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Multidisciplinary approach for aesthetic rehabilitation in gummy smile and fluorosis: a case report

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ABSTRACT
Background: Teeth, gingiva and lips are the three interrelated primary components in aesthetic dentistry. These combinations warrant a multidisciplinary approach for planning and predictable treatment outcome. **Objective**: The aim of this article is to describe the multidisciplinary approach for aesthetic rehabilitation involving gingivectomy and minimally invasive tooth preparation with porcelain laminate veneer (PLV) restorations and resin bonded bridge. **Case**: A 25-year-old female patient attended with existing space between maxillary anterior teeth post orthodontic treatment and missing mandibular anterior teeth. Intraorally, patient had uneven interdental spacing in between 13 to 23, missing 31 and 32, with merging and irregular opacities suggestive of enamel fluorosis appearance. The zenith lines were asymmetrical with short clinical crowns and disharmonious teeth axes. To optimize the aesthetic outcome and overall smile appearance, gingivectomy was performed after confirmation of biologic width. Eight weeks after healing, PLV restorations were delivered from 13 to 23, and zirconia resin bonded bridge were used to restore missing mandibular lateral incisors. **Conclusion**: The present case illustrates the sequential and predictable approach for management of gummy smile and fluorosis. An alternative treatment modality such as electrocautery may enhanced the smile and obtain positive outcome.
Keywords: gummy smile, fluorosis, gingivectomy, veneer
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INTRODUCTION

Gummy smile and fluorosis whether congenital or developmental origin may cause an esthetic concern for patient especially in the anterior teeth. The condition of gummy smile or excessive gingival display (EGD) are usually corrected with gingivectomy, or apically positioning flap with or without osteotomy depending on the biologic width.[1] Various approach has been documented to remove the EGD, and electrocautery is one of the simple and effective method.[2] Less pain and discomfort were also recorded when compared to scalpel.[3] By correcting the gummy smile, the perfect balance of three interrelated primary components teeth (white), gingiva (pink) and lips can be achieved for smile correction and to restore the patient's confidence.[4] To achieve these goals, multidisciplinary treatment and the biomimetic approach are usually a dual approach to reproduce the biomechanics, structure, function and esthetic of natural tooth.[4,5]

Fluorosis are generally treated with direct composite restoration, indirect composite or all-ceramic laminate veneers and metal-free full coverage crowns.[6] Compared to the previous years where adhesive dentistry was not common, the full coverage crowns were approved as a treatment of choice to restore discoloured tooth. It is known that this treatment option can be damaging to the tooth and possibly affect the condition of the pulp and surrounding periodontal tissues. As biomimetic concept is introduced, direct composite resin restoration has gained popularity, particularly because of its esthetic properties and being minimally invasive.[4] Although this treatment can be in a single visit, this option has limited longevity because of discolouration, susceptible to wear and prone to fracture.[7] Therefore, the application may be limited and may need frequent maintenance.

As an alternative for longer clinical performance, the indirect approach with minimal preparation is preferred for tooth size and shape modification.[6] All-ceramic laminate veneer has superior esthetic result and less invasive than full coverage crown preparation.[8] This modality is recommended in the tooth condition that require minimum preparation, provides lower rate failure and excellent esthetic.[9] To ensure tooth preparation is minimum, the conservative approach is applied by using the guidance from the presume final shape, contour and texture of the restoration, known as aesthetic pre-evaluative temporary (APT) technique.[10] In addition, bonding between ceramic material and tooth structure can be improved by bonding to enamel rather than dentinal layer. The complications like microleakage or debonding of all ceramic veneer is reduced when the restoration

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is bordered on all margins by the enamel.[10] Hence, the purpose of this case report is to illustrate a predictable soft tissue management by removing the excess gingiva, and demonstrate a sequential approach for the restoration of polydiastema, fluorosis appearance and missing teeth.

CASE

A 25-year-old lady was referred to Prosthodontic Clinic from Outpatient Department Faculty of Dentistry, Universiti Teknologi MARA (UiTM), Sungai Buloh, Selangor, Malaysia for management of spacing in between maxillary anterior teeth and missing mandibular anterior teeth, 31 and 32 (Fig. 1A). She completed fixed orthodontic treatment 12 years ago at a private orthodontic clinic, and was provided with a maxillary Essix retainer and mandibular removable partial acrylic denture to replace missing 31 and 32. However, the patient was not compliance with the retainer and defaulted orthodontic treatment follow up since then. Subsequently, relapse occurred resulting in the spacing. She was medically fit and healthy. On intraoral examination, the patient had uneven interdental space between 13 to 23, asymmetrical tooth size proportion and disharmonious teeth axes, generalised merging and irregular white opacities on enamel surfaces of the maxillary and mandibular teeth suggestive of enamel fluorosis appearance that affect more than 50% of the enamel surfaces (TFI score 3) and asymmetrical zenith lines. (Fig.1B) On the radiographic evaluation, there was no abnormality noted and the pulp vitality test was positive for all the maxillary and mandibular anterior dentition.

MANAGEMENT

After completed clinical, radiographic evaluation and investigations, a comprehensive treatment approach that consisted of aesthetic crown lengthening followed by the porcelain laminate veneers (PLVs) with lithium disilicate and resin bonded fixed dental prosthesis (RBFDPs) with zirconia to restore the interdental spacing, and missing teeth. After obtaining informed consent from the patient, she was advised to practice good oral hygiene care to prevent any oral diseases prior to the treatment. During diagnosis and treatment planning, maxillary and mandibular primary impressions were made using irreversible hydrocolloid impression material (Kromopan, Lascod, Illinois, USA) and poured with Type 3 dental stone (Model stone, Zhermack, Italy) to produce study models. Following that, study models were mounted on an arcon, semi-adjustable articulator (Denar® Mark II Articulator) using facebow (Denar® Slidematic Facebow) transfer and interocclusal record taken in maximum intercuspation position (MIP). The conformative occlusal approach was applied in this case since it only involved rehabilitation of anterior dentition. Diagnostic wax-up was fabricated to help the patient to visualize the proposed outcome in terms of both aesthetics and function (Fig.2a).

Veneer preparations were performed based on the *aesthetic pre-evaluative temporaries* (APTs) technique. The APTs technique was divided into two steps, which are the evaluation of the APTs followed by tooth preparations through the APTs. Evaluation of the APTs was carried out with Bis-acryl composite resin temporisation material (Protempt™ 4, 3M/ESPE, Shade A2) prior to the treatment in order to assess the patient in terms of aesthetic, function and phonetics (Fig.2b). Transgingival probing was performed to determine the alveolar bone level on labial and interproximal area. Due to adequate supracrestal attachment provided, crown lengthening procedure was done without osteotomy. Based on diagnostic mock-up, gingivectomy was performed with electrocautery to produce the favourable gingival zenith and gingival aesthetic line. A monopolar electrocautery tissue contouring system (PerFect® TCS II, Coltene, Germany) was used for gingivectomy procedure with an external bevel incision at an angle of 45° to the root surface. (Fig.3a).

During provisional phase, minimal tooth preparation for PLVs from 13-23 were performed through the APTs restoration using a horizontal depth cutter diamond bur. The preparation grooves were marked to ensure the equal and necessary minimum tooth/enamel reduction from the facial aspect and to mimic the exact final contours of the PLVs. (Fig.3b) The incisal edge was reduced evenly with a butt-joint preparation. The preparation margins were shaped with a smooth shoulder margin and clearly established within the enamel surface for better bonding. For PLVs, provisionalisation was performed using the spot etch technique. For cantilever RBFDPs, the retainer wing of zirconia cantilever RBFDPs preparation was performed on tooth 33 with lingual veneer preparation, a fine cervical shoulder margin, a groove on the cingulum and a small proximal box preparation; approximately 2x2 mm^2. The proximal preparation was positioned lingually to the proximal contact. (Fig.3c) Prior to the impression taking, electrocautery was done to create an ovate pontic on the missing space (Fig.3d). The missing space was then restored with patient's mandibular removable partial acrylic den-

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ture supported with 31 acrylic teeth.

For impression taking, a single cord impression technique was used with the cord size #00 (Ultrapak, Ultradent Products Inc., South Jordan, Utah, USA) on RBFPDs preparation (tooth 33). Double cord impression technique was used on all veneer preparation (teeth 13-23) since the cervical preparation margin was placed equigingivally. The final/working maxillary and mandibular impressions were made using heavy and light-bodied consistency polyvinyl siloxane (PVS) (Aquasil, Dentsply Sirona, USA) impression materials. During the definitive restorations, surface treatments for lithium disilicate PLVs and zirconia RBFPDs were carried out prior cementation. The clear shade of light-cure universal adhesive resin dental cement (NX3 Nexus™ Third Generation, Kerr Corporation, USA) was selected to cement PLVs and the translucent (TR) shade of dual cure, adhesive resin dental cement (RelyX Ultimate, 3M™ ESPE™ AG, Germany) was applied for zirconia RBFPDs. She was very happy and satisfied with the treatment outcome, felt confident with her new appearance (Fig.4a,b,c,d). Maxillary hard occlusal splint (Michigan) was provided as a protective guard to protect the new anterior bonded restorations and also act as retainer to prevent relapse. The patient was reviewed after one week for delivery of her occlusal splint and was reviewed another three months.

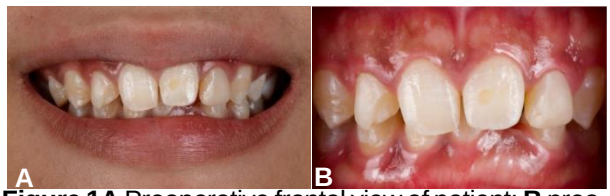

Figure 1A Preoperative frontal view of patient; **B** preoperative frontal view intraoral condition

Figure 2A Diagnostic wax up; **B** mock up try in was done to evaluate the esthetic and function

DISCUSSION

The clinical presentation of gummy smiles may lead patients to seek treatment to address the aesthetic and functional concerns. The condition of excessive gingival display may result from altered passive eruption of the maxillary dentition, a high lip line, a hypermobile upper lip or vertical maxillary excess.[11] In relation to the smile aesthetics, the critical consideration is the relationship of the gingival margins to the edge of the upper lip.[12] After stabilizing the periodontal health, the comprehensive treatment with gingivectomy was planned to expose the ideal clinical crowns and improve the patient's gummy smile.[13] The new ideal clinical crown heights were planned to make sure they were not violating the supracrestal attachment tissue width, which was measured as 2.04 mm.[14] As recorded in this patient, the keratinized tissue width of 5 mm was observed in through transgingival probing, indicates adequate procedure for gingivectomy for esthetic purpose.

Developmental anomalies of the enamel can have an important effect on dental aesthetic appearances especially on the anterior teeth. Fluorosis frequently manifest as white colour defects with high opacity, presenting a significant challenge for the clinician to mask these alterations. It may due to developmental whitish enamel defects that result from pathological changes of ameloblasts that im-

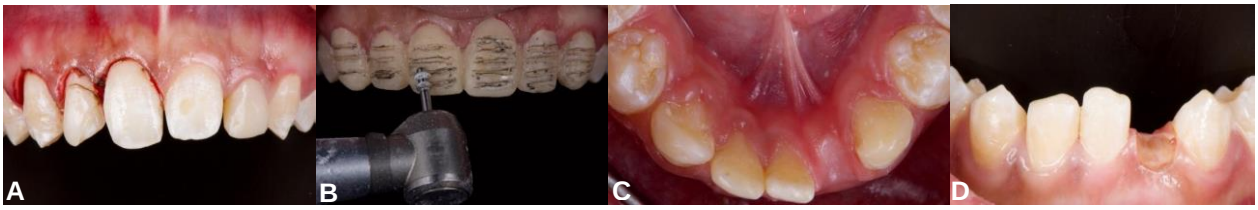

Figure 2A Gingivectomy with electrocautery; **B** preparation with APT technique; **C** preparation of grooves on lingual retainer; **D** creation of oviate pontic on #32

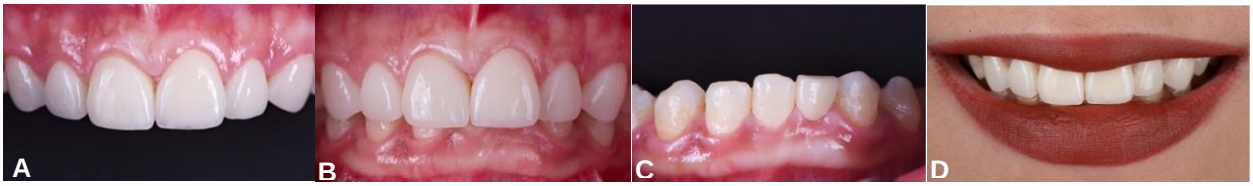

Figure 3A Intraoral frontal view of maxillary anterior teeth; **B** intraoral frontal view of mandibular resin bonded bridge; **C** intraoral frontal view after three months follow up; **D** extraoral view of patient smile.

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pede the formation of normal hydroxyapatite crystals. Several treatment options have been proposed to improve the appearance of the fluorosis, including the placement of veneers or full crowns, composite restoration, microabrasion, bleaching, and or resin infiltration. Bleaching and microabrasion have been recommended for treating mild cases of fluorosis; however, in moderate to severe cases, bleaching and microabrasion are either ineffective or may lead to only transient improvement,[15] while composite restorations are prone to discoloration, chipping, and debonding. The PLVs were planned since they require minimal tooth preparation, provide satisfactory aesthetic results to mask the fluorosis presentation and close the interdental spacing, as well as demonstrate high survival rate.[16,17] According to Gurel et al, the 12-year survival rate of PLVs was 98.7%.[18] Another retrospective clinical study by Arif et al reported that PLVs exhibited a high survival rate of 98% over 7 years and 88.2% over 14 years follow-up.[19] There are a lot of advantages of PLVs compared to other treatment modalities. For instance, PLVs are able to provide strong bonded restorations especially if cemented on enamel surfaces,[18] resist staining[20] and are excellent in tissue tolerance. In addition, the highly glazed smooth porcelain surface provides less plaque adherence.[21]

Systematic treatment planning helps us to obtain desirable and excellent outcomes and fulfill a patient's high aesthetic demands. The diagnostic wax-up information is transferred to the patient's mouth in order to provide a physical evaluation of the proposed design of the final restoration.[22-25] For this case, diagnostic mock-up with Bis-acryl composite resin temporisation material was carried out prior to the treatment in order to assess the patient in terms of aesthetic, function and phonetics. During this stage, the patient can physically evaluate the desired outcome and the clinician is able to modify specific areas as needed.[10] PLVs preparation in this case was confined to enamel the surface. Based on a retrospective study up to 12 years by Gurel et al, porcelain veneers cemented on enamel showed significantly higher clinical longevity than those cemented on dentin, with survival rates of 99.0% where margin and preparation depth were in the enamel and 94.0% for veneers with enamel only at the margins.[18]

Resin-bonded fixed dental prostheses are considered a minimally invasive treatment approach for the replacement of single missing anterior teeth and provide excellent clinical outcomes, high survival rates and great patient satisfaction.[26-27] The RBFDPs have many advantages including simple and conservative preparation, low cost and reversible treatment option, with no risk of pulpal irritation, no need for anaesthesia, and minimal risk of caries development and less demanding postoperative care.[26-27] Moreover, these restorations demonstrated a high survival rate of up to 81.8% after 18 years of clinical service.[28] Anterior all-ceramic cantilever single-retainer RBFDPs made from zirconia ceramic showed a highly successful clinical outcome after 10 years of clinical service with a 10-year survival rate of 98.2% and a success rate of 92.0%.[28-29] Although overloading can result in debonding in zirconia RBFDPs, the higher flexural strength and fracture load would make reattachment of zirconia RBFDPs is possible as compared to glass infiltrated alumina that is prone to fracture.[29-30] In addition, the design of cantilever the RBFDPs has recorded the success and survival rates of 100% after 18 years as compared with only 10% and 50% with 2-retainer metal-ceramic counterparts.[31] This 2-retainer RBFDP design was documented to have differential movement of the 2 abutment teeth, resulting in a shear force on the wing of the retainer, debonding of RBFDPs and consequently a lower survival rate.[32]

It was concluded that a well-planned diagnosis and multidisciplinary approaches are necessary to deliver the patient's aesthetic needs for predictable and longterm success of the treatment chosen.

REFERENCES

1. Hamasni FM, Majzoub ZAK. Effect of patient- and surgery-related factors on supracrestal tissue reestablishment after crown lengthening procedure. Quintessence Int 2019; 50 (10): 792-801.
2. Robbins W. Differential diagnosis and treatment of excess gingival display. Pract Periodontics Aesthet Dent 1999; 11: 265–72.
3. Garber DA, Salama MA. The aesthetic smile: diagnosis and treatment. Periodontol 2000 1996;11(1): 18-28.
4. Assaf M. Esthetic crown lengthening for upper anterior teeth: indications and surgical techniques. Int J Dent Med Res 2014;1(3):86-91.
5. Gargiulo A, Wentz F, Orban B. Dimensions and relations of the dentogingival junction in humans. J Periodontol 1961;32(3):261-7.
6. Denbesten P, Li W. Chronic fluoride toxicity: dental fluorosis. Monographs in Oral Science 2011; 22: 81–96.

DOI: 10.46934/ijp.v3i1.131

7. da Cunha LFPL, Gonzaga CC, Furuse AYJ. Aesthetic, occlusal and periodontal rehabilitation of anterior teeth with minimum thickness porcelain laminate veneers.J Prosthet Dent 2014:1315-8.
8. Veneziani M. Ceramic laminate veneers: clinical procedures with a multidisciplinary approach. Int J Esthet Dent 2017;12(4):426-48.
9. Gurel GSN, Calamita MA, Coachman C, Morimoto S. Influence of enamel preservation on failure rates of porcelain laminate veneers. Int J Periodontics Restorative Dent 2013:31-9.
10. Arif RDJB, Garcia D, Yaman P. Retrospective evaluation of the clinical performance and longevity of porcelain laminate veneers 7 to 14 years after cementation. J Prosthet Dent 2018:31-7.
11. Magne P, Douglas WH. Rationalization of esthetic restorative dentistry based on biomimetics. J Esthet Dent 1999;11(1):5-15.
12. Quirynen MBC. The influence of surface roughness and surface-free energy on supra and subgingival plaque formation in man. A review of literature. J Clin Periodont 1995:1-14.
13. Magne P, Belser UC. Novel porcelain laminate preparation approach driven by a diagnostic mock-up. J Esthet Restor Dent. 2004;16(1):7-16.
14. Coachman C, Gurel G, Calamita M, Morimoto S, Paolucci B, Sesma N. The influence of tooth color on preparation design for laminate veneers from a minimally invasive perspective: case report. Int J Periodontics Restor Dent 2014;34(4):453-9.
15. Beier USKI, Dumfahrt H. Clinical long-term evaluation and failure characteristics of 1,335 all-ceramic restorations. Int J Prsothodont 2012:70-8.
16. Soares PVSP, Carvalho VF, Souza PG, Gonzaga RC, Tolentino AB, Machado AC. Aesthetic rehabilitation with laminated ceramic veneers reinforced by lithium dislicate. Quintessence Int 2014: 129-33.
17. Kern M. Resin-bonded fixed dental protheses as alternative to implants in the anterior region-Age as a criterion, Implantol 2016; 24:389-98.
18. Sasse M, Kern M. All-ceramic resin-bonded fixed dental prostheses: treatment planning, clinical procedures, and outcome. Quintessence Int 2014; 45:291-7.
19. Kern M. Fifteen-year survival of anterior all-ceramic cantilever resin-bonded fixed dental prostheses. J Dent 2017; 56:133-5.
20. Kern M, Passia N, Sasse M, Yazigi C. Ten-year outcome of zirconia ceramic cantilever resin-bonded fixed dental prostheses and the influence of the reasons for missing incisors. J Dent 2017;65:51-5.
21. Denry I, Kelly JR. State of the art of zirconia for dental applications. Dent Mater 2008; 24:299-307.
22. Botelho MG, Chan AW, Leung NC, Lam WY. Long-term evaluation of cantilevered versus fixed- fixed resin-bonded fixed partial dentures for missing maxillary incisors. J Dent 2016; 45: 59-66.
23. Sasse M, Kern M. Survival of anterior cantilevered all-ceramic resin-bonded fixed dental prostheses made from zirconia ceramic. J Dent 2014;42:660-6

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In vitro and in vivo examination of the osteogenic ability of 3D scaffold chitosan-hydroxyapatite: a systematic review

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ABSTRACT
Background: Alveolar bone resorption in dentistry cases can be caused by several factors. Some of which are periodontal disease, post-tooth extraction trauma, post enucleation cyst, and post-tumor surgery. The idea of bone tissue engineering, especially biomaterials will be focused on precise scaffold design in terms of physicochemical in cell adhesion, proliferation, differentiation, and specific organ tissue formation. Chitosan can be combined with hydroxyapatite (HA) in form of scaffold 3D design for bone remodeling procedure. **Purpose**: discover osteogenic ability with scaffold 3D chitosan-HA in vitro and in vivo. **Method**: utilizing literature review by collecting, compiling similarities, and concluding references related to osteogenic ability with scaffold 3D chitosan-HA in vitro and in vivo on bone remodelling process. **Results**: based on journal research with keywords of 3D scaffold, chitosan, HA, bone engineering, in vitro and in vivo, a total of 15 articles were used as references. **Conclusion**: Scaffold integrates bone tissue and provide effective room for new bone formation. Scaffold 3D (combination of chitosan and collagen) plays significant part in bone regeneration and becomes natural polymer containing ion complex as to maximalize characteristics of osteoconductivity contained. Scaffold chitosan/hydroaxipatite possesses osteogenic ability integral to repair bone fracture.
Keywords: 3D scaffold, chitosan, hydroxyapatite, bone engineering, in vivo and in vitro

INTRODUCTION

Alveolar bone fracture in dentistry can be caused by several factors, for instance periodontal disease, post-tooth extraction trauma, post enucleation cyst, and post-tumor surgery. If periodontal disease is not immediately handled, fracture in bone tissue will ensue, leading to tooth loss. With the innovation of bine tissue engineering, biomaterials will be focused on the proper design of *scaffold* in terms of *physicochemical* in cell adhesion, proliferation, differentiation, and specific organ tissue formation.[1]

Scaffold is a media or structure with function to build and help stem cell perform adhesion, proliferation, and differentiation that eventually creates tissue aimed to be replicated.[2] *Scaffold* must be properly formed as to carry correct characteristics and function well. In fact, surface of *Scaffold* should contain suitable morphology for both cell adhesion and cell differentiation. Selection of precise biomaterials to match extracellular matrix of replaced tissue is integral because characteristics of biomaterials will influence growth of stem cell.[3] Requirement of ideal *scaffold* creation involves characteristics of osteoconductive, osteogenic, *biodegradable,* good microstructure as well as precise mechachanic. Also, the most vital requirement is the ability to stimulate cell adhesion and maintain tissue function.[4]

Chitosan is a material commonly used as *graft* material which is less osteoconductive if not combined with other materials. *Chitosan* can be combined with collagen in form of *scaffold 3D* design for bone remodelling. *Chitosan* is an amino polysaccharide (poly-1,4-D-glucosamine) which is widely used as polymer of tissue engineering. *Chitosan* offers numerous advantages in terms of functionality due to its high biocompatibility characteristic, *biodegradable,* and low toxicity. *Chitosan* is chitin derivative obtained through deacetylation process.[5]

Scaffold with singular organic as basic material of *scaffold* is not osteoconductive enough and not quite fulfilling for mechanism characteristic necessary for *scaffold*.[6] Therefore, in creation of *scaffold,* additional materials are necessary for making *scaffold* more efficient in its use.[7] HA has over time focused on the continual development due to its good biocompatibility as well as strong bond with biopolymer and has been proven as biocompatible. Plus, it is well absorbed by tissues in human mouth. In addition, HA also possesses osteoconductive ability and has proven to be able to stimulate osteoblast differentiation growth and bone formation. Positive characteristic of this biomaterials is well-known in dentistry, for instance bone *remodelling,* periodontal defect treatment, tooth implant layering, repair material fills including ceramic resin and glass ionomer powder. *Scaffold 3D Chitosan* functions in the process of bone recovery process because both materials form complex ionic comp-

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ound that can enhance osteoconductivity characteristics.[1] The enhancement of *callus* formation in cracks with *scaffold* containing HA and pyrophosphate compared to *scaffold* control without pyrophosphate and HA or merely pyrophosphate.[9]

HA is a primary inorganic component of a bone, and commonly used as material for bone regeneration process. HA contains good characteristics, for instance non-toxic, non-immunonegic, non-inflammatory, biocompatibility, osteioconduction as well as good bioavailability on bone tissues and cells due to sharing similarities with bone tissue.[10,11] HA possesses the ability in good bond formation on host compared to other bone substitutes. However, due to its slow degradation progress and fragility, it can be modified by *collagen* and *chitosan* as to help repair bone.

This systematic review is aimed to discuss osteogenic ability with scaffold 3D chitosan-HA in vitro and in vivo.

METHODS

Source of article search utilized *Google Scholar* data base, *Pubmed,* and *Science Direct* by searching keywords, for instance 3D *scaffold*, *chitosan*, *hydroxyapatite*, *bone engineering*, in vitro, in vivo. Search was limited to Indonesian and English articles, with year range of article publication for the last 10 years. *In vitro* and *in vivo* laboratory research involving animal test will be included in the *review.* Only articles discussing about osteogenic ability with *scaffold 3D chitosan*-HA will be included in the *review.* A total of 326 articles were found and a total of 15 articles were selected after the author read throughout the article content based on the most relevant topic in line with inclusion and exclusion criteria.

RESULTS

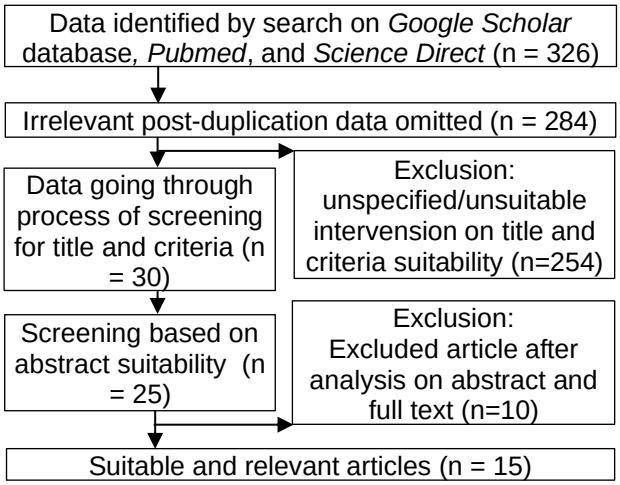

Figure 1 Prisma flow diagram

The PRISMA flowchart (Fig.1) shows the process of searching for articles according to the inclusion and exclusion criteria so that were obtained 15 articles that match the keywords (table 1).

