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Soft Tissue Changes Assessment In Screw-Retained Maxillary Implant Supported Complete Denture with Electric Welded Metal Framework Versus Casted One (Rct, Split Mouth Design)

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ABSTRACT

This study aimed to assess the changes in the soft tissues in screw-retained maxillary implants supported complete denture with electric welded framework versus casted metal framework. Six implants were inserted in the edentulous maxilla of 11 patients after fabricating a complete dentures for each one, A split-mouth design was used in this study, where, either the left or the right side of the edentulous maxilla was blindly chosen to weld a titanium bar directly inside the patient`s mouth using electric welding machine, while with the other side the conventional casted technique for the fabrication of the metal framework was used, then both sides picked up with patient`s previously fabricated denture using hardliner, the soft tissue changes were investigated in the aspect of probing depth in four sites around each implant. Insignificant difference was found in the probing depth level between the two groups the conventional cast metal framework and the intraorally welding bar, the mean probing depth showed a reduction with time from 3.79 mm immediately after loading to 2.92 mm after 9 months of loading in the conventional group and from 3.79 mm to 2.88mm in the welded bar group. the intraoral electric welding technique presented a satisfactory outcomes in terms of the soft tissue changes, and with being cost-effective and a less time as compared with the conventional casting technique

Keywords: screw-retained, hybrid prosthesis, casting, intraoral welding

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INTRODUCTION

Screw-retained implant-supported fixed prostheses for full arch replacement are broadly used in implant treatment for edentulous patients and have showed a high long term success rate. Nevertheless, Implant-supported restorations, are subject to biological and mechanical complications. For the management of these complications, it is important to accomplish prosthesis passive fit and retrievability. Abutment-crown junction misfit has been showed increase these complications, among them, screw-loosening, screw fracture, frame-work fracture, possible implant fracture and marginal bone loss. The commonly used lost-wax casting technique, for the fabrication of metal frameworks on implant abutments, associated with many distortions. Furthermore, the long span metal framework requires sectioning and conventionally soldered to obtain passive fit.¹ The distortion equation, which is the total of all variables that affect how distorted a final implant prosthesis will be. This deviation stresses the implant-prosthesis system internally. When a functional stress (such, for example, anxiety) is added to this internal tension, the entire amount of stress might be tolerated because to biologic. Either tolerated or not, resulting in a biologic or prosthetic breakdown. According to the distortion equation, distortion can occur at the following locations: Impression-making process, pouring master casts, making wax patterns, framework fabrication, final prosthesis fabrication and final prosthesis delivery, all are equal to the final distortion.² Intraoral welding has been used for welding metal parts of dental restorations in the lab since 1970. This method is more advantageous than conventional technique, as it can be conducted directly on the master cast to eliminate risk of inaccuracies of the duplication of the model. The intraoral welding technique then showed to be an effective method in the complete arch immediate restorations of both the mandible and maxilla, with a fixed provisional restoration carried the on the day of the implant surgery³. One of the main parameters that are used to predict if the implants are surviving or would undergo a failure are the clinical parameters that included as the soft tissue changes, as far as we know the framework casting technique is the golden standard for the fabrication of the implant framework, in this study we will answer the question whether the intraoral welding of the metal bar to the implants using an electrical welding machine would have effect on the soft tissues around the implants or would it have the same effect as with the traditional casting technique.

MATERIALS AND METHOD

This split mouth study directed to assess the soft tissue changes around maxillary implants which are splinted using two techniques, first group (group A) with prefabricated metal casted framework and the second group (group B) with intra orally welded bar, with follow

up of immediately after loading, 3, 6, and 9 months after loading. The study was conducted at the prosthodontics department, faculty of dentistry, Cairo University, Egypt. Patients who were selected according to definitive inclusion criteria will be listed below from the outpatient clinic of the department of prosthodontics, faculty of dentistry, Cairo University, Egypt. A randomized, controlled, single-blinded, split-mouth, two-arm clinical trial was conducted. The patient were selected according the selected Inclusion criteria: Patients` age ranged from 30 to 65 years old. Patients were completely edentulous. The patients had enough bone height and width for implants minimum length of 10mm and a minimum diameter of 5 mm and showed good oral hygiene. The interarch space ranged from 12-15mm to be sufficient for fabricating screw retained prosthesis. Absence of any intraoral pathological condition. Also patients should comply with all the surgical and prosthetic steps and all the given instructions. The excluded patient were as the Patients with recent extraction of soft tissue still have not recovered (less than 3 months). Inflamed ridge or candida infection, para functional habits e.g. Bruxism Heavy smokers, more than 20 cigarettes per day

