (MPa)		
	n	$\bar{x}$ ± SD	p
Pumice	10	93,63 ± 10,22	
Eggshell	10	118,42 ± 12,66	0,001*
Toothpaste	10	105,91 ± 9,80	

Note: *significant

Based on least significant difference (LSD) test, the value of transverse strength between the pumice group and the eggshell group with a value of p was 0.001; less than 0.05, the pumice group with toothpaste group with a value of p was 0.019; less than 0.05, eggshell with toothpaste group with p value was 0.017; less than 0.05 (Table 2).

Table 2 LSD test results for each group

	Pumice	Eggshell	Toothpaste
Pumice	-	0.001*	0.019*
Eggshell	0.001*	-	0.017*
Toothpaste	0.019*	0.017*	-

Note: *significant

The results show that the three groups have transverse strength values above the standard value accepted in dentistry, which is 65 MPa. Based on the statistical test results, the eggshell group has the highest transverse strength value compared to the pumice group and toothpaste group. There was a significant difference between the eggshell group with the pumice group and toothpaste group.

DISCUSSION

The results show that the value of transverse strength varies in the same group. The acquisition of these varied results can be caused by a rough surface that increases the capacity of water absorption.[6] Acrylic resins have the characteristics of absorbing water slowly over a period of time by the mechanism of water absorption through the diffusion of water molecules according to the diffusion law. Absorption occurs because water molecules penetrate the mass of polymethyl methacrylate and occupy the positions between the polymer chains which causes disruptions to the polymer chains.[14] The water absorbed acts as a plasticizer which affects the surface hardness, dimensional stability, colour stability, fatigue limit and transverse strength.[5]

Research by Hasanah shows that the surface roughness values of HCA resin polished with alumina were 0.3488 ± 0.0767 µm.[15] Sahin stated that HCA resin polished with alumina and immersed in aquades for 2 days produces tranverse strength value of 64.27 ± 4.30 MPa.[16] The acquisition of a low transverse strength value is due to the rough surface of the acrylic resin resulting in high water absorption. Study conducted by Oliviera obtained that the HCA resin polished with pumice and chalk resulting in surface roughness value of 0.0427 ± 0.25 µm.[17] Braun stated that the HCA resin polished with pumice and chalk and soaked in aquades for 2 days resulted in a transverse strength value of 89.05 ± 0.73 MPa.[18] The acquisition of high transverse strength value is due to the smooth surface of acrylic resin resulting in low water absorption. This is supported by Rahal et al stating that high water absorption occurs on rough surfaces where

water enters through the surface porosity of acrylic resin after polishing.[19]

Based on the data obtained, the mean and the standard deviation value of transverse strength of pumice group was 93.63 ± 10.22 MPa. The value of transverse strength of eggshell group was 118.42 ± 12.66 MPa. The transverse strength value of toothpaste group was 105.91 ± 9.80 MPa. From the one-way Anova test in Table 1, it can be seen that there were minimal significant differences in the two groups because the significance of p was 0.001 and less than 0.05.

The pumice group has transverse strength value above the standard required in dentistry. In this study, the pumice group has a mean transverse strength value of 93.63 ± 10.22 MPa, this value was not much different from previous study which had a transverse strength value of 94.77 ± 9.45 MPa.[4] Although the value of transverse strength in the pumice group is more than the required standard value but the value is lower than the eggshell and the toothpaste group due to the high water absorption in the pumice group. Water absorption occurs on rough surfaces where water enters through the surface porosity on acrylic resin.[19] Yudi's study obtained that the HCA resin polished with pumice results in higher surface roughness value compared to eggshell and toothpaste group.[20] This is due to the differences in particle size, particle shape, particle hardness and abrasive material content of each polishing agent is different.[10,13] Pumice with an irregular particle shape has a particle size of 5-8 µm and particle hardness of 6-7 according to the Mohs scale. High particle hardness and size produces higher surface roughness of acrylic resin, to the extend that when acrylic resin is immersed in distilled water, high water absorption occurs and the transverse strength decreases because water acts as a plasticizer which results in HCA being flexible.

