Vertical Ridge Augmentation Using “Bone Ring” Technique along with Simultaneous Implant Placement in Patient with Nephrectomy- A Case Report

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Abstract
Although chronic kidney disease (CKD) has been considered a global public health problem, its effect on dental implant treatment is largely unknown. Atrophic or severely deficient edentulous single tooth dental implant sites require osseous augmentation before any dental implant placement. However, due to complications of CKD, bone grafting procedures, and dental implant treatment for renal failure patients and patients with nephrectomy is more challenging. This article presented a successful case of vertical ridge augmentation using DFDBA allograft “Bone ring” along with simultaneous implant placement in a patient with nephrectomy.

Introduction
A nephrectomy is a surgical procedure for the removal of a kidney or a section of the kidney. Kidney removal is performed on patients with severe kidney damage from disease, injury, or congenital conditions. In CKD patients, the normal physiological mechanisms regulating blood levels of calcium, phosphate, vitamin D, parathyroid hormone (PTH), and fibroblast growth factor 23 (FGF23) are disturbed, which subsequently impact the bone structural integrity and lead to chronic kidney disease-mineral and bone disorders (CKD-MBD). A recent study examined the characterization of the mandibular bone in a mouse model of chronic kidney disease, and the results showed a significant reduction in cortical bone thickness. The chronic kidney disease is also regarded as a risk factor for periodontitis.
Borawskiet al. reported that the loss of clinical attachment level of the CKD patients was significantly higher than that of general population subjects, indicating a high severity of periodontitis in the renal failure patients. Although chronic kidney disease has been considered a worldwide public health problem, its effect on dental implant treatment is largely unknown. Oral and nephrological literature suggests that osseous periodontal surgical procedures such as bone grafting or dental implants may be contraindicated in patients with significant renal osteodystrophy. Others, however, investigated the quantity and quality of the alveolar bone of dialysis patients, which showed that the residual bone volumes were adequate for implant insertion, suggesting this type of treatment applies to CKD and nephrectomy patients.

One of the most crucial requirements for endosseous implant placement is sufficient width and height of the alveolar ridge at the implantation site. Various techniques have been proposed in the literature for vertical and horizontal bone augmentation which include bone block grafts, particulate biomaterials, bone in combination with either sandwich osteoplastic or membrane technique, distraction osteogenesis. The main drawback with these techniques is that the implant cannot be placed simultaneously at the same time and requires around 6 months for healing after bone augmentation, thus requiring more time for overall treatment. Therefore, to reduce the overall treatment time and difficulties in the management of bone defects, a new technique was introduced using the bone ring transplantation procedure developed by Bernhard Giesenhagen.

The “bone ring” technique is a surgical methodology that allows bone augmentation and implant placement in a one-stage procedure. Compared to the more conventional two-stage augmentation procedure, the main advantage of “bonering” is the significant reduction of treatment time. This technique enables vertical/horizontal augmentation & formation of new bone, thereby simplifying the surgical treatment of three-dimensional bone defects. The present case report aimed to evaluate the success of extensive bone reconstruction of the atrophic maxillary alveolar ridge using DFDBA allograft bone ring and simultaneous implant placement in a patient with nephrectomy.

Case Report
An 18-year-old male patient reported to the department with a chief complaint of missing natural teeth in the upper front region of the jaw. (Figure 1) The patient gave a history of trauma 3 years back and a nephrectomy procedure 7 years back. Radiographically, CBCT examination showed the horizontal and vertical bone loss in the maxillary right central incisor region. (Figure 2) Three-dimensional reconstruction of bone defects using DFDBA allograft bone ring and simultaneous implant placement was planned. Routine pre-operative blood investigations and urine examination were carried out. The patient was informed about the potential risks and benefits of the procedure, and consent was obtained. A physician’s consent was obtained...
regarding the fitness of the patient for surgery. Preoperative cone beam computed tomography was carried out to evaluate the surgical site, amount of augmentation required, and decide the length and diameter of the implant to be used based on the regional anatomy. After proper examination and diagnosis, initial therapy consisting of supra and subgingival scaling was performed to achieve a plaque control score of <1, and oral hygiene instructions were given.

