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The effect of implant surface treatment on bone height changes in implant retained mandibular overdenture with locator attachment

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Aim: This study aimed to examine alterations in bone height by digital periapical radiography to assess the impact of SLActive implants compared to SLA acid-etched implants assisting lower overlay dentures with locator attachments.

Materials and Methods: Thirty fully edentulous cases, were distributed in random fashion into two equal groups from outpatient clinic of prosthodontics, school of dentistry Ain Shams University and rehabilitated with two Implants in the region of inter foramina, to retain lower overdenture after CBCTs assessment. Group I rehabilitated with two SLActive hydrophilic implants with locator while group II received two conventional SLA implants with locator of equal retaining force, both were conventionally loaded after three months of healing and dentures conversion achieved.

The alterations in bone height surrounding the implants were assessed utilizing a linear measurement system through standardized digital periapical radiographs, which were carried out using the parallel technique with GSX-700 software to measure the changes mesialy and distally to each one.

The measurements were made for each follow up appointment (at 0,6,12,18 months),the loss in marginal bone at different intervals was gained by calculating the difference in bone height level at specific visit from that of base line.

Results: Findings indicated a persistent elevation in crestal bone height loss during the duration of the research, although mean values in group (II) were higher than those in group (I), there was no statistically significant difference between the two groups throughout the study period.

Conclusion: Given the constraints of patient quantity and follow-up duration, the loss in the crestal bone height in both groups exhibited a consistent rise across the research period, but it remained within an acceptable range and there was absence of statistically significant difference between groups during period of follow-up.

Keywords: implant retained overdenture, locator, slactive implant.

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Introduction

Complete dentures impose several adverse effects on users, as numerous individuals struggle to acclimatize to the prosthesis and experience difficulties with articulation and mastication due to reduced stability and retention.[1]

Mandibular full dentures exhibit several well-documented challenges, including insufficient stability and retention; many patients have trouble with eating, chewing, and speaking due to movement of the lower complete denture.[2]

Implant-retained overlay dentures by two implants in the edentulous mandible have demonstrated reliability and are regarded as the best practice for edentulous cases.[3]

Research has shown that implant-retained mandibular overdentures enhance retention and chewing efficacy. Additionally, less bone resorption and less movement of the lower denture during eating, laughing, and speaking result in increased aesthetic satisfaction.[4] Implant-retained lower overlay dentures significantly enhance happiness and quality of life in comparison to conventional dentures.[5]

The features of a dental implant's surface significantly affect the osseointegration process. The physical features of implants, particularly their surface features, have driven advancements in implant therapy during the last few decades. Based on what is known now, improving osseointegration is possible by micro surface modification, which increases surface area and influences cell shape.[6,7]

Raising the surface roughness of an implant is possible using variable techniques. A frequently implemented approach entails the integration of sandblasting and etching via acid (SLA), and successful-osseointegration using this method has been commonly recognized. In a series of alterations, the implant's hydrophilic characteristics and wettability are enhanced, thus reducing the amount of time required to attain secondary implant stability is certainly doable, and accelerating proteins absorption over it.[8,9]

Nowadays, dental implants' surface is altered by mixture of sandblasting and etching acid (SLA). These alteration procedures combine the advantages of sandblasting and acid-etching to reach a micro-roughed scale surface. To improve the surface quality of an implant, sandblasting is a physical alteration technique that raises the micro-scale roughness, instead, etching in powerful acids produces micro pits on the implants resulting in improved surface energy, cellular adhesion, protein adsorption, and ultimately osseointegration.[10,11]

Straumann's® SLActive implant is asserted to maintain stability over the initial 1.5 to 3 weeks of the 3 to 4-week period necessary for osseointegration, a time often characterized by temporary instability.[12]

After the second step of treatment, which is acid-etching, the SLA implants are allowed to remain dry, whereas the SLActive one washed in the presence of nitrogen protecting gas and immersed in saline capsules till usage. Consequently, they are similar in surface topography but chemically different. There is a correlation between surface chemistry and surface charge as well as wettability. Surface energy directly influences wettability and impacts surface interaction with the physiological environment. As a result, the higher the surface wettability, the better interaction between the implant and surrounding tissue fluids. Therefore, this chemical variance in surfaces causes SLActive exhibiting elevated surface energy, reduced carbon contamination, and increased hydrophilicity than SLA surface.[13,14]

