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Research Article

Randomized Controlled Clinical Study of Immediate Implant Placement with Simultaneous Augmentation Using Autogenous versus Xenogenic Ring Block Graft for Periodontally Hopeless Teeth

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Abstract

Background: Different bone graft materials and techniques had been used in guided bone regeneration for dental implants placement. An innovative technique was developed called "bone ring technique" to install implant simultaneously in one stage procedure following teeth extraction.

Objectives: The aim of this study was to evaluate and compare clinically the efficacy of bone augmentation around immediate implant placement for hopeless periodontally involved anterior teeth using autogenous bone ring block graft harvested from retromolar area versus xenogenic bone ring block graft.

Materials and Methods: Twenty patients with periodontally hopeless anterior maxillary teeth based on clinical and radiographic examination and indicated for extraction were included in this study. The extraction sites were classified randomly into two groups; group A (ten immediate implants placed simultaneously with autogenous bone ring block graft) and group B (ten immediate implants installed within xenogenic bone ring block graft). The following clinical parameters: plaque index, probing depth and bleeding on probing were carried out for each patient in both groups after implant placement at 6, 9 and 12 months. While other clinical parameters were carried out at different periods; pink esthetic score (PES) at 9 and 12 months and Patient's esthetic satisfaction at 12 months.

Results: Upon comparing the mean differences of Plaque index and bleeding on probing of the two groups there were no statistically significant. And upon comparing the mean differences of pocket depth among the two groups there was significant difference in favor of group A at 12 months. There was significant increase of the PES of group A when compared to group B at 9 and 12 months. Also, Patient's esthetic satisfaction was statistically significant in favor of group A at 12 months.

Conclusion: The present study demonstrated that either the application of autogenous bone ring or xenogenic bone ring within immediately placed dental implants in periodontally compromised extraction sites reduced the time for restoration function and esthetic. Also, they improved the soft tissue contour and patient satisfaction. But the autogenous bone ring graft showed better comparable clinical results when compared with xenogenic bone ring graft.

Keywords: *Bone ring; Immediate Implant; Periodotally; Autogenous; Retromolar; Xenogenic*

Introduction

The presence of adequate volume of bone is one of the essential key factors for achieving successfully osseointegration and long-term retention of endosseous dental implants [1]. Periodontally hopeless teeth with severe attachment loss have a very limited capacity to

regain natural periodontal form, function, and esthetics. It is challenge procedure for the clinician to decide whether to retain a periodontally compromised tooth or replace it with an implant restoration [2].

After tooth extraction, the alveolar bone undertakes resorption and atrophy varying noticeably between different individuals. The bone defects which may occur after extraction of periodontally compromised anterior teeth represent a challenge problem for implant restoration [3].

A variety of guided bone regeneration techniques using combinations of barrier membranes and bone grafts like autogenous grafts, allografts and xenografts, as well as different types of natural and synthetic biomaterials have been suggested to promote bone regeneration in localized defects at implants placed into extraction sockets [4].

Immediate implant placement after tooth extraction has become a common clinical therapeutic approach, alternative to a staged surgical protocol. As the reduction in the number of surgeries needed and the advantage of a shorter time to rehabilitate function and aesthetic has provided an impetus to study this surgical approach [5].

A new technique was introduced by Stevens*., **et al.*** [6] to augment the defective socket with autologous "bone ring" graft harvested from chin with simultaneous implant placement. By this technique, the harvested rings can then be secured to the extraction socket using the dental implants restoring the deficient crestal bone in a three dimensions fashion.

Due to lack of studies about the effects of autogenous ring bone block graft harvested from retromolar area versus xenogenic ring bone block graft around immediate implants placement in periodontally involved sites, the present study was designed to evaluate whether or not this innovative technique will improve soft and hard tissue regeneration around immediate implant placement.

Materials and Methods

Approval for this study was obtained from Tanta Faculty of Dentistry, Tanta University Research Ethics Committee (REC). The purpose of the present study was explained to the patients and informed consents were obtained.

A total of Twenty patients with periodontally hopeless anterior maxillary teeth based on clinical and radiographic examination were selected from patients who fulfilled the following inclusion criteria: Patients in good health with absence of relevant medical condition that contraindicate implant placement e.g. uncontrolled diabetes mellitus or blood coagulation disorder, age ranged from 35 - 45 years old, adequate bone height apical to the alveolus of the extracted tooth (≥ 5 mm) to ensure primary implant stability and optimal compliance as evidenced by no missed treatment appointments and a positive attitude toward oral hygiene.

