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Morbidity and complications of bone grafting of the floor of the maxillary sinus for the placement of endosseous implants

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Summary

Placement of endosseous implants in the atrophic maxilla is often limited because of a lack of supporting bone. A technique to augment the floor of the maxillary sinus with autogenous bone graft seems to be a new reliable treatment modality. The morbidity and complication rate of augmentation of the maxillary sinus floor was studied in 75 patients. The sinus floor was augmented with iliac crest (n = 65, 128 sinuses, 276 implants), mandibular symphysis (n = 8, ten sinuses, 21 implants), or maxillary tuberosity grafts (n = 2, two sinuses, two implants). The width of the alveolar crest had to be reconstructed in 52 patients, while in the other 23 patients augmentation and implantation were performed simultaneously. Perforation of the sinus membrane occurred in 45 patients, but this did not predispose them to the development of sinusitis. Loss of bone particles and sequesters were observed in one (diabetic) patient only, in whom a mucosal dehiscence occurred. A second augmentation procedure was successful. Symptoms of transient sinusitis were observed in two of the seven patients with a predisposition for sinusitis. These symptoms were successfully treated with decongestants and antibiotics. One patient developed a purulent sinusitis which resolved after a nasal antrostomy. The bone volume was sufficient for insertion implants in all patients. Twenty of 299 patients (6.7%) in whom Brånemark implants had been inserted were lost to follow-up (mean, 32 months); no sinus pathology was observed. The patients received implant-supported overdentures (58 patients) or fixed bridges (17 patients) and experienced no complaints with regard to the grafts or implants. We conclude that the morbidity and complication rate of bone grafting of the floor of the maxillary sinus floor with autogenous bone is low.

Keywords

Endosseous implant · Maxilla · Bone grafting · Sinus augmentation · Oral rehabilitation

Dental implantology is one of the most exciting and rapidly developing areas of dental practice, as it is now a proper treatment alternative to conservative prosthodontics. In the edentulous mandible, endosseous implants for the rehabilitation of patients have proven to be a treatment modality with predictable success. The insertion of two or four implants in the mandible has proven to be a reliable treatment with a success rate of at least 95% [1]. Rehabilitation of the extremely atrophic edentulous maxilla using endosseous implants is compromised, as the alveolar bone volume is often inadequate. The latter may be due to severe resorption and/or increased pneumatization of the maxillary sinuses. Without grafting techniques, primary stability of the implants often cannot be achieved, because the height and width of the alveolar crest is insufficient.

In the literature, several grafting procedures have been described to increase the bone volume in this region, including total or segmental bone onlays, Le Fort I osteotomy with interpositional bone grafts, and grafting of the maxillary sinus with autogenous bone and/or bone substitute [2–14]. A combination of these procedures is also possible. Bone onlay or Le Fort I osteotomy with interpositional grafts is the treatment of choice in patients with horizontal maxillary deficiency or a wide interarch distance. Neither procedure is applicable in patients with an inadequate interarch distance, which is the case in most partially or fully edentulous patients. In these patients, augmentation of the maxillary sinus floor may be able to create sufficient bone volume for the placement of implants without reducing the interarch distance. In this study, we evaluated the morbidity and complication rate of augmentation of the maxillary sinus floor with autogenous bone.

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Patients and methods

Autogeneous bone grafts were used to augment the floor of the maxillary sinus in 75 patients (36 men and 39 women) with a mean age of 42 ± 11 years (range, 17–68 years). The maxillary alveolar crest below the maxillary sinus was not high enough for reliable placement of endosseous implants in the posterior maxilla (mean height, 4.2 mm; range 1–8 mm). Sixty patients were edentulous in the maxilla, and 15 patients were partially dentate.

