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Systematic Review
Dental Implants

Placement of dental implants in the maxillary tuberosity: a systematic review

L. F. dT. P. Lopes[1], V. F. da Silva[2], J. F. Santiago Jr.[1], S. R. Panzarini[2], E. P. Pellizzer[1]

[1]Department of Dental Materials and Prosthodontics, Araçatuba Dental School, UNESP – Universidade Estadual Paulista, Araçatuba, São Paulo, Brazil; [2]Department of Surgery and Integrated Clinics, Araçatuba Dental School, UNESP – Universidade Estadual Paulista, Araçatuba, São Paulo, Brazil

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Abstract. The aim of this systematic review was to identify clinical studies on implants placed in the tuberosity region to determine the survival rate of these implants when compared to implants placed in other regions of the maxilla. A search for data published up until March 2014 was undertaken using the PubMed, Cochrane Library, Embase, and ScienceDirect databases. Eligible studies were selected according to inclusion and exclusion criteria. The first database search revealed 310 titles. After inclusion and exclusion criteria were applied, five studies remained for the detailed analysis. A total of 113 patients were followed for a period of 6–144 months; 289 implants were placed in the patients evaluated. There were eight failures/losses of dental implants in the tuberosity region; the overall survival rate was 94.63% for these implants. In controlled studies, the cumulative survival rates for implants placed in the maxillary tuberosity and other maxillary regions were 96.1% and 95%, respectively. In conclusion, implants placed into the maxillary tuberosity are a predictable alternative for the treatment of patients with insufficient bone volume in the maxillary region. However, randomized trials are needed to assess the effectiveness of this treatment.

Key words: dental implants; maxilla; maxillary sinus; alveolar bone.

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Oral rehabilitation with osseointegrated implants is a viable option for the treatment of patients with partial or total loss of teeth,[1] since the use of implants is considered a predictable and reliable treatment.[2]

Implant survival is directly related to primary stability and osseointegration, which are dependent on mechanical aspects and the biological response of tissues,[3–5] such as bone quality and quantity,[6] anatomical conditions in the area where the implant is to be installed, the implant surface,[7] immediate or delayed loading, prosthesis design, and the occlusal pattern during the healing phase, all of which must be considered.[8]

However, failures in rehabilitation with dental implants should be considered when osseointegrated implants are installed in areas of poor bone quality, such as in the upper molar region, especially in cases of severe bone resorption.[7,9–12] According to Lekholm and Zarb,[13] bone quality in the posterior maxillary region is usually type III or IV, characterized by thin cortical bone and low density trabecular bone. Further, in many situations the bone height in this region is insufficient for proper implant placement because of the presence of the maxillary sinus. These factors are detrimental to the achievement of high primary stability.[2,14–16] This region tends to show low success rates,[2] not only due to inappropriate primary locking, but also because short implants may present unfavourable biomechanics. The rehabilitation of this

region is therefore a challenge to the dentist.[17]

Consequently, grafts utilizing the iliac crest have been the most commonly used to increase bone volume in this area. Grafts with Le Fort I osteotomy, bone grafts for sinus lifting, zygoma implants, and implants in the pterygoid region have also been suggested.[18–20] However, many of these techniques have long operative times, are surgically complex, and may be physically demanding for the patient, especially the elderly. Furthermore, from an economic standpoint, such procedures may be too expensive for the patient and a burden on health care resources.[21] They may also be impractical, such as for patients submitted to severe maxillary surgical resection due to a tumour or neoplasia.[22,23]

Implant placement in the maxillary tuberosity region, which is the most distal area in the maxillary alveolar process,[24] posterior to the maxillary sinus,[23] has been suggested as an alternative by many authors.[21–23,25–30] In fact, bone tissue in the tuberosity region should be less dense than in other areas of the maxilla[30]; it is unclear whether very spongy bone quality provides predictable osseointegration.[31] However, this alternative relies on the placement of these implants on an incline, without the use of bone grafts, with the implant placed posterior to the maxillary sinus and not invading it (as shown in Fig. 1).[1,21,22,26,28,29]

All procedures in the tuberosity region should be evaluated carefully, since the tuberosity region may not always be available or may have a low amount of bone available for implant placement. In this region, the bone is mainly types III and IV,[21,23,25] so firm primary stability should be obtained at the surgical stage.[26] In addition, appropriate reverse planning is very important.