The exclusion criteria included the following: Presence of persistent and unresolved infection in the implant site, smoker patients, pregnant, patients with parafunctional occlusal habits as bruxism and clenching, insufficient vertical inter-arch space, history of radiotherapy or chemotherapy in the head and neck region and use of bisphosphonate therapy.

The twenty extraction sites among the patients were randomly classified into two groups using sealed envelopes. The patients were treated with one of the following treatment modalities as follows; Group (A) where ten immediate implants* were placed using autogenous bone ring block graft harvested from the retromolar area and covered with pericardium collagen membrane≈ (Figure 1). And Group (B) included ten immediate implants were placed using xenogenic bone ring block graft• and covered with pericardium collagen membrane (Figure 2). In this study, all the implants which were installed had a diameter 3.8 mm to achieve comparison standardization of the block graft in both groups. But the implant length was variable according to the anatomical site limitation. The implant length in all sites was 15 mm except in four sites where the implant length was 12 mm.

*Biohorizion implant system USA (tapered internal design).

≈ Tutopatch, Tutogen medical company Germany.

•Tutogen bone block (bovine origin) Tutogen Medical GmbH, Germany.

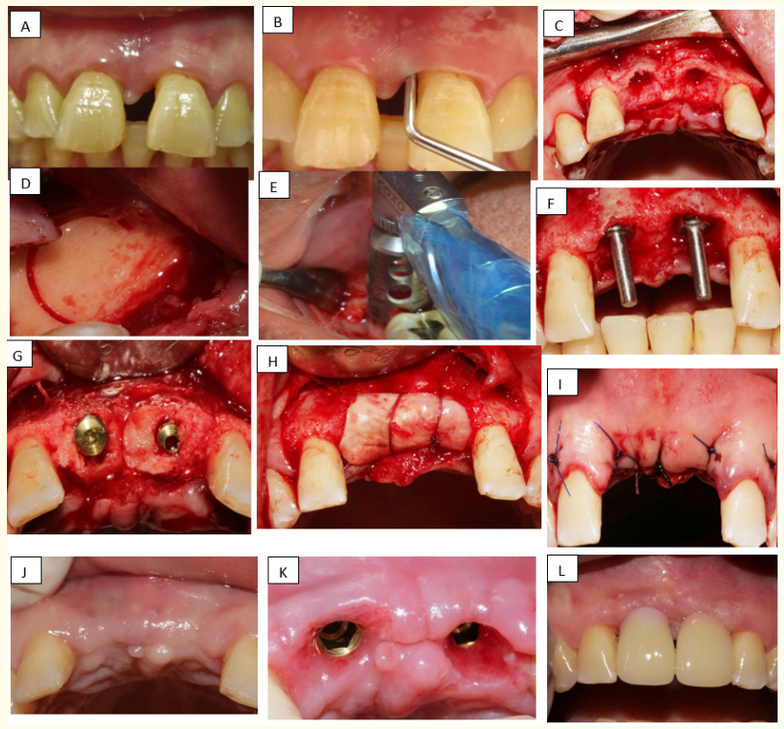

Figure 1A-1L: *A case from group A (autogenous bone ring group): (A) selected site before phase I therapy, (B) probing after phase I, (C) a traumatic extraction sites and socket debridement of granulation tissue, (D) flap reflection at retromolar area (donor site) and marking of osteomy site, (E) harvesting autogenous block by length marked trephine drill, (F) parallel pins used to evaluate position and angel of implant osteotomy site, (G) implant placement inside block, (H) stabilization of pericardium collagen membrane by absorbable suture, (I) flap suturing, (J) postoperative healing, (K) Soft tissue emergence profile and (L) final ceramic restoration.*

