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# Bone Truss Bridge (BTB) Approach for Atrophic Maxilla Rehabilitation Utilizing Narrow Compressive Implants

**Henri Diederich***
Doctor in dental medicine, 114 av de la Faiencerie, L-1511 Luxembourg

**Corresponding authors:** Henri Diederich, Doctor in dental medicine, 114 av de la Faiencerie, L-1511 Luxembourg

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## Abstract

The rehabilitation of the atrophic maxilla presents significant clinical challenges, traditionally addressed with invasive bone augmentation. The Bone Truss Bridge (BTB) approach offers a minimally invasive alternative by optimizing the biomechanical utilization of available native bone. Utilizing narrow, one-piece compressive implants anchored in dense cortical buttresses (pterygomaxillary and trans-nasal regions), this approach circumvents extensive grafting. This report details the clinical workflow, implant characteristics, and presents three diverse clinical cases demonstrating the predictability, reduced morbidity, and immediate/early loading potential of the BTB approach. High patient satisfaction was recorded due to reduced treatment time and a less invasive surgical procedure compared to traditional methods.

## Keywords

Bone Truss Bridge; Atrophic maxilla; Narrow compressive implants; Minimal invasiveness; Pterygoid implants; Immediate loading.

# Introduction

## Problem statement challenge of atrophic maxilla

The rehabilitation of the atrophic maxilla remains one of the most significant challenges in modern implant dentistry. Maxillary atrophy characterized by severe bone loss in the upper jaw frequently results from long-term edentulism, severe periodontal disease, trauma, or congenital conditions (Albrektsson &Johansson, 2001). Furthermore, the native bone in the maxilla is typically less dense than that of the mandible (often classified as Lekholm and Zarb D3-D4), which inherently compromises primary implant stability (Esposito et al., 2006) and complicates the biological process of osseointegration.

## Limitations of traditional methods

Historically, the "gold standard" for addressing severe maxillary atrophy has involved invasive autologous bone augmentation techniques, such as sinus floor elevation, onlay grafting, and guided bone regeneration (GBR). While clinically effective, these conventional methods present several distinct disadvantages: They are highly invasive, technically complex, and time-consuming. They significantly increase patient discomfort and morbidity, often presenting donor site complications (Chiapasco et al., 2006). They require extended healing periods, delaying functional prosthetic restoration, and elevate the overall cost of treatment. Alternative options, such as zygomatic implants, demand highly advanced surgical skills and may not be anatomically suitable for all patients.

## Need for minimally invasive solutions

Consequently, there is a distinct clinical demand for minimally invasive, efficient treatment modalities that provide immediate structural integrity and long-term stability without the drawbacks of extensive bone grafting. Alternative approaches should prioritize structural integrity, long-term stability, and reduced patient morbidity.

# The Bone Truss Bridge (BTB) Approach

## The bone truss bridge (BTB) in dental implantology

The Bone Truss Bridge (BTB) technique is an advanced surgical modality engineered to circumvent the clinical limitations and morbidity of conventional bone augmentation by optimizing the biomechanical utilization of available native bone. The biomechanical rationale derives from the structural principles of the Bowstring Truss Bridge, originally patented by Squire Whipple in 1841. In surgical implantology, this loadbearing mechanism is replicated by rigidly anchoring specialized dental fixtures into anatomically favorable, high-density cortical buttresses (Duarte et al., 2015; Misch, 2007) to achieve physiologic force distribution and counteract destabilizing lateral shear forces (Rosen & Gapski, 2017).

## Key components

The BTB methodology utilizes strategic cortical anchorage sites:

- **Pterygoid Region:** Engages the dense cortical bone of the pterygomaxillary buttress, providing rigid posterior stability and counteracting horizontal and lateral vector forces.
- **Pyriform and Trans-Nasal Regions:** Utilizes narrow, one-piece tissue-level implants advanced via a palatal trajectory to achieve bicortical purchase in the cortical floor of the nasal cavity, bypassing horizontal alveolar ridge deficiencies.