DISCUSSION

The innovation of bone tissue engineering is focused on biomaterials applications that are being developed. One of which is *scaffold. Scaffold* in form of 3D with porous structure suitable for cell adhesion, proliferation, differentiation, and specific tissue formation.[15] Biomaterials that can be created in form of *scaffold* are *chitosan* and HA. *Chitosan* and *collagen* are polymers with characteristics of biodegradable and good biocompatible as well as low toxicity. Therefore, it is suitable to be combined in form of *scaffold* because precise *scaffold* requires those characteristics.[16]

Chitosan is a natural polysaccharide that resembles glycosaminoglycan, especially poly-D-glucosamine in terms of structure. On connective tissue, glycosaminoglycan is the mostly discovered component in extracellular matrix or so-called ECM.[17] *chitosan* is created from deacetylation of chitin by removing acetyl group, leading to create a cationic *chitosan.*[18] The higher the level of deacetylation of chitin is, the greater the cationic characteristic will be. In fact, the higher the level of deacetylation, the lower the biodegradable ability will be.[19] *Chitosan* with positive charge can form ion complex bond by bonding with negative charged materials such as collagen. The cationic characteristic on *chitosan* can stimulate cell adhesion, acting as cell morphology modulator, differentiation, cell movement, synthethic, and cell function.[20] *Chitosan* is generally known to be able to stimulalate growth and differentiation of osteoblast on cell culture. *Chitosan* can be created in any forms and utilized in broad medical aspects for medication, for instance wound healing, gum connective tissue regeneration, and a *scaffold* to regenerate both soft and hard tissue.[21]

On *in vitro research,* obtained effects of *chitosan* on bone formation has achieved cellular level that can affect the enhancement of osteoprogenitor cell differentiation and stimulate new bone formation.[22] Currently, *chitosan* has become one of the most superb materials to research, especially as a medium of bone substitute with multiple characteristics as expected, leading to the creation of precise *scaffold.* However, the idea of *scaffold* as singular material using organic materials is less sustainable to fulfill all criteria necessary for the success of bone tissue regeneration. *Chitosan it-*

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Table 1 Characteristics of the articles

Research Title	Author	Subjects & Methods	Variables	Research Results
Osteogenetic properties of electrospun nanofibrous PCL scaffolds equipped with chitosan-based nanoreservoirs of growth factors	Ferrand et al., 2013.	Mouse in vitro - in vivo	Chitosan=bone engineering; regeneration; scaffold; periodontitis	No citotoxicity, biomineralization enhancement, and osteogenetic enhancement. Scaffolds combined with chitosan and BMP-2 shown in vitro and in vivo in calvaria mouse had osteogenetic ability through osteopontin gene expression enhancement and calcium phosphate biomineralization.
Chitosan/HA scaffolds for tissue engineering manufacturing method effect comparison	Sierra et al.,2015	Mouse in vitro - in vivo	chitosan, HA in situ=bone and tissue engineering	Scaffolds showed the best structural integrity and porosity was scaffolds CH//HAis. Scaffolds was recommended material for tissue engineering and bone regeneration.
Graphene oxide enhances chitosan-based 3D scaffold properties for bone tissue engineering	Dinescu et al., 2019	Mouse in vitro - in vivo	Scaffolds chitosan/HA, graphene oxide	Scaffolds chitosan proved to support ostogenic hASC in vitro differenferentiation for 28 days as well as bone repair in vivo on mouse model for 18 weeks. Scaffolds chitosan improved to discover indicator degree on the highest osteogenic both in vitro and in vivo. Therefore, it can be considered the most recommended solution for bone tissue engineering
Evaluation of in vitro and in vivo osteogegenic differentiation of nanoHA/chitosan/poly(lactide-co-glycolide) scaffolds with human umbilical cord mesenchymal stem cells (hUCMSCs)	Wang et al., 2013	Mouse in vitro - in vivo	hUCMSCs, bone marrow mesenchymal stem cells, poly(lactide-co-glycolide) (PLGA), nHA, chitosan = bone tissue engineering	Scaffolds showed mechanism power of scaffolds nHA/chitosan/PLGA can be enhanced. Next, scaffolds nHA/chitosan/PLGA was the most suitable solution for adhesion, proliferation, and differentiation osteogenic hUCMSCs in vitro
Multi-compartment scaffold fabricated via 3D-printing as in vitro co-culture osteogenic model	Giglio et al., 2018	Mouse in vitro	Scaffolds = bone tissue engineering	In vitro 3D model can become insight on bone regeneration to boost experiments in clinic as well as reduce cost to minimalize duration
In vitro and In vivo investigation of osteogenic properties of self-contained phosphate-releasing injectable purine-crosslinked chitosan-HA constructs	Jahan et al., 2020	Mouse in vitro - in vivo	scaffold, osteogenic, chitosan-HA	Results showed enhancement on callus formation in fracture with scaffold bearing both HA and pyrophosphatase or only pyrophosphatase. This result proved that pyrophosphatase-Scaffolds composite HA had the capacity to facilitate fractured bone.
Bone remodeling using a 3D chitosan-HA scaffold seeded with hypoxic conditioned human amnion mesenchymal stem cells	Kamadjaja., 2021	Mouse in vivo	bone tissue engineering; chitosan-HA scaffold; human amniotic mesenchymal stem cells	Toxicity test that combined the use of MTT assay showed that scaffolds CH-HA was 79.42%. also, cells could adhere themselves to surface of scaffolds CH-HA planted in calvaria defect bones.
Study on antibacterial of chitosan/HA doped magnesium composite as a material for bone graft applications	Laksono et al., 2019	in vitro	chitosan, komposit, HA-magnesium, bakteri *E.coli*,	Addition of chitosan influenced chitosan-HA- magnesium composite morphology, showing that composite with added chitosan formed granule with hard surface capable of enhancing biocompatibility.
Enhanced biomineralization and protein adsorption capacity of 3D chitosan/HA biomimetic scaffolds applied for bone-tissue engineering	Nga et al., 2020	Chicken egg shell in vitro	chitosan/HA, scaffolds	scaffolds chitosan-HA showed suitable pores, swelling ratio, pull force, and biodegradation in bone scaffolds. Scaffolds chitosan/HA displayed biomineralization and absorption ability better than in vitro.

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Table 1 ……continuing

In vitro evaluation of HA, chitosan, and carbon nanotube composite biomaterial to support bone healing	Paretris et al., 2021	Mouse in vitro	HA, chitosan, carbon nanotube composite biomaterial, vero cells, MSCs	This biomaterials composite can be used with MSC. biomaterials composite HA, chitosan, and carbon nanotube are not cytotoxic. Therefore, they are applicable for in vivo test
Chitosan and HA scaffolds with amoxicillin for bone repair	Ponciano et al., 2021	Mouse in vitro	Chitosan, HA, scaffolds, amoxicillin	Scaffolds resulted from this research not only has physical characterteristics, but also chemical and biological. Scaffolds with HA 30% exhibiting the best result for cells in vitro survival. Test of viability proved that fibroblast could grow and proliferate on scaffolds. This also proved that biomaterials were non-toxic and biologically acceptable as scaffolds.
In vivo bone regeneration induced by a scaffold of chitosan/dicarboxylic acid seeded with human periodontal ligament cells	Sukpaita et al., 2019	Mouse in vivo	chitosan, scaffold, periodontal ligament cells	scaffolds chitosan/DA stimulates bone formation in vivo. Scaffolds with or without top primary hPDLC could enhance bone tissue repair on mouse calvarial defect. Scaffolds chitosan/dicarboxylic acid could function as host or itself to repair bone defect, and it is suitable for bone tissue engineering.
Indirect 3D printing technology for the fabrication of customised β-TCP/chitosan scaffold with the shape of rabbit radial head—an in vitro study	Wang et al., 2019	Rabbit in vitro	β-TCP, Chitosan, scaffolds	Scaffold β-TCP/chitosan had good function and degradation level, and in vitro cell test also confirmed that scaffold had sustainable cytocompatibility and bioactivity
Chitosan/HA composite coatings on porous Ti6Al4V titanium implants: in vitro and in vivo studies	Zhang., 2020	Mouse in vitro - in vivo	Chitosan/HA, titanium implants	Experiment in vitro showed that porous Ti-implant had no biological toxicity. In vivo test result also showed that porous tissue was beneficial because bone tissue could grow into porous. So, this exhibited good osseointegration. Porous Ti with chitosan/HA layer could enhance cell proliferation and differentiation MC3T3-E1 and osseointegration in vivo
Comparative study of porous HA/chitosan and whitlockite/chitosan scaffolds for bone regeneration in calvarial defects	Zhao et al., 2017	Mouse in vitro	HA, whitlockite, chitosan	Membrane composite whitlockite/chitosan had better biocompability, enhance human MSCs osteogenic proliferation and differentiation ability compared to HA/Chitosan. In fact, porous scaffold whitlockite/chitosan could significantly boost bone regeneration on calvarial defect.

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itself is nearly not osteoconductive enough. Therefore, the ability to form new bone is not yet optimal. An approach to handle to answer such hindrance is to design a composite by combining forces of different materials so that weaknesses of two different materials can be minimalized.[6] One of organic materials that also plays a great deal in tissue engineering is collagen.[23] Collagen possesses anionic characteristics or negative charged. A combination of *chitosan* (cationic) and collagen (anionic) can form ion complex that can maximalize osteoconductive characteristic of a material on bone fracture. Optimal osteoconduction can support cell adhesion of bone formation integral to the new bone formation.[4]Osteogenic ability of *scaffold chitosan* can stimulate new bone growth.[24] *Scaffold* is created out of biomaterials and factor of osteogenic signaling as well as bone tissue engineering that appears to be the most effective method to regenerate any bones, including either weight-sustaining bones or non-weight-sustaining bones. The use of natural or synthethic *scaffold* for bone regeneration has been considered a promising alternative for natural bone graft. Factors of bioactive osteogenic growth also provide suitable condition for stem cell adhesion and capture or so-called osteoblast, that leads to proper osteogenic differentiation both *in vitro* and *in vivo.* Bone morphogenetic protein 2 (BMP2) is a protein-based growth factor with integral role in stem cell osteogenic differentiation.[24] Potential of osteogenic from *scaffold* covered with layers of CHI and BMP-2 can reduce a number of bioactive components, reducing economical cost.

Research conducted by Wang by implanting *scaffold* on mouse with defect of skull then evaluating bone formation by using micro-computed tomography (micro-CT) and histology examination. The researcher successfully modified OGP on *scaffold* and proved that *scaffold* posed an osteogenic effect significant through kinase/extracellular protein path that is arranged by kinase protein (MAPK/ERK) activated by mitogen both *in vitro* and *in vivo.*[26]

Research conducted by Sukpaita showed that *scaffold chitosan/dicarboxylic acid* proved to be able to enhance bone regeneration on calvaria mouse defect.[24] New bone formation can be seen in the 6th week and 12th week on the defect impleplemented with *scaffold chitosan/dicarboxylic acid.* solvent of *chitosan* can enhance synthethic of type I collagen and hPDLC differentiation into osteoblast. This is proven to have potential to induce new bone formation on defect mouse. *Scaffold chitosan* was also developed so that it could release growth factors which included BMP-2 and insulin-like growth factor-1 (IGF-1). This *scaffold* could enhance restoration and regeneration of rabbit bone. This showed that *chitosan* was the finest *scaffold* material for bone formation.[24]

Research performed by Nga showed that scaffold 3D chitosan and HA exhibited completely porous tissue with porous size approximately 265 mm, and porosity with average 75,01%; pull force of scaffolding was 2.45 MPa, completely matching trabekular.[13] Addition of HA into *chitosan* matrix can efficiently reduce swelling. The percentage of *scaffold chitosan*-HA and maintained level of composite degradation matching the *scaffold*. The percentage of *scaffold chitosan*-HA was 46.37% after 28 days soaked in physiology solvent. *Scaffold chitosan*-HA showed biomineralization ability higher than *scaffold chitosan,* releasing apatite layer after 15 days of incubation of body fluid simulation. The presence of HA imitating biological apatite in *scaffold* composite facilitated higher protein absorption ability, compared to *scaffold chitosan.* The result showed that *scaffold chitosan*-HA had great potential as biocompatible material for bone tissue engineering. [14]

Scaffold shows integral role as biomaterial in bone repair due to its role in neoformation, neovascularisation, adhesion facilitation, and cell activity enhancement. Porous *scaffold* tissue enhances surface as to provide space for cell fixation and support chemical bond on close tissues. Moreover, the high level of porosity responsible for arranging bioactivity that directly affects structural permeability due to degraded *scaffold.* Biomaterial degradation in biological condition is one of the most relevant variables because it is directly related to long-term durability after being implanted in patient.[12] Research conducted by Sultana proved that *scaffold* HCG (HA*, chitosan, gelatin*) showed fine result with interconnected porous tissue. The size of porous from this *scaffold* allows *scaffold* to perform cell adhesion, proliferation, and nutrition supply enhancement that enable bone tissue growth quickly and precisely.[27]

In previous research, it is evident that concentration of HA exceeded 80%, creating a fragile *scaffold. Chitosan* and HA were homogen combined *in situ* synthethic HA using coprecipitation method and porous tissue generated from lyophilisation showed fine porosity and some cells could grow in 3D *scaffold* porous.[7] Porous had diameter about 50-100 m. Porous about 40-100 m enabled growth into blood vessel to facilitate vascularisation and

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bone mineralization. In this matter, *scaffold* has this dimension porous. Therefore, it can be used for bone remodelling. The smallest porous less than 20 mm was also essential for protein absorption, ionic leaching, and osteoblast adhesion on *scaffold.* According to Manjubala, *scaffold* applied for tissue engineering should contain interconnected porous tissues and high porosity to provide space for cell adhesion, proliferation, and migration. The ability of swelling is pivotal for *scaffold in vitro* and *in vivo* in tissue formation.[25]

Based on literature review conducted, *scaffold* 3D was a combination of *chitosan* and collagen with role in bone regeneration because a combination of both materials became natural polymer containing ion complex as to maximalize osteoconductivity contained. *Scaffold 3D chitosan*-HA possesses osteogenic ability vital to bone fracture repair.

Based on research outcome, it is evident that there are suggestions available for researchers starting from conducting in-depth research and literature review in regards to *scaffold* materials with osteogenic ability. In addition, it is necessary for a research and a literature review to be conducted further as to discover advantages of *scaffold 3D chitosan*-HA on bone fracture.

REFERENCES

1. Rahmitasari F. Chitosan and collagen 3D scaffold as graft in cases of bone damage. J Dent Mater 2016;5(2):1-7
2. Indrani DJ, Adi WA. Preparation of nanocrystalline hydroxyapatite for bone tissue engineering scaffold. Indonesian J Mater Sci 2018;13(4):36-9.
3. Herda E, Puspitasari D. Overview of the role and properties of materials used as scaffolds in tissue engineering. J Dent Mater 2018;5(1):56-63.
4. Sakamoto M, Matsumoto T, Tal H. Bone regeneration. Tal H, ed. Croatia: InTech Europe; 2012.p.109-20.
5. Sularsih, Soeprijanto. Comparison of osteoblast cell number in wound healing between the use of chitosan gel 1% and 2%. J Dent Mater 2012;1(2):145-52.
6. Ariani MD. New development of carbonate apatite-chitosan scaffold based on lyophilization technique for bone tissue engineering. Dent Mater J 2013;32(2):317-25.
7. Prasadh, Somasundaram, Wong, Raymond CW. Unraveling the mechanical strength of biomaterials used as a bone scaffold in oral and maxillofacial defects. Oral Sci Int 2018;15(2):48-55.
8. Mozartha M. Hydroxyapatite and its Applications in Dentistry. Cakradonya Dent J 2015;7(2):835-41.
9. Jahan, Kaushar. In vitro and in vivo investigation of osteogenic properties of self-contained phosphate-releasing injectable purine-crosslinked chitosan-hydroxyapatite constructs. Scientific Reports 2020;10(1):1-17.
10. Rujitanapanich S, Kumpapan P, Wanjanoi P. Synthesis of hydroxyapatite from oyster shell via precipitation. Energy Procedia 2014; 56:112-7.
11. Henggu KU, Ibrahim B, Suptijah P. Hydroxyapatite production from cuttlefish shells as a bone scaffold biomaterial preparations. Indonesian Fisheries Processing Journal 2019;22(1):1-13
12. De OP, Rosemary C. Chitosan and hydroxyapatite scaffolds with amoxicillin for bone repair. Res Soc Develop 2021;10(5): e13410514790-e13410514790.
13. Nga NK, Tam LTT, Ha NT, Viet PH, Huy TQ. Enhanced biomineralization and protein adsorption capacity of 3D chitosan/hydroxyapatite biomimetic scaffolds applied for bone-tissue engineering. Res Adv 2020;10: 43045-57.
14. Paretsis NF, Junior VG, de Queiroz Hazarbassanov, Marcondes GM, de Guzzi Plepis AM, et al. In vitro evaluation of hydroxyapatite, chitosan, and carbon nanotube composite biomaterial to support bone healing. Braz J Vet Res Anim Sci 2021; 58: e179885
15. Niu X, Fan Y, Liu X, Li X, Li P, Wang J, et al. Repair of bone defect in femoral condyle using microencapsulated chitosan, nanohydroxyapatite/collagen and poly (l-lactide)-based microsphere-scaffold delivery system. Artificial Organs 2011;35(7): E119-28.
16. Zhao H, Ma L, Gao C, Shen J. Fabrication and properties of mineralized collagen-chitosan/hydroxyapatite scaffolds. Polymers For Advanced Technologie 2008;19(11):1590-6.
17. Yoo JH, Lee MC, Lee JE, Jeon KC, Kim YM, Jung MY, et al. Evaluation of chondrogenesis in collagen/chitosan/glycosaminoglycan scaffolds for cartilage tissue engineering. J Korean Orthop Res Soc 2005;8(1):28-40.
18. Kim S, Venkatesan J. Chitin and chitosan derivatives: advances in drug discovery and developments. CRC Press; 2013.
19. Jiang T, Deng M, Fattah WIA, Laurencin CT. Chitosan-based biopharmaceutical scaffolds in tissue engineering and regenerative medicine. *Chitosan-based* systems for biopharmaceuticals: Delivery targeting and polymer therapeutics; 2012.p.393-427.
20. Gorgieva S, Kokol V. Collagen- vs gelatine-based biomaterials and their biocompatibility: review and perspectives. Biomaterials applications for nanomedicine 2; 2011.p.17-52
21. Sonia TA, Sharma CP. Chitosan and its derivatives for drug delivery perspective. Chitosan For Biomaterials I; 2011.p.23-53.

DOI: 10.46934/ijp.v3i1.88

22. Kung S, Devlin H, Fu, E, Ho KY, Liang SY, Hsieh YD. The osteoinductive effect of chitosan–collagen composites around pure titanium implant surfaces in rats. J Periodon Res 2011;46(1):126-33.
23. Cui K, Zhu Y, Wang XH, Feng QL, Cui FZ. A Porous scaffold from bone-like powder loaded in a collagen–chitosan matrix. J Bioact Compat Polym 2004; 19(1):17-31.
24. Sukpaita T, Chirachanchai S, Suwattanachai P, Everts V, Pimkhaokham A, Ampornaramveth RS. In vivo bone regeneration induced by a scaffold of chitosan/dicarboxylic acid seeded with human periodontal ligament cells. Int J Mole Sci 2019;20(19):4883.
25. Wang JQ, Jiang BJ, Guo WJ, Zhao YM. Indirect 3D printing technology for the fabrication of customised B-TCP/chitosan scaffold with the shape of rabbit radial head-an in vitro study. J Orthop Surg Res 2019;14(1):1-9
26. Wang Q, Yang X, Wang G, Wan L, Wang S, Niu X, et al. Osteogenic growth peptide-loaded 3D-printed PCL scaffolds for the promotion of osteogenesis through the ERK pathway. Mater Design 2020;193:108811.
27. Sultana T, Rana M, Akhtar N, Hasan Z, Talukder AH, Asaduzzaman SM. Preparation and physicochemical characterization of nano-hydroxyapatite based 3D porous scaffold for biomedical application. Adv Tissue Eng Regen Med Open Access 2017;3(3):00065.

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Carbon fiber frameworks and lithium disilicate crowns for implant rehabilitation: case report

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ABSTRACT
A new era of materials can improve the implant rehabilitations. Different materials such as carbon fiber, PEEK, glass fiber or quartz fiber with composite, hybrid composites or lithium disilicate crowns cemented over the implants, can offer the best solution for the patients. Their occlusal impact absorbing and dissipating behavior allows to obtain a lower stress in the implant-bone-prosthesis area, reducing the risk of bone resorption of the implant when the patient has gingival inflammation. This case report discusses about a partially edentulous of 27-year-old women patient. The chief complaint of the patient was esthetic aspect; to rehabilitate her mouth with a fixed implant prosthesis. The treatment plan for the patient was a full mouth implant rehabilitation, those are as many as 18 implants (10 on the upper and 8 on the lower jaw), bilateral sinus lift, horizontal regeneration, maxillary impaction (orthognathic surgery). Both prostheses made with carbon fiber frameworks and lithium disilicate crowns cemented over them.
Keywords: occlusal impact, carbon fiber, implant rehabilitation, impact absorbing, full mouth rehabilitation
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INTRODUCTION

A full mouth rehabilitation over teeth or implants is a great challenge. Preserving all the teeth or implants and the prosthesis over time is not only an objective but also a mandatory aspect. Rehabilitating a young patient, as in this case, is more complicated, since it is not known how long these implants and the prosthesis can be maintained with correct function and esthetics. Two important aspects should be taken into account, namely the rehabilitation materials[1-21] and the patient at risk, like smoker, poor hygiene, previous periodontitis, uncontrolled diabetes, implant surface, alcohol, who will have gingival inflammation.[22-36]

Both aspects have an important relationship, namely increased stress in the implant-bone-prosthesis area can affect bone resorption, especially in patients with gingival inflammation. By using materials that absorb and/or dissipate functional and parafunctional forces, such as carbon fiber, PEEK, hybrid composite, quartz fiber, graphene, etc., the risk of the peri-implant bone resorption decreases.[1,5,6,9,11,12,15,16,19-21]

This article aims to discuss a case about a partially edentulous 27-year-old women patient that was treated with a fixed implant prosthesis.

CASE

A case is presented of a 27-year-old female (Fig.1) with chief of complaint of the patient was esthetic aspect; to rehabilitate the mouth with a fixed implant prosthesis. The patient comes to the dental clinic and shows his lower jaw was partially edentulous with hopeless remaining teeth, completely edentulous in the upper jaw, reduced intraoral space and a gingival smile (Fig.1-3).

Figure 1A Initial situation sometimes before; **B** initial situation.

Figure 2A Gingival exposure in a social smile; **B** short intraoral space in the correct vertical dimension.

Figure 3 Hopeless remaining teeth

MANAGEMENT

The treatment plan for the patient was a full mouth implant rehabilitation those are as many as 18 implants (10 on the upper and 8 on the lower jaw), bilateral sinus lift, horizontal regeneration,

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maxillary impaction (orthognathic surgery). Both prostheses made with carbon fiber frameworks and lithium disilicate crowns cemented over them.

Our objective was to recover the functional and aesthetic parameters as soon as possible, because the patient had 3 complete prostheses in the upper jaw, but it was impossible for the patient to use them again.

But in this case, according to the initial situation, to use a complete prosthesis in upper jaw or both jaws were not possible before implant placing, bilateral sinus lift and orthognathic surgery. The patient understood the situation and the team started with the treatment.

Then, the first step was to extract all the remaining teeth. After that, the implant surgery was performed 2 months later, includes bilateral sinus lift, horizontal bone regeneration and 18 implants (10 in upper and 8 in lower jaw) C1 (MIS-Dentsply, Israel) in one day under sedation (Fig.4).

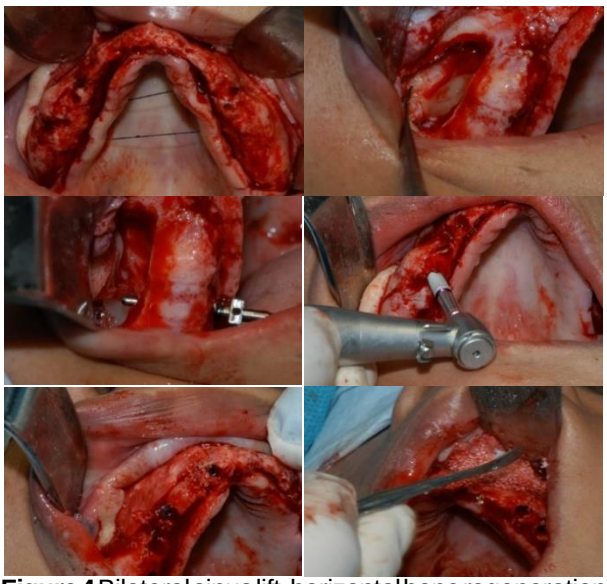

Figure 4 Bilateral sinus lift, horizontal bone regeneration and implant placing.

After that surgery, the patient goes without provisional prosthesis. We needed to get more space and a correct maxillary relationship before placing them. During surgical wound healing, we started to prepare the provisional prostheses to place them the day of the maxillary impaction (Fig.5).

It was observed the lack of space for teeth and the excessive exposure of them in rest and social smile. This is the reason the patient went without prosthesis during this healing time.

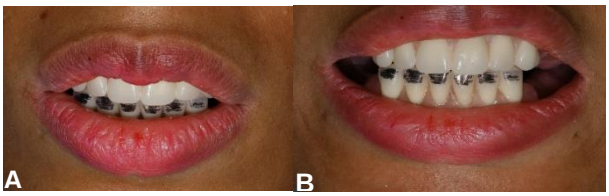

Figure 5A Teeth try in in rest position; **B** teeth try in in a social smile.

In the second step, four months later, provisional prostheses in both arches were screwed (Fig.6A) guiding us the correct position the day of the orthognathic surgery (maxillary impaction) under general anesthesia (Fig.6B and Fig.7).

Figure 6A Both provisional prostheses were screwed in mouth guiding us the maxillary impaction; **B,C** different aspect of the maxillary impaction.

Figure 7A The orthognathic surgery was finished; see the new teeth exposure with the provisional prosthesis; **B** 15 days post-surgery; observe the final aspect of the patient.

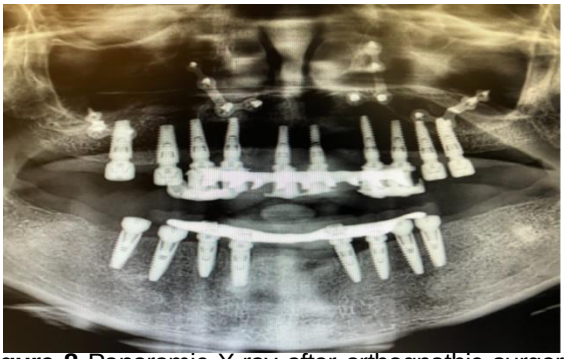

Figure 8 Panoramic X-ray after orthognathic surgery. The provisional upper and lower prostheses have been screwed.

Figure 9 Both full arches made with carbon fiber milled from carbon fiber discs.

For 4 months, the occlusion, VD, esthetic, and functional parameters were found. Final prostheses were performed according to the provisional parameters, both esthetics and functional. The final prostheses were both screwed milled carbon fiber

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frameworks from a disc Bio Carbon Tablet (Micromedica srl, Italy) (Fig.9) designed with CAD system (Fig.10A), with titanium abutment cemented to the frameworks, and pressed lithium disilicate crowns IPS Emax Press (Ivoclar-Vivadent, Liechenstein) (Fig.10B) cemented over them (Fig.11A, 11B).

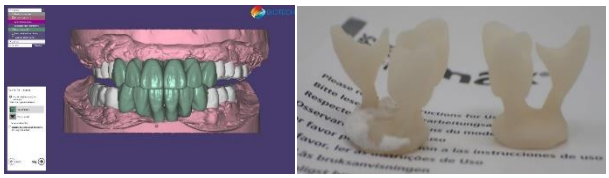

Figure 10A CAD design of the framework and single lithium disilicate crowns; **B** lithium disilicate crowns made from a pressed block.

Figure 11A Upper final prosthesis; the lithium disilicate crowns cemented over carbon fiber frameworks; **B** the gingiva was made with composite.

Figure 12 Final result after implant rehabilitation.

DISCUSSION

The implant rehabilitation is the usual care for our patient, but different treatments can be considered before starting. On this case, a prosthesis made with carbon fiber was chosen for both frameworks. The reason to choose that material is, such other materials as PEEK, glass fiber or quartz fiber, it can absorb and dissipate the occlusal impact (functional or parafunctional), then it can reduce the stress in implant neck-bone-prosthesis area.[1-20] All the literature explains us that stress and gingival inflammation, together leads to bone resorption around the implant, that is peri-implantitis.[1,19-36] Using these kinds of materials, the risk of peri-implantitis can be decreased,[1,4-7,9,12,19,20] and when treating young patients, perhaps, this option can help us to improve implant survival keeping the prosthesis in the mouth longer; and lithium disilicate gives dentists and patients the correct aesthetic aspect all along (Fig.12).

This type of implant rehabilitation material is used to maintain the functional and aesthetic parameters for the patient for a long time, and preserve not only the implant, but also the prosthesis.

Conflict of interest

The case report is not funded and there is no potential conflict of interest.

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REFERENCES

1. Castorina G. Carbon-fiber framework for full-arch implant-supported fixed dental prostheses supporting resin-based composite and lithium disilicate ceramic crowns: case report and description of features. Int J Periodont Resto Dent 2017.
2. Baldissara P, Katsinas G, Scotti R. Use of carbon-epoxy frameworks for reinforcing provisional fixed partial dentures. J Prosthet Dent 2004; 91(1):89-92.
3. Conserva E, Menini M, Tealdo T, Bevilacqua M, Ravera G, Pera F, et al. The use of a masticatory robot to analyze the shock absorption capacity of different restorative materials for prosthetic implants: a preliminary report. Int J Prosthodont 2009;22(1):53-5.
4. di Franco A. Full arch frameworks: lithium silicate meets carbon fiber. eLABORATE 2018;4:26-8.
5. Erkmen E, Meric G, Kurt A, Tunc Y, Eser A. Biomechanical comparison of implant retained fixed partial dentures with fiber reinforced composite versus conventional metal frameworks: a 3D FEA study. J Mech Behav Biomed Mater 2011;4(1):107-16.
6. Gracis SE, Nicholls JI, Chalupnik JD, Yuodelis RA. Shock-absorbing behavior of five restorative materials used on implants. Int J Prosthodont 1991;4(3):282-91.
7. Magne P, Silva M, Oderich E, Boff LL, Enciso R. Damping behavior of implant-supported restorations. Clin Oral Implants Res 2013;24(2):143-8.
8. Menini M, Conserva E, Tealdo T, Bevilacqua M, Pera F, Signori A, et al. Shock absorption capacity of restorative materials for dental implant prostheses: an in vitro study. Int J Prosthodont 2013;26(6):549-56.
9. Menini M, Pesce P, Pera F, Barberis F, Lagazzo A, Bertola L, et al. Biological and mechanical characterization of carbon fiber frameworks for dental implant applications. Mater Sci Eng C Mater Biol Appl 2017;70(1):646-55
10. Muhsin SA, Hatton PV, Johnson A, Sereno N, Wood DJ. Determination of Polyetheretherketone (PEEK) mechanical properties as a denture material. Saudi Dent J 2019 Jul;31(3):382-91.

