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CASE REPORT

PATIENT-CENTERED VERTICAL RIDGE AUGMENTATION USING THE TENT POLE CONCEPT

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ABSTRACT

Background: Vertical ridge augmentation remains one of the most challenging procedures in implant dentistry because severe alveolar defects frequently require complex regenerative approaches, multiple surgical interventions, and prolonged treatment periods before definitive prosthetic rehabilitation. Maintaining a stable regenerative space during healing is considered a critical factor for successful three-dimensional bone reconstruction.
Case Presentation: This report presents the clinical application of the Tent Pole System, which combines implant-supported tenting abutments (SANTA®) and a wide-head tenting screw (SBB®) to maintain regenerative space during simultaneous implant placement and vertical ridge augmentation. A patient with severe posterior maxillary alveolar ridge deficiency associated with extensive horizontal and vertical bone loss underwent simultaneous implant placement, sinus augmentation, and three-dimensional ridge reconstruction. The regenerative procedure incorporated concentrated growth factor (CGF), StickyBone™, and a collagen membrane. Implant-supported tenting abutments were used in implant sites, while a wide-head tenting screw was applied in an implant-free pontic region to provide continuous space maintenance throughout the defect. Clinical, radiographic, and prosthetic outcomes were evaluated during follow-up.
Results: The Tent Pole System allowed reconstruction of the deficient alveolar ridge with stable maintenance of the augmented volume. Early provisional rehabilitation was achieved, followed by definitive prosthetic restoration with satisfactory functional and esthetic outcomes. At two-year follow-up, stable peri-implant hard and soft tissues were observed without biological or prosthetic complications. Soft tissue enhancement was successfully achieved using a minimally invasive sutureless free gingival graft technique.
Conclusion: The Tent Pole System represents a promising approach for managing severe vertical ridge defects by integrating implant-supported and implant-free space-maintaining devices within a simplified regenerative protocol. Although the presented clinical outcomes are encouraging, further prospective controlled studies with larger patient populations and longer follow-up are required to validate its predictability and long-term effectiveness.

Keywords: Vertical ridge augmentation; Tent Pole Concept; guided bone regeneration; implant dentistry; SANTA®; SBB®; concentrated growth factor.

1. INTRODUCTION

Vertical ridge augmentation remains one of the most technically demanding procedures in implant dentistry due to the limited predictability of vertical bone regeneration and the biological challenges associated with maintaining a stable regenerative space. Conventional approaches, including autogenous block bone grafting, distraction osteogenesis, titanium mesh, and non-resorbable membrane-guided bone regeneration, have demonstrated successful clinical outcomes; however, these techniques are frequently associated with limitations such as donor-site morbidity, graft resorption, membrane exposure, prolonged healing periods, and the need for multiple surgical procedures.[1–4] Moreover, in cases involving severe vertical ridge deficiencies, simultaneous implant placement is often considered difficult or contraindicated, resulting in extended treatment timelines before definitive prosthetic rehabilitation can be achieved.

To overcome these limitations, the Tent Pole Concept was introduced as a biologically driven approach that combines implant placement with vertical ridge augmentation. This concept utilizes a 2-mm-high tenting abutment (SANTA®, Biotem Implant Co., Seoul, Republic of Korea) directly connected to the implant

platform within the augmented site. The implant and the tenting abutment function as a biological "tent pole," supporting the overlying soft tissue, preventing collapse of the regenerative compartment, and maintaining a stable three-dimensional space for bone formation during healing. This approach allows simultaneous implant placement and vertical ridge augmentation, potentially reducing surgical complexity, patient morbidity, and overall treatment duration.[5]

Despite these advantages, the conventional Tent Pole Concept using the SANTA® system has limitations in situations where implant placement is not possible, such as implant-free pontic regions or extensive vertical defects requiring staged reconstruction. To address this clinical challenge, the wide-head tent-pole screw (WHTPS; SBB®, Biotem Implant Co., Seoul, Republic of Korea) was developed as an implant-independent space-maintaining device. Unlike conventional tenting screws, which generally require multiple fixation points to provide adequate support, the SBB® (Sohn's Bone Builder) incorporates a wider supporting head designed to increase contact with the grafted area and maintain regenerative space with fewer fixation devices.[6]

The present case report describes the clinical application of an integrated Tent Pole System combining implant-supported tenting with SANTA® and implant-free space maintenance using SBB®. This combined approach enables continuous vertical augmentation across both implant-containing and implant-free regions within extensive ridge defects. A patient with severe vertical ridge deficiencies was treated using this integrated system, demonstrating its clinical feasibility as a simplified and biologically oriented strategy for three-dimensional vertical ridge reconstruction.