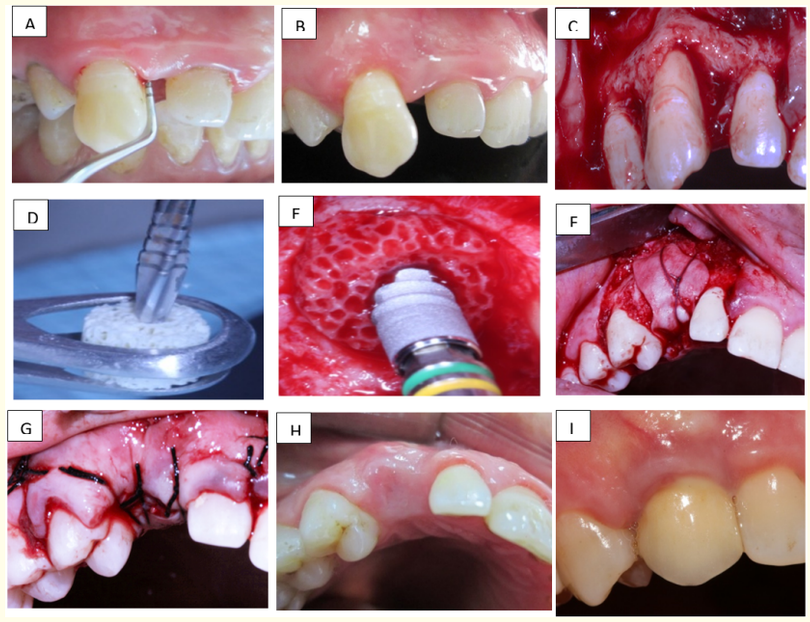

Figure 2A-2I: *A case from group B (xenogenic bone ring group): (A) selected site before phase I therapy, (B) after phase I therapy, (C) mucoperiosteal flap reflection,(D) drilling a central hole inside block by using conventional drill set for the implant to be installed, (E) implant installation inside xenogenic ring block, (F) stabilization of the membrane with absorbable suture, (G)flap suturing, (H) one month post-operative healing and (I) final ceramic restoration.*

For all the patients full mouth scaling and root planning was carried out as well as a comprehensive oral hygiene instructions. All required restorative and endodontic treatments were performed prior to implant placement. The periodontal condition of all subjects was monitored until a full-mouth bleeding on probing score was < 20%. Re-evaluation was conducted after four weeks to evaluate the patient response to phase I therapy.

All the surgical procedures were performed by the same operator. One hour before surgery the patient was instructed to take 1 gm amoxicillin claviolanate[⊕] and just before procedures the patient rinsed with 0.1% chlorhexidine gluconate[ø] for 2 minutes.

Infiltration local anesthesia was obtained by administration of 2% lidocaine with 1: 800,000 epinephrine. Intra-sulcular incisions around the necks of the periodontally hopeless tooth and extended mesially and distally around the adjacent teeth. Two vertical releasing incisions were made at the mesial and distal side of the flap. A facial full thickness pyramidal mucoperiosteal flap was reflected beyond the mucogingival line.

Horizontal releasing incision was performed at the periosteal level of mucogingival junction to allow for tensionless flap movement and cover the bone block without dehiscence. The hopeless tooth was removed with atraumatic extraction. The socket walls were properly curetted with spoon bone curette to remove any remaining granulation tissue and irrigated with normal saline. Also, the granulation tissue attached to the periosteal surface of the flap was removed.

Harvesting autogenous bone block (donor site)

Mandibular nerve block anesthesia was obtained by administration of 2% lidocaine with 1: 800,000 epinephrine. Buccal sulcular incision was done at the lower second molar extending distally to retro molar area. Another vertical oblique incision was performed mesially to lower second molar. Reflection of the flap was done by using a periosteal elevator.

The trephine drill was directed from the buccal aspect of the retromolar area in a parallel direction to the lower third molar to avoid damage to the inferior alveolar bundle which closely located to the lingual periosteum at this site. The selected retro molar area was outlined with a length marked trephine bur of a diameter 8.0 mm. under copious irrigation, the trephine drill was penetrated into the bone at a low speed of 2000 - 3000 rpm to get a smooth clean osteotomy cut. To avoid choking of bone inside the trephine bur, the trephine drill was pulled up and down.

The entire circular bone block 8 mm width x 5 mm height was either pulled out simultaneously with the trephine bur during its withdrawal or was removed with the aid of the fine chisel. The block was handled with a tissue forceps and subsequent drills were used similar to the implant site preparation. The central osteotomy was then tapped using a special tap drill through the entire length of the bone block to prevent it from fracturing at the stage of implant installation.

By preforming a hole at the center of the block graft, it seemed like a ring block graft where the implant could be simultaneously placed inside to be installed at the extraction socket of the periodontally involved tooth. The central hole in the graft was equal to 3.8 mm which is equal to the implant diameter used in this study. By this way, there was approximately 2.1 mm of the bone around the implant mesio-distally and bucco-palatly (i.e. 8 mm width of block minus 3.8 mm width of central hole and subdivided by 2 equal 2.1 mm). The harvested ring was kept in normal saline. Flap closure was accomplished using 4-0 silk interrupted sutures.