DOI: 10.46934/ijp.v3i1.133

11. Pera F, Pesce P, Solimano F, Tealdo T, Pera P, Menini M. Carbon Fiber vs metal framework in full-arch immediate loading rehabilitations of the maxilla-a cohort clinical study. J Oral Rehabil 2017;44(5):392-7.
12. Rahmani H, Najafi S, Saffarzadeh-Matin S, Ashori A. Mechanical properties of carbon fiber/epoxy composites: effects of number of plies, fiber contents, and angle-ply layers. Polym Engineer & Sci 2014;54(11):2676–82.
13. Schwitalla AD, Spintig T, Kallage I, Muller WD. Flexural behavior of PEEK materials for dental application. Dent Mater 2015;31(11):1377-84.
14. Schwitalla AD, Spintig T, Kallage I, Muller WD. Pressure behavior of different PEEK materials for dental implants. J Mech Behav Biomed Mater 2016;54:295-304.
15. Segerstrom S, Sandborgh-Englund G, Ruyter EI. Biological and physicochemical properties of carbon-graphite fibre-reinforced polymers intended for implant suprastructures. Eur J Oral Sci 2011;119(3):246-52.
16. Stawarczyk B, Egli R, Roos M, Ozcan M, Hammerle CH. The impact of in vitro aging on the mechanical and optical properties of indirect veneering composite resins. J Prosthet Dent 2011;106(6):386-98.
17. Steinberg EL, Rath E, Shlaifer A, Chechik O, Maman E, Salai M. Carbon fiber reinforced PEEK Optima-a composite material biomechanical properties and wear/debris characteristics of CF-PEEK composites for orthopedic trauma implants. J Mech Behav Biomed Mater 2013;17:221-8.
18. Canto-Naves O, Medina-Galvez R, Marimon X, Ferrer M, Figueras-Alvarez O, Cabratosa-Termes J. A 3D finite element analysis model of single implant-supported prosthesis under dynamic impact loading for evaluation of stress in the crown, abutment and cortical bone using different rehabilitation materials. Mater 2021; 24;14(13)
19. Medina-Galvez R, Canto-Naves O, Marimon X, Cerrolaza M, Ferrer M, Cabratosa-Termes J. Bone stress evaluation with and without cortical bone using several dental restorative materials subjected to impact load: a fully 3d transient finite-element study. Mater 2021; 4;14(19)
20. Bacchi A, Consani RL, Mesquita MF, dos Santos MB. Stress distribution in fixed-partial prosthesis and periimplant bone tissue with different framework materials and vertical misfit levels: a three-dimensional finite element analysis. J Oral Sci 2013;55(3):239-44.
21. Derks J, Tomasi C. Peri-implant health and disease. A systematic review of current epidemiology. J Clin Periodontol 2015;42 Suppl 16:S158-71.
22. Duyck J, Vandamme K. The effect of loading on peri-implant bone: a critical review of the literature. J Oral Rehabil 2014;41(10):783-94.
23. Insua A, Monje A, Wang HL, Miron RJ. Basis of bone metabolism around dental implants during osseointegration and peri-implant bone loss. J Biomed Mater Res A 2017;105(7):2075-89.
24. Klinge B, Meyle J, Working Group 2. Peri-implant tissue destruction. The third EAO consensus conference 2012. Clin Oral Implants Res 2012;23 Suppl 6:108-10.
25. Lindhe J, Meyle J, Group D of European Workshop on Periodontology. Peri-implant diseases: Consensus Report of the Sixth European Workshop on Periodontology. J Clin Periodontol 2008;35(8 Suppl):282-5.
26. Mazel A, Belkacemi S, Tavitian P, Stephan G, Tardivo D, Catherine JH, et al. Peri-implantitis risk factors: A prospective evaluation. J Investig Clin Dent 2019;10(2)
27. Mombelli A, van Oosten MA, Schurch E,Jr, Land NP. The microbiota associated with successful or failing osseointegrated titanium implants. Oral Microbiol Immunol 1987;2(4):145-51.
28. Naert I, Duyck J, Vandamme K. Occlusal overload and bone/implant loss. Clin Oral Implants Res 2012;23 Suppl 6:95-107.
29. Ramseier CA, Warnakulasuriya S, Needleman IG, Gallagher JE, Lahtinen A, Ainamo A, et al. Consensus Report: 2nd European Workshop on Tobacco Use Prevention and Cessation for Oral Health Professionals. Int Dent J 2010;60(1):3-6.
30. Sanz M, Lang NP, Kinane DF, Berglundh T, Chapple I, Tonetti MS. Seventh European Workshop on Periodontology of the European Academy of Periodontology at the Parador at la Granja, Segovia, Spain. J Clin Periodontol 2011;38 Suppl 11:1-2.
31. Afrashtehfar KI, Afrashtehfar CD. Lack of association between overload and peri-implant tissue loss in healthy conditions. Evid Based Dent 2016;17(3):92-3.
32. Chang M, Chronopoulos V, Mattheos N. Impact of excessive occlusal load on successfully-osseointegrated dental implants: a literature review. J Investig Clin Dent 2013;4(3):142-50.
33. Favot LM, Berry-Kromer V, Haboussi M, Thiebaud F, Ben Zineb T. Numerical study of the influence of material parameters on the mechanical behaviour of a rehabilitated edentulous mandible. J Dent 2014;42(3):287-97.
34. Mattheos N, Collier S, Walmsley AD. Specialists' management decisions and attitudes towards mucositis and peri-implantitis. Br Dent J 2012;212(1):E1.
35. Pesce P, Canullo L, Grusovin MG, de Bruyn H, Cosyn J, Pera P. Systematic review of some prosthetic risk factors for periimplantitis. J Prosthet Dent 2015;114(3):346-50.

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Evaluation of swelling ability of scaffold combination of chitosan and hydroxypatite

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ABSTRACT
Background: Tissue engineering is an important treatment strategy and used in current and future regenerative therapies. To achieve the success of tissue engineering, it is necessary to select a scaffold with certain characteristics. The ability to absorb water or swelling in the scaffold material is one of the properties related to architecture and cell activation. Swelling indicates the ability of the scaffold to absorb or retain water from the scaffold. The swelling ability is expected to absorb water from the surrounding tissue and have an impact on the morphology of the scaffold, especially the combination of chitosan and hydroxyapatite on cell growth. **Purpose**: Knowing the ability of water absorption (swelling) on the scaffold combination of chitosan and hydroxyapatite for the purpose of bone tissue engineering. **Method**: Literature review with statistical review method that uses inclusion and exclusion criteria with article design used experimental laboratory in vitro and or experimental laboratory in vivo. **Results**: There are eight articles showing increased swelling ability and five articles showing decreased swelling ability. **Conclusion**: The combination of chitosan and hydroxyapatite biomaterials can increase and decrease the ability of water absorption on the scaffold so that affects the success of tissue engineering**.**
Keywords: scaffold, chitosan, hydroxyapatite, swelling

INTRODUCTION

Tissue engineering is a strategy used in tissue engineering regenerative therapy with the aim of restoring, regenerating, maintaining or improving the function of damaged tissue or tissue lost due to various diseases.[1] In prosthodontics, tissue engineering is used in prosthodontic therapy for the implantation of prostheses aimed at replacing missing tooth. Missing teeth can usually be caused by tooth fracture or alveolar bone resorption which changes the morphology and quality of the bone after tooth extraction.[2]

For the purposes of tissue engineering, important components are needed, namely cells, matrix, and signals. The matrix required for tissue engineering must be similarly to the extracellular matrix (ECM) because it has functions and effects that affect cell activity. Scaffold is an example of a matrix that can be used to replace ECM because it functions in vitro and in vivo, and has a similar role to ECM.[3] The success of tissue engineering is determined by the characteristics of the scaffold. The ability of water absorption or swelling ability of the scaffold material is one of the properties related to architecture and cell activation. Swelling shows the ability of the scaffold to absorb or retain water from the scaffold so that it has an impact on the morphology of the scaffold and cell growth. The nature of water absorption is influenced by several factors, including the nature of the biomaterial for making scaffolds.[4]

Biomaterials that are often used to make scaffolds include chitosan and hydroxyapatite. Chitosan (CS) is a natural polymer with a linear structure consisting of D-glucosamine linked by glycosidic bonds-(1-4) and a variable number of N-acetyld Glucosamine (NAG) groups. The CS has bioactive, biodegradable, biocompatible, antibacterial proties, and has a hydrophilic surface that is not found in many synthetic polymers. Chitosan plays a role in increasing cell adhesion, proliferation, and differrentiation of osteoblasts and mineralization which can support its function as one of the basic ingredients in the design and fabrication of scaffolds to get better results in the improvement of bone tissue engineering.[5]

Hydroxyapatite (HA) is a biomaterial that has biocompatibility and similarity to the mineral composition of hard bone. HA acts as an osteoconductive and osteogenesis that occurs due to cell germination before implantation. Pore size and morphology in HA scaffold are important factors for good osteointegration. The HA pores with sizes ranging 100-150 m are very influential for bone growth and angiogenesis. However, the higher pores size, which is in the range of 200-500 m can be helpful for osteoblast colonization, fibrovascularization, and new bone apposition. The HA scaffold must meet certain criteria, including mechanical mechanical properties similar to those at the bone repair site, biocompatibility, biodegradability, and cell porosity.[6] In order to maintain the integrity of the bio-

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material as an implant against tissue engineering, the mechanical properties must be maintained. A cause of the loss of the mechanical strength is the absorption of water. In addition, blending of synthetic and natural polymers such as CS and HA are used to control not only swelling, but also to improve mechanical performance.[7]

The aim of this review is discussing the ability of water absorption on the scaffold combination of chitosan and hydroxyapatite for the purpose of bone tissue engineering.

METHODS

The source of the article search used the Pubmed, Google Scholar, and Science Direct databases using the keywords *scaffold*, *chitosan*, *hydroxyapatite*, and *swelling*. The search was limited to articles in Indonesian and English, with the year of publication of the article in the last 10 years. Scaffold manufacturing methods, swelling ability observation methods, and scaffold material ratios are not limited in this review. A total of 288 articles were found and as many as 12 articles were selected after the authors read the entire contents of the article based on the relevant topics, inclusion and exclusion criteria.

DISCUSSION

The ability of the scaffold to absorb fluids (swelling) and hydrophilicity is important to create a good interaction between the scaffold and the surrounding tissue so that cell migration and colonization of the scaffold occurs so that swelling can become a standard whether the scaffold is hydrophilic and capable of absorbing large amounts of liquid.[8] In the research of Kartikasari et al.,[9] scaffold containing HA and CS (BHA-G-CS) has an increased swelling ratio which means that the hydrophilicity of these components has a high possibility of cell attachment to absorb nutrient-containing fluids. In the research of Wattanutchariya and Whattanapong,[10] it was also found that the swelling ability increased with the increase in the chitosan-gelatin concentration, but was inversely proportional to the decreased HA concentration. This can occur in order to provide an optimal balance between a favorable surface area for cell attachment and the strength of its structure. Good swelling ability if used in a large area, the higher the better.[11]

Rogina et al.[12] stated that the scaffold with lower organic phase content than inorganic showed a slight increase in swelling capacity because lower HA content could affect the amount of water absorbed so that it could inhibit swelling. This can be an obstacle for HA which plays a role in preventing water seepage into the CS matrix. Meanwhile, in the research of Kar et al,[13] HA plays a role in reducing the hydrophilicity of CS by binding to the hydrophilic -COOH and -NH2. Other organic components in the form of OM play a role in reducing swelling which inhibits the interaction between polymer macromolecules and water molecules, resulting in a decrease in the water content of the CS-OM and CS-OM-HA composite scaffolds. Therefore, the swelling properties of a CS-based composite can be determined based on the appropriate amount of inorganic phase.

The effect of adding nano-HA to Hydrogel ZN-CS/NHAP/β-GP increases swelling in the research of Dhivya et al.,[14] namely the increase in high swelling ability due to fluid retention resulting in relaxation of the mechanical CS chain, which can cause an increase in the surface area of the scaffold. In the study of Shakir et al.[15] showed a significant decrease in the swelling capacity of n-HA/CS and n-HA/CS-ST scaffolds in SBF solution for different time intervals (1, 7, 14, 21, and 28 days). This could be due to the higher intermolecular interaction of n-HA/CS-ST which refers to the possibility of H-bonding between starch OH and CS amino groups. The low swelling rate of scaffold mixture containing starch indicates a higher mechanical strength to support growth into bone tissue.

In research by Pengfei et al,[16] shows a decrea-sed swelling rate because the PVA affects the 3D structure and porosity of the scaffold. Compressive strength of the composite will increase if the PVA content is high and the nHAp content is less than 12.5% has little effect on the spatial structure of this scaffold, namely maintaining stable water absorption ability.[17] The swelling ratio will be stable when the nHAp content in the scaffold is within a certain range. Swelling ratio according to Porrelli, et al,[18] increased by ~1850% after one day. CSL in combination with hDPSC can be used to accelerate bone healing. Then on research Bakopoulou et al,[19] also found an increase in swelling on the scaffold CS/Gel-0.1 showed a value of 980% and was higher than CS/Gel-1 with a value of 590%. Scaffolds with higher swelling ratios are related to the distance between bonds in the hydrogel network. In the research of Iqbal et al,[20] the presence of cross-linkers in varying amounts can ultimately affect the properties of the scaffold whereas the distribution of HA and CS in the matrix to facilitate cellular properties.

Further research by Zhang, et al,[21] stated that there was a decrease in the swelling ratio of scaf-

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RESULTS

Table 1 Results of article characteristics

No	Author and Year of Publication	Research Title and Design	HA:CS Ratio	Scaffold Making Method	Swelling Ability	Research result
1	Kartikasari N, Yuliati A, Listiana A, Setijanto D, Suardita K, Ariani MD, et al, 2016	Characteristic of bovine HA gelatin-chitosan scaffolds as biomaterial candidate for bone tissue engineering (In vitro laboratory experiments)	BHA: CS 70:15	Freeze-drying, fourier trans-form infrared spectroscopy (FTIR), scouldning electron microscopy coupled with energy dispersive X-ray (SEM-EDX)	Scaffold BHA-GK material has an enlarged swelling ratio of 3.00+0.23 and the percentage of water (WCP) is 74.90 + 1.41% with 30% organic components. The higher the mate-rial composition can increase the swelling ratio and WCP.	Scaffold BHA-GK material has swelling ratio and WCP characteristics above average, and the hydrophilic properties of its components can indicate the possibility of increasing cell adhesion so that it has the ability to absorb liquid containing nutrients.
2	Wattanutchariya W, Changkowchai W, 2014	Characterization of porous scaffold from CS-Gelatin/HA for bone grafting (In vitro lab exp)	CS gel: HA: 1% acetic acid 2.62:2.17: 95.21	Freeze-drying, X-ray dif-fraction analysis (XRD)	The extent of expansion and swelling ability of the scaffold is good when used over a large area; as soon as possible. Scaffold material with this ratio can reach 95.5% swelling.	The mixture of CS Gelatin and HA scaffold porous has conclusion especially the swelling that increased if there was an increase in CS-gelatin and a decrease in the concentration of HA.
3	Rogina A, Rico P, Gallego-Ferrer G, Ivankovic M, Ivankovic H, 2016	In situ HA content affects the cell differentiation on porous CS/HA scaffolds (In vitro laboratory experiments)	CS:HA 100/0;90/ 10; 0/20; 70/30;60/ 40; 0/50; 40/60	FTIR, XRD	Scaffold showed a high swelling ratio (>130%) after 24 hours of immersion in DPBS at 37°C and during swelling, the texture of the scaffold changed from soft sponge to hydrocolloid with increasing water absorption.	Swelling and compressive strength showed a higher value for the composite scaffold with lower HA content for the function of cell and nutrient diffusion, and prevention of body fluid loss.
4	Kar S, Kaur T, Thirugnanam A, 2016	Microwave-assisted synthesis of porous chitosan modified montmorillonite-HA composite scaffolds (In vitro lab exp)	CS:OM:H A 2:10:10	XRD analysis, Attenuated Total Reflectance-FTIR (ATR-FTIR), freeze drying.	HA forms a temporary barrier that prevents water from seeping into the CS and decreases the hydrophilicity of CS by binding to the hydrophilic -COOH and -NH2. Incorporation of CS HA with OM plays a role in reducing swelling.	Improved mechanical properties and bioactivity were observed in the CS-OM-HA composite due to the strengthening of OM-HA. Swelling, degra-dation, and protein adsorption of the CS-OM-HA scaffold were decreased com-pared to the CS and CS-OM scaffolds. All prepared scaffolds were non-toxic to the MG 63 osteoblast cell line
5	Dhivya S, Saravanan S, Sastry TP, Selvamurugan N, 2015	Nano-HA-reinforced CS composite hydrogel for bone tissue repair in vitro and in vivo (In vitro and in vivo laboratory experiments)	Zn-CS:β-GP:nHAp 8:1:1	SEM, EDX, FTIR, and XRD	The presence of nanoHA (NHAP) in Hy-drogel ZN-CS/NHAP/-GP increases swel-ling, fluid retention causes an increase in surface area (swelling) which can facilitate cell infiltration into the scaffold.	The role of NHAP in thermosensitive CS-based hydrogel to improve its physical & biological cha-racteristics. Increased protein adsorption, swel-ling, & decreased susceptibility to lysozyme de-gradation shown by the addition of nano-HA.
6	Shakir M, Jolly R, Khan MS, Iram Ne, Khan HM, 2015	Nano-HA/CS–starch nano-composite as a novel bone construct: Synthesis and in vitro studies (In vitro lab exp)	CS : HA 85 : 99	FTIR, SEM, transmission electron microscopy (TEM), x-ray diffraction (XRD), ther-mogravimetric analysis (TGA), and differential thermal analysis (DTA)	Decreased swelling capacity of nHA/CS and nHA/CS-ST scaffolds regularly at in-tervals of 1,7,14,21 and 28 days. n-HA/ CS-ST has a much lower swelling capacity than nHA/CS means nHA/CS-ST has high-er molecular interaction enhancement	Scaffold n-HA/CS and n-HA/CS-ST in some spectra showed significant intermolecular inter-actions between different components in both nanocomposites, improved thermal stability, better bioactivity to facilitate the formation of ingrowths into bone and good osteointegration.

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7	Ma P, Wu W, Wei Y, Ren L, Lin S, Wu J, 2021	Biomimetic gelatin/CS/polyvinyl alcohol/nano-HA scaffolds for bone tissue engineering (In vitro lab exp)	CS : HA 5: 12.5	Electromicron (EM), micro-CT, mechanical tests, degradation experiments, pH & swelling tests, FTIR, XR	The swelling capacity of the scaffold decreased with increasing PVA. swelling capacity GCP2, GCP3 and GCP4 were significantly lower than GCP1. nHAp 12.5% has effect on GCPH scaffold to maintain water absorption ability	The mixed Gel, CS and PVA matrix showed adjustable pore size, porosity, swelling, degradation and mechanical strength. Then nHAp was introduced as scaffolds fabrication for bone tissue engineering.
8	Porrelli D, Gruppuso M, Vecchies F, Marsich E, Turco G, 2021	Alginate bone scaffolds coated with a bioactive lactose modified CS for human dental pulp stem cells proliferation and differentiation (In vitro lab exp)	CS : HA 0.2 : 3	SEM, X-ray microcomputed tomography analysis, ATR-FTIR,	The CSL (Chitosan Lactosed) structure swelled rapidly in the first minutes of the experiment; reached maximum swelling (~1850%) after 1 day.	CSL was used as a coating for the porous scaffold, cell adhesion and osteogenic activity increased synergistically when differentiation stimuli were added. CSL induces hDPSC towards bone phenotype so that CSL-coated scaffold in combination with hDPSC can be used to accelerate bone healing.
9	Bakopoulou A, Georgopoulou A, Grivas I, Bekiari C, Prymak O, Loza , et 2018[19]	Dental pulp stem cells in CS/gelatin scaffolds for enhanced orofacial bone regeneration (In vitro and in vivo lab exp)	CS : HA 2 : 9	SEM–EDX analysis, XRD & Rietveld refinement analysis, X-ray powder diffraction, XRD;thermo-gravimetry,TG	The degree of swelling of the scaffold CS/Gel-0.1 showed a value of 980% and was higher than that of CS/Gel-1, which was measured by a value of 590%.	In vitro studies revealed that the CS/Gel type of scaffold supports viability, cell proliferation, and demonstrated extensive formation of a HA-rich nanocrystalline calcium phosphate phase.
10	Iqbal H, Ali M, Zeeshan R, Mutahir Z, Iqbal F, Nawaz MAH, et al, 2017	CS/HA/hydroxypropylmethyl cellulose (HPMC) spongy scaffolds-synthesis and evaluation as potential alveolar bone substitutes (In vitro lab exp)	CS:HA 1:1.25	SEM, freeze drying	high HA caused by CS/HA/HPMC interaction resulted in a scaffold with better pore size, low porosity and low swelling ratio. Whereas swelling increased with increasing HPMC concentration.	The presence of cross-linkers in varying amounts can affect the properties of the scaffold, where the even distribution of HA and CS in the matrix can facilitate cellular properties. Scaffold composition can be adjusted for mineralized tissue formation.
11	Zhang XY, Chen YP, Han J, Mo J, Dong PF, Zhuo YH, et al, 2019	Biocompatiable silk fibroin/car-boxymethyl CS/strontium substituted HA/cellulose nanocrystal composite scaffolds for bone tissue engineering (In vitro laboratory experiments)	CS : HA 4 : 1	Freeze drying, Cross linking	The swelling ratio of SF/CMCS/Sr-HAp scaffolds decreased significantly compared to SF/CMCS because addition of Sr-HAp reduced the hydrophilicity of carboxymethyl CS and silk fibroin	Scaffold SF/CMCS-based incorporating Sr-HAp and/or CNC to improve mechanical properties and osteoinductivity. The interconected porous structure, improved mechanical properties, and protein adsorption prove the superiority of SF/CMCS/Sr-HAp/CNC.
12	Salim SA, Loutfy SA, El-Fakharany EM, Taha TH, Hussien Y, Kamoun EA, 2021.[22]	Influence of CS & HA incorporation on properties of electrospun PVA/HA nanofibrous mats for bone tissue regeneration: nanofibers optimization and in-vitro assessment (In vitro laboratory experiments)	CS:HA 1.5 : 2	electrospinning, SEM, FT-IR and, Mechanical Tensile	PVA/HA/CH achieved a high swelling ratio of~325%, compared to PVA/HA of~300%, PVA/HA/HAP showed a swelling ratio of ~170% after 2 days of swelling; however, the addition of CS into the nanofibers (PVA/HA/CH/HAP nanofibers) reached a swelling ratio of ~240%, after 4 days.	The incorporation of CS into NF significantly increased swelling, protein adsorption, hemocompatibility, and antimicrobial activity of NF mats. However, incorporation of HA into NF reduced swelling, increased mechanical/thermal stability, and increased the adhesion and proliferation behavior of WI38 cells.

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folds containing HA (SF/CMCS/Sr-HAp) compared to scaffolds containing CS (SF/CMCS) due to the addition of Sr-HAp which reduced the hydrophilicity of carboxymethyl CS and silk fibroin. In addition, by providing more physical crosslinks to the carboxymethyl CS chains and silk fibers, the addition of Sr-HAp and CNC made the scaffold network structure more stable. In the study of Salim et al, [22] the PVA/HA/CH combination scaffold achieved a high swelling ratio compared to PVA/HA. The addition of CS which has a hydrophilic group that allows the penetration of water molecules in the scaffold chain. As a result, PVA/HA/CH showed the highest hydrophilicity and swellability. This was inversely proportional to the addition of salinized HA nanoparticles into the NF. The incorporation of HA into the nanofibers significantly reduced the swelling rate due to the interaction between the HA nanoparticles and the –OH group. On the other hand, the presence of CS can increase the swellability and penetration rate of nanofibers, due to the high hydrophilicity of CS.

From the evaluation of the 12 articles used, there are eight articles that show increased swelling of the scaffold and lead to biomaterial properties that can meet tissue engineering requirements such as an increase in the surface area of the scaffold, increased cell adhesion, overall distribution of cell nutrients, good mechanical strength, and in combination with other stem cells, for example human dental pulp stem cell (hDPSC) can support the repair of defective bone tissue. There are four articles which show that the decrease in swelling can occur due to several factors such as; combination of other organic components that can inhibit the hydrophilicity of the scaffold. The presence of other components can reduce the swelling ratio, but in some cases can also help the mechanical strength of the scaffold itself.

According to the authors' understanding, the high amount of CS in the scaffold can affect the cell properties such as increasing porosity and also making the scaffold enlarging or have an increased swelling ratio. However, the decreased HA when combining materials on the scaffold can also improve the mechanical properties of the scaffold with too large a porosity so that the mechanical, physical, and thermal properties of the scaffold can be balanced with the swelling ability which is not as great as when CS is added. Several studies have shown that swelling is initially beneficial for adhesision or cell growth in 3D scaffold mode because it causes an increase in pore size, but if swelling increases continuously it will cause loss of mechanical integrity and compressive strength of the surrounding tissue, as stated by Chen et al.[23] Therefore, the amount of HA within a certain range can still maintain the optimal swelling ratio.

Scaffold with combination of CS and HA biomaterials has the ability to increase the potential for successful bone tissue engineering by increasing the swelling ratio. The increased swelling ratio can help in cell migration, cell adhesion, and is able to absorb and distribute nutrients that are important for cells. Meanwhile, slightly decreased swelling can benefit several aspects such as increasing compressive strength and cell porosity.

So, further research is needed on the optimal swelling ability and ratio, component ratio and particle size of HA/CS which can produce the most ideal swelling ability in determining the modification of scaffold manufacture.

BIBLIOGRAPHY

1. Rodríguez-Vázquez M, Vega-Ruiz B, Ramos-Zúñiga R, Saldaña-Koppel DA, Quiñones-Overa LF. Chitosan and its potential use as a scaffold for tissue engineering in regenerative medicine. Biomed Res Int 2015:1-15
2. Yamada M, Egusa H. Current bone substitutes for implant dentistry. J Prosthodont Res [Internet]. 2018;62(2): 152–61. Available from: http://dx.doi.org/10.1016/j.jpor.2017.08.010
3. Sivashankari PR, Prabaharan M. Prospects of chitosan-based scaffolds for growth factor release in tissue engineering. Int J Biol Macromol [Internet] 2016;93:1382–9. Available from: http://dx.doi.org/10.1016/j.ijbiomac.2016.02.043
4. Aryyaguna D, Mindya YDFS. Analysis of architectural properties of chitosan scaffold and chitosan-RGD crab shells with SEM and swelling tests. Dep Oral Biol Fac Dent Univ Indonesia; 2016;
5. Saravanan S, Leena RS, Selvamurugan N. Chitosan based biocomposite scaffolds for bone tissue engineering. Int J Biol Macromol [Internet] 2016;93:1354–65. Available from: http://dx.doi.org/10.1016/j.ijbiomac.2016.01.112
6. Dasgupta S. Hydroxyapatite scaffolds for bone tissue engineering. Bioceram Dev Appl 2017;7(2):5025.
7. Felfel RM, Gideon-Adeniyi MJ, Zakir HKM, Roberts GAF, Grant DM. Structural, mechanical and swelling characteristics of 3D scaffolds from chitosan-agarose blends. Carbohydr Polym [Internet] 2019;204:59–67. Available from: https://doi.org/10.1016/j.carbpol.2018.10.002
8. Podporska-Carroll J, Ip JWY, Gogolewski S. Biodegradable poly (ester urethane) urea scaffolds for tissue en-

DOI: 10.46934/ijp.v3i1.134

gineering: interaction with osteoblast-like MG-63 cells. Acta Biomater 2014;10(6):2781–91.
9. Kartikasari N, Yuliati A, Listiana I, Setijanto D, Suardita K, Ariani MD, et al. Characteristic of bovine hydroxyapatite-gelatin-chitosan scaffolds as biomaterial candidate for bone tissue engineering. IECBES 2016-IEEE-EMBS Conf Biomed Eng Sci 2016;623–6.
10. Wattanutchariya W, Changkowchai W. Characterization of porous scaffold from chitosan-gelatin/hydroxyapatite for bone grafting. Lect Notes Eng Comput Sci 2014;2210.
11. Shahoon H, Yadegari Z, Valaie N, Farhadi S, Hamedi R. Evaluation of hydroxyapatite nanoparticles' biocompatibility at different concentrations on the human peripheral blood mononuclear cells: An in vitro study. Res J Biol Sci 2010;5(12):764–8.
12. Rogina A, Rico P, Gallego FG, Ivanković M, Ivanković H. In situ hydroxyapatite content affects the cell differentiation on porous chitosan/hydroxyapatite scaffolds. Ann Biomed Eng 2016;44(4):1107–19.
13. Kar S, Kaur T, Thirugnanam A. Microwave-assisted synthesis of porous chitosan-modified montmorillonitehydroxyapatite composite scaffolds. Int J Biol Macromol [Internet] 2016;82:628–36. Available from: http://dx.doi.org/10.1016/j.ijbiomac.2015.10.060
14. Dhivya S, Saravanan S, Sastry TP, Selvamurugan N. Nanohydroxyapatite-reinforced chitosan composite hydrogel for bone tissue repair in vitro and in vivo. J Nanobiotechnol 2015;13(1):1–13.
15. Shakir M, Jolly R, Khan MS, Iram Ne, Khan HM. Nano-hydroxyapatite/chitosan-starch nanocomposite as a novel bone construct: Synthesis and in vitro studies. Int J Biol Macromol [Internet] 2015;80:282-92. Available from: http://dx.doi.org/10.1016/j.ijbiomac.2015.05.009
16. Ma P, Wu W, Wei Y, Ren L, Lin S, Wu J. Biomimetic gelatin/chitosan/polyvinyl alcohol/nano-hydroxyapatite scaffolds for bone tissue engineering. Mater Dec [Internet] 2021;207:109865. Available from:https://doi.org/10.1016/j.matdes.2021.109865
17. Xu M, Qin M, Zhang X, Zhang X, Li J, Hu Y, et al. Porous PVA/SA/HA hydrogels fabricated by dual-crosslinking method for bone tissue engineering. J Biomater Sci Polym Ed 2020;31(6):816–31.
18. Porrelli D, Gruppuso M, Vecchies F, Marsich E, Turco G. Alginate bone scaffolds coated with a bioactive lactose modified chitosan for human dental pulp stem cells proliferation and differentiation. Carbohydr Polym [Internet] 2021;273:118610. Available from: https://doi.org/10.1016/j.carbpol.2021.118610
19. Bakopoulou A, Georgopoulou A, Grivas I, Bekiari C, Prymak O, Loza , et al. Dental pulp stem cells in chitosan/gelatin scaffolds for enhanced orofacial bone regeneration. Dent Mater 2019;35(2):310–27.
20. Iqbal H, Ali M, Zeeshan R, Mutahir Z, Iqbal F, Nawaz MAH, et al. Chitosan/hydroxyapatite (HA)/hydroxypropylmethyl cellulose (HPMC) spongy scaffolds-synthesis and evaluation as potential alveolar bone substitutes. Colloids Surfaces B. Biointerfaces 2017;160:553–63.
21. Zhang XY, Chen YP, Han J, Mo J, Dong PF, Zhuo YH, et al. Biocompatiable silk fibroin/carboxymethyl chitosan/strontium substituted hydroxyapatite/cellulose nanocrystal composite scaffolds for bone tissue engineering. Int J Biol Macromol [Internet] 2019;136:1247–57. Available from: https://doi.org/10.1016/j.ijbiomac.2019.06.172
22. Salim SA, Loutfy SA, El-Fakharany EM, Taha TH, Hussien Y, Kamoun EA. Influence of chitosan and hydroxyapatite incorporation on properties of electrospun PVA/HA nanofibrous mats for bone tissue regeneration: Nanofibers optimization and in-vitro assessment. J Drug Deliv Sci Technol [Internet] 2021;62:102417. Available from: https://doi.org/10.1016/j.jddst.2021.102417
23. Chen T, Huang H, Cao J, Xin Y, Luo W, Ao N. Preparation and characterization of alginate/HACC/oyster shell powder biocomposite scaffolds for potential bone tissue engineering applications. RSC Adv. 2016;6(42):35577-88.

