

# Trans-Sinus Dental Implants, Bone Morphogenetic Protein 2, and Immediate Function for All-on-4 Treatment of Severe Maxillary Atrophy

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**Purpose:** The aim of this study was to evaluate the clinical outcomes of trans-sinus dental implant placement by use of bone morphogenetic protein 2 (BMP-2) grafting and immediate functional loading by the all-on-4 scheme.

**Patients and Methods:** After bone reduction to create the all-on-4 shelf or because of severe maxillary atrophy and prominent sinus anatomy, 10 patients were selected to undergo trans-sinus implant placement and simultaneous BMP-2 sinus floor grafting for immediate provisional loading. Insertion torque was measured upon implant placement. Patients were followed up for at least 1 year after final restoration when either a computed tomography scan or panoramic radiograph was obtained and analyzed for the presence of trans-sinus peri-implant bone. Hounsfield units were recorded mid sinus graft.

**Results:** Of 19 trans-sinus implants, 18 remained integrated at the 1-year follow-up, for a 5.2% failure rate. All sinus grafts formed bone, with a mean of 460 Hounsfield units. Final fixed prostheses were completed for all 10 patients.

**Conclusion:** Trans-sinus dental implant placement with BMP-2 grafting to gain anterior-posterior spread for immediate function by use of all-on-4 treatment appears to be a viable alternative to the use of zygomatic implants in the presence of severe maxillary atrophy.

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Severe maxillary atrophy, in the presence of prominent sinus anatomy, is a significant surgical challenge for all-on-4 immediate function. We report a new technique in which posterior implants are angled forward, passing trans-sinus, to fixate into the lateral nasal wall. The trans-sinus implants are then grafted with bone morphogenetic protein 2 (BMP-2) and placed into immediate function.

Immediate function of trans-sinus dental implants is facilitated in part by the simultaneous BMP-2 grafting to the sinus floor.<sup>1,2</sup> When atrophy is severe, with less than 5 mm of vertical height, often in the presence of only 2 to 4 mm of alveolar width and prominent sinus cavities, zygomatic implants or combined alveolar/sinus floor grafting by use of a delayed loading protocol have been prescribed.<sup>3-8</sup> These patients are often elderly and may not have adequate bone volume available from maxillofacial sites for implant fixation except in the zygoma.<sup>9,10</sup> Common use of the zygomatic implant for immediate function, however, is still lacking, with relatively few surgeons experienced with the technique.<sup>11</sup>

Because of this, the question arises—could implants be placed trans-sinus, bone grafted at the same time, and then be functionally loaded? The development of BMP-2 as a grafting material known to form de novo bone in the sinus was tested in this setting over a 2-year period.

The use of BMP-2 for sinus bone grafting is well established for use in a delayed-implant placement protocol but has not been well studied for simultaneous implant placement.<sup>12-15</sup> If BMP-2 could be depended on

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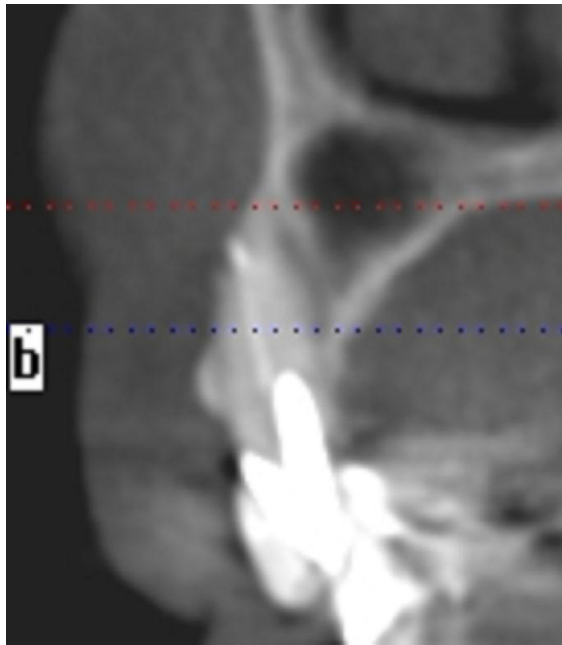
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**FIGURE 1.** An axial view taken in the premaxillary area can sometimes show anterior sinus deflections subnasally that present on the CT scan as round central alveolar defects. (The so-called bullet sign is well shown in this dentate patient not included in the study.)

