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The Use Of Computer Assisted Planning To Increase The Predictability Of Intra Oral Welding Technique Of Dental Implants - A Clinical Study

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Abstract:
Background*: substantial progress has been made in terms of the immediate placement of dental implants after tooth extraction. In cases were the bone is healthy with no atrophy, Periapical lesions, infection and enough bone component is available immediate implant is considered. Recently implant abutment welding was introduced specially for those edentulous patients who need immediate loading and who wanted to go out of the surgery with full load of teeth and a perfect esthetics and function.*
Materials and Methods*: In this prospective randomized controlled study, 8 patients of ASA physical status I and II belonging to age group of 50-60years undergoing dental implants, welding and immediate restorations were randomly allocated into 2 groups of 4 patients each, Group A with intraoral bending of wire and Group B in which wire was pre bent on a STL model before surgery (computer aided)*
Results*: There was no significant difference between stability values measured at different intervals*
Intra-operative time and bone loss measured in group (B) was significantly higher than that measured in group (A)
Conclusion: *The use of computer assisted planning to increase the predictability of intra oral welding technique of dental implants saves much time intra operatively and preserves bone from being lost*
Keyword*: Computer guided, STL model, wire bending, implant welding, stability, osseointegration, time consumption*

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I. Introduction

Edentulism is the complete loss of all dentition [(1)]. According to the World Health Organization (WHO) criteria, edentulous patients are considered to be physically impaired, disabled, and handicapped due to their inability to masticate and speak properly [(2)].

Edentulism occurs because of many diseases, such as periodontal problems, dental caries trauma and oral cancer. Social and/or behavioral factors have led to this condition or disease [(3)].

The latest researches show that Edentulism is not condition related to gender which means both men and women become Edentulous equally [(4)].

Edentulous patients are usually associated with poor nutrition and diet, osteoporosis, and higher risk of having coronary artery disease and hypertension. It was stated that edentulous patients are more likely to be smokers and have smoking-associated diseases such as cancer, asthma and emphysema. Some studies indicate that Edentulism is one of the main problems that can affect the quality of life, where patients report to have unsatisfactory esthetics and lowered self-esteem [(3, 5)].

Complete denture rehabilitation is one of the most traditional and popular prosthodontics treatment options for complete edentulous patients who have systemic, anatomic, and/or financial problems [(6)]. Successful outcomes of complete denture patients may depend on prognostic factors such as patient demographic, age, and attitudes. Personal traits and other psychological factors, expectations, previous denture experience, residual ridge anatomy and form, dentures quality and changes over time, ways of construction, and esthetics. Although there has been so much debate on the influence and significance of these factors on the denture therapy outcome, one thing that is certain is the prolonged denture use sequelae [(7)].

So many denture wearers said that they keep their dentures a secret from friends, family members, siblings and others. In addition some denture wearers (patients) may avoid certain social situations, such as

eating at weddings and parties, and avoiding socialism, job interviews and networking with other professionals [8].

Dental implants is one of the solutions for this problem which is a prosthetic device of alloplastic material that can be put into the oral tissue beneath the mucosal and periosteal layer inside the bone to provide support and retention for both fixed and removable prosthesis [9]. Many studies have documented high success rate of Osseo integrated titanium dental implants to support fixed restorations and /or removable over dentures for partially dentate or completely edentulous patients [10-12].

There are many ways to use dental implants as tooth replacement in edentulous patients some of these ways are the conventional way, over dentures, all on four techniques and all on six techniques.

Implant supported restorations show high success rates [13, 14]. Reconstruction by implant-supported single-unit crowns or fixed bridges represents a valid way to rehabilitate partially edentulous patients [15-17]. Long-term data and researches of implant-supported fixed prostheses or over dentures in edentulous jaws are available and present a reliable treatment [18].

Over denture is a removable dental appliance that covers and rests on one or more remaining natural teeth, the roots of natural teeth, and/or dental implants [19]. Implants supporting over dentures have been shown to provide a successful long-term result, especially when used to rehabilitate edentulous patients [20, 21]. High Implant survival rates and patient satisfaction has been reached with this treatment option [22].

The number of implants used depends on the type of prosthesis and the choice of the design of the prosthetic. The number of implants that can be placed with respect to anatomic-morphologic conditions will determine to a certain degree the design and type of the prosthesis. In addition to that the curvature, size and shape of the ridges determine the distribution of the implants over the arch.

The principle of the all-on-four concept is to use four implants in the anterior part of complete edentulous patient to support a provisional, fixed, and immediately loaded prosthesis. The two most anterior implants are placed axially, whereas the two posterior implants are placed distally angled this is to minimize the cantilever length and also to allow the application of prostheses with up to 12 teeth. Final prosthetic solutions can either be removable dental prostheses or fixed (FDP) [23-25].

The principle of All-on-6 treatment was designed for immediate use. This principle is used to replace all of the upper and/or lower set of teeth. Moreover so many patients have benefited from restored teeth since its inception and are a better, stronger, healthier replacement for dentures.

Immediate loading aim is to reduce the healing time, in the one-stage technique implants are immediately loaded with prostheses. Depending on the situation, immediately load implants can result in similar or even less marginal bone loss compared to delayed implant loading process [26,27], many approaches have been used to fabricate the full arch fixed prosthesis for the one-stage technique. A temporary prosthesis is constructed in many cases, installing the temporary copings over the implants and picking them up using the patient denture [28, 29]. This prosthesis does not have a metal bar and needs to be replaced. When full-arch immediate prostheses are made with the metal reinforcement they can be used as permanent appliance, or in other difficult cases, tooth exchange can be done after the period of Osseointegration.

