RESEARCH ARTICLE Br J Med Health Res. 2023;10(05) ISSN: 2394-2967

BJMHR
British Journal of Medical and Health Research
Journal home page: www.bjmhr.com

Bone Changes Assessment In Screw-Retained Maxillary Implant Supported Complete Denture With Electric Welded Metal Framwor Versus Casted Framework(RCT, Split Mouth Trial)

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ABSTRACT

The aim of this study: is to assess bone height changes under screw retained maxillary implant supported complete denture using two types of framework casted metal versus electric welded at one year follow up period**.** This split mouth study on screw retained implant supported maxillary complete denture supported by 6 implants, where the study were conducted in two groups each participant maxillary ridge was blindly allocated to right or left side, either group I (metal casted framework group (the gold standard treatment choice or group II (intraoral electric welded framework) then both groups were received a picked up screw retained hybrid prosthesis sectioned in the mid line , palate less and reduced in the 2nd premolar area. Bone height changes assessment were evaluated by performing a standardized digital periapical radiographs using parallel technique(long cone technique) around each implant in both mesial and distal aspects. Through the 1 year follow up period there was a significant difference in increasing bone height changes though out the follow up period in both groups (casted group and welded group), whereas the electric welded framework shows the least amount of bone height changes. 1- there was bone height changes around implants through the whole follow up period in both groups, where bone height changes yields lower values in the electric welded group than that in the conventional casted group.

Keywords: Implants, hyprid prosthesis, cast metal framework, electric welding.

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Received 29 April 2023, Accepted 24 May 2023

Please cite this article as: Magdy S *et al.*, Bone Changes Assessment In Screw-Retained Maxillary Implant Supported Complete Denture With Electric Welded Metal Framwor Versus Casted Framework(RCT, Split Mouth Trial). British Journal of Medical and Health Research 2023.

INTRODUCTION

Complete edentulism is a devastating condition result in inferior impact on both oral and general health, even after using the complete denture it didn't fulfill the expected needs of the patients, therefore, introducing implants to resolve these complications seems to be the promising answer. Inserting six implants in the edentulous maxilla to support the future screw retained prosthesis, which in fact seems to be the best treatment of choice to solve the complications of the complete edentulism.

Screw retained prosthesis also known as fixed-detachable prosthesis have demonstrated successful outcomes in terms of force distribution and retrievability for many decades as well as the biological benefits in eliminating the inflammation in peri implant tissues and ease of repair, they were designed to be screwed either directly onto the implant or onto a screw-retained abutment positioned on the implant. Screw-retained prosthesis represent a secure and easy way as a prosthetic restoration.[1]

There are many techniques of fabrication of the fixed detachable prosthesis frameworks such as casted framework which are constructed in a castable pattern over the cast to be invested into different alloys (gold, base metal or titanium) alloys. This technique still needs many steps with a doubtful result due to distortion from laboratory errors.an other type is the milled framework which eliminate the errors resulted from the lost wax technique used in casted framework as a result better fit was obtained.

The casted framework even being the gold standard of framework types, but due to it's possible distortions, recently introducing techniques to adjust misfit such as soldering, laser welding, spark erosion and (CAD/CAM) procedures was the suitable answer.

Since 1970, laser welding has been used in the lab to join metal pieces of dental restorations. This procedure is superior to traditional techniques since it may be performed directly on the master cast, eliminating construction lab errors, welding close to resin or ceramic pieces without any damage and fatigue of restoration. Electric-welded connections have a high reproducible strength. Moreover, because the beam is restricted to a small area, temperature fluctuations do not induce deformities or stresses to implants or the surrounding tissues. it has been reported that the laser-welded titanium approach show superior passive fit which will reduce the stresses on implant bone interface result in less peri implant bone resorption.[2]

In fact as it had been reported in many studies, the bone height changes is affected by different types of framework. [3]

So, the question research ,Is the casted metal framework will affect marginal bone height more than electric welding when used under screw retained maxillary implant supported complete denture?