Treatment planning

After physical examination, appropriate orthopantomograms, lateral cephalograms, and posteroanterior oblique radiographs were made to determine the height of the maxillary alveolar bone, the dimensions of the maxillary sinus and nasal cavity, and the antero-posterior relationship between the maxilla and the mandible. Furthermore, diagnostic setups of the protheses were made in close cooperation with the

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Knochentransplantate im Oberkieferhöhlenboden als Grundlage für Implantate – Morbidität und Komplikationen

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Zusammenfassung

Die Verankerung enossaler Implantate in den atrophierten Oberkiefer ist oft durch das Fehlen von unterstützendem Knochen begrenzt. Eine neue zuverlässige Behandlungsmethode scheint die Augmentation des Kieferhöhlenbodens mit autologen Knochentransplantaten zu sein. An 75 Patienten wurden nach Augmentation des Oberkieferhöhlenbodens die Morbidität und die Komplikationsrate untersucht. Zur Augmentation wurden Transplantate aus Beckenkamm (n = 65, 128 Sinus, 276 Implantate), mandibularer Symphyse (n = 8, 10 Sinus, 21 Implantate) oder maxillarer Tuberositas (n = 2, 2 Sinus, 2 Implantate) verwendet. Die Breite des Alveolarkamms mußte bei 52 Patienten rekonstruiert werden, während bei den anderen 23 Patienten die Augmentation und die Implantation simultan durchgeführt wurden. Die Sinusmembran wurde in 45 Fällen perforiert, was aber nicht zu einer Prädisposition für die Entstehung einer Sinusitis führte. Der Verlust von Knochenpartikeln und -sequestern wurde bei 1 (diabetischen) Patienten beobachtet, bei dem auch eine mukosale Dehiszenz auftrat. Eine 2. Augmentation war erfolgreich. Symptome einer transienten Sinusitis wurden bei 2 von 7 Patienten mit einer Sinusitisprädisposition beobachtet. Diese Symptome wurden erfolgreich mit Dekongestionsmitteln und Antibiotika behandelt. 1 Patient entwickelte eine purulente Sinusitis, die nach nasaler Antrostomie verschwand. In allen Fällen war das Knochenvolumen für die zu inserierenden Implantate ausreichend. 20 von 299 inserierten Brånemark-Implantaten (6,7%) wurden während der Nachbeobachtungszeit (durchschnittlich 32 Monate) verloren, es wurde keine Sinuspathologie beobachtet. Die Patienten erhielten Implantat-gestützte Gebisse (58 Patienten) oder feste Brücken (17 Patienten) und zeigten hinsichtlich der Knochentransplantate und der Implantate keine Beschwerden. Wir schließen hieraus, daß die Morbidität und die Komplikationsrate von autologen Knochentransplantaten des Kieferhöhlenbodens niedrig sind.

Schlüsselwörter

Enossales Implantat · Oberkiefer · Knochentransplantat · Kieferhöhlenbodenaugmentation · Orale Rehabilitation

prosthodontists and were converted into surgical templates. Decisive factors include aesthetics (position of teeth and support for lips and cheek), estimated position of implants, oral hygiene, intermaxillary relationship, and expected type of superstructure and implant loading. The basic assumption for the edentulous maxilla using implants is different from that for the mandible. Such a concept guarantees optimal retention and support of the mesostructure and loading of the implants. A superstructure with a high degree of rigidity is needed for an optimal distribution of occlusal loading to ensure a good prognosis for implant survival. A minimum of six implants of at least 13–15 mm in length have to be inserted, equally distributed over the maxilla or positioned opposing teeth or implants in the implants in the mandible and connected with a mesostructure. Prosthodontic considerations for the insertion of additional implants in the anterior region are as follows: (a) the implants have to be positioned as near as possible to the planned maxillary dental arch, (b) sufficient intermaxillary space is required for the mesostructure and the overstructure construction, paying particular attention to the distance to the occlusal plane, and (c) the width of the prothesis in the anterior region is important. The interarch distance is often insufficient for a prosthetic construction with an optimal aesthetic and phonetic result. In such patients, two mesostructures are made supported by three implants, inserted in the region between the canine and first molar.