A variety of joining devices are employed to attach implants to overdentures, either splinted or isolated. The attachment technique employed is determined by financial considerations, the necessary retention level, anticipated oral hygiene, and the quantity of bone available, the patient's expectation, the maxillo-

mandibular relationship, the restorative apace, and the state of opposing jaw.[15,16]

A well-designed attachment system should have a number of desired properties, the most desirable of which are a high level of retentive strength and the endurance of components overtime, ease of maintenance, components that are structurally strong enough, preservation of the attachment matrix is acceptable, and minimum dimensional constraints that ensure the overdenture remains structurally intact.[17,18]

Selecting the right attachment system is challenging, despite the abundance of research on the attachments' therapeutic efficacy because of the large number of availability and continuous introduction of new designs in the dental market.[19]

One example is the stud attachment, which may be placed directly using self-cured or light-cured resin, or it can be attached to the denture using a transfer coping system and cast with implants replica. The female partition is frictionally maintained over the male stud then integrated into denture resin.[20]

One of the primary benefits of stud attachments is their capability to be used in V-shaped arches so connecting the implants can interfere with tongue space, based on their function, stud attachments are classified as either robust or non-resilient.

Resilient one allows some movement in both the vertical and rotational directions, defending the abutments or implants below. In addition, resilient attachments typically necessitate a gap and may result in posterior mandibular resorption with vertical movement of the prosthesis. Conversely non-resilient ones don't let the dentures move at all while they're being used. They are usually used when there is inadequate restorative space.[21]

Locator attachment system is made up of both female and male components. The female component is made up of a titanium locator abutment with a titanium-nitride coating that is placed into the implant, while the male part is a locator cap with an interchangeable insert, the male part engages the female part to provide a adequate retention force to stabilize and retain the overdenture, because of its rounded edges, dual retention, long-lasting sturdiness, and accommodation for divergent implants, the locator attachment system is a self-aligning attachment system. An additional point the height of the locator (abutment and metal cap) is as low as 2.5 mm. This height suite cases with limited restorative apace or during retrofitting a denture.[22,23]

Both inside and outside retention for conventional male transparent, pink and blue, utilizing an undercut against the periphery of the abutment, inner and outer direction of retention work together lasting the longest of 60000 rounds of in vitro insertion and removal.[24]

The self-locating design makes it easy for patients to put in their overdenture without having to make sure the connecting parts are perfectly aligned. Easy solutions for divergent implants up to 40 degrees, one tool that can do three things for all clinical and laboratory procedures.[25]

The aim here was to observe the alterations in bone height associated with SLActive implants compared to SLA acid-etched implants assisting mandibular overlay dentures with locator attachments, while the null hypothesis was adopted the absence of difference between the groups.

Materials and methods

Sample size:

Thirty edentulous participants were chosen at random from the outpatient clinic of the prosthodontics at Ain Shams University's dental school.

The size of sample was selected using G*Powerversion 3.1.9.7 based on the results of a previous study.[26] The predicted sample size (n) was (30), fifteen patients per group. To detect the difference if exist between the groups regarding bone height changes.

The study protocol was aproved by the ethical committee of research, Faculty of dentistry, Ain Shams university no : 90PC

Participants were motivated for the therapy, completed an informed consent form before participating in the study.

Construction of complete dentures:

The clinical examination was conducted in two consecutive phases, including extraoral and intraoral assessments.

Complete dentures were made and delivered following the conventional manner.

Pre surgical radiographic examination:

Before surgery, ConeBeam CT scan was done for all the patients with guttapercha placed at the canine positions to check the quality of the mandibular alveolar ridge and measure the width and height of the bone from the ridge's peak to the lower edge of the mandible in region of interforamina to receive two implants of 3.7 mm diameter and 10 mm height. Locate the positions of mental foramina, loop of mental nerve if present.

Grouping

Patients were randomly split into two groups based on an Excel worksheet, and each group got two implants placed between the foramina to hold the lower overdenture in place.

