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Radiographic Assessment of Buccolingual Dimension of Allogenic Bone Ring When Used Simultaneously with Dental Implant Placement

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ABSTRACT

Purpose: This study aimed to evaluate the use of allogenic bone ring technique to restore the bucco-lingual dimension of the alveolar bone defects combined with simultaneous dental implant placement. **Subjects and methods:** Ten patients requiring bone augmentation horizontally or both horizontally and vertically at the time of implant placement were included in this retrospective study. All patients received simultaneous bone augmentation surgery and implant placement with allogenic bone ring grafts. Postoperative efficacy of the technique was evaluated using CBCT as a radiographical parameter. **Results:** Survival rates of implants were 100%. Cone-beam computed tomography revealed that the allogenic bone ring graft had significantly sufficient horizontal bone augmentation below the implant neck platform to 0 mm, 1 mm, 2 mm, and 3 mm. It could also provide an excellent peri-implant tissue condition during the 6 months' follow-up after loading. **Conclusion**: The bone ring technique with allogenic bone ring graft could increase and maintain horizontal bone mass in the region of the implant neck platforms in serious horizontal bone defects.

KEYWORDS

Bone Ring Technique,
Allogenic Bone Ring,
Simultaneous Implant Placement

INTRODUCTION

In recent decades, implants have proven to be the first-choice permanent solution for repairing dental defects caused by missing and irreparable teeth. Any dental implant's long-term durability and implant support for oral cavity rehabilitation depend on a number of fundamentals. For osseointegration to occur, the implant surface must be able to connect with the bone at an adequate level, particularly in the esthetic zone[(1)].

- Paper extracted from Doctoral thesis titled: Comparative study between two different bone ring techniques simultaneously with dental implant placement for three-dimensional alveolar ridge augmentation (clinical & radiographic study)

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Studies show that bone augmentation is frequently necessary prior to implant placement in the site with a thickness of 3 mm bone or with a horizontal bone deficiency in defects of class III–IV[2,3]. The class III–IV horizontal defects have been augmentable by a variety of techniques, including, guided bone regeneration (GBR) using titanium-mesh, customized or readymade bone blocks, and distraction methods [4,5]. The above methods have been proved to be effective at increasing bone volume in clinical trials, but they still have some drawbacks, including long treatment times for a two-stage implant placement, additional trauma at the secondary surgery site, and higher infection rates[6]. One of the latest trends in the past years has been the use of ready-made bone rings for both bone augmentation and implant placement simultaneously (Bone Ring Technique). The results of most studies have been promising and reliable[2].

Many studies have shown that the use of autogenous bone ring technique integration with the dental implant and the implant site can offer excellent outcome for dimensional bone augmentation and implant stability[7,8]. As a result of this technique, both the implant and bone augmentation are placed simultaneously, thereby reducing treatment time and maintaining a sufficient spatial structure for the implant. Additionally, in most cases, clinicians use autogenous bone blocks to restore the alveolar lesions because of the osteoinductive, osteoconductive, and osteogenic qualities of these grafts[1]. However, autogenous bone harvesting frequently necessitates a second surgical site, which can exacerbate intraoperative discomfort and cause difficulties with surgery duration and donor site morbidity[9]. Thus, shortcomings in the autogenous bone ring method deter patients from pursuing this form of treatment. Additionally, there are situations when severe bone deficiencies in many implant regions prevent it from providing enough bone grafts, and there are times when the donor site has already been utilized for other purposes.

Today, several clinical trials have begun to develop and put into action the use of bone substitute materials in the bone ring approach to obtain enough bone augmentation and resolve the limitation of autogenous grafts [5,10,11]. Various studies have shown that allogenic bone rings are an excellent and reliable alternative to autogenous ones that need minimal tissue morbidity and don't require donor site surgery[12]. Allogeneic grafts, however, may cause immunologic cell responses and pose a possibility of disease transmission due to their inferior biomechanical qualities[13]. The utilization of xenogeneic bone substitutes as an option to autogenous bone graft has therefore been documented[14]. · On the other hand the resorption rate of processed allogenic and very minimal to non-immunological reaction makes it under scope now to benefit from the timing factor [1]. Furthermore, researchers have evaluated the histological attributes of numerous common bone grafts used to refill bone deficiencies using animal studies, bovine cancellous bone, autogenous bone, allogeneic grafts, calcium phosphate hydroxyapatite substitutes, and calcium sulphate substitutes are a few examples. Autogenous bone exhibited the greatest histochemical quality, followed by allogenic and bovine bone; nevertheless, most other graft qualities fell far short of those of allogenic bone[7].

