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FOUR IMPLANTS PLACED IN EXTRACTION SOCKETS OR HEALED RESIDUAL RIDGES AND IMMEDIATELY LOADED WITH MAXILLARY ALL ON 4 FIXED RESTORATIONS. ONE YEAR PROSPECTIVE CLINICAL AND RADIOGRAPHIC OUTCOMES

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ABSTRACT

Objectives: The aim of this prospective study was to evaluate clinical and radiographic outcomes of four implants placed in extraction sockets or healed residual ridges and immediately loaded with maxillary All on 4 fixed restorations

Materials and methods: The study group comprised 6 patients who had terminal dentitions in the maxillary jaw and received 4 immediate implants (according to the All-on-4 protocol) in extraction sockets and the gap between implants and sockets was filled with bone graft. Control group composed of 6 participants who had completely edentulous healed maxillary ridges and case matched to study group, then received 4-implants without any bone grafting. For both groups immediate loading of the implants was performed by modified maxillary dentures. Six months later, final porcelain fused to metal fixed screw retained prosthesis was constructed. Clinical and radiographic outcomes of the implants were collected after, 6 months and 12 months after insertion.

Results: Implant survival rate was 91.7% and 95.9% for test and control groups respectively. For both groups, plaque and gingival scores significantly increased from base line to 6 months, then significantly decreased again. Implant stability significantly decreased from baseline to 6 months, then significantly increased later. Depth of probing and peri- implant bone loss significantly increased with time. Study group recorded significant higher plaque scores, depth of probing and peri- implant bone loss than control group after 6 and 12 months. Control group recorded significant higher implant stability than study group after 6 months.

Conclusion: Within the scope of this investigation, four implants installed in extraction sites and immediately loaded with maxillary All on 4 fixed restorations is associated with similar implant success compared to implants placed in healed edentulous ridges. However, it showed increased plaque scores, depth of probing and peri- implant bone loss after one year.

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INTRODUCTION

Immediate implant placement in extraction sockets has advantages such as reduction of treatment, reduction of surgical procedures, increased patient acceptance, improved esthetics by preventing further bone loss, and preservation of hard and soft tissues[1]. Owing to lower bone density in the maxilla, immediate loading presented a greater challenge than in the mandible. Furthermore, implant anchorage is usually compromised due to bone loss particularly in the maxillary posterior areas [2]. Immediate implant placement in maxilla requires adequate primary implant stability to avoid micromotions especially if immediate loading protocol is used[3]. High levels of primary implant stability may not be achieved in maxillary extraction sockets. Therefore, a more palatal implant placement to engage native dense bone, under preparation of implant osteotomy, increasing implant diameters may help to obtain adequate primary stability of the implants that is required for immediate loading[3, 4].

In various clinical situations, the patients presented with partially edentulous arches and the need extraction of the remaining teeth/roots and replacing them immediately with fixed full arch restorations to avoid wearing the conventional complete dentures for 4-6 months after extraction till complete healing of the ridges occur to allow implant placement.[5] Immediate restoration of such patients with immediate loaded implants in extraction sockets to support fixed prosthesis provide several advantages as reduction of discomfort and embarrassment caused by conventional dentures, reduction of treatment time and costs[6, 7].

Fixed full arch prostheses supported by four implants according to "the All-on-4" concept was introduced by Malo et al. in the last two decades and proved a valid treatment modality for edentulous arches with good survival rate[2, 8-11]. For edentulous maxillary ridge, the concept includes installation of 2 implants anteriorly in the premaxilla, and the additional 2 implants are installed mesial to the maxillary sinuses and posteriorly inclined 30° in addition to plane of occlusion[12]. Tilting of posterior implants allow reduction of cantilever length, widen prosthetic support, allow increase of implant length to obtain sufficient primary stability required for immediate loading[2, 13, 14]. Moreover, in case of posterior ridge atrophy and sinus pneumatization, complex surgical procedures such as sinus lift and bone graft is avoided, thus reducing morbidity and costs[14, 15]. Furthermore, immediate restoration of function and esthetics is achieved by immediate loading of the implants with fixed provisional restoration[16]. The All on 4 protocol for maxillary rehabilitation showed favorable clinical outcomes [2, 12, 13].