MATERIALS AND METHOD

Preoperative procedures: (Diagnosis for patients)

Study Design:

Split mouth design A two-arm randomized clinical controlled trial with a 1:1 allocation ratio was carried out using a computer-generated allocation system. Maxillary screw retained implant supported prosthesis was performed over six implants with two groups. Where a cast metal framework was used on one side (group I) and an electric welded framework was used on the other.

Bone height changes were measured using a standardized series of x-rays taken during the follow-up period (on the day of prosthesis loading, 6 months later, 9 months later, and 12 months later).

The age ranges from 45 to 65 years old, the absence of any medical disorder that could complicate the surgical phase or affect osseointegration as uncontrolled diabetics, and the patients were completely edentulous were the inclusion criteria. The patient must have a minimum bone length of 12mm, good oral hygiene, adequate inter arch space for screw-retained hybrid prosthesis greater than 15mm, and a proper attached gingiva thickness greater than or equal to 2mm.

Each eligible patient received both treatments and was randomly assigned to the right and left sides of the arch using a computer-generated system (each patient served as their control, intervention side, and control side (intervention side that was treated using an implant-supported prosthesis with an electric welded framework).

Radiographic Evaluation (Bone Quality assessment):

The trial upper dentures were duplicated to fabricate a radiographic stent for CBCT imaging using cold cure acrylic resin and gutta-percha to determine corresponding tooth locations, which helped in plane and measure both width and length of the bone for treatment planning of implants, and the patient was instructed to wear the stent during CBCT imaging by biting on a cotton roll.

The bone width and height were then measured using Blue Sky Plan Bio software (Blue Sky Bio, LLC, IL, USA) at the proposed implant sites to ensure that the width was not less than 5mm and the length was not less than 10mm.

Complete denture Fabrication

First, complete dentures were made

Following denture delivery, the patient's maxillary denture was duplicated using 1 mm thick hard vacuum sheets to be used as a guide in implant placement according to previous planning. Holes were made at the correspondents teeth position to aid in determining the site of drilling in each implant site.

Surgical Procedures:

The surgical steps in all cases are the same in order to achieve standardization, Implants are placed in accordance with the manufacturer's instructions. In each patient, 6 implants with diameters (4.1*10) were inserted at the crestal bone level in specific positions (positions 15, 13, 11, 21, 23, 25) before suturing the flap with resorbable material. The maxillary denture was relieved at the proposed implants position at the fitting surface of the denture so the patient could use the denture during the osseointegration period without any stress on the implants. Following a four month osseointegration period, second stage surgery was performed, and healing abutments were attached to the implants. Prosthetic procedures began 2-3 weeks after the healing collars were placed.

Prosthetic stage

After leaving the healing collars for 2-3 weeks to allow soft tissue healing, casted framework fabricated and electric fram work were done

Electric welded group

1-The following was the preparation stage: In exchange, a 1.5 thickness titanium bar (JD weld titanium wire, Moderna, Italy, 1.5mm in diameter) was shaped and bent in a staggered form to surround the implants from the mesial and distal sides, then at a pre prepared certain point (welding point) which was a prepared flat surface area on the shaping abutment (Shaping screw-retaind dental abutment, Biomate, Taiwan), titanium bar and shaping abutin all cases, with standardized parameters (wire diameter 1.5 mm, abutment 4.2 diameter, 25% power, and 2 pulses.

2- The welding procedure is divided into three steps: 1) the preparation phase, during which only pressure and no current are delivered; 2) the welding phase, during which pressure and current are delivered concurrently; and 3) the cooling phase, during which current is turned off but pressure is maintained .The welding process was electrical, with an argon gas supply protecting it (Syncrystallization). The machine is capable of welding metallic elements intraorally. The two metals to be welded were sandwiched between the two electrodes of a welding clamp. The framework was then removed from the mouth along with the abutments to be finished and polished before being reinserted. Both frameworks became ready for pickup.