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The effect of educational videos on the level of community knowledge and awareness of the importance of treatment in prosthodontics

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ABSTRACT
In addition to chewing and speaking, teeth play an important role in a person's appearance. The concerns that are often experienced by patients are usually caused by the opinion of the patient who is not included in the planning of treatment in the field of prosthodontics, the patient's understanding and knowledge about treatment in the field of prosthodontics is minimal, and the patient's attitude towards treatment in prosthodontics. Counseling is one of the efforts to increase understanding and knowledge related to prosthodontic treatment. In this study, the patient's level of understanding and knowledge will be evaluated after and before watching the educational video of Prosthodontics, Faculty Dental Medicine, Universitas Airlangga. This research is an analytic observational study with a cross sectional approachand used used a questionnaire before and after being given an educational video. After watching the educational video, there was an increase in knowledge about follow-up care after tooth extraction from those who previously did not know to know as much as 42.5%. It was concluded that there is an increase in public knowledge and awareness about the impact of tooth loss and restoration options after watching educational videos.
Keywords: tooth loss, prosthodontics, treatment, knowledge, video

INTRODUCTION

Apart from chewing and speaking, teeth contribute significantly to an individual's look. Cavities, periodontal disease, and trauma can all result in tooth loss that have an emotional impact due to speech, chewing, and cosmetic problems.[1] Dentures can be used to restore masticatory and aesthetic functions. With the advancement of communication technology, public awareness of dental health has improved, so creating an opportunity to promote denture use in the community. However, Indonesian Basic Health Research or Riskesdas reports that 42.2 % of the Indonesian population with oral health concerns self-medicate. As many as 13.9% of respondents visited a dentist, while the remainder visited general practioners (5.2%), dental nurses (2.9%), speciality dentists (2.4%), and dental craftsmen (1.3%).[2] This thing demonstrates that, while public awareness is relatively high, public information about whom to consult for treatment is still quite limited. People choose to self-medicate, even dental care from expert doctors.

Prosthodontic treatment encompasses many procedures, including tooth replacement for indivividuals with imperfect teeth, rehabilitation following partial or complete tooth loss, fabrication of maxillofacial and finger prostheses, and even treatment of temporomandibular joint (TMJ) disorders. A prosthodontist can do all of these procedures. All procedures are performed to restore the function and aesthetics of the entire dental and oral care system and the organs being restored. However, this treatment is less popular and less well-known among the general public. As a result, patients frequently choose to abandon it, lowering their quality of life.

Comfort, function, and aesthetic are the three primary factors that influence patient acceptance and success with any form of prosthetic treatment. Mechanical and biological variables determine comfort and function. Acceptance of aesthetic features is influenced by social and cultural factors and individual attitudes and opinions.[3]

Concerns frequently expressed by patients stem from the fact that the patient's opinion is not included in the planning of treatment in the field of prosthodontics, the patient's understanding and knowledge of minimally invasive treatment in the field of prosthodontics, and the patient's attitude toward treatment in the field of prosthodontics.[4,5] Patient non-participation in treatment planning is frequently due to a lack of patient knowledge, and the patient's attitude toward treatment is linked to the patient's capacity to absorb the information provided by the dentist. Thus, it is vital to raise patient awareness and education, as this is necessary for success in performing treatments in prosthodon-

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tics that improve these patients' quality of life.

Counselling is one of the strategies used to promote patient comprehension and information about prosthodontic therapy. Through counselling regarding prosthodontic therapy, the larger community and patients will receive accurate knowledge regarding the necessary prosthodontic treatment. Choosing the appropriate strategy and media is critical when counselling the general audience. This is to ensure that the general population absorbs the most information possible.

Health education is delivered through a combination of face-to-face interactions and certain media. Print media, exhibition/display media, audio media, audio-visual media, and multimedia are all examples of media used. Video media can be used to counsel patients about treatment options in the field of prosthodontics. Media in videos containing explanations about treatments that prosthodontic specialists can carry out with visual messages supported by sound and explanations by dentists can increase knowledge and understanding. The effectiveness of extension media is highly dependent on the number of accepted senses involved. The more engaged senses, the more easily counselling messages can be comprehended.[6]

In this study, patients' level of understanding and knowledge will be evaluated before and after watching the educational video of the Prosthodontics Department, Faculty of Dental Medicine, Universitas Airlangga.

METHODS

This research was an analytic observational study with a cross sectional approach, used a questionnaire as a measurement before and after being given an educational video. The research was conducted using cluster sampling. Subjects were taken in Dental Hospital of Universitas Airlangga on May-August 2021. Each member in the selected group will be taken as a subject. The population of this study were all people who had experienced tooth extraction and had never experienced tooth extraction.

To determine the level of community knowledge in missing teeth, measurements were used by answering questions before and after being given an educational video. Questions that will be asked are the history of dental treatment, knowledge about treatment after tooth extraction, knowledge of teeth that have been extracted and not replaced, knowledge of the field of dentistry that manufactures dentures, knowledge of treatments that are not included in the field of prosthodontics, knowledge of treatment including maxillofacial in the field of prosthodontics, knowledge of jaw joint care including in the field of prosthodontics. The data that has been obtained was then presented to determine the characteristics of the respondents and the mean final score of all samples.

RESULTS

The study was conducted by means of respondents filling out a questionnaire before and after watching an educational video about the importance of replacing missing teeth that had been prepared (fig.1) to see the differences in the level of knowledge of the respondents. There are 80 total respondents with an age distribution between 16-70 consisting of 27.5% male (22 people) and 72.5% female respondents (58 people). The distribution of all respondents can be seen in fig.2 and fig.3A. From the total of 80 respondents, almost 80% had experienced tooth extraction (64 people) and the remaining 16 people had never experienced extraction.

After watching the educational video, there was an increase in knowledge of follow-up care after tooth extraction from those who previously did not know as much as 42.5% (34 respondents) and the rest answered that they knew the procedure (fig. 3B). As many as 70% of respondents (56 people) understand the consequences of not replacing dentures after watching educational videos and the rest already know before watching educational videos. As many as 72.5% respondents (58 people) only understood the scope of prosthodontic treatment after watching educational videos, but only 18.7% of respondents (15 people) knew that TMJ care was included in prosthodontics field before watching the video, the remaining 81.3% (65 people) knew after watching the educational video.

DISCUSSION

This study was conducted to obtain informa-

Figure 1 Snippets from the educational video

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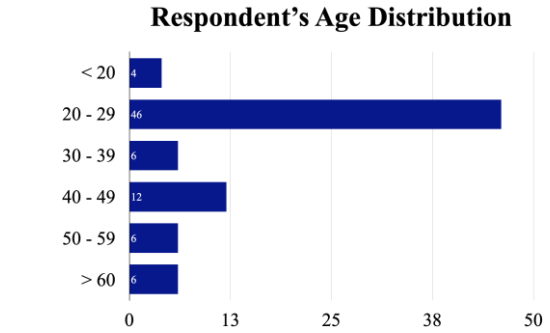

Figure 2 Characteristics of respondent by ages

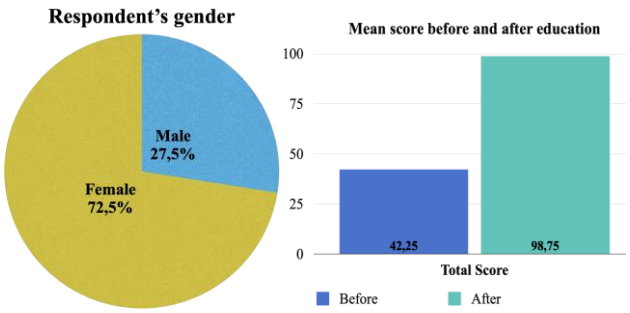

Figure 3A Characteristics of respondent by genders; **B** the mean score pre and post watching educational video

tion about public knowledge and awareness of the impact of tooth loss and the available restoration options in the field of prosthodontics obtained from the results of questionnaires conducted before and after viewing educational videos. The results obtained showed more female respondents than male respondents. Therefore, the study results will show the influence of female sex characteristics compared to the male gender. The number of female respondents who are more dominant can be caused by women generally pay more attention to appearance than men. In conditions there is tooth loss, especially in the front, generally, women will immediately seek treatment to restore the missing tooth. This study also follows the results of Teofilo and Leles, which stated that women felt the impact of tooth loss on chewing function more than men. This may be caused by women generally prioritize dental health compared to men.[7]

Teeth are one of the organs that have essential functions for the body. Without teeth, some parts can be disturbed. Most of the respondents in this study had experienced toothache. Functional disorders due to tooth loss include masticatory function, speech function, and aesthetic function. For example, a person who experiences tooth loss will result in a less than optimal chewing function of food, the pronunciation of words in certain letters is less than optimal and aesthetic function is disturbed. Disturbances due to tooth loss can be prevented by using dentures to replace missing teeth. Dentures are artificial devices used to replace missing teeth and surrounding tissues.[8]

Knowledge is one of the supporting factors in taking action. Actions based on knowledge will be better than actions not based on knowledge. A person's actions can be seen and influenced after they know something information, and then they will assess or respond to that information.[9] The results of the study showed that there was an increase in knowledge of follow-up care post tooth extraction after watching educational videos. This shows the importance of the knowledge that a person has to take action, for example, the knowledge obtained from the educational video information provided in this study.

Knowledge can also play a role in developing one's health. Knowledge can be a predisposing factor or a factor that makes it easier for someone to perform a health behavior such as prosthodontic treatment. Health behavior is a person's response to objects related to illness, disease, and the health care system. Services for dentures are also included in one form of dental and oral health services. Public knowledge of the use of dentures can be obtained from anywhere, even though the individual does not wear dentures.[8] As explained in the educational video, the result of not replacing missing teeth with dentures can cause other surrounding teeth to shift, resulting in gaps in existing teeth and allowing food debris to get trapped in these gaps, and causing bad breath to teeth and caries. In addition, if the extracted tooth is not replaced with a denture, the opposing tooth will be extruded, or a condition where the tooth seems to continue growing and causing it to appear longer, sometimes causing the tooth to wobble until it is indicated to be extracted.

The area of the post-extraction tooth that is not replaced with a denture can cause the tooth arrangement to become disharmonious. If this condition is left unchecked, over time, it can cause pain and discomfort in the jaw joint, which is usually characterized by a jaw joint that makes a sound when used to chew and limitations when opening the mouth. However, knowledge about jaw joint care is still low. In general, public knowledge about missing teeth and treatment in prosthodontics tends to increase after watching the educational video in this study. Some of the factors that cause a lack of public knowledge before watching educational videos can be caused by educational background and information obtained by the community. Information about dentures can come from anywhere, both

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print and electronic media. In addition, whether or not socialization is often carried out by related parties, regarding the function, the use of dentures also plays an essential role in increasing public knowledge. Interests can also affect a person's knowledge. Interest is a tendency or strong desire for something. Interest makes someone try and pursue something to gain deep knowledge.[10]

Media in the form of videos in health education is a tool that aims to convey health messages by stimulating the senses of sight and hearing. The existence of information with motion models can increase the respondent's desire to pay attention to what information is presented in the video. The information contained in the video is then clarified with the researcher's explanation to the lecturer so that it can increase the knowledge of the respondents.[10]

This study is in accordance with the results of previous research by Sari, et al, that there was a change in the increase in respondents' knowledge before and after receiving health education videos. According to the researcher, the increase of the respondent's knowledge reflects the respondent's understanding of the material that has been received. The knowledge that has increased in this study is influenced by learning media, namely videos, that make it easier for respondents to remember and perceive the material provided. The existence of video media helps respondents better understand the information to be conveyed through video content to create a better understanding for respondents.[10]

Based on this study, it is concluded that there is an increase in public knowledge and awareness of the impact of tooth loss and the restoration options available in the field of prosthodontics after watching educational videos. Several factors causes a lack of public knowledge before watching educational videos can be caused by educational and informational backgrounds. However, the information with motion models in the form of videos, can help respondents to better understand information to be conveyed through video content so as to create a better understanding for respondents.

REFERENCES

1. Siagian KV. Kehilangan sebagian gigi pada rongga mulut. e-CliniC 2016;4(1):1-6.
2. Ministry of Health, National Institute of Health Research and Development. National report on basic health research - RISKESDAS. Jakarta: Badan Litbangkes; 2018.
3. Conny DJ, Tedesco LA, Brewer JD, Albino JE. Changes of attitude in fixed prosthodontic patients. J Prosthet Dent 1985;53(4):451-4.
4. Akeel R. Attitudes of Saudi male patients toward the replacement of teeth. J Prosthet Dent 2003;90(6):571-7
5. Shigli K, Hebbal M, Angadi GS. Attitudes towards replacement of teeth among patients at the Institute of Dental Sciences, Belgaum, India. J Dent Edu 2007;71(11):1467-75.
6. Sanjaya AN, Suwargiani AA, Wardani R. Comparison between audiovisual media and simulation on the tooth brushing skills of elementary school students. Padjadjaran J Dent 2019;31(3):177-83.
7. Teófilo LT, Leles CR. Patients' self-perceived impacts and prosthodontic needs at the time and after tooth loss. Braz Dent J 2007;18:91-6.
8. Padu F, Lampus BS, Wowor VN. Gambaran tingkat pengetahuan masyarakat terhadap pemakaian gigi tiruan di kecamatan Tondano Barat. e-GiGi 2014;2(2):1-7.
9. Randa Y. Pengetahuan dan sikap masyarakat terhadap pemakaian gigi tiruan di kelurahan Pakowa kecamatan Wanea. Dentire J 2013; 1(2):38-42.
10. Sari NP, Angelina R, Fauziah L. Pengaruh edukasi melalui media video terhadap pengetahuan dan sikap keluarga tentang pneumonia pada balita. Jurnal Ilmu Keperawatan Anak 2019;2(2):69-76.

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Interdisciplinary treatment approach of skeletal Class III malocclusion patient with multiple missing teeth: A case report

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ABSTRACT
Background: Combination of poor dental hygiene and poor dental treatment lead to multiple missing teeth. Periodontics, orthodontics, oral & maxillofacial surgery, and prosthodontics treatments were undertaken in proper timing and sequence with an interdisciplinary approach. **Objective**: Proper diagnosis, treatment planning and teamwork were crucial to solve difficult cases. **Case**: A 30-year-old unilateral cleft lip and palate female patient with Class III malocclusion and several missing maxillary anterior and posterior teeth and mandibular posterior teeth came to the clinic to improve both her esthetic and function. Patient had a unilateral cleft lip and palate. **Management**: After initial periodontal care was completed, orthodontic treatment was completed to prepare her orthognathic surgery. Space consolidation and occlusion correction were also completed to prepare her for final prosthesis post surgery. Partial dentures were delivered by the prosthodontists. As a result, a stable Class I occlusion with good esthetic and function treatment results were achieved. **Conclusion**: The case showed that proper diagnosis and treatment planning is very important especially in an interdisciplinary treatment of Class III malocclusion patient.
Keywords: interdisciplinary approach, Class III malocclusion, multiple missing teeth, unilateral cleft lip and palate
This title has been presented in The 12th Biennial Congress of Asian Academy of Prosthodontics, 21 August 2021

INTRODUCTION

Good hygiene along with regular dental visits and correct treatment will lead to good oral health. A 30-year-old female patient with a severe Class III malocclusion came to the office for treatment and with the chief complaint: "I want to fix my bite and my look.

In a tough case, a comprehensive treatment plan by combining several specialties in dentistry can provide satisfactory results for patients and doctors themselves. An organized, planned and well-discussed treatment plan allows doctors and patients to produce successful treatments. Interdisdisciplinary cares with a collaboration of various dental discipline can result in ideal and optimal occlusion.[1,2]

The main objective of this case report is to show that proper treatment planning with the correct team will lead to a good result for the patient, both functionally and esthetically.

CASE

The initial extraoral and intraoral photographs (Fig.1) show that patient has a Class III malocclusion, anterior and posterior crossbite, multiple spacing, multiple missing maxillaries and mandibular (anterior and posterior) teeth. Patient also has asymmetry soft tissue and/or lip canting. She has a unilateral cleft lip and palate. Panoramic radiograph (Fig.2) shows that patient has multiple dental restoration and periodontal disease, along with multiple, prolonged spacing shown by teeth drifting. Lateral cephalogram (Fig.3A) shows a high angle, skeletal Class III malocclusion and her posteroanterior cephalogram (Fig.3B) suggested skeletal asymmetry. The combination between poor dental hygiene and poor prior dental treatment was the cause of the multiple missing teeth.

Figure 1 Pre-treatment; **A** extra and **B** intraoral photographs


Figure 2 Pre-treatment panoramic radiograph

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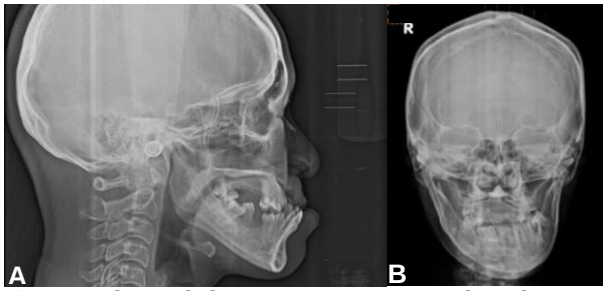

Figure 3 The cephalogram: **A** pre-treatment lateral; **B** pre-treatment posteroanterior cephalogram

Figure 4 Progress/intermediate panoramic radiograph (post periodontics and orthognathic surgery)

Figure 5 Progress/intermediate: **A** extra and **B** intraoral photographs (post periodontics, orthodontics and orthognathic surgery).

Figure 6 Post-treatment **A** extra; **B** intraoral photographs

MANAGEMENT

Periodontic, orthodontic, oral and maxillofacial surgery and prosthodontics treatments were undertaken in the proper timing and sequence with an interdisciplinary approach. Initial periodontal care was completed by a periodontist. After stabilizing the patient's periodontal health, orthodontic treatment was completed to correct patient's occlusion and prepare patient for orthognathic surgery. After aligning, leveling and diastema closure phases, a modified Le Forte osteotomy, a mandibular setback with bilateral sagittal split osteotomy and a genioplasty were performed (Fig.4).

Space consolidation and occlusion correction were also completed to prepare her for final prosthesis post-surgery (Fig.5). Removable partial denture was delivered by the prosthodontist based on request by the patient after multiple options were given. As a result, a stable Class I occlusion with good esthetic and function treatment results were achieved (Fig.6). Patient were happy with the result of treatment.

DISCUSSION

Indonesia consisted of over 17,000 islands. In certain locations, especially in rural areas and/or islands, doctors and dentists are rarely found. In other areas, the level of health services is very low and is not able to fulfill the needs of the population. This incident was experienced by this patient which caused the patient to receive limited treatment, where curative and preventive care were minimal. The patient lost multiple teeth, both posterior and anterior teeth. Additionally, the patient had a skeletal Class III malocclusion with asymmetry where none of her local dentists can treat.

The patient needed a long commute to reach the clinic. After clinical examination and additional data collection it was decided that she needed integrated treatment between periodontist, orthodontist, oral and maxillofacial surgeon, and prosthodontist. Initial treatment consisted of periodontal treatment due to patient irregularity of having a dental cleaning. Patient has a generalized moderate periodontitis. Orthodontics treatment with fixed appliance were started after her periodontal disease was stabilized. The patient underwent a surgery to correct her upper and lower jaw relationship followed by completion of orthodontics treatment to adjust the position of her remaining teeth and close the space. Her surgery included a double jaw surgery to correct her Class III skeletal malocclusion and asymmetry of the mandible. A genioplasty was performed to reduce the position of the chin thereby reducing her Class III facial profile.

Orthognathic surgery is a good approach in treating anterior crossbite and open bite relating to

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skeletal problems in adult patient.[3-5] Changes in profile and occlusion were obvious. Study have shown that many orthognathic surgery patients have benefit which include improved smile, more positive esthetics, increased self-esteem, and consequently a better quality of life.[6,7] After 24 months of active treatment, the patient showed a Class I molar and canine relationship and an ideal overbite and overjet. Her profile had improved, and her lip were competent. She has a good overall balance of her hard and soft tissue.

Her final treatment was the fabrication and delivery of upper and lower removable partial dentures. The prosthodontist and orthodontist had to work together to ensure that the patient will have the most ideal and stable occlusion with her removable partial denture.

It is concluded that proper diagnosis and treatment planning is very important especially in tough cases which require an interdisciplinary approach such as the case shown at this case report. The treatment of patients with complex dentofacial abnormalities is always a great challenge to orthodontists. Orthognathic surgery is a good approach in treating anterior crossbite and open bite relating to skeletal problems in adult period. Sometimes, a multidisciplinary approach is necessary to achieve the best esthetic and functional outcome.

REFERENCES

1. Jacobson A. The art of the smile: Integrating prosthodontics, orthodontics, periodontics, dental technology, and plastic surgery in esthetic dental treatment. Am J Orthod Dentofac Orthop 2005;128(5): 674-5.
2. Pinho T, Neves M, Alves C. Multidisciplinary management including periodontics, orthodontics, implants, and prosthetics for an adult. Am J Orthod Dentofac Orthop 2012:142(2):235-45.
3. Halim H, Halim I. Changes in profile after orthognathic surgery in skeletal Class III patients. Open J Stomatol 2015; 5(12): 321-7.
4. Gallone M, Robiony M, Bordonali D, Bruno G, De Stefani A, Graco AA. Multidisciplinary treatment with a customized lingual appliance for an adult patient with severe Class III malocclusion and multiple missing teeth. Am J Orthod Dentofac Orthop 2019;156:401-11.
5. Rizzatto SMD, Menezes LM, Filho JJ, Allgayer S. Conventional surgical-orthodontic approach with double-jaw surgery for a patient with a skeletal Class III malocclusion: Stability of results 10 years posttreatment. Am J Orthod Dentofac Orthop 2018;154:128-39.
6. Souki BQ, Figueiredo DSF, Lima A, Oliveira DD, Miguel JAM. Two-phase orthodontic treatment of a complex malocclusion: Giving up efficiency in favor of effectiveness, quality of life, and functional rehabilitation? Am J Orthod Dentofac Orthop 2013;143:547-58.
7. Kokich VO, Kinzer GA, Janakievski J. Congenitally missing maxillary lateral incisors: Restorative replacement. Am J Orthod Dentofac Orthop 2011; 139(4): 435.

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The effect of dental cleanser from plant extracts inhibiting the growth of *Candida albicans* on acrylic resin plates: a systematic review

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ABSTRACT
Background: Sodium hypochlorite is a denture cleaning solution that is widely used as an efficient cleaning method. However, it has disadvantages of uncomfortable taste and smell. Therefore, therapeutic plant extracts are safer for the human body, they are used as an alternative for denture cleaning agents. **Objective**: To analyze the effect of active compounds extracted from therapeutic plants in inhibiting the growth of *Candida albicans*. **Methods**: Ten selected articles were obtained from five search engines with due observance of PICO and specified inclusion criteria, then an assessment was carried out on ten selected articles which were assessed based on the assessment criteria of The Joanna Briggs Institute Criticial Appraisal Tools checklist and deserved to be included in writing a systematic review. **Results**: The plant extracts from ten articles were lemongrass extract and cinnamon extract, which were fungistatic and fungicidal; while the extracts of black cumin, mangrove leaf, rosella flower, ketapang leaf, mexico tea, and grape seed were fungistatic only. **Conclusion**: The active compounds of the terpenoid and phenolic groups from had adequate antifungal activity, but the active compounds in the phenolic group had lower antifungal activity due to the withdrawal of chlorophyl and carotenoid pigments which are known have antioxidants and antifungal properties.
Keywords: denture cleanser, plant extract, *Candida albicans*, minimum inhibitory

INTRODUCTION

Edentulism is still considered as one of the main oral health problems since it affects a large part of the world population because for decades the public oral health policy in underdeveloped or developing countries was based on tooth extraction for treating pain, caries, and infection, among other oral problems. This curative practice is reflected in the contemporary population, in which it was found a high number of partially or completely edentulous individuals.[1] This population is generally rehabilitated with removable prostheses, which are fabricated of polymethyl methacrylate, due to the good esthetic qualities and excellent cost benefit ratio.[2]

Oral candidosis is an opportunistic infection caused by over growth and penetration of the oral tissues by pathogenic forms, hyphae and pseudohyphae, of *Candida spp*., mainly *Candida albicans*. *Candida-associated denture stomatitis* (CADS), the most frequent type of oral candidosis and the most common mucosal alteration in the elderly, affects approximately 65% of removable denture wearers and has been associated with multiple etiologic factors. Despite its etiology involving systemic and local factors, CADS is mainly associated with an overgrowth of *Candida* in pathogenic form on the denture surface as a biofilm. The first crucial step of denture biofilm formation is adherence of yeast-form cells to the acrylic surfaces.[1]

Maintenance of denture hygiene plays an important role in the denture care process because it can help maintain the strength, stability and retention of the denture, as well as maintain the health of the surrounding tissue in the oral cavity.[3]

The most common method of controlling biofilm on dentures is brushing with toothpaste, because it is easy to reach and low cost. Mechanical brushing is a simple and widely used cleaning method to control biofilm on dentures. However, there are pores in acrylic resin, and in some situations, toothbrush bristles do not properly clean the pores.[4] In addition, many denture users are geriatric patients, who have had decreased visual acuity or even loss of motor skills, thereby impairing cleaning and performance. Although immersion in chemical solutions has been recommended as a complementary method for mechanical cleaning, it has been observed that this treatment also fails to remove the biofilm *C.albicans*. In cases where *C.albicans* is a persistent infection, the use of antifungal agents has become a daily routine, e.g. fluconazole and nystatin. *C.albicans* drug resistance is one of the major problems in fighting the survival and spread of biofilms and can ultimately lead to treatment failure.[4]

This article reviews the effect of dental cleanser from plant extracts inhibiting the growth of *C.albicans* on acrylic resin plates.

METHODS

This systematic review is written according to the guidelines of preferred reporting items for systematic reviews and meta-analyses (PRISMA)

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for reporting studies evaluating health care interventions. Population, intervention, control, and outcome (PICO) questions of the present systematic review were *C.albicans* on acrylic resin plates, active compounds of therapeutic plant extracts, the effect of active compounds on the growth of *C.albicans*, and minimal inhibitory concentration of therapeutic plant extracts on the growth of *C. albicans*.

The Wiley Online Library, Science Direct, Pubmed Online Library, Cochrane Library, and Google Scholar were the searching engine of to get articles in English. The searchings were conducted to identify articles published in dental journals from January 2016 to December 2020 focusing on effect of dental cleanser from plant extracts inhibiting the growth of *C.albicans*. The MeSH key-words used were *denture cleanser*, plant extract, *C.albicans*, and *minimum inhibitory*. The electronic search is limited to articles in English, the search period, and the type of text availability. A manual search of published full-text articles and related reviews was carried out afterwards. There are 825 studies describing this topic but only 10 articles meeting the inclusion criteria. Specific keywords were used to identify appropriate study needs, and followed the characteristics of the PICO questions.