Implants used for immediate loading of full arch restorations usually inserted in healed residual ridges after long period of edentulism. Controversy exists in the literature regarding the success of immediately loaded implants inserted in extraction sockets. De Bruyn[17] found increased failure rate of implants inserted in extraction sockets and immediately loaded. Other recent systematic review[18] reported no difference in success of immediately versus delayed loaded implants inserted in fresh sockets. Several studies advocated increasing the number of implants (from 5 to 8 implants) when these implants were planned to be inserted in extraction socket and immediately loaded with fixed full arch restorations[6, 19]. However, only limited data available on immediate loading of implants inserted in extraction sockets to support fixed restoration using the All-on-4 concept[5, 20]. In a previous report, Mozzati et al[7] demonstrated that insertion of four implants in extraction sockets and immediate loading of them is a valid option for restoration of edentulous mandible. Unfortunately, the comparison of the success of implants placed in extraction sockets with implants placed in healed ridges to support fixed prosthesis according to the "All-on-4 concept" especially for edentulous

maxilla still scarce in the literature. Accordingly, the aim of the present prospective study was to evaluate and compare clinical and radiographic outcomes of four implants placed in extraction sockets or healed residual ridges and immediately loaded with maxillary All on 4 fixed restorations after one year. The null hypothesis was that there would be no significant difference in clinical and radiographic outcomes between the 2 treatments approaches.

MATERIALS AND METHODS

Patient cohort and study design

This prospective non-randomized case-controlled clinical trial was conducted on 12 patients (6 males and 6 females, mean age of 54±5.7 years) who seek restoration of their maxillary arches with four implants to support fixed full arch restorations according to the All on four concept. All patients were selected from patients attending the Prosthodontic department. The study group comprised 6 patients (3 males and 3 females) who had terminal dentitions (hopeless or badly decayed teeth or remaining roots) that require extraction because of periodontal disease or carries (fig 1). The included patients in this group should have no active periapical infection and should have adequate remaining bone after extraction of the teeth to provide initial stability of the implants required for immediate loading. This was verified by preoperative cone beam computerized tomography (CBCT, (Imaging Sciences International, USA) (fig 2). Control group composed of 6 participants who had completely edentulous maxillary ridges and case matched to study group regarding age and gender. Both groups required to have; 1) adequate amount of bone volume (height and width) in the region between the sinuses to permit installation of 4 implants (3.8x11-13 mm) according to the All on four concept (bone dimensions were evaluated by preoperative CBCT, 2) posterior maxillary ridge resorption that preclude insertion of dental implants due to maxillary sinus pneumatization 3) adequate oral hygiene, 4) adequate restorative space for construction of fixed full arch metal ceramic restoration in the maxillary arch and 4) Partially edentulous mandibular jaw or complete dentition presented in the mandible. The exclusion criteria included; blood disorders, bone metabolic disorders such as diabetes mellitus, bad habits such as smoking or clenching, chemotherapy or radiotherapy to the head region, and immune-compromised patients. All patients were informed about objectives of the study, and before enrollment, written consents were collected from all participants. The study was conducted according to principles included in the Helsinki Declaration for biomedical research on Humans and approved by the ethical committee of the faculty of dentistry Beni-Suef

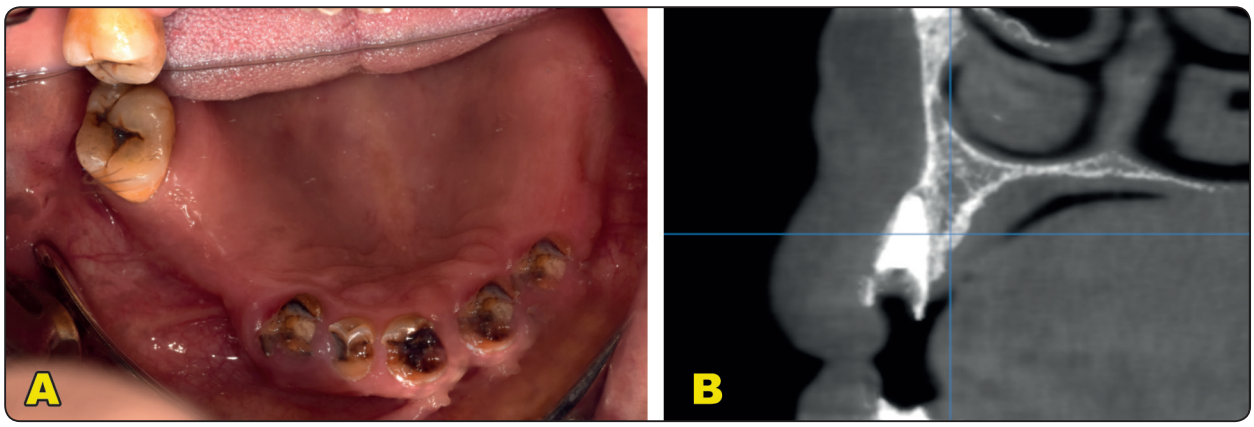

Fig. (1) Test group, a) terminal dentition, b) verification of adequate remaining bone volume after extraction.

University (Approval No FDBSUREC/09122021/MM). For control group, 4-implants were inserted according to the All on four concept using the flap surgical approach without any bone grafting. For study group, extraction of the teeth was performed, immediate implant was placed in extraction sockets and the space between the implants and the bone walls was filled with bone graft.

