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Simplified 3-Dimensional Ridge Augmentation Using A Tenting Abutment

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Abstracts

Vertical bone defects present a challenge for the placement of implants with a successful treatment outcome. This case report describes the utilization of tenting abutments as tenting poles for preventing collapse of bone graft during healing period in order to achieve vertical bone gain.

Keywords: Vertical augmentation, Guided bone regeneration, Tenting pole, Tenting abutment

Abbreviations: GBR: Guided bone regeneration; AFG: Autologous fibrin glue; CGF: concentrated growth factors; d-PTFE: dense-polytetrafluoroethylene.

Introduction

Oral rehabilitation with dental implant-supported restorations are well accepted in modern dentistry. However, the placement of dental implants on an atrophic alveolar ridge is still considered a highly challenging due to poor bone quality or lack of bone volume and may require number of surgical visits. To overcome an atrophic alveolar ridge at implant sites, numerous surgical procedures including guided bone regeneration (GBR) using a non-resorbable barrier membrane or titanium mesh, Onlay block grafting using an intraosseous or extraosseous bone block, distraction osteogeneses and sandwich osteotomy with an interposition bone graft, and the ramus split bone technique have been utilized to overcome vertical bone deficiency [1-7]. Among these procedures, GBR technique is widely accepted for vertical augmentation because implants can be placed simultaneously and the surgical technique is relatively simple compared to block graft surgery or distraction osteogenesis [8,9].

GBR using a non-resorbable membrane or titanium mesh revealed predictable and superior bone gain according to clinical studies due to superior space-making capacity [10]. However, these barrier membranes are susceptible to early exposure, which can cause poor bone regeneration [11,12]. Preventing collapse of bone graft placed on the defect is critical for successful reconstitution of a 3-dimensional bony defect. To minimize resorption of bone grafting, it is also necessary to over-graft the bone graft. The placement of titanium screws on the large vertical defects as tenting poles help to prevent collapse of the bone grafting [13,14]. However, this technique does not allow simultaneous implant placement and requires removal of tenting screws later. Instead of using these surgical methods, less invasive ridge augmentation can be achieved using tenting abutments placed on implants. We present three cases of 3-dimensional ridge augmentation using a dental implant and tenting abutment to simplify the surgical procedure and to shorten the edentulous healing period.

Case Report: 1

A 56-year-old female patient visited our department on November 25, 2015 complaining of severe mobility and tooth pain on her lower right 2nd and 3rd molar. The lower right 2nd and 3rd molars were extracted under local anesthesia. Implant placement and ridge augmentation was done on the same day. The extracted teeth were immediately prepared for decalcified particulate tooth bone graft using a vacuum-ultrasonic machine (Vacua Sonic system, Cosmobio Medicare, Seoul, Korea). The patient's venous blood was taken from the forearm to make autologous fibrin glue (AFG) and concentrated growth factors (CGF) membrane for ridge augmentation. Sohn's sticky bone was prepared as

described by Sohn et al. [15]. A pre-operative radiogram and cone-beam computed tomogram scan indicated severe horizontal and vertical alveolar bone deficiency. The surgical procedure was performed under local anesthesia after IV administration of preoperative antibiotics (Flomoxef, Flumarin®, Ildong Pharm, Korea). A full thickness mucoperiosteal flap was elevated, and the inflammatory tissue was removed completely with a bony scraper tip and piezoelectric bone surgery. Bone Pen (Acrodent Co, Kimhae, Korea) as a 3-dimensional positioning guide was utilized to perform the initial osteotomy. Under-osteotomy was applied to obtain initial stability. Two 4.65 mm high x 10 mm wide implants (I.C.E. Implant, Alpha-Bio Tec., Petah Tikva, Israel) were placed simultaneously. Implant platforms were placed 1mm subcrestally to adjacent proximal bone height.