2. CASE PRESENTATION

A 64-year-old male patient was referred to our department for management of a persistent oroantral fistula that developed after surgical treatment of maxillary sinusitis associated with infection of a previously performed bone graft in the right posterior maxilla. The patient had undergone surgical intervention for sinus-related complications; however, postoperative infection resulted in extensive bone loss and the formation of an oroantral communication.

To eliminate the oroantral fistula, a vascularized interpositional periosteal connective tissue (VIP-CT) flap was performed. The procedure resulted in complete closure of the oroantral communication and resolution of the associated soft tissue defect. Three months after fistula closure, the patient returned for clinical and radiographic evaluation. Clinical examination revealed complete healing of the surgical site, with no signs of recurrent infection, inflammation, or communication between the oral cavity and maxillary sinus. However, severe horizontal and vertical alveolar ridge deficiencies were identified in the right posterior maxilla, resulting from extensive previous bone resorption.

Cone-beam computed tomography (CBCT) evaluation demonstrated a severely compromised alveolar ridge with combined horizontal and vertical bone deficiency. A large residual osseous defect remained between the alveolar ridge and the maxillary sinus due to advanced bone resorption. Furthermore, marked thickening of the Schneiderian membrane was observed, suggesting chronic inflammatory changes associated with the previous sinus pathology (Figure 1).

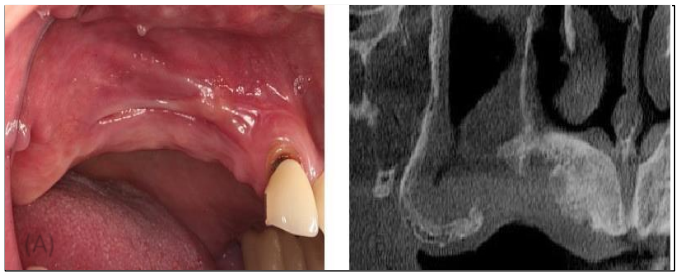

Figure 1. Preoperative clinical and radiographic findings.

(A) Preoperative intraoral examination showing severe horizontal and vertical alveolar ridge deficiency in the right posterior maxilla following successful closure of the oroantral fistula.
(B) Preoperative CBCT coronal view demonstrating extensive vertical alveolar bone loss and a large residual osseous communication between the alveolar ridge and the maxillary sinus. Thickening of the Schneiderian membrane is also evident, indicating chronic inflammatory alterations.

Because the patient desired rehabilitation with a fixed implant-supported prosthesis, a comprehensive treatment plan was established to reconstruct the severely deficient posterior maxilla and restore function as efficiently as possible. The main surgical objectives were to eliminate the residual communication with the maxillary sinus, restore adequate three-dimensional alveolar bone volume, and achieve a stable foundation for implant-supported prosthetic rehabilitation.

After detailed discussion regarding available treatment options, the patient was informed that conventional staged reconstruction using guided bone regeneration (GBR) with non-resorbable membranes, such as expanded polytetrafluoroethylene (e-PTFE), or titanium mesh would generally require multiple surgical procedures. In

such a treatment sequence, ridge reconstruction would typically be followed by a separate implant placement procedure after sufficient graft maturation, resulting in a prolonged treatment period that could extend beyond 18 months before definitive prosthetic rehabilitation.

Although conventional staged augmentation remains a well-established approach for severe vertical defects, the anticipated prolonged edentulous period, additional surgical interventions, and delayed functional restoration were considered important factors in this patient's treatment decision. Considering the patient's preference for earlier restoration of oral function and reduction of surgical burden, an alternative treatment strategy was selected.

The treatment plan was therefore designed to achieve simultaneous implant placement and three-dimensional ridge reconstruction while minimizing the number of surgical interventions. To accomplish this goal, an integrated Tent Pole System approach was planned, combining implant-supported and implant-free space-maintaining components.

In the implant-supported regions, implants connected with SANTA® tenting abutments (Biotem Implant Co., Seoul, Republic of Korea) were planned to function as biological tent poles by maintaining vertical regenerative space around the implants. In the implant-free pontic region, where placement of an implant was not feasible due to anatomical limitations, a wide-head tent-pole screw (SBB®, Sohn's Bone Builder, Biotem Implant Co., Seoul, Republic of Korea) was planned to provide independent space maintenance.