- **Anterior Maxilla:** Incorporates strategically spaced implant fixtures within the anterior alveolar segment to cross-stabilize the arch and dissipate axial occlusal loads.

### Ideal implant placement strategy

In comprehensive full-arch rehabilitations, the standardized structural framework ideally incorporates eight strategically positioned fixtures: two in the pterygoid region, two in the pyriform rim/nasal floor, and four distributed across the anterior maxillary segment. The definitive fixture count and spatial distribution are calibrated to individual residual bone volume and site-specific osseous density.

## Advantages of the BTB Approach

- **Cortical Anchorage and Biomechanical Stability:** Strategic oblique trajectories exploit dense cortical pillars specifically the pterygoid plates and trans-nasal / pyriform regions for robust bicortical stabilization, optimizing occlusal force dissipation and minimizing individual fixture strain.
- **Reduced Morbidity via Graft-Free Protocols:** Bypassing sinus floor elevations and onlay grafting significantly reduces perioperative morbidity, eliminates donor-site complications and graft failure risks, accelerates healing, and reduces total treatment cost.
- **Predictable Immediate/Early Loading:** Aggressive thread geometries and tapered apices achieve high primary stability with insertion torques commonly exceeding 50 to 70 Ncm, facilitating early prosthetic loading and rapid functional and aesthetic rehabilitation.
- **Marginal Bone Preservation and Retrievability:** The one-piece tissue-level architecture eliminates crestal micro-gaps to mitigate peri-implant bone resorption, while milled frameworks with angulated screw channels ensure a passive fit and predictable prosthetic retrievability for maintenance.

## Limitations of the BTB Approach

- **Surgical Complexity and Anatomical Hazards:** Engaging remote cortical sites demands advanced surgical expertise. Deviations in trajectory introduce risks of iatrogenic trauma, including Schneiderian membrane perforation, nasal cavity violation, or neurovascular injury.
- **Prosthodontic Rigor and Passive Fit:** Rehabilitating highly divergent, obliquely angled fixtures requires extreme precision. Fabrication. inaccuracies or residual framework misfit can induce localized strain at the implant-bone interface, precipitating mechanical component fracture or biological failure.
- **Technological Overhead and Workflow Demands:** Achieving definitive passivity mandates strict clinical and laboratory protocols, including CBCT imaging, rigid open-tray impressions, verification jigs, and precision CAD/CAM milling, resulting in higher initial technological and capital expenditures.

## Case Reports

### Case 1

A 58-year-old female patient presented with a failed maxillary rehabilitation. She had previously received an implant-supported, full-arch fixed bridge following a delayed loading protocol; after six years of function, progressive mobility developed, culminating in the loss of all supporting implants (**Figure 1**).



**Figure 1:** The failed restoration following retrieval: full-arch bridge with four implants retained implants and two fixtures lost separately.

The preoperative panoramic radiograph (orthopantomogram) revealed an edentulous maxilla exhibiting severe vertical ridge resorption and pneumatised maxillary sinuses (**Figure 2**). Cone-beam computed tomography (CBCT) confirmed profound atrophy of the alveolar process, demonstrating minimal residual bone height subjacent to the nasal floor and maxillary sinus cavities (**Figure 3 and 4**). Three-dimensional volume rendering illustrated the comprehensive extent of crestal bone resorption (**Figure 5**).



**Figure 2:** Preoperative panoramic radiograph demonstrating a severely resorbed, edentulous maxilla with extensive sinus pneumatisation.


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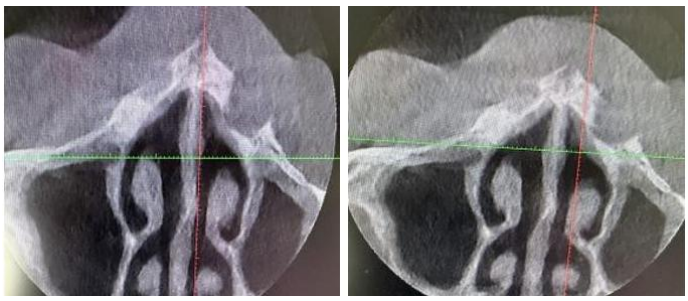


**Figure 3-4:** Coronal CBCT sections confirming profound atrophy of the alveolar process beneath the nasal floor and maxillary sinuses.

