

# THE COMPLETE MANDIBULAR SUBPERIOSTEAL IMPLANT: AN OVERVIEW OF ITS EVOLUTION

## Editor's Note

*This is an introductory and salient description of the subperiosteal implant that will give the reader interesting background relating to the article that follows.*

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Subperiosteal implants have been in use for over 45 years. They are used to help restore fully edentulous maxillary or mandibular arches as well as maxillary or mandibular posterior unilateral edentulous areas. This paper will review the evolution of the complete mandibular subperiosteal implant.

Full upper and lower dentures are retained in the mouth through the close adaptation of the denture base to the oral soft tissues and adaptation of the oral musculature to help stabilize the dentures. Occasionally, retention of a conventional denture is impossible no matter how precisely a denture is made, because there is a select group of people with inadequate ridge height. It was for this type of patient that the implant denture was conceived.

The first lower subperiosteal implant was inserted by the Swedish dentist Gustav Dahl in 1942. In the late 1940s, Drs Gershkoff and Goldberg visited Dahl and brought his idea back to the United States. Since then much has been learned, and the subperiosteal implant has evolved in many different aspects.<sup>1</sup>

## INDICATIONS

There are several reasons why one would elect to use a subperiosteal implant as opposed to endosteal implants to support a denture. One indication is the amount of available bone. The subperiosteal implant is indicated for patients with Type I, Division C; Type II, Divisions C and D; and Type III, Di-

visions C, D, C. Although these patients may be able to have endosteal implants in the anterior section, an RP-4 restoration may be compromised by: (1) an arch shape that provides a very small anterior-posterior distance between implants, thus resulting in inadequate cantilever support, and (2) a poor ratio of implant length to restoration height, caused by severe bone resorption. An RP-5 restoration would also be contraindicated in these patients due to poor posterior ridge anatomy.<sup>2</sup>

Other reasons for the use of subperiosteal implants include time and finances. A patient who elects to have a subperiosteal implant-supported denture could have a stable temporary prosthesis in as short a time as two months, as opposed to an endosteal-supported denture, which would take about seven months to prepare and place. When all things are considered, the fee for a subperiosteal supported-denture compared with that of an endosteal-supported denture in an atrophic mandible is usually smaller. This is based on an increase in the number of endosteal implants needed, in the number of bone grafting procedures, and possibly in the number of nerve repositioning procedures.

## DESIGN

The design of the subperiosteal implant has gone through many changes. The first designs consisted of a narrow strip of vitallium, which rested solely on the crest of the mandible and was held in place by screws.<sup>3</sup> Attached to this metal strip were posts that protruded through the mucosa and on which a denture would rest. These

posts are known as "abutments." The metal strip is termed the "substructure."

The infrastructure has gone through major changes. Initially, the amount of metal contacting the bone was increased to make the implant more stable to prevent dislodging. The infrastructure evolved, as seen in the work of Lew, who, while working in the late 1940s and early 1950s, refined his own basic implant designs by gradually reducing the bulk of his earlier lattice designs until he developed a simplified modern design in which fewer metal parts rested on bone.<sup>1</sup>

Today's design seeks to reduce the amount of metal under the gum while at the same time increasing the area of metal on stable dense cortical bone. Areas of importance are the external oblique ridge, the lateral surface of the ramus, the genial tubercle, the mylohyoid ridge, and the surface of the symphysis.<sup>4</sup>

While the amount of metal under the gum has decreased, there has been an increase in the amount of metal above the gum. These integral additions to the substructure casting, which connect the anterior and posterior abutments intraorally, are termed Brookdale or mesostructure bars. These rigid bars, located well above the oral mucosa, provide rigidity and strength to the infrastructure and more equally distribute mastication forces throughout the supporting bone.<sup>5</sup>

This mesostructure design has been modified to connect the anterior and posterior abutments, as well as to extend posteriorly to connect with the framework on the lateral ramus as a continuous U-shaped bar. The number

of abutments connected to the structure has also increased in certain cases.

Thus far, all these changes have been developed to stabilize the implant and to evenly distribute force as much as possible, a process which tends to decrease bone resorption beneath the infrastructure.

Advancements in biomaterials are now enabling doctors to rebuild deficient areas of the ridge under parts of the implant. Some of the biomaterials being used are composite grafts of particulate marrow cancellous bone (PMCB), hydroxyapatite (HA) particles, and HA-coated titanium.

According to Kay, Golec, and Riley, "A high quality coating of HA can be applied on a custom basis to (1) provide a more biologically suited substrate for soft tissue and bone adaptation; (2) accelerate the attachment of soft tissue and bone to the implant surface; (3) provide a surface for direct bone adaptation with no intervening fibrous tissue, and (4) create a stronger attachment to bone and inhibit the release of metallic ions from the implant surface."<sup>6</sup>

Boyne and James also found that when these new biomaterials are used, the HA tends to form lamellated compact bone in areas of the graft that are more resistant to resorption. The lamellated bone tends to replace the previous cancellous bone of the edentulous ridge, and it produces an alveolar ridge that is better designed to withstand occlusal prosthetic forces.<sup>7</sup> These advances in design and biomaterials have made the full subperiosteal implant one of the most successful, versatile, and predictable of all implant systems.<sup>8</sup>

#### IMPRESSIONS

Success of the subperiosteal implant is dependent on the close adaptation of the metal substructure to the underlying bone. In this respect, the duplication of the mandibular bony surface is of utmost importance. The first sub-

periosteal implants performed by Gershkoff and Goldberg were not produced from direct bone impressions. Instead, soft tissue impressions were taken on those early patients requiring subperiosteal implants. From these impressions, a master model was poured up in stone. This master model was then "scraped" to approximate what the clinician imagined the mandible would be like; the clinician was aided only by review of X rays and by digital palpation.<sup>1</sup> The patient required only one surgical procedure: insertion of the implant that was fabricated from this crude master cast. Screws were used to stabilize the implant, which merely rested on the crest of the ridge. Needless to say, many of these failed rapidly.<sup>9</sup>

A two-phase surgical procedure was introduced concomitantly by Dr. Isaiah Lew and Dr. Nicholas Berman. This technique was developed in 1951 and is still the norm today. Fabrication of a custom tray and a bite rim is made from a soft tissue impression. The first surgical procedure exposes the mandibular bone, allowing a direct impression using the custom tray. At the same time, a bite registration is taken that records the distance from the crest of the mandibular ridge to the occlusal plane of the maxillary arch. This allows the lab technician to: (1) make a more accurate fitting "substructure" and (2) make the "abutments" and "superstructure" with the correct occlusal clearance. At the second surgery the implant, which was constructed on an exact replica of the mandibular bone, is inserted and is found to be much more stable; rarely does it require screws for retention.<sup>10</sup>

With the increase in computer technology, specifically CAD-CAM multiplanar diagnostic imaging, it is possible to replicate the mandible without having to take a direct impression. Because this new technique eliminates one surgery, resulting in less patient anxiety and trauma, a subperiosteal

implant may become an even more viable treatment option.<sup>11</sup>

#### CONCLUSION

Mentioned above are some of the more significant areas in the evolution of the complete mandibular subperiosteal implant. These evolutionary changes have helped make this restoration the treatment of choice for the patient with an atrophic mandible who is unable to function with a conventional denture.

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