Group I received two SLActive hydrophilic implants while Group II received two SLA implants, both groups were loaded conventionally after three months with locator attachments retaining lower overdentures of equal retention 1.36kg.

patients were selected according to these criteria, completely edentulous arches for at least 12 months before beginning of the study with lower ridge bone height more than 11mm and width more than 5mm, the density was ranged between 1400-900 HIU assessed by CBCTs to receive two implants, medically free with sufficient restorative space minimally 15mm, good oral hygiene, mandible did not show any bony pathosis or residual infection, all the patients were 55 to 65 years old.

This study did not include the following patients who are alcoholics, smokers, had poor oral hygiene, those with metabolic diseases, uncontrolled diabetes, prisoners, handicapped patients.

Surgical procedures:

The surgical operations were conducted in two phases, after the confirmation of the anesthetic efficacy, a modified surgical clear stent by duplication of each patient's lower denture into transparent heat-cured resin, was properly seated in position in the patient's mouth and a dental probe was inserted into the notches made in the stent to puncture the mucosa for flap reflection.

A mucoperiosteal flap of full thickness was reflected using a sharp elevator. The lingual flap was dissected too. A pilot of 1.3mm diameter drill held vertically was used for drilling at 900-1100 RPM associated with continuous flow of copious cooled isotonic saline. The successive drilling by using a delicate up and down pumping action figure (1), the drilling was continued for the full length of the implant which is secured by the stopper. The sterile vial figure (2) containing the hydrophilic implant was opened and the implant was installed to the osteotomy by the finger driver and stabilized in the osteotomy, rotated clockwise with downward pressure until noticeable resistance was encountered, then adjustable TorqueWrench was attached to the implant with the directional arrow facing Clockwise and engages the neck of the Ratchet adapter into the square opening of the wrench to finalize the insertion process to crestal bone level. The implants were advanced with the TorqueWrench to a minimum of 35Ncm for both groups. In randomized fashion group I received two SLActive implants of 3.7mm diameter, 10mm height of Straumann ** While group II received two SLA implants of 3.7 mm diameter, 10mm height, three simple interrupted sutures were done bilaterally. Healing period of three months was allowed to progress.

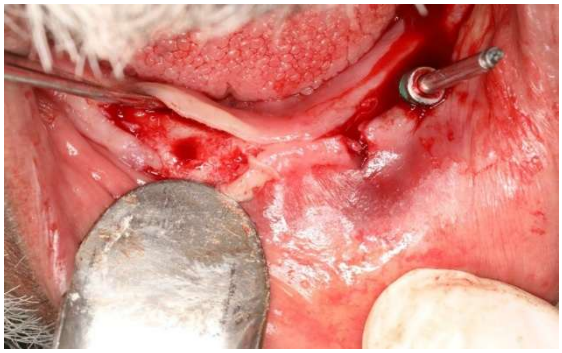

Figure (1): Reflected two flaps with two osteotomies.

Figure (2): Slactive implant in vial solution.

After the healing phase, a CBCT radiograph was conducted to verify the absence of radiolucency around the implants, the cover screws were removed, and healing abutments were installed. Osseointegration was assessed by pounding on the abutments with a mirror handle to detect resonant metallic sound. The intaglio surface of lower overlay dentures were alleviated at the implants' sites and tried in the patient'smouth until dentures were comfortably placed with no rocking. Oneweek later, the conical healing abutments were replaced by the original locator abutments. Regions in the denture corresponding to the two locator abutments (matrix) were modified to provide sufficient room for the patrix. The denture was fitted in the patient's mouth to verify proper seating. white spacer ring was fitted over the head of each abutment to protect the sub housing area from acrylic flow and the housing was placed in position and self-cured acrylic was used to directly pickup the attachment following the conventional technique figure (3), patients were instructed to close in centric until complete polymerization took place, excess material was trimmed out and finished. Patients were frequently recalled for inspection and post insertion adjustments. Follow up visits were, at time of conversion, six, twelve and eighteen months after denture conversion for making radiographic records to evaluate the implant marginal bone height changes.

Figure (3): The two male parts and denture conversion.

Straumann ® Swiss dental implant system.

A clinical assessment was conducted to assess the status of the denture-bearing region, abutments and hygiene.

Radiographic evaluation

By employing standardized digital peri-apical radiographs, linear measuring system was employed to assess the changes in marginal bone height around implants. which were carried out using the parallel technique with GSX-700 software*** to ascertain the alterations in bone height that occur mesial and distal to each implant.