For both groups immediate loading of the implants was performed by existing maxillary conventional dentures after modifications. Six months after osteointegration, the provisional maxillary dentures were replaced by metal ceramic fixed screw retained prosthesis.

Surgical and prosthetic interventions

For both groups, conventional maxillary dentures were constructed. For both groups, mounting the casts on the articulator was made and a diagnostic waxup was performed to evaluate occlusal relations. For study group, impressions and jaw relations were performed to construct the maxillary immediate complete denture. On the maxillary cast, remaining teeth were removed, and packing of acrylic resin was performed against the modified maxillary casts. For control group, conventional maxillary complete denture was constructed. Cone beam computerized tomography (CBCT) was performed to assess the amount of residual bone, identify anatomical structures, identify periapical pathology, and evaluate location of implants. Preoperative medications include chlorhexidine digluconate 0.2% and prophylactic antibiotics: amoxicillin and clavulanic acid (Augmentin® 1gm) started one hour before surgery.

For both groups, a crestal incision was made from premolar area on one side to premolar area on the other side, then a mucoperiosteal flap was elevated (fig 2). For test group, atraumatic removal of the teeth and roots was performed, curettage and irrigation of the sockets was completed, then trimming of the sharp bone edges was made.

For both groups, U-shaped metal guide (J DentalCare, Italy) designed specifically for All-on-4 implant placement was fixed to the maxillary bone at midline. A 2mm pilot drill was used to make a hole in the midline of the maxilla, then the metal pin of the template was inserted in the hole. Care was taken to avoid injury of the nasopalatine canal by shifting the drill a little bite mesially or distally. The template contains vertical parallel lines to identify implant placement sites and implant angulation. The direction from occlusal side of the posterior line to the gingival side of the anterior line is adjusted in the template to provide 30° distal implant inclination. The template was curved to follow the contour of the alveolar ridge (fig 3).