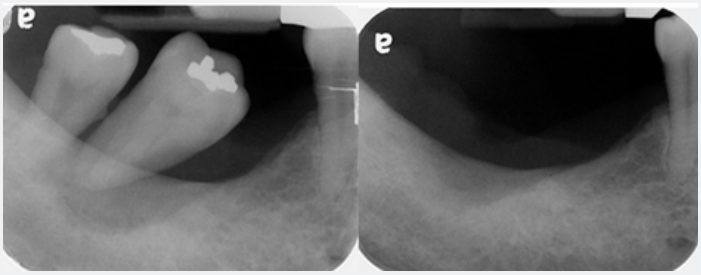

Figure 1: A plain radiograph indicating severe 3-dimensional ridge deficiency on the right posterior mandible. Before extraction (left) and after extraction (right).

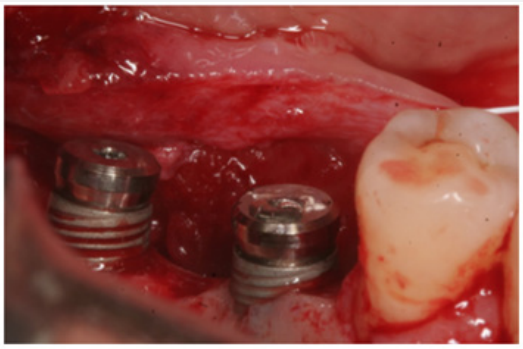

Figure 2: A 6mm vertical bony defect was verified at the distal aspect of 2nd molar. A 3mm vertical defect was measured between the two implants. A 2mm-high healing abutment was placed as a tenting abutment on the implant platform to maintain the volume of bone grafting during the healing period.

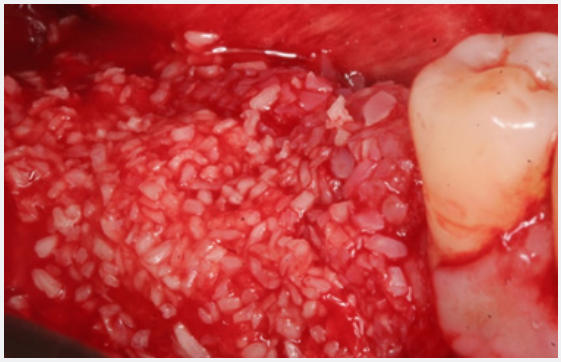

Figure 3: Sticky autologous tooth bone graft was placed on the exposed implant surface, tenting abutments and the bony defect

A 3mm vertical defect was measured between the two implants,and a 6mm vertical defect was measured from the posterior to the 2nd molar implant. A 2mm-high healing abutment as a tenting abutment was placed and tightened in 20Ncm on each implant in order to allow over-grafting of the bone graft over the implant platform. Prepared sticky tooth bone graft was grafted on the exposed implant surface and bony defect for 3-dimensional ridge augmentation. A resorbable collagen membrane (Lysogide, Oscotec Co., Chunan, Korea) was used to cover the bone graft and 2 CGF membranes were placed over the collagen barrier to accelerate

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wound healing. Tension free sutures were done through the use of periosteal-releasing incision. Healing was uneventful before the uncovering procedure (Figures 1-3). On March 29, 2016, an apically repositioned flap was used to expose the implants and augmented ridge. Favorable 3-dimensional augmentation was achieved. A final zirconia-based restoration was completed after 2 months of loading of provisional restoration. After 3 years in loading, there was favorable maintenance of the augmented ridge (Figures 4-9).

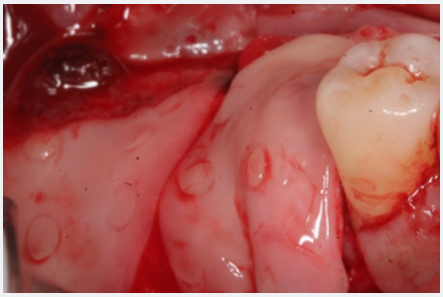

Figure 4: A resorbable collagen membrane was placed over the bone graft in order to stabilize it, and CGF membranes were placed over the collagen barrier to accelerate tissue healing.