Surgical procedure

A palatal incision just below the top of the alveolar crest with vertical releasing incisions was made, and a mucoperiosteal flap was raised to expose the alveolar crest and the lateral aspect of the maxilla. The lateral wall of the maxillary sinus was subsequently fenestrated with a round diamond bur at high speed. Care was taken to avoid perforation of the sinus membrane. Together with the sinus membrane, a bony window was mobilized and rotated upward. Small perforations of the sinus membrane require no treatment, as these defects are sealed due to folding of the membrane. This procedure was followed by immediate insertion of the implants if both the maxillary bone height below the sinus floor and the width of the alveolar crest were both more than 5 mm (one-stage procedure). Sufficient primary stability of the implants can be expected in such patients. Otherwise, the implants were inserted after 3 months (two-stage procedure).

One-stage procedure

The holes for the implants were drilled at the required positions using the surgical template. Thereafter, a monocortical cancellous bone block was placed in the sinus with the cortical layer facing upward. The remaining space between the iliac bone block and the alveolar crest was filled with cancellous bone. To enable insertion of an implant, the graft was stabilized with a small clamp. Self-tapping Brånemark implants were inserted through the alveolar bone into the grafts. Up to three implants were placed in each bone graft.

Two-stage procedure

During the first stage, the width and height of the alveolar crest were reconstructed to enable implant placement with sufficient primary stability during the second stage (Fig. 1A). The sinus floor was grafted as described above, and the width of the alveolar process was reconstructed by placing corticocancellous bone blocks buccally on the cortex of the alveolar defect (Fig. 1B). These grafts were fixed with titanium screws to the alveolar bone, and cancellous bone particles were used to fill the small gaps between the bone graft and the alveolar crest. Three months after grafting, the implants were inserted using the surgical template (Fig. 1C).

Broad-spectrum antibiotics were administered immediately before the augmentation procedure, and continued for 48 h. A 0.2% chlorhexidine mouth rinse was prescribed for 2 weeks. One month postoperatively, the edentulous patients were allowed to wear dentures, which were carefully relieved and relined with a soft liner. Six months postoperatively, the im-