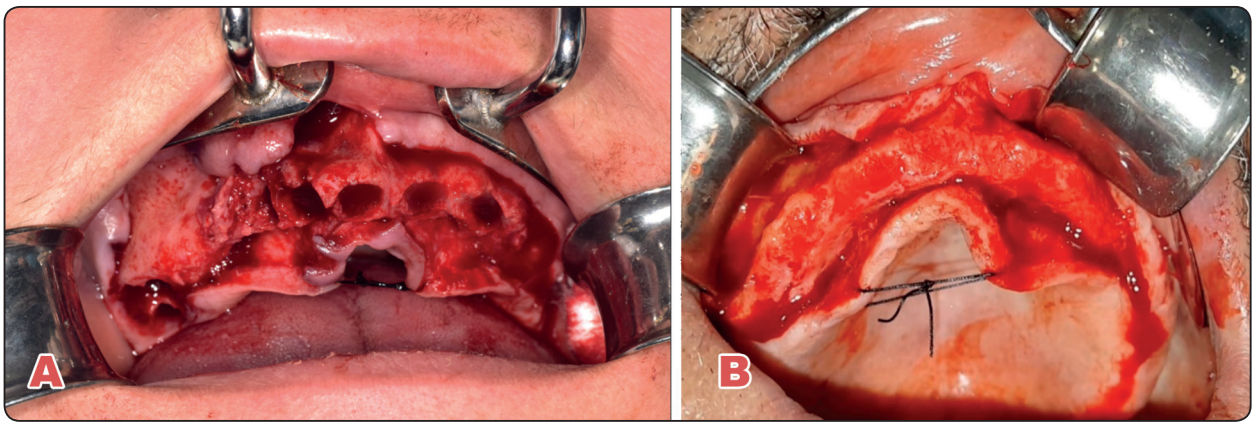

Fig. (2) Crestal incision and flap elevation; a) test group, b) control group

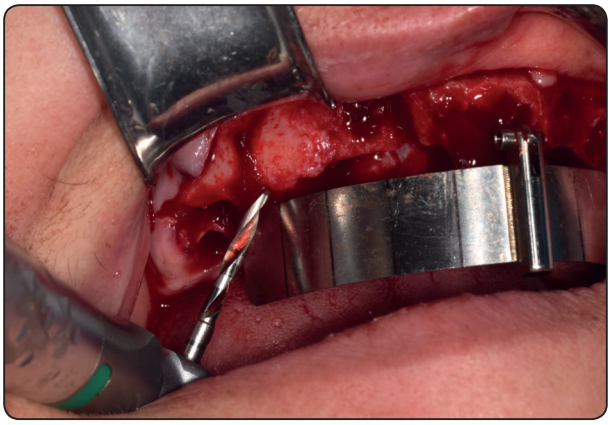

Fig. (3) Implant osteotomy preparation using the metal template as a guide

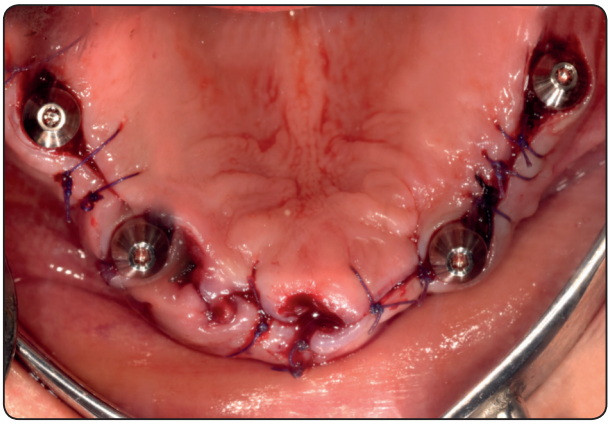

Fig. (4) Closure of the flap around the cover caps of the multiunit abutments

Using the metal guide, 4 implants (Biohorizon, Irvine, California, USA) were inserted in the area between the maxillary sinuses according to the All-on-4 protocol[2, 12, 13]. Two implants were inserted with 30° posterior inclination just anterior to the maxillary sinuses on each side, and two implants were installed vertically in lateral incisors or canine areas. The direction and angulation of the implants was controlled during process using the lines drawn on the metal template. For study group, implant osteotomy was prepared using sequential drilling in the native bone palatal to the sockets of the extracted teeth to gain sufficient primary stability. Moreover, under preparation of implant osteotomy, or increasing implant diameters than prepared osteotomy was made incase of reduced bone quality to obtain adequate primary stability of the implants that is required for immediate loading[3, 4]. The gap between the implants and the sockets was filled with xenograft bone material (Intergraft, Neobiotech, particle size 0.2-1.0mm, South Korea). For control group, implant osteotomy preparation was performed, and implants were installed without bone grafts. For both groups, at least 40 Ncm could be obtained at implant insertion to allow immediate loading. If this insertion torque cannot be reached, the patient was excluded from the study and replaced by another one[5]

Multiunit abutments were threaded into implant fixtures (two 30° abutments were used for posterior inclined implants and two 15° implants were used for anterior implants to compensate for bone inclination in the premaxilla). The inclined implants allow emergence of the abutments at mesial cusp of the first molar artificial teeth. This implant inclination helped in reduction of cantilever length and increases anteroposterior spread[14]. All abutments were torqued at 25Ncm. Cover caps of multiunit abutments were connected to the abutments, and the flap was sutured tension free using Vicryl 4-0 resorbable suture (fig 4).

For both groups, titanium temporary cylinders were threaded to the abutments. The maxillary dentures were trimmed using denture conversion technique to allow immediate loading of the implants (fig 5). The labial, buccal and palatal flanges were removed, and the denture was perforated above the metal caps. Rubber dam sheets were fastened around the metal caps to prevent contact of acrylic resin to the undercuts of multiunit abutments, then the modified maxillary denture was attached to the metal cylinders using self-cure resin. The cylinders were sectioned, and the excess resin was finished. The second molar artificial teeth of the dentures were removed, and the occlusal contact were relieved over the first molar and second premolar

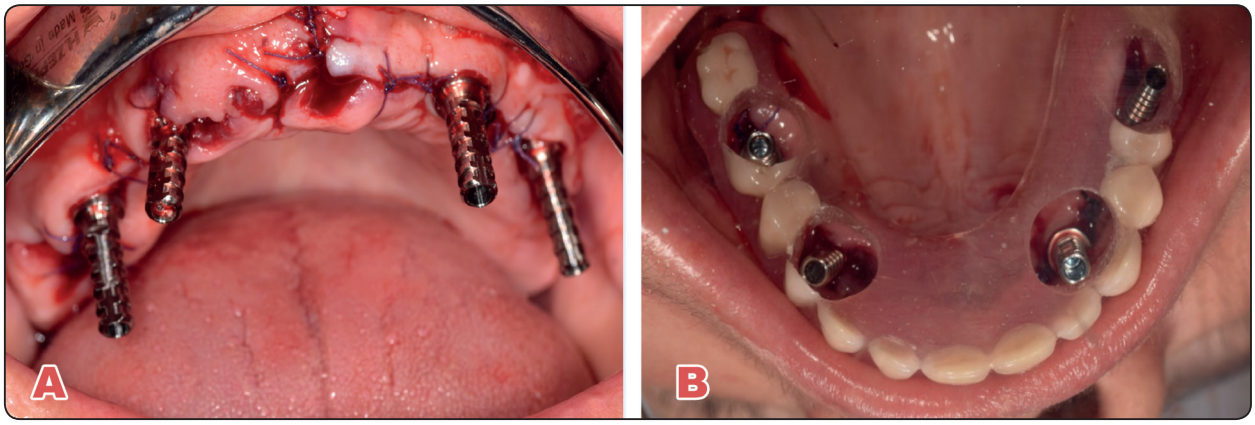

Fig. (5). Immediate loading of the implants with fixed provisional modified maxillary denture (denture conversion technique); a; titanium caps threaded to the multiunit abutments; b; modified denture hollowed above the titanium caps.