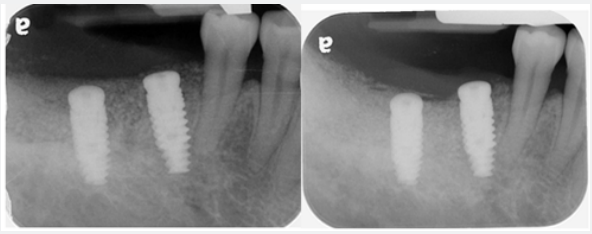

Figure 5: A periapical radiograph after surgery (left) showing bone grafting on the defect. After 4 months of healing, a periapical radiograph (right) revealed well-maintained bone graft over the implant platform.

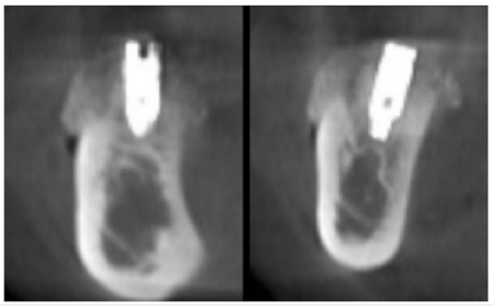

Figure 6: CBCT image after surgery. Lower right 1st molar implant (left) 2nd molar implant (right).

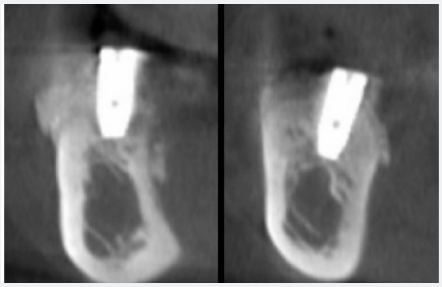

Figure 7: CBCT image after 4 months of healing indicated favorable 3-dimensional ridge augmentation on the defect. Lower right 1st molar implant (left), 2nd molar implant (right).

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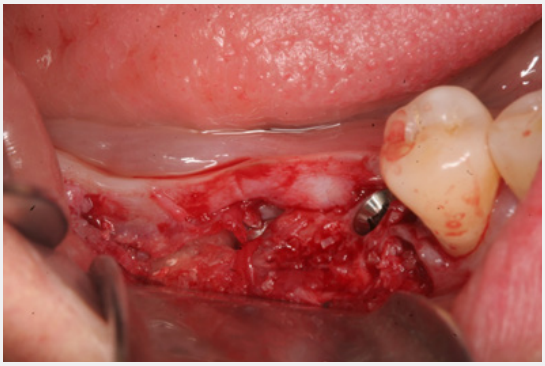

Figure 8: The uncovering procedure revealed favorable 3-dimensional ridge augmentation after 4 months of healing.

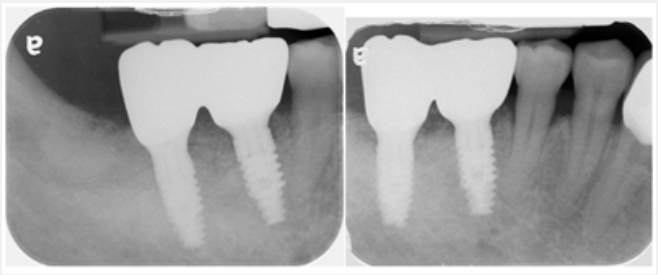

Figure 9: A periapical radiogram after completion of final restoration (left). A periapical radiogram after 3 years in function reveals favorable maintenance of the bone graft (right).

Case Report: 2

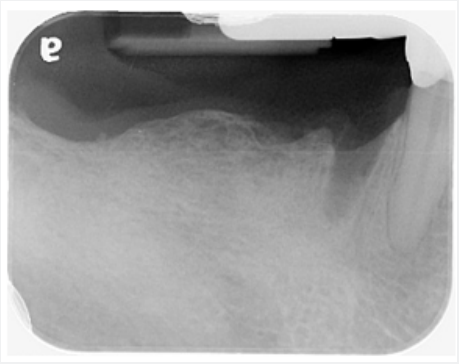

Figure 10: Edentulous ridge on the right mandibular posterior area. The 1st premolar and 3rd molar were extracted to prepare for the tooth bone graft before implant surgery.