Pick up stage

Tefelon was used to cover the screw holes in all shaping abutments to prevent pick up material from blocking the holes, and the denture was hollowed around the framework to ensure no rocking before the pickup process with hardliner. Following that, the denture was removed to be finished and polished, and the excess hardliner material was removed. Additionally, the palate less denture was reduced to follow the shortened dental arch (SDA) concept, and the final prosthesis was sectioned at the mid line, resulting in two separate super-structures**.** (Figure 1)

Figure 1: The final hyprid prosthesis (SDA)concept

Pressure indicating paste (PIP) was used on the tissue surface of the finished denture, in order to check the pressure areas in the final denture, then the sectioned denture in the mid line was screwed to the implants.

Table 1: Radiographic bone height changes assessment

Prioritization of Outcome	**Outcome**	**Measuring Device**	**Measuring Unit**
Primary Outcome	bone height changes	Digital Periapical radiograph Parallel technique	Mm

All parameters were measured at the time of prosthesis loading (T0), 6 months later (T1), 9 months later (T2), and 12 months later (T3). A charge coupled device (CCD) was used to take long-cone standardized periapical digital radiographies to assess peri-implant marginal bone loss.

To standardize exposure parameters, additional silicon impression material was mixed and applied between the maxillary screw retained restoration and the mandibular denture near each implant, then the patient was asked to close on the material to preserve the same sensor-implant distance as well as cone-implant distance (16 inch), and patient position was fixed during subsequent digital radiographs on the day of prosthesis delivery with the help of sensor p. After being set (customized jig), this customized bite block was used in subsequent digital radiographs. This modification resulted in standardized intraoral radiography and the ability to reproduce radiographic analysis.

The x-ray sensor was assembled to the customized jig on its place, and each customized jig was positioned on its place, and the patient was gently closed, followed by x-ray cone positioning with the holder ring patient exposure, and digital image creation for each implant for all patients at follow-up radiographic examination visits. The procedure was performed on the day of prosthesis loading for each patient, as well as six, nine, and twelve months later.

The accompanying software was used to trace the digital images, and bone resorption was calculated as the distance between the implant-abutment junction and the initial bone-to-implant contact. The established implant length and width were used to adjust for magnification in accuracies used to adjust image readings to their true values. The resorption of bone was averaged from the mesial and distal surfaces of each implant. (Figure 2)

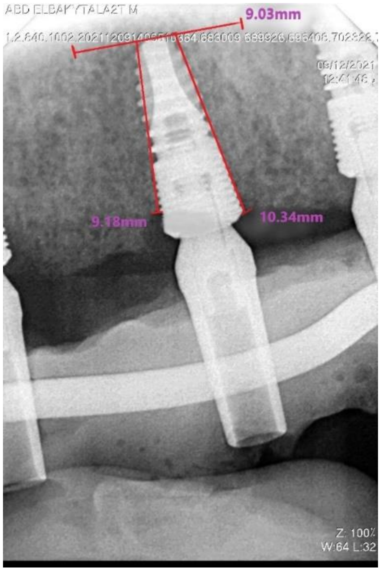

Figure 2: Measuring bone loss around implants

The amount of bone change was calculated by measuring the distance between two points: one at the implant's apex and the other at the most coronal bone at the crestal area surrounding the implant.

Because the statistician was blinded, all measurements were taken, collected, and sent to the statistician in two different groups, with no indication of which group was welded and which was cast.

RESULTS AND DISCUSSION

In group I, the comparison between different follow-up periods was made using the Repetitive One-Way ANOVA test, which concluded a significant difference between them as P 0.05 in overall, followed by the Tukey's Post Hoc test for multiple comparisons, which revealed a significant difference between means with different superscript letters as P 0.05, but an insignificant difference between means with similar superscript letters as $P > 0.05$ (Baseline).

Table 1: Mean difference and standard deviation of amount of bone changes between different intervals:

N=10	Group I		P value
	MD	**SD**	
Baseline – 6 months	-0.40 a	0.11	<0.0001*

MD: mean difference

SD: standard deviation

P: probability level which is significant at $P \leq 0.05$

Mean with similar superscript letters were insignificantly different as $P > 0.05$

Means with different letters were significantly different as $P < 0.05$

Bone height changes:

In terms of bone height changes between different intervals, comparing groups I and II revealed a significant difference as P 0.05 in (Baseline loading time) - 6 months.

