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Long-term survival rate of implants placed in conjunction with 246 sinus floor elevation procedures: Results of a 15-year retrospective study

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ABSTRACT

Objectives: The aim of the present long-term study was to retrospectively evaluate the survival rate of implants placed in regenerated maxillary sinuses and to assess the influence of hypothetical predictors of implant failure.

Methods: A database including 218 patients who received dental implants after sinus lift procedures was analyzed. The following variables were systematically included and evaluated: type of graft material used, number of surgeries performed, and use of membranes to cover the lateral antrostomy and/or to repair accidental Schneiderian membrane perforations. The Kaplan–Meier estimator was used for comparisons among the groups.

Results: A total of 589 dental implants were positioned in 246 grafted sinuses and were in function for 3–186 months. The Kaplan–Meier cumulative survival rate was 98.3% after 15.5 years of follow-up. All implant losses occurred within 52 months (4.3 years) after augmentation. According to the log-rank test, no statistically significant difference was shown between each patient/implant variable ($p > 0.05$).

Conclusions: Despite the limitations inherent in this type of study, no statistically significant differences between the groups could be found. Intraoperative Schneiderian membrane perforations did not affect the outcome of the implants positioned.

Clinical significance: The present long-term study is intended as a reference for clinicians approaching sinus floor elevation surgery in order to provide them with relevant operative findings. Since all the drawbacks occurred within the first 5 years, medium-term follow-up studies could be suitable for further retrospective evaluations.

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1. Introduction

Loss of teeth in the posterior maxillary area can lead to adverse consequences concerning masticatory functions and occlusal equilibrium, resulting in a negative psychophysical condition associated with muscular and temporomandibular joint diseases. A negative influence on the mental state and a reduction in the quality of life of the patient has also been reported.[1] In addition, in long-standing edentulous jaws, the regional anatomy is also influenced. It is not uncommon, indeed, to observe a severe pneumatization of the maxillary

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sinus that could be influenced by intrasinus positive pressure.[2,3] Furthermore, the resorption of the sinus floor may be aggravated by increased osteoclastic activity originating from the periosteum of the Schneiderian membrane after tooth loss, due to the absence of osteogenesis normally stimulated by the functional load upon the bone, hypothetically reducing implant prosthetic alternatives for the replacement of missing teeth.[4,5] Implant treatment can be an alternative to traditional restorations, such as dentures or bridges; however, an adequate bone volume is clinically needed in the case of a fixed implant-supported prosthesis, due to the osteointegration process firstly described by Brånemark.[6] Maxillary sinus grafting combined with the elevation of the Schneiderian membrane was proposed to re-establish an ideal quantity and quality of bone prior to implant placement, in clinical situations where interocclusal distance is not altered. Onlay bone grafts and guided bone regeneration (GBR) procedures are indicated in the case of increased interocclusal distance, caused by vertical bone loss in the alveolar ridge below the sinus. More frequently, apico-coronal resorption is combined with a centripetal horizontal bone loss, requiring appositional saddle-shaped bone grafts or GBR. If the horizontal and/or vertical subsinus bone loss is coupled with an intrasinus vertical resorption, sinus grafting is recommended.[7]

Two surgical techniques were proposed in order to perform the maxillary sinus floor elevation (the so-called ''sinus lift''): (a) the lateral approach and (b) the crestal approach. It was beyond the scope of the present article to investigate the latter. The elevation of the maxillary sinus floor by means of the lateral window approach has been described by Boyne and James,[8] and consists in the Caldwell-Luc technique, followed by the elevation of the Schneiderian membrane, grafting the resulting volume with particulate autogenous bone, according to Tatum.[9] Implants could be placed simultaneously or during second-stage surgery, depending on the residual bone height and width and the potential to achieve adequate primary stability, both of which are prognostic factors for the success of the treatment.[10]

Sinus grafting was considered a predictable and effective therapeutic procedure, as highlighted by the Sinus Consensus Conference, reporting long-term survival rates ranging from 90 to 97% after a retrospective analysis of 3354 dental implants placed on 1007 sinus grafts, in place for at least 3 years.[11] The surgical protocol has gone through several developments during the years, regarding variables that could influence the treatment outcome, including (a) grafting materials, (b) resorbable barrier membranes (c) dental implant surface topography and (d) implant placement timing. A wide range of results and conclusions have been reported in literature, as a consequence of the heterogeneity of clinical studies that have been published during the years about the factors influencing the survival rate of implants inserted in grafted maxillary sinus. Such variability has been investigated in subsequent reviews, with a survival rate using patient-based analysis estimated as ranging from 36 to 100%.[12,13]

The aim of the present study was to retrospectively evaluate the survival rate of dental implants placed in regenerated atrophic maxillary sinuses in relation to possible predictors of implant failure.

2. Materials and methods

2.1. Patient recruitment

Originally, 218 patients in good general health were recruited from 1998 to 2013 at the same clinical centre, namely the Department of Implantology, Maxillo-Facial and Odontostomatology Unit, Fondazione Ca' Granda IRCCS, University of Milan, Milan, Italy.

Inclusion criteria were both mono and bilateral partial edentulisms associated with different degrees of vertical and horizontal bone loss in the lateral-posterior maxilla (according to classes II–VI, Cawood & Howell atrophy classification[14]) with pneumatization of the maxillary sinus requiring sinus floor elevation procedures for implant placement purposes. In particular, only patients presenting a residual radiological bone height below the maxillary sinus included between 1 and 6 mm were treated with a lateral antrostomy approach and were than considered in the present study. Patients showing a native apico-coronal bone dimension >6 mm were augmented via osteotome techniques and were therefore not considered. All patients underwent pre- and post-operative radiological examinations, including panoramic radiograph and computed tomography.

Exclusion criteria were: signs and symptoms of maxillary sinus disease, poor oral hygiene, active periodontal infections, uncontrolled systemic pathologies and presence of smoking habit (>10 cigarettes/day).

2.2. Surgical procedures

Before surgery, patients received proper oral hygiene instructions and professional oral hygiene. At the end of the initial therapy, before starting the surgical procedures, the patients demonstrated proper plaque control. The same pre-surgical protocol was adopted in all cases: prophylactic antibiotics consisted of a preoperative oral amoxicillin-clavulanate (2 g given 1 h before the procedure) and continued for 7 days (1 g twice daily). Patients were also asked to rinse with chlorhexidine 0.2% three times a day, starting from one week before surgery and up to suture removal.

The surgical procedures were performed under local anaesthesia, including a pre-operative rinsing of the oral cavity with a 0.2% chlorhexidine antiseptic solution and perioral skin disinfection with benzalkonium chloride. Local infiltration anaesthesia was used with mepivacaine chlorhydrate; subsequently, 4 mg dexamethasone was injected into the submucosa around the surgical site to reduce post-operative swelling.

Basically, all surgical procedures consisted of a sinus floor elevation approached through a lateral-window antrostomy, following the Boyne and James procedure protocol.[8] A mid-crestal horizontal incision was made, with mesial and distal vertical releasing incisions, in order to mobilize a trapezoidal full-thickness flap. The flap was carefully elevated from the buccal and palatal aspect to expose the residual alveolar ridge and the lateral-posterior upper maxilla. The lateral wall of the maxillary sinus was approached with a small round diamond bur on a low-speed straight handpiece under sterile saline

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