Preoperative procedures:

Diagnosis for patients by extraoral evaluation for the patient facial and lip support and smile line. And intraoral evaluation assesses the thickness of the mucosa, ridge shape, and width. The diagnosis also included prosthetic diagnosis (interarch space assessment) by making diagnostic casts, diagnostic bite and diagnostic arrangement of the teeth after mounting them on a semi-adjustable articulator. A measurement of the interarch space was then obtained by removing the upper trial denture from the articulator and measure the distance from the upper ridge to the occlusal plane of the lower trail denture, a distance of 12-15 mm⁴ required for the patient to be eligible for the fabrication of implant supported hybrid screw retained prosthesis. A putty index for the trial denture is made to be used later on as an index for the casted framework, in order to be included in boundaries of the denture. After which radiographic Evaluation (Bone Quality assessment) were performed by duplicating the upper trial dentures to fabricate a radiographic stent for CBCT imaging using cold cure acrylic and gutta-percha were used to designate the position of the implants to be placed to evaluate the bone quality and quantity. The patient was then instructed to wear the stent during CBCT imaging by biting on a cotton roll. The bone width and height then assessed using (Blue Sky Plan Bio software, BlueSkyBio software, LLC, IL ,USA) at the proposed implant sites, the minimum width was more than 5mm and the minimum length more than 10mm.

Intervention:

Each eligible patient received both treatments and randomly allocated to the right and left side of the arch (each patient served as his own control, the control side (group A) treated

using Casted technique (screw retained metal framework).and the intervention side (group B) treated using electric welding technique. All patients instructed about oral hygiene measures, soft diet for 4 weeks after surgery and anti- microbial prophylaxes (amoxicillin 500mg twice daily for 5 days starting 1 hour before surgery). Post-surgical analgesic treatment performed with ibuprofen 600mg twice daily.

Denture Fabrication:

First, for all patients complete dentures were constructed in as following: A Primary impression using alginate (CAVEX CA 37 NORMAL SET, Cavex Holland B.V. of Haarlem, The Netherlands) in order to fabricate diagnostic cast, and special tray. Secondary impression was taken using rubber base (Elite P&P putty - Medium viscosity A-Silicone, Zhermack Spa, Badia Polesine, Rovigo, Italy) to have master cast and occlusion blocks. A facebow (BIO-ART A7PLUS ARTICULATOR SEMI-ADJUST W/ QUICKMOUNT FACEBOW, Brazil) transfer and a centric relation record utilized to mount the master casts on a semi adjustable articulator. Maxillary and mandibular casts were mounted on the articulator. Setting of teeth on a semi adjustable articulator and trying the denture in the patient's mouth. Processing of acrylic and lab remounting. Delivery of the denture and follow up. Finally, patients were given all the instructions required for denture delivery.

Fabricating Surgical Stent:

After denture delivery the patient's maxillary denture were duplicated using 1 mm thickness hard vacuum sheets(Dental Lab hard Splint Material Thermoforming Dental Sheet Thermoform Plastic, Fencia) to be used as a guide to fabricate and surgical templates, holes were made at the correspondents' teeth position prepared for the first drill of the implant sires. Then the maxillary denture was modified to an implant-supported interim fixed prosthesis in the dental laboratory.

Surgical Procedures:

The surgical steps in all cases are the same to fulfill standardization in all cases which were as follow: Anesthesia with vasoconstrictor 1:100,000 epinephrine (Septodent, Canada) are used then a blade number 15 (Bard-Parker company, INC., USA.) was used for making incisions on the totally edentulous alveolar ridge on a round handled scalpel holder. Surgery began with a mid-crestal incision, a full-thickness flap was elevated, Crestal incision made from the first maxillary molar area extending to the contralateral side with vestibular releasing, taking into consideration a sharp clean cut is required. Mucoperiosteal flap elevated using Prichard elevator (CHL MEDICAL SOLUTIONS, Srl Via Felice Cavallotti, 15 20122 Milán – Italia). Surgical stent used to determine drilling sites according to the planning that has been done. Parallel pins were used to check that each osteotomy drilled is parallel with the others. Figure 1 Then, implants placed following manufacture instruction in each patient