**Surgical procedure**
Before the surgery, 500 mg amoxicillin was given to the patient and instructed to rinse the mouth with 0.2 % chlorhexidine gluconate. After achieving profound anesthesia, a full-thickness flap with vertical releasing incisions was reflected to expose the vertical defect. The bony defect was measured using a trephine drill (Jalandhar Surgical, Mumbai) to determine the DFDBA allograft bone ring. (Tata Memorial Hospital Mumbai) The diameter of the bone ring was 8 mm. (Figure 3) At Next, the ideal implant position was determined by pilot drilling. For preparation of the bed for the bone ring, a trephine according to the chosen ring size was used for circular osteotomy at the defect site. The implant bed was prepared through the bone ring with a sequential drilling technique following implant protocol. The implant (Myriad Plus, Netherlands) of dimension 3.3/11 mm was then inserted through the bone ring subcrestally, obtaining primary stability from the local bone and using its crestal portion to keep the bone ring in place. Then the cover screw was placed. (Figure 4) The implant was inserted at least 3 mm deep into the local bone through the bone ring into the native bone. After the implant placement, the primary stability of the implant was assessed using the Ostell device. ISQ score after the implant placement was 57. The implant shoulder was placed about 1.5 mm below the cranial surface of the bone ring to compensate for possible resorption. Then, the edges of the bone ring were smoothened to prevent perforation of the soft tissue. The defect was then covered with osseograft particles (DMBM xenograft, Advanced Biotech Product, Chennai, India) (Figure 5). After that, the augmented ridge was covered with healiguide (Absorbable collagen membrane, Advanced Biotech Product, Chennai, India) (Figure 6) Flap closure & suturing was done once the implants were inserted & the cover screw secured, and the augmented ridge was covered with membrane. The interrupted sutures were placed using 4-0 vicryl suture material. Immediate postoperative radiographic examination showed complete filling of the defect and the proper implant position. (Figure 7) The patient was followed up for 6 months. (Figure 8)
Figure 3: Intra-surgical measurement of defect site

Figure 4: Fixation of bone ring at defect site with placement of implant

Figure 5: Covering of the defect with particulate bone graft

Figure 6: Placement of the barrier membrane

Figure 7: Immediate Postoperative Radiographic view

Figure 8: 6 months post – operative view – gingival former placement
Treatment outcome
At the 6th month follow-up, clinical and radiographic examination was performed. The implant was osseointegrated without any clinical sign of graft exposure or infection. The implant stability (ISQ) score at 6 months was 68. The radiographic examination at the follow-up showed crestal bone loss of 1.06 mm on mesial and 1.12 mm at the implant site. After radiographic examination, the cover screw was replaced with a gingival former. One week later final prosthesis was successfully placed. The patient was satisfied with the outcome of the therapy. (Figure 9)

Discussion
In this article, a unique case of a successful three-dimensional bone augmentation using bone ring technique and simultaneous implant placement in a patient with nephrectomy was presented. An in vivo experiment carried out by HuaweiZou et al.13 to evaluate the effect of CKD on osteogenic differentiation of bone marrow mesenchymal stem cells and peri-implant bone formation, the X-ray examination and histological evaluation confirmed the successful osseointegration of titanium implants, indicating that dental implant treatment is applicable in patients with CKD and nephrectomy. However, data from this experiment suggest that CKD impaired the osseointegration of titanium implants at the early healing stage.

There was a controversy in literature regarding bone grafting procedures and implant placement in patients with nephrectomy or renal failure. Literature suggests that osseous periodontal surgical procedures such as bone grafting or dental implants may be contraindicated in patients with significant renal osteodystrophy.8,9 Others, however, investigated the quantity and quality of the alveolar bone of dialysis patients, which showed that the residual bone volumes were adequate for implant insertion, suggesting this type of treatment applied to CKD patients.10

Vertical ridge augmentation is one of the greatest challenges for bone regeneration in implant dentistry. This is primarily due to technique sensitivity and, consequently, frequent intra and post-operative complications. It is biologically demanding also.14,15 DFDBA allograft ring was
used in the present case for vertical ridge augmentation. Demineralized freeze-dried bone allograft is osteoinductive, thus helps in bone regeneration.

In this case, graft stability was achieved through the preparation of the sites using a trephine bur and placing the bone ring of slightly lesser diameter than the dimension of the prepared osteotomy site, thus allowing the bone ring to be snugly fitted in its recipient site with adequate stability and maximum surfaces of bony contact. This agreed with the findings of Marx\textsuperscript{16} who emphasized the importance of graft stability during the early phases of bone healing and the reflection of this on early vascularization and graft incorporation.

Previously, the bone ring technique was performed with an autogenous bone graft. But the necessity of a second surgical site and to avoid postoperative discomfort to the patient allogeneic bone ring was used for vertical bone augmentation in the present case. A recent in vivo study carried out by S Neto et al.\textsuperscript{17} compared autologous bone block to allogenic bone block for lateral ridge augmentation and found allogenic blocks to be a good option for lateral ridge augmentation and gain in marginal bone level, as there were no significant differences found between the autologous and allogenic groups. Thus, allograft may substitute autogenous bone. The radiographic examination at 6 months follow-up showed crestal bone loss of 1.06 mm on mesial and 1.12 mm at the implant site. The result of this case is in accordance with the study done by Omara et al.\textsuperscript{18} who examined the bone ring transplant cases radiographically immediately and at 6 months postoperatively. They measured crestal bone changes and reported minimal crestal bone resorption in the linear measurement during the follow-up period.

**Conclusion**

This case study recorded, for the first time, the effect of nephrectomy on osseointegration of titanium implant and bone grafting procedure. We achieved successful osseointegration of implant without any clinical and radiographic sign of failure. This data implies that dental implant treatment might be applicable for nephrectomy patients, but special requirements in bone healing time may need to be considered. This technique showed promising results in managing bone defects and implant placement in nephrectomy patients, but further research is required to be carried out to prove this concept.

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**References**