Instructions were given to patients to refrain from moving during radiographic exposure, at time of prosthesis conversion standardized peri-apical radiographs were recorded for both groups.

They were carried out using the long cone parallel technique, by using the bite block of the RinnXCP set****.

The RinnXCP set comprises a bite block (film-holder) and an extraoral collimator ring that is perpendicular to the film retaining plane of the x-ray sensor. It is used to hold the sensor, extra-oral collimator ring is used to direct the long cone. Addition PVS material***** was positioned on the top and underside of the biting block, the patient was instructed to

bite over it, which culminated in the secure attachment of an index to the bite block.

Bite blocks are uniquely assigned to each patient and kept in their medical record, then measuring the changes in bone height on both mesial and distal surfaces of each implant using GSX-700 program.

The X-ray machine was adjusted at 70Kvolts, 7m.ampars, 0.6 seconds, during the follow-up period, these parameters were constant for all patients, calibration was done by the parallel digital periapical radiographs which were introduced to the software and horizontal lines were drawn tangential to implants apices and at right angle to their long axes, then two lines were drawn longitudinally on the implants mesial and distal surfaces starting from the first bone-implantcontact extending to the horizontal lines drawn at implants apices figure (4).

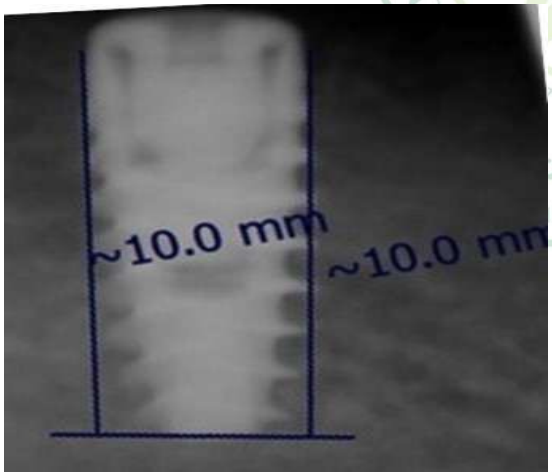

Figure (4): Linear measurements mesial, distal to the implant.

GXS-700-digital intraoral sensor- Gendex-USA.

Rinn XCP manufactures C. Ligin, III, USA.

zhermach eliteHD+, Germany.

The software automatically measured the marginal bone height in millimeters and the results were recorded in the patient's follow up charts during 0, 6,12,18 months.

The evaluation of changes in bone height was conducted by two operators who were blinded to ensure objective findings.

Calculating difference in bone height at each interval from the base line measurement allowed us to determine the marginal bone loss at various intervals.

Results

The results are shown in tables (1,2,3). Using paired t-tests, we checked for statistical significance between the means of each group; using student t-tests, we compared the means of groups I and II, probability level (p)of 0.05 or less was chosen as level of significant difference.

Over the course of the research, the average reduction in crestal bone height for both groups was steadily rising.

The calculated mean for group I was found to be -0.456, -0.528 and -0.673 at six, twelve and eighteen months after loading respectively.

Table (1): Means, SD and the results of paired t-test for crestal-bone changes bytime within group (I) during followup.

Period	Mean difference	SD	T-values
6 months	-0.456	0.031	4.12
12 months	-0.528	0.053	4.78
18 months	-0.673	0.046	5.32

Regarding group II patients, means, SD and results of paired t-test for boneheight changes within group (II) patients are shown in table (2). The calculated mean difference was found -0.488, -0.563 and -0.789 at six and twelve and eighteen months after loading respectively.

Table (2): Means, SD and the results of paired t-test for crestal bone changes within group (II) during follow-up.

Period	Mean difference	SD	T-values
6 months	-0.488	0.042	3.26
12 months	-0.563	0.019	3.62
18 months	-0.789	0.044	4.21

The comparison of crestal boneheight loss between the groups revealed a consistent increase in loss throughout the study, as illustrated in Table 3. Although the mean values in Group II exceeded those in Group I, no statistically significant difference was observed between the two groups.

Table (3): Means, SD and results of student t-test for comparison between two groups bone height changes during the follow up period.

