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Clinical Paper
Dental Implants

Five-year outcome of bone remodelling around implants in the maxillary sinus: assessment of differences between implants placed in autogenous inlay bone blocks and in ungrafted maxilla

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Abstract. The placement of implants in the posterior maxillary area is considered a reliable procedure, offering recognized rehabilitative advantages. The aim of this study was to evaluate the performance of dental implants placed in the sinus floor augmented with a block autograft by comparing the outcomes over 5 years with those of dental implants positioned in non-augmented bone. This retrospective cohort study included 16 patients who had undergone prosthetic rehabilitation supported by dental implants between 2000 and 2006. One implant per patient was included and assigned to one of two predictor groups: grafted versus ungrafted maxillary sinus. Changes in marginal bone level (MBL) and apical bone level (ABL) over time, at 1, 3, and 5 years, were the primary outcome variables. Appropriate pair-wise comparison tests were performed. No significant differences were seen with regard to ABLs and among times between the grafted group (nine implants) and the ungrafted group (seven implants). Significant marginal bone resorption was found over time, primarily at the buccal aspect, in both study groups. The bone surrounding the apex of dental implants appeared stable after sinus augmentation in the grafted area. The behaviour of the two groups with regard to loss of MBLs over time was very similar.

Key words: sinus lift; autologous bone graft; dental implants.

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Patients who are affected by severe maxillary atrophy require reinforcement of the supporting bone if a fixed prosthetic rehabilitation through osseointegrated dental implantation is needed. When posterior maxillary areas are involved in the rehabilitation, and a modification of the crown/root ratio via augmentation of the alveolar crest is not helpful, dental implants can be successfully placed beneath the existing maxillary sinus if pneumatization has not occurred. However, if the vertical dimension of the residual bone is insufficient for implant placement, a maxillary sinus floor lifting procedure is unavoidable.

Different materials have been employed for this purpose, both non-autogenous, including synthetic bone graft, allograft,[1] and xenograft, and autogenous[2–4] (the material that still most satisfies the requirements of an ideal graft), with linear and volumetric analyses showing that all these materials are resorbed over time.[2,5,6]

Various authors have described peri-implant bone resorption, which has been the subject of several reviews, although it should be noted that data from studies that have not excluded advanced surgery[7–9] (for example a sinus lift operation), or which have been related to studies exclusively limited to maxillary implants, are limited in number.[8] With regard to studies describing the apical modification of materials used to increase the bone volume beneath the maxillary sinus floor, a pneumatization phenomenon has been reported, with particulate autogenous bone appearing to be more sensitive to this event.[10] Nevertheless, some authors have asserted that inorganic additives or xenogeneic materials used as bone substitutes have demonstrated no positive influence on the resorption rate, with an observed reduction in bone height during the observation period.[2,10–13] Only a few of them have reported a progressive bulging of the apex of dental implants into the sinus cavity.[2,6] Moreover, a recent review paper suggested that the risk of bone resorption and sinus pneumatization could be reduced with the use of a mixture of particulated autogenous bone and bovine bone materials or alloplastic materials, such as bovine bone mineral or hydroxyapatite.[14] The short-term resorption of the materials surrounding dental implants inserted into autogenous and allogeneic grafts appears to be restricted to a percentage of <25%, and this is attested to the maintenance of the apical cortical plate of the block and to the absence of 'bulging' of the implant apex in the sinus.[10,15]

The purpose of this study was to analyze the long-term changes in autogenous bone placed into the maxillary sinus in block form by comparing them to those of ungrafted areas. The investigators hypothesized that the compact, dense, and thick nature of the corticocancellous graft might guarantee bone preservation when the autogenous bone is inlay grafted into the maxillary sinus.[16]

The specific aims of the study were: (1) to compare apical and marginal bone resorption around dental implants placed in the sinus floor augmented with a block autograft with that of dental implants positioned in non-augmented bone beneath the maxillary sinus; (2) to compare bone resorption for each of the groups (grafted and ungrafted) at three follow-up times (1, 3, and 5 years); and (3) to investigate the survival of the dental implants placed.

Materials and methods

Study design/sample

In order to investigate the present assumption, the investigators designed and implemented a retrospective cohort study. The patient population comprised all subjects requiring fixed prosthesis rehabilitation who were treated with endosseous dental implants in the posterior maxilla between January 2000 and December 2006. All patients were treated at the study hospital.

Patients were included as study subjects if they met the following inclusion criteria: (1) at least one dental implant placed in the posterior maxilla either in ungrafted bone, beneath the sinus floor, or in bone augmented with an autologous bone block sinus grafting procedure; (2) presence of a complete set of computed tomography (CT) scans (acquired at 1 year (T_1), 3 years (T_2), and 5 years (T_3) after dental implant insertion).

Patients were excluded as study subjects if they had undergone adjunctive surgical procedures performed on the alveolar crest in the same posterior maxilla, or bone resection and irradiation as a result of oncologic treatment; they were also excluded if they had been subjected to a pharmacological treatment affecting bone turnover (such as bisphosphonate drugs).

Surviving dental implants placed in the posterior maxillary area were divided into two groups: (1) those in an ungrafted area, comprising dental implants placed in native bone beneath sinuses that had not undergone surgical augmentation, and (2) those inserted in augmented bone following a sinus lift and autogenous block graft procedure. One implant per patient was selected randomly using a computerized random allocation process. The present retrospective cohort study was approved by the ethics committee of the study institution.

Variables

Variables were divided into those for sample description and those that defined the sample composition, the latter being the primary predictor variables that were used to classify patients into a finite number of subgroups. The radiological measurements of bone level were the numerical input variables obtained directly by the clinicians and related to the outcome. The outcome variables (changes in bone levels) were obtained from the input variables.

Variables for sample description

Sample description variables were age, gender (male or female), smoking habit (smoker or non-smoker), location, length, and diameter of the dental implant placed, and the thickness of the residual sinus floor measured before surgery at the site planned for the dental implant placement. The number of adjunctive simultaneous bone augmentation procedures in areas other than the enrolled maxillary posterior area (contralateral or anterior site), if such procedures had been required, was also recorded.

Primary predictor variables

The primary predictor variable was the type of bone in which the implant was placed, i.e., an ungrafted area, or a grafted area.

Radiological measurements

The input variables obtained by the clinicians were the following: (1) the distances between the apex (the axis origin) and bone level of the sinus floor measured for all four aspects: buccal, palatal, mesial, and distal (apical bone levels (ABLs)). When the position of the new sinus floor was coronal to the implant apex, the ABL vector was negative, otherwise positive. ABL_1, ABL_2, and ABL_3 were the ABLs at 1, 3, and 5 years, respectively. (2) The marginal bone level (MBL) values were obtained from the arithmetical difference between the crestal bone height (measured with the apex of each dental implant as the axis origin) and the implant length for the same four aspects. MBL_1, MBL_2, and MBL_3 were the MBLs at 1, 3, and 5 years, respectively.