In case of immediate loading adequate stability and fixation of implants are very important conditions in order to prevent the risk of micro movements and losing implants. Rigid splinting have an important role in response of peri-implant tissues, as it is able to reduce stress exerted on implants; the immediate fixation of more implants can be achieved by intraoral welding of abutments.

Intraoral welding gives immediate retention to Osseo integrated implants. The method consists in welding a titanium bar directly to the abutments in the oral cavity before the immediate loading. The main advantage of intraoral welding is placing definitive restoration on the same day of surgery, or few days later. In fact, the lack of retention and stability of denture is the main discomfort complained about by totally edentulous patients.

Degidi and coll have published many studies about immediate loading of multiple implants by welding a titanium bar directly on abutments in order to create a metal reinforced definitive or temporary restoration. The results showed that two-piece implant is not that effective as one piece implant for intraoral welding [30-37].

II. Material And Methods

This prospective comparative study was carried out on patients of Department of study done in Department of oral and maxillofacial surgery, Ain Shams University specialized hospital, Cairo, Egypt from September 2022 to September 2023. A total 8 adult subjects (both male and females) of aged 50-60 years were for in this study.

Study Design: Prospective open label observational study

Study Location: study done in Department of oral and maxillofacial surgery, Ain shams university specialized hospital, Cairo, Egypt

Study Duration: September 2022 to September 2023

Sample size: 8 patients

Subjects & selection method: The current study included 8 completely edentulous patients who were rehabilitated with fixed full mouth restoration over dental implants. The patients were recruited from the outpatient clinic of Ain Shams University – Oral and Maxillofacial Surgery Department. Patient included in this study were selected from those were seeking rehabilitation of their complete Edentulism by immediate loading of dental implants. All patients signed informed consent after approval of the ethical committee.

Inclusion criteria:
1. Males and females with age range 50-60 years old
2. ASA I & ASA II
3. Patients having fully edentulous arch either maxilla and/or mandible
4. All Patients had the same complain of being edentulous and signed the informed consent before the procedure.
5. Opposing dentition either natural dentition or fixed restoration

Exclusion criteria:
1. Patients who require horizontal ridge augmentation or with horizontal ridge dimension less than 6.5 mm
2. Patients who require vertical ridge augmentation or with vertical ridge defect
3. Patient with active acute infection related to edentulous arch and diseases affecting bone healing
4. Patients smoke more than 10 cigarettes per day
5. Pregnant or lactating mothers
6. Alcohol and drug abuse
7. presence of residual lesion related to the planned implant sites
8. disease of the immune system or any medical condition that may influence the outcome (uncontrolled diabetes), Neurological disorder and systemic infections
9. patients with history of bisphosphonate use
10. patients had treatment with radiation therapy in the craniofacial region with the previous 12 month
11. Patients with past history of bruxism before losing the teeth and being edentulous

Grouping:
Each patient received a number of dental implants distributed on the edentulous jaw
The patients were assigned into 2 groups using a coin toss to be either in Group A or Group B
Group A: included 4 patients who were rehabilitated with a 4-6 implants per arch. The abutments in each patient were connected with a 2 mm thick titanium wire that was pre bent on STL model prior to surgical phase. The wire was intraorally welded to the abutments .The implants were immediately loaded with a resin modified Acrylic restoration in full occlusal loading.
Group B included 4 patients who were rehabilitated with 4-6 implants per arch. The abutments in each patient were connected with a 2 mm thick titanium wire that were bent intra orally after implant insertion .The implants were immediately loaded with a resin modified acrylic restoration in full occlusal loading

Methods:
1: Preoperative patient records and preparation
i. Preoperative extra oral and intra oral photographs were taken for the diagnoses and planning the esthetic solution of the patients
ii. Clinical examination of the edentulous site or areas of extraction to ensure absence of infection or any signs of inflammation.
iii. Primary impression was made to make the study cast
iv. Study model were casted
v. CBCT radiograph[1] was requested to evaluate the edentulous site. Radio graphical examination by low dose Cone Beam Computed tomography was accomplished to assess all ridge dimensions (Buccolingual and Mesiodistal dimensions)

[1] Planmecca romexis mid

vi. Acrylic dentures were made for each patient
vii. Fabrication of surgical guide for both groups and STL model for group A

Pre-operative impressions were made to obtain pre-operative casts, mock ups STL models (for pre bending the welding wire) and diagnostic waxing ups were prepared on the casts as well as Surgical guide using polyvinyl sheets will be formed

To create a dental surgical guide and STL model for edentulous arches (Group A patients arches) for precise implant insertion, impression was taken for the patients for creating a dental model capturing the patient's oral anatomy accurately. The impression was scanned to create a digital model. This was done using desktop scanner[2].