This integrated strategy allowed the regenerative space to be maintained continuously throughout the entire defect, including both implant-containing and implant-free areas.

The surgical procedure was performed under local anesthesia following intravenous administration of preoperative antibiotics (Flomoxef, Flumarin®, Ildong Pharm, Republic of Korea). Prior to surgery, venous blood was collected from the patient's forearm and processed to prepare autologous fibrin glue and concentrated growth factor (CGF) membranes. These autologous biological materials were incorporated into the preparation of Sticky Bone according to the technique originally described by Sohn et al. (7).

A mid-crestal incision combined with anterior and posterior vertical releasing incisions extending into the vestibular mucosa was performed. A full-thickness buccal mucoperiosteal flap was carefully elevated to provide complete visualization of the reconstructed area. Following flap reflection, a large osseous defect extending between the posterior alveolar ridge and the maxillary sinus was clearly identified.

The Schneiderian membrane was carefully elevated using sinus elevators. During sinus membrane elevation, the palatal bony wall of the maxillary sinus was widely exposed to enhance vascular access and facilitate formation of a well-vascularized subantral regenerative compartment. This approach was intended to optimize the biological environment for subsequent bone regeneration.

During surgical preparation, a bony defect surrounding the previously compromised implant site in the premolar region was identified. During elevation of the Schneiderian membrane, a small perforation occurred. Instead of filling the sinus cavity with conventional particulate bone graft material, four CGF blocks were placed within the elevated sinus cavity.

The use of CGF blocks was intended to support repair of the Schneiderian membrane perforation, enhance biological regeneration, and reduce the risk of postoperative sinus complications. The newly created subantral space was maintained without the use of particulate graft material within the sinus cavity.

Following sinus membrane management, implant placement was performed in the canine, first premolar, and second molar regions using implants from Biotem Implant Co. (Seoul, Republic of Korea).

The implant platforms in the canine and first premolar regions were positioned approximately 2 mm apical to the proximal bone level of the adjacent healthy lateral incisor. SANTA-2 abutments with a 2-mm height were connected to these implants and served as implant-supported tent poles to maintain vertical regenerative space.

A SANTA-1 abutment was connected to the implant positioned in the second molar region to provide additional support for horizontal and vertical ridge reconstruction.

To maintain the regenerative space in the implant-free second premolar pontic region, a 6-mm-diameter SBB® was inserted into the palatal aspect of the defect. The device was inserted at 50 rpm using a handpiece connected to an implant motor.

The height of the SBB® head was carefully adjusted to correspond with the height of the SANTA® abutments. This created a continuous tenting framework consisting of implant-supported and implant-independent components, allowing stable maintenance of the three-dimensional regenerative space throughout the entire defect (Figure 2).

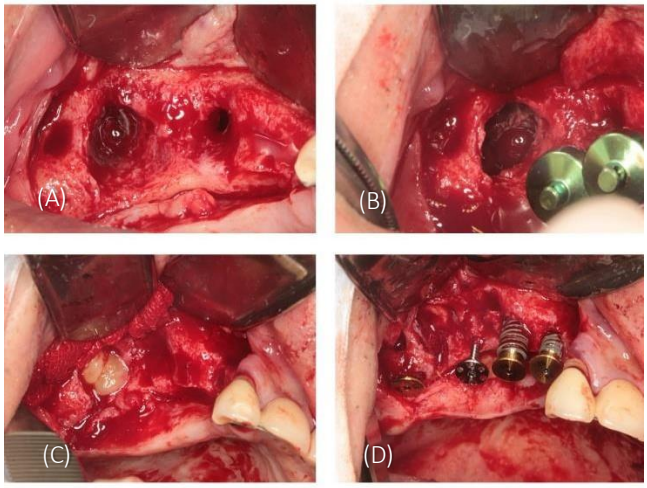

Figure 2. Surgical procedures for reconstruction using the Tent Pole System.