The eggshell group has a mean transverse strength value of 118.42 ± 12.66 MPa higher than the pumice and toothpaste group. Yudi's research found that eggshell produces smoother surface.[20] According to Areeg & Bassam et al, physical properties of abrasive materials such as particle size and hardness are directly proportional to the quality of surface roughness.[10] In this study, ball mill was used for 60 minutes. Wu SC et al stated that grinding eggshell using a ball mill for 60 minutes can produce an average particle size of 2.21 µm. Based on that study, it was known that longer grinding time with a ball mill produces smaller particle size.[21] The hardness of eggshell particle is 4 according to Mohs scale. Smaller particle size and lower particle hardness of polishing materials have an advantage that is to produce smoother surface. In addition, the abrasiveness of eggshell material is influenced by the calcite content in calcium carbonate ranging 94-98.2%, calcite acts as an abrasive.[10] With this, the water absorption that occurs in acrylic resin is low. This results in acrylic resin having great strength and being able to reduce deflection when force is applied which produces high transverse strength value.

The toothpaste group has a transverse strength value of 105.91 ± 9.80 MPa. Yudi's study found that toothpaste showed a lower surface value than pumice group but higher surface roughness value than eggshell group.[20] Pisani et al after experimenting the effect of abrasive toothpaste on surface roughness of acrylic resin, stated that toothpaste which contains silica has polishing effect on the surface of denture bases.[13] The shape of the toothpaste particle is square or slightly rounded and the hardness of the particles according to the Mohs scale is 5.[22] Although the amount of abrasive material in toothpaste ranges 20-55%, it is less than the pumice and eggshell group which makes the abrasive ability of toothpaste to be low thus the effectiveness when polishing is reduced, however the particle size is smaller than pumice and eggshell group which is an advantage for the toothpaste group. Toothpaste produces smoother surface compared to pumice group. Water absorption is high, thus resulting in lower transverse strength value compared to eggshell but higher transverse strength value than pumice group.

The LSD test shows a significant difference between the pumice group and eggshell group with p was 0.001, pumice group and toothpaste group with p was 0.019 and the eggshell group with the toothpaste group with a value of p was 0.017. Based on this, it can be statistically seen that the 4 eggshell group produced the highest transverse strength value compared to pumice and toothpaste group, while the toothpaste group produced higher transverse strength value compared to pumice group. Eggshells have an advantage, whereby is has the highest amount of abrasive material compared to other polishing material in which it has calcium carbonate content 94-98.2%.[10]

Clinically, the standard transverse strength value of denture base is not less than 65 MPa. Based on this, all three groups have fulfilled the standard transverse strength value requirement.

Pumice is the most widely used polishing material for acrylic resins because it has been proven that the transverse strength is more than 65 MPa, however the transverse strength value is still not better compared to eggshell and toothpaste. Eggshell produces better transverse strength value compared to pumice and toothpaste. Toothpaste produces better transverse strength value compared to pumice, however it is still not better compared to eggshell.

It was concluded that the use of different polishing materials on heat cured acrylic bases has an influence on the value of transverse strength. Heat cured acrylic resin which was polished using eggshell has higher transverse strength value than that which was polished using pumice and toothpaste.

