

Clinical Impact of Alveolar Socket Augmentation on Success of Delayed Immediate Implant

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Abstract: Problem statement: Benefits of grafting fresh alveolar socket as a pivotal step proceeding delayed immediate implants is still a point of controversy. So, the aim of this study was to evaluate the clinical impact of immediate alveolar socket augmentation on delayed immediate implant success versus non grafted model. **Patients and methods:** Fifteen patients: 13 females and two male received sixteen dental implants were divided equally into two groups. In the 1st group patients were received Bio-Oss Collagen graft after extraction of non-restorable maxillary bicuspid teeth while, in 2nd group sockets were left to heal normally. In both groups, all implants were placed 6-8 weeks post-extraction, and were subjected to immediate loading. All patients were assessed clinically either at baseline (T0), 6 months (T1) and at 12 months (T2) of follow up regarding to Modified bleeding index, Modified plaque index, implant stability and radiographically for assessment of marginal bone level (MBL). Pink esthetic score was evaluated after one year from crown cementation. **Results:** No significant differences were recorded between both groups regarding to implant stability, Modified bleeding index and Modified plaque index either at (T0) or at (T1) and (T2) periods of follow up ($P=0.999, 0.57, 0.232$), ($P=0.059, 0.602, 0.725$), ($P=0.429, 0.241, 0.215$) respectively. Regarding PES there was no significant difference between both groups ($p=1.000$), after 1 year of follow up. No significant differences were recorded between both groups regarding to MBL either at 6 or 12 months ($P=0.370, 0.149$) respectively. **Conclusions:** Grafting fresh alveolar socket cannot be considered as a pivotal maneuver that can improve significantly the clinical outcomes associated with delayed immediate implants subjected to immediate loading.

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Key Words: Delayed immediate implant, immediate loading, implant stability, socket augmentation.

1. Introduction

Delayed immediate implant protocol has been established as a successful treatment modality that offers many advantages. It provides adequate soft tissue closure, high osteogenic potential, necessary time to overcome the pre-existing infection and finally, its reasonable reduction of time between tooth extraction and final prosthesis when compared to delayed implantation protocol.⁽¹⁻⁵⁾

The reduction of alveolar bone volume after tooth extraction may interfere the placement of implants and influence the treatment success, function and esthetics.^(6,7) On the other hand, the use of grafting materials in fresh, post-extraction sockets has been questioned because they can interfere with the normal healing process.⁽⁸⁻¹⁰⁾

Additionally, In 2011, **Araujo et al.**⁽¹¹⁾ reported a positive impact on formation of new bone for sockets which had been grafted with collagenous bovine bone matrix Bio-Oss Collagen.⁽¹¹⁾ In contrast, a clinical study carried out by **Heberer et al.**⁽¹²⁾ reported lower regeneration of bone in grafted extraction sockets, by Bio-Oss Collagen compared to the control extraction socket after six to eight weeks of healing period.⁽¹²⁾

Based on such debate, this study was directed to evaluate the clinical impact of immediate alveolar socket augmentation on delayed immediate implant success versus non grafted alveolar sockets.

2. Patients and Methods

Fifteen patients: 14 females and only one male received sixteen dental implants with an age ranged between 25 and 45 years, were selected from outpatient's clinic, Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Mansoura University. All included patients were free of any parafunctional activity in addition to local or systemic factors that would inhibit wound healing such as acute infection and major chronic pathologies, and systemic contraindications for implant. Patients showed also intact 4-walled extraction sockets with no dehiscences or fenestration.

The patients were divided equally in two groups: In both groups, implants were placed 6-8 weeks' post-extraction of non-restorable maxillary bicuspid teeth, and were subjected to immediate loading. The study group (A) received Bio-Oss Collagen grafting material after extraction and groups (B) was considered as a control, where sockets were left to heal normally.

Conventional, two pieces, screw type acid etched implants were used (Implus, Leader, Cinisello Balsarona Milano-Italy). The average used implant length 11.5mm and implant diameter was 3.75mm. Moreover, the same operator according to the adopted research protocol carried out all operations.