teeth to protect the tilted implants from increased forces. The participants were instructed to perform oral hygiene and maintaining soft diet during the healing period. Postoperative medications include chlorhexidine digluconate (0.2%) mouthwash, and antibiotics (amoxicillin 625 mg + clavulanic acid 125 mg, Augmentin® 1gm) given twice daily for 7 days. Moreover, analgesics (Ketolac® 10mg), and non-steroidal anti-inflammatory (Alphintern) drugs were prescribed one day before surgery and continued after surgery for 5 days. The patients were instructed to apply ice bags after surgery to decrease postoperative edema. Any necessary occlusal or denture adjustments were performed during follow-up visits.

Open tray impression was started six months after implant placement to construct the final restoration. Abutment level impression transfers were connected to the abutments in the splinted together with Duralay acrylic resin (Reliance, USA). Light Viscosity rubber base impression (Zhermack®, Italy) were loaded around the transfers and the impression was made was putty material in a perforated stock tray (fig 6). The abutment analogues were attached to the transfers and the impression was poured. Plastic cylinders were connected to abutments and maxillary fixed screw retained hybrid metal ceramic prosthesis was designed with 12 teeth (from first molar tooth on one side to first molar tooth on the other side). The prosthesis replaces lost teeth, bone and gingiva using pink porcelain. The metal substructure was cast suing cobalt-chromium alloy, then tried in patient mouth for testing and passivity using single screw test. The opaquer was added to the metal frame, then porcelain powder (VITA Zahnfabrik, Germany) was mixed and added over the opaquer, fired, and finished. The restorations were given to the participants after making occlusal adjustments. Follow-up visits were scheduled for participants and oral hygiene measures were reviewed and reinforced.

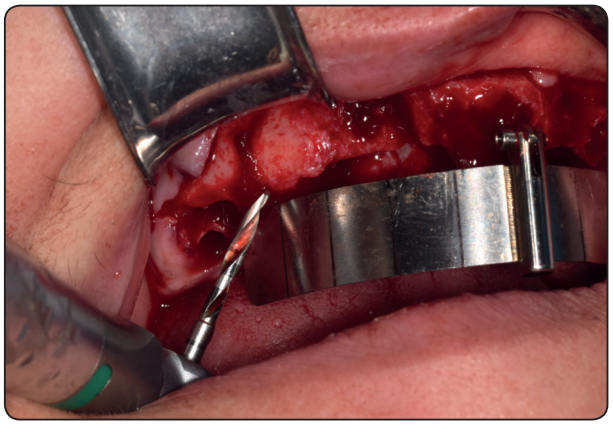

Fig. (6) Splinting the transfer coping using Duralay resin and injection of the light viscosity rubber base impression around the copings (open tray impression technique).

Clinical and radiographic evaluations

Evaluations of the implants were made after restoration insertion, 6 months, and 12 months after insertion. The implant success criteria of Albrektsson et al.[21] were utilized which include; no detectable mobility, no radiolucency, no infection, and bone loss less than 2mm. The implant was considered survived if it still functioning and fulfill the success criteria.

Plaque and gingival indices were investigated according to the method described by Mombelli et al. [22]. A plastic periodontal probe was utilized for assessing the depth of probing in mm as the distance from gingival margin to most apical depth of probing [23, 24]. These parameters were measured at the mid-facial, mid-lingual, mid-mesial, and mid-distal aspects of each fixture. Implant mobility was performed by resonance frequency analysis. The Osstell device measures the mobility as implant stability quotient (ISQ). The multiunit abutments were removed and smart pigs of the Ostell device were connected to the implants. The hand of the testing device was held perpendicularly to the long axis of the implant from the labial and the buccal aspects. Three measurements were performed for each fixture and averaged for all fixtures.

Crestal bone height changes were measured using digital periapical radiographs (Digora, Soredex) taken by long cone paralleling technique. An interocclusal acrylic jig was used to hold the film holder (XCP bite blocks, Dentsply) between maxillary and mandibular teeth during subsequent film exposures to maintain a repeatable position of the film for standardization. Using the software (Digora, Soredex), crestal bone height was measured from implant platform (implant abutment connection, point A) to first bone to implant contact (point B)[25] (fig 7). To avoid magnification, the actual implant dimensions was compared to implant dimensions in the x-ray to obtain the actual bone height changes in the x-ray. Crestal bone loss was estimated by subtracting corresponding bone heights after 6 and 12 months from their values at baseline. Calculations were performed on both the mesial and distal aspects of each implant and the mean was subjected to statistical analysis.