6 implants(Biomate Medical Devices Technology Co., Ltd, TAIWAN (R.O.C)) were inserted at crestal bone level in predefined positions (positions 15, 13, 11, 21, 23, 25) with the help of a surgical template following a submerged healing protocol. No bone grafting material was used. Finally suturing the flap using resorbable (Vicryl Undyed Braided & Coated Absorbable Suture, Ethicon) material interrupted suture. A panoramic radiograph taken to ensure the position and the parallelism of the implants. Maxillary denture was relieved at the implants position so the patient could use the denture during the osseointegration period. After a 4-month osseointegration period, second-stage surgery was performed and healing abutments placed. Figure 2 After the second-stage surgery, prosthetic procedures will be initiated.

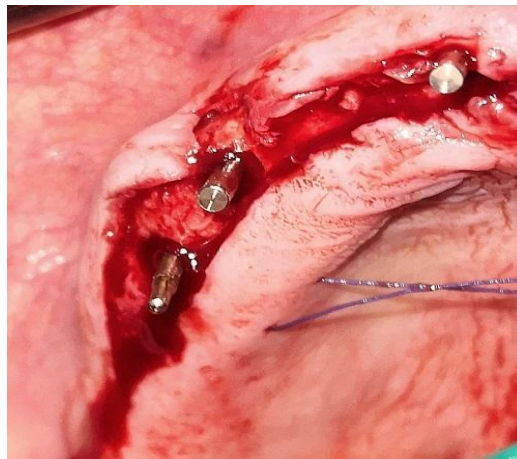


Figure 1: Inserting paralleling pins in the prepared osteotomies to check parallelism



Figure 2: Intraoral occlusal view after 2nd stage surgery showing the implants with healing collars

Prosthetic Procedures

Group A metal casted framework:

After a healing period of no less than 4 months, healing abutments were placed for 2-3 weeks for complete soft tissue healing, then the healing abutments removed and replaced with the transfer copings. For the cast metal framework group, UCLA abutments (healing abutments, Biomate Medical Devices Technology Co., Ltd, TAIWAN (R.O.C) (Titanium abutments

with a plastic castable sleeve) are fastened over the analogues (Biomate implant analogues, Taiwan.) of the placed implants, on an analogue model. For the preparation of the verified model, open tray (pick-up) impression copings (Biomate implant copings, Taiwan) are fastened to the placed implants, and an un splinted impression⁵ will be made using A-silicone putty and light body impression material (Hydrorise Zhermack Spa, Badia Polesine, Rovigo, Italy) (in a single step manner, using putty and light consistency addition silicone. A stone model is obtained after fastening of the implant analogues, fabrication of a gingival mask and pouring the impression using extra-hard dental stone. Over the obtained stone model, splinting of the open tray impression copings is performed using duralay (Duralay, Inlay pattern resin USA) resin to obtain a jig that will be further separated and re-splinted intraorally, over which a splinted pick-up impression will be remade. The new impression will be poured into extra-hard stone after fabricating a gingival mask (Xilgum, Lascod, Italy).

⁶ On the verified master analogue model, occlusion blocks are constructed for adjustment of vertical dimension and bite registration. Afterwards, UCLA abutments are fastened, followed by waxing, spruing and casting. The resultant framework will be tried inside the patient's mouth to insure passivity of fit with one screw test. In case of framework misfit, separation is performed using a disc, followed by intraoral splinting using duralay resin and soldering. After framework soldering, another try-in will be done to insure framework fit, then the final pick-up of the framework into the denture will be performed. The final prosthesis is sectioned at the mid line resulting in two separate supra-structure, after which they are screwed back to the abutments.