Therefore, the purpose of this study was to evaluate the effectiveness of allogenic grafts used after bone rings and implants were placed simultaneously.

MATERIAL AND METHODS

Study Setting:

The study Efficacy of allogenic bone ring augmentation with simultaneous implant placement in inadequate socket was carried out in patients who reported to the Department of Oral and Maxillofacial Surgery, Faculty of Dental Medicine for Girls, Al-Azhar university meantime patients reported to dental department of St. Vincent hospital- Cleveland Dental Institute.

Study Design:

Sample size was determined to be 10 patients. Patients who required immediate replacement of their decayed or mobile teeth with bone defect and/or those with resorbed alveolar ridge in two or three directions were included in the study. All the patients were informed about the study after ethical committee of NEOMED university approved the study design. Oral surgery informed consent as well as implant consent was explained and taken from all the patients including photography and video consents. Routine preoperative orthopantomography and intra oral periapical radiographs were taken. All the patients in the same group were subjected to the same protocol of site preparation followed by allogeneic bone ring placing simultaneously with dental implantation.

All patients have been treated according to the group they were assigned to using the same materials, same technique within the same group and same operator for all groups.

Inclusion criteria:

- Age group from 25 to 45 years.
- The alveolar bone surrounding the extraction socket is defective either due to periodontal disease or traumatic extraction.

Exclusion criteria:

- Patient not willing to participate in study.
- Patients with habits like smoking and alcohol consumption.
- Patients with underlying metabolic or endocrine diseases.
- Patients with immunocompromised diseases that may retard the healing.
- Patients who have recently undergone radiation therapy, Patients with underlying bone diseases (Paget's disease, osteoporosis etc.)

Once they are selected to be enrolled in the study; All the patients underwent through the same clinical and radiographic protocol as following:

- Extraoral examination as a general exam for head and neck including the lymph nodes and facial deformities.
- Intraoral examination in form of detailed hard and soft tissue exams.
- Preoperative panoramic view as well as CBCT for hard tissue clearance and treatment planning.

Surgical procedures

All chosen patients underwent periodontal and dental examinations and got efficient periodontal care. The operations were performed under local anaesthetic by a single qualified surgeon (Articaine hydrochloride 4 percent; Epinephrine, 1:100,000). First, a gingival incision and buccal mucoperiosteal flap were used to prepare the implant site utilising the pioneer drill of the implant system. The recipient area was then fitted to the allogenic bone ring graft after the bone defect area near the implant site was prepped using a trephine bur.

This was followed by insertion of the dental implant through the bone ring which was in 7 mm outer ring diameter and the implant was positioned about 1 mm below the coronal border of the ring. Thereafter, the graft was fixated with the dental implant and then cap screw which was attached to the cover screw of the dental implant, more than 5 mm of the implant's length was inserted into the alveolar bone and roughly 3-4 mm into the bone ring. A 25–35 Ncm insertion torque was used to provide the implants with their initial level of stability. Implant was seated and covered with a collagen membrane (Straumann Jason membrane 20*30 mm– Switzerland). The flaps were eventually carefully adjusted and sutured free of tension to avoid dehiscence. Amoxicillin 500 mg was given to all patients three times daily for three days (Fig. 1A, B). A CBCT was taken for every patient then for osseous assessment (Fig. 2).

