Maxillary sinus floor augmentation using bioactive glass granules and autogenous bone with simultaneous implant placement

Clinical and histological findings

Key words: sinus augmentation, titanium implants, bioactive glass, maxillary sinus, grafts/surgery

Abstract: This clinical study was undertaken to: 1) evaluate the use of bioactive glass Biogran™ combined with autogenous bone as grafting material for maxillary sinus augmentation with simultaneous implant placement using radiography and histology; and 2) document the short-term post-loading success of implants inserted in sinus cavities augmented with this material. Unilateral or bilateral sinus augmentation was performed in 12 patients with 3–5 mm of alveolar crestal bone height in the posterior maxilla prior to grafting. The sinuses were grafted with bioactive glass mixed in a 4:1 ratio with autogenous bone. Simultaneously, 2–3 threaded titanium implants were inserted into the augmented sinuses. Second stage surgery was carried out 9 to 12 months post implantation. At abutment connection, 10 core biopsy specimens were taken from different grafted sites and evaluated histologically. All 27 implants were clinically stable at second stage surgery. A mean increase in mineralized tissue height of 7.1 ± 1.6 mm was evident when comparing the pre-surgical CT scans with those performed 9–12 months following the sinus augmentation procedure. Evaluation of the cores yielded a mean of 30.6 ± 5.7% of bone tissue in the grafted sites. One implant failed during the prosthetic phase while the remaining 26 implants were stable 12 months post loading. This study suggests that Biogran™/autogenous bone graft combination used in one-stage sinus augmentation yields sufficient quality and volume of mineralized tissue for predictable simultaneous implant placement in patients with 3–5 mm of bone height prior to grafting.

Sinus grafting procedures using autogenous bone and other bone substitutes have been shown to be a safe technique with high predictability of success [Hirsch & Ericsson 1991; Misch et al. 1991; Smiler et al. 1992; Raghoobar et al. 1993; Betts & Miloro 1994; Hürzeler et al. 1996]. Various bone grafting materials have been used in sinus augmentation including autogenous grafts [Hirsch & Ericsson 1991; Raghoobar et al. 1993; Lundgren et al. 1996], freeze-dried bone allografts [Smiler et al. 1992; Nishibori et al. 1994], hydroxyapatite [Wagner 1991; Moy et al. 1993, Wheeler et al. 1996], and xenografts [Smiler et al. 1992; Valentini & Abensur 1997]. Although the results of these investigations indicate that sinus augmentation is clinically successful with various graft materials, it is not established which of these materials, except for autogenous bone, provide better osteogenic potential and biomechanical properties. Autogenous bone remains the material of choice currently available for bone reconstructive procedures [Wood & Moore 1988; Hirsch & Ericsson 1991; Moy et al.
The following patients were excluded preoperative radiographic examination. Sinus floor as evidenced at the baseline edentulous crest level to the maxillary posterior (unilateral or bilateral) edentulism involving the premolar/molar areas; and patients with ongoing pathology of the maxillary sinus.

At the initial visit, all patients received a radiographic (periapical and panoramic), clinical and occlusal examination. Computerized tomographic (CT) scans were carried out in all patients using surgical stents with radiopaque markers in the planned position of the fixtures. The radiographic criteria of thickness (≥2.4 mm) and height (3–5 mm) of the remaining alveolar bone below the sinus floor were re-assessed more accurately on the CT scans.