REFERENCES

1. Khindira SK, Mittal S, Sukhija U. Evolution of denture base materials. J Indian Prosthodont Soc 2009; 9(2): 64-9
2. McCabe JF, Walls AWG. Applied dental materials.9th ed. London: Blackwell Munksgaard; 2008.p.110-23
3. Watri D. Pengaruh penambahan serat kaca pada bahan basis gigtiruan resin akrilik polimerisasi panas terhadap kekuatan impak dan transversal [Skripsi]. Medan: Fakultas Kedokteran Gigi Universitas Sumatera Utara, 2010: 36-7.
4. Orsi IA, Andrade VG. Effect of chemical disinfectants on the transversal strength of heat-polymerized acrylic resins submitted to mechanical and chemical polishing. J Prosthet Dent 2004; 92: 382-8
5. Hemmati MA, Vafaee F, Allahbakhshi. Water sorption and flexural strength of thermoplastic and conventional heat-polymerized acrylic resins. J Dent, Tohran University of Medical Sciences 2015; 12(7): 478-9.
6. Utami M, Febrida R, Djustiana N. The comparison of surface hardness between thermoplastic nylon resin and heat-cured acrylic resin. Padjajaran J Dent 2009; 21(3): 200-3.
7. AL-Kheraif. The effect of mechanical and chemical polishing techniques on the surface roughness of heat-polymerized and visible light-polymerized acrylic denture base resins. Saudi Dent J 2014, 56-62
8. Manapallil JJ. Basic dental materials. 4th ed. New Delhi: Jaypee Brothers Medical Publishers (P); 2016.p. 532-52
9. Murakami FS, Rodrigues PO, de Campos CMT, Silva MAS. Physicochemical study of CaCO3 from eggshells. Ciencia Tecnol Aliment 2007: 27 :658-62.
10. Onwubu SC, Vahed A, Singh S, Kanny KM. Using eggshell for development of a quality alternative material to pumice in reducing the surface roughness of heat-cured acrylic resins [Thesis]. Johanesburg: Durban University; 2016: 6-14,23-5,34-5,49
11. Joiner A. Whitening toothpaste: A review of the literature. J Dent 2010: e17-24
12. Herda E, Fawzia AF, Soufyan A. Pengaruh penyikatan dengan pasta gigi terhadap kekasaran permukaan nano-ionomer dan semen ionomer kaca modifikasi resin. JMKG 2012; 1(1): 23-32
13. Pisani MX. Evaluation of the abrasiveness of dentifrices for complete dentures. J Prosthodont 2010, 25; 19: 369-73
14. Pantow FPCC, Siagian KV, Pangemanan DHC. Perbedaan kekuatan transversal basis resin akrilik polimerisasi panas pada perendaman minuman beralkohol dan aquades. E-Gigi J 2015; 3(2): 398-402.
15. Hasanah N, Triaminingsih S, Matram N. Karakterisasi kekasaran permukaan resin akrilik polimerisasi panas dengan serat dan tanpa serat [Skripsi]. Fakultas Kedokteran Gigi Universitas Indonesia; 2014. p.1-11.
16. Sahin C, Ergin A, Ayyildiz S, Uzun G. Evaluation of flexural strength and Candida albicans adhesion of an acrylic resin repaired with 4 different resin materials. Clin Dent Res 2012; 36(2): 10-4.
17. Oliviera LV, Mesquita MF, Henriques GEP. Effect of polishing technique and brushing on surface roughness of acrylic resins. J Prosthodont 2008; 17: 308-11.
18. Braun KO, Mello JAN, Rached RN, Del Bel Cury AA. Surface texture and some properties of acrylic resins submitted to chemical polishing. J Oral Rehabil 2003; 30: 91-8.
19. Rahal JS, Mesquita MF, Henriques GEP. Influence of chemical and mechanical polishing on water sorption and solubility. Braz Dent J 2004; 15(3): 225-30.
20. Setiawan Y. Perbedaan kekasaran permukaan basis resin akrilik polimerisasi panas menggunakan bahan pumis, cangkang telur dan pasta gigi sebagai bahan poles [Skripsi]. Program Sarjana Fakultas Kedokteran Gigi Universitas Sumatera Utara.
21. Wu SS, Hsu HC, Hsu SK, Chang YC, Ho WF. Synthesis of hydroxyapatite from eggshell powders through ball milling and heat treatment. J Asian Ceram Soc 2015; 198: 1-6.
22. Sumendap IB, Herda E, Eriwati YK. Effect of whitening toothpaste on the discoloration level of stained conventional glass ionomer cement. J Phys: Conf Ser 2018; 1073: 1-6.

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