Table 3: Mean difference and standard deviation of bone height changes at different intervals in both groups and comparison between them:

	Group I		Group II		P value
	MD	**SD**	**MD**	**SD**	
Baseline – 6 months	-0.40	0.11	-0.08	0.13	<0.0001*

SD: standard deviation *MD: mean difference*

P: probability level which is significant at $P \leq 0.05$

DISCUSSION:

Passivity is the primary concern with screw-retained frameworks. Because it is a passive fit, the adjustment should be performed with no tension on the retaining screws. A perfect passive fit is currently impossible, especially with screw-retained prostheses, and a misfit of 30 to 150 m has been deemed clinically acceptable. [4]

Internal stresses in the prosthesis framework, implants, and bone supporting the implant can cause mechanical complications like screw loosening, screw fracture, or framework fracture, as well as monolithic prosthesis fracture or biological complications like mucositis or peri implantitis. [5]

Different methods for assessing bone changes could be used, with varying degrees of reliability. Radiography is one of these techniques. Many studies chose digital intraoral radiography for bone height evaluation due to its ease of use and lower radiation dose (when compared to cbct). According to the literature, the intraoral radiograph has proven its dependability and accuracy in assessing bone height changes.[6]

Despite the fact that intraoral radiography only visualizes the mesial and distal bone, its superiority is enhanced by its high resolution and low dosage. When bone changes reach a certain level, it means that they can be detected radio graphically. Because early changes are difficult to detect, the use of digital radiography and specialized software to perform quantitative evaluations of bone height surrounding the implant was validated. As a result, quantitative intra-oral digital radiography was choosen.[7]

Standardized imaging and evaluation procedures are critical for reaching a trustworthy and correct conclusion. Using a radiographic film-holder to standardize specific criteria such as radiographic film position, X-ray beam angulation, and film-focus/film-object distance is critical for accurately repeating the projection geometry of the exposures at different times. Film holders help to reduce projection errors while also standardizing the superimposition effect.[8]

The current study's findings revealed that there were bone height changes around implants throughout the entire follow-up period, with a significant increase in the mean bone height changes in both groups, indicating increased crestal bone resorption in the first six months, which could be explained by the continuous remodeling process of bone surrounding the implant, resulting in bone resorption followed by bone deposition.[9]

The findings also revealed that the bone changes were greater from 6 months to 12 months than from loading to 6 months, which is similar to a study conducted to compare marginal bone changes around axial versus tilted implants to support screw retained prosthesis, which could be attributed to bone remodeling that occurs after implant placement and bone response to healing combined with functional stresses, the crestal bone resorption. The current study's mean marginal bone loss from baseline to twelve months is considered within accepted permissible limits for most dental implants.[10]

The main reason for the framework type's effect on bone height changes, as reported in the literature, is its passive fit condition, which ensures long-term implant restorative success. When no external forces are applied, a passive fit prosthesis places no strain on its infrastructure. Because of the numerous variables involved in prosthesis manufacturing, clinical passivity fit cannot be obtained. Misfits are thus a clinical reality; while they cannot be eliminated, the level of fit is acceptable.[11]

In 1991, Jemt defined passive fit as the threshold that ensured a problem-free long-term prosthesis and concluded that misfits of less than 150 microns were acceptable. Carr found no significant difference in bone response in baboons when two degrees of mismatch, 38 and 345 microns, were compared without functional loads. Michaels et al. found no differences in the mean% area of bone integration with up to 400 microns of misfit after 12 weeks. [12]

Another study on radiographic examination of cobalt-chromium framework fabricated by different techniques revealed mild bone loss during the first year of function and throughout the follow-up period with no relation to the superstructure materials.[13]

In group II, a mean change in bone height of -.43 mm was detected after 12 months of loading in the intraorally welded metal framework, which was also observed in a previous study that was conducted to assess the clinical and radiological outcomes of patients who were treated with fixed prosthesis supported by intraorally welded titanium framework; in fact, this study concluded that the intraorally welded titanium framework shows promising treatment option when compared to other treatment options.[14]