For the eligibility criteria, inclusion criteria were articles in English, published in the year 2016 to 2020, fulltext of laboratory experimental research and clinical reports, research using plant extracts, using the *minimum inhibitory concentration* (MIC) and *colony forming unit* (CFU) tests.
Meanwhile, the exclusion criteria were research that discusses denture cleaners that do not use plant extracts as the main ingredient, and research that is in abstract or in a report.

The special keywords were used by the three authors to select the articles being analyzed in the abstract and the full text. Independently, researchers selected papers based on predefined inclusion criteria. After that, all abstracts and full texts were downloaded and evaluated one by one. Eligibility criteria were used to identify the articles to be used for this systematic review.

The data were retrieved by three reviewers that regarding following parameters: year of publication; effect of denture cleanser from plants extract; and objective. All of the full-texts which met the inclusion criteria were read independently by the three reviewers, and evaluated to formulate this systematic review.

RESULTS

The database search yielded 825 references, including 43 from Wiley Online Library, 78 from Science Direct, 669 from Pubmed Online Library, 10 from Cochrane Library, and 26 from Google Scholar. After removing duplicate references, there were 799 studies remained. The titles and abstracts were reviewed afterward, and 19 studies were eligible for further analysis. The full-texts then be reviewed by the authors and yielded 10 articles which met the inclusion criteria. The flowchart of article selection is shown in Fig.1 with total 10 selected articles from initial yield of 825 studies by electronic literature search. After 825 titles reviewed, 10 articles were declared eligible for this systematic review inclusions, whereas the other 815 articles were excluded for some different reasons.

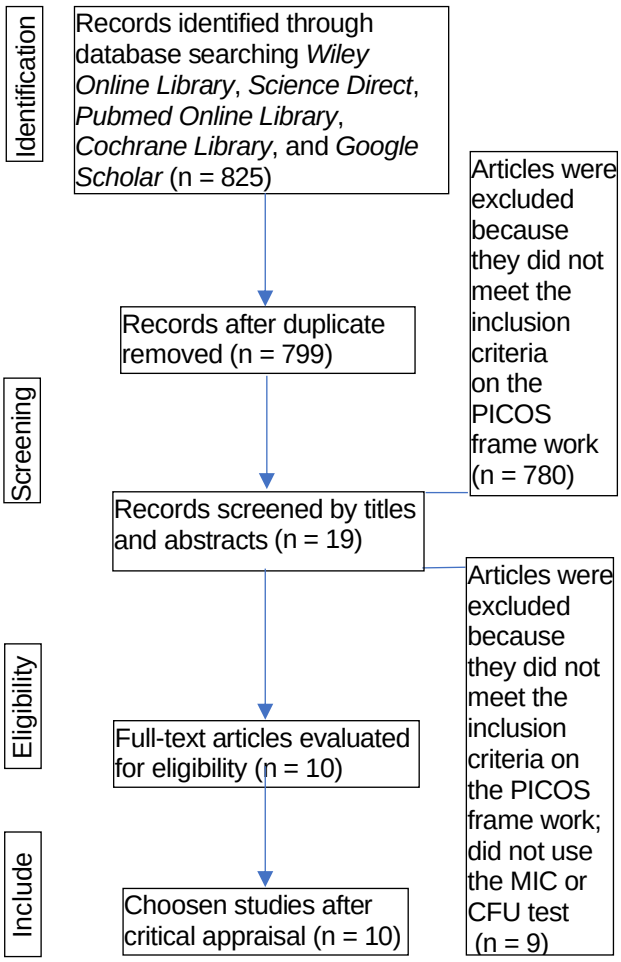

Figure 1 PRISMA flow chart of article selection

DISCUSSION

Cell walls and membranes play an important role in cell viability, morphogenesis, response to environmental influences, and pathogenesis; thus, these morphological changes are thought to reflect damage to cell homeostasis, resulting in cell death. So, this systematic review of effective therapeutic plant extracts inhibits the growth of *C.al-*

Table 1

No	Author (Year)	Plant Extract	Concentration	Active compound	Secunder metabolit	Sample	Group control	Test	Type	Result
1	de Fátima LD, et al (2016)	Essential oil from citronella & cinnamon	citronella 250 µg/mL; Cinnamon 65.5 µg/mL	Citronella & cinnamaldehyde	Terpenoid	9	Phosphat Buffer Saline	MIC & CFU	Fungistatic & fungicidal	Inhibitory effect from citronella 250 µg/mL & cinnamon on MIC 65.5 µg/mL, both essential oil significantly (p<0,05) reduce microorganism and biofilm
2	Madeira PLB, et al (2016)	Lemongrass extract	0.625 mg/mL	Citronelal & linalool	Terpenoid	9	Distilled water	MIC	Fungistatic & fungicidal	Minimum concentration of lemongrass extract needed to inhibit growth *C.albicans* 0.625 mg/mL. The presence of lemongrass extract during biofilm development resulted in a decrease in the number of cells (p<0.05) which makes MIC enough to reduce approx 90% cell (p<0.0001). Lemongrass extract has significant antifungal effects at all concentrations (p<0,05).
3	Khan MA, et al, (2016)	Nigella sativa/ black seeds (Thymoquinione) Essential oil from thyme (p-Cymene & timol)	0.25 mg/mL	Thymoquinone p-Cymene timol	Terpenoid	60	Distilled water	CFU	Fungistatic	Essential oil from thyme and black seeds has almost equal effectiveness against *C.albicans* but the difference was not statistically significant (p = 0,79)
4	Al-Thobity AM, et al (2017)	*Nigella sativa*/ black seeds (essential oil, alcaloid, fix oil, protein & saponin)	0.5%	Thymoquinone (TQ)	Terpenoid	80	PMMA 0%	MIC	Fungistatic	The inhibitory effect of TQ on MIC significantly reduced the number of *C.albicans*. The addition of 0.5% TQ to PMMA caused a significant decrease in *C.albicans*. Increasing the of TQ (0.5-5%), the number of *C.albicans* decreased drastically to zero using the slide count evaluation method
5	Ariamanesh H, et al (2019)	*Nigella sativa*/ black seeds	0.2 mg/mL	Alkoholic extract from *Nigella sativa*/black seeds	Terpenoid	30	+positive control: nistatin 100.000 unit -control: distilled water	CFU	Fungistatic	Black seeds at low concentrations (0.2 and 0.4 mg/mL) has a low antifungal effect against *C.albicans*. However, with increasing concentrations of black cumin, the number of Candida colonies decreased significantly
6	Utama MD, et al (2017)	Mangrove leaves extract *(Avicennia marina)*	10%	Flavonoid & saponin	Fenolic	10	Denture cleanser commersil	MIC	Fungistatic	7.5% mangrove leaves extract had optimal inhibition against the growth of *S.mutans* (p <0.05). Mangrove leaf extract at a concentration of 10% had not shown an inhibitory effect against *C.albicans*

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No	Author (Year)	Plant Extract	Concentration	Active compound	Secunder metabolit	Sample	Group control	Test	Type	Result
7	Utama MD, et al (2017)	Rosella flower extract (*Hibiscus sabdarifa L*)	10%	anthocyanin, riboflavin, ß-caroten, polisakarida, & flavonid	Fenolic	90	Denture cleanser commer-sil	CFU	Fungistatic	There was no significant difference in effectiveness between the immersion time of 5, 10, and 15 minutes in the 10% rosella
8	Gonçalves LM, et al (2019)	Ketapang leaves extract (Terminalia catappa Linn.)	0.25 mg/mL	Tanin, fraksi n-butanol Terminalia catappa Linn	Fenolic	108	Fluco-nazole solution	MIC	Fungistatic	MIC value is 0.25 mg/mL of the n-butanol fraction of Terminalia catappa Linn. (FBuTC) was observed for the planktonic cells of *C.albicans* and *C.glabrata*. FBuTC exposure at 10xMIC had a significant effect on the biofilm C.albicans, indicating a decrease in cell count
9	Maria P, et al (2019)	*Chenopodium ambrosioides* extract / Mexican tea extract	0.25 mg/mL	Quercetin & kaempferol	Fenolic	72	+control: sodium hypo-chlorite (SH 1%) -control: Phos-phat	MIC	Fungistatic	The observed effect of mexican tea extract on MIC for planktonic *C.albicans* cells obtained a value of 0.25 mg/mL, indicating antifungicidal activity. The effect of mexican
10	Chiaki Tsutsumi-Ara et al (2019)	Grape fruit seeds extract	0,1 %	Polifenol	Fenolic	250	Distilled water	CFU	Fungistatic	The treatment with 1% grape seed extract for 5 minutes almost completely removed the biofilm formed on the resin. Treatment with 0.1% grape seed extract, Polident, & 0.1% G + P for 5 minutes showed a statistically significant inhibitory effect on the biofilm. The 0.1% GSE and 0.1% G + P treatment gave a persis-tent inhibitory effect on the biofilm.

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bicans consists of two groups of metabolites secondary, namely terpenoids and phenolic.

For secondary metabolites of the terpenoid group, among others, are obtained from essential oils of the cinnamon plant with the active compound in the form of cinnamaldehyde,[5] essential oil of lemongrass with active compounds such as citronellal, geraniol, and citronellol,[6] black seeds with the content of essential oils obtained from the compound *Nigella sativa* seeds active in the form of thymoquinione, p-Cymene, and thymol.[7,8]

Secondary metabolites of the phenolic group are obtained from mangrove leaves with active compounds in the form of flavonoid and saponin,[9] rosella flower with active compounds in the form of anthocyanin, riboflavin, beta-carotene, polysaccharide, and flavonoid,[10] ketapang leaves with active compounds in the form of tannins and n-butanol (*Terminalia catappa Linn*). Fraction,[11] Mexican tea extract with the active compound form quercetin and kaempferol, grape seed extract with active compounds in the form of polyphenols.[12]

The terpenoid compounds are lipophilic; the antifungal activity in the secondary metabolites of the terpenoid group can cause the membrane to be blocked from dissolving lipids found on the cell membrane. The antifungal activity of phenolic compounds can damage cell walls and cell membranes, precipitate proteins, and inactivate enzymes.

This systematic review concludes that two groups of secondary metabolites namely terpenoids and phenolic, have adequate antifungal activity, but from several articles found that phenolic compounds have antifungal activity not as good as the antifungal activity of the terpenoids due to withdrawal some pigment content. Pigments contained in both plants therapeutic namely chlorophyl and choratenoids pigments which are known to be a high antioxidant and antifungal properties activities. None of the plant extracts from the selected ten articles are toxic, from the article it is concluded that because the plant extract is not toxic, it is used as an alternative ingredient for denture cleanser.

REFERENCES

1. Sugio CYC, Garcia AA, Albach T, Moraes GS, Bonfante EA, Urban VM, et al. Candida associated denture stomatitis and murine models: what is the importance and scientific evidence? J Fungi 2020.
2. Chaves SCL. Oral health in Brazil: The challenges for dental health care models. Braz Oral Res 2012;26(Spec Issue 1):71–80.
3. Carlsson GE, Omar R. The future of complete dentures in oral rehabilitation: a critical review. J Oral Rehabil 2010; 37(2):143–56.
4. Hasan S. Denture stomatitis: A literature review denture stomatitis. J Orofac Health Sci 2015;6(2):1–6.
5. de Fátima L, de Almeida D, de Paula JF, Vanessa R, de Almeida D, Williams DW, et al. Efficacy of citronella and cinnamon essential oils on Candida albicans biofilms. Acta Odontol Scand 2016;1–5.
6. Madeira PLB, Paschoal MAB, de Sousa EM, Moffa EB, de Jesus R, Tavarez R. In vitro effects of lemongrass extract on *Candida albicans* biofilms, human cells viability, and denture. J Front Cell Infect Microbiol 2016;6:1-9
7. Al-thobity AM, Al-khalifa KS, Gad MM, Alnassar T. In vitro evaluation of the inhibitory activity of thymoquinone in combatting candida albicans in denture stomatitis prevention. Int J Environ Res Public Health 2017;1–9.
8. Ariamanesh H, Tamizi PDN. The Effectiveness of *Nigella sativa* alcoholic extract on the inhibition of *Candida albicans* colonization and formation of plaque on acrylic denture plates: an in vitro study. J Dent Shiraz Univ Med Sci 2019;20(3):171–7.
9. Dharma Utama M, Tetelepta R, Ikbal M, Warti AEA. Effect of mangrove leaves extract (*Avicennia marina*) concentration on the growth of *Streptococcus mutans* and *Candida albicans*. J Dentomaxillofac Sci 2017;2(3):155-9
10. Dharma Utama M, Machmud E, Cialy JS, Mapangara S. Pengaruh waktu perendaman terhadap efektifitas larutan tablet effervescent rosella dalam menghambat pertumbuhan koloni Candida albicans dan Streptococcus mutan. In: medan international scientific dental meeting (misdm). 2017;1–3.
11. Gonçalves M, Levid P, Madeira B, Diniz RS, Nonato RF, Suelen F, et al. Effect of *Terminalia catappa Linn*. on biofilms of *Candida albicans* and *Candida glabrata* and on changes in color and roughness of acrylic resin. Hindawi Evidence-Based Complementary and Alternative Medicine 2019;1–7.
12. Maria P, Zago W, Júlio S, Branco C. Anti-biofilm action of *Chenopodium ambrosioides* extract, cytotoxic potential and effects on acrylic denture surface. Front in Microbiol 2019;10(8):1–9.
13. Id CT, Id KT, Arai Y, Terada-ito C, Takebe Y, Imamura T, et al. Grapefruit seed extract effectively inhibits the Candida albicans biofilms development on polymethyl methacrylate denture-base resin. Plos One 2019;1-13
14. Jubhari EH. Tingkat kepuasan terhadap pembersih gigitiruan pada pengguna gigitiruan di Rumah Sakit Gigi Mulut Fakultas Kedokteran Gigi Universitas Hasanuddin satisfaction level about denture cleanser of denture wearers on the dental hospital. J Dentofasial 2013;12(3):164–8.
15. Nishi Y, Seto K, Kamashita Y, Take C, Kurono A. Examination of denture-cleaning methods based on the quantity of microorganisms adhering to a denture. J Compil Gerodontol Soc 2011;1–8.

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TNFα signaling mechanism against cell necrosis due to overextended denture

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ABSTRACT
Objective: Not all removable partial dentures are successful or function well. One thing that patients complain about injuries to the oral mucosal tissue. The presence of denture edges that are too long or what is often referred to as overextended can cause necrosis of oral mucosal cells which show a clinical form of ulcers. The purpose of this paper is to explain the process of mechanical injury due dentures overextended against cell necrosis. **Methods**: Conduct a review by covering the keywords mucosal ulceration, overextended denture, TNFα signaling. Various articles that have been obtained were thoroughly reviewed according to the inclusion and exclusion criteria. **Results** and **discussion**: The literatures show that overextended dentures cause discomfort. This is due to pain caused by injury to the mucosal lining of the oral cavity. Injury due to overextended denture causes cells to release death receptors in the form of TNF-R1 receptors. TNFα signals to bind to TNFα trimer with the TNF-R1 receptor. This response then proceeds to various processes that then lead to necrotic cell death. **Conclusion**: Death receptors and TNFα initiate cell death where this necrotic cell death depends on the formation of reactive oxygen species.
Keywords: overextended denture, TNFα signaling, necrosis cells

INTRODUCTION

In the field of prosthodontics, the manufacture of removable dentures (RD) aims to improve aesthetics, masticatory function, speech function and protect the supporting tissues under RD. Not all removable partial dentures (RPD) are successful or function properly, because there are many patient complaints, including loose prostheses, pain due to excessive pressure on the oral mucosal tissue, occlusion errors and the presence of a fractured prosthesis base.

One thing that complained by the patient is the injury to the oral mucosal tissue. The wound is a cell death that causes ulcers of traumatic lesions. Traumatic lesions are tissue discontinuities that extend from the dermis to the subcutis and always occur in pathological conditions. In general, these lesions are caused by mechanical trauma and the relationship between the causes is known.[1]

Traumatic lesions are classified as reactive lesions of cell necrosis with a clinical picture in the form of a single ulcer on the mucosa which can be caused by physical or mechanical trauma, thermal, chemical and radiation changes that cause tissue damage.[2] The lesion is characterized by a yellowish purulent fibrin membrane accompanied by pain.[3] These lesions may be healed within a few days or weeks after the cause of the trauma is removed. The pain will go away within 3 or 4 days, and will heal within 10-14 days. The RPD can cause trauma to the hard and soft tissues beneath the denture. These changes begin to occur as soon as the patient wears the denture and involve a high proportion of mucosal inflammation within one year of the denture being made. In a new complete denture (CD), which is clinically good dexterity. The existence of a denture edge that is too long or what is often referred to as overextended can cause necrosis of oral mucosa cells which shows a clinical form of ulcers.

Thus, this paper is aimed to to explain the process of mechanical injury due to overextended denture to against cell necrosis.

Removable dentures

Dentures are artificial devices that are used to replace part or all of the natural teeth that have been lost and restore changes in tissue structure that occur due to the loss of natural teeth. The purpose of making dentures, both CD and partial dentures, is essentially to improve the function of mastication, taste, aesthetics, maintain tissue health and prevent further damage to the structure of the oral cavity organs. In elderly patients itself the goal is to maintain the health and function of the masticatory system by establishing preventive measures without involving excessive medication.[4] The indications for making CD are loss of all teeth, the condition of the alveolar process is still good, the patient's oral condition is good, the general condition of the patient is good, and the patient is willing to have dentures made.[5] Problems often occur after

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the installation of a full denture include continuous pain under dentures, denture less fixed and comfortable, the mouth feel full and uncomfortable and impaired speech function.[6]

The RD consist of dentures that are attached to the base of the prosthesis; their bases can be made of metal or metal alloys. However, most denture bases are made of polymers, commonly are made of poly (methyl methacrylate) resin. This resin is very stable, does not change color under ultraviolet light, is durable, and is quite stable in heat. Acrylic resin is more often used because of its advantages, that is light weight, cheap, the same color as the gingival color, easy to manufacture and easy to prepare. The disadvantage, acrylic has micropores, make it easier for food debris and bacteria to enter it.[4]

Overextended denture

Denture *overextended* is a term applied to denture plate is longer than the peripheral seal mucosa. The denture will cause injury to the oral mucosa in the form of ulcers. Dentists who have made dentures on a patient often get complaints about the feeling of discomfort or pain due to the use of the denture. Usually, dentists only reduce or remove the parts of the denture that are considered to be the cause. But what is often found is abnormalities or pain that arise because the supporting mucosa is not treated. As a result, it is difficult for patients who have suffered from abnormalities or changes in the oral mucosa to support dentures to be able to accept dentures again if they are not treated properly.[7]

Necrosis cell

Necrosis is the death of cells as a result of damage or trauma (for example: lack of oxygen, extreme temperature changes, and mechanical injury), where cell death occurs uncontrollably which can cause cell damage, an inflammatory response and very potentially cause serious health problems. Stimulus that is too heavy and lasts too long and exceeds the adaptive capacity of cells will cause cell death in which cells are no longer able to compensate for the demands of change. A group of cells that experience death can be recognized by the presence of lysis enzymes that dissolve various cell elements and the emergence of inflammation. Leukocytes will help digest dead cells and then morphological changes begin to occur. Necrosis is usually caused by a pathological stimulus. Apart from pathological stimuli, cell death can also occur through a programmed cell death mechanism; after reaching a certain life span, the cell will die. This mechanism is called apoptosis, that is cells will destroy themselves (suicide).[6,7]

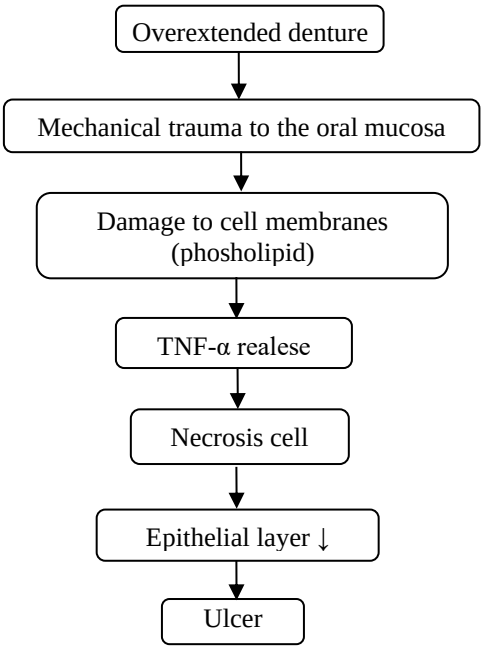

Figure 1 Conceptual mapping

METHODS

This literature review was compiled by searching articles through *databases* literature search *Google Scholar* and *PubMed*. The review was carried out by covering the keywords mucosal ulceration, overextended denture, TNFα signaling. Various articles that have been obtained were thoroughly reviewed according to the inclusion criteria and exclusion criteria. The inclusion criteria used were articles on the mechanism of signaling TNFα on cell necrosis due to *overextended dentures*. The exclusion criteria used were articles that did not have a complete structure, so they were taken for information only.

RESULTS

A good denture is able to improve the function of mastication, taste, aesthetics, maintain tissue health and prevent further damage to the structure of the oral cavity organs. Sometimes it is difficult for dentists to determine the boundaries of movable and immovable mucosa in the oral cavity, resulting in an overextended denture.

The overextended denture causes discomfort to the patient. The discomfort is due to pain in the oral mucosa of the oral cavity. The pain is caused by injury to the mucosal layer by a denture base that is too long. The oral mucosa of the injured oral cavity is in the form of ulceration. Ulceration is a

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lesion formed by local damage from the epithelial tissue to the lamina propria.[8] Cells are damaged and experience the death of cells that exfoliate constantly until the release of stratum basalis even to the lamina propria.

DISCUSSION

The basic function of the mucosa is a barrier, continuing sensation from the external environment, regulating heat and as a medium for the secretion of saliva. The mucosal surface epithelium forms a barrier major to various physical and chemical conditions. Keratinization is a form of protection against adjustment of function from stimulation or irritation. The mucosa in the oral cavity can be either keratinized or non-keratinized.[9] Gingival mucosa is a masticatory mucosa that had epithel as keratinized epithelium, with moderate vascularization. Collagen connective tissue in the mucosa is denser, thicker and more regular than the collagen connective tissue in the covering mucosa. The mucosa of the cheeks, lips and ventral tongue is a flexible covering mucosa. The epithelium of this mucosa is non-keratinized stratified squamous epithelium, while the lamina propria is composed of elastic and reticular collagen fibers.[9-11]

Mucosa which has a small amount of keratin is relatively more prone to injury due to pressure. In other studies; it is said that this pressure causes the mucosa to atrophy. Atrophy is an adaptive response that can lead to reduced blood supply, inadequate nutrition, hypoxia and pressure. Associated with these effects, cell atrophy may increase to the point where cells are injured and die.[12]

Initially, injury occurs because the overextended denture causes the cells to secrete death receptors, namely TNF-1 receptors (TNF-R1). The TNF-1 receptor then activates the caspase. TNFα signals the TNFα trimer that binds to the TNF-R1 receptor. This triggers a change in the receptor that binds the adapter proteins TRADD and RIP1 to the death domain receptor. The adapter protein then recruits TRAF2 and IKK in a complex manner. Recruitment of TRADD, RIP1, and TRAF2 leads to degradation of protein IκBα and activation of MAP kinase (MAP3K). The proteolytic degradation of IκBα that normally maintains NF-B in the cytoplasm allows the translocation of NF-κB to the nucleus, where it acts as a transcription factor. The MAP3K phosphorylates and activates downstream kinases, thereby activating MAP kinases, JNK, p38 and ERK. Activation of this kinase is combined with activation of NF-kB. When NF-B activation is reduced or prevented, TNFα signaling causes FADD and caspase-8 to recruit a secondary complex that triggers caspase-8 activation, leading to cell apoptosis. One of the caspase-8 substrates is RIP1. The continued increase in RIP1 lysis leads to apoptosis. When caspases are inhibited, apoptosis is prevented and the RIP$_1$ protein is stabilized. The RIP$_1$ and TRADD form a complex with NOXO1, and NOXO1 recruits Nox1 and Rac1 to form superoxide to produce the active complex. The RIP1 is an important factor in NOXO1 recruitment, and TRADD is important in complex activation by interacting with the SH3 domain of NOXO1. The presence of NOXA1 as a driving factor is predicted, but has not been demonstrated. The presence of p22 in the complex is unknown. Superoxide production was proposed to promote continuous activation of JNK, leading to cell necrosis.[13]

It is concluded that the injury due to the overextended denture causes cells to release the death receptors in the form of TNF-R1 receptors. The TNFα signals to bind to the TNFα trimer with the TNF-R1 receptor. This response then proceeds to various processes that then lead to the necrotic cell death.

REFERENCES

1. Langlais R, Miller C. Atlas berwarna: kelainan rongga mulut yang lazim. Jakarta: Hipokrates; 2007.p.40-2.
2. Jayasingha R. Impact of marginal contact of removable acrylic partial denture on periodontal parameters. Int J Res Med Health Sci 2013; 1(3): 1-11.
3. Applegete. Essensial of removable partial denture prosthesis. 2nd ed. Philadelphia: WB Saunders; 1960.p.40
4. Tanjong A. Pengaruh kosentrasi ekstrak kelopak bunga rosella (Hibiscus sabdariffal) terhadap koloni Candida albicans yang terdapat pada plat gigitiruan [Skripsi]. Makassar: FKG Unhas; 2011.
5. Bakar A. Kedokteran gigi klinis. Yogyakarta: Quantum Sinergis Media; 2012. hal.176,184.
6. Berutu MS. Pengaruh penggunaan gigitiruan penuh terhadap kualitas hidup manula di kota Makassar [Skripsi]. Makassar: FKG Unhas; 2014.hal.11-3
7. Soenartyo H. Denture stomatitis: penyebab dan pengelolaannya. Majalah Kedokteran Gigi 2000; 33:148-51
8. Regezi JA, Sciubba JJ, Jordan RCK. Oral pathology: Clinical pathologic correlations. 5th ed. New York: Elsevier; 2008.p.22-3.
9. Avery JK. Oral development and histology. 3rd ed. New York: Thieme; 2001.p.248-73.
10. Pareira BR, Tanaka OM, Lima AA, Maruo OG, Carmago ES. Metal and ceramic bracket effect on human bucal

DOI: 10.46934/ijp.v3i1.138

mucosa ephitelial cells. Angle Orthodont [serial online] 2009:373-9. Available from URL: http://www.angle.org/doi/pdf/10.2319/021 508-92.1
11. Kahn MA. Oral exfoliative cytology procedures: conventional brush biopsy and ThinPrep. J Tenn Dent Assoc [serial online] 2001; 81: 17-20. Available from: URL:http://www.unboundmedicine.com/evidence/ub/citation/11324194/Oral_exfoliative _cytology_procedures:_conventional_bru sh_biopsy_and_ThinPrep_
12. Arruda EP, Trevillato PC, Carmago ES, Woyceichoski IE, Machado AN, Vieira I, et al. Preclinical alterations of oral epithelial cells in contact with orthodontic appliances. Brazil [serial online] 2011: 299-303. Available from: URL:http://biomed.papers.upol.cz/getrevsrc.ph p?identification=public&mag=bio&raid= 172&type=fin&ver=2
13. Morgan MJ, Sun Kim Y, Gang Liu Z. TNFα and reactive oxygen species in necrotic cell death. Cell Res 2008; 18:343-9.

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Comparison of bone loss around implants using radiographs

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ABSTRACT
This article presents an original-research conducted at Pushpagiri College of Dental sciences, Thiruvalla, Kerala to compare and evaluate the vertical crestal bone changes around implants with different surface coatings and diameter using CBCT and RVG taken at the time of loading and one year after loading. Thirty-six samples were divided in 4 group; based on 3 parameters: implant surface coating, implant diameter, and single versus multiple implants supported bridges. Length of all implants is kept standardised at 10 mm. Data were statistically analyzed by Students paired t-test and comparison between CBCT and RVG is done using interclass correlation test. The mean crestal bone loss has increased statistically significant from the time of loading and after one year of loading. The average crestal bone loss on single implants were less compared to multiple implants supported bridges at both timings. CBCT shows more accurate and reliable values than RVG both clinically and statistically. It was concluded that crestal bone loss was less among single implants with calcium phosphate surface coating and wider diameter than alumina blasted and narrow diameter implants. Single implant shows less bone loss than multiple implants. The CBCT shows a reliable method of detecting circumferential peri-implant bone defects than RVG.
Keywords: dental implant, marginal bone loss, cone beam computed topography, radiovisiography, radiographic evaluation
This title has been presented in The 12th Biennial Congress of Asian Academy of Prosthodontics, 21 August 2021

INTRODUCTION

The use of endosseous implants to restore lost dentition has proved to be a successful treatment modality, providing the patient with near natural replacement.[1] The success rate obtained with dental implants depends to a great extent on the quality of osseointegration. Early identification of signs and symptoms of bone loss is, therefore essential to prevent implant loss.[2]

Evaluation by radiographs is considered as a source of information for determining the amount of cervical bone loss around dental implants.[3] According to established criteria for the assessment of implant survival and success by Albrektsson et al,[4] marginal bone level changes in the first year should be less than 1-1.5 mm and ongoing annual bone loss should be less than 0.2 mm. Bone loss usually begins from the crest region of an osseointegrated implant and progresses apically. Possible cause of crestal bone loss could be a local inflammation and mechanical stresses acting on the crestal bone around the implant crest module.[5] Anatomic factors such as the quality and architecture of bone tissue, as well as implant features, example: length, surface area, coating, implant timing and occlusal load influence alveolar bone crest resorption.[6,7]

Implant success or failure is largely dependent on the macroscopic and microscopic design of implant. Macroscopics design features include body design thread geometry. Microscopic design, includes implant materials, surface morphology and surface coating.