A removable denture was made for the edentulous arch and a radiopaque markers were added on it. We used dual scan protocol for the process that is scanning the denture alone with CBCT then scan it again while the patient is wearing it in place while biting. We used a digital program[3] to import dicom data of the denture scan on the scan of the patient while wearing the denture with the aid of the opaque markers so we have the shape of bone and denture in place with mucosa as well. Virtual implants ancourage pins in place of the plan for surgical guide formation

A surgical guide was designed based on the digital model. This guide helps for precise placement of the implants in the planned locations on the software. The final step involves converting the digital model into an STL file and 3D printing the physical model. The 3D printed model aids in the fabrication of the surgical guide.

There are generally two main types of dental surgical guides:
1. Static Surgical Guides: These are guides that are stationary and are designed with specific pre-planned positions to aid in accurate implant placement during surgery.
2. Dynamic Surgical Guides: These guides use real-time tracking technology to guide the surgeon during implant placement to adjust for any changes in position or angle during the surgery.

The surgical guide were classified according supporting surfaces as well and the condition of the patient into:
1-Teeth supported surgical guide
2-Bone supported surgical guide
3-Soft tissue supported surgical guide

For formation of the STL model we used same steps and then we added abutments for the implants on the same long access of the virtual access on the plan that is a bit longer than expected in patient mouth and the final step involves converting the digital model into an STL file and 3D printing the physical model with the abutments are connected on it

Types of dental STL models that can be used for edentulous patients for implant insertion include:
1. *Master Models*: These are detailed representations of the oral anatomy and are used for precise planning of the implant placement.
2. *Surgical Guides*: These guides are created to assist dentists during the implant surgery. They ensure accurate placement of the implants in the edentulous areas.
3. *Diagnostic Models*: These models are helpful for visualizing the patient's condition and planning the treatment accordingly.

Preoperative Medication

Prophylactic antibiotic were given to all subjects 1 hour prior to the surgical procedure using 2 gm. Ampicillin intra muscular injection. Patients were asked to rinse with an antiseptic mouthwash containing chlorohexidine" For 5 minutes before the surgical procedure

2: Surgical phase

1. local anesthesia were done to the target patients (using articaine 4 % 1/100000 epinephrine[4])
2. Extraction of any remaining roots, loose teeth or unrestorable teeth is done and Clinical examination of extracted site to ensure absence of infection or any signs of inflammation before surgery
3. A mucoperiosteal flap were reflected after a crestal incision were made expose the alveolar bone at the site of implants placement.
4. Surgical guide were fixed in place by positioning screws

Medit I 600 scanner [2]
Blue sky plan [3]
Artpharm dent , Cairo - Egypt [4]

5. Drilling by pilot drill, twist drill then final drills and implants[5] were secured in their sites.(According to manufacturer)
6. Abutments were secured on the implants
7. In Group A we started welding the pre bent titanium bar in place while in Group B we did the bending in operation room inside the patients mouth (time should be calculated in both groups)[6] then start welding
8. Determining the value of primary stability by using Resonance Frequency Analysis Device[7]

Surgical Technique and Prosthetic immediate loading technique:

On all the implant sites local anesthesia was administered via infiltration technique on the buccal and lingual or palatal sides using articaine with concentration 4% 1:100000

A one line crestal incision was performed over the edentulous ridge joined by a releasing incision to the surgical site whenever needed, then the flap was reflected, and the ridge of the surgical site was exposed and the surgical guide was fixed in place (figure 1)

The implant site was prepared by sequential drilling according to the manufacturer's instructions that was pre specified Surgical drills starting with the first drill (the pilot drill) was inserted via a hole created in the midocclusal surfaces through the surgical guide made prior to the surgery (figure 2)

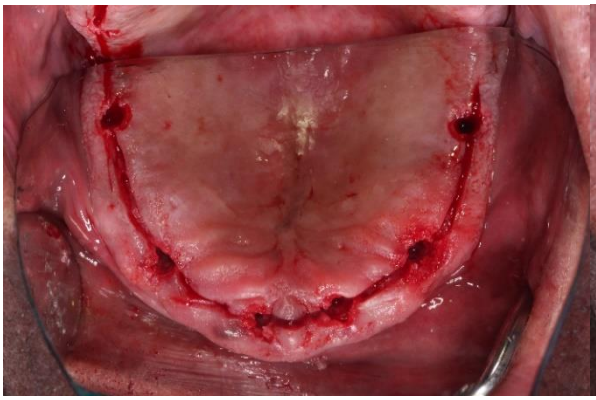


Figure 1 surgical incision

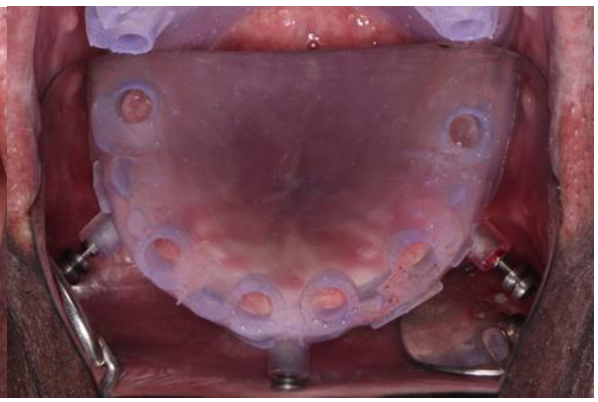


Figure 2 surgical guide in place

Implants were introduced into the prepared osteotomies through the edentulous area on each arch.

These implants had no hexed conical connection and their abutments had platform switching design'. Peak Insertion Torque (PIT) was measured and recorded at this time using the torque wrench that was provided by the implant manufacturer.