Preparation of the xenogenic block graft

The xenogenic bone block was trimmed to get approximately circular dimensions of 8 mm width x 5 mm height by using a length marked trephine drill of a diameter 8 mm. By drilling a hole performed in the center of the block using a conventional drill set for the implant to be used, the graft became similar to a ringed block. The central hole was prepared to be approximately equal 3.8 mm which is the

[⊕]Augmentin 1 gm, Smith Kline Deecham Pharmaceuticals, England.

[ø]Antiseptol mouth wash, Kahira Pharmaceuticals and Chemical Industries Co., Egypt.

diameter size of the implant used in this study. Also, the block was tapped to decrease friction during implant installation. The prepared xenogeneic ring block was rehydrated in a saline before use.

Preparation of implant site

The implant bed was prepared according to the manufacturer's instructions using the recommended drills sequence. Drilling was done under a constant stream of sterile irrigation. A pumping motion employed with a gradual drill sequence to prevent over-heating the bone. Initial osteotomy was done by 2.0 mm starter drill and followed by 2.5 mm depth drill. Paralleling Pins was used to evaluate osteotomy position and angle. The final drill diameter used was 3.4 mm to install an implant of a diameter 3.8 mm.

Membrane application and flap closure

Pericardium collagen membrane was trimmed, rehydrated in saline and placed to cover the grafted site. Membrane stabilization was done with periosteal vertical mattress suture by using absorbable suture material (vicryl) of a size 5 zero. Tension-free flap suturing was achieved using horizontal mattress sutures and single interrupted sutures by non-absorbable suture material (silk) of a size 4 zero.

Six months postoperatively, a minimal crestal incision was performed under local anesthesia and a small flap was reflected to expose the covering screw. The healing abutment was then secured, and the flap closed around it to give a natural gingival appearance after healing. After 3 weeks, the healing abutment was removed, and the transfer abutment was secured. The impression was then taken to construct the final restoration. Finally, the fabricated zircon crown was permanently cemented using resin modified cement over the final abutment. After Prosthetic installation, the patients were instructed for meticulous care of their oral hygiene; this includes: Chlorohexidine gluconate 0.1% mouth wash was twice daily for 2 weeks and proper tooth brushing.

The following clinical parameters plaque index (PI), probing depth (PD) and bleeding on probing (BOP) were measured at 6, 9, and 12 months interval from implant placement. While other clinical parameters were carried out at different periods; pink esthetic score (PES) at 9 and 12 months and Patient's esthetic satisfaction at 12 months.

The collected data were organized, tabulated and statistically analyzed using computer software Statistical Package for Social Science (SPSS version 16).

Results

Using t test, there was no statistically significant difference between group A and group B at all the study periods intervals 6 (base line), 9 and 12 months post implant placement as $P < 0.05$ (Table 1). And upon comparing the mean values of bleeding on probing (BOP) of group A and group B at 6, 9 and 12 months post implant placement, there were (2.925 ± 0.3545 versus 2.725 ± 0.3217), (2.200 ± 0.5244 versus 2.325 ± 0.2648) and (2.225 ± 0.7212 versus 2.200 ± 0.2449) respectively. When comparing the mean value of BOP at 6, 9 and 12 months there was no statistically significant difference as $P < 0.05$ (Table 2).

Group	Mean ± SD	t	p
6 months (group A)	0.7500 ± 0.1667	1.861	0.0792 ns
6 months (group B)	0.8750 ± 0.1318		
9 months (group A)	0.3000 ± 0.1054	1.877	0.0769 ns
9 months (group B)	0.4500 ± 0.2297		
12 months (group A)	0.2250 ± 0.1419	1.697	0.1069 ns
12 months (group B)	0.3250 ± 0.1208		

Table 1: *Intergroup comparison of the mean values of plaque index (PI) at 6 (base line), 9 and 12 months post implant placement. Significance: p* < 0.05, p** < 0.01, p*** < 0.001 and ns = Not Significance.*

Group	Mean ± SD	t	P
6 months group A	2.925 ± 0.3545	1.861	0.0792 ns
6 months group B	2.725 ± 0.3217		
9 months group A	2.200 ± 0.5244	1.877	0.0769 ns
9 months group B	2.325 ± 0.2648		
12 months group A	2.225 ± 0.7212	1.697	0.1069 ns
12 months group B	2.200 ± 0.2449		