Pre-operative panoramic digitalized radiographs (Soredex, total filtration 2.7 mm Al/ Line voltage 230/240 Vac \pm 10% / 115 Vac (50/60 HZ) / Exposure time 17.6 second) were taken by Digital Panoramic System for all patients to verify the bone height, and to clarify that the intended implantation site are free from any local osseous pathological conditions.

Surgical and prosthodontics Procedure

The extraction procedure was performed under local anesthesia (Mepivacaine HCL 2% with Levonordefrin 1:20,000. Alexandria Co. for Pharmaceuticals and Chemical Ind. Alexandria. Egypt). After tooth removal, the socket was thoroughly curetted to remove any granulation tissue and to stimulate vascularization from the local osseous bed. Then, copious irrigation with normal saline solution of the alveolus was performed in both groups. Thereafter, the socket was augmented with Geistlich Bio-Oss Collagen® (Geistlich Pharma AG. Wolhusen Switzerland) in Study Group (A). The Bio-Oss Collagen was cut in harmony with dimensions of the alveolar socket to enable uncondensed placement. (**Fig.1A**). Graft was applied, not exceeding the height of the alveolar crest with gentle pressure. Care was taken to ensure that the collagen was saturated with blood. Finally, the gingival margin was gently adapted and fixed with a figure 8 fashion sutures.

After 6-8 weeks of healing period, Amoxicillin 1g was prescribed twice a day for 48 hours preoperatively as prophylactic antibiotic. Local anesthesia administration followed by a marginal gingival incision was made. Then, the mucoperiosteal flap was reflected (**Figs. 1C&2C**). The drilling was done using a low speed, high-torque contra angle with surgical motor unit. Drilling was performed at 600-800rpm at the accurate direction guided by the surgical drill guide (**Fig.2B**). After irrigation the implant bed with saline (**Figs.1 D&2D**), the sealed sterile implant package was then opened and the implant was inserted into the prepared osteotomy site with coupling wrench and ratchet until its final position became flashed with the level of the alveolar bone crest (**Fig.1E**). The mucoperiosteal flap was repositioned around the abutment and primary closure was achieved using black silk (3/0) interrupted suture (**Fig. 2E**). The impression was made in same day of surgery for all implants included in this study with the aid of impression post and laboratory implant analogue using silicon rubber base material to fabricate a working cast. Final porcelain fused to metal

crown was fabricated and cemented permanently on the abutment within 72 hours.

Post-operative care

Postoperative medication consisted of continuing the Amoxicillin 1g oral antibiotics every 12 hours for 5 days (Emox, Egyptian Int. Pharmaceutical Industries Co., E.I.P.I.C.O., A.R.E). Diclofenacpotassium (Oflam, Mepha Pharma Egypt S.A.E) 50mgtablets, a non-steroidal anti-inflammatory and analgesic drug was prescribed. Patients were instructed for maintaining optimal oral hygiene with Chlorohexidine (0.12%), (Hexitol, Arab Drug Company, Cairo, A.R.E), and to avoid chewing solid textured food. Sutures were removed one week after surgery.

Clinical evaluations

All of patients included in this study were evaluated immediately, six and twelve months from prosthetic attachment for the following parameters postoperatively:

1) Implant stability

Implant stability was assessed at all follow-up visits using periotest. The score was determined according to the following grades.⁽¹³⁾ Grade I; ranges from -08 to 0. Good osseointegration; the implant is well integrated and pressure can be applied to it. Grade II; ranges from +1 to +9. A clinical examination is required; the application of pressure on the implant is generally not (yet) possible. Grade III; ranges from +10 to +20. Osseointegration is insufficient and no pressure may be allowed to act on the implant.

2) Modified Sulcus Bleeding Index

The score was determined according to the following.⁽¹⁴⁾ Score 0; no bleeding when a periodontal probe is passed along the gingival margin adjacent to the implant. Score 1; isolated bleeding spots visible. Score 2; blood forms a confluent red line on margin. Score 3; heavy or profuse bleeding.

3) Modified Plaque Index

The score was determined according to the following.⁽¹⁴⁾ Score 0; no detection of plaque. Score 1; plaque only recognized by running a probe across the smooth marginal surface of the implant. Score 2; plaque can be seen by the naked eye. Score 3; abundance of soft matter.