Period	Group I		Group II		T-values
	Mean	SD	Mean	SD	
6 months	0.456	0.031	0.488	0.042	0.510
12 months	0.528	0.053	0.563	0.019	0.182
18 months	0.673	0.056	0.789	0.044	0.183

Discussion

The lack of success in lower denture acceptance prompted effective patient education and treatment planning with implant techniques, which significantly benefited prosthodontic practice and attracted unhappy patients.[27]

Implants have become an integral part of prosthodontics rehabilitation. The implant-retained overdenture, supported by both implants and tissue, is suitable for compromised situations. It improves masticatory performance, minimizes stress to the underlying tissues, decreases the rate of bone resorption, and boosts patient tolerance.[28]

The hydrophilicity of the surfaces of the implants is also influenced by their surface chemical composition. Hydrophilic surfaces are preferable for their interactions with biologicalfluids, cells, and tissues. Consequently, surface chemistry is a serious factor in the predictability of the implant.-bone reaction that affects the apposition of the bone to implant.[13]

When compared to smooth titanium surfaces, rough surfaces provide maximal bone-implant contact and cells migration, and clinically promote osseointegration more rapidly, the roughness value of the SLAsurface is nearly 2.34 mm, with a range of 1.3–3.7 mm for the SLActive.[29]

Consequently, SLAand SLActive implants have alike surface topography. Surfaces with rougher textures are more likely to have bone-implant contact, according to researches, the same chemical characteristics that influence wettability may also influence bone migration to implant surfaces. The initial advancing water contact angle for SLActive implants is zero degree, whereas for SLA implants it ranges from 138 to 140°, which offers the SLActive implants with an extra hydrophilic nature than SLAimplants.[30] According to further research, SLActive surfaces had the best osseointegration results when they underwent a surface transformation from hydrophobic to hydrophilic, resulting in a nano rough surface. The implants' ultra-hydrophilic surface reawakens upon contact with blood, triggering the formation of an indiscrete conditioning layer. At 2 and 4 weeks, the SLActive surface exhibited superior bone-implant contact in comparison to the conventional surface, as evidenced by certain studies.[31]

With freestanding implants, you may utilize versatile stock retentive abutments, which is a huge plus. The implementation of the interconnecting implant bar necessitates further laboratory and clinical processes for its production with associated rise in fees & time, It has been noted that the design of the Locator attachment meets all the necessary criteria.[32,33]

Standard clinical, surgical, laboratory techniques and materials were used and followed for all patients to eliminate any possible errors. To ensure that the outcomes of this research would not be impacted by any factors or habits that may have an undesirable effect, the patients were carefully chosen and scrutinized. The age of selected patients was nearly the same and ranged between 55 and 65 years to

avoid the influence of age variations on bone and state of the oral mucosa.

Remaining ridges with widths below 5 mm may negatively impact bone stress levels and crestal bone maintenance, according to well-documented biomechanical evidence.[34]

Thus, pre-operative CBCTs (Cone Beam CT) with markers were carried out for all patients to reveal any pathological conditions that may hinder the proper implant placement, evaluate quality and quantity of mandibular residual ridge.

Group I rehabilitated with two SLActive implants of 3.7mm diameter, 10mm height of Straumann. While group II received two SLA implants of 3.7 mm diameter, 10mm height, The three-month healing period was given the green light to continue.

Following the healing period, CBCT radiographs were performed to check that there was no radiolucency around the implants, then healing abutments were put in place for one week and the necessary adjustments were made for dentures fitting surfaces, at end of the week, they were replaced by locator abutments, and dentures conversion takes place with direct pickup technique.

Scheduled visits were made and patients were often contacted back for inspections and follow-ups at time of conversion, six, twelve and eighteen months after overlay denture conversion for keeping radiographic records to evaluate the implant marginal bone height changes, using the linear measuring system by Standardized digital peri-apical radiographs which were carried out using the parallel technique with GSX-700software to measure bone height changes mesialy and distally to each implant.[35]

The loss of the marginal bone at various intervals was determined by computing the alteration in bone height from the baseline measurement at each period. The results revealed that there was a nonstop rise in the loss of the crestal bone height all over the study for both groups, which remained within the acceptable range mostly due to the proper selection of the patients and proper follow up in addition to the resilient low profile locator attachment, although mean values in group (II) were greater than those in group (I) regarding to its superior surface properties, between the two groups there was no statistically significant difference exist , so null hypothesis of this study was accepted.