Table 2: *Intergroup comparison of the mean values of BOP at 6, 9 and 12 months post implant placement.*

Significance: p < 0.05, p** < 0.01, p*** < 0.001 and ns = Not Significance.*

Using t test, it was found that the mean values of PD of group A and group B at 6, 9 and 12 months post implant placement were (2.390 ± 0.3315 versus 2.680 ± 0.4158), (2.450 ± 0.1650 versus 2.690 ± 0.4483) and (2.950 ± 0.6364 versus 3.490 ± 0.2998) respectively. There was statistically significant difference at 12 months while at 6 and 9 months there was no statistical significant difference as $P < 0.05$ (Table 3).

Group	Mean ± SD	t	p
6 months (group A)	2.390 ± 0.3315	1.725	0.1017 ns
6 months (group B)	2.680 ± 0.4158		
9 months (group A)	2.450 ± 0.1650	1.589	0.1295 ns
9 months (group B)	2.690 ± 0.4483		
12 months (group A)	2.950 ± 0.6364	2.427	0.0259*
12 months (group B)	3.490 ± 0.2998		

Table 3: *Intergroup comparison of the mean values of PD at 6, 9 and 12 months post implant placement.*

Significance: p < 0.05, p** < 0.01, p*** < 0.001 and ns = Not Significance.*

It was found that the mean values of PES between group A and group B at 9 and 12 months post implant placement were (9.700 ± 1.252 versus 7.100 ± 2.807 versus) and (11.00 ± 1.886 versus 8.400 ± 2.675) respectively. When comparing the mean values of PES at 9 and 12 months there were statistical significant difference in favor of group B as $P < 0.05$ (Table 4). At 12 months the mean values regarding patient's esthetic satisfaction in group A and group B were 8.000 ± 0.5774 and 7.100 ± 0.6146 and respectively. And upon comparing the mean value of patient's esthetic satisfaction between the two groups it was significant for group B as $P < 0.05$ (Table 5).

Group	Mean ± SD	t	p
9 months group A	9.700 ± 1.252	2.512	0.0217*
9 months group B	7.100 ± 2.807		
12 months group A	11.00 ± 1.886	2.675	0.0154*
12 months group B	8.400 ± 2.675		

Table 4: *Intergroup comparison of the mean values of PES at 9 and 12 months post implant placement.*

Significance: p < 0.05, p** < 0.01, p*** < 0.001 and ns = Not Significance.*

Patient's esthetic satisfaction		
Group	**Group A**	**Group B**
Mean ± SD	8.000 ± 0.5774	7.100 ± 0.6146
t	3.375	
p	0.0034**	

Table 5: *Patient esthetic satisfaction of group A and group B at 12 months:*

Significance; p < 0.05, p** < 0.01, *** < 0.001 ns = Not Significance.*

Discussion

The present study was carried out to evaluate and compare the efficacy of bone augmentation around immediate implant placement in severely periodontally involved anterior maxillary teeth using pericardium collagen membrane with autogenous bone ring block graft harvested from retromolar area versus xenogenic ring block graft. The patients who participated in this study were selected according to inclusion and exclusion criteria to avoid bizarre selection. Furthermore, cases were medically free, to avoid the possible impact of systemic disorders on the periodontal condition and their possible effect on clinical parameters, since many systemic disorders have been implicated as risk factor for implant success [7].

Concerning the bone augmentation technique used in this study i.e. bone ring technique where immediate implant was installed simultaneously within the bone block either through autogenous block graft harvested from the retromolar area (group A) or xenogenic block graft (group B). This technique was based on the idea pioneered by Giesenhagen and Yu¨ksel [8] and Stevens., *et al* [6]. The merits of this technique, including a three dimensional augmentation of the native alveolar ridge, elimination of the gap between socket implant interface and the ability to provide additional stability of the implant at the crestal region of the implant and shorten the treatment time instead of performing 2 surgeries; one for socket augmentation, then another surgery for implant placement. So, this technique provides one stage procedure for augmentation with simultaneous implant placement [6].

Regarding the donor site for harvesting autogenous block graft was the retromolar area, which is derived from intramembranous bone origin, which shows less resorption than the grafts derived from endochondral bone origin which give a benefit of graft volume maintaining. Furthermore, intra membranous bone grafts do not present a physical barrier to rapidly in growing blood vessels and show rapid revascularization than endochondral bone with a thicker cancellous component [9].