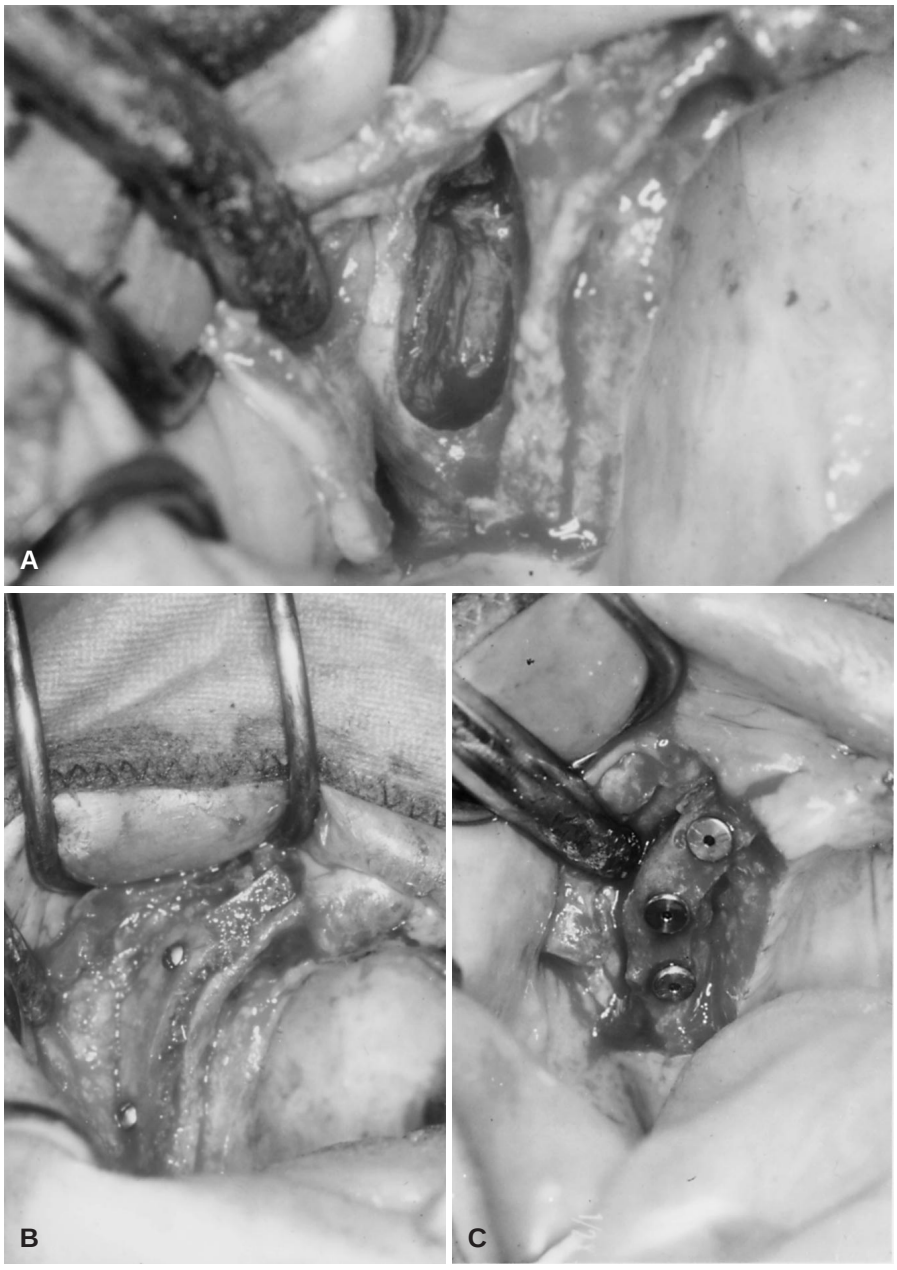

Fig. 1. **A** The height and the width of the alveolar process are too small for insertion of an implant with proper primary stability. Access to the sinus floor for augmentation is obtained by upward rotation of the lateral sinus wall. **B** The floor of the maxillary sinus and the width of the alveolar process is grafted with a monocortical iliac bone graft. Titanium screws are used to fix the iliac bone graft. Bone volume is sufficient in height and width for proper implant placement. **C** Three implants were inserted

plants were uncovered, the oral mucosa was thinned when applicable, and the abutments were connected.

Augmentation and implants

The sinus floor was augmented with bone grafts from the iliac crest (n = 65 patients, 128 sinuses, 276 implants), mandibular symphysis (n = 8, ten sinuses, 21 implants), or maxillary tuberosity (n = 2, two sinuses, two implants). The one-stage procedure was performed in 23 patients (42 sinuses, 95 implants) and the two-stage procedure in 52 patients (98 sinuses, 204 implants). A total of 299 Brånemark implants were placed; the length was 13 mm (42 implants), 15 mm (249 implants), or 18 mm (eight implants).

Prosthodontics

The patients were rehabilitated with implant-supported overdentures (n = 58, Fig. 2) or fixed bridges (n = 17). The prosthodontic concept in the edentulous maxilla consisted of a primary cast, rigid mesostructure, and a cast overstructure integrated in the overdenture (Fig. 2).

Evaluation and follow-up

The mean duration of follow-up after implantation was 32 ± 28 months (range, 12–84 months). All patients were seen at regular intervals. Complications during surgery, postoperative healing (inflammation, wound dehiscence, sequestration, and loss of bone particles), loss of implants, and sinus pathology were recorded. Sinusitis was suspected to be present if the patient complained about pain or tenderness in the region of the sinus in combination with mucopurulent rhinorrhea. It was diagnosed by nasendoscopic examination of the condition of the nasal mucosa and the area of the ostio-meatal complex. This examination provides an excellent view of the drainage of the maxillary sinus and ethmoids at the infundibular level [15]. In these patients, posteroanterior oblique radiographs were also taken and compared with presurgical X-rays to detect the presence of sinus pathology.