4) Esthetics

Esthetics was evaluated according to pink esthetic score (PES).⁽¹⁵⁾ The PES is based on seven variables: mesial papilla, distal papilla, soft-tissue level, soft tissue contour, alveolar process deficiency, soft-tissue color and texture. Each variable was assessed with a 2-1-0 score, with 2 being the best and 0 being the poorest score. The mesial and distal papillae were evaluated for completeness, incompleteness or absence. All other variables were assessed by comparison with a reference tooth (the corresponding tooth).

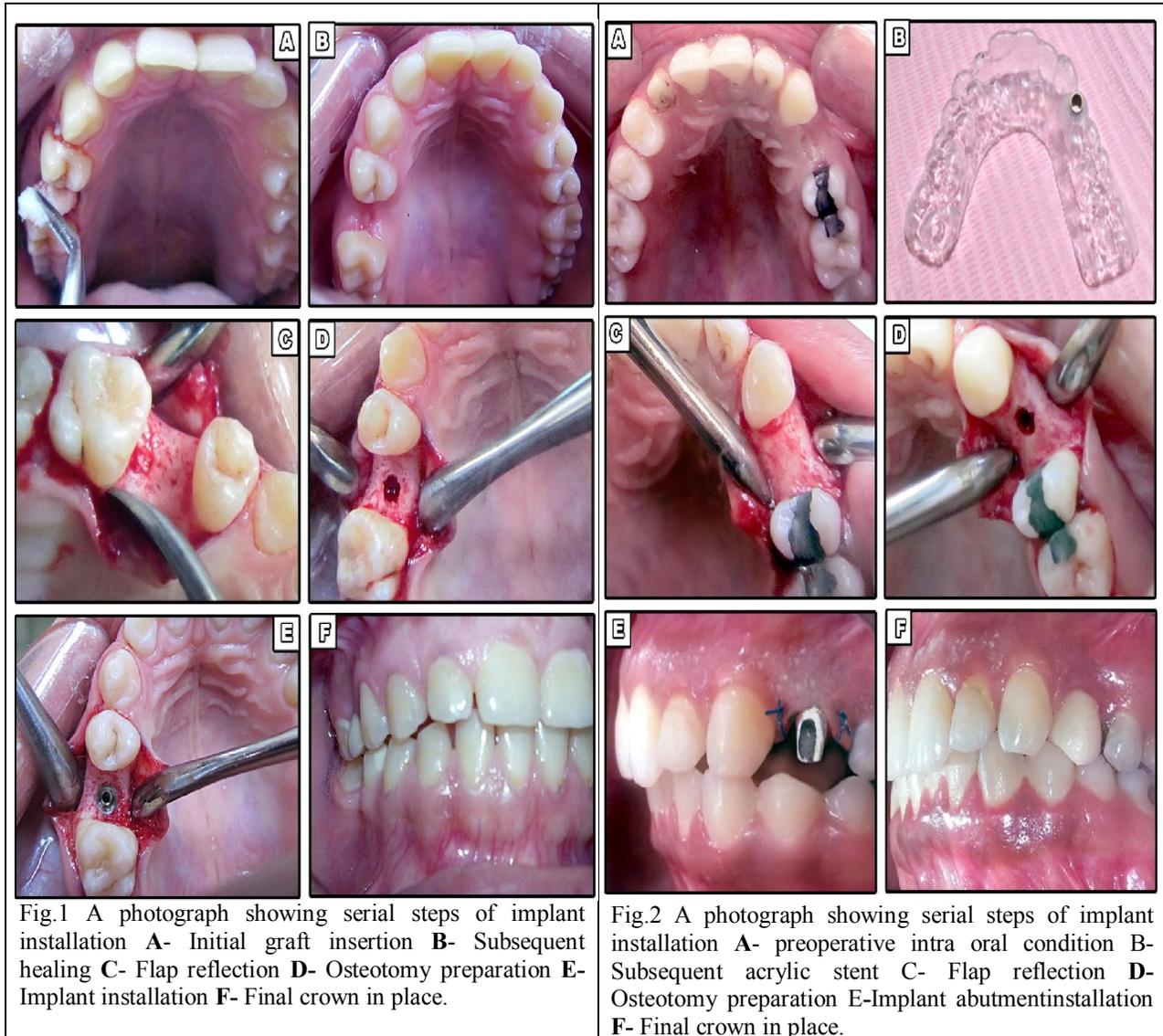


Fig.1 A photograph showing serial steps of implant installation A- Initial graft insertion B- Subsequent healing C- Flap reflection D- Osteotomy preparation E- Implant installation F- Final crown in place.