Another explanation for this selection is the little site morbidity associated with, retromolar site in comparison with chin graft as temporary mental paresthesia after harvesting chin grafts ranges from 10% to 50%, whereas the mandibular ramus ranges from 0% to 5%. While chin is better in accessibility and provide more cancellous bone but harvesting from this area carry a risk for dysesthesia of the anterior mandibular dentition, loss of teeth vitality, post-operative change in soft-tissue contour of chin and chin ptosis found [10].

Upon comparing the mean values of plaque index and bleeding on probing for the two groups, there were no statistically significant differences at different follow up intervals. These results were attributed to the comprehensive oral hygiene instructions followed properly by the patient, periodic maintenance program, meticulous scaling of supra-gingival and sub-gingival plaque and calculus and good fabricated crown restoration regarding glazed porcelain surface and restoration contour. This led to a reduction of accumulated dental plaque and in sequence reduction of inflammation [11].

This explanation was in accordance with Zortuk*., et al.* [12] who concluded that surface roughness of provisional fixed prosthodontic materials causes adhesion of bacteria, accelerates dental plaque formation and accumulation and the development of periodontal diseases resulting in gingival bleeding. While glazed porcelain surface was considered more biocompatible preventing bacterial adhesion and plaque accumulation. On the other hand, Verhoeven., *et al.* [13] analyzed the reliability of different periodontal parameters to reflect the clinical condition of a dental implant. They found a rather poor specificity and sensitivity for the plaque and bleeding index and considered the afore-mentioned parameters as unreliable for clinical evaluation in implant dentistry.

And upon comparing the mean values of pocket depth of the two groups, there was statistically significant differences at 12 months in favor of group A. Although, the mean values of PD revealed a slight increase over time none of these increases were suggestive of inflammation. For estimations of incidence rates of peri-implantitis, implants that were not affected until the end of the observation period as peri-implantitis was defined as an incidence of PD ≥ 5mm with positive BOP and radiographic signs of bone loss [14].

In the present study, pink esthetic score (PES) was used to evaluate the soft tissue alternations around immediate implant restoration in esthetic zone. This is in agreement with Fürhauser., *et al.* [15] who stated that PES is a suitable sensitive tool for reproducibly assessing peri-implant soft tissue. On the other hand, some authors reported that PES has limitations including; the seven parameters forming PES are given the same weight however, these parameters seemed to be unequal important from the perspective of soft tissue esthetics. Also, PES does not reflect patients' satisfaction with the esthetic outcomes as PES is a professional esthetic assessment tool that might not be of decisive importance for the patient [16].

Upon comparing the mean values of PES between the two groups at 9 and 12 months there was statistically significant difference in favor of group A. The possible explanation is the difference of crestal bone level among the two group which had effect on aesthetic outcomes. This is in accordance with Tarnow., *et al.* [17] who stated that the interproximal bony crest plays a critical role in the presence or absence of peri-implant papillae.

In the present study patient's esthetic satisfaction parameter was used for subjective evaluation of immediate implant esthetic outcomes as the ultimate outcomes of the therapy was to satisfy the patient's desire to replace a lost tooth with a functional, and esthetic solution. This is in accordance with Buser., *et al.* [18] who stated that patient satisfaction is a key factor in the success of implant therapy, especially in the anterior area.

In our study, all patients accepted the crowns provided being satisfied with the final esthetic outcome. The patient's esthetic satisfaction of the present study was revealed best results with group A (immediate implant with autogenous block graft) where gingival tissue changes were within clinical expectations, as confirmed by the patients' response to the questionnaires, where in a mean esthetic satisfactory rate of 8.0 ± 0.57 was recorded. This is in accordance with Luo., *et al.* [19] who suggested a tight correlation between PES outcome and patients' subjective assessment. The authors stated that the PES value generally reflects the degree of patient satisfaction with the peri-implant soft tissue esthetic result.

Conclusion

The present study demonstrated that either the application of autogenous bone ring or xenogenic bone ring within immediately placed dental implants in periodontally compromised extraction sites reduced the time for restoration function and esthetic. Also, they improved the soft tissue contour and patient satisfaction. But the autogenous bone ring graft showed better comparable clinical results when compared with xenogenic bone ring graft.

Conflict of Interest

There is no financial interest, or any conflict of interest exists.

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