A 70-year-old male patient presented with loss of the right mandibular 1st and 2nd premolar and 1st and 2nd molar. He wanted implant-supported fixed restoration. The patient had no significant medical history. A preoperative radiogram indicated vertical alveolar defect defects in the edentulous area. The surgical procedure was performed under local anesthesia after IV administration of preoperative antibiotics (Flomoxef, Flumarin®, Ildong Pharm, Korea) on March 29, 2019. Porcine bone (BONE-XP, Medpark, Busan, Korea) was mixed with AFG to make a sticky porcine bone graft before implant placement. A full-thickness flap was retracted to expose the alveolar bone. Osteotomy was performed in parallel to place the implant at the desired site. Initial stability of the implant was obtained through under-sized osteotomy. Three implants (Biotem Implant Co, Busan, Korea) were placed on the 1st premolar, the 1st molar and the 2nd molar areas with good initial stability. A horizontal bony deficiency was evident at the 1st premolar implant. Sticky porcine bone was grafted after connection of the healing abutment as a one-stage procedure. As an alternative to a collagen barrier, a CGF membrane was pierced through the healing abutment and used to cover the bone graft through the Poncho technique introduced by Sohn et al. in order to stabilize the bone graft and accelerate wound

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healing [16]. A 3-dimensional bony defect was evident around two molar implants. A specially designed tenting abutment (SANTA®, Biotem implant co. Busan, Korea) as a tenting pole was placed on the implant platform for maintaining the volume of the sticky bone graft during the healing period. A 1mm-high SANTA and a 2mm-high SANTA were applied to the 1st molar and 2nd molar implants, respectively. A resorbable collagen membrane (Colla-D, Medpark, Busan, Korea) was used to cover the bone graft. After making a periosteal-releasing incision, tension-free sutures were put in place. Postoperative discomfort was insignificant (Figure 10-15). Uncovering was performed on July 10, 2019, which indicated that favorable 3-dimensional ridge augmentation over the implant platform had been achieved. Provisional restoration was delivered 2 weeks after uncovering. After 4 weeks loading of temporary restoration, a final zirconia-based restoration was completed (Figure 16-18).

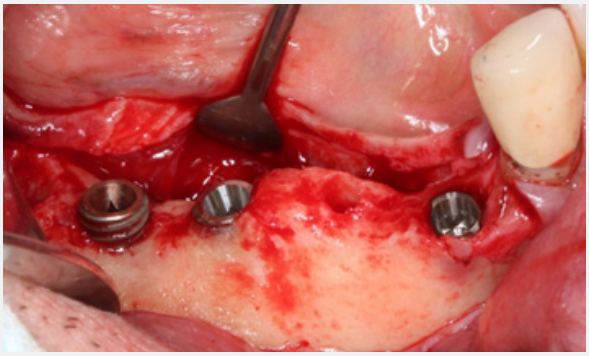

Figure 11: Note vertical bony defect on the molar implants area and horizontal deficiency on the 1st premolar implant area.

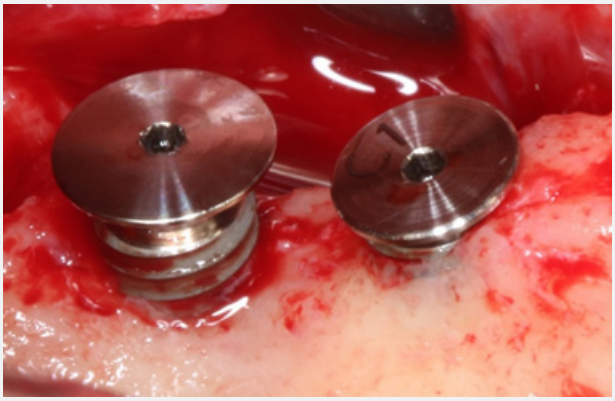

Figure 12: A tenting abutment (SANTA®) was placed over the implant platform for preventing collapse of the grafting material placed over the implant platform to achieve vertical and horizontal ridge augmentation during the healing period.