Statistical analysis

The data were explored for normality of distribution using Shapiro-wilk test. The implant survival rate was calculated using Kaplan Meier analysis and comparison of implant survival between groups was made using the Log rank test. The non-parametric data (plaque, and gingival indices) were presented as median (minimum and maximum) for descriptive statistics and compared between observation times suing Freidman test and Wilcoxon signed ranks test for pair-wise comparisons. The parametric data (Probing depth, stability and crestal bone resorption) were presented as mean±SD for descriptive statistics and compared between observation times and groups suing repeated measures ANOVA followed by Tukey test for pairwise comparisons. The data were analyzed using SPSS® software version 25 (SPSS Inc., Chicago, IL, USA). P-values <0.05 were considered to be significant.

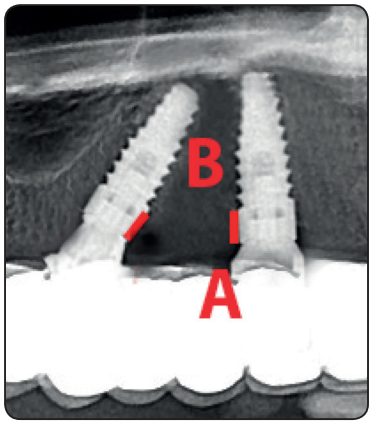

Fig. (7) Measurement of marginal bone height changes

RESULTS

Of 48 implants inserted (24 implant in each group, 4 implants in each patient), 2 implants (in one patients) failed to integrate in study group, and one implants (in one patient) failed to integrate in the healed ridge within six months after immediate loading with provisional modified acrylic denture yielding implant survival rate of 91.7% and 95.9% for test and control groups respectively and no implant failures occurred after 12 months. The failed implants occurred as a result of implant overloading without suppuration and all failures were accompanied by implant movement. The non-integrated implants were explanted, and bone grafting procedures were performed for future implant placement. The 2 patients were excluded from the study and the data were collected for the remaining patients. Kaplan Meier analysis of the survival functions for both test and control group is shown in fig 8. The survival rate of the implant did not significantly differ between groups (Log test, p=.558).

Plaque and gingival indices of study and control groups at different measurement times is demonstrated in table 1. Plaque index significantly differs between measurement times for both groups. Plaque index significantly increased from baseline to 6 months, then significantly decreased from 6 months to 12 months for both groups. Multiple comparison of plaque index between each two measurement times is presented in table 1. At baseline, there was no significant difference in plaque index between groups. After 6 and 12 months of implant loading, study group had a significant increased plaque index than control group. For gingival index, there was a significant difference between measurement times for both groups. Gingival index significantly increased from baseline to 6 months, then significantly decreased from 6 months to 12 months for both groups. Multiple comparison of Gingival Index between each two measurement times is presented in table 1. At all measurement times, gingival index did not differ between groups.

Comparison of pocket depth, fixture stability, and marginal bone resorption between study and control group at several measurements is demonstrated in table 2. For pocket depth, there was a significant difference between measurement times for both groups. pocket depth significantly increased from insertion to 6 months, then significantly increased from 6 months to 12 months for both groups. Multiple comparison between each 2 measurements is shown in table 2. At all measurement times, study group recorded significant higher pocket depth than control group. Implant stability (ISQ values) significantly differ between observation times for both groups. ISQ values significantly decreased from baseline to 6 months, then significantly increased again at 12 months. There was no significant difference in ISQ between baseline and 12 months. At baseline and 12 months, there was no significant difference in implant stability between groups. At 6 months, study group recorded significant lower implant stability than control group. For marginal bone loss, there was a significant difference between observation times for both groups. Marginal bone loss significantly increased from 6 months to 12 months for both groups. Study group showed higher marginal bone resorption than control group after 6 and 12 months

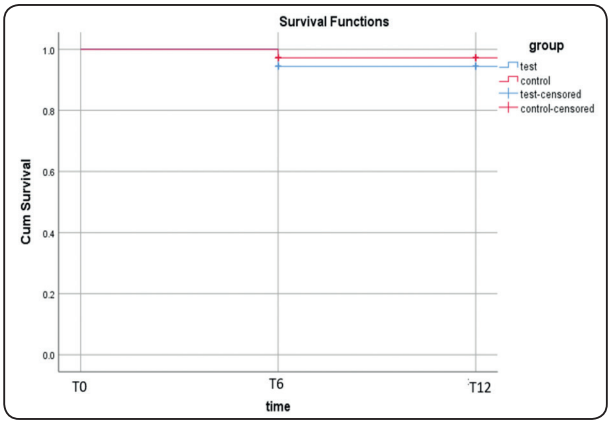

Fig. (8) Implant survival functions of both groups for all measurement times using Kaplan Meier analysis

TABLE (1) Plaque and gingival indices of study and control group at different measurement times

