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Bone Ring Autogenous Graft and Immediate Implant Reconstruction in Atrophic Posterior Mandibular Area

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Bone Ring Autogenous Graft and Immediate Implant Reconstruction in Atrophic Posterior Mandibular area

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ABSTRACT

Purpose: to evaluate clinical and radiographic outcome of bone ring grafting technique with immediate implant placement in fresh extraction socket in mandibular posterior area. **Patients and methods:** Clinical study was conducted on six patients, suffer from deficiency in vertical height at posterior mandibular area. Extraction and immediate implant reconstruction with symphyseal bone grafting in one-stage procedure. All steps of harvesting by trephine bur, implant osteotomy and placement within the socket were guided by computerized surgical stent for donor and recipient sites. Platelet Rich Fibrin (PRF) membrane was prepared to cover the implant at suture line. Patients were followed up clinically and radiographically by Cone Beam Computed Tomography (CBCT) at immediate,3 and 6 months postoperatively to evaluate the implant site and vertical bone height changes. **Results:** One successful case out of six showed excellent soft tissue healing with implant stability. Clinically one case showed sever infection at 2 weeks postoperatively with looseness of implant. Dehiscence and pain were found in 83.3% of the cases. Four cases had mild pain and one case suffered from severe pain, edema was mild in the majority of patients, numbness was found in 4 cases with 66.7%. CBCT results showed significant decrease in 3D dimensions of vertical bone height from immediate postoperative to 6 months with percentage of resorption (Buccally37.49±12.14, Lingually36.12±12.04, Mesially 39.55±15.05 and Distally10.92±0.76). **Conclusion:** From our study, Bone ring augmentation technique for fresh defective sockets with immediate implants at posterior mandibular area achieved low success rate, long procedure time and donor site morbidity.

KEYWORDS

Bone ring augmentation, Immediate implant, Surgical guides.

- Paper extracted from Master Thesis tilted "Bone Ring Autogenous Graft and Immediate Implant Reconstruction in Atrophic Posterior Mandibular area"

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INTRODUCTION

Immediate implant placement, has been considered a predictable and acceptable procedure. In addition, it is easy with minimal use of surgical drills because the socket already exists. Except for the slight increase in the socket depth in an attempt to improve primary stability, this procedure provides minimal surgical trauma, less treatment time, ideal implant location.

Also, preservation of gingival tissues and papilla in the esthetic zone, with less risk of bone necrosis while permitting bone remodeling process to occur. Moreover, the natural socket is rich in periodontal cells and matrix which makes the healing faster and more predictable and allows woven bone to be transformed into lamellar bone [(1)].

Atrophic alveolar ridge occurs secondary to many local and systemic factors. Local factors related to teeth extraction (quality, quantity and shape of the residual ridge, muscle attachment, etc.), bite stress from the denture to the edentulous ridge, infections, periodontitis, reduced bucco-lingual dimension of the alveolar crest, root fracture, traumatic extraction or endodontic complications. Systemic factors may include patient's age, gender, calcium deficiency, systemic osteoporosis, hormone imbalance. All of these factors together cause resorptive changes in the alveolar part of the maxilla and mandible[(2).]

Many trials for bone augmentation were done to prepare the osteotomy site with autogenous bone, in anterior maxilla and in the mandibular premolar molar. Palti A. was the first to practice the bone ring harvesting technique in 2003, He advocated simultaneous augmentation and implantation in the posterior maxilla [(3)].

There are some merits to 3D augmentation of alveolar ridge. It enhances the soft tissue contour, the harvested bone rings can be carved to any desired dimension. It is a one stage procedure with simultaneous implant placement and shorter overall treatment time when compared with another methods of block augmentation. However, there are some limitations as the potential of bicortical harvest and block graft fracture, neurosensory deficits of the lower lip, chin and anterior mandibular teeth, ptosis of chin and dehiscence [(4)].