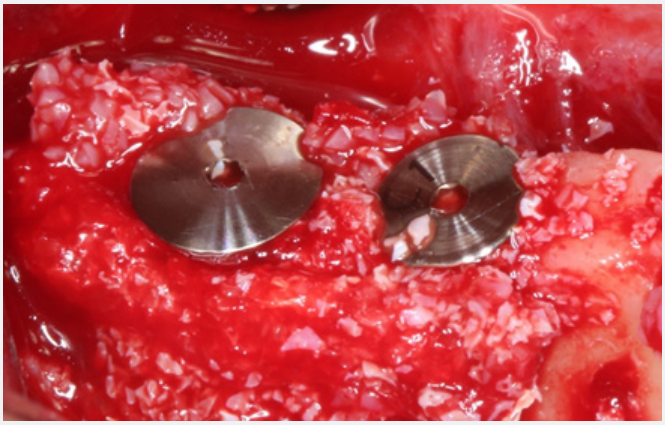

Figure 13: Sticky porcine bone graft was grafted between two tenting abutments and the bony defect.

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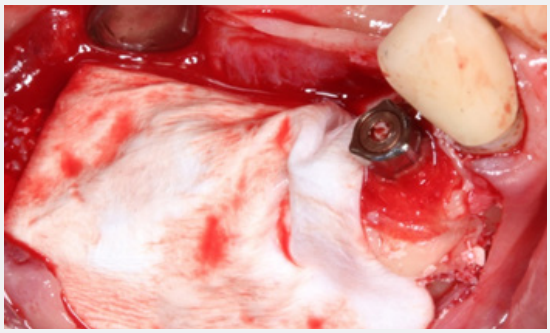

Figure 14: The grafted area was covered with a collagen membrane on the bone graft. Sohn's poncho technique using CGF membrane was performed on the 1st premolar area as a one-stage procedure.

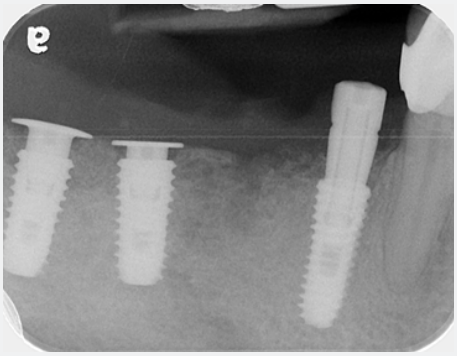

Figure 15: A postoperative radiogram showed bone grafting over the implant platform and the bony defect.

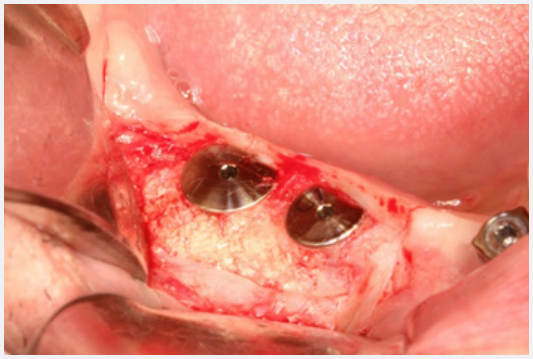

Figure 16: Uncovering was done after 14 weeks of healing. Note the successfully augmented ridge on the 1st and 2nd molar implant sites.

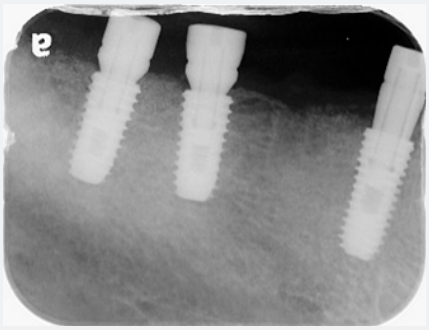

Figure 17: A periapical radiograph after connection of the healing abutments. The vertical defect was significantly improved over theplatform level and bony defect.

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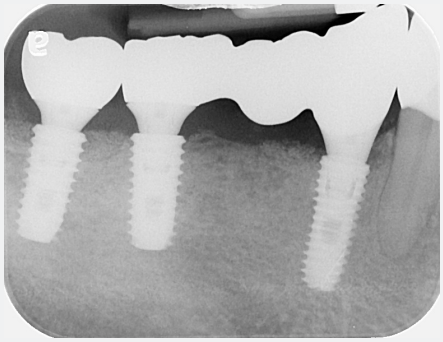

Figure 18: Periapical radiograph of the final restoration. Note that the grafted bone was preserved over the implant platform without significant bone resorption.