(A) Full-thickness buccal flap elevation revealing a severe three-dimensional alveolar ridge defect with a large osseous communication between the residual alveolar ridge and the maxillary sinus.
(B) Schneiderian membrane elevation and implant site preparation performed using a Bone Pen surgical guide.
(C) CGF-assisted sinus augmentation following Schneiderian membrane perforation, performed without the use of particulate bone graft material inside the sinus cavity. Four CGF blocks were placed within the elevated sinus compartment to support membrane healing and promote biological regeneration.
(D) Placement of a 6-mm SBB® in the implant-free second premolar region and connection of SANTA® abutments to the implant platforms. The combination of implant-supported SANTA® abutments and implant-independent SBB® established the integrated Tent Pole System.

Following implant placement and installation of the tenting components, Sticky Bone™ was prepared by combining deproteinized bovine bone mineral with autologous fibrin obtained from the patient's blood-derived concentrates. The prepared Sticky Bone™ was applied throughout the reconstructed region to completely fill the vertical and horizontal defect and was extended slightly over the heads of both the SANTA® abutments and the SBB®.

The use of Sticky Bone™ provided mechanical stability of the grafted material and facilitated maintenance of the augmented volume within the regenerative compartment. A 3 × 4 cm resorbable collagen membrane was subsequently positioned over the grafted area. Due to the cohesive characteristics and stability of the Sticky Bone™ graft, additional fixation using membrane tacks was not considered necessary.

After adequate periosteal releasing incisions were performed to achieve passive flap advancement, the buccal flap was repositioned and primary wound closure was achieved with slight coronal eversion of the flap margins. The surgical site demonstrated tension-free closure, allowing undisturbed healing of the augmented region.

Five months after augmentation, a second-stage surgical procedure was performed. A palatal crestal incision was made to expose the tenting components. The SANTA® abutments and SBB® were carefully removed, and the implant platforms were evaluated. Scan bodies were connected to the implants, and a digital impression was obtained for prosthetic fabrication (Figure 3).

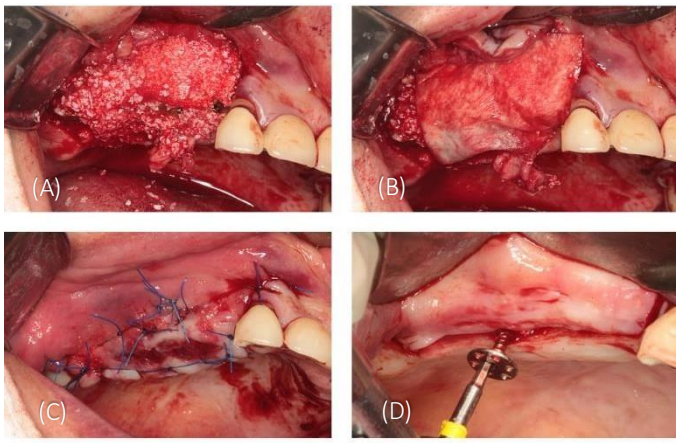

Figure 3. Guided bone regeneration and second-stage surgery.

(A) Sticky Bone™ was applied to reconstruct the severe vertical ridge deficiency, completely filling the augmented area and slightly covering the heads of the SANTA®abutments and SBB®.
(B) The augmented region was protected with a resorbable collagen membrane without additional fixation devices.
(C) Tension-free primary closure was achieved following periosteal releasing incisions and passive advancement of the buccal flap.

(D) Five months after healing, the SANTA® abutments and SBB® were exposed through a palatal crestal incision and removed before digital impression procedures. Immediate postoperative CBCT evaluation demonstrated successful reconstruction of the three-dimensional ridge contour following simultaneous implant placement, CGF-assisted sinus augmentation, and application of the Tent Pole System. The regenerated area showed maintenance of the planned regenerative space around both implant-supported and implant-free regions (Figure 4).

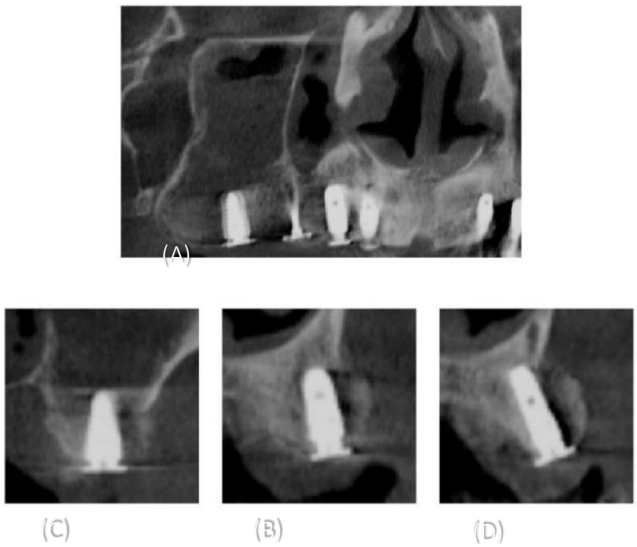

Figure 4. Immediate postoperative CBCT evaluation.