In contrast, a study conducted to evaluate an electric intra-oral welding technique for the construction of a prosthesis for edentulous jaws on the day of surgery reported no bone loss, and in some individuals, supportive bone formed around the implant surface, as described in two recent studies by Degidi et al. 2008 and Weng et al. where they observed the formation of newly laid down bone 2 mm above the level of the implants They mentioned that the surgical procedure and the implants were inserted 2 mm below the bone crest, which could be the reason.[15]

Many studies have found that different types of framework affect bone height changes. For example, when comparing titanium frameworks to gold frameworks, titanium frameworks had lower mean bone loss. Furthermore, Jemt et al reported that there were no statistical differences, implying that minor bone loss was comparable. Nonetheless, it has been reported that the laser-welded titanium approach provides a superior passive fit, reducing stresses on the implant-bone interface and resulting in less peri-implant bone resorption. Furthermore, other researchers found that cast metal frameworks caused more bone loss than carbon fibre frameworks and laser-welded titanium frameworks.[16, 17, 18]

In our study, the comparison of bone height changes between different intervals between groups I (casted framework) and II (electric welded framework) revealed a significant difference in all intervals in favour of the electric welded group, which may be due to inaccuracies that can emerge during impression and lab manufacturing procedures with conventional casted framework techniques, which are eliminated by intraoral welding techniques as well as.[19]

The acceptable amount of bone change in both groups could be attributed to the use of a shortened dental arch concept, which eliminates the cantilever effect as well as the even distribution of loads, resulting in a reduction in the amount of stress transmitted to the peri implant tissues.[20]

A study comparing the casted and welded frameworks found that measuring mean marginal bone loss in both groups revealed that the casted framework group had statistically higher mean bone loss levels than the welded framework group. The cause of this variation is unknown, but systematic flaws in framework design, changes in framework rigidity, changes in framework fit, and biocompatibility of the framework metal could all be factors.[21]

Mesial and distal bone level measurement in electric welded bar

CONCLUSION

Within the limitation of this study concerning the screw retained maxillary implant supported complete denture with electric welded metal framework versus casted one it was concluded that:

There was bone height changes around implants through the whole follow up period in both groups (electric welded and casted frameworks). It was revealed that in both groups the bone changes was greater in the period from 6 months to 12 months than the bone height changes from time of loading to 6 months after loading. On comparison between both groups it was found that the bone height changes yields lower values in the electric welded group through the follow up period (1 year) than that in the conventional casted group.

REFERENCES

1. Abdelwahab K, Abdalla M. Evaluation of Patient Satisfaction with Mandibular Screw Retained Hybrid Prosthesis Versus Mandibular Implant Over-Dentures Retained by Telescopic Attachments. Egyptian Dental Journal. 2021 Oct 1; 67(4):3457-63.
2. Khatami AH, Smith CR. “All-on-Four” immediate function concept and clinical report of treatment of an edentulous mandible with a fixed complete denture and milled titanium framework. Journal of Prosthodontics. 2008 Jan; 17(1):47-51.
3. Lesaffre E, Philstrom B, Needleman I, Worthington H. The design and analysis of split-mouth studies: what statisticians and clinicians should know. Statistics in medicine. 2009 Dec 10; 28(28):3470-82.
4. Hadi AM, Yilmaz B, McGlumphy E, Brantley W, Johnston WM. In vitro fit of CAD-CAM complete arch screw-retained titanium and zirconia implant prostheses fabricated on 4 implants. The Journal of Prosthetic Dentistry. 2018 Mar 1; 119(3):409-16.
5. Buzayan MM, Yunus NB. Passive fit in screw retained multi-unit implant prosthesis understanding and achieving: a review of the literature. The Journal of Indian Prosthodontic Society. 2014 Mar; 14:16-23.
6. 6.Cardaropoli G, Lekholm U, Wennström JL(2005). Tissue alterations at implant-supported single-tooth replacements: A 1-year prospective clinical study. Clin Oral Implants Res. 17(2):165-171.
7. Parashis A, Andronikaki-Faldami A, Tsiklakis K. Clinical and radiographic comparison of three regenerative procedures in the treatment of intrabony defects. International Journal of Periodontics & Restorative Dentistry. 2004 Jan 1;24(1).
8. Beschnidt SM, Cacaci C, Dedeoglu K, Hildebrand D, Hulla H, Iglhaut G, Krennmair G, Schlee M, Sipos P, Stricker A, Ackermann KL. Implant success and survival rates in daily dental practice: 5-year results of a non-interventional study using CAMLOG SCREW-LINE implants with or without platform-switching abutments. International journal of implant dentistry. 2018 Dec; 4:1-3.
9. Chiapasco M. Early and immediate restoration and loading of implants in completely