On the control side, the same procedures of local anesthesia, crestal and releasing incisions, drilling for implants placement, implants insertion and PIT recording was performed

For each implant inserted, Implant Stability Quotient (ISQ) values were measured on two opposing sides using Resonance Frequency Analysis device (Ostell) and the results were recorded and tabulated for statistical analysis. This was made immediately after surgery, 3 month and 6 month after surgery.

The implants received the welding abutments. Those abutments were actually one type of impression copings of the same system that had a long architecture and had the ability to withstand the heat of the welding.

A titanium welding wire having a thickness of 2mm' was cut to fit the length between all abutments and adjusted clinically to be touching all abutments at the same time. Wire bending and cutting took place using a special kit designed for this procedure.

In group A wire cutting and bending were done on the STL model prior to the surgery while in group B wire cutting and bending were done inside the patient's mouth and Time was recorded using stop watch in both groups.

The titanium wire was welded to the abutments for both groups utilizing an intra-oral welding device[8] adjusted to high voltage mode (figure 3 and 4)

[5] Vetronix Implants
[6] Stop watch
[7] Ostell
[8] Smart IW, Made in Italy

Figure 3 frontal view of welding

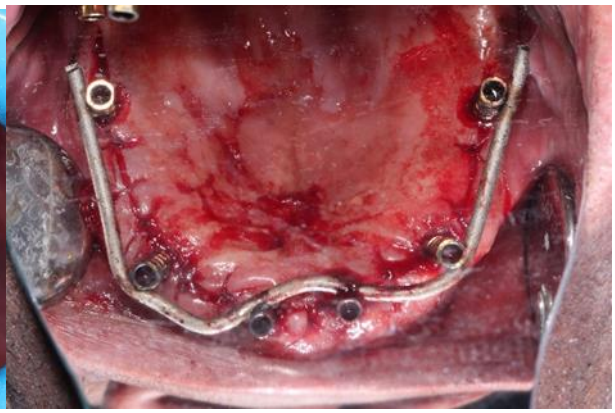


Figure 4 occlusal view of welding

After the abutments were welded together with the wire inside the patient's oral cavity, they were removed by unscrewing and re-inserted to make sure they fit over the implants passively without undue pressure on the implants. Post-operative suturing of the flaps was accomplished via multiple interrupted sutures on both side with vicryl type suture material .An open tray impression was made using additional silicone material and sent to lab for the preparation of an immediate temporary fixed acrylic denture

Surgical site were immediately loaded using the pre-operative made acrylic Resin denture that was then seated over the abutments and surgical sites

After the make of the temporary fixed denture with the abutments and welding bar located inside it is placed in place after removal of the removable temporary denture (figure 5 and 6). The occlusion was adjusted on each side to provide full occlusal contact in centric occlusion, but it was a light contact as determined by the contact points made by an articulating paper as well as it was free of interferences in lateral excursions .

Figure 5 acrylic temoporary Denture

Figure 6 Temporary acrylic denture after insertion

A final polishing was performed, and the restorations were delivered to the patient after its modification.

Finally, occlusion was rechecked to make sure that both sides were not out of occlusion but achieving proper occlusal loading in centric relation.

3: Postoperative phase

Postoperative instructions

1. Cold fomentation for the first 24 hours.
2. Warm mouthwash on the next day.
3. Oral hygiene recommendation.

Postoperative medication

1. Amoxicillin 875+clavulanic acid 125 antibiotic[9] for 5 days 2 times daily tab for 1 week after the surgery
2. Non-steroidal anti- inflammatory drugs[10] for 5 days 3 times daily (diclofenac potassium 50mg tablets), thereafter only if they were needed for pain relief.

Augmentin [9]

3. Antiseptic mouthwash[11]: 3 times daily starting from the second day postoperatively and then for two consecutive weeks. "With chlorohexidine anti septic material

Diet protocol
The patients were instructed to follow a soft diet protocol for 3 months post-operative

4: Methods of evaluation*:*

- Periapical radiograph were done immediately, post-operative 3 months and 6 months by paralleling technique for calculating crestal bone loss using a digital program[12] by measuring the bone loss by a ruler on the system in millimeter starting from the top of implant surface as a reference point to the point of first contact of the bone with the implant (Figure 27) this was done for both sides (mesial and distal) of each implant on the Periapical radiographs.
- Implant stability quotient (ISQ)[13] on immediately and after 3 months and 6 months. In which a smart peg were connected to the implant and the resonance frequency analysis device tip were used to evaluate the stability of the implant from 3 sides (Buccal , mesial and distal) and the average reading were taken.
- Time of bending were evaluated intraorally and on STL model using a stop watch staring on the second we started bending the wire and finished at the moment the wire was ready for welding intraorally
- Statistical analysis were recorded and tabulated using SPSS analysis.

Data Management and Analysis:

The collected data was revised, coded, tabulated and introduced to a personal computer using Statistical package for Social Science (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22. Armonk, NY: IBM Corp).
Data was presented and suitable analysis was done according to the type of data obtained for each parameter.
I. Descriptive statistics:

- Mean.
- Standard deviation (± SD).
- Minimum and maximum values (range) for numerical data.
- Frequency and percentage of non-numerical data.