Results

Perforation of the sinus membrane, which occurred in 45 patients (32%), did not result in loss of bone particles or sequesters through the nose or predispose patients to development sinusitis. Symptoms of transient sinusitis were observed in two of the seven patients with a predisposition for sinusitis. In one of these patients, the sinus membrane had also been perforated accidentally during the surgical procedure. The sinus symptoms ceased after treatment with decongestants and antibiotics in both patients. One patient developed a purulent sinusitis which resolved after a nasal antrostomy and sinus irrigation. After 2 weeks, healing was uneventful. No signs of maxillary sinusitis or of other sinus pathology were observed after the implantation procedure.

Three patients developed a dehiscence near a titanium screw. Healing was uneventful after removal of the screw. In one diabetic patient, loss of bone particles and sequesters was observed. This patient had previously been treated in another clinic, undergoing vestibuloplasty with skin grafts and implants without success. One week after the augmentation procedure, a mucosal dehiscence occurred with loss of the bone grafts (Fig. 3).

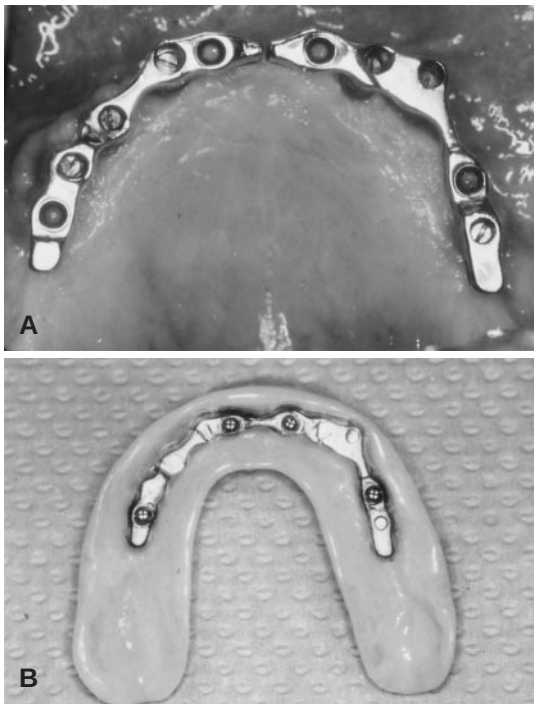

Fig. 2 A, B. A 43-year-old man in whom an implant-supported overdenture was fabricated 4 years previously. **A** Clinical appearance of the mesostructure to support the overdenture. **B** The horseshoe-shaped overdenture

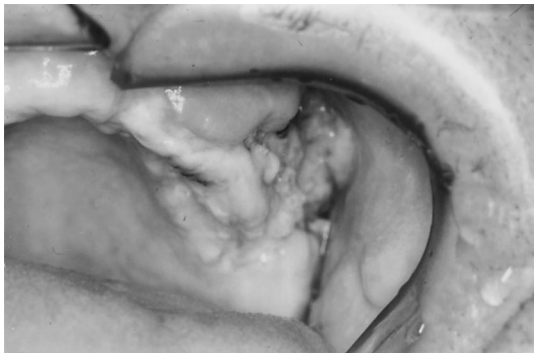

Fig. 3. Mucosal dehiscence in the maxilla with exposure of the bone grafts

The bone sequesters were removed, and the wound was closed with a buccal fat pad. The wound healing was subsequently uneventful, but there was not enough bone for insertion of implants. A second augmentation procedure with insertion of eight implants was successful.

No major complications were observed with regard to the donor sites. One patient developed a wound hematoma, and one patient developed a seroma, which had to be removed surgically. Transient hypoesthesia of the labial gingiva of the donor site (mandibular symphyseal bone graft) was observed in one patient.

In the patients with grafted sinuses, 20 with Brånemark implants (6.7%) were lost to follow-up. Twelve were lost before the prosthetic phase, and eight were lost 2–2.5 years after loading. In 18 of the patients lost to follow-up, implants were inserted in iliac crest bone grafts, and in two they were inserted in chin bone grafts.