edentulous patients. International Journal of Oral & Maxillofacial Implants. 2004 Nov 2;19(7).

10. Hasan I, Keilig L, Bourauel C, Lückerath W. The effect of screw preload and framework material on the success of cementable fixed partial prostheses: A finite element study. Annals of Anatomy-Anatomischer Anzeiger. 2015 May 1; 199:58-66.
11. Haghi HR, Shiehzadeh M, Nakhaei M, Ahrary F, Sabzevari S. Effect of technique and impression material on the vertical misfit of a screw-retained, three-unit implant bridge: An in vitro study. The Journal of the Indian Prosthodontic Society. 2017 Jan;17(1):41.
12. Kallus T, Bessing C. Loose gold screws frequently occur in full-arch fixed prostheses supported by osseointegrated implants after 5 years. International Journal of Oral & Maxillofacial Implants. 1994 Mar 1; 9(2).
13. Jemt T, Bergendal B, Arvidsson K, Bergendal T, Karlsson U, Linden B, Palmqvist S, Rundcrantz T, Bergström C. Laser-welded titanium frameworks supported by implants in the edentulous maxilla: a 2-year prospective multicenter study. International Journal of Prosthodontics. 1998 Nov 1; 11(6).
14. Degidi M, Nardi D, Piattelli A. Prospective study with a 2-year follow-up on immediate implant loading in the edentulous mandible with a definitive restoration using intra-oral welding. Clinical oral implants research. 2010 Apr; 21(4):379-85..
15. Coli P, Jemt T. On marginal bone level changes around dental implants. Clinical Implant Dentistry and Related Research. 2021 Apr;23(2):159-69.
16. Delucchi F, De Giovanni E, Pesce P, Bagnasco F, Pera F, Baldi D, Menini M. Framework materials for full-arch implant-supported rehabilitations: A systematic review of clinical studies. Materials. 2021 Jun 12;14(12):3251.
17. Naveau A, Shinmyouzu K, Moore C, Avivi-Arber L, Jokerst J, Koka S. Etiology and measurement of peri-implant crestal bone loss (CBL). Journal of clinical medicine. 2019 Feb 1;8(2):166.
18. Gehrke P, Degidi M, Spanel A, Dhom G, Piattelli A. Intra-oral welding of temporary implant abutments with a pre-fabricated titanium bar: A new technique for accelerated rigid splinting of immediately loaded implants. International Magazin of Oral Implantology. 2005;3:6-13.
19. Karl M, Taylor TD. Bone Adaptation Induced by Non-Passively Fitting Implant Superstructures: A Randomized Clinical Trial. International Journal of Oral & Maxillofacial Implants. 2016 Mar 1; 31(2).
20. Ramanauskaite A, Galarraga-Vinueza ME, Obreja K, Sader R, Schwarz F. Prevalence of peri-implant diseases in patients with full-arch implant-supported restorations: A

systematic review. International Journal of Prosthodontics. 2021 Jan 1; 34(Suppl):s27-45..

21. Kammoun YA, El Sharkawy A, Khamis MM, Fahmy RA. Radiographic Assessment Of Bone Level Changes Around Four Implants Supporting Immediately Loaded Mandibular Screw-Retained Prosthesis. Alexandria Dental Journal. 2022 Aug 1;47(2):113-20.