II. Analytical statistics:

1. Paired-Samples T Test was used to assess the statistical significance of the difference between two means of one quantitative variable measured twice for the same study group.
2. The Independent-Samples T Test was used to assess the statistical significance of the difference between the means of both groups.

P- Value was set that:

- P>0.05: Non -significant (NS).
- P< 0.05: Significant (S).
- P<0.01: Highly significant (HS).

3. Lin's concordance correlation coefficient to assess intra-examiner error. The concordance correlation coefficient evaluates the degree to which pairs of observations fall on the 45° line through the origin. Strength of agreement criteria for Lin's concordance correlation coefficient:

- < 0.90 Poor
- 0.90 - 0.95 Moderate
- 0.95 - 0.99 Substantial
- >0.99 Almost perfect

III. Result

Demographic data and baseline characteristics:

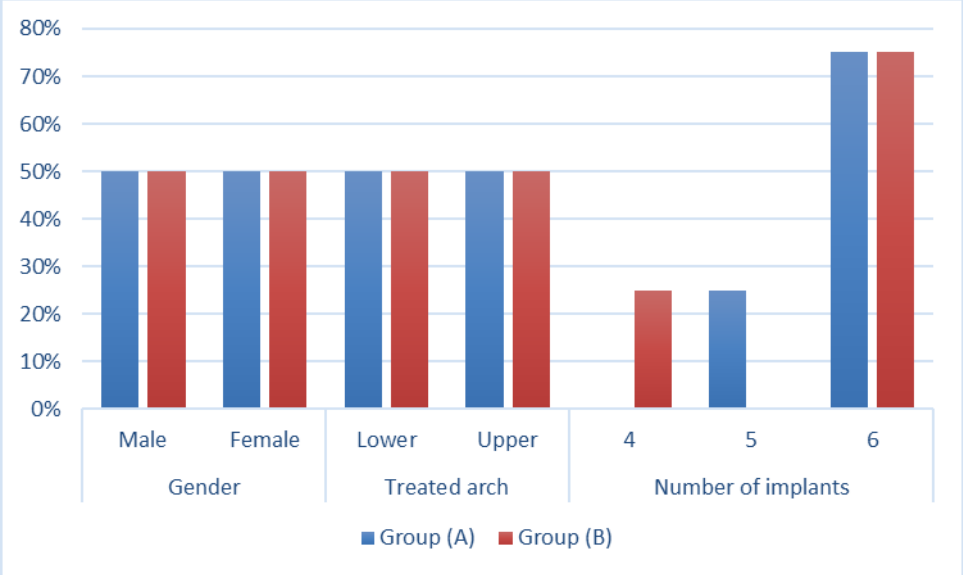
The study was conducted on 8 cases that were randomly and equally allocated to each of the studied groups (i.e., 4 cases each). Each group had an equal number of both genders and treated arches. The mean age of the cases in group (A) was (58.25±2.36) years, and in group (B), it was (54.75±3.86) years. In group (A), 5 implants were placed in a single case, while three cases had 6 implantations, making the total number of

[10] Cataflam
[11] Hexitol
[12] Handy Dentist
[13] Ostell

implants 23. In group (B), a single case had 4 implants, and similarly, 6 implants were placed in 3 cases, making the total number of implants 22. There was no significant difference between both groups regarding different demographics and baseline data.

Intergroup comparisons and summary statistics for demographic data and baseline characteristics.

Parameter		Group (A)	Group (B)	p-value
Gender [n (%)]	Male	2 (50.00%)	2 (50.00%)	1ns
	Female	2 (50.00%)	2 (50.00%)	
Age (Mean±SD) (years)		58.25±2.36	54.75±3.86	0.173ns
Treated arch [n (%)]	Lower	2 (50.00%)	2 (50.00%)	1ns
	Upper	2 (50.00%)	2 (50.00%)	
Number of implants [n (%)]	4	0 (0.00%)	1 (25.00%)	1ns
	5	1 (25.00%)	0 (0.00%)	
	6	3 (75.00%)	3 (75.00%)	



Bar chart showing different demographics and baseline data.

Bone loss:

A-Intergroup comparisons:

Immediately post-operative: Group (B) (1.82±1.08) (mm) had a higher loss than group (A) (1.28±1.02) (mm), yet the difference was not statistically significant (p=0.172).

3 months: Group (B) (1.87±1.07) (mm) had a higher loss than group (A) (1.29±0.98) (mm), yet the difference was not statistically significant (p=0.072).

6 months: Group (B) (1.96±1.13) (mm) had a higher loss than group (A) (1.42±0.98) (mm), yet the difference was not statistically significant (p=0.108).

12 months: Group (B) (1.96±0.79) (mm) had a higher loss than group (A) (1.44±0.89) (mm), yet the difference was not statistically significant (p=0.212).