Conclusion

Considering the constraints of patient numbers, follow-up duration, and the findings of this research, it can be concluded that there was a consistent rise in crestal bone height loss across the study period for both but remaining within acceptable limits.

Although crestal bone loss was limited with SLActive implants, there was no statistically significant difference exist between the two groups during the period of study, so further studies may be required for medically compromised patients.

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Data availability: Available on request
Competing interest: The authors declare no conflict of interest, financial or otherwise.

References

1)Sutton AF. A Randomized Controlled Trial Comparing the Levels of Patient Satisfaction with Three Types of Posterior Occlusal Forms for Complete Dentures. The University of Manchester (United Kingdom); 2005.
2) De Moraes Flores P, Kern R, da Silva Tedesco A, Teixeira EF, Celeste RK, Brondani M, Mengatto CM. A qualitative analysis of denture wearing experience affecting the quality of life of older adults. Clinical Oral Investigations. 2023 Jul;27(7):3799-807.
3) Bedard JF, Cullum DR. Diagnosis and treatment planning for minimally invasive dental implant treatmen. InMinimally invasive dental implant surgery 2016 (pp. 3-27). John Wiley & Sons, Hoboken.
4) Pan YH, Yu LM, Lin TM. Dental implant-retained mandibular overdenture therapy: A clinical

study of patients' response. Journal of Dental Sciences. 2014 Jun 1;9(2):118-24.
5) Sharka R, Abed H, Hector M. Oral health-related quality of life and satisfaction of edentulous patients using conventional complete dentures and implant-retained overdentures: An umbrella systematic review. Gerodontology. 2019 Sep;36(3):195-204.
6) Elias CN. Factors affecting the success of dental implants. Implant dentistry: a rapidly evolving practice. Rijeka: InTech. 2011 Aug 29:319-64.
7) Kumar PS, KS SK, Grandhi VV, Gupta V. The effects of titanium implant surface topography on osseointegration: literature review. JMIR Biomedical Engineering. 2019 Jun 11;4(1):e13237.
8) Rupp F, Liang L, Geis-Gerstorfer J, Scheideler L, Hüttig F. Surface characteristics of dental implants: A review. Dental materials. 2018 Jan 1;34(1):40-57.
9) Dos Santos MV, Elias CN, Cavalcanti Lima JH. The effects of superficial roughness and design on the primary stability of dental implants. Clinical implant dentistry and related research. 2011 Sep;13(3):215-23.
10) Tuikampee S, Chaijareenont P, Rungsiyakull P, Yavirach A. Titanium Surface Modification Techniques to Enhance Osteoblasts and Bone Formation for Dental Implants: A Narrative Review on Current Advances. Metals. 2024 Apr 28;14(5):515.
11) Nevins M, Chen CY, Khang W, Kim DM. Clinical and histological efficacy of a new implant surface in achieving early and stable osseointegration: An in vivo study. International Journal of Oral Implantology. 2023 Jul 1;17(3).
12) Chambrone L, Shibli JA, Mercúrio CE, Cardoso B, Preshaw PM. Efficacy of standard (SLA) and modified sandblasted and acid-etched (SLA ctive) dental implants in promoting immediate and/or early occlusal loading protocols: a systematic review of prospective studies. Clinical Oral Implants Research. 2015 Apr;26(4):359-70.
13) Gittens RA, Scheideler L, Rupp F, Hyzy SL, Geis-Gerstorfer J, Schwartz Z, Boyan BD. A review on the wettability of dental implant surfaces II: Biological and clinical aspects. Acta biomaterial. 2014 Jul 1;10(7):2907-18.
14) Nicolau P, Guerra F, Reis R, Krafft T, Benz K, Jackowski J. 10-year outcomes with immediate and early loaded implants with a chemically modified SLA surface. Quintessence Int. 2019 Jan 25;50(2):114-24.
15) Trakas T, Michalakis K, Kang K, Hirayama H. Attachment systems for implant retained overdentures: a literature review. Implant dentistry. 2006 Mar 1;15(1):24-34.
16) Mirchandani B, Zhou T, Heboyan A, Yodmongkol S, Buranawat B. Biomechanical aspects of various attachments for implant overdentures: A review. Polymers. 2021 Sep 24;13(19):3248.
17) Wakam R, Benoit A, Mawussi KB, Gorin C. Evaluation of retention, wear, and maintenance of attachment systems for single-or two-implant-retained mandibular overdentures: a systematic review. Materials. 2022 Mar 4;15(5):1933.
18) Alqarni M. Measurement and comparison of retention load values between three implant overdenture attachment systems (Doctoral dissertation, University of British Columbia).
19) Laurito D, Lamazza L, Spink MJ, De Biase A. Tissue-supported dental implant prosthesis (overdenture): the search for the ideal protocol. A literature review. Annali di stomatologia. 2012 Jan;3(1):2.
20) Raghavan R, Shajahan PA, Manoj AA. Attachments used with implant supported over denture: a review. Int J Health Sci Res. 2021;6:105-9.
21) Bollineni U. A Finite Element Analysis of Stress Distribution in the Bone, Around Implant Retained Mandibular Overdenture by Comparing between Rigid and Resilient Attachment Configuration (Master's thesis, Rajiv Gandhi University of Health Sciences (India)).
22) Miler AM, Correia AR, Rocha JD, Campos JC, da Silva MH. Locator® attachment system for implant overdentures: a systematic review. Stomatologija. 2017 Jan 1;19(4):124-9.
23) Brandt S, Lauer HC, Fehrenz M, Güth JF, Romanos G, Winter A. Ball versus Locator® attachments: A retrospective study on prosthetic maintenance and effect on oral-health-related quality of life. Materials. 2021 Feb 23;14(4):1051.
24) Chavez SA. Retention of Implant-Retained Overdentures: A Comparison of Locator and Locator R-TX Retention Inserts (Master's thesis, The University of North Carolina at Chapel Hill).
25) Taleb FA, Abel-Aal ZM. Study of locator attachment effect in implant-assisted complete lower over denture opposed with dentulous versus edentulous upper arch. Tanta Dental Journal. 2017 Jul 1;14(3):139-47.
26) Shoeib A, Mansour M, El-Haddad D, Baraka Y. Bone Height Changes in Implant Supported Overdenture with Ball Attachments. Al-Azhar Assiut Dental Journal. 2020 Apr 1;3(1):25-31.
27) Hines M. Marketing implant dentistry: Attract and influence patients to accept your dental implant treatment plan. John Wiley & Sons; 2015 Oct 26.
28) Carlsson GE, Omar R. Trends in prosthodontics. Medical Principles and Practice. 2006 Apr 28;15(3):167-79.
29) Sener-Yamaner ID, Yamaner G, Sertgöz A, Çanakçi CF, Özcan M. Marginal bone loss around early-loaded SLA and SLActive implants: radiological follow-up evaluation up to 6.5 years. Implant dentistry. 2017 Aug 1;26(4):592-9.
30) Rupp F, Scheideler L, Olshanska N, De Wild M, Wieland M, Geis-Gerstorfer J. Enhancing surface free energy and hydrophilicity through chemical