Case Report: 3

A 49-year-old male patient visited our department complaining of foul odor from the mouth and intermittent dull pain in the lower right 1st and 2nd molar implant-supported restoration. This implant-supported restoration showed signs of peri-implantitis, including gingival swelling, pus discharge and severe bone resorption. Immediate implant placement with 3-dimensional ridge augmentation was planned after the removal of the two failed implants. The surgical procedure was performed under local anesthesia after IV administration of preoperative antibiotics (Flomoxef, Flumarin®, Ildong Pharm, Korea). Implants were removed easily with forceps on February 27, 2019 under local anesthesia. The lower left 1st molar was extracted due to severe mobility, and the extracted tooth was prepared for particulate tooth bone graft on the same day. The patient's venous blood was taken from the forearm to obtain AFG to make sticky tooth and bovine bone graft. Complete curettage of inflammatory granulation tissue was performed with piezoelectric bone surgery and an attached bony scraper tip. After performing under-ostetomy, implants 5.0 mm wide x 11.5 mm high and 5.0 mm wide x 10 mm high (implant (Biotem Implant Co, Busan, Korea) were placed on the right 1st and 2nd molar areas, respectively. Implants were placed about 1mm subcrestally to adjacent proximal bone height. The initial stability of both implants was above 30Nm. Two 2mm-high tenting abutments (SANTA®, Biotem Implant Co, Busan, Korea) were applied on the implants to allow over-grafting for 3-dimensional socket augmentation over the implant platform and the bony defect. Layered bone grafting was performed.

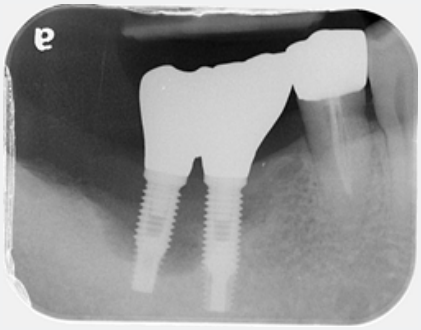

Figure 19: Periapical radiogram indicated peri-implantitis on the right mandibular 1st and 2nd molar areas.

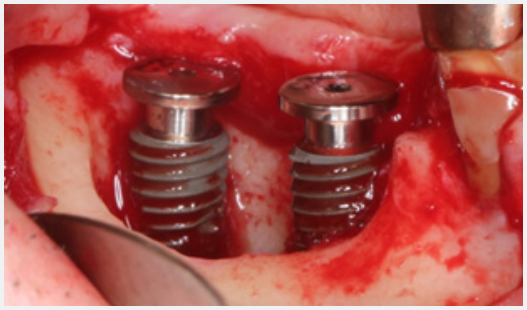

Figure 20: After the implants were removed, two new implants were placed on the area. A significant bony defect was found around the implants. For preventing collapse of bone graft, two tenting abutments were applied on the implant platform.

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Figure 21: Layered bone grafting, using sticky tooth and bovine bone graft, was performed on the bone defect. A collagen barrier was used to cover the bone graft.

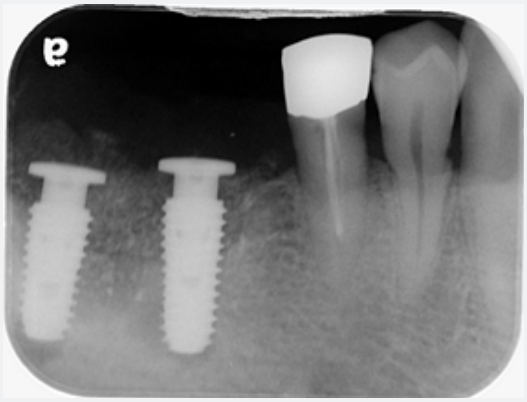

Figure 22: A postoperative radiogram showing the bone graft over the implant platform.