Group B electric welded framework:

A preexisting or prepared flat surface area served as the welding point. A 1.2 mm thickness titanium bar is shaped and bended following the curvature of the implants positioned in a staggered form. At this point, titanium shaping abutments then shaping abutments (Shaping screw-retained dental abutment, Biomate, Taiwan.) had been welded with the titanium bar in the oral cavity, using the Syncrystallization Unit (JDweld syncrystallization unit, Modena Italy). The welding process is electrical and protected by an argon gas supply (Syncrystallization) using the electric welding device Figure. 3. The equipment allows the welding of metallic elements directly in the mouth. The two elements to be welded (titanium bar and shaping abutment) were placed between the two electrodes of a welding clamp with firm pressure during the whole process. Continuous cooling during the welding process to reduce the heat generation. Figure.4 After 2 pulses they were directly welded together in the oral cavity using the Syncrystallization Unit with a standardized parameters in all patients (wire diameter 1.5 mm, abutment 4.2 diameter, 25% power and 2 pulses). The welding process is subdivided into 3 stages: preparation, welding, and cooling. The framework then

has been removed out of the mouth along with the abutments and the welding procedure was finalized extraorally using the same device and the same parameters and with continuous cooling, the abutments were polished, and then it was reinserted into the mouth. Figure 5 periapical radiograph taken to check the passive fit of the shaping abutments Figure 6 Finally, the prosthetic framework, created by welding the titanium bar to the implant abutments, is removed and finished and polished.



Figure 3: Intraoral welding device



Figure 4: Welding clamps with firm contact of the abutment and the titanium bar with continuous irrigation



Figure (5) the metallic framework welded to the abutments

a) extraorally to polish it before reinsert

b) intraorally after screwing

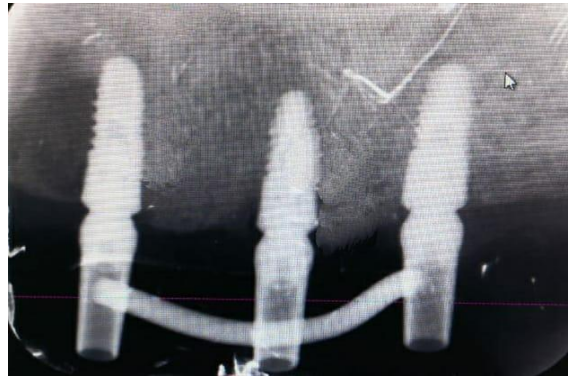


Figure 6: Periapical parallel radiograph showing welded bar

Pickup Procedure:

Next step is to pick up the both sides (casted framework and the welded bar) using the patient's denture, the denture hollowed around the framework and ensuring no rocking before the pickup process is performed with hardliner (Luxa pick-up material, DMG Chemisch-Pharmazeutische, Hamburg | Germany) .Teflon small pieces were inserted inside screw holes of the abutments, in order to ensure not to cover the screw holes with any pickup material .After the pick-up procedure was completed, the denture was removed to be finished and polished and the excess hardliner material was removed, in addition the denture was reduced to follow the shortened dental arch (SDA) concept. Figure 7 The palate part of the denture was also reduced and was splitted into two halves at the midline. Pressure indicating paste (PIP) (mizzy, Operatory, pip, Pressure Indicating Paste (PIP),USA.) was used on the tissue surface of the finished denture, in order to check the pressure areas in the final denture. Then the denture was screwed to the implants. Figure 8



Figure 7: Occlusal view the hybrid prosthesis show shortened dental arch (SDA) concept



Figure 8: Front view showing the sectioned denture with the occlusion

Outcome Measurement: The primary outcome measurement used in this study was the probing depth using periodontal probe, measured in millimeters. According to the Consensus report of workgroup 4 of the 2017 World Workshop, for the classification of the peri-implant diseases and conditions, the diagnosis the peri-implant health requires that the probing depth show no increase as compared to previous examinations.⁷ The height of the soft tissue at the site of the implant would determine the probing depth peri-implant health diseases can exist around implants with different levels of bone support. Probing depth was measured at four sites of each implant (mesiobuccal, distobuccal, mesiolingual, and distolingual) by using a manual periodontal probe (Williams Colour-Coded Probe; Hu-Friedy, Chicago, USA). Implant shoulder were used as a reference point as the abutments along with the welded bar were removed during the probing depth measurements. These data were then collected and delivered to the statistician, who was blinded in this study, the data were coded and group A (the side that received the casted framework) and group B (the side that received the welded framework). The outcomes were assessed at the time of delivery of the final prosthesis, three months, six months, and nine months after final prosthesis delivery.