modification of microstructured titanium implant surfaces. Journal of Biomedical Materials Research Part A: An Official Journal of The Society for Biomaterials, The Japanese Society for Biomaterials, and The Australian Society for Biomaterials and the Korean Society for Biomaterials. 2006 Feb;76(2):323-34.
31) Lang NP, Salvi GE, Huynh-Ba G, Ivanovski S, Donos N, Bosshardt DD. Early osseointegration to hydrophilic and hydrophobic implant surfaces in humans. Clinical oral implants research. 2011 Apr;22(4):349-56.
32) Jo HY, Hobo PK, Hobo S. Freestanding and multiunit immediate loading of the expandable implant: an up-to-40-month prospective survival study. The Journal of Prosthetic Dentistry. 2001 Feb 1;85(2):148-55.
33) Kulak Özkan Y. Attachment Selection for IOD (IROD/ISOD). InTreatment Options Before and After Edentulism: Implant Overdenture 2024 Nov 22 (pp. 147-216). Cham: Springer Nature Switzerland.
34) Merheb J, Quirynen M, Teughels W. Critical buccal bone dimensions along implants. Periodontology. 2014 Oct;66(1):97-105.
35) Mohamed M, El Homossany ME. Comparison of marginal bone loss and stability in locator and ball and socket assisted mandibular overdenture after immediate implantation and loading. Ain Shams Dental Journal. 2022 Mar 1;25(1):15-25.