Nowadays, virtual planning and computer guided stents are used to guide osteotomy drills and implant fixture to the correct position, angulation and depth, and guidance of amount of bone reduction at the bone harvesting site if needed. In addition, they also had advantages of being safety whereas prevent damage of vital structure during surgery, reduction of operating time. In this study, autogenous bone ring harvesting technique was used to repair 3D vertical defects at posterior mandibular area with simultaneous immediate implant in a one-stage procedure guided by computerized surgical stents for both donor and recipient sites as a means of accuracy and safety [(5)].

PATIENTS AND METHODS

Study design and population

The study included 6 patients. All patients had fresh extraction sockets with deficiency in vertical height at posterior mandibular area and needed immediate implant placement. The patients were selected from the outpatient clinic of the Department of Oral and Maxillofacial Surgery, Faculty of Dental Medicine, Al-Azhar University for Girls. The operations were done from January 2018 to September 2019. Selection of patients was done according to inclusion criteria, the patients were over 18 years old and had fresh defective extracted sockets in mandibular posterior area in comparison to adjacent teeth, gingival recession and with mobility not more than grade I, no signs and symptoms of inflammation, or previous history of incomplete traumatic extraction[(6)].The exclusion criteria included, systemic diseases that could affect or interfere with normal bone healing and osseointegration, presence of any periapical pathology, parafunctional habits, pregnancy, heavy smoker and alcohol abuse [(7)].

In accordance with the Declaration of Helsinki, a written informed consent was taken from all patients, and the study was approved by local ethics review committee of the Faculty of Dental Medicine at Al-Azhar University for Girls.

Surgical protocol

Pre-surgical preparation

Preoperative CBCT was performed for all patients to evaluate the implant site and alveolar bone dimensions. Dental impressions were taken to make study casts and surgical guides for the donor and recipient sites [8].

Full mouth scaling, a single dose of prophylactic antibiotic one hour before surgery (Amoxicillin 875 mg + Clavulanic acid 125 mg) and the patients were instructed to perform chlorhexidine gluconate mouth rinse before the surgical procedure [9].

Surgical guides

The surgical guides were checked in the patient's mouth one day before surgery. Four surgical guides were fabricated; the chin harvesting surgical guide and the implant drilling chin guide, the other two surgical guides were for the implant osteotomy and the trephine preparation at the recipient site [10].

Trephine bur selection

The size of trephine bur varied with every patient, to fit the socket and for harvesting bone ring. It was determined by preoperative plan of ridge augmentation according to the selected implant diameter. The size of trephine bur for the donor site was larger than the size of the trephine bur that was used for socket preparation to receive the bone ring. The most common sizes used were (11,10,9,8,7,6,5) which represent the outer circumference of the trephine bur the internal lumen of trephine bur is 1mm less than the written size [11].

PRF Preparation

PRF membrane was prepared by collecting 10ml of patient's venous blood which was divided into two sterile vacutainer tubes without anticoagulant. The blood sample was centrifuged at 3000 revolutions per minute (rpm) for 15 minutes. The collected PRF was compressed between two perforated sterile metal plates to form a membrane[12].

Surgical procedure

All patients were operated on under local anesthesia (using Articaine hydrochloride 4% with epinephrine 1:100 000), they received bilateral mandibular block an additional dose was infiltrated for hemostasis at lower anterior area. The symphysis was accessed through a vestibular incision, flap was raised and the mental nerves were protected. The chin harvesting surgical guide was fixed that that was designed to be 3-4mm away from the root apices of the lower anterior teeth The guide was seated occlusally on the incisal edges of the lower anterior teeth and the remaining part was supported on bone.

Donor Site Steps (Fig.1)

After fixing the "chin harvesting surgical guide" in its position a circular osteotomy was outlined with the trephine bur to a depth of 5 mm under copious saline irrigation mono-cortically. The "chin harvesting surgical guide" was then replaced by the "Implant drilling chin guide" and successive sequential drilling was done according to implant diameter which ranged between (4-3.7-3.5). Using special drills with suitable length taking in consideration the height of the guide sleeve (5 mm) and implant length according to the preoperative planning. Implant osteotomy was done in the center of the bone ring disc with preservation of at least 2mm of normal intact bone all around the implant osteotomy. Finishing drill was used to allow passive entrance of implant through the grafted bone to be fixed later in the apical basal bone of the socket. Finally, tapping of the osteotomy was performed