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to form osseointegration, then implant placement with minimal osseous contact could be performed. However, the major problem with implant placement in the highly atrophic maxilla for immediate function is the difficulty

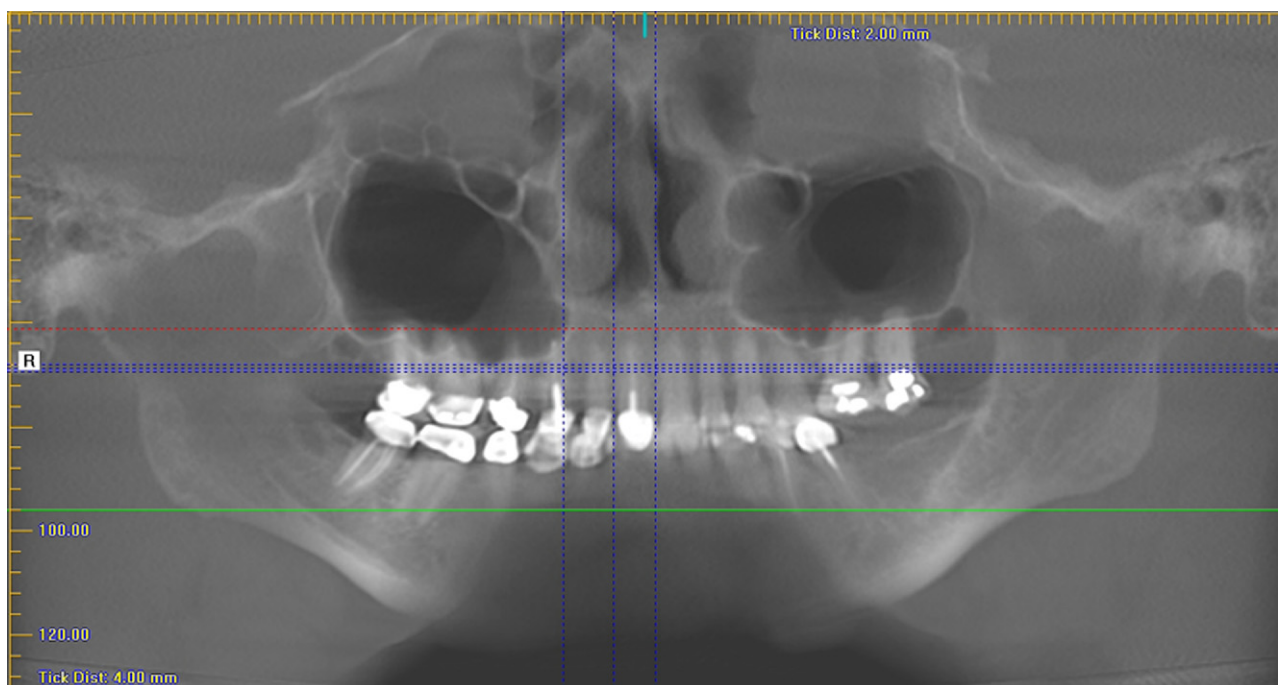
in gaining any primary stability even if BMP-2 grafting is done as an adjunct.<sup>16</sup>

The purpose of this article is to describe the use of trans-sinus application of posteriorly angled implants for maxillary all-on-4 immediate function by use of simultaneous BMP-2 grafting in the sinus floor and around exposed implants. The technique is an alternative to the placement of zygomatic implants.

## Patients and Methods

We identified 10 maxillary edentulous Cawood Class V patients who presented with maxillary sinus pneumatization subnasally.<sup>17</sup> Patients were sometimes classified as having extreme vertical atrophy after alveolar bone leveling from creation of the all-on-4 shelf.<sup>18</sup> Premaxillary pneumatization was observed on cross-sectional computed tomography (CT) scans as an often circular sinus defect, described as the “bullet sign” (Fig 1). (This occurs when the anterior sinus wall extends subnasally, sometimes even to the central incisor location. The bullet sign, when present on CT scan, usually extends just past the canine fossa into the lateral incisor position.) Of the 10 patients selected, 3 had extension to the lateral incisor, 2 had extension distal to the central incisor, and 5 had extension to the canines (Fig 2).

Other radiographic selection criteria included sufficient pyriform bone mass ( $\geq 3$  mm in thickness) in order for apical fixation to be obtained.



**FIGURE 2.** Panoramic radiograph of sinus extending forward below nasal fossa into canine lateral region. (This patient is not included in the study.)

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