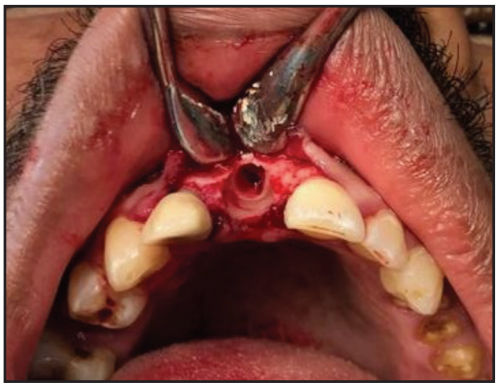

Figure (1A) Bone ring site preparation

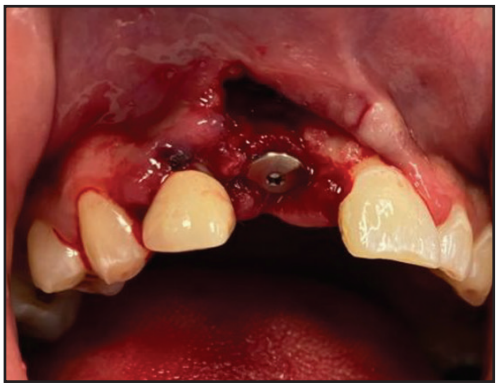

Figure (1A) Bone ring site preparation

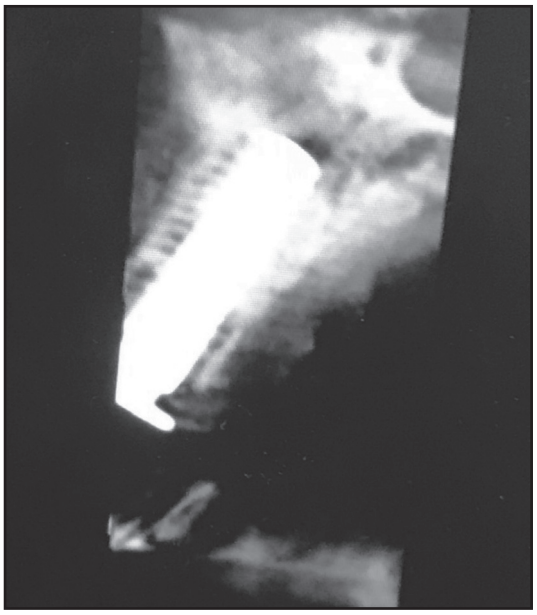

Figure (2) Bucco-lingual dimension on CBCT showing the thickness of the bone

RESULTS

The current study included 10 patients (7 males and 3 females with an average age of 43.75±9.80 years) at the time of implant placement. Detailed information of all patients is highlighted in patients' chart on Dentrix Software during follow-up period, one patient presented with a failure of the wound to heal up 1-week post-surgery but healed after receiving secondary intervention without further developing complications. Ten implants were performed in anterior and posterior regions with implant success rate of 90%, following the commonly accepted implant success criteria. No major complications in all cases during or after the treatment. The average insertion torque for the implants was 35 N/CM, which granted a good primary stability for the implants as a main factor for grafting to be taken as well as the implant integration. However, the implant secondary stability was checked manually during prosthetic phase. And it was found that the marginal bone loss was 0.96±0.2 mm in the buccal side of the implants through the CBCT 9 months after implant restorations (Fig. 3).

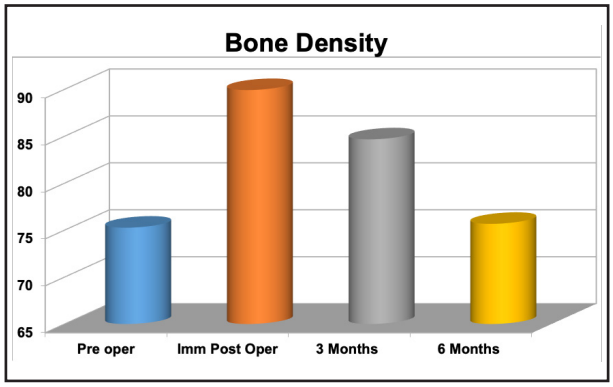

Figure (3) Column chart showing mean bone density in different observation times

On the level of horizontal bone, the mean bone gain at all planes were 4.90±0.2 mm at immediate postoperative and 3.11±0.3 mm at 12 months after prosthetic restorations. The changes were showing significant decreases, which indicated the mean bone resorption was observed at all planes ($p \geq 0.05$). The mean bone resorption at all planes was 1.8±0.36 mm.