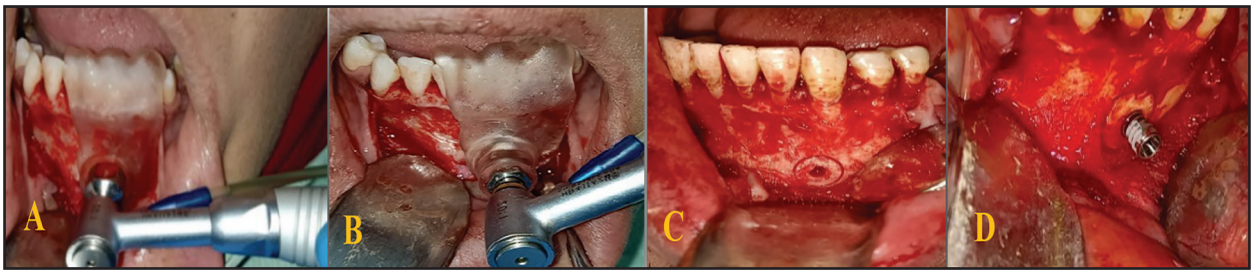

Figure (1) showing (A) Bone ring harvesting using a trephine bur guided by the prefabricated surgical stent ring. (B) preparation of implant site within bone ring guided by another surgical stent. (C) Bone ring after implant osteotomy. (D) Implant within the bone ring.

using implants without rotation of the bone ring. The harvesting bone ring was then completed to its definitive desired depth (10 mm) using the same trephine bur. The "bone ring" was then carefully removed from the chin. This cortico-cancellous graft was then kept in normal saline until debridement, irrigation and closure of the donor site

Recipient site surgical steps (Fig. 2)

Atraumatic extraction was carried out. Gingival incision (to be continued with vestibular incision at premolar area) were made around the socket. After placement of the first surgical guide, the socket was prepared using a trephine bur to facilitate fixing the ring in the recipient site. The diameter of the trephine bur of the recipient site should be sequentially smaller one size than the one used for graft harvesting at the chin. Trephine total depth penetration to level of apical native bone. The second implant surgical guide replaced the first one to prepare the apical portion of basal bone and provide primary stability in an accurate position and angulation. The bone ring graft with implant was inserted within the prepared socket and implant was ~~pass~~ passively inserted through the ring to be screwed in the basal bone, to provide primary stability. The implant was then, secured with a cover screw. Bone ring was placed to a level higher than the preoperative crestal bone level to overcome the deficiency of the vertical height (not more than 5 mm). Sharp edges of the ring were smoothened, the bone ring with implant was covered with (PRF) membrane as a protective layer and finally, tension free wound closure with interrupted sutures using 3-0 Vicryl.

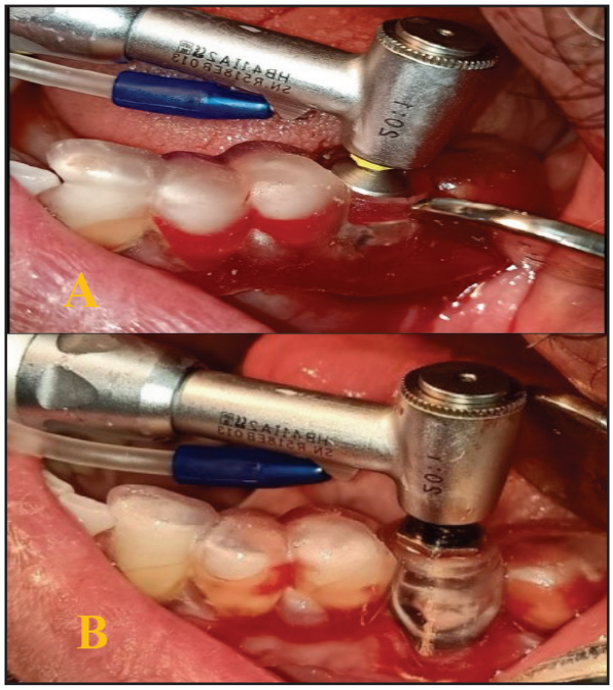

Figure (2) showing (A) Recipient site preparation by trephine bur guided by surgical stent (B) Implant osteotomy done through another preplanned surgical guide