	Baseline (at loading) Mn(mi-mx)	6 months Mn(mi-mx)	12 months Mn(mi-mx)	Freidman Test (p value)
Plaque indeces				
Study group	.00a (.00-.00)a	2.25b (1.50-2.75)b	1.60c (.80-1.50)c	.005*
Control group	.00a (.00-.00)a	1.75b (1.25-2.0)b	1.00 c (.75-1.25)c	.003*
Mann-Whitney test (p value)	1.00	.015*	.019*	
Gingival indices				
Study group	.00a (.00-.00)a	2.00b (1.50-2.50)	.90 c (.50-1.25)	.011*
Control group	.00a (.00-.00)a	2.22 (1.45-2.60)	1.00c (.75-1.60)	<.021*
Mann-Whitny (p value)	.90	.425	.581	

Mn; median, mi; minimum, ma, maximum, *p is significant at 5%. Different letters express a difference between 2 measurement times (Wilcoxon test, p<.05), while similar letters show no difference between each 2 measurement times.

TABLE (2) Depth of the pockets, stability of the fixtures, and marginal bone resorption between study and control group at different measurement times

	Baseline (at loading) X±Std	6 months X±Std	12 months X±Std	Repeated ANOVA (p value)
Pocket depth				
Study group	2.34± .38a	2.80±.40b	3.10±.49c	.012*
Control group	1.88±.35a	2.32±.45b	2.76±.50c	.013*
t-test (p value)	.030*	.021*	.031*	
Stability of implants				
Study group	59.9±3.5a	57.4±3.9b	60.2±3.2 a,c	.031*
Control group	61.2± 2.9a	59.5±3.5b	61.3±3.7 a,c	.042*
t-test (p value)	.058	.010*	.66	
Marginal bone loss				
Study group	-	0.82±.25a	1.1±.34b	.011*
Control group	-	0.75±.29a	.91±.31b	.013*
t-test (p value)		.023*	.001*	

X; mean, Std; standard deviation *p is significant at 5%. Different letters express a difference between 2 measurement times (Tukey test, p<.05), while similar letters show no difference between each measurement times

DISCUSSION

Implant survival was 91.7% and 95.9% for study and control groups. Similarly, the authors in another study[26] reported 96% implant success rate for implants placed in extraction socket of maxillary arch and immediately loaded with fixed full arch restoration. Conversely, Grandi et al. [5] reported 100% implant survival rate after18-month without implant failure for immediately loaded fixed full-arch restoration on 4-implants inserted in the extraction sockets in the mandibular jaw.

Moreover, Krennmair et al [20] noted no implant failures occur for 4-implants placed in fresh extraction and healed sites and immediately loaded by cantilevered fixed restoration in the mandibular jaw. The reduced survival rate in this study compared to Grandi et al and Krennmair et al. may be attributed to the reduced bone density and quality of the maxillary bone compared to mandibular bone in those studies. The reduced bone quality (in maxilla compared to the mandible) may subject the implants to more micromotions caused by immediate loading which may affect bone to implant contact and disrupt osseointegration as micromotions are significantly affected by reduced bone density[27]. However, no significant difference in implant survival between groups was observed. Similarly, Krennmair et al [20] reported no difference in survival rate between implants installed in extraction sockets and in healed ridges and immediately loaded with fixed restoration in the edentulous mandible. The lack of difference between groups in our study may be due to the initial implant stability that was obtained at implant placement which is mandatory for success of immediate loading[28,29], as the patients with reduced implant stability were excluded from the study and scheduled for conventional loading protocols. The highest initial stability will be obtained by using the largest possible dimensions of implant, placing the implants more palatally in the native palatine dense bone, and under preparation of implant site by omitting the final drills[6,19]. Moreover, the connection of implants may provide splinting, wide load distribution, and a safer transfer of load on each implant[5].

For both groups, plaque and gingival scores significantly increased from base line to 6 months, then significantly decreased again. This could be attributed to the presence of provisional acrylic denture which have spaces around the implants that may hinder adequate cleaning by the patients. When professional restoration was replaced by metal ceramic restoration, plaque scores decreased after 12 months due to the smooth convex surface of prosthesis and the high adaptation of the prosthesis to the abutments. The increased gingival scores after 6 months are attributed to the increased plaque scores which cause gingival inflammation. Another explanation may be due to the flap surgery used in both groups which makes the patients develop the habit of avoiding adequate cleaning around the sutures to avoid pain or disrupting the sutures. Study group recorded significant higher plaque scores than control group. This may be due to implants in the study group are placed 2 mm deeper in the extraction socket to decrease spaces around the implants, accommodate the peri-implant crestal bone loss caused by initial healing, and decrease the size of bone augmentation material[20]. The deeper implant placement in the study group resulted in higher peri-implant pocket depth which is usually associated with reduced extensibility[20,30]. Although plaque scores were significantly higher in the study group compared to control group, regular cleaning and wound healing prevented progression of gingival inflammation, and consequently gingival scores did not significantly differ between groups.