Discussion

The surgical procedure for augmentation of the bone volume in the posterior maxillary region has potential clinical applicability because of its simplicity and the good treatment results achieved so far. Our results show 6.7% failures for implants in the posterior region. Perforation of the sinus membrane was the most common complication during the sinus lifting procedure, but they all healed uneventfully [10]. An advantage of the cortical bone plate on the top of the graft just below the sinus membrane is that this bone plate will prevent spread of bone fragments into the maxillary sinus if a perforation is not closed off by folding of the membrane [13, 14]. Shedding of bone might lead to local inflammation and subsequent severe resorption of the bone graft. In our study, two patients developed signs of sinusitis, while other authors have reported transient sinusitis in 10–20% of their patients [9, 16]. The sinus mucosa usually regenerates over the immobilized bone graft during normal healing. A second advantage of a bone graft with a cortical bone plate is that the bone graft can be fixed when the implants are inserted simultaneously, as is the case in the one-stage procedure, providing optimal stability for both the bone grafts and the implants [13, 14]. Finally the bone particles can be firmly packed into the created space.

It was reported that patients in whom postoperative chronic maxillary sinusitis occurred apparantly have a predisposition for this condition [15]. Patients without sinus problems and with no radiographic evidence of pathological diseases do not develop sinusitis attributable to reduced sinus drainage. Preoperative sinus disease has been positively correlated with the development of acute postoperative sinusitis after maxillary sinus grafting [9, 15]. Patients with a history of sinusitis should therefore be evaluated preoperatively to rule out factors related to sinus clearance which could be exacerbated by the normal inflammatory process produced by the sinus augmentation.

Various space maintainers have been proposed, but from both a clinical and biological point of view, filling of the bony defect with autogenous bone is preferred. There is still a lack of sound scientific data supporting the use of heterogeneous bone-filling materials or a combination. In addition, the high concentration of osteocompetent cells within autogenous grafts explains why autogenous bone grafts are preferred. Support for this view comes from a histomorphometric study on bone formation within grafted sites [17]. The yield of bone after grafting with cortical chin bone was 59.4%, while the yield after grafting with ei-

ther hydroxylapatite graft alone, hydroxylapatite mixed with cortical bone, or hydroxylapatite mixed with demineralized bone was 20.3%, 44.4%, and 4.6%, respectively. These results indicate that the use of autogenous bone increases the amount of bone formed within the sinus.

The use of mandibular bone grafts for the augmentation of the floor of the maxillary sinus is becoming more widespread [10, 11]. Less resorption of these bone grafts occurs after transplantation compared with iliac crest, tibial, or rib grafts. Slight resorption of the bone grafts was observed, comparable with the results of other studies [11, 18, 19]. Other advantages of intraorally harvested bone grafts are the use of local anesthesia instead of general anesthesia, a relatively short operating time, no need to stay in hospital preoperatively, less morbidity at the donor sites, and lower costs [10, 11, 18, 19]. A disadvantage is that the intraoral donor sites offer smaller volumes of bone than the iliac crest, and larger volumes are often needed in cases of bilateral sinus augmentation, as in our patients. Bone harvested from the inner table of the anterior iliac crest is therefore a good option for the reconstruction of bone defects; the morbidity is low [20].

Sufficient volume of healthy bone at the implantation site is the prerequisite for proper long-term prognosis of osseointegrated implants. For good stability of endosseous implants, particularly in the case of vertical defects of the alveolar ridge, local ridge augmentation is essential. Without augmentation, implant placement would result in gross malpositioning of the implants in relation to the natural or artificial dentition. The anatomically unfavorably positioned or angulated implants might result in aesthetic dissatisfaction, periodontal problems because of compromised oral hygiene, and even loss of implants. Augmentation of the maxillary sinus floor with autogenous bone has proven to be a reliable procedure to enable optimal placement of implants. The morbidity and complication rate is low, and this is therefore a reliable surgical procedure. Additional studies are needed to evaluate the long-term results of the described method with regard to implant stability and resorption of bone around the implants.

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