RESULTS AND DISCUSSION

Statistical analysis

Statistical analysis was performed with SPSS 20®, Graph Pad Prism® and Microsoft Excel 2016. All quantitative data were explored for normality by using the Shapiro Wilk Normality test and presented as minimum, maximum, median, means and standard deviation (SD) values. The tests used: Shapiro Wilk Normality test for data exploration. Repetitive One Way ANOVA was to compare between all intervals of the same group of normal data. followed by Tukey`s Post Hoc test for multiple comparisons. One Way ANOVA was to compare between all surfaces of the same group of normal data. followed by Tukey`s Post Hoc test for multiple comparisons. Independent t-test to compare between both groups.

Normality exploration:

Exploration of the given data was performed using Shapiro-Wilk test and Kolmogorov-Smirnov test for normality. As Listed in Table 1, it was revealed that the significant level (P-value) was shown to be insignificant as P-value > 0.05, which indicated that alternative hypothesis was rejected, and the concluded data originated from normal distribution (parametric data) resembling normal Bell curve regarding probing depth of central incisor, canine and 2nd premolar, while difference between intervals revealed non-parametric data.

I. Group A (conventional technique): Mean and standard deviation of probing depth in central incisor, canine and 2nd premolar at T0, T3, T6 and T9 of group A was performed and revealed insignificant difference between them in all intervals as P > 0.05, as presented in table 2.

II. Group B (Electric welding technique) Mean and standard deviation of probing depth in central incisor, canine and 2nd premolar at T0, T3, T6 and T9 of group B was performed and revealed insignificant difference between them in all intervals as $P > 0.05$, as presented in table 3.

Table 1: Normality exploration of both groups:

		Group A	Group B
Probing depth	Central incisor	> 0.05	> 0.05
	Canine	> 0.05	> 0.05
	2 nd premolar	> 0.05	> 0.05

Table 2: Mean and standard deviation of probing depth in central incisor, canine and 2nd premolar at T0, T3, T6 and T9 of group A:

	T0		T3		T6		T9	
	M	SD	M	SD	M	SD	M	SD
Central Incisor	3.75 ^A	0.71	3.38 ^A	0.60	3.13 ^A	0.59	2.88 ^A	0.54
Canine	3.75 ^A	0.71	3.25 ^A	0.57	3.00 ^A	0.57	2.88 ^A	0.54
2 nd premolar	3.88 ^A	0.73	3.13 ^A	0.55	3.00 ^A	0.57	3.00 ^A	0.56
Overall	3.79 ^A	0.72	3.25 ^A	0.57	3.04 ^A	0.58	2.92 ^A	0.55
P value	0.9741 (ns)		0.8124 (ns)		0.9521 (ns)		0.9556 (ns)	

M: mean *SD: standard deviation*

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

Mean with the same superscript letters (lower case per row / upper case per column) were insignificantly different

Means with different superscript letters (lower case per row / upper case per column) were significantly different

Table 3: Mean and standard deviation of probing depth in central incisor, canine and 2nd premolar at T0, T3, T6 and T9 of group B

	T0		T3		T6		T9	
	M	SD	M	SD	M	SD	M	SD
Central Incisor	3.88 ^A	0.75	3.38 ^A	0.59	3.25 ^A	0.62	2.88 ^A	0.54
Canine	3.75 ^A	0.70	3.13 ^A	0.55	2.88 ^A	0.55	2.75 ^A	0.52
2 nd premolar	3.75 ^A	0.71	3.38 ^A	0.60	3.00 ^A	0.57	3.00 ^A	0.56
Overall	3.79 ^A	0.72	3.29 ^A	0.58	3.04 ^A	0.58	2.88 ^A	0.54
P value	0.9744 (ns)		0.7448 (ns)		0.5554 (ns)		0.7842 (ns)	

M: mean *SD: standard deviation*

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

Mean with the same superscript letters (lower case per row / upper case per column) were insignificantly different

Means with different superscript letters (lower case per row / upper case per column) were significantly different

Table 4: comparison between group A & B regarding probing depth in central incisor, canine, 2nd premolar and overall, at T0, T3, T6 and T9:

	Intervals	Group A		Group B		P value
		M	SD	M	SD	
Central incisor	T0	3.75	0.71	3.88	0.75	0.6953 (ns)
	T3	3.38	0.6	3.38	0.59	1.000 (ns)
	T6	3.13	0.59	3.25	0.62	0.6628 (ns)
	T9	2.88	0.54	2.88	0.54	1.000 (ns)
Canine	T0	3.75	0.71	3.75	0.7	1.000 (ns)
	T3	3.25	0.57	3.13	0.55	0.6376 (ns)
	T6	3	0.57	2.88	0.55	0.6376 (ns)
	T9	2.88	0.54	2.75	0.52	0.5902 (ns)
2 nd premolar	T0	3.88	0.73	3.75	0.71	0.6912 (ns)
	T3	3.13	0.55	3.38	0.6	0.3443 (ns)
	T6	3	0.57	3	0.57	1.000 (ns)
	T9	3	0.56	3	0.56	1.000 (ns)

M: mean *SD: standard deviation*

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

Table 5: Mean and standard deviation of probing depth level at different intervals in both groups and comparison between them:

	Group A		Group B		P value
	M	SD	M	SD	
Baseline	3.79	0.72	3.79	0.72	1.000 (ns)
After 3 months	3.25	0.57	3.29	0.58	1.000 (ns)
After 6 months	3.04	0.58	3.04	0.58	1.000 (ns)
After 9 months	2.92	0.55	2.88	0.54	0.8715 (ns)

M: mean *SD: standard deviation*

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

III. Comparison between group A & B:

1. Each tooth separately: comparison between group A & B regarding probing depth in central incisor, canine, 2nd premolar and overall, at T0, T3, T6 and T9 revealed insignificant difference between them regarding all intervals of central incisor, canine and 2nd premolar, as $P > 0.05$, as presented table 4.
2. Probing depth at all intervals: Comparison between group A & B revealed insignificant difference between them regarding all intervals as $P > 0.05$, as presented in table 5.

The study design is a split-mouth technique in which each qualified patient received both treatments the conventional cast framework and the intraoral welding bar, and was randomly allocated to the right and left side of the arch (each patient served as his own control). The split-mouth design's principal goal is to eliminate any components relating to subject differences from treatment comparisons. The error variance (noise) of the experiment can be minimized by using within-patient comparisons rather than between-patient comparisons,

resulting in a more powerful statistical test.⁸ Treating each patient with both types minimized the variables in each patient, these variables may affect the implant osseointegration for example bone quality and quantity, etc. In addition to the patient-related factors that may affect the soft tissue changes, which are of interest in this study, such as mucosal thickness, gingival biotype, the quantity of keratinized gingiva, susceptibility to infections, and history of periodontitis. In this manner, when assessing the clinical parameters such as probing depth, bleeding on probing, or gingival redness, the factors above mentioned are excluded and mainly the factors related the frameworks are measured. As explained, this study design is randomized in a way that only which half of the maxilla will receive the casted framework and which will receive the intraoral welded framework is randomized, the co-supervisor of this study was responsible for generating the random sequence and allocation concealment. The study included many technical and laboratory procedures for the fabrication of the metal casted framework. As differences between these procedures are noticeable, the operator and the technician involved in the study in addition to the outcome assessor were impossible to be blinded. Nonetheless the statistician were blinded. All aspects that may affect the osseointegration of implants were carefully considered in this study, from patient selection and later after prosthesis fabrication. These factors could be mechanical, biological, or both, the biological factors might be correlated to the patient's selection criteria, the steps of implant placement, and to oral hygiene level that were followed during patient selection and after restoration. In this study, a consecutive series of 11 patients with edentulous maxilla were restored after a protocol that introduced certain adjustments to the original process defined by Degidi et al⁹, in an effort to make the process simpler and with still predictable results. In each patient, 6 implants were placed in the maxilla to support the prosthesis. The rigid splinting with metallic bar help in reducing mechanical stresses applied on the single implants and guarantees a great distribution of the occlusal load reducing the lateral forces. The 6 implants were purposefully distributed in the upper jaws in the area of (15, 13,11,21,23, and 25), to use the load-bearing capacity of maxillary bone in a more favorable way. The selected positions of the implants led to the choice of a shortened occlusal arch for the prosthesis, ending with the first molar since the teeth supporting the higher functional load were preferred in correspondence of the fixture emergence, in this way minimizing the cantilever and subsequently reduced the risk factors.¹⁰ Bone quantity and quality were assessed radiographically to ensure the primary stability of the implant at the time of its insertion. Adding to that, patients with adequate buccolingual width at proposed sites of implants were only selected to ensure at least one mm. thickness of bone remaining lingual and buccal sides to the implant after its placement. As a study, implant-supported overdenture with a cast metal framework is considered an effective treatment modality for completely