Pocket depth significantly increased with time in both groups. This may reflect the increased marginal bone loss combined with gingival overgrowth that occurred in both groups. The increased pocket depth in both groups with time could be attributed to peri-

implant gingival inflammation and enlargement caused by flap reflection, re-adaptation and suturing the flap over the abutments together with increased peri-implant bone loss[31]. Study group recorded significant higher pocket depth than control group. This may be due to the deeper implant placement in the study group as stated previously which may complicate oral hygiene resulting in increasing plaque accumulation, peri-implant marginal bone loss, gingival inflammation/enlargement and consequently increased pocket depth. In contrast to our finding, Krennmair et al.[20] found no significant difference in pocket depth between implants placed in extraction sites and healed sites which were immediately loaded with mandibular fixed prosthesis. The difference in the results of our study and results of Krennmair et al could be attributed to the mucosal thickness and bone density in each arch. In our study, implants installed in extraction sites were associated with increased pocket depth due to increased thickness of maxillary mucosa, and reduce the bone density, while the reduced thickness of mandibular mucosa and increased bone density in the mandible may be the reason for reduced bone resorption and pocket depth in the study of Krennmair et al.

Primary stability is considered an important factor for the success of immediate loading of implants[32]. Implant stability significantly decreased from baseline to 6 months then significantly increased again at 12 months for both groups. The decrease in implant stability after 6 months could be attributed to the decrease in the bone to implant contact that occur during the initial healing period as a result of bone remodeling[33]. The increase in implant stability after 12 months could be due to the increased bone to implant contact occurred thereafter with increased bone density around implants and increased anchorage of the implants in the bone. Control group recorded significant higher implant stability than test group after 6 months. This may be due to higher bone to implant contact in the control group compared to test group. The reduced bone to implant contact in the test group may be due to the gap between the implant and the bone caused by the anatomy of the extraction socket which was filled with bone graft. This graft needs a time to form new reparative bone which may be still soft at 6 months and need sufficient time to reach adequate bone density. Bone density increased for the test group after one year, and consequently bone to implant contact increased. This may explain the insignificant difference of implant stability between both groups after one year.

For both groups, crestal bone loss did not exceed 1.1mm after 12 months and the mean marginal bone resorption was. 1.1±.34mm and .91±.31 for test and control group respectively. These values are located within the normal limit of accepted bone resorption values that occurred during the first year (1.2mm)[21]. However, the mean marginal bone loss for distal group 1.1±.34mm was higher than that obtained in other studies[5, 34] in which the authors reported 0.7 ± 0.3 mean bone loss for implants inserted in extraction sockets in the mandibular arch to support fixed full arch prosthesis. This difference in marginal bone loss may be due to maxillary bone are more liable to resorption than mandibular bone due to reduced bone density and increased implant angulation[35]. Moreover, the cancellous bone may subject the maxilla to increased forces[36]. Marginal bone loss significantly increased from 6 months to 12 months for both groups. This unavoidable time dependent bone loss could be attributed to bone response to healing process and loading. A similar finding was noted in another investigation[5] which reported significant increase of marginal bone loss from 6 to 12 and from 12 to 18 months for immediate loaded implants inserted according to the All on four protocol in mandibular extraction sockets to support fixed full arch restoration in the mandible.

Study group had significant higher bone resorption than control group after 6 and 12 months.

The same result was obtained in another study[20] which found that implants inserted in extraction sockets was associated with significant higher marginal bone loss than implants inserted inherently in healed extraction sites and immediately loaded with fixed mandibular prosthesis. Also, Penarrocha-Diago et al.[19] observed more marginal bone loss for implant stability immediately after extraction compared to the implants placed in healed sites for the fixed full arch implant-supported prosthesis. The high bone resorption in the study group may be due to the deeper implant insertion depth which may complicate oral hygiene, increased plaque accumulation, and increased probing depths. This may create localized unhygienic condition which when combined with increased forces caused by immediate loading protocol may lead to increased peri-implant one loss[19, 37]. In contrast, implants inserted in healed sites are delivered with alveolar bone crest and are less deep than those inserted in extraction sockets. Therefore, these implants reached consolidation of the implant bone contact level and established the biologic width earlier, thus having more stable marginal bone level than implants inserted deeply and extraction sockets[20]

The limitations of this investigation are; the reduced patient cohort and the small observation period. Moreover, lack of randomization between groups presents another limitation. Additionally, the effect of adding bone graft versus non-grafting technique for managing the space between implants and extraction socket needed to be investigated separately.

CONCLUSION

Within the scope of this investigation, four implants installed in extraction sites and immediately loaded with maxillary All on 4 fixed restorations is associated with similar implant success compared to implants placed in healed edentulous ridges. However, it showed increased plaque scores, depth of probing and peri- implant bone loss after one year.

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