Fig.2 A photograph showing serial steps of implant installation A- preoperative intra oral condition B- Subsequent acrylic stent C- Flap reflection D- Osteotomy preparation E- Implant abutment installation F- Final crown in place.

5) Radiographic assessments

Panoramic radiographs were taken immediately, (T0), six months (T1) and after twelve months (T2) in both groups after all titanium implant placement and prosthetic attachment to evaluate the vertical bone loss. All radiographs were taken with the same device and transferred with the same program to standardize the result. Initially, a transverse line was observed at the junction of the cover screw and the neck of the implant on the first panoramic radiograph (T0). Mesial and distal vertical distances between the transverse line and the crestal bone levels were documented to determine the initial crestal bone level around the implant (Fig.1 H& 2H). The mesial and distal vertical bone loss between transverse line and the deepest marginal bone level were evaluated at different time intervals of the follow up either at (T1) and (T2). The

highest difference between the mesial and distal at T1 and T2 was chosen to determine the mean vertical bone loss.⁽¹⁶⁾

Statistical analysis

Data was entered and statistically analyzed using the Statistical Package for Social Sciences (SPSS) version 21. The normality of data was first tested with one-sample Kolmogorov-Smirnov test. Continuous variables were presented as mean \pm SD (standard deviation) for parametric data and Median for non-parametric data. The two groups were compared with chi square test (non- parametric data) and simple t test for paired data «p value ≤ 0.05 » was considered to be statistically significant.

Clinical result

Sixteen dental implants were placed 6-8 weeks after extraction of non-restorable maxillary bicuspids

teeth. Six first premolar and ten second premolar were subjected to immediate loading within (24-72) hours after fixture installation.

All patients included in this study were evaluated clinically through applying the following parameters.

1-Implant stability

In the 1st group, the average mean of PTVs were ranged between -2.15 ± 0.83 recorded at T0 and -3.25 ± 0.46 at T2. While, in the 2nd group, the average mean were ranged between -1.87 ± 0.83 recorded at T0 and -3.37 ± 0.74 recorded at T2 (Table1)

Comparing both groups, there were no statistical significant differences either at (T0) or at (T1) and (T2) of follow up ($P=0.999, 0.57, 0.232$ respectively) (Table 1).

In both groups, there was no statistical significant difference between (T0) values versus those recorded either at (T1) or (T2) ($P=0.986, 0.970- 0.268, 0.955$ respectively). Additionally, no statistical significant difference was recorded between (T1) values against (T2) values ($P=0.063- 0.970$ respectively) within both groups.

Table (1): Showing Mean, standard deviation and level of significance regarding to implant stability between both groups at different time intervals of follow up.

Groups		Study Group(1)	Control Group(2)	P
Evaluation Time				
Immediately (T0)	Mean	-2.125	-1.875	0.999
	± SD	0.83	0.83	
6 months (T1)	Mean	-2.63	-2.38	0.57
	± SD	0.74	0.92	
12 months (T2)	Mean	-3.25	-3.37	0.232
	± SD	0.46	0.74	

2-Modified sulcus bleeding index

In the 1st group, the average mean values of Modified sulcus bleeding index were ranged between 1.5 ± 0.53 recorded at (T0) and 1 ± 0.76 at (T2). While, in the 2nd group, the average mean values of Modified sulcus bleeding index were ranged between 2.13 ± 0.64 recorded at (T0) and 0.88 ± 0.64 recorded at (T2). (Table 2).

Comparing both groups, no statistical significant differences were found at different time intervals of

follow up either at (T0) or (T1) and at (T2) ($P=0.059, 0.602, 0.725$ respectively) (Table 2).