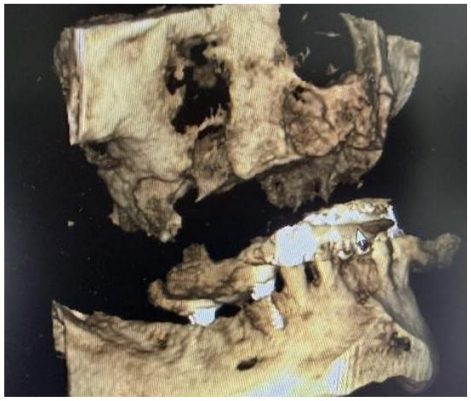


**Figure 5:** Three-dimensional CBCT reconstruction illustrating the extent of crestal bone loss.

Surgical intervention was performed under local anaesthesia. A crestal incision with vertical relieving incisions was initiated in the left quadrant and extended to the midline; a wide, full-thickness mucoperiosteal flap was subsequently elevated to expose the residual alveolar ridge (**Figure 6**).

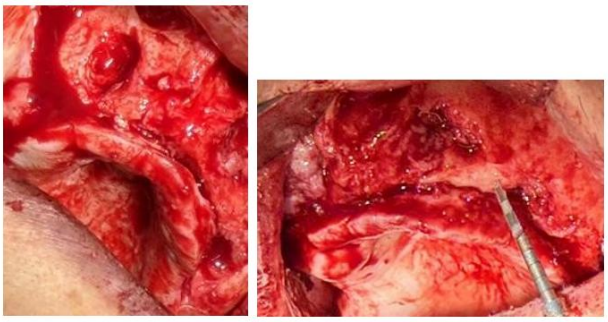


**Figure 6:** Elevation of a full-thickness mucoperiosteal flap exposing the residual ridge, followed by initial cortical entry using a manual driver.

One-piece (monobloc screw retained), tissue-level implants were selected (ROOTT P and ROOTT M Implants; ROOTT AG, Switzerland). These fixtures feature an aggressive, self-tapping thread geometry engineered to achieve bicortical engagement and high primary stability. Because the endosseous component and transmucosal abutment form a single solid unit, the design eliminates any implant–abutment microgap at the crestal bone level (**Figure 7**).


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**Figure 7:** ROOTT one-piece, tissue-level implant mounted on the insertion driver, showing the aggressive self-tapping thread profile.

The self-tapping implants were inserted directly into under-dimensioned osteotomy sites, condensing the peri-implant trabecular bone (**Figure 8**). High primary stability was achieved across all sites.

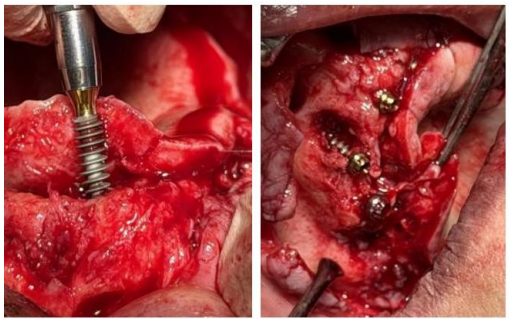


**Figure 8:** Direct insertion of self-tapping implants into under-prepared osteotomy sites, achieving local bone condensation.

The postoperative panoramic radiograph confirmed the placement of seven maxillary implants (**Figure 9**). Five implants in the anterior and premolar regions engaged the cortical bone of the nasal aperture and the basal cortex. In addition, bilateral, distally inclined pterygoid implants were placed to serve as rigid posterior anchors within a truss configuration.



**Figure 9:** Postoperative panoramic radiograph confirming the placement of seven maxillary implants, including bilateral pterygoid fixtures and anterior cortical engagement.

Postoperative panoramic radiograph confirming the placement of seven maxillary implants, including bilateral pterygoid fixtures and anterior cortical engagement.