Postoperative care

Bandage on chin area, ice packs, soft diet, antibiotic and anti-inflammatory regimen

Postoperative clinical evaluation:

All patients were followed daily for 5 days postoperatively, weekly during the first month, then on intervals of 1, 4 and 6 months postoperatively to evaluate the following parameters: Wound healing, suture breakdown and dehiscence, Implant and /or graft exposure. Checking for presence or absence of pain, numbness, swelling, infection, hematoma and bleeding at both donor and recipient sites.

Postoperative radiographic evaluation

Radiographic examination in the follow up period was achieved by cone beam C.T scan (Scanora 3d, Soredex, Finland) at immediately, 3 months and 6 months postoperatively to evaluate the 3D vertical dimensions of bone graft. After acquisition, data was imported as DICOM file and then downloaded via a Compact Disk (CD) to a computer for analysis by using software (3 diagnosys 4.2,3 diemme, Italy).

Statistical analysis

Data was collected analyzed using Microsoft Excel software. Data was then imported into Statistical Package for the Social Sciences (SPSS version 20.0) (Statistical Package for the Social Sciences) software for analysis.

RESULTS

Demographic data:

Six patients with deficiency in vertical height of the alveolar ridge with badly decayed teeth or remaining roots at the posterior mandibular area who completed the follow up were included in the statistical analysis of this study. The mean of the patient's age was 33.5±4.23, regarding sex 66.7% were female and male were 33.3%. Implant site were first premolar, 16.7% second premolar, 33.3% first molar, 33.3 % second molar 16.7%.

CBCT postoperative outcomes

Gradual significant bone resorption in all dimensions of bone graft was recorded which was measured by percentage of change throughout the follow up intervals. The percentage of change of **Buccal bone;** from immediate to 3 months was 11.91±3.12 (p value = 0.00), from 3 months to 6 months it was 29.18±10.87 (p value = 0.004) and from immediate post to 6 months it was 37.49±12.14 (p value= 0.001), The percentage of change of **Lingual bone;** from immediate post to 3 months was 12.35±4.0 (p value= 0.001) and from 3 months to 6 months it was 27.36±11.38 (p value = 0.002) it significantly decreased from immediate post to 6 months 36.12±12.04 (p value = 0.001), as for the **Mesial bone;** the percentage of change of immediate post to 3 months was 11.38±4.08 (p value= 0.001) and from 3 months to 6 months 32.24±13.65 (p value= 0.002) also from immediate post to 6 months 39.55±15.05 (p value= 0.001). The percentage of change of **Distal bone;** from immediate post to 3 months 12.85±0.68 (p value = 0.001) also from 3 months to 6 months 7.47±2.0 (p value= 0.007) and from immediate post to 6 months it was 10.92±0.76 (p value = 0.003) as shown in Table (1).

Clinical postoperative outcomes

One successful case out of six showed excellent soft tissue healing with implant stability. Clinically in the early postoperative weeks, one case showed severe infection at 2 weeks with looseness of implant. Dehiscence was found in 83.3% and edema was mild in the majority of the cases, pain was reported in 83.3% (5 cases), it was mild in four cases but pain was severe in one case, numbness was present in 66.7%. (Fig.3)