B-Intragroup comparisons:

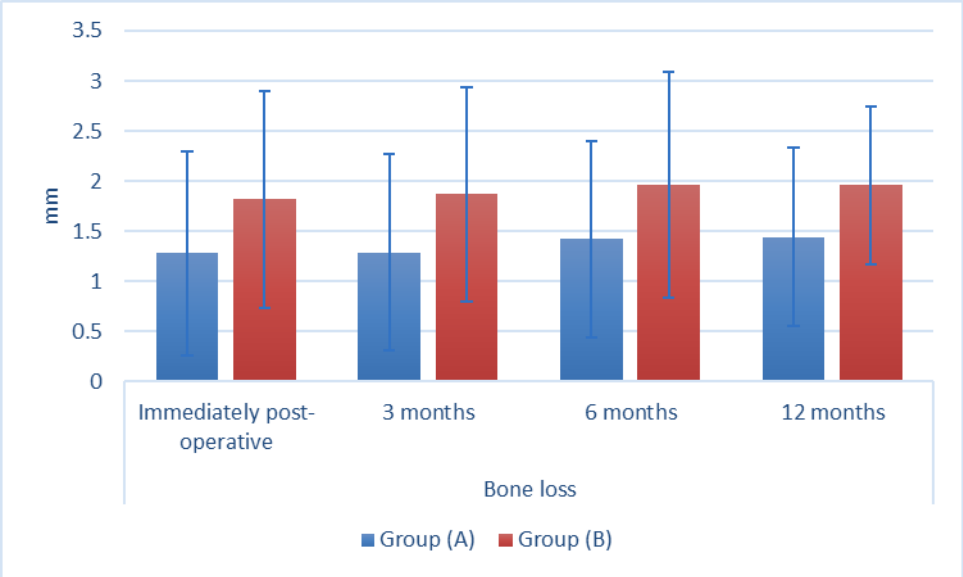
Group (A): There was no significant difference between bone loss measured at different intervals (p=0.064). The highest loss was measured after 12 months (1.44±0.89) (mm), followed by 6 months (1.42±0.98) (mm), then 3 months (1.29±0.98) (mm), while the lowest loss was found immediately post-operative (1.28±1.02) (mm).

Group (B): There was no significant difference between bone loss measured at different intervals (p=0.792). The highest loss was measured at 6 months (1.96±1.13) (mm) and 12 months (1.96±0.79) (mm), followed by 3 months (1.87±1.07) (mm), while the lowest loss was found immediately post-operative (1.82±1.08) (mm).

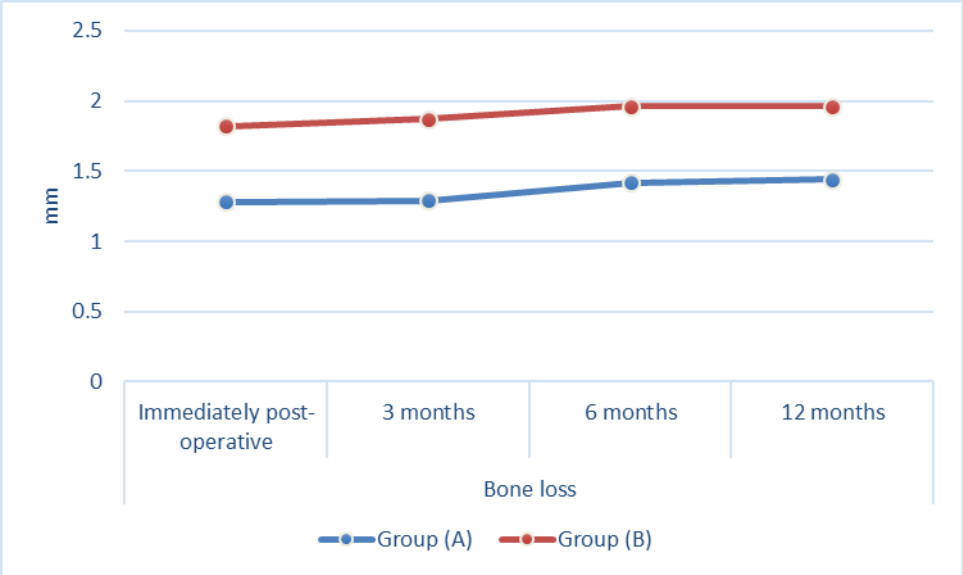
Inter, intragroup comparisons and summary statistics for bone loss (mm).

Time	Bone loss (mm) (Mean±SD)		p-value
	Group (A)	Group (B)	
Immediately post-operative	1.28±1.02^{A}	1.82±1.08^{A}	**0.172ns**
3 months	1.29±0.98^{A}	1.87±1.07^{A}	**0.072ns**
6 months	1.42±0.98^{A}	1.96±1.13^{A}	**0.108ns**
12 months	1.44±0.89^{A}	1.96±0.79^{A}	**0.212ns**
p-value	**0.064ns**	**0.792ns**	

Values with **different superscripts** within the **same vertical column** are significantly different, ns not significant.



Bar chart showing mean and standard deviation values of bone loss (mm).



Line chart showing average bone loss (mm).

Implant stability:

A-Intergroup comparisons:

Immediately post-operative: Group (A) (65.44±9.34) had a significantly higher stability than group (B) (52.56±8.55) (p=0.001).

3 months: Group (A) (66.81±6.78) had a significantly higher stability than group (B) (57.31±8.43) (p=0.010).

6 months: Group (A) (65.88±5.39) had a significantly higher stability than group (B) (58.50±7.91) (p=0.040).

12 months: Group (A) (65.81±5.31) had a significantly higher stability than group (B) (58.31±7.91) (p=0.037).

B-Intragroup comparisons:

Group (A):

There was no significant difference between stability values measured at different intervals (p=0.959). The highest stability was measured at 3 months (66.81±6.78), followed by 6 months (65.88±5.39), then 12 months (65.81±5.31), while the lowest stability was found at immediately post-operative (65.44±9.34).