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**Figure 10:** Definitive screw-retained metal–resin prosthesis, demonstrating the metal substructure and the screw access channels corresponding to the seven implants.

## Case 2

A 45-year-old female patient presented with severe, localised periodontitis in the posterior maxilla, accompanied by persistent pain, tooth mobility, chronic suppuration, and extensive alveolar bone resorption that significantly compromised conventional rehabilitation (**Figure 11**).



**Figure 11:** Preoperative OPG at initial presentation.

Following atraumatic dental extractions, the extensive osseous defect was meticulously debrided and augmented using particulate bone graft material (**Figure 12 & 13**).



**Figure 12:** Residual osseous defect following surgical debridement of the infected site.


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**Figure 13:** Particulate bone graft condensed into the defect site.

Monobloc tissue-level implants (ROOTT P and ROOTT M systems; ROOTT AG, Switzerland) were inserted immediately, successfully achieving primary stability by engaging the residual cortical bone (**Figure 14-15**).




**Figure 14:** ROOTT Tissue Level Implants.



**Figure 15:** Immediate implant placement engaging the residual cortical bone.

A definitive screw-retained, ceramic-bonded bridge was delivered three weeks postoperatively (**Figure 16**), fully restoring aesthetics and masticatory function. The postoperative orthopantomogram (OPG) confirmed fixture placement according to the Bone Truss Bridge (BTB) protocol, demonstrating trans-nasal and bilateral pterygoid cortical anchorage (**Figure 17**).



**Figure 16:** Definitive screw-retained, ceramic-bonded prosthesis.



**Figure 17:** Postoperative OPG illustrating the completed Bone Truss Bridge (BTB) configuration utilising trans-nasal and pterygoid cortical anchorage.

## Technical Details and Materials Implants Used

The clinical protocol relies on one-piece, tissue-level fixtures, specifically ROOTT Compressive (ROOTT M) and ROOTT Pterygoid (ROOTT P from ROOTT AG, Switzerland) (**Figure 12**), specifically engineered for narrow ridges and severe atrophy. These feature an integrated monobloc architecture, eliminating the crestal micro-gap, and deep, aggressive thread geometries for osseo compression. Fabricated in extended dimensions (16 mm to 26 mm) with narrow diameters, they facilitate deep anatomical engagement into distant cortical buttresses without requiring wide horizontal alveolar ridges.




**Figure 12:** Tissue Level Implants.

### Surgical procedure

The surgical phase prioritizes a tissue-sparing approach utilizing either a crestal linear incision or a full-thickness mucoperiosteal flap. Atraumatic exodontia is followed by immediate osteotomy preparation. Fixtures are inserted along predetermined straight or off-axis oblique trajectories to achieve bicortical stabilization (routinely achieving 50-70 Ncm insertion torque). Peri-implant voids are managed with particulate xenogeneic bone graft substitute to promote osteoconductive osseointegration.


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### Prosthetic phase

Directly following fixture placement, impressions are captured. A verification jig and interocclusal records confirm dimensional accuracy. A CAD/CAM milled metal framework with angulated screw channels (ASC) is evaluated and finalized as a definitive screw-retained metal-acrylic or metal-ceramic prosthesis, delivered within 2 to 3 weeks.

## Conclusion

The Bone Truss Bridge (BTB) protocol, implemented with narrow compressive and one-piece tissue-level implants, presents a minimally invasive alternative to traditional bone augmentation for the severely atrophic maxilla. By engaging remote, high-density cortical pillars via strategic oblique trajectories, this approach achieves bicortical anchorage with insertion torques frequently exceeding 50 to 70Ncm, providing the primary stability required for predictable immediate or early functional loading. The one-piece implant architecture preserves peri-implant bone levels, while CAD/CAM-milled frameworks with angulated screw channels ensure passive fit and complete prosthetic retrievability. Although advanced surgical expertise and meticulous CBCT planning are critical, the BTB method significantly shortens treatment timelines, reduces patient morbidity, and rapidly restores dentofacial function and aesthetics.

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