In both groups, there were statistical significant differences between values recorded at (T0) versus those recorded either at (T1) or (T2) ($P=0.008, 0.046- 0.009, 0.015$ respectively). On the other hand within both groups, no statistical significant difference was recorded between (T1) versus (T2) values ($P=0.180- 0.564$).

Table (2): Showing mean, standard deviation and level of significance regarding to Modified sulcus bleeding index between both groups at different time intervals of follow up.

Groups		Study Group(1)	Control Group(2)	P
Evaluation Time				
Immediately (T0)	Mean	1.50	2.13	0.059
	± SD	0.53	0.64	
6 months (T1)	Mean	0.63	0.75	0.602
	± SD	0.52	0.46	
12 months (T2)	Mean	1	0.88	0.725
	± SD	0.76	0.64	

3-Modified plaque index.

In the 1st group, the average mean values of Modified plaque index were ranged between 1.13 ± 0.64 recorded at (T0) and 1 ± 0.53 at (T2). While, in the 2nd group, the average mean values of Modified plaque index were ranged between 0.88 ± 0.64 recorded at T0 and 1.38 ± 0.74 recorded at (T2) (Table 3).

Regarding Modified plaque index, no statistical significant differences were recorded between both

groupseither at (T0), (T1) and(T2) of follow up periods ($P=0.429, 0.241, 0.215$) respectively (Table 3).

In both groups, there were no statistical significant differences between (T0) values versus those recorded either at 6 months (T1) or at 12 months (T2) of follow up periods ($P=0.705, 0.564- 1.000, 0.157$ respectively). Additionally, no statistical significant difference was recorded between (T1) values versus (T2) values ($P=0.527- 0.157$).

Table (3): Showing mean, standard deviation and level of significance regarding to Modified plaque index between both groups at different time intervals of follow up.

Groups		Study Group(1)	Control Group(2)	P
Evaluation Time				
Immediately (T0)	Mean	1.13	0.88	0.429
	± SD	0.64	0.64	
6 months (T1)	Mean	1.25	0.88	0.241
	± SD	0.89	0.35	
12 months (T2)	Mean	1.0	1.38	0.215
	± SD	0.53	0.74	

4-Esthetics: (pink esthetic Score).

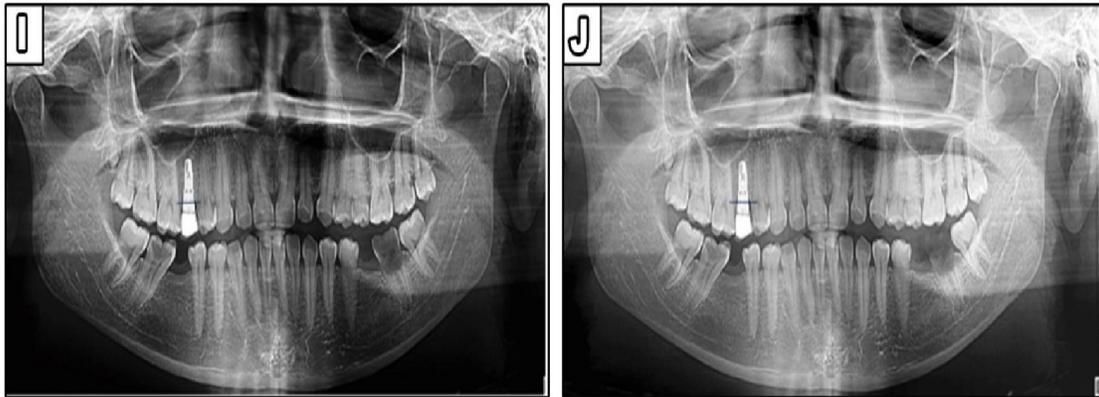
The mean PES values at the time of final restoration for both groups ranged from 12 to 14, with a mean of (13.6) (Figs.1F & 2F)). There was no statistical difference between both groups after 12 months of follow up ($P=1.000$) (Table 4).

Table (4): Showing mean, standard deviation and level of significance regarding to P.E.S. in both groups after 12 months from the time of final restoration.