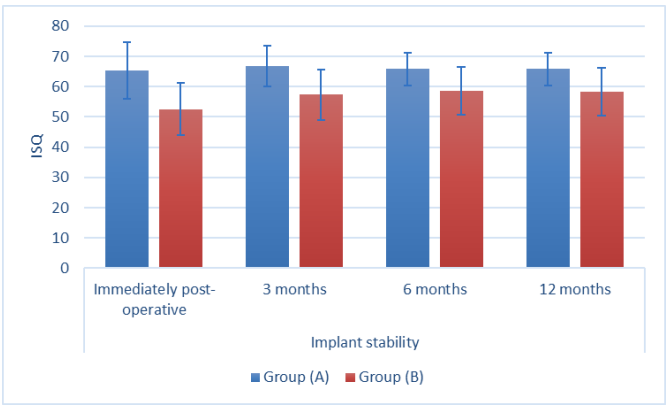
Group (B):

There was no significant difference between stability values measured at different intervals (p=0.081). The highest stability was measured at 6 months (58.50±7.91), followed by 12 months (58.31±7.91), then 3 months (57.31±8.43), while the lowest stability was found at immediately post-operative (52.56±8.55).

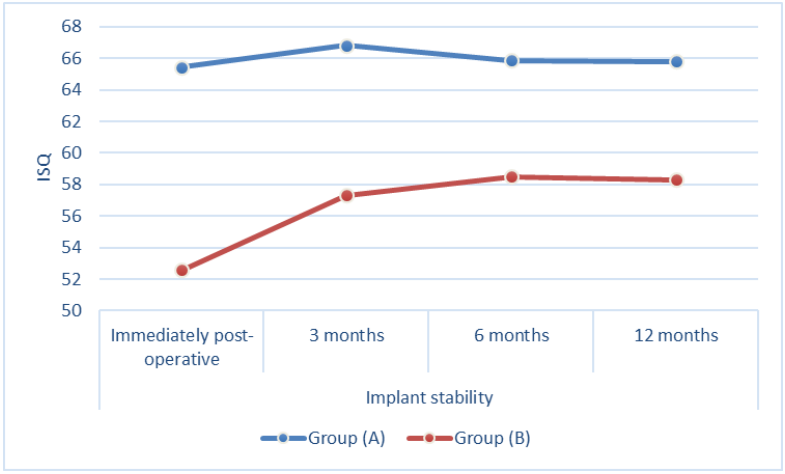
Inter, intragroup comparisons and summary statistics for implant stability (ISQ).

Time	Implant stability (ISQ) (Mean±SD)		p-value
	Group (A)	Group (B)	
Immediately post-operative	65.44±9.34^{A}	52.56±8.55^{A}	**0.001***
3 months	66.81±6.78^{A}	57.31±8.43^{A}	**0.010***
6 months	65.88±5.39^{A}	58.50±7.91^{A}	**0.040***
12 months	65.81±5.31^{A}	58.31±7.91^{A}	**0.037***
p-value	**0.959ns**	**0.081ns**	

Values with **different superscripts** within the **same vertical column** are significantly different, * significant (p<0.05), ns not significant.



Bar chart showing implant stability's mean and standard deviation values (ISQ).



Line chart showing average implant stability (ISQ).

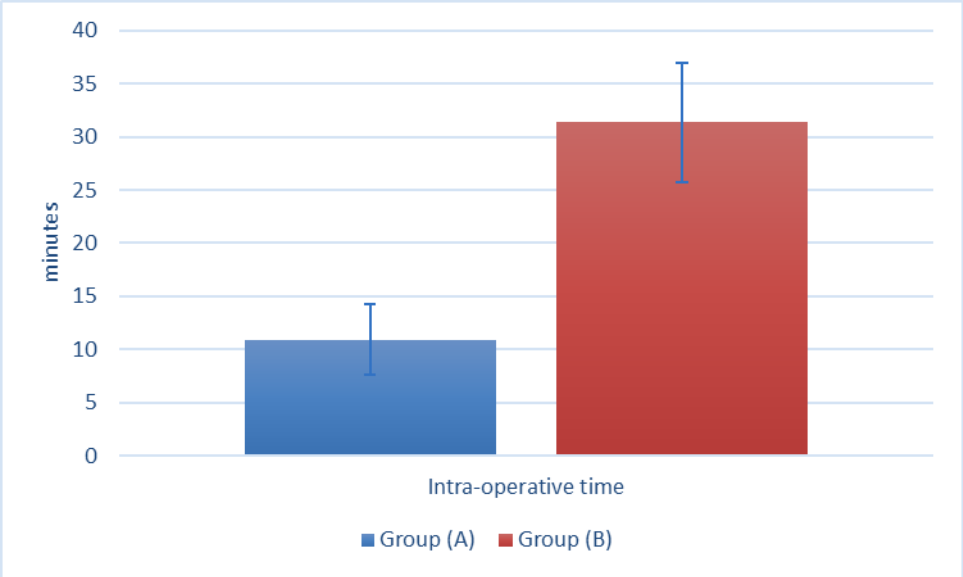
Intra-operative time:

Intra-operative time measured in group (B) (31.38±5.59) (minutes) was significantly higher than that measured in group (A) (10.88±3.32) (minutes) ($p<0.001$).