Several investigations have reported that the crestal bone loss can be minimized by increasing the contact area of bone to implant interface and therefore reducing stress at the cortical alveolar crest.[8] Studies have showed that there is marginal bone loss initially after loading of dental implant with prosthesis. But how much marginal bone loss will be there before loading of delayed loading implants with respect to different diameter, surface coating and number of implants needs further assessment. Keeping this in mind, a study was undertaken to assess marginal bone loss occurring 6 months after the implant placement, but before loading of dental implant with prosthesis.[9]

The aim of the study was to evaluate the vertical crestal bone changes of delayed loading implants using cone beam computed tomography (CBCT) and radiovisiography (RVG); specifically to evaluate the crestal bone loss between the surface coatings of single implant system at the time of loading and after one year of loading, to assess the crestal bone loss between different diameter of single implant system at the time of loading and after one year of the loading, to measure the vertical crestal bone loss between single and multiple im-

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plant supported bridges, and to assess the comparison of measurement between CBCT and RVG.

METHODS

This study was conducted at the Department of Prosthodontics, Pushpagiri College of Dental Sciences, Thiruvalla, after receiving approval from the Institutional Ethics Committee (IEC) and the Review Board, Pushpagiri Institute of Medical Sciences and Research Center and clearance obtained for the same (No.PCDS/IEC/K10/11/15).

The present invivo study was designed to be of the quasi-experimental type. The selection of cases was purely based on the patients desires for a radiographical analysis of crestal bone around the implants. A total of 36 samples with 9 samples in each group was collected for the study based on the values from previous studies for a confidence level of 95% and power of study as 80%. According to the selection criteria, 36 patients were selected for the study, who have placed implant in the mandibular posterior right or left region with a minimum period of 3 months of healing were selected. The patients were selected based on the criteria of age group between 20 and 60 years, non-smoker, no relevant medical history, good oral hygiene, healthy remaining dentition, and adequate ridge width and height to place implants, wheras the patients with poor oral hygiene, medically compromised severe bruxism, untreated periodontitis or periapical pathology, heavy smoking and alcoholics were excluded from the study. Informed consent was taken from every patient.

This study was divided into groups based on 3 parameters ie. implant surface coating, implant diameter as well as single and multiple implant-supported bridges. The length of the implant was standardized and kept at 10 mm.

Patients who met the inclusion criteria were divided into 4 groups. Group A comprised of patients with single implant (ADIN [Osseofix] 3.75×10 mm. calcium phosphate); Group B comprised of patients with single implant (ADIN [Toureg] 3.75×10 mm alumina blasted; Group C comprised of patients with single implant (ADIN 4.2×10 mm, calcium phosphate; Group D comprised of patients with multiple implant (ADIN 4.2×10 mm, calcium phosphate.

The comparison is taken between 1) two implants with different surface coating (ADIN [Osseofix] 3.75×10 mm) and ADIN (alumina blasted, 3.75×10 mm), Group A & Group B; 2) two implants with different diameter (ADIN [Osseofix] 3.75×10 mm) and ADIN [Osseofix] 4.2×10 mm), Group B & Group C; and 3) single implant versus implant supported bridge (ADIN [Osseofix] 3.75×10 mm and ADIN [Osseofix] Implant supported bridges, 4.2×10 mm, Group 1 & Group 4).

Thyroid collar, lead apron, ADIN surgical kit, RVG x-ray cover, RVG sensor holder, Toureg^{TM}-S implant (ADIN dental implant system, Alon Tavor, Israel) and Osseofix^{TM}-OS implant resorbable blast medium (RBM) (ADIN Dental implant systems, Alon Tavor) are materials used to carry out this study; and CBCT-CS9300 3D Manual (Carestream Dental Atlanta, GA) and RVG)-6200, Carestream Dental Atlanta, GA) are the equipments used in this study.

Both radiographic techniques were explained to the patients and case history was taken. Preoperative radiographs were also examined to find out the position and angulation of implant or presence of any cyst or pathology. The RVG was taken using sensor plate of thickness 7.3 mm of size 1 sensor model. The radiographs were taken perpendicular to the long axis of the implants with a long-cone parallel technique. The patient position was standardized with the upper arch parallel to the floor and midsagittal plane parallel to the floor. X-ray was operated at 60 kVp with minimum source to skin distance at about 100 mm.

The CBCT was taken with 90 voxel size, 84kv, 6.3 Ma with exposure time 20 sec and area 753 mGy.cm^2. The image was taken in accordance with ALARA principle. The CBCT and RVG were taken immediately after loading which were taken as baseline reference and also after 1 year.

Measuring bone loss in RVG marginal bone loss was performed as follows: the marginal height of each fixture is measured mesially and distally by using the fixture thread as an internal dimensional reference with the help of a millimetric grid. Marginal bone loss is measured by measuring the distance from the shoulder on the implant fixture to the most coronal point on the mesial and distal alveolar bone crest respectively. Two perpendicular lines were dropped on the mesial and distal aspect of the implants to the first bone-to implant contact. Comparative measurements of mesial and distal crestal bone levels adjacent to implants were made to the nearest 0.1 mm. A minimum of 3 readings were made on mesial and distal side for each case and average values were used to calculate the amount of crestal bone loss. The crestal bone loss measured using Carestream viewer software to the accuracy of 0.2 mm. CBCT measurement were taken on mesial, distal, buccal and lingual side same as that of RVG. The marginal bone loss was defined as the difference between true crestal bone levels

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at the baseline and after one of loading. So, calculated crestal bone change is *crestal bone change (at given time) = bone level at base line - bone level at that time.*
Two investigators, a radiologist and a dentist performed the radiographic analysis.

Statistical analysis

The data analysed and presented as mean and SD for the outcome variable at different time periods (at the time of loading and after 1 year of loading). Comparison of effect of two implant diameters, 3.75 mm and 4.2 mm, at different time periods were done using Student t-test. Similarly, the effect of different surface coating and single verses multiple were also compared using the same test. The correlation between CBCT and RVG was also calculated using interclass correlation test.

RESULTS

Table 1 and Table 2 depicts the mean crestal bone loss values of 4 different types of implants using RVG and CBCT respectively, whereas Fig.1 and Fig.2 are the graphical representation of comparison of the average crestal bone loss occurring around 4 different types of implants at the time of loading and after one year using RVG and CBCT, respectively.

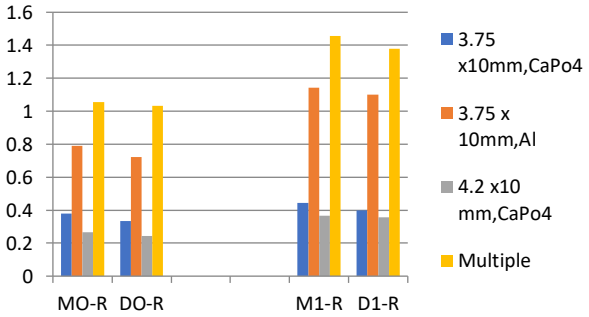
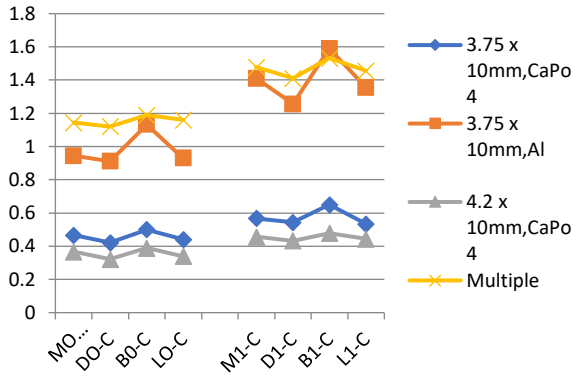


Figure 1 Graph representing crestal bone loss of 4 different types of implants using RVG

Both RVG and CBCT, reveals that in each group, there is an increase in crestal bone loss evaluated after 1 year of loading when compared to the time of loading. Calcium phosphate implants shows reduced bone loss at both intervals when compared to alumina blasted implants. Multiple-implant shows the highest range of crestal bone loss at both intervals. In each group, RVG shows more marginal bone loss in the mesial side of implant when compared to distal side of implant. Whereas CBCT reveals average crestal bone loss more in buccal side followed by mesial, lingual, and distal sides in all types of implants at the time of loading. Buccal side of multiple-implant shows less bone resorption when compared to alumina blasted implants after one year of loading. The average crestal bone loss of 3.75 and 4.2 implant is very much less when compared to multiple-implant supported and alumina blasted implant.



Graph 2 Graph representing crestal bone loss of 4 different types of implants using CBCT

Table 1 Mean crestal bone loss values of 4 different type of implants using RVG

Group	M_0-R Mean±SD	M_1-R Mean ± SD	D_0-R Mean ± SD	D_1-R Mean ± SD
1	0.378±0.13	0.444±0.13	0.333±0.150	0.40±0.130
2	0.789±0.10	1.140±0.17	0.722±0.190	1.10±0.273
3	0.260±0.15	0.367±0.20	0.244±0.113	0.35±0.123
4	1.050±0.36	1.456±0.23	1.030±0.260	1.37±0.150

Table 3 show the comparison of bone loss between different implant surface coatings Group 1 and Group 2 using RVG and CBCT. This data interprets that calcium phosphate implant has less bone loss compared to alumina blasted implants. The latter shows significant bone loss at the time of loading and after one year of loading. RVG shows marginal bone loss in mesial side more than distal side of both implants at two intervals. CBCT reveals average crestal bone loss maximum on buccal side followed by mesial, lingual, and distal side. Increase in bone loss seen at the end of one year when compared to the time of loading.

Table 4 shows the comparison of bone loss between Group 1 and Group 3 (different diameter).

Table 2 Mean crestal bone loss of 4 different type of implants using CBCT

Group	M_0-C Mean±SD	M_1-C Mean ± SD	D_0-C Mean ± SD	D_1-C Mean ± SD	B0-C Mean±SD	B1-C Mean±SD	L0-C Mean±SD	L1-C Mean±SD
1	0.467±0.07	0.567±0.08	0.422±0.13	0.544±0.11	0.489±0.07	0.650±0.51	0.440±0.09	0.533±0.07
2	0.944±0.20	1.411±0.17	0.911±0.15	1.256±0.25	1.133±0.17	1.589±0.11	0.930±0.29	1.355±0.12
3	0.367±0.11	0.456±0.08	0.322±0.13	0.433±0.08	0.389±0.10	0.478±0.09	0.340±0.13	0.444±0.08
4	1.144±0.28	1.478±0.21	1.120±0.23	1.411±0.11	1.189±0.24	1.533±0.08	1.160±0.17	1.456±0.11

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Table 3 Comparison of bone loss between Group 1 and Group 2 (implant surface coating)

Type of radiograph	Surfaces	Group	N	Mean	Standard deviation	t	df	P value
RVG	Distal	1	9	-.111	.220	2.819	16	.012
		2		-.377	.178	2.819	15.34	.013
	Mesial	1	9	-.066	.150	3.68	16	.002
		2		-.355	.181	3.68	15.46	.002
CBCT	Distal	1	9	-.122	.044	2.99	16	.009
		2		-.344	.218	2.99	8.65	.016
	Mesial	1	9	-.100	.100	5.88	16	.000
		2		-.466	.158	5.88	13.51	.000
	Buccal	1	9	-.022	.044	8.72	16	.000
		2		-.455	.142	8.72	9.52	.000
	Lingual	1	9	-.055	.101	4.95	16	.000
		2		-.444	.212	4.95	11.45	.000

Table 4 Comparison of bone loss between Group 1 and Group 3 (implant diameter)

Type of radiograph	Surfaces	Group	N	Mean	Standard deviation	t	df	P value
RVG	Distal	1	9	-.111	.220	.231	16	1.00
		3		-.111	.105	.345	11.47	1.00
	Mesial	1	9	-.006	.150	.485	16	.634
		3		-.100	.141	.485	15.94	.634
CBCT	Distal	1	9	-.122	.044	.447	16	.661
		3		-.111	.060	.263	14.67	.661
	Mesial	1	9	-.100	.100	.263	16	.796
		3		-.088	.078	.268	15.11	.796
	Buccal	1	9	-.022	.044	2.68	16	.016
		3		-.088	.060	2.68	14.67	.017
	Lingual	1	9	-.055	.101	1.07	16	.297
		3		-.100	.070	1.07	14.29	.299

Table 5 Comparison of bone loss between Group 1 and Group 4 (single versus multiple)

Type of radiograph	Surfaces	Group	N	Mean	Standard deviation	t	df	P value
RVG	Distal	1	9	-.111	.220	2.38	16	.030
		4		-.344	.194	2.38	15.75	.030
	Mesial	1	9	-.066	.150	4.26	16	.001
		4		-.400	.180	4.26	15.48	.001
CBCT	Distal	1	9	-.122	.044	2.98	16	.009
		4		-.288	.161	2.98	9.18	.015
	Mesial	1	9	-.100	.100	3.50	16	.003
		4		-.333	.173	3.50	12.80	.004
	Buccal	1	9	-.022	.044	4.33	16	.001
		4		-.344	.218	4.33	8.65	.002
	Lingual	1	9	-.055	.101	4.21	16	.001
		4		-.300	.141	4.21	14.50	.001

It was found out that larger diameter (4.2×10 mm) shows less marginal bone loss when compared to 3.75×10 mm implant.

Table 5 shows the comparison of bone loss between single versus multiple (Group 1 and Group 4). It is evident from the measurements that in both RVG and CBCT multiple implants has a highly significant amount of bone loss when compared to single implants.

Table 6 shows the comparison between CBCT and RVG. It is observed that CBCT values are higher than RVG values. The average bone loss values occurring after one year is greater than values obtained at the time of loading. CBCT shows more accurate and reliable values than RVG both clinically and statistically.

Table 6 Comparison between CBCT and RVG

Sides at different time	Type-1	Type-2	Type difference	p-value
M_0	0.622	0.730	0.108	0.207
M_1	0.852	0.977	0.125	0.163
D_O	0.583	0.694	0.111	0.169
D_1	0.808	0.911	0.103	0.189

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DISCUSSION

Endosteal implant is effective and appropriate for replacing single teeth, as well as for rehabilitating edentulous arches. The long-term preservation of crestal bone height around osseointegrated implants is often used as a primary success criterion for different implant systems. Radiographic evaluation of bone is a very important and viable means of detecting health and stability of bone around the peri-implant hard tissue. A decrease of crestal bone level indicates that the implant is loosening its bony anchorage.

The aim of this study is to examine the effect of several variables on marginal bone loss around implant supporting fixed restorations. Inspite of lack of consensus on what factors affect marginal bone loss, the generally accepted guidelines for implant induced bone loss is same as described by Alberktsson in 1986 that the success criteria for implant include average bone loss should be less than 1.5 mm in the first year of service, and thereafter less than 0.2 mm annually.[4] Jung, et al in his studies reported that more than 50% of the total bone loss recorded in 12 months period occurred during the first three months. The rapid initial bone loss might be the result of periosteal elevation, surgical trauma, the preparation of the recipient bed and stress concentration from excessive tightening of the implant.[10] Roccuzzo et al in his study described that the mean marginal bone loss of 0.65 mm for implants after 6 weeks loading and 0.77 mm after 12 weeks loading was observed when comparing 68 implants subjected to initial loading by the common technique.[11]

Various causes of greater crestal bone loss in the 1st year of implant function are surgical trauma, occlusal overload, peri-implantitis, presence of microgap, reformation of biologic width and implant crest module design. It has been documented that, subtle changes in shape, length, width and number of endosseous implants can influence success rate.[5]

Various imaging radiographs are available for the evaluation of the recipient site, such as IOPA radiographs, panoramic radiograph, CBCT, oblique cephalometric radiographs, digital subtraction radiography. Radiographs are helpful in assessing stress concentration around implants, thereby obviating excessive alveolar bone loss.[12] For this study CBCT and digital-RVG had been used for assessing crestal bone loss and then compared the values between both of them. The RVG was taken using long cone paralleling technique with the help of radiographic film holders (Rinn XCP; Densply) to minimize distortion and errors. Both RVG and CBCT was taken at the time of loading and after one year of loading. This invivo study was undertaken to compare the crestal bone loss occurring along the implants of different diameters, surface coating, and single versus multiple implants and also to find out the difference between values of both CBCT and RVG.

Implant surface treatment

The surface texture plays a very important role in osseointegration process. The composite effect of surface energy, composition, roughness, and topography influences the biological response of the local tissue in terms of protein adsorption and cellular adherence.

Calcium phosphate surface coated implants that were used in this study, is a resorbable blast media which does not involve acid-etching, once the surface was coated with the active layer and the inventors claim the ill-effects of acid etching such as boundary degradation as a surface that is 100% free of acid residues is formed.

Rajpal in his study has suggested that rough surface implants show less bone loss when compared to smooth surface implants.[13] Jimbo et al in 2013 did a study to evaluate the early integration of 5 commercially available implants and found that in all five groups the trabecular regions were characterized by woven bone formation which was in close contact with the implant surface.[14] All the above study shows similar results as of our study. The possible reason of calcium phosphate showing less resorption might be due to the fact that the surface roughness and micropores on the Group 1 implant will help to convert part of the shear force component into compressive and tensile component. The adjacent crestal bone osseointegrates into the micropores, elevations and depressions of the rough surface of implant.

From the results obtained in our study, it can be observed that, overall average crestal bone loss of Group 1 at the time of loading using RVG was 0.35 mm and average crestal bone loss of Group 2 was 0.755 mm. The overall average crestal bone loss of Group 1 at the time of loading using CBCT was 0.454 mm and average crestal bone loss of Group 2 was 0.979 mm. Difference of bone loss with both types of implants using different radiographs at this stage was statistically significant. Surgical trauma and lack of positive stimulation due to occlusal forces may have caused this observed bone loss and these observations are commensurate with other studies.[15]

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After twelve months of loading the implants ie. one year of implant service, average annual crestal bone loss with Group 1 implants using RVG was 0.422 mm and with Group 2 implants was 1.122 mm. The difference in crestal bone loss between Group 1 and 2 was statistically significant on the mesial, distal, and lingual side of the implants. On the buccal side, the difference was not statistically significant, though average bone loss was more on the buccal side as compared to other three sides. The reason for greater bone loss on buccal side could be that the buccal plate is more dense and compact as compared to the interdental bone or the lingual plate, hence has comparatively less vascularization and healing potential. Average crestal bone loss was maximum on the buccal side of implants, followed mesial, lingual and distal sides. Using CBCT, the crestal bone loss was 0.574 mm in Group 1 and 1.402 mm in Group 2. Both these figures are below 1.5 mm of annual bone loss in the first year of implant service and fulfil the success criteria as described by Albertsson.[4]

Implant diameter

In the present study, the crestal bone loss in relation to the size of the dental implant was evaluated using CBCT and RVG. All implants were placed at the same level of the crestal bone and have the same length but different diameter. Group 1 with diameter of 3.75×10 mm and Group 3 with diameter of 4.2×10 mm was used. Taking the size of implant into consideration, the mean crestal bone around Group 1 at the time of loading using RVG was 0.355 mm and after one year was 0.462 mm. The overall average bone loss of Group 3 using RVG at the time of loading was 0.255 mm and after one year was 0.452 mm. Group 1 with 3.75×10 mm diameter implant has the highest bone loss at the end of the first year in comparison to 4.2 mm implants. This pattern of bone crestal bone loss was maintained at the end of one year of evaluation. The difference in the crestal bone level at the time of loading and after one year between different implant diameters were not statistically significant. Mesial side shows more bone loss than distal side at both time intervals.

Bone loss measured using CBCT at the time of loading in Group 1 was 0.454 mm and in Group 3 was 0.255 mm. After 12 months values in Group 2 was 0.574 mm and in Group 3 was 0.361 mm. The p-values for both mesial and distal aspects of implants were found to be non-significant ($p<0.05$ is highly statistically significant). Thus, in this study, the bone loss was found to be non-significant for both 3.75 mm and 4.2 mm diameter implants on both mesial, distal, buccal and lingual aspects of implants. Ding has reported that increasing the diameter and length of the implant decreased the stress and strain on the alveolar crest and the diameter had a more significant effect than length to relieve the crestal stress and strain concentration.[16] There are many studies which supports the result of our study.[17-19]

Single implant versus multiple implant

When two or more consecutive posterior teeth are missing, each tooth has to be separatively restored by single tooth implant. Splinting multiple implants to replace the consecutive teeth has been thought to help in distribution of functional loads and therefore reduce marginal bone loss.[17] However, single-tooth implant restoration has shown predictable long term results.[20,21] In addition, separate single-tooth implants are advantageous in aesthetic and passive framework fit while splinted implants effectively distribute functional loads.[22,23]

In our study, we compared and evaluated the marginal bone changes between functionally loaded single and multiple implants in the posterior jaws for up to 1 year. Overall crestal bone loss around single implant using RVG at the time of loading was 0.355 mm and after one year was 0.422 mm. The mean crestal bone loss around multiple-implant using RVG at the time of loading was 1.044 mm and after one year of loading was 1.417 mm. it is observed that multiple-implant shows statistically significant bone loss at both intervals. The CBCT values of Group 1 was 0.454 mm at the time of loading and after one year was 0.574 mm whereas Group 4 shows 1.153 mm at the time of loading and 1.467 mm after one year of loading. The CBCT values also shows statistically significant bone loss in single implants when compared to multiple implants. Kwon, et al in his study stated that separate single-tooth implant restorations to replace consecutive missing teeth may clinically function well in the posterior.[24] This study also is in accordance with our results.

Radiographs

Periapical radiography represents a generally accepted method to assess the long term evaluation of interproximal crestal bone changes of osseointegrated implants; however, the sensitivity for detecting small changes in bone level is low.[25] A major limitation of periapical radiographs is that only two dimensional-images can be obtained and superimposed bone structures in the interproximal areas

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are visualized. These limitations can be resolved with three-dimensional scanning techniques such as CBCT; which can improve the detection of anatomical sturctures and have the capacity to assess bone quality in greater detail.[26] A possible drawback of 3D scannings is the higher radiation dose received by the patient compared with the 2D-imaging-techniques.[27]

In our study, the values obtained from CBCT shows higher value when compared to RVG. However, the values were not statistically significant. The overall crestal bone loss using RVG on mesial side at the time of loading and after one year was 0.622±0.38 mm and 0.85±0.50 mm respectively and on distal side was 0.58±0.36 mm and 0.80± 0.48 mm, respectively. The overall mean crestal bone loss using CBCT on mesial side at the time of loading and after one year was 0.730±3.7 mm and 0.977±0.49 mm respectively and on distal side was 0.694±0.11 mm and 0.911±0.10 mm respectively. The p-values for both mesial and distal aspects of implants were found to be non-significant ($p<0.05$) is highly statistically significant. The result of this study is in accordance with study conducted by Adell et al who determined that the mean bone loss for Branemark osseointegrated implants was 1.5 mm for the 1st year.[28]

The sample size of the study is limited. The reliability of radiographic methods for the assessment of marginal bone level around oral implants is influenced by technical factors such as X-ray beam angulations, strict parallelism between implant and the sensor plane and also the thickness of ridge into which implants are placed. Grouping based on occlusion can also be done as marginal bone changes can occur due to occlusal loading patterns and traumatic occlusion.

Further studies can be conducted using a larger population. A longer follow up is recommended to substantiate the data presented in the study. Bone loss occurring in complicated situations such as implant supported full mouth rehabilitation can be investigated. The amount of bone loss occurring in cases where graft have been placed can also be taken as one parameter. To evaluate the intra-surgical versus the radiographic level assessments in measuring peri-implant bone loss.

Within the limitation of this study, it can be concluded that different implant parameters like diameter, surface coating and number of implants has a definite role in the peri-implant bone level around implants. Also, CBCT helps to accurately detect the bone level changes in each follow-up visits and thereby helps the patient to take corrective measurements on the right time and thus prevent failure of implants.

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REFERENCES

1. Ramakrishna R, Nayar S. Clinical assessment of primary stability of endosseous implants placed in the incisor region, using resonance frequency analysis methodology: an in-vivo study. Indian J Dent Res Publ Indian Soc Dent Res 2007;18(4):168-72.
2. Chung DM, Oh T-J, Lee J, Misch CE, Wang H-L. Factors affecting late implant bone loss: a retrospective analysis. Int J Oral Maxillofac Implants 2007;22(1):117-26.
3. Verhoeven JW, Cune MS, de Putter C. Reliability of some clinical parameters of evaluation in implant dentistry. J Oral Rehabil 2000; 27(3):211-6.
4. Albrektsson A. The longterm efficacy of currently used dental implants: A review and proposed criteria of success. Int J Oral Maxillofac Implants [Internet]. [cited 2017 Nov 8];1986(1):11-25.
5. Oh TJ, Misch CE, Lau K. The causes of early implant bone loss: Myth or Science? 2002; 73: 322.
6. Leonardo MR, Borges ATN, Martins-Junior W, de Queiroz AM, Assed S. Vertical alveolar crest bone maintenance around implants in two-stage surgery: an in-situ study in dogs. Braz Dent J 2008;19(2):103-8.
7. van Steenberghe D, Naert I, Jacobs R, Quirynen M. Influence of inflammatory reactions vs occlusal loading on peri-implant marginal bone level. Adv Dent Res [internet].1999 [cited 2017 Nov 20];13(1):130-5.
8. Himmlova L, Dostalova T, Kacovsky A, Konvickova S. Influence of implant length and diameter on stress distribution: a finite element analysis. J Prosthet Dent 2004;91(1):20-5.
9. Vikhe DM, Tambe SD, Mascarenhas R, Bawane S, Jadhav R, Kathariya R. Assessment of crestal bone loss surrounding the implant before prosthetic loading of dental implant systems: A pilot study. J Int Oral Health 2016; 8(12):1110-3.
10. Jung YC, Han CH, Lee KW. A 1-year radiographic evaluation of marginal bone around dental implants. Int J Oral Maxillofac Implants1996;11(6):811-8.
11. Roccuzzo M, Bunino M, Prioglio F, Bianchi SD. Early loading of sandblasted and acid-etched (SLA) implants: a prospective split-mouth comparative study. Clin Oral Implants Res 2001;12(6):572-8.

DOI: 10.46934/ijp.v3i1.139

12. Misch CE. Implant success or failure: Clinical assessment in implant dentistry. In: Contemp Implant Dent. St. Louis: Mosby; 1993. p.33-66.
13. Rajpal J, Srivastava A, Tandon P, Chandra C, Gupta K. Assessment of hard and soft tissue changes around implants: A clinic-radiographic in-vivo study. J Dent Implants [Internet].2014[cited 2017 Nov 20];4(2):126.
14. Jimbo R, Ancheita R, Baldassarri M, Granato R, Marin C, Teixaira HS, et al. Histomorphometry and bone mechanical property evolution around different implant systems at early healing stages: an experimental study in dogs. Implant Dent 2013;22(6):596-603.
15. Singh P, Garge HG, Parmar VS, Viswambaran M, Goswami MM. Evaluation of implant stability and crestal bone loss around the implant prior to prosthetic loading: A six-month study. J Indian Prosthodont Soc 2006:6(1):33.
16. Ding X, Liao SH, Zhu XH, Zhang XH, Zhang L. Effect of diameter and length on stress distribution of the alveolar crest around immediate loading implants. Clin Implant Dent Relat Res 2009;11(4):279-87.
17. Strong JT, Misch CE, Bidez MW, Nalluri P. Functional surface area: thread-form parameter optimization for implant body design. Compend Contin Educ Dent 1998;19(3):4-9.
18. Scurria MS, Shugars DA, Hayden WJ, Felton DA. General dentist patterns of restoring: endodontically treated teeth. J Am Dent Assoc 1995;126(6):775-9.
19. Ghahroudi AR, Talaeppour AR, Mesgarzadeh A, Rokn A, Khorsand A, Mesgarzadeh N, et al. Radiographic vertical bone loss evaluation around dental implants following one year of functional loading. J Dent Tehran Univ Med Sci [Internet].2010 [cited 2017 Nov 9]:7(2):89-97.
20. Norton MR. Biologic and mechanical stability of single-tooth implants: 4-7 years follow -up. Clin Implant Dent Relat Res 2001;3(4):214-20.
21. Norton MR. Multiple single-tooth implant restorations in the posterior jaws: maintenance of marginal bone levels with reference to the implant abutment microgap. Int J Oral Maxillofac Implants 2006;21(5).
22. Gotfredsen K. A 5-year prospective study of single tooth replacements supported by the Astra Tech implant: A pilot study. Clin Implant Dent Relat Res 2004;6(1):1-8.
23. Guichet DL, Yoshinobu D, Caputo AA. Effect of splinting and interproximal contact tightness on load transfer by implant restorations. J Prosthet Dent 2002;87(5):528-35.
24. Kwon MJ, Yeo IS, Kim YK, Yi YJ, Yang JH. Use of separate single tooth implant restorations to replace two or more consecutive posterior teeth: a prospective cohort study for up to 1 year. J Adv Prosthodont 2010;2(2):54-7
25. Yepes JF, Al-Sabbagh M. Use of cone-beam computed tomography in early detection of implant failure. Dent Clin [Internet]. 2015 [cited 2017 Nov16];59(1):41-56.
26. Akdeniz BG, Oksan T, Kovanlikaya I, Genc I. Evaluation of bone height and bone density by computed tomography and panoramic radiography for implant recipient sites. J Oral Implantol 2000;26(2):114-9.
27. Raes F, Cosyn J, Crommelinck E, Coessens P, de Bruyn H. Immediate and conventional single implant treatment in the anterior maxilla: 1-year results of a case series on hard and soft tissue response and esthetics. J Clin Periodontol 2011;38(4):385-94.
28. Adell R, Lekholm U, Rockler B, Branemark PI. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. Int J Oral Surg 1981:10(6):387-416.