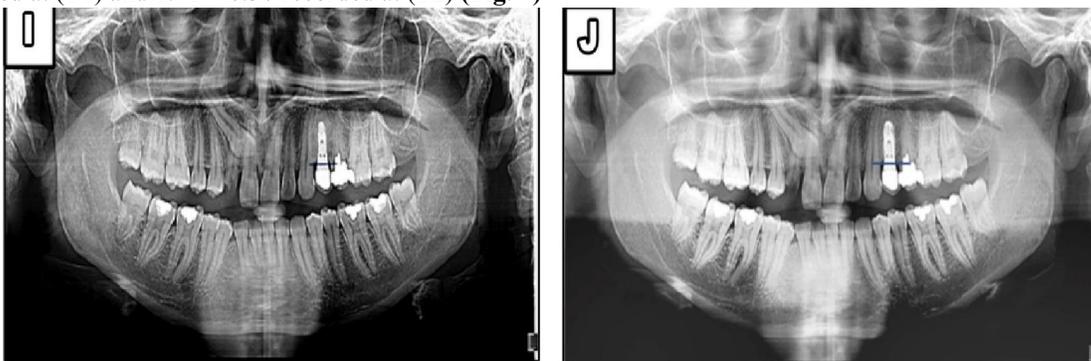
Groups	Study Group(1)	Control Group(2)	P
P.E.S at (T2)			
Mean	13.57	13.57	
Standard deviation	0.787	0.787	1.000

5-Marginal Bone Level (MBL)

In the 1st group, the average mean values of Marginal bone level were ranged between 0.86 ± 0.14 recorded at (T1) and 1.23 ± 0.18 at (T2). (Fig.3).

**Fig. 3 (Study group A)** A panoramic radiograph showing marginal bone level at T1 (I) & T2 (J).

While, in the 2nd group, the average mean values of Marginal bone level were ranged between 0.79 ± 0.18 recorded at (T1) and 1.41 ± 0.30 recorded at (T2) (Fig. 4)

**Fig.4 (control group B)** A panoramic radiograph showing marginal bone level at T1 (I) & T2 (J).

On the other hand, there were no statistical significant differences between both groups regarding to marginal bone level at the different time intervals of follow up either at, (T1) or at (T2) ($P=0.370, 0.149$) respectively (**Table 5**).

In both groups, there wear statistical significant differences between (T0) values versus those recorded

either at (T1) or (T2) ($P=< 0.001, < 0.001- < 0.001, < 0.001$ respectively). Additionally, statistical significant differences were recorded between (T1) values against (T2) values ($P=< 0.001- < 0.001$ respectively) within both groups.

Table (5): Showing mean, standard deviation and level of significance regarding to marginal bone level between both groups at different time intervals of follow up.

Groups Evaluation Time		Study Group(A)	Control Group(B)	P
6 months (T1)	Mean	0.86	0.79	0.370
	± SD	0.14	0.18	
12 months (T2)	Mean	1.23	1.41	0.149
	± SD	0.18	0.30	

4. Discussion:

Delayed implant placement after healing of the socket seems to be an effective alternative, providing more stable marginal bone, the soft tissue easier to manage, suitable for augmentation techniques, reducing the risks for infection during implant placement and provide good solution of any acute infection.^(17,18) Additionally, **Nemcovsky and Artzi** ⁽¹⁹⁾ have also considered that post-extraction period in delayed immediate implant protocol give advantage of increased osteoblastic activities.⁽¹⁹⁾

On the other hand, the controversial impact of grafting materials in fresh, post-extraction sockets has been reported because some authors has declared that it can interfere with the normal healing process.⁽⁸⁻¹⁰⁾ In harmony with that immediate loading protocol was applied in this study since it has gained popularity due to various elements containing treatment time reduction, minimize trauma, psychological and aesthetic benefits to the patient.⁽²⁰⁾

Regarding to implant stability, the mean periotest values (PTV) of patients within the study group were ranged between (-2.125±0.83 to -3.25±0.46) at T0 and at T2 periods of follow up, and for control group were ranged between (-1.87±0.83 to -3.37±0.74) at T0 and at T2 periods of follow up. According to study conducted by **Atsumi et al.**, using periotest device, the primary stability can be obtained with values between (-4 to -2) with immediate loading pattern.⁽²¹⁾