Table (1): *Assesment of 3D dimension of bone height at different times*

		Mean ± SD	Paired t	P
Buccal bone height at immediate post		13.03±0.601	9.105	0.00**
Buccal bone height 3M		11.47±0.651		
Percentage of change	**Mean ±SD**	11.91±3.12		
	Median(Range)	12.87(8.08-15.14)		
Buccal bone height at immediate post		13.03±0.60	6.775	0.001**
Buccal bone height 6M		8.14±1.80		
Percentage of change	**Mean ±SD**	37.49±12.14		
	Median(Range)	42.18(10.24-45.85)		
Buccal bone height 3M		11.47±0.65	5.118	0.004*
Buccal bone height 6M		8.14±1.80		
Percentage of change	**Mean ±SD**	29.18±10.87		
	Median(Range)	33.45(2.17-41.09)		
Lingual bone height at immediate post		13.15±0.44	7.468	0.001**
Lingual bone height 3M		11.52±0.59		
Percentage of change	**Mean ±SD**	12.35±4.0		
	Median(Range)	13.65(5.85-15.97)		
Lingual bone height at immediate post		13.15±0.44	7.141	0.001**
Lingual bone height 6M		8.39±1.61		
Percentage of change	**Mean ±SD**	36.12±12.04		
	Median(Range)	39.21(11.46-45.38)		
Lingual bone height 3M		11.52±0.59	5.85	0.002*
Lingual bone height 6M		8.39±1.61		
Percentage of change	**Mean ±SD**	27.36±11.38		
	Median(Range)	29.06(5.9-39.83)		
Mesial bone height at immediate post		12.97±0.55	6.861	0.001**
Mesial bone height 3M		11.49±0.69		
Percentage of change	**Mean ±SD**	11.38±4.08		
	Median(Range)	11.67(5.32-15.83)		
Mesial bone height at immediate post		12.97±0.55	6.346	0.001**
Mesial bone height 6M		7.81±1.76		
Percentage of change	**Mean ±SD**	39.55±15.05		
	Median(Range)	43.9(10.24-50.58)		
Mesial bone height 3M		11.49±0.69	5.847	0.002*
Mesial bone height 6M		7.81±1.76		
Percentage of change	**Mean ±SD**	32.24±13.65		
	Median(Range)	36.48(5.2-41.34)		
Distal bone height at immediate post		12.85±0.686	6.286	0.001**
Distal bone height 3M		10.92±0.76		
Percentage of change	**Mean ±SD**	12.85±0.68		
	Median(Range)	12.8(12.0-14.01)		
Distal bone height at immediate post		12.85±0.686	5.357	0.003*
Distal bone height 6M		7.47±2.0		
Percentage of change	**Mean ±SD**	10.92±0.76		
	Median(Range)	10.83(10.05-12.08)		
Distal bone height 3M		10.92±0.76	4.431	0.007*
Distal bone height 6M		7.47±2.0		
Percentage of change	**Mean ±SD**	7.47±2.0		
	Median(Range)	7.06(6.01-11.41)		

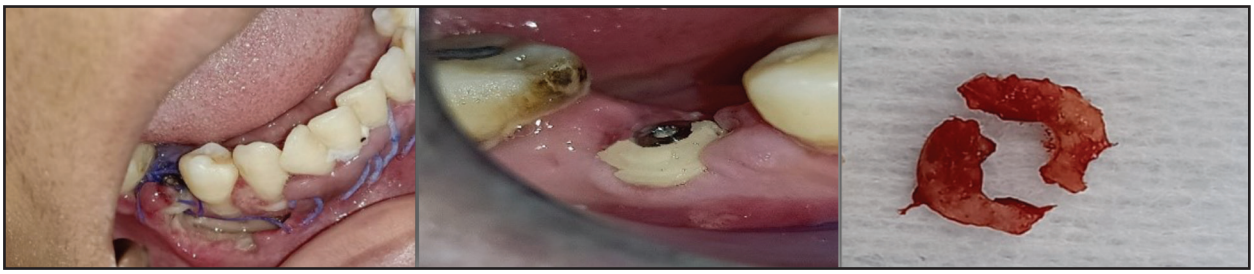

Figure (3): (A, B) showing bone dehiscence (C) exfoliated bone

DISCUSSION

Several techniques were developed for the augmentation of defective sockets for implant placement either immediately or after complete bone formation to achieve both functional and aesthetic requirements for atrophic alveolar ridge. Guided bone regeneration, particulate or onlay block grafting, distraction osteogenesis, ridge splitting, these procedures can be complex, time consuming for the patient and the clinician, depending on the location and size of the bone defect and the treatment method used [13].