Intergroup comparison and summary statistics for intra-operative time (min).

Intra-operative time (min) (Mean±SD)		p-value
Group (A)	Group (B)	
10.88±3.32	31.38±5.59	**0.001***

* Significant ($p<0.05$).



Bar chart showing mean and standard deviation values of intra-operative time (min)

IV. Discussion

The Advantage of intraoral welding procedure is the creation of a very precise rigid framework directly and quickly in the oral cavity, when immediate functional loading is planned [38]. Rigid framework splinting limits the micro movements in immediate loading protocols and is indicated in full arch prosthesis, to reduce the mechanical stresses applied on each single implant, decreasing the lateral forces on healing implant and assure an optimal distribution of occlusal load and decreasing the lateral forces on healing implant. With this technique a passive fit of the rigid framework is easily obtained [39]. On splinting implants together, partial and full arch immediate restorations can be applied under low insertion torque. This decreases the micro movement of weaker implants and increases the osseointegration. [38]

The implant type used in the current study offered an indexed conical connection which offers less micro motion and marginal bone loss between the implants and the abutments at the implant abutment connection thus more stability to the future restoration. Degidi M et al in 2012[40].

Peak Insertion Torque (PIT) was measured to ensure the eligibility of implants for immediate loading only. On the other hand ISQ values and bone loss around implants were used as a methods of assessment to be measured multiple times throughout the study.

The authors in the literature claimed that the rigid fixation of the superstructures by welding provided favorable results due to the "Syncrystalisation" concept that occurs between the implant abutments and the wire [41, 42] which was exactly what we had in our study, in addition to the urge of having high ISQ values which was also a factor present in our case.

Implant Stability Quotient (ISQ) values were measured with OSSTEL device and peri-implant bone loss around dental implants were measured using Periapical paralleling technique radiographs and used as references throughout the methods of assessment as it provides a very accurate tools to measure implant primary stability and peri-implant bone loss and compare this as reference to the secondary stability and bone level around implants achieved after the prosthetic procedures and throughout the course of the study.

All Efforts were made towards having direct contact of the wire to the abutments to avoid air entrapment between them. Air entrapment will result in weak joint or welding gap that might lead to failure or negatively affect the welding joint stability.

A specialized kit was used for the wire bending and cutting otherwise it will consume lots of force and time to be cut and bent. However, this kit, designed by Dr Degidi, provided proper and adequate force necessary to be used.

A Computer aided design for STL model was made in our study and used to pre bend the wire on it before intra oral insertion in the operation room and in the other group it was bent directly in mouth in the operation room. Time of intra oral application of the wire was measured using a stop watch to calculate time consumption in operation time and it was found that Computer guided surgery using STL model saves much time in the operation room.

The welded framework should be fitting passively to the implants and this passive fit was ensured by removal and reinsertion of the abutments several times after welding so as to rule out any excessive forces that may fall on the implants or the implant abutment connection throughout the procedure.

Full occlusal load with light contact in centric relation was adopted in the study. This is in accordance to Degidi M et al in 2012[40]. Who proved that no difference occurred between full occlusal loading (immediate loading) and no occlusal loading (immediate restoration) both provided favorable results with no statistically significant difference. However, lateral excursive movements were ensured to be out of occlusion due to that those transmit destructive forces on the implant.

Immediate full occlusal loading proved to be successful and would not affect negatively the implants nor the loading protocol. As proven by Degidi M et al in 2012[40]. When he compared immediate loading with delayed ones in his study the results he came up with showed no statistically significant difference. The fact that there is no difference between having full occlusal contacts or minimal contact favors the technique of immediate occlusal loading because if the patient was given the option to have restorations in full function since the first day that would definitely be his choice.

the indications of immediate loading such as presence of high implant stability and lack of occlusal overloads or patient occlusal habits, should determine if immediate loading can be used or not. Regarding immediate loading implant primary stability is a requirement and determining factor. The intraoral welding offer a full occlusal loading in case of full arch. Hence splinting the dental implants together will provide for functional rigidity and more favorable clinical outcomes with less risk of failure.

In our study, results were based on measurements of (ISQ) Values and Peri-implant bone loss around dental implants.

As for ISQ values that were measured for each implant surface immediate post-operative, 3 months, 6 months and 12 months results showed a significant difference in all the four measuring periods. The higher ISQ values was measured after 6 months followed by 12 months, then 3 months. While the lowest stability was found immediately post-operative. This was applied in both Groups while Group A was a bit more stable than Group B in all times.

As for peri-implant bone loss values that were measured in both groups for each implant surface were immediate post-operative, 3 months, 6 months and 12 months. Results showed a significant difference in all the four measuring periods. The higher peri-implant bone loss was measured after 12 months followed by 6 months, then 3 months, while the lowest value was measured immediately post-operative. Bone loss in group B was a bit higher than group A in all times.

In our study the result demonstrated the success of rehabilitating the edentulous maxilla and mandible by immediate loading with a definitive or provisional restoration supported by an intraorally welded titanium bar to the abutments. The mean peri-implant bone loss observed in the study was 1.44 mm in Group A and 1.96 mm in group B. This actually explicable that the splinting effect of the dental implants may actually prevent or minimize bone loss around dental implants with immediate full occlusal loading. A feature claimed by the author of the original protocol that occur with the welding technique Degidi M et al in 2008. [43]

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