Our findings showed that primary stability increased with the period at follow-up examination from T0 to T2 for both groups. In contrast with our findings, **Carini et al.**, have compared the immediate implant with delayed immediate implants subjected to immediate loading, declared that the timing of dental implant insertion did not affect the achievement of primary stability.⁽²²⁾

The result of present study showed that no statistical significant impact of alveolar socket

augmentation on improvement primary stability at different time intervals of assessment between both groups ($P=0.999, 0.57, 0.232$ respectively). This can be explained by the fact that bone graft does not fully integrate with alveolar bone socket. This comes in agreement with authors who concluded that the consistency of the alveoli filled with Bio-Oss is still rather soft even after four months.^(23,24) However, in our study such waiting period was ranged only between six to eight weeks.

Regarding modified plaque index, it was considered as an etiologic factor for implant diseases and may induce bone loss.⁽²⁵⁾ Therefore, the presence of plaque can be used as a predictor for disease and for planning intervention.⁽²⁶⁾ All patients in both groups in our study showed low plaque levels during the period of the study with no statistical significant differences when comparing both groups at different time intervals ($P= 0.429, 0.241, 0.215$ respectively). This can be attributed to the plaque control by the patient and the frequent motivation of oral hygiene measures given to the patient.

The present study showed stable peri-implant soft tissue and recorded no statistical significant differences between both groups at different time intervals regarding to Modified bleeding index at T0 or T1 and at T2 periods of follow up: ($P=0.059, 0.602, 0.725$ respectively). Historically, **Lekholm et al.** found no correlation between bleeding-on-probing and histology, microbiology and radiographic changes,⁽²⁷⁾ while others claim bleeding as an important indicator for disease.⁽²⁸⁾

Regarding to Pink Esthetic Score, there was no statistical significant difference between both groups after 12 months of follow up ($P=1.000$) with average mean (13.57). Such finding can be attributed to minimized bone resorption, which is an important factor in achieving good esthetic results and providing sufficient bone to support the implants. However,

some authors reported that the mean PES scores for delayed implant placement with immediate loading after 1 year of follow up was (12.80 ± 1.40 and 12.22 ± 1.13 respectively), that showed lower value than the present study.^(23,24) Such finding can be attributed to the applied grafting procedures and loading pattern used in this study

Regarding marginal bone level (MBL) the average mean of Marginal bone level in study group (A) were ranged between 0.86 ± 0.14 recorded at (T1) and 1.23 ± 0.18 at (T2) periods of follow up. While, in group (B) the average mean of Marginal bone level were ranged between 0.79 ± 0.18 recorded at (T1) and 1.41 ± 0.30 recorded at (T2) periods of follow up.

In the study carried out by **Soydan et al.** which evaluated the marginal vertical bone loss comparing immediate against delayed immediate implants in both maxillary and mandibular jaw. The average mean of MBL was (0.80 mm) in delayed immediate implants groups (four weeks after tooth extraction) with conventional loading protocol.⁽¹⁶⁾ Moreover, **Annibali et al.** evaluated interproximal marginal bone loss adjacent to delayed immediate implant in mandibular or maxillary first molar sites. The average mean was (0.91 ± 0.28 mm) through nine months after baseline and at the 22 months after baseline (1.04 ± 0.25 mm).⁽¹⁷⁾

The result of present study showed that the impact of alveolar socket augmentation did not enhance their ability for decreasing significantly the interproximal marginal bone loss, while such condition can be attributed to the immediate loading pattern of both groups. These results are in agreement with **Schou et al.** who suggested that the impaired remodeling during the healing phase could be the causative factors for initial bone loss to implants during the first year,⁽²⁹⁾ especially with modifying loading pattern in addition to the variation of time elapsed between extraction and subsequent delayed immediate implant installation within this study (8 weeks).

According to the best of our knowledge, the limitation of published literature focused on delayed immediate implant placement protocols associated with immediate loading especially, with presence or absence of postextraction augmentation in addition to the small sample size of included patients within this study represented two main challenging point. However, it represented a pivotal finding about the clinical impact of immediate socket grafting on delayed immediate implant success versus non grafted model.

Conclusions:

Grafting fresh alveolar socket cannot be considered as a pivotal maneuver that can improve significantly the clinical outcomes associated with

delayed immediate implants subjected to immediate loading.

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