(A) Coronal CBCT image demonstrating the reconstructed posterior maxillary ridge immediately after simultaneous implant placement and Tent Pole System application. (B–D) Cross-sectional CBCT images showing the three-dimensional configuration of the augmented ridge and preservation of the regenerative compartment surrounding the implant sites and implant-free pontic region.

At the five-month postoperative evaluation, CBCT examination demonstrated stable maintenance of the reconstructed ridge volume and evidence of new bone formation throughout the augmented region.
The vertical ridge contour was preserved, and the regenerated bone surrounding the implants and pontic area remained stable (Figure 5).

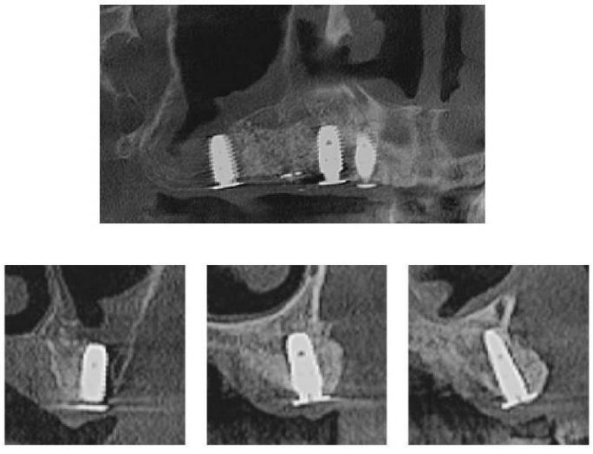

Figure 5. Five-month postoperative CBCT evaluation.

(A) Panoramic CBCT image demonstrating stable vertical ridge reconstruction following application of the integrated Tent Pole System and CGF-assisted sinus augmentation.
(B–D) Cross-sectional CBCT images confirming maintenance of the regenerated three-dimensional ridge architecture around the implants and within the implant-free pontic region.

Following confirmation of satisfactory healing and implant stability, a screw-retained functional provisional restoration was delivered two weeks after the second-stage surgery. Functional loading was initiated immediately with the provisional restoration, allowing prosthetically guided soft tissue shaping and maturation of the peri-implant mucosa.

After evaluation of implant stability, occlusal adaptation, and soft tissue condition, the definitive implant-supported prosthesis was fabricated and delivered following successful provisionalization.

At 18 months after functional loading, clinical examination revealed that the width of keratinized tissue around the definitive restoration remained insufficient. Therefore, a sutureless free gingival graft (FGG) procedure was performed to increase the amount of peri-implant keratinized mucosa. The graft was stabilized using tissue cyanoacrylate adhesive instead of conventional sutures. This technique was performed with the aim of simplifying soft tissue augmentation and reducing surgical morbidity. The sutureless approach allowed stabilization of the graft with minimal manipulation and shortened surgical time. Compared with conventional sutured FGG procedures, this technique may provide potential advantages including reduced operative duration, decreased postoperative discomfort, limited surgical trauma, and improved patient acceptance.
At the two-year follow-up examination, the definitive implant-supported restoration remained stable, with satisfactory esthetic and functional outcomes. Clinical and radiographic evaluations demonstrated stable peri-implant conditions, preserved marginal bone levels, and no evidence of biological complications, prosthetic complications, or recurrence of the previous oroantral pathology (Figures 6 and 7).

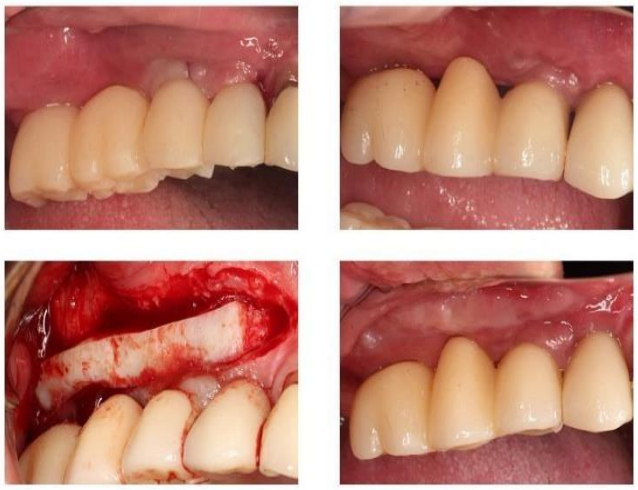

Figure 6. Clinical outcomes following prosthetic rehabilitation.