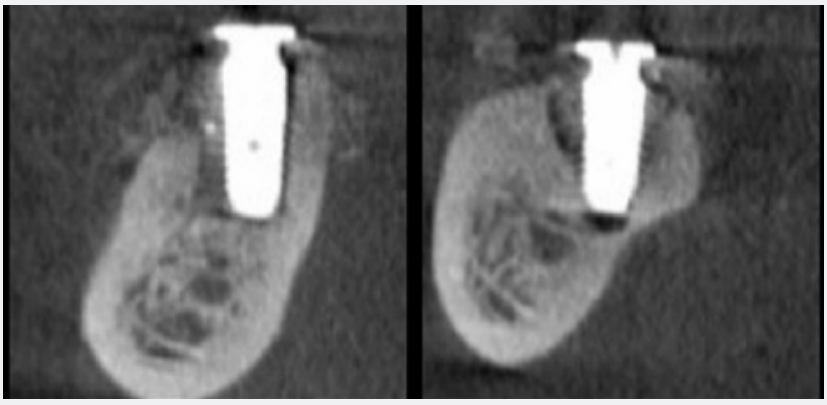

Figure 23: Postoperative CBCT images indicated bone grafting on the exposed implant surface and bony defect on 1st molar (left) and 2nd molar site (right).

The prepared sticky osteoinductive tooth bone graft was grafted first around the exposed implant, and sticky osteoconductive and non-resorbable inorganic bovine bone (Inducera®, Oscotec Inc., Sungnam, Korea) was grafted over the grafted tooth bone and the residual defect for a 3-dimensional ridge augmentation. A resorbable collagen membrane (Remaix, Matricel Co., Herzogenrath, Germany) was used to cover the bone graft in order to stabilize the grafted bone materials. CGF membranes were placed over the barrier membrane, and tension free suture was completed (Figure 19-23). There was no significant post-operative discomfort. After 13 weeks of healing, favorable 3-dimensional ridge augmentation was observed, and an uncovering procedure was performed to connect the healing abutments. Provisional restoration was completed after 2 weeks of healing. The final restoration was completed after 3 months of temporary loading (Figures 24 & 25).

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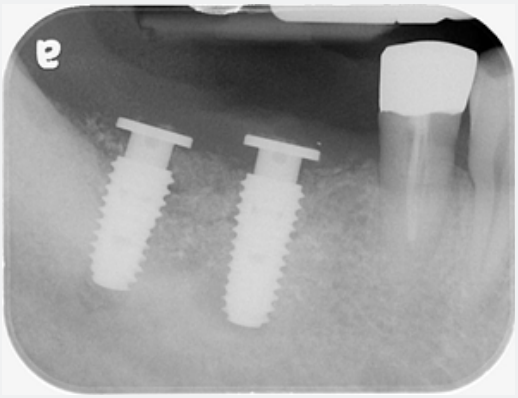

Figure 24: Note favorable ridge augmentation over the implant platform after 3 months of healing.

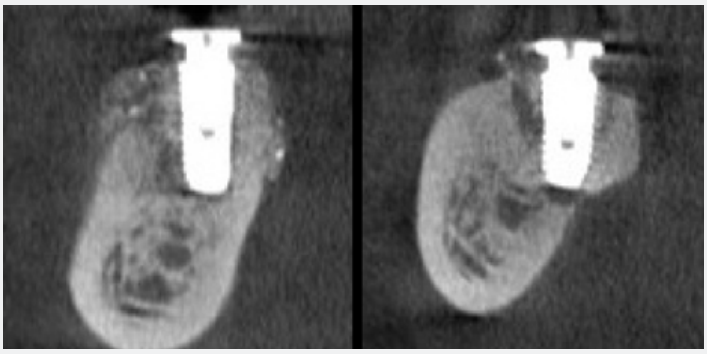

Figure 25: CBCT images after 3 months healing indicated well-maintained bone graft under the tenting abutments on the 1st molar (left) and 2nd molar site (right).

Figure 26: A final Zirconia restoratio .