Autologous "bone ring" graft harvested from chin with simultaneous implant placement was proven by some authors to be successful with high success rate in localized alveolar bone deficiencies in maxillary and mandibular ridges. Omara M [14] used this technique that encouraged this study as a solution of this problem to the type of cases. Symphysis area offers a sufficient amount of cortico-cancellous autogenous bone in addition to its easy access under local anesthesia. For achieving accuracy in selection of implant length, diameter, exact site, angulation without endangering the nearby vital structures and increase success rate with less operative time and less operator skill by using preoperative computerized virtual planning of donor and recipient surgical sites and fabrication of surgical guided stent [15].

Statistical analysis of CBCT images linear measurements in our study revealed that, there was a significant decrease in 3D dimensions of vertical bone height from immediate to 6 months with high percentage of bone resorption. The percentage of change in the bone height from immediate postoperative to six months postoperatively at buccal and lingual surfaces were 37.49±12.14 (p value=0.001), 36.12±12.04 (p value= 0.001). Also, at mesial and distal surfaces the readings were 39.55±15.05 (p value=0.001**) and 10.92±0.76 (p value=0.003) respectively. Similar findings were observed by Chandra et al. who stated that, bone ring augmentation for initial fresh extraction socket with delayed implant had higher bone gain than with simultaneous immediate implant [16].

Dehiscence was found in 83.3% which may be due to sharp edges of the graft, as smoothening was not that ease as the bone ring became very thin and delicate thus liable to fracture or fragmented. In addition, the gingival flap was continued with the distal end of the vestibular flap of the donor site, and which could be the preliminary cause for the shown results. Tension on the flap with muscle function may have been responsible for the dehiscence, however the presence of PRF membrane was helpful in protection of the graft to allow soft tissue healing through the follow up period. Numbness was found in 66.7% which may be attributed to surgical manipulation, which was perceived by the patient as uncomfortable and caused dissatisfaction[4].

Most of these postoperative complications was also mentioned by Naenni N et al. [17]. such as, graft fracture, wound dehiscence with exposure of implant and grafts, numbness of lower lip, infection. They found that incision-line dehiscence was

exclusively found following chin bone harvesting in 10.7% of the cases and an altered sensation in the mandibular incisors has been identified as a source of morbidity on a frequent basis following chin bone harvesting[17].

Unfortunately, these results indicate that, bone ring augmentation has low success rate with immediate implant placement in posterior premolar molar mandibular area.

In our study, the aim was to increase the vertical bone height with sufficient thickness of cortical layer surrounding implant at crestal part that missed in fresh extraction socket with immediate implant as a one stage procedure, but this was not achieved and turned out to be unsatisfactory due to multiple factors. Hienz S et al.[18] stated that the presence of gingival crevice fluid (GCF) and local inflammatory mediators that are generated by the macrophages and the T-lymphocytes by a direct or in an indirect effect on the periodontal tissues that surround badly decayed teeth can stimulate bone resorption even after tooth extraction which is not seen with the naked eye. This opinion may be considered as one from other factors that may be responsible for the significant postoperative bone resorption in this study. In addition to, the use of trephine bur to prepare the socket to seat the ring graft in some cases may contribute to the decrease of the buccal and lingual bone thickness, the removal of vital bone causes widening of the socket and misfit of the bone ring which is considered as a traumatic factor[18].

Moreover, fracture of bone ring during complete implant fixation specially, at the premolar area may have resulted because the cortical part of the bone ring was very thin and weak and the cancellous bone of the chin graft was fragile together with the limited thickness of bone to support the ring. Achieving primary stability of implant was very difficult in most of cases as the graft spins during the implant insertion which leads to more friction which may initiate an inflammatory reaction and existence of a gap between the graft and socket.

In spite of using surgical guides for both donor and recipient sites which actually facilitates preparation of ring harvesting and implant osteotomy and provides accurate position and angulation during the procedure. Nonetheless, the procedure is expense, time consuming as regard planning and fabrication.

CONCLUSION

The bone ring technique achieved a low success rate, it is a time-consuming procedure with donor site morbidity. It is an unreliable technique for augmentation of fresh defective sockets with immediate implant installation at posterior mandibular area.

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