(A) Clinical view of the screw-retained functional provisional restoration delivered two weeks after second-stage surgery, allowing immediate functional loading and prosthetically guided soft tissue maturation.
(B) Definitive implant-supported restoration delivered after successful provisional rehabilitation and confirmation of implant stability. (C) Clinical view following sutureless free gingival grafting. (D) Clinical view at the 2-year follow-up, demonstrating stable peri-implant soft tissue and long-term maintenance of the definitive restoration.

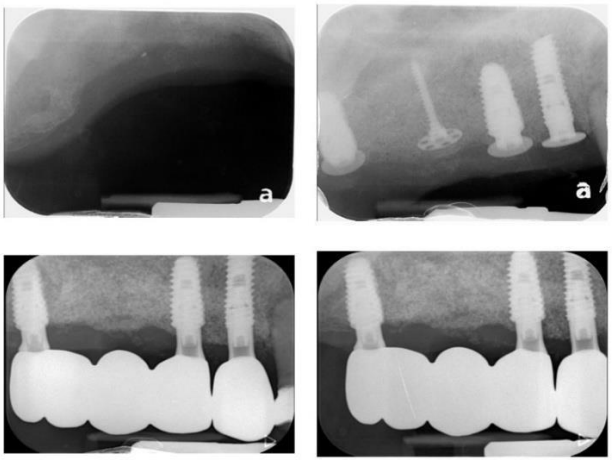

Figure 7. Radiographic evaluation throughout treatment and follow-up.

(A) Preoperative radiograph demonstrating severe vertical alveolar ridge deficiency in the right posterior maxilla.
(B) Immediate postoperative radiograph following simultaneous implant placement, application of the Tent Pole System, and three-dimensional ridge reconstruction.
(C) Radiograph obtained after delivery of the definitive implant-supported restoration demonstrating successful reconstruction of the alveolar ridge and prosthetic rehabilitation.
(D) Two-year follow-up radiograph showing stable peri-implant marginal bone levels and long-term maintenance of the definitive restoration.

DISCUSSION

Vertical ridge augmentation remains one of the most challenging procedures in implant dentistry because successful reconstruction requires not only the formation of sufficient new bone but also the long-term maintenance of a stable regenerative compartment throughout the healing period. Unlike horizontal augmentation procedures, vertical reconstruction is particularly sensitive to soft tissue pressure, graft displacement, membrane collapse, and resorption-related volume reduction. Therefore, the fundamental biological principle underlying successful vertical augmentation is the establishment and preservation of a protected three-dimensional space that allows uninterrupted osteogenesis.

Numerous surgical techniques have been developed for the management of severe vertical ridge deficiencies, including autogenous block bone grafting, distraction osteogenesis, sandwich osteotomy, and vertical guided bone regeneration (GBR) using titanium mesh or non-resorbable membranes. Although these approaches have demonstrated favorable clinical outcomes, each technique presents specific limitations that may affect treatment predictability, patient morbidity, and overall treatment duration.

Autogenous block bone grafting has traditionally been considered a reference technique for vertical ridge reconstruction because of its osteogenic, osteoinductive, and osteoconductive properties. The presence of viable bone-forming cells and inherent biological potential makes autogenous bone an attractive graft material. However, this technique requires harvesting from an additional donor site, which may result in increased postoperative discomfort, donor-site morbidity, limited graft availability, and unpredictable dimensional changes caused by graft remodeling and resorption. Furthermore, implant placement is commonly delayed until sufficient graft maturation has occurred, resulting in an extended period of edentulism and delayed functional rehabilitation.[8]

Distraction osteogenesis represents another approach capable of achieving substantial vertical bone gain by gradual mechanical separation of bone segments while simultaneously expanding the surrounding soft tissues. However, despite its regenerative potential, the technique is associated with several clinical challenges. Previous systematic reviews have reported complication rates approaching 50%, including incorrect distraction vector, device-related complications, infection, wound dehiscence, and patient discomfort associated with prolonged activation and consolidation periods.9) In addition, precise control of the transport segment is technically demanding, particularly in anatomically complex regions such as the posterior maxilla.