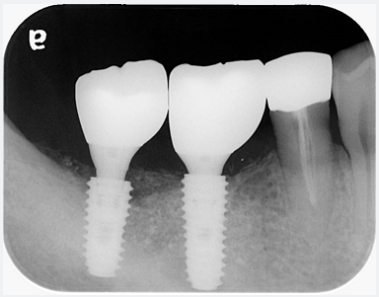

Figure 27: A periapical radiogram after final restoration showed stable ridge augmentation.

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Discussion

For the placement of implants in the edentulous alveolar ridge, sufficient quantity and quality of alveolar bone is essential, but many patients lack enough alveolar bone due to a number of causes, including trauma, periodontitis and other bone destructive diseases. However, the reconstruction of large vertical bone defects is recognized as a very difficult technique. Space maintenance with a bone graft should be provided during the healing period. Autologous block bone graft provides solid space maintenance during the healing period. However, the block bone procedure is known to have a low acceptance rate by patients due to several disadvantages, including increased surgical time and cost, increased post-operative patient discomfort, and additional surgery from the donor site [17-19]. Other complications have also been reported, including decreased volume at the recipient site, unpredictable resorption after healing, failure of the autograft, fracture of the mandible during harvesting of autogenous block bone, and neurosensory disturbances at recipient sites [20,21].

As an alternative to autogenous block bone, allogenic block bone has been utilized for the reconstruction of large 3-dimensional defects because it has no donor site morbidity and is of an unlimited volume in quantity [22,23]. However, according to some studies, allogenic block bone grafts have some disadvantages, including faster resorption during the healing period, cracking of the bone graft due to occlusal force, and poor integration of grafts [24,25]. To overcome the disadvantages of 3-dimensional augmentation using block bone grafts, guided bone regeneration (GBR) has been widely utilized for the reconstruction of large defects with simultaneous or delayed implant placement [1,26]. To achieve successful bone regeneration using the GBR procedure, stability of the particulate bone graft, primary wound closure, and angiogenesis and exclusion of soft tissue invasion using a barrier membrane, are essential [27]. As a resorbable barrier membrane, collagen membranes are the most common barrier used to exclude soft tissue invasion. However, due to poor stiffness of resorbable collagen membranes, non-resorbable barriers such as dense-polytetrafluoroethylene (d-PTFE), expanded-polytetrafluoroethylene (e-PTFE) and titanium mesh are utilized to achieve more favorable vertical support in 3-dimensional ridge augmentation [26]. However, the main disadvantage of a non-resorbable barrier membrane is early exposure, which can cause unfavorable bone generation [28].

Another disadvantage of non-resorbable barrier supported GBR are technical difficulties when placing it over the bone graft and when removing it after the healing period. To stabilize these barriers over the bone graft placed on the bony defect, several bone tacks should be placed on the edge of the barrier membrane to stabilize it. In addition, over-grafting is essential when performing GBR with a non-resorbable barrier or titanium mesh, because a 1-2mm thick soft tissue layer is always regenerated under a non-resorbable barrier [29]. The screw tent-pole technique with the GBR procedure is known to achieve predictable horizontal and vertical ridge augmentation [13,14]. This technique is technically simple and presents minor complications compared to GBR using a non-resorbable barrier [30]. The screw tent pole prevents collapse of the space produced by the bone graft and minimizes resorption of the grafting material [31]. This tent-pole technique is relatively simpler and a less invasive augmentation procedure, compared to other augmentation techniques using block bone or titanium mesh [32-34].

However, the tenting pole technique requires a long edentulous period and an increased number of surgeries because implants can't be placed at the same time when performing tent-pole-assisted ridge augmentation. In contrast to the tenting-pole screw technique, a tenting abutment technique is performed when placing implants simultaneoulsy on the bony defect. Therefore, the number of surgeries is reduced, and the edentulous healing period is shortened. In addition, this technique prevents vertical and horizontal collapse of the bone graft and minimizes resorption of the bone graft during healing as shown in this report. Surgeons must ensure about a 2mm-high interocclusal space in order to prevent early wound exposure from contact of the opposing dentition during healing. This case series report demonstrated simplified 3D ridge augmentation using tenting abutments to hold the graft material around the implant fixture. Long-term follow up is needed to evaluate the stability of the augmented ridge.

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