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Effect of alginate impression disinfection with sodium hypochlorite and castor oil on *Candida albicans* counts and dimensional stability of the study model

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ABSTRACT
Alginate is the most common used impression material because it is easy to use, affordable, and well accepted by patients. When impression is performed, alginate would be in contacting with the surface of the oral cavity and Saliva. It caused the microflora, like *Candida albicans* would adhere to the surface so that it can cause cross-infection. Cross-infection prevention could be done by disinfecting the impression material before filling with gypsum. The main thing of choosing a disinfectant is that the disinfectant material could eliminate microorganisms and affect the dimensional stability of impression material. This study aimed to determine the effect of alginate impression disinfection with sodium hypochlorite and castor oil (*Ricinus communis oil*) on the *C.albicans* counts and the dimensional stability of the study model. The sample of *C.albicans* was counted by colony counter and the dimensional stability tested by digital caliper. This study showed that alginate impression desinfection with castor oil had almost the same effectiveness as sodium hypochlorite in reducing the *C.albicans* counts, but the dimension was changed even though the value of the dimensional changes is still within the tolerance limit.
Keywords: alginate, sodium hypochlorite, castor oil, *Candida albicans*, dimensional stability

INTRODUCTION

Dental Impression is the stage of making the negative imprint of the oral cavity tissue obtained from the impression material using an impression tray or custom impression tray into the oral cavity until the impression material is setting, then the impression was made into a study model or working model. Alginate is the most common used material because it is easy to use, affordable, and well accepted by patients.[2] One study found that 67% of the materials dentists sent to the dental laboratory were contaminated with *Streptococci, Staphylococci, P.aeruginosa, methicillin-resistant S.aureus* (MRSA), and *Candida* spp. *Candida albicans* are normal microflora in the oral cavity, which is 45% in neonates, 45-65% in healthy children and 39-45% in healthy adults, 50-65% in removable denture wearers, 90% in chemotherapy patients, and 95% in HIV patients. *C.albicans* could be pathogenic and causes opportunistic infection if there were predisposing factors such as low salivary pH and low salivary flow, tooth loss, poor oral hygiene, weakened immune system and systemic diseases. *C.albicans* count in the oral cavity will increase if there is one of these predisposing factors. This allowed cross-infection from patients, tools, and impression materials to dentists and dental technicians in the dental laboratory, thus preventing infection transmission and reducing cross-contamination before the impressions are sent to the laboratory, infection control must be carried out by disinfecting the impression before filling it with dental stones.[3-7]

There are two types of impression disinfection, such as immersion and spraying. Saber claimed that impression disinfection by immersion showed the same antimicrobial activity with the spraying technique.[8] Alginate impression should not be soaked for too long in disinfectant liquid because the impression quality would decrease due to water absorption. The sprayed alginate impression had smaller dimensional changes compared to the immers because less liquid was absorbed. The dimensional stability of the alginate impression is a critical aspect to the success of making accurate impression. Therefore, the spraying was the most effective technique to reduce imbibition that could affect the dimensional stability of the impression. Before disinfecting, the impression material was rinsed under running water to clean the debris and saliva attached. Thereafter, the impression was sprayed with 3 mL of disinfectant solution for 30 seconds at a distance of ± 5 cm and the impression was inserted into a sterile plastic clip bag for 10 minutes. According to the American National Standards Institute/American Dental Association (ANSI/ADA) specification No.18 changes in dimensions that occur in impression material less than 0,5%.[9]

Chemical disinfections were recommended by ADA guidelines because they are virusids, bactericids, and sporosids. Disinfecting materials that

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were often used to disinfect impression material were divided into two types, namely non-traditional and traditional chemicals.[10] Sodium hypochlorite is a commonly used, has prices that are not too expensive and show good bactericidal and fungicide properties compared to other chemical disinfectants.[11] Sodium hypochlorite also has disadvantages, such as the compound irritating mucous membranes, unpleasant odor, and a corrosive effect on metals. Therefore, it was necessary to search alternative natural materials with non-toxic disinfectant properties to prevent cross-infection.[12] One of the natural products that is commonly being studied in medicine is castor oil. It is relatively safe, biocompatible in periapical tissue, antimicrobial, bactericides, fungicides, and anti-inflammatory.[13]

This study was aimed to analyze the effect of alginate impression disinfection with 0.5% sodium hypochlorite and 10% castor oil on *C.albicans* count and dimensional stability of the study model.

METHODS

The research sample for calculating *C.albicans* counts used alginate impression obtained from the impression to the master model, while the sample for measuring dimensional stability in the study was a study model made by the type III plaster obtained from the results of pouring the maxillary master model. The model was prepared with a round bur on the mesioincisal of right central incisive, cusp of mesiopalatal of left first molar, and cusp of mesiopalatal of right first molar which was used as anteroposterior (AP) line and cross arch (CA) line.

Preparation of alginate samples

In the manufacturing of alginate impression samples, the master model was first disinfected by spraying 70% alcohol to avoid contamination with other microorganisms. Alginate impression material with a ratio of powder and liquid according to the manufacturer's instructions was put into a rubber bowl and stirred with a spatula until homogeneous. Alginate impression material that has been homogeneous is inserted into the appropriate tray and then impressed on the master model. After setting, then the tray is removed from the master model.

Procedure for making castor oil 10%

Prepare a 10 mL of castor oil solution and dissolve it into 100 mL of aquadest by adding 0,5 mL of Tween 80 solvent. The solution is stirred until homogeneous, then filtered with paper filter.

Candida albicans counts

The samples were divided into 3 groups; they are A1 (aquadest), A2 (0.5%sodium hypochlorite, and A3 (10% castor oil). The impressions were stored in a plastic bag for 10 minutes, swabbed using a cotton swab and transferred to a test tube containing phosphate-buffered saline. The test tubes were vibrated using a vortex for 30 seconds so that *Candida* attached to the cotton swab could be released. Using a micropipette, 100 µL of phosphate buffer saline containing the *C.albicans* was transferred to a petri dish. Pour the thawed Sabouraud dextrose agar into a petri dish and then gently shake it over a flat surface and leave it until hardens. The petri dish was put into the incubator for 24 hours at 37°C. *C.albicans* counts was carried out after 24 hours being removed from the incubator, using a colony counter.

Dimensional stability (DS) measurement

In measuring dimensional stability, the contaminated alginate impression was rinsed with running water for 15 seconds. The samples were divided into 3 groups, namely group B1 (aquadest), group B2 (sodium hypochlorite 0,5%), group B3 (castor oil 10%). The alginate impressions were sprayed with 3 mL of disinfectant solution for 30 seconds at a distance 5 cm. Each impression was inserted into a sterile plastic clip bag for 10 minutes. The alginate impression was filled using a type-III dental stone on top of the vibrator and waited until the cast setting for about 45-60 minutes and then removed. The measurements were carried out by measuring the distance from the mesioincisal right central incisor to the mesiopalatal cusp of the maxillary left first molar (AP line) and measuring the distance between the mesial cusp of the palatal right first molar to the mesial cusp of the palatal left of the left first molar maxillary (CA line) using a digital caliper. The percentage of the dimensional changing obtains by using the formula

$$\mathrm{DS} = \frac{\text{Master model} - \text{gypsum model}}{\text{Master model}}\ x\ 100\%$$

RESULT

After the univariate analysis, *C.albicans* counts in alginate impression after disinfection was known group A1, the smallest value was 18 CFU/mL, the largest was 43 CFU/mL, and the mean value was 27.70±8.02. In group B1 the smallest value was 0 CFU/mL, the largest value was 1 CFU/mL, and the mean value was 0.20±0.42. In group C1 the smallest value was 0 CFU/mL, the largest was 3 CFU/mL, and the mean value was 1.00±0.81 (Table 1).

The dimensional stability value of the study model in group A2 viewed from the AP line the smallest value was 0.084% and the largest was 0.225%,

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Table 1 *C.albican* counts in alginate impression after disinfection with sodium 0.5% hypochlorite and 10% castor oil

Sample	*C.albicans* counts (CFU/mL)		
	Aquadest (Group A1)	Sodium Hypochlorite (Group B1)	Castor oil (Group C1)
1	19	1**	1*
2	25	0*	3**
3	35	1	1
4	27	0	0
5	18*	0	0
6	22	0	1
7	24	0	1
8	36	0	1
9	28	0	1
10	43**	0	1
$\bar{X}$± SD	27.70 ± 8.02	0.20 ± 0.42	1.00 ± 0.81

Table 2 The dimensional stability value of the study model after disinfection with sodium hypochlorite 0,5% and castor oil 10% viewed from AP dan CA line

Sample	The dimensional stability value of the study model (%)					
	Aquadest (Group A2)		Sodium Hypochlorite (Group B2)		Castro oil (Group C2)	
	AP	CA	AP	CA	AP	CA
1	0.084*	0.115	0.169*	0.231	0.112*	0.202*
2	0.140	0.086	0.309	0.289	0.169	0.231
3	0.112	0.057*	0.252	0.202*	0.281	0.289
4	0.169	0.115	0.366	0.376	0.366	0.202
5	0.197	0.144	0.479**	0.550**	0.309	0.347
6	0.112	0.086	0.422	0.434	0.422	0.492**
7	0.225**	0.057	0.281	0.463	0.253	0.405
8	0.197	0.115	0.338	0.347	0.281	0.463
9	0.140	0.202**	0.450	0.289	0.450**	0.318
10	0.169	0.173	0.253	0.318	0.338	0.347
$\bar{X}$± SD	0.154 ± 0.044	0.115 ± 0.047	0.332 ± 0.098	0.349 ± 0.108	0.298 ± 0.104	0.329 ± 0.102

and the mean value was 0.154%±0.044, viewed from the CA line the smallest value was 0.057% and the largest was 0.202% with the mean value was 0.115%±0.047. In group B2 viewed from the AP line the smallest value was 0.169% and the largest was 0.479% with the mean value was 0.332% ±0.098; viewed from the CA line the smallest value was 0.202% and the largest was 0.550% with the mean value was 0.349%±0.108. In group C2, viewed from the AP line the smallest value was 0.112% and the largest was 0.450% with the mean value was 0.298%±0.104; viewed from the CA line the smallest value was 0.202% and the largest was 0.492% with the mean values was 0.329%±0.102 (Table 2).

The normality test was carried out on *C.albicans* counts using Shapiro-Wilk test and an abnormal distribution was known; so to determine the effect of disinfection of alginate impression with group A1, group B1, group C1 on *C.albicans* counts was tested statistically with the Kruskal-Wallis test. That found a significance level 0.0001 (p <0.05). It indicates that there was an effect of disinfection of alginate impression disinfection with group A1, group B1, group C1 on *C.albicans* counts (Table 3).

Table 3 Effect of alginate impression disinfection with 0.5% sodium hypochlorite and 10% castor oil on *C.albicans* counts

Group	N	*C.albicans* Counts $\bar{X}$± SD	p
A1	10	27.70±8.02	
B1	10	0.20±0.42	0.0001*
C1	10	1.00±0.81	

The result of normality test of dimensional stability value using the Shapiro-Wilk test was an abnormal distribution so that to determine the effect of alginate impression disinfection with group A2, group B2, group C2 on study models dimensional stability, the study models were tested statistically with the one-way Anova test. The results of the statistical test from the AP line obtained a significant level of p = 0,0001 (p <0,05) and from the CA line obtained a significant level of p = 0.0001 (p<0.05). It indicates that there was an effect of disinfection of alginate impression with group A2, group B2, group C2 on dimensional stability value (Table 4).

DISCUSSION

C.albicans counts in groups A1, B1, C1 had different variations. The difference in *C.albicans*

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Table 4 Effect of alginate impression disinfection with 0.5% sodium hypochlorite and 10% castor oil on dimensional stability value of the study model

		The dimensional stability value (%)		
Group	Line	n	$\bar{X}$± SD	p
A2		10	0.154±0.044	
B2	AP	10	0.332±0.098	0.0001*
C2		10	0.298±0.104	
A2		10	0.115±0.047	
B2	CA	10	0.349±0.108	0.0001*
C2		10	0.329±0.102	

counts were caused by effectiveness differences of disinfection between aquadest, 0.5% sodium hypochlorite, and 10% castor oil. Group A1 showed the highest *C.albicans* counts compared to other groups because the aquadest does not contain any disinfectants, so *C.albicans* was still attached to the alginate impression. It showed that washing the alginate impression under running water could only reduce the number of microorganisms attached to the impression by 40-90%.[14] Therefore, the ADA said impression materials been washed under running water should be disinfected before pouring to prevent cross-infection to operators and dental laboratories.[12] Group B1 showed the least amount of *C.albicans* where the chlorine content in the released sodium hypochlorite adhered to the cell cytoplasm which could destroy important *C.albicans* proteins.[15]

The results of this study are in accordance with Ahirwar's research which shows that the amount of microorganisms in alginate impression is less after disinfection with sodium hypochlorite compared to aquadest.[16] Group C1 also showed a lower amount of *C.albicans* than group A1 where the sodium ricinoleate component in castor oil correlated with a decrease in acid production, thereby inhibiting the formation of biofilms.[17,18] The results of this study are in accordance with the research of Hanoem; disinfection of alginate impression with 50% neem oil showed a smaller amount of microorganism colonies compared to aquadest.[19] The results of this study are in accordance with Basofi's research that disinfection of alginate impression with galangal rhizome decoction showed fewer bacterial colonies than aquadest.[20] The results of this study are also in accordance with the Trivedi research that disinfection of alginate impression with aloe vera showed a lower amount of *C.albicans* compared to aquadest.[21]

Values of DS were varied in each sample in one group; they might be due to the simple measuring tools used such as digital calipers which allow scratches on the distance between lines to be measured in the study model so it can cause inaccurate measurements by the operator. In addition, the compressed stress was not matched by the strain when releasing the spoon from the master model which was not fast enough, so that the stress received would be greater than the strain, this could cause permanent deformation.[22] Another possibility that could affect dimensional stability was air humidity. Accordance Arini, et al alginate impression stored in plastic would expand due to high humidity.[23] Based on ADA specification No.18, the dimensional stability value of the study model in the three groups (A2, B2, and C2) was still within tolerable limits (<0.5%). Group A2, the mean value of dimensional stability was smaller than the other groups because in the control group, the alginate impression was only sprayed with aquadest, so that the dimensional stability did not change too much. Group B2 showed an average value of dimensional stability that is greater than group C2 where sodium hypochlorite when reacted with water would decompose slowly, which would release chlorine, oxygen and sodium hydroxide causing an oxidation process. Oxygen was a strong oxidizing agent that could cause pressure fluctuations in the solution. During the disinfection process, the sodium hypochlorite solution was in contact with the alginate impression material, the imbibition nature of the alginate which absorbed water and the pressure on the absorbed solution causes the alginate impression to expand and the dimensional stability of the study model can change.[24]

Group C2 shows a smaller mean value of dimensional stability than group B2, this might be due to the presence of phenol in castor oil which when in contact with alginate impression material would cause an esterification reaction that produces esters, such as the reaction of ester formation by bonding with carboxylic acids which form an ester contained in the chemical structure of the alginate impression material. The esterification reaction would produce esters and H_2O, while alginate had properties that were easy to imbibe causing the increase of the disinfectant solution absorption and affecting the dimensional stability of the study model.[9,24,25]

Group B1 showed the greatest decrease in the amount of *C.albicans* caused by the disinfectant effect of sodium hypochlorite where the chlorine content of the released sodium hypochlorite adheres to the cell cytoplasm which could destroy important *C.albicans* proteins. The results of this study were in accordance with the research of Bustos, et al in their research explaining that 0.5% so-

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dium hypochlorite could reduce the amount of bacteria including *C.albicans* in alginate impression.[26] The results of this study were also in accordance with research by Badrian, et al which showed a reduction in the amount of *C.albicans* in alginate impression after being sprayed using 0.525% sodium hypochlorite solution bacterial colonies on alginate impression after spraying with 0.5% sodium hypochlorite.[27] The results of this study are in accordance with Ahirwar's research that there was a reduction in the number bacterial colonies on alginate impression after spraying with 0.5% sodium hypochlorite.[16]

Group C1 showed a decrease in the amount of *C.albicans*. The main component of castor oil, such as sodium ricinoleate, correlates with a decrease in acid production which can inhibit the formation of biofilms. Castor oil had bactericidal and fungicidal effects because it contains substances such as alkaloids, saponins, tannins, terpenoids, steroids, glycosides, phenolics, and flavonoids.[28] According to Pisani, et al castor oil had a detergent action against microorganisms associated with cell wall damage, allowing cytoplasmic components to disappear and resulting in the cell death.[17] The results of this study were in accordance with the research of Hanoem, et al in their research concluded that 50% neem oil spraying was effective in reducing the amount of microorganism colonies on alginate impression.[19] The results of this study are also in accordance with the research of Basofi, et al that there are differences in the amount of bacterial colonies on alginate impression after immersed with galangal rhizome decoction.[20] According to Trivedi, et al spraying disinfection with aloe vera effectively reduced *C.albicans* counts in alginate impression.[21]

Disinfection of alginate impression with 0,5% sodium hypochlorite in group B2 showed an effect on the dimensional stability of the study model. This was because sodium hypochlorite when reacted with water would decompose slowly, which would release chlorine, oxygen, and sodium hydroxide causing an oxidation process. The oxygen was a strong oxidizing agent that can cause pressure fluctuations in the solution. During the disinfection action, the sodium hypochlorite solution was in contact with the alginate impression material, the imbibition nature of the alginate which absorbs water, and the pressure on the adsorbed solution causes the alginate impression to expand and the dimensional stability of study model can change.[24] The results of this study were in accordance with previous research from Sari, et al spraying 0.5% sodium hypochlorite on alginate impression resulting in dimensional changes that were still within tolerance limits.[29] This study was also in accordance with the study of Amelia, et al. which showed there was a change in dimensional stability which was still within the tolerance limits of alginate impression after 0.5% sodium hypochlorite was sprayed.[9]

Disinfection of alginate impression with 10% castor oil in group C2 showed an effect on the dimensional stability of the study model. The results of this study were in accordance with previous study by Hasanah, et al concluded that disinfection of alginate impression by spraying 80% betel leaf solution resulted in insignificant changes in dimensional stability.[30] The results of this study are also in accordance with the study by Wirayuni, et al spraying noni extract on alginate impression produces dimensional changes that were still within tolerance limits.[31] Betel leaf and noni had some of the same content as castor oil. The phenol content in castor oil if in contact with alginate impression material would occur an esterification reaction that produces esters and H2O and the properties of alginate is easy to imbibition causing the increase of the disinfectant solution absorption so that the alginate impression changes the dimensions.[24,25]

This study showed that alginate impression desinfection with castor oil had almost the same effectiveness as sodium hypochlorite in reducing *C.albicans* counts, but dimension was changed even though the value of the dimensional changes is still within the tolerance limit.

REFERENCES

1. Budiono, Susilaningsih E, Fatmasari D. Pengembangan instrumen penilaian kinerja keterampilan mencetak rahang bergigi teknik mukostatik. J Edu Res Eval 2016; 5(1): 49-56.
2. Amalina R, Susanto D, Sunendar B. Perbandingan tensile strength, tear strength dan reproduction of detail bahan cetak alginat sintesis dengan variasi jumlah nanoselulosa dan metakaolin terhadap jeltrate. J Sonde 2018; 3(1): 1-15.
3. Chidambaranathan AS, Balasubramanium M. Comprehensive review and comparison of the disinfection techniques currently available in the literature. J Prosthodont 2017: 1-8.
4. Haralur SB, Al-Dowah OS, Ganna NS, Al-Hytham A. Effect of alginate chemical disinfection on bacterial count over gypsumm cast. J Adv Prosthodont 2012; (4): 84-8.

DOI: 10.46934/ijp.v3i1.36

5. Zilinskas J, Junevicius J, Ramonaite A, Pavilonis A, Gleiznys A, Sakalauskiene J. Viability change: Microbiological analysis of dental casts, Med Sci Monit 2014; 20: 932-7.
6. Nasution M. Lesi rongga mulut. Medan: USU Press; 2018. p.49-57.
7. Bintari NWD, Setyapurnawanti I, Dechy NLP, Widana AAO, Prihatiningsih A. Screening *Candida albicans* penyebab kandidiasis oral dan edukasi oral hygiene pada lansia di Panti Sosial Tresna Werdha Wana Seraya Bali. J Pengabdian Kesehatan 2020; 3(1): 28-34.
8. Saber FS, Abolfazli N, Kohsoltani M. The effect of disinfection by spray atomization on dimensional accuracy of condensation silicone impressions. J Dent Res, Dent Clin, Dent Prosp 2010; 4(4): 124-9.
9. Amelia AN, Suharti N, Rahmi E. Perbedaan stabilitas dimensi antara cetakan alginat yang diberi desinfektan ekstrak daun alpukat (*Persea americana mill*) dengan sodium hipoklorit. J Andalas Dental 2017; 78-87.
10. Mushtaq MA, Khan MWU. An overview of dental impression disinfection techniques–a literature review. J Pakistan Dent Assoc 2018; 27: 207–12.
11. Gandhi K. Pengaruh desinfeksi basis gigi tiruan resin akrilik polimerisasi panas dengan sodium hipoklorit dan minyak jarak (*Ricinus Communis Oil)* terhadap jumlah *Candida albicans* dan Stabilitas warna. Universitas Sumatera Utara. 2018. Skripsi.
12. Pisani MX, Macedo AP, Paranhos HdFO, Silva CHLd. Effect of expeimental ricinus communis solutions for denture on the properties of acrylic resin teeth. Braz Dent J 2012; 23(1): 15-21.
13. Sartori IADM, Bernandes SR, Soares D, Thome G, editors. Biosafety and disinfection of impression materials for professional in prosthetic dentistry. Swis: Straumangroup; 2020.p.4-5.
14. Lone MA, Zargar NM, Shahnaz, Shah UI. Effect of three different disinfection material on alginate impression by spray method. Int J Appl Dent Sci 2019; 5(2): 181-4
15. Ritonga PWU. Nugraha BP. Pengaruh desinfeksi cetakan fisiologis dengan microwave dan sodium hipoklorit terhadap jumlah *Candida albicans* dan stabilitas dimensi model kerja gigi tiruan cekat. J Ilmiah PANMED 2018; 12 (3): 322-7.
16. Ahirwar A, Ramanna PK, Moyin S, Punathil S, Adars VJ, Chohan A. Antimicrobial efficacy of different disinfectant materials on alginate impression- A Comprative Study. Int J Oral Care Res 2018; 6 (1): 7-11.
17. Pisani MX, Macedo AP, Paranhos HFO, Silva CHLD. Effect of expeimental *Ricinus communis* solutions for denture on the properties of acrylic resin teeth. Braz Dent J 2012; 23(1): 15-21.
18. Setyaningsih D, Nurmillah OY, Windarwati S. Kajian aktivitas antioksidan dan antimikroba biji, kulit, buah, batang dan daun tanaman jarak pagar (Jatropha curcas L.). Institut Pertanian Bogor 2014.
19. Hanoem EH, Wahjuni W, Artini DD. The effectieness of mimba oil (*Azadirachta indica A.Juss*) spray disinfectant on alginate impression. Dental J 2011; 44 (4): 187-91.
20. Basofi M, Fatmawati DWA, Soesetijo FA. Bacterial colonies on irreversible hydrocolloid impressing produce after sion in Alpinia galanga solution 2015; 3(1): 128-32.
21. Trivedi R, Sangur R, Bathala LR, Srivastava S, Madhav S, Chaubey P. Evaluation of efficacy of aloe vera as a disinfectant by immersion and spray methods on irreversible hydrocolloid impression material and its effect on the dimensional stability of resultant gypsum cast-n in vitro study. J Med and Life 2019; 12 (4): 395-402.
22. Anusavice, Kenneth J. Phillips' science of dental materials.12th ed.Missouri: Elsevier Saunders;2013.p.171-5
23. Arini SS, Saraswati I, Utomo AW, Santoso O. Pengaruh penyemprotan ekstrak daun teh hijau (*Camellia sinensis*) terhadap stabilitas dimensi hasil cetakan alginat. J Ilmu Kimia Pendidikan Kimia 2021; 10(1): 14-22.
24. Lamiah D, Parnaadji RR, Sumono A. Effect of disinfection with spraying technique 35% betel pepper leaf boiling water and 0,5% sodium hypochlorite on dimensional stability of casts made from alginate. Jurnal Pustaka Kesehatan 2016; 3(3): 530-5.
25. Zeni MA, Kristiana D, Fatmawati DWA. The effect of bay leaf (*Eugenia polyantha Wight*) boiling water 100% and sodium hypochlorite (NaOCl) 1% to dimensional stability of irreversible hydrocolloid impressing produce. Jurnal Pustaka Kesehatan 2015; 3 (3): 555-9.
26. Bustos J, Herrera R, Gonzales U, Martinez A, Catalan A. Effect of immersion disinfection with 0,5% sodium hypochlorite and 2% glutaraldehyde on alginate and silicone: Microbiology and SEM study. Int J Odontostomat 2010; 4 (2): 169-77.
27. Badrian H, Ghasemi E, Khalighinejad N, Hosseini N. The effect of three different disinfection materials on alginate impression by spray methode. J Int Scholarly Res Network Dent 2012: 1-5.
28. Puji AY. Pengaruh perendaman basis gigi tiruan thermoplastic comfort system dalam larutan ekstrak daun jarak pagar (*Jatropha Curcals L.*) terhadap pertumbuhan *C.albicans*. Hasanuddin University. Semantic Scholar 2016
29. Sari DF, Pamaadji RR, Sumono A. Effect of disinfection techniques with various disinfectant solution on alginate mold results for dimensional stability. J Pustaka Kesehatan 2013; 1 (1): 29-34.
30. Hasanah NY, Arya IW, Rachmadi P. Efek Penyemprotan desinfektan larutan daun sirih 80% terhadap stabilitas dimensi cetakan alginat. Dentino J Ked Gigi 2014; 2 (1): 65-9.
31. Wirayuni KA. Juniawati DNA. Teknik desinfeksi perendaman dan penyemprotan ekstrak mengkudu (*Morinda Citriifolia Liin*) terhadap perubahan stabilitas dimensi cetakan alginat. Sound Dent 2020; 5 (1): 36-4.

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Updating on dental implant osseointegration and survival rate in osteoporotic bone

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ABSTRACT
Background: Systemic diseases may impact osseointegration of dental implants. Osteoporosis has become one of the concerning diseases since its prevalence reached 18.3% in the world and 10.3% in Indonesia. It is characterized by the decrease in bone thickness, alteration of trabecular structures, and increase in ratio of carbonate and phosphate, making the bone more fragile and prone to fracture. Consequently, the issue of bone quantity and quality will have a great impact on dental implant survival rate. **Objectives**: To know the effect of osteoporosis on survival rate and osseointegration of dental implants. **Conclusion**: Dentists should be more cautious if patients receiving dental implant treatment have a bone mineral density score of -2.5 < T-Score < -1 and an estrogen deficiency, because both are directly related to osteoporosis. Consumption of bisphosphonates should also be asked because it could cause osteonecrosis of the jaw. Most studies show no significant differences between survival rate of implants placed on osteoporotic patients and healthy patients after a short time period, 0-1 year. However, most studies show significant differences after a long time period, 5-7 years, so evaluation of implants is recommended.
Keywords: survival rate, osseointegration, dental implants, osteoporosis

INTRODUCTION

Over time, dental implant treatment replacing single tooth loss to edentulous jaw has become popular. One of the keys to success of dental implants is osseointegration. Patients often come with specific medical conditions or the consumption of certain drugs that can affect the osseointegration of dental implants. Several diseases such as diabetes mellitus, cardiovascular disease, hypothyroidism, rheumatoid arthritis and osteoporosis may affect the osseointegration of dental implants.[1] There are 86 studies in total being assessed for the prevalence of osteoporosis worldwide. From 86 studies with a total of 103,334,579 samples ranging in age from 15-105 years, the prevalence of osteoporosis in the world was 18.3%.[2] In Indonesia, osteoporosis needs to be concerned because it has a prevalence of 10.3%, which means that 2 out of 5 Indonesians are at risk for osteoporosis.[3] Osteoporosis is characterized by a decrease in bone thickness, changes in trabecular bone structure and increase in the ratio of carbonate to phosphate so that the bone becomes susceptible to fracture.[4]

Based on the World Health Organization, the diagnosis of osteoporosis is established based on the value of bone mineral density (BMD) -2,5 < T-score < -1.0.[5] Osteoporosis is classified into primary and secondary osteoporosis, type I primary osteoporosis is closely related to low levels of estrotrogen in postmenopausal women. The decrease in estrogen levels in women occurs about 2-3 years before entering the menopause phase and will continue for 3-4 years after entering the menopausal phase.[6] Estrogen is essential for bone metabolism; deficiency of the hormone causes inhibition of osteoclast cell apoptosis, resulting in bone loss until fracture.[7]

Tooth loss can lead to reduced quality of life for a person because it causes problems in mastication and aesthetics. One of the treatments to replace missing teeth is dental implants. A dental implant is a form of metal screw that is implanted in the jawbone to support a crown, partial or full denture or prosthesis.[8] The choice of dental implant treatment has now drastically increased due to osseointegration ability of implants to bone, so the success rate is high and the risk of complications is low.[9] Calculation of the success or survival rate of the implant is based on 4 clinical categories which contain conditions of success, satisfactory survival, compromised survival, and failure. An implant is said to have failed if it had to or had been removed.[10]

Success of dental implant treatment is highly dependent on osseointegration. Failure of bone osseointegration with dental implants occurs when bone decreases in mass and density.[11] The estrotrogen deficiency causes type-1 primary osteoporosis (post-menopausal osteoporosis) resulting in a decrease in bone mass by 2-5% per year and a decrease in trabecular bone density by 50% and cortical bone by 35%.[12] Therefore, osteoporosis is considered to be one of the risk factors for dental implant treatment.[11] This study aims to further ana-

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lyze osteoporosis as a risk factor for dental implant treatment and its effect on survival rate.