edentulous patients. And it is a common treatment option for complete denture wearers, as well as this treatment modality has a lot of difficulties regarding to laboratory procedures and other issues.¹¹ Among these complications and difficulties, are the multiple and the extensive clinical visits required, the misfits between the framework and the abutments, which is unavoidable to a certain extent, whatever accuracy is followed during the impression making. As well as, the meticulous technical procedures required. Intraoral welding paved the way for splinting of implants immediately at the chair side in a simple and effective technique to avoid the complications above mentioned of casting the framework, also considered an effective method to prevent the misfit that occurs that may lead to the micro-movements which result in future fracture of the restoration or the loss of the implants at the end. Splinting multiple implants with metal bars intraorally using an intraoral welding technique has shown great success in cases of immediate loading, particularly in the maxilla, where sufficient rigidity is required to withstand occlusal forces and to aid in load transfer to protect the immediately loaded implants during the osseointegration process. An intriguing case study in 2014 argued the use of the intraoral welding technique for splinting implants immediately with pre-fabricated titanium bars on the abutments on the day of surgery, as well as to using the patient's prefabricated complete denture, after preparation, to be screw retained over the implant and welded framework, hence achieving esthetics and function provided by complete denture in addition to rigidity and passivity of the welded framework.¹² The titanium bar that was used in the welding group was of 1.2 mm diameter, this was in order to ease the bending of the bar around the abutments, the bending is done in a staggered form in order to reduce the axial forces.¹³ The crystallization and cooling phase is due to the huge difference in the thermal conductivity of the copper electrode tips and the titanium structures. The electrodes absorb the high temperature quickly inducing cooling and crystallization of the fused contact points of the titanium without resulting in harm to the neighboring tissues. Delayed implant loading were used instead of immediate loading to minimize the risk factors that may compromise the implant osseointegration, as type of bone, pattern of bone resorption and presence of maxillary sinus and the need for bone grafting. However, according to a meta-analysis¹⁴, as regard to the type of bone, the implants placed in the maxilla found to be at slightly higher risk than those placed in the mandible, the difference were statistically significant. Adding smoking in exclusion criteria is also for the reason to eliminate the potential risk factors, the literature advocates the evidence that smoking delays the prognosis of the dental implants in a dose dependent fashion. The abovementioned¹⁴ meta-analysis, concluded that smoking significantly increases the risk of early implant failure 1.3 to 2.3 times in accordance with other literature.

The abutments were used in the welding group were shaping abutments (titanium abutments) that enable the welding procedure due to the different thermal conductivity between the titanium and the copper of the two electrodes¹⁵ The framework misfit may lead to bacterial accumulation and micromovements at the defect site, leading to biological and mechanical complications. Previously, outlined clinical guidelines were followed in this study to avoid such complications¹⁶ A verification jig was used to record and assess the inter implant relation precisely, a dental stone verification jig to assess the passivity, and a radiographic examination to confirm the cast bar fit. An implant-supported hybrid prosthesis can be defined as a full fixed acrylic resin dental prosthesis supported by implants which is considered as a solution in extreme cases where the prosthesis is required for esthetics, function, lip support, and speech. For this purpose the treatment modality that was been chosen in this study in use the patient own complete denture to be the final prosthesis that is supported by 6 implants and splinted by a metal framework to enhance the rigidity of the final restoration. A systematic review conducted on 2021¹⁷, suggested that the choice between either 4 or 6 splinted implants-supporting a maxillary overdenture is not directly related to the clinical parameters detected. There was an advantage in the use of 6 implants instead of 4 implants due to the decreased implant length and diameter, poor bone quality and quantity, and thus, low primary stability could result in implant loss in the maxilla. In this situation, if an implant is lost, the use of a 6 implant could prevent a new surgical involvement and would just require an adaptation of the overdenture. Contrarily, when an implant is lost in the 4 implants approach, a new implant and prosthesis suprastructure are often needed before the overdenture can be adjusted. The decision to use the hardliner resin material for the pick-up procedure helped in eliminating the thermal reaction as it is made mainly from Bis-acryl based resins that proved to generate a significantly lower degree of heat during polymerization, making it the material of choice to potentially minimize thermal reaction.⁽¹⁸⁾, showing a good biocompatibility, because it does not contain any methyl methacrylate or hydrogen peroxide, it can be directly polymerized in the patient's mouth, which ensures a stress-free and strong hold for the attachments around implant. The 11 consecutively treated patients stated in this RCT were treated with the similar modified method and followed for more than 1 year. Of the 66 implants, No implants were failed, presenting a survival rate of the implants of 100%, which is similar with those attained in other clinical studies on maxillary implants, delayed loading.¹⁹ However, all the prostheses continued in place for the whole duration of the study, with a 100% survival rate of the prosthetic part, and no prosthetic complications, such as fracture of the acrylic resin or teeth, was seen during the follow-up period. The patient, both during intraoral welding and in the following days, showed neither trouble nor pain and had no problems with the dental and