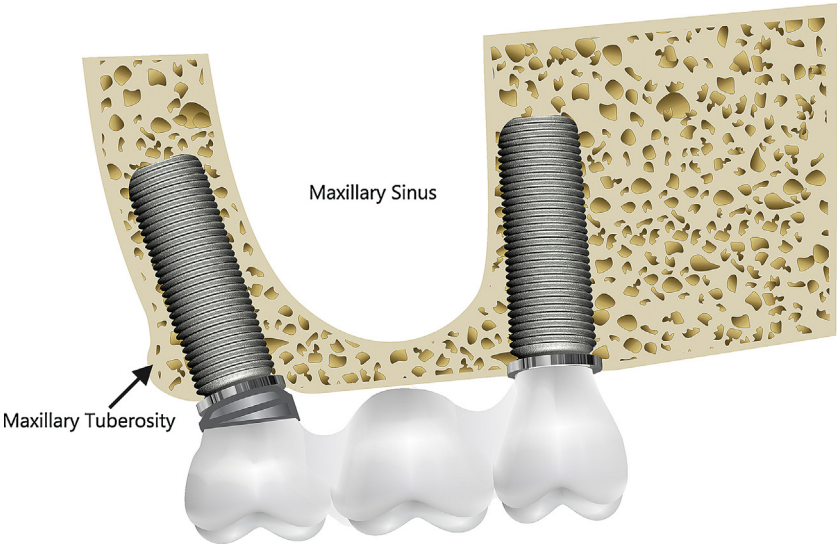

Fig. 1. Schematic diagram of a fixed partial denture supported by two dental implants, one installed prior to pneumatization of the maxillary sinus and the other in the region of the maxillary tuberosity (after pneumatization of the maxillary sinus).

Another recommended technique for implant placement in the posterior maxilla is related to the use of a pterygoid implant.[20,32] Pterygoid implant placement requires passing through the pillar of bone composed of the maxilla, pyramidal process of the palatine bone, and the pterygoid process of the sphenoid.[15,20,32,33] Bidra and Huynh-Ba[20] stated that implant placement in the pterygoid region involves the tuberosity region; however, implants placed in the tuberosity region are not necessarily fixed in the pterygoid plates.

These two techniques have important anatomical differences (Table 1).[20,21,23–26,32–35] A systematic review indicated a 92% survival rate (first year) for implants placed in the pterygoid region[20]; however, evidence-based reviews addressing implants placed in the tuberosity region are scarce.

Clinically, there is evidence that implants positioned in the tuberosity region show suitable outcomes in patients with atrophied jaws[21,26–28,36] and in patients with severe maxillary defects.[22] In addition, easy access and visibility of the site of the tuberosity[36] facilitate the surgical procedure. However, little is known about the long-term results.

Table 1. The concept of implants placed in the tuberosity and in the pterygoid region.[a]

Points addressed	Tuberosity implant	Pterygoid implant
Definition	Region most distal to the maxillary alveolar process.[20,24] Bahat[23] indicated that the real posterior structure of the maxillary tuberosity is the pyramidal process of the palatine bone.[26] Therefore, these implants may involve the pyramidal process of the palatine bone.[20] Finally, Venturelli[25] stated that the posterior border of the maxillary tuberosity is defined by the pyramidal process of the palatal bone and the anterior–inferior surface of the pterygoid laminae of the lamellae.	This implant passes through a pillar of bone composed of the maxilla, pyramidal process of the palatine bone, and the pterygoid process of the sphenoid.[32,33] Furthermore, it is conceived as implant insertion through the maxillary tuberosity and pterygoid Plate.[20,24] Vrielinck et al.[34] stated that ''The pterygoid implant enters in the region of the former second molar, follows an intrasinusal trajectory in a dorsal and mesio-cranial direction, where it subsequently perforates the posterior sinusal wall and the pterygoid plates''.
Bone type	Bahat[23] stated that the bone in this area is very cancellous. Different bone types have been reported: III and IV,[21,25,35] II, III, and IV.[23]	The pyramidal process of the palatine bone and the pterygoid process of the sphenoid are dense cortical bone.[20,32,35]
Vital structures	The posterior wall of the maxillary sinus.[20,21] Ridell et al.[21] stated that: ''Attention must be paid to the region posteriorly and medially to the tuberosity considering the maxillary artery and its branches specifically the greater palatine artery''.	Internal maxillary artery, posterior or superior alveolar nerve, pterygoid muscles,[32] infratemporal fossa, pterygopalatine fossa, nasopharynx, and sphenoid sinus.[20]
Angulation of implants	10–20°,[23] <30°,[25] and 15–35°[26]	45–50° angulations[32]

[a] Adapted from Bidra and Huynh-Ba.[20]