LITERATURE STUDIES

Osteoporosis

Osteoporosis is a multifactorial disease that interferes with the bones, including maxilla and mandible, characterized by the decreased bone strength and increased risk of bone fracture. Osteoporosis risk factors are genetic, intrinsic, exogenous and lifestyle that influence each other.[13] Osteoporosis' particular features are a decrease in bone density and bone quality. The disease causes the decrease in bone thickness, mineral level of the bone, changes in trabecular structure, and an increase in ratio of carbonate to phosphate so that the bone becomes susceptible to fracture. This greatly affects the treatment in prosthodontics which requires good bone quality.[4]

Classification of osteoporosis

Based on the cause of the disease, osteoporosis is classified into primary and secondary. Primary osteoporosis is divided into two types. Type 1, called postmenopausal osteoporosis, is associated with low levels of estrogen. The decrease in estrogen levels in women does not occur during the menopausal phase, but about 2-3 years before entering the menopausal phase and will continue to be persistent until 3-4 years after the menopause. Type-2 is osteoporosis associated with old age, calcium and vitamin D levels in the bones. Individuals over 70 years of age have twice the risk of osteoporosis than people with type-1 osteoporosis. The cause of secondary osteoporosis are diseases such as Ehler-Danlos syndrome, hyperthyroidism, hypothyroidism, Cushing's syndrome, result of a surgery, or taking drugs that accelerate bone loss.[6]

Pathophysiology of osteoporosis

Homeostasis of human bone is maintained by the presence of three main cells that play a role in bone remodeling, namely osteocytes, osteoblasts and osteoclasts. The process of bone remodeling can repair bone damage, maintain bone structure and homeostasis of calcium and phosphate, which are important minerals in bone. To maintain its strength, bone needs to hold resorption and new bone formation continuously.[14] In osteoporosis, the process does not run normally. The number of osteoprotegerin (OPG) receptors decreased so that they could not bind to the *receptor activator of nuclear of kappa*-B *ligand* (RANKL) optimally, as a result there was no inhibition of osteoclast differentiation and decreased osteoclast apoptotic activity. Increased osteoclast activity causes an imbalance in the function of osteoblasts-osteoclasts, resulting in a decrease in bone mass leading to bone loss.[6]

Bone mineral density

The BMD is a value obtained from the amount of inorganic minerals in bone. The BMD value is influenced by several factors, namely age, gender, disease, genetics, and lifestyle.[15] Determination of the diagnosis of osteoporosis is by looking at the BMD value. The normal BMD-value of adult human is T-Score > -1. Whereas osteoporosis patients have an average BMD value of -2,5 < T-Score < -1.0.[5] BMD is one of the important risk factors for bone fractures in osteoporosis patients. The lower the T-Score value that determines the BMD value, the greater the risk of a person's bone fractures.[16]

Estrogen deficiency

Estrogen deficiency is associated with primary osteoporosis type-1 or postmenopausal osteoporosis. Estrogen has an important role in the maturation, mineralization and maintaining the bone mass.[17] Estrogen deficiency accelerates bone loss by stimulating the formation of inflammatory cytokines that act as osteoclast regulators, such as IL-1, IL-2, IL-6 and prostaglandin-E (PGE).[6] When estrogen levels in the blood fall below normal, what happens is an increase in osteoclast formation causing excessive bone resorption. Low estrogen also inhibits osteoclast cell apoptosis and when all of them occur together, it will cause bone loss and eventually fracture.[7] The importance of estrogen to bone was proven in a study conducted by Hendrijanti et al[12] that decrease in estrogen levels in osteoporosis patients causes a decrease in the bone mass by 2-5% per year and a decrease in trabecular bone density by 50% and in cortical bone mass by 35%. Estrogen deficiency with aging can interfere with bone formation processes involving oxidative stress mechanisms.[17]

Aging

Older people are at greater risk of osteoporosis. Entering the fourth decade of life, humans will begin to experience a progressive decline in BMD values. The risk of bone fracture will increase starting from the ninth decade of life and beyond.[18] When osteoporosis patients will undergo implant treatment, age is important to determine the prognosis of successful installation. The elderly pati-

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ents tend to have systemic health problems, have poor bone conditions and their healing abilities are not as good as when they were young.[11]

Osteoporosis manifestation in the oral cavity

Osteoporosis can manifest in bones throughout the body, including the maxilla and mandible. The manifestations include decreased cementum vascularity, alveolar ridge, jaw bone mass and density and bone metabolic capacity as well as changes in the stomatognathic system due to the patient's low BMD, increased maxillary and mandibular porosity, periodontal tissue changes, and increased the trabecular bone spacing. In addition, the temporomandibular joint also undergoes changes, in particular, reabsorption in the condyle area. Radiographic examination is important to see the manifestations of osteoporosis in the oral cavity, the commonly used is panoramic radiography.[19]

Bisphosphonate therapy in the osteoporotic patients

Osteoporosis patients often receive bisphosphonate over therapy. Intravenous administration of bisphosphonate causes the patient to develop osteonecrosis of the jaw. The bisphosphonates will accumulate at the site of bone remodeling centers that interfere with the bone replacement process, cause surgical trauma to the alveoveolar bone, increase postoperative drug accumulation, and increase the risk of peri-implantitis because the bisphosphonates reduce peri-implant bone resistance to oral bacteria.[11] Osteonecrosis of the jaw because of bisphosphonates is referred to as Bisphosphonate (BP)-related osteonecrosis of the jaw (BRONJ). Zoledronic acid in the bisphosphonates makes patients feel pain. BRONJ manifests as necrotic bone in the maxilla or mandible. Its conditions can be exacerbated by infection with the *actinomyces.* For that, oral hygiene osteonecrosis patients must be maintained to reduce pathogenic bacteria.[20]

Implant treatment in prosthodontics among patients with osteonecrosis need special attention. Meanwhile, the survival rate of implant placement in osteonecrosis patients within a period of 1-4 years is still 100%. Siebert, et al showed from 120 implants placed in the mandibular interforaminal area in the group of osteoporosis patients who received bisphosphonate therapy every year and non-osteoporosis patients who did not receive bisphosphonate therapy results in no significant difference, no implant mobility was found and there was no difference in the mean marginal bone loss and crestal bone loss in both groups of study subjects.[20]

Dental implants

Tooth loss is a problem that humans always have to face. During the era when food was minimally processed, tooth loss would make the mastication and chewing processes less effective, endangering the human survival. However, in this modern era, survival is no longer a problem, due to advancements in food processing. Now, aesthetic factors and the ability to enjoy various food textures are the important reasons to replace lost teeth.[21]

One of the ways of replacing the lost teeth is through dental implants. Dental implant is a metal screw placed in the jaw bone through surgical procedures, and acts as a replacement for lost root. Dental implants can support single tooth replacement as crowns, fixed partial or full dentures or maxillofacial prosthetics.[8] A dental implant has 3 main components which are 1) implant body, inserted into the bone, 2) abutment, on top of implant body, 3) superstructure or denture. High success rate and low risk of complications have made dental implants frequently chosen to repair aesthetics and mastication processes of a patient.[22,9]

Indications and contraindications of the dental implants

Indications for dental implants are 1) replacing a single tooth, 2) distal extension base, 3) completely edentulous state, 4) long edentulous spans, 5) when a fixed partial denture is compromised due to weak support, long edentulous spans, cantilever, and unfavorable number and location of abutments, 6) when full denture is compromised by poor muscle coordination, low mucosal tolerance, compromised supporting tissues, parafunctional habits that affect denture stability, unrealistic prosthodontic expectations, hyperactive gag reflex, and patient's requirement for fixed dentures and psychological inability to wear removable dentures.[22]

Contraindications for dental implants are divided into two categories, absolute and relative. Absolute contraindications are 1) high dose irradiated patients, 2) hematologic systemic disorders, 3) psychiatric problems, such as psychosis and dismorphophobia, 4) surgical contraindications due to systemic conditions. Relative contraindications are 1) low dose irradiated patients, 2) diabetes, 3) smoking, alcohol consumption and drug abuse, 4) children up to 18 years old (until jaw bone

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growth has stopped), 5) pregnancy.[22]

Survival rate of dental implants

On the 5th October of 2007, a Pisa, Italy Consensus Conference sponsored by *International Congress of Oral Implantologists* (ICOI), modified James-Misch Health Scale and agreed on four clinical categories. They consist of success, *satisfactory survival*, *compromised survival*, and failure. Success category describes implant in optimal condition, survival category describes a functioning implant but not in ideal condition, and failure category describes implants that must be or have been removed.[10]

Table 1 Health scale for dental implants.[10]

Implant Quality Scale Group	Clinical Conditions
I. Success (optimum health)	a) No pain or tenderness upon function b) 0 mobility c) <2 mm radiographic bone loss from initial surgery d) No exudates history
II. Satisfactory survival	a) No pain on function b) 0 mobility c) 2–4 mm radiographic bone loss d) No exudates history
III. Compromised survival	a) May have sensitivity on function b) No mobility c) Radiographic bone loss >4 mm (less than 1/2 of implant body) d) Probing depth >7 mm e) May have exudates history
IV. Failure (clinical or absolute failure)	Any of following: a) Pain on function b) Mobility c) Radiographic bone loss >1/2 length of implant d) Uncontrolled exudate e) No longer in mouth

DISCUSSION

Effect of osteoporosis on the dental implant survival rate

Human bone metabolism goes through a balance between bone formation and bone resorption that occurs throughout life. If at any time this process is disturbed until an imbalance occurs, for example, systemic skeletal disorders such as osteoporosis, later the bones will become more brittle, lose strength (decreased bone mass) and are at risk of fracture. The balance of this process is also very closely related to the estrogen hormone. In general, a deficit of estrogen can disrupt the balance of bone metabolism, increasing osteoclastogenesis so that the formation process decreases and is dominated by the bone resorption process, making bone mass and quality decreases and is at risk for fracture, this condition is often the cause of patients with primary type-1 osteoporosis or what is often called osteoporosis postmenopausal.[23]

Although studies have shown association of osteoporosis with small implant failure, bone quality still plays a major role as a benchmark for good implant treatment outcomes. So, in systemic conditions where there is a decrease in bone quality and quantity, such as osteoporosis, need to be considered before implant treatment in patients. To help dentists diagnose osteoporosis as a risk factor for implant treatment, the WHO has determined the criteria for the diagnosis of osteoporosis patients based on the value of BMD which is -2.5 < T-Score < -1.0. In addition, female patients who have entered the menopause phase should also be suspected of having osteoporosis due to estrogen deficiency. If a patient undergoing the implant treatment has osteoporosis, the survival rate of the dental implants needs to be reviewed before treatment.[7,23,24]

Several scientific articles provide information on the *survival rate* of implant treatment in osteoporosis patients both in the short and long term. Merheb, et al[25] proved that of 160 dental implants placed in osteoporosis patients and after being followed up for 3 months, none failed, so the *survival rate* of the osteoporosis group was 100% not significantly different from the control group (healthy patients). Likewise, Temmerman, et al[23] conducted a study of installing 148 dental implants in osteoporosis patients and only 12 failed after being followed up for one year so that the *survival rate* was 98.4% at the implant level and 97.9% at the subject level. However, research by Holahan, et al[26] who installed 168 implants, after being followed up for a period of 5-10 years, only 26 implants failed, so the average *survival rate* was only 82.6%, much lower than the control group. Niedermaier, et al[27] installed 34 implants in osteoporosis patients and after 7 years of observation, only 2 of 34 dental implants failed, resulting in a *survival rate* of 94.1% lower than the control group. Temmerman, et al[28] also showed the results of a comparison of *survival rates* that differed significantly between dental implants in the control group and the osteoporosis group. Of the 63 dental implants installed, after being followed up 5 years later there were 5 dental implants that failed so that the *survival rate* was 91.5% at the implant level and 89.2% at the subject level. Finally, Alsaadi, et al[29] also investigated the installation of 120 dental implants in osteoporosis patients and the results of a 5-year follow-up showed that 1 implant failed, not much different from the installation of dental implants in non-osteoporosis patients. In this study, the *survival rate* of implants in osteoporosis patients was 96.3%.

Most studies show no significant differences

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Table 2 Short term studies (0-1 year)

Author	Short-Term Placement (0-1 year)			
	Total number of dental implants	Number of failed implants	Survival rate	Survival rate differences between osteoporosis and control group
Merheb J et al[25]	160 (3 months)	0 (3 months)	100% (3 months)	Not significant
Temmerman A et al[23]	148 (1 year)	12 (1 year)	98.4% on implant level and 97.9% on subject level (1 year)	Not significant

Table 3 Long term studies (5-7 years)

Author	Long-Term Placement (5-7 years)			
	Total number of dental implants	Number of failed implants	Survival rate	Survival rate differences between osteoporosis and control group
Holahan CM et al[26]	168 (5-10 years)	26 (5 to 10 years)	82.6% remains constant (5-10 years)	Significant
Niedermaier R et al[27]	34 (up to 7 years)	2 (up to 7 years)	94.1% (up to 7 years)	Significant
Temmerman A et al[28]	63 (5 years)	5 (5 years)	91.5% on implant level and 89.2% on subject level	Significant
Alsaadi W et al[29]	120 (5 years)	1 (5 years)	96.3% (5 years)	Not significant

between survival rate of implants placed on osteoporotic patients and healthy patients after a short time period (0-1 year). However, most studies show significant differences after a long time period (5-7 years) so evaluation of implants is recommended.

Differences in results between human and animal

Differences of results between experiments regarding implant osseointegration on osteoporotic humans and animals can be observed. On dental implants placed for at least 3 years in humans, there are no significant differences in the marginal bone loss (MBL), plaque index (PI), and probing depth between osteoporotic and non-osteoporotic groups.[29] Then, there is also no significant correlation between mandibular cortical index (MCI) of osteoporosis and MBL on the dental implants placed for at least 2 years in humans.[30] On the other hand, the implants on rats show the peri-implant bone volume, trabecular architecture, bone-to-implant contact (BIC), and biomechanical parameters decrease progressively and significantly within 12 weeks post-ovariectomy.[31] On implants placed for 28 days in rats undergone ovariectomy, results indicate significant decrease of bone volume/total volume (BV/TV) and BIC. Maximum torque, stiffness, and energy of torque are also lower on ovariectomy rats compared to normal rats.[32] Based on the experimental results above, it can be observed that osteoporosis has a greater negative effect on animals compared to humans.

One of the factors that influence this phenomenon is the location of implants on animals which is usually the femoral or tibial bone. This creates an environment for implants that is different from the oral cavity, because actual dental implants are always exposed to chemical agents, bacteria, and mastication forces.[33] It is also shown in rats that femoral and tibial bone experience greatest bone loss post-ovariectomy, 75.0% and 70.4% respectively in week 36. In contrast, the jaw and cranial bones only experience 1-3% bone loss in week 36 post-ovariectomy. Trabecular structures of femoral and tibial bones also experience significant destruction, whereas jaw bones are relatively stable post-ovariectomy.[34]

Bioactive agents and stem cells to improve osseointegration

Technology and innovation in dental implants have progressed really far, making it as the main choices for replacement of lost teeth. However, the risk of implant failures still exists, especially in patients with systemic diseases such as osteoporosis, which causes a decrease in bone mass and interferes with osseointegration. Modifications of implant surfaces have been developed to modulate

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host tissue response to implant and improve osseointegration. Some methods that are currently studied are loading of bioactive agents and stem cells on implant surfaces to improve osseointegration, especially in osteoporotic patients.[35,36]

Loading of bioactive agents such as the anti-osteoporosis medications like bisphosphonates, RANKL antibody, parathyroid hormone (PTH) and selective estrogen receptor modulators (SERM) have been proven to increase implant osseointegration. Bioactive molecules like platelet-derived growth factor, insulin-like growth factor, fibroblast growth factor, vascular endothelial growth factor (VEGF), and bone morphogenetic protein (BMP) have also been used to improve osteogenic differentiation and mineralization of bone marrow stem cells. Inorganic elements such as calcium (Ca), strontium (Sr), magnesium (Mg), zinc (Zn), and silicone (Si) can also stimulate osteogenesis.[36] Strontium (Sr) is often used in treatment of osteoporosis due to its similarity to calcium (Ca) and its ability to simultaneously stimulate osteoblast and inhibit osteoclast. Implant surfaces loaded with Sr through hydrothermal reaction have a positive effect on promoting early osseointegration in osteoporotic rabbits.[37] Moreover, biomimetic coating of Ca-P or calcium-phosphate have been used frequently due to its excellent biocompatibility from mimicking natural bone mineralization process.[38]

Many researchers have also studied stem cells to improve the osseointegration. Stem cells have potential to undergo osteogenic differentiation and proliferate to promote the bone regeneration. Like the human umbilical cord mesenchymal stem cells (hUCMSCs) are proven to have high osteogenic effect and improve bone regeneration in osteoporotic animal model.[39] Human amniotic mesenchymal cells (hAMSCs) can also improve bone regeneration and osseointegration of implants in rabbits.[40] The bone marrow mesenchymal stem cells (BMSCs) coatings cultured in extracellular matrix on implant surface can also improve osseointegration in rats.[41] Studies on animals show that stem cells have a great potential to be used in dental implants. However, more clinical tests are needed to determine the safety, efficacy, and feasibility of stem cell application in humans.

It concluded that most studies show no significant differences between survival rate of implants placed on osteoporotic patients and healthy patients after a short time period (0-1 year). However, most studies show significant differences after a long time period (5-7 years) so evaluation of implants is recommended. Measurements of BMD level and estrogen are recommended before implant treatments because both are directly related to osteoporosis. Patients with BMD score of -2.5 < T-score < -1 must be observed cautiously because their bone mass and density have decreased which could in turn, decrease implant survival rate. Decrease of estrogen levels in women could also indicate postmenopausal osteoporosis, so they could potentially experience 2-5% bone loss every year, and decrease in trabecular and cortical density, 50% and 35% respectively. Consumptions of anti-osteoporosis drugs like bisphosphonates should also be asked because it could cause osteonecrosis of the jaw. Finally, studies on animals show that bioactive agents and stem cells have the potential to improve osseointegration but further clinical tests are needed to determine their safety, efficacy, and feasibility in humans.

Further studies regarding implant survival rate on osteoporotic patients should be conducted to help dentists when considering dental implant treatment for osteoporotic patients. Moreover, further studies are required regarding the reason why there is mostly a significant decrease of survival rate in osteoporotic patients after a long period of time but not after a short period of time. Further clinical tests of bioactive agents and stem cells are required before their application in humans.

REFERENCES

1. Aghaloo T, Pi-Anfruns J, Moshaverinia A, Sim D, Grogan T, Hadaya D. The effects of systemic diseases and medications on implant osseointegration: a systematic review. Int J Maxillofac Implant 2019;34.
2. Salari N, Ghasemi H, Mohammadi L, Rabieenia E, Shohaimi S, Mohammadi M. The global prevalence of osteoporosis in the world: a comprehensive systematic review and meta-analysis. J Orthopaed Surg Res 2021;16(1): 1-20.
3. Kemenkes RI. Infodatin: situasi osteoporosis di Indonesia. Kementerian Kesehatan Republik Indonesia. 2020.
4. Gibreel S, Mohamed HG, Suraj AR, Anil S. Osseointegration of dental implants and osteoporosis in current concepts in dental implantology-from science to clinical research. IntechOpen 2021
5. Bover J, Ureña-Torres P, Torregrosa JV, Rodríguez-García M, Castro-Alonso C, Górriz JL, et al. Osteoporosis, bone mineral density and CKD–MBD complex (I): Diagnostic considerations. Nefrología (English Edition) 2018; 38(5):476-90.
6. Limbong EA, Syahrul F. Rasio risiko osteoporosis menurut indeks massa tubuh, paritas, dan konsumsi kafein. Jurnal Berkala Epidemiologi. 2015;3(2):194-204.

DOI: 10.46934/ijp.v3i1.120

7. McNamara LM. Osteocytes and estrogen deficiency. Current osteoporosis reports. 2021 Nov 26:1-2.
8. Gbadebo OS, Lawal FB, Sulaiman AO, Ajayi DM. Dental implant as an option for tooth replacement: The awareness of patients at a tertiary hospital in a developing country. Contemp Clin Dent 2014;5(3):302–6.
9. Shemtov-Yona K, Rittel D. An overview of the mechanical integrity of dental implants. BioMed Research International. Hindawi Publishing Corporation; 2015.
10. Misch CE, Perel ML, Wang HL, Sammartino G, Galindo-Moreno P, Trisi P, et al. Implant success, survival, and failure: The International Congress of Oral Implantologists (ICOI) pisa consensus conference. Implant Dent 2008; 17(1):5–15.
11. Dutta SR, Passi D, Singh P, Atri M, Mohan S, Sharma A. Risks and complications associated with dental implant failure: Critical update. National J Maxillofac Surg 2020; 11(1):14.
12. Hendrijanti N, Rostiny R, Kuntjoro M, Hidajati HE, Soekobagiono S, Subianto A, et al., 2019. The effect of low-level estrogen in mandibular bone: An in vivo study. Dent Res J 2019;16(2):65.
13. Föger-Samwald U, Dovjak P, Azizi-Semrad U, Kerschan-Schindl K, Pietschmann P. Osteoporosis: pathophysiology and therapeutic options. EXCLI J 2020; 19:1017.
14. Barnsley J, Buckland G, Chan PE, Ong A, Ramos AS, Baxter M, et al. Pathophysiology and treatment of osteoporosis: challenges for clinical practice in older people. Aging Clin Experimen Res 2021;33(4):759-73.
15. Kranioti EF, Bonicelli A, García-Donas JG. Bone-mineral density: clinical significance, methods of quantification and forensic applications. Res Reports Forensic Med Sci 2019;25(9):9-21.
16. Siris E, Adler R, Bilezikian J, et al. The clinical diagnosis of osteoporosis: A position statement from the National Bone Health Alliance Working Group. Osteoporosis Int 2014; 25(5):1439-43.
17. Ho-Pham L, Nguyen N, Nguyen T. Quantification of the relative contribution of estrogen to bone mineral density in men and women. BMC Musculoskeletal Disorders 2013; 14:366.
18. Aspray TJ, Hill TR. Osteoporosis and the aging skeleton. Biochemistry and cell biology of ageing: Part II Clin Sci 2019:453-76
19. Watanabe PC, Rodrigues GA, Azenha MR, Ribeiro MC, de Almeida Souza FE, Vieira RA, et al. Bone quality of the dentomaxillofacial complex and osteoporosis. opportunistic radiographic interpretation. In Osteoporosis-Recent Advances, New Perspectives and Applications 2021 Mar 12. IntechOpen.
20. Siebert T, Jurkovic R, Statelova D, Strecha J. Immediate implant placement in a patient with osteoporosis undergoing bisphosphonate therapy: 1-year preliminary prospective study. J Oral Implantol 2015;41(S1):360-5.
21. Block MS. Dental implants: The last 100 years. J Oral Maxillofac Surg 2018;76(1):11–26.
22. Rangarajan V, Padmanabhan TV. Textbook of Prosthodontics-E Book. Elsevier Health Sciences; 2017.
23. Temmerman A, Rasmusson L, Kübler A, Thor A, Quirynen M. An open, prospective, non-randomized, controlled, multicentre study to evaluate the clinical outcome of implant treatment in women over 60 years of age with osteoporosis/osteopenia: 1-year results. Clin Oral Implant Res 2017;28(1):95-102.
24. Trajanoska K, Rivadeneira F. The genetic architecture of osteoporosis and fracture risk. Bone 2019;126:2-10.
25. Merheb J, Temmerman A, Rasmusson L, Kübler A, Thor A, Quirynen M. Influence of skeletal and local bone density on dental implant stability in patients with osteoporosis. Clin Implant Dent Relat Res 2016;18(2):253-60.
26. Holahan CM, Wiens JL, Weaver A, Assad D, Koka S. Relationship between systemic bone mineral density and local bone quality as effectors of dental implant survival. Clin Implant Dent Relat Res 2011;13(1):29-33.
27. Niedermaier R, Stelzle F, Riemann M, Bolz W, Schuh P, Wachtel H. Implant-supported immediately loaded fixed full-arch dentures: evaluation of implant survival rates in a case cohort of up to 7 years. Clin Implant Dent Relat Res 2017;19(1):4-19.
28. Temmerman A, Rasmusson L, Kübler A, Thor A, Merheb J, Quirynen M. A prospective, controlled, multicenter study to evaluate the clinical outcome of implant treatment in women with osteoporosis/osteopenia: 5-year results. J Dent Res 2019;98(1):84-90.
29. Alsaadi W, AbouSulaiman A, Monzer AlSabbagh M, Alsadi W. Retrospective study of dental implants survival rate in postmenopausal women with osteoporosis. Int J Dent Oral Sci. 2021;8(9):4259–66.
30. Corcuera-Flores JR, Alonso-Domínguez AM, Serrera-Figallo MÁ, Torres-Lagares D, Castellanos-Cosano L, Machuca-Portillo G. Relationship between osteoporosis and marginal bone loss in osseointegrated implants: a 2-year retrospective study. J Periodontol 2016;87(1):14–20.
31. Li Y, He S, Hua Y, Hu J. Effect of osteoporosis on fixation of osseointegrated implants in rats. Part B applied biomaterials. J Biomed Mater Res 2017;105(8):2426–32.
32. Lotz EM, Cohen DJ, Ellis RA, Wayne JS, Schwartz Z, Boyan BD. Ibandronate treatment before and after implant insertion impairs osseointegration in aged rats with ovariectomy induced osteoporosis. JBMR Plus. 2019;3(7)
33. Chen X, Moriyama Y, Takemura Y, Rokuta M, Ayukawa Y. Influence of osteoporosis and mechanical loading on bone around osseointegrated dental implants: A rodent study. J Mechanic Behav Biomed Mater 2021;123.
34. Liu XL, Li CL, Lu WW, Cai WX, Zheng LW. Skeletal site-specific response to ovariectomy in a rat model: change in bone density and microarchitecture. Clin Oral Implant Res 2015;26(4):392–8

DOI: 10.46934/ijp.v3i1.120

35. Meng HW, Chien EY, Chien HH. Dental implant bioactive surface modifications and their effects on osseointegration: a review. Biomarker Res 2016;4(1).
36. Zhang C, Zhang T, Geng T, Wang X, Lin K, Wang P. Dental implants loaded with bioactive agents promote osseointegration in osteoporosis: a review. Vol.9, Frontiers in Bioengineering and Biotechnology. Frontiers Media S.A.; 2021.
37. Lin G, Zhou C, Lin M, Xu A, He F. Strontium-incorporated titanium implant surface treated by hydrothermal reactions promotes early bone osseointegration in osteoporotic rabbits. Clin Oral Implant Res 2019;30(8):777-90.
38. al Mugeiren OM, Baseer MA. Dental implant bioactive surface modifiers: an update. J Int Soc Prev Comm Dent 2019;9(1):5–12.
39. Hendrijantini N, Kusumaningsih T, Rostiny R, Mulawardhana P, Danudiningrat CP, Rantam FA. A potential therapy of human umbilical cord mesenchymal stem cells for bone regeneration on osteoporotic mandibular bone. Eur J Dent 2018;12(3):358.
40. Yin L, Zhou ZX, Shen M, Chen N, Jiang F, Wang SL. The human amniotic mesenchymal stem cells (hAMSCs) improve the implant osseointegration and bone regeneration in maxillary sinus floor elevation in rabbits. Stem Cells International 2019.
41. Feng Y, Jiang Z, Zhang Y, Miao X, Yu Q, Xie Z, et al. Stem-cell-derived ECM sheet-implant complexes for enhancing osseointegration. Biomater Sci 2020;8(23):6647–56

DOI: 10.46934/ijp.v3i1.120