DISCUSSION

The first report for bone ring technique by Giesenhagen, allows the operator to restore the alveolar ridge in three- way of space also it does allow augmentation of the resorbed ridge with simultaneous implant placement in a single-stage procedure. Bone ring technique is very significant option compared to conventional bone grafting in treating serious defects, in terms of reducing the overall treatment time[3,13]. However, autogenous bone ring technique will need an extra surgical site, and increase the risk of infection and paraesthesia of chin through the incisal nerve injury[2]. Those complications usually discourage patients from going for the autogenously choice as first line of treatment. Thus, the application of bone substitute materials is regarded to be increasingly vital and urgent for bone ring technique in correction of horizontal bone defects.

Based on published reports, the allogeneic bone ring grafts had been used before in randomized clinical trials and the results were very good on the level of amount of bone gaining. The application of allogeneic grafts is still limited by factors such as high cost, the risk of disease transmission but In this study, the allogenic bone has been widely employed in medicine due to its superior biomechanical and bone conductibility qualities[15]. A study showed that bovine cancellous bone as a source for xenogeneic bone rings exhibits better histological characteristics than other bone substitutes[10]. The natural three-dimensional porous structure and arrangement of the geometric outline that has been done by Straumann which allowing the blood to infiltrate and immerse the bone ring is spotting the light on this allogenic bone ring and make it the best choice for the research.

Bone cylinders made from allogenic bone by Straumann has a special bone ring kit to get the site prepared and place the implant which is equivalent to the chosen size of the ring. To guarantee a close match between the implant and the graft, the bone ring and implant site were both drilled using the implant's continuing drills. Knowing that the same company implant sizes are compatible with the bone ring size which make it easy and simpler than any other available bone rings in the market. The application of the allogenic bone ring technique requires that the medial distal dimension of the receptor site be more than 7 mm. In the present study, we found that all the bone rings will need some reshaping at the crestal part in order to allow free of tension soft tissue closure. Therefore, we chose the suitable rings according to the site and size of horizontal bone defects[9,16].

There was significant difference in the rate of new bone formation when we used that bone rings and that may be related to the design which is called secret of Straumann and theoretically the holding of blood clot in high level has been achieved very well with no dramatic collapse after placement and treatment[8,17].

The formation of new bone around the neck of the implant which was considered as completely in a grafted area represented by the ability of the bone ring to hold the clot at high level which made it more predictable and valuable[8,9].

In recent study, Yohei reported that osseointegration in the vertical bone augmented area showed low new bone to implant contact in the xenogeneic bone rings when it was used to treat the same cases however there was variability on the level of cases and the operator. While they also pointed out due to the surrounding of collagen fibers, osteoblasts could not grow into the xenogeneic ring structure. It might be the reason why xenogeneic ring presented low new bone formation in the animal experiment[13].

CONCLUSION

In conclusion, this study confirmed that the bone ring technique using allogenic bone ring is a predictable treatment option for building up horizontal bone. The present study showed the value of the allogenic bone ring for regeneration

of alveolar bone. This approach could increase and maintain horizontal bone volume in most defects in the horizontal direction. It could reduce the overall treatment time with simultaneous implant placement in a single-stage procedure, and avoid additional surgical site comparable to autogenous one. Therefore, this technique may be the treatment of choice regarding severe horizontally bone defects.

RECOMMENDATIONS

Further researches are needed to evaluate the reliability and predictability of allogenic bone rings also to assess the marginal bone loss after a longer observational time and a larger-scale clinical trials to consider this approach.

Some difficulties in the techniques may make it needs more calibration and alignment of the implant with the bone ring to be in the same place and prosthetically driven.

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Conflict of interest

Authors hereby declare no conflict of interest.

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