periodontal structures of the support elements. The soft tissue changes were reported using probing depth parameter around each implant in four sites (mesio-buccal, mesio-lingual, disto-buccal and disto-lingual) this outcome was assessed at same day of the delivery of the prosthesis, 3 months, 6 months and 9 months after the final loading. The measurement was done using periodontal probe .A mean probing depth of 2.92 mm after 9 months of loading was observed in cast metal framework group, which is thought to be a regular phenomenon around implants. An interesting finding was the decreasing tendency in probing depth between immediately post-implant loading (3.79 mm) and upon study termination (2.92 mm). Comparable reduction in pocket depth was reported to decrease during follow-up period for maxillary supported cast bar overdenture prostheses in a study by Lehmann et al.²⁰ and was reported by earlier literature similarly.²¹ Contrarily, it was reported a significant increase in PD from T0 to T12 months for bar retained mandibular overdentures.²² While the mean probing depth around implants in the intraorally welded bar was (2.88) mm after 9 months of loading. Again the probing depth tended towards reductions from 3.79 mm at baseline (directly post loading) and upon 9 months of loading the probing depth was 2.88 mm, in accordance with a study by Fanali et al that reported the probing depth under electric welding of titanium bar intraorally < 3 mm²³, and the same reduction tendency in the pocket depth measurements were stated in a prospective study.²⁴ In addition the reduction in the cast group might be attributed to measures were taken to avoid the misfit of the framework which may lead to bacterial accumulation and micromovements at the defect site, leading to biological and mechanical complications. The difference between the conventional cast side and the welding side might be attributed to the fact that the intraorally welded bar allowed the creation of a passive prosthetic structure and lack the micromovements accompanied with the cast metal frameworks that might transmit those stresses to the tissues around the implants.²⁵ The reduced PD in both groups may be due the use of short dental arch (SDA concept) leading to the reduction in the cantilever length of denture saddles, increased anterior-posterior spread, provided enhanced and wide load distribution causing in reduced peri-implant bone stress.¹⁹ Intraoral welding is a useful procedure for quickly and directly creating a very precise rigid framework inside the oral cavity. Degidi et al, reported this procedure in several studies. They report a 6-year cumulative survival rate of 92.12 percent for implants placed in the maxilla and intraoral welded.²⁶ Biomechanical implant complications have been linked to several factors such as the bone quality, presence of para-functional habits and prosthetic design as well as implant number and distribution. In implant-supported fixed prostheses, an ideal biomechanical distribution of stresses at the prosthetic superstructure and implant design is of dominant importance, being affected by several factors such as correct prosthetic design and occlusal scheme. Furthermore, accomplishing less stress in an implant-

supported restorative system is one of the principal goals of implant treatment. Overall, this treatment approach seemed to be reliable and it expedited the creation of a definitive prosthesis directly in the patient`s mouth without the extensive and detailed laboratory steps. The prosthesis delivered to the patient was a durable one, lessening treatment costs and time for both the clinician and the patient. Additional evaluation with an increased number of cases and a longer follow-up is warranted to confirm the long-term reliability of the proposed technique.

CONCLUSION

Within the limitation of this study, it demonstrated the possibility to rehabilitate the edentulous maxilla successfully with fixed permanent screw-retained prosthesis supported by intraorally welded titanium bar without inducing harmful changes in the soft tissues around the implants, obtaining similar results to the conventional standard treatment option with cast metallic framework.

RECOMMENDATIONS

More extended investigations over longer follow-up periods are required for a better determination for the long-term success of this approach. Greater sample size is required in order to verify the results obtained in this study.

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