Similarly, sandwich osteotomy has been described as an effective technique for vertical augmentation in selected cases. However, its application requires extensive surgical experience and carries potential risks, including segment fracture, compromised vascular supply, unfavorable healing, and wound complications. The technique may also be limited in cases with severe three-dimensional defects requiring simultaneous horizontal and vertical reconstruction.

Vertical GBR using titanium mesh or non-resorbable membranes has become a widely accepted approach for managing complex alveolar defects because of its ability to maintain regenerative space and facilitate substantial bone formation. Nevertheless, exposure of the membrane or mesh remains one of the most frequently reported complications and may negatively influence regenerative outcomes by increasing bacterial contamination and compromising the healing environment. Furthermore, non-resorbable barriers generally require a second surgical procedure for removal, increasing surgical burden, patient discomfort, and overall treatment duration.[10–12]

In addition to these conventional approaches, tenting screw techniques have been introduced to overcome one of the major limitations of vertical augmentation: collapse of the regenerative space. By mechanically supporting the grafted area, tenting devices can prevent soft tissue compression and maintain a protected environment for bone formation. However, conventional mini-tenting screws often require placement of multiple fixation devices to support large defects. This may increase surgical complexity, prolong operative time, and complicate the management of extensive three-dimensional defects.

The biological principle of the present approach differs from conventional vertical augmentation techniques. The Tent Pole System was developed based on the concept that stable maintenance of regenerative space is the key determinant of successful vertical bone formation. Rather than relying exclusively on external fixation devices or staged reconstruction, this approach integrates implant placement and space maintenance whenever possible, allowing simultaneous reconstruction and prosthetic rehabilitation.

The primary objective of this concept is not simply to maximize regenerated bone volume but to optimize the overall treatment pathway by reducing surgical interventions, shortening the edentulous healing period, and facilitating earlier restoration of oral function. This philosophy reflects the principles of contemporary patient-centered implant dentistry, in which treatment success is evaluated not only by radiographic bone gain but also by biological stability, patient experience, treatment efficiency, and functional rehabilitation.

The original Tent Pole Concept was introduced using the SANTA® (Sohn's Augmentation New Tenting Abutment), which is connected directly to the implant platform and functions as an implant-supported biological tent pole. Unlike conventional tenting screws, the SANTA® serves a dual purpose by acting simultaneously as a healing component and a regenerative space-maintaining structure. By utilizing the implant itself as a supporting framework, the need for additional fixation devices around the implant site can be reduced, while maintaining the required vertical dimension during healing.[13]

However, despite these advantages, the original SANTA® concept had an inherent limitation. Because its function depends on simultaneous implant placement, its application was restricted to implant-supported regions. In extensive defects involving implant-free pontic areas or anatomical sites where implant placement was not feasible during augmentation, an alternative space-maintaining strategy was required.

To overcome this limitation, the wide-head tent-pole screw (SBB®, Sohn's Bone Builder) was subsequently developed. Unlike conventional mini-tenting screws, the SBB® incorporates an enlarged supporting head designed to provide broader contact with the grafted region and maintain regenerative space with fewer fixation points. This design allows the biological principle of tenting to be extended beyond implant-supported regions.

In a previous retrospective clinical investigation, the SBB® demonstrated a mean vertical bone gain of 8.86 mm with only 17.8% radiographic dimensional reduction during the healing period.[6] Furthermore, histomorphometric evaluation demonstrated newly formed bone ranging from 21.2% to 57.5% beneath the screw head without evidence of inflammatory tissue reaction, suggesting that stable space maintenance may support predictable bone regeneration.[14]

The present case report expands these previous concepts by combining SANTA® and SBB® into a unified Tent Pole System. The principal innovation of this approach is not the individual use of either device but rather their integration according to the anatomical characteristics of the defect. The SANTA® provides implant-supported space maintenance in regions where implants can be simultaneously placed, whereas the SBB® extends the same biological principle to implant-free pontic regions.

In the presented case, this combined strategy allowed continuous maintenance of the regenerative compartment across the entire posterior maxillary defect. The implant-supported and implant-free components functioned together as a single three-dimensional framework, supporting the grafted material and preventing collapse of the reconstructed ridge contour.

Another important aspect of this case was the management of the maxillary sinus. Conventional sinus augmentation generally involves placement of particulate bone graft material within the elevated sinus compartment

to promote bone formation. In the present case, following Schneiderian membrane perforation, CGF blocks were used instead of particulate graft material. The objective was to provide biological support for membrane healing while avoiding potential complications associated with particulate graft displacement into the sinus cavity. Although this approach demonstrated favorable healing in this patient, further clinical investigations are required to evaluate its reproducibility and long-term effectiveness.

The combination of Sticky Bone™, CGF, and the Tent Pole System provided mechanical stability and biological enhancement during the regenerative process. Sticky Bone contributed to stabilization of the grafted material, while the tenting framework maintained the required three-dimensional space. However, because multiple regenerative components were applied simultaneously, the individual contribution of each component cannot be independently determined from this case.

From a clinical perspective, the main advantage of the Tent Pole System is the possibility of simplifying complex vertical augmentation procedures while reducing the need for multiple fixation devices. In appropriately selected cases, simultaneous implant placement and ridge reconstruction may reduce treatment stages and shorten the period before functional rehabilitation. Nevertheless, this approach should not be considered a replacement for established augmentation techniques in all clinical situations. Patient selection, defect morphology, soft tissue condition, residual bone anatomy, and surgeon experience remain critical factors influencing treatment outcomes. Several limitations should be acknowledged. First, this report describes only a limited clinical experience and does not allow definitive conclusions regarding superiority compared with conventional augmentation methods. Second, the long-term stability of the regenerated bone requires evaluation through larger prospective studies with extended follow-up periods. Third, comparative clinical trials are necessary to determine whether the integrated Tent Pole System provides advantages in terms of bone gain, complication rates, treatment duration, and patient-reported outcomes compared with established regenerative approaches.

Future investigations should focus on prospective multicenter studies evaluating vertical bone gain, volumetric stability, implant survival, peri-implant tissue health, complication rates, and patient-centered outcomes. Such evidence will be essential to determine the appropriate indications and limitations of this treatment concept.

Overall, the present case demonstrates the clinical feasibility of combining implant-supported and implant-free tenting principles within a single regenerative framework. The Tent Pole System represents an evolution of space-maintaining strategies in vertical ridge augmentation by adapting regenerative support according to the anatomical characteristics of complex defects. Further clinical validation is required; however, this approach may provide an additional option for managing challenging vertical ridge deficiencies while emphasizing biological stability, procedural simplification, and patient-oriented treatment planning.

3. CONCLUSION

Vertical ridge augmentation in severely resorbed alveolar regions remains a complex clinical challenge, requiring stable maintenance of the regenerative space, adequate vascular support, and careful management of both hard and soft tissues. The present case demonstrates the clinical feasibility of an integrated Tent Pole System combining implant-supported SANTA® tenting abutments and implant-independent SBB® wide-head tent-pole screws for reconstruction of an extensive three-dimensional vertical ridge defect.

The SANTA® component provides a biological space-maintaining function in implant-supported regions by utilizing the implant itself as a stable tenting structure, allowing simultaneous implant placement and vertical ridge augmentation. The SBB® extends this same regenerative principle to implant-free areas, such as pontic regions, where conventional implant-supported tenting cannot be applied. By combining these two components, the Tent Pole System enables continuous maintenance of regenerative space across complex defects involving both implant-containing and implant-free regions.

In the present case, the integrated approach allowed simultaneous implant placement, reconstruction of a severely deficient posterior maxillary ridge, management of the associated sinus-related defect, and subsequent prosthetic rehabilitation with stable clinical and radiographic outcomes at two years of follow-up. The technique reduced the requirement for multiple fixation devices and avoided a prolonged staged reconstruction protocol, thereby potentially decreasing surgical burden and shortening the pathway to functional rehabilitation. Nevertheless, the findings of this report should be interpreted within the limitations of a case-based observation. Although the clinical outcome was favorable, larger prospective studies with longer follow-up periods and comparative designs are necessary to evaluate the long-term stability, reproducibility, and clinical indications of the Tent Pole System.

Within these limitations, the presented approach represents a potential advancement in vertical ridge augmentation by integrating implant-supported and implant-free space maintenance into a unified regenerative concept. Further clinical investigation will determine its role among contemporary strategies for the management of complex alveolar ridge deficiencies.

DECLARATIONS

Ethical Approval

Not applicable.

Competing Interests

The author is the developer of the SANTA® and SBB® systems.

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None.

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