Surgical technique
Immediately prior to surgery, the patients were asked to rinse with a chlorhexidine digluconate solution 0.2% for 2 min. A horizontal antero-posterior incision was made slightly palatal to the alveolar crest and supplemented by buccal releasing incisions at the anterior and posterior ends of the horizontal incision. Full-thickness flaps were elevated to expose the alveolar crest and the lateral sinus wall. Soft tissue was carefully removed within the implant sites. An oval-shaped osteotomy, with the inferior border about 5 mm superior to the alveolar bone margin, was made on the lateral aspect of the sinus wall using a fissure bur with generous saline irrigation to ensure access to the sinus cavity (Fig. 1a). The bone in the center of the window was then gently infractured with its most superior part left intact creating a trapdoor effect. The sinus membrane was carefully elevated and the trapdoor including the elevated sinus membrane was rotated inward and upward. With curettes of different shapes, the sinus membrane was gradually detached along the inferior wall of the sinus and as far as the medial wall. The vertical height of the alveolar bone below the sinus floor was measured. Perforations in the anterior wall of the sinus were made when possible. Preparation of the threaded fixture sites (3i, Implant Innovations Inc., Palm Beach Gardens, FL, USA) was undertaken using surgical guides and according to the standard surgical procedures and implant therapy; patients with recent extractions (less than 1 year) in the involved area; patients with thin ridges which may not allow immediate primary stability; and patients with ongoing pathology of the maxillary sinus.

Recently, bioactive glass has been subjected to intensive experimental and clinical use as a bone substitute in peri-odontal and various osseous reconstructive applications (Schepers et al. 1991; Schepers et al. 1993, Wilson et al. 1993, Furusawa & Mizunuma 1997, Low et al. 1997, Schepers & Ducheyne 1997). Biogran™ is a resorbable amorphous bioactive glass of 300–355 μm particle size. It is composed of 45% silicon dioxide (SiO₂), 24.5% calcium oxide (CaO), 24.5% sodium oxide (Na₂O), and 6% phosphorous pentoxide (P₂O₅). It has been shown to enhance bone repair not only by the osteoconductive properties of the particles, but also by their osteostimulative potential defined as bone formation within internal pouches excavated within the bioglass particles away from the pre-existing bony defect walls (Schepers & Ducheyne 1997).

The aim of the present study was to clinically, radiographically and histologically evaluate the use of Biogran™ grafting material in maxillary sinus elevation procedures with simultaneous implant placement in humans. It was also the purpose of this report to document the short-term clinical success of fixtures inserted in the sinus cavities augmented with Biogran™.

Material and methods
Preoperative evaluation
Twelve patients were selected for the sinus elevation and implant placement procedure based on the following inclusion criteria: 1) maxillary total or partial [unilateral or bilateral] edentulism involving the premolar/molar areas; and 2) presence of 3–5 mm of bone from the edentulous crest level to the maxillary sinus floor as evidenced at the baseline preoperative radiographic examination. The following patients were excluded from the study: a) smokers; b) patients with systemic contraindications to oral clinical procedures for the implant system. The quality of bone present at the implant sites was specified according to Lekholm & Zarb [1985]. If perforation of the sinus membrane occurred during the procedure, a collagen membrane was used to seal it and ensure confinement of the graft material.

Two intraoral donor sites, the mandibular symphysis or the maxillary tuberosity, were used to harvest the autogenous bone grafts. For the mandibular grafts, the mandibular symphysis was exposed through a two-layer incision made between the deepest part of the vestibule and the lip. Multiple circular unicortical cuts were made through the buccal cortex using a 5 mm diameter trephine under abundant saline irrigation. The lingual cortical plate was left intact. The cuts were made at least 5 mm inferior to the root apices of the mandibular anterior teeth and 4 mm superior to the mandibular inferior border. The corticocancellous bone cores were stored in saline solution until particulated with a surgical bone mill (Biomix, Geistlich Söhne AG, Wolhusen, Switzerland). The residual symphysial cavity was packed with a hemostatic agent (Spongostan, Johnson & Johnson Medical, Skipton, UK). The periosteum and muscle attachments were carefully sutured in one layer, and the mucosa closed as a second layer using resorbable sutures. In cases where a smaller quantity of grafting material was needed, bone cores were harvested from the posterior tuberosity area using a 2 mm diameter trephine and particulated using a bone rongeur.

A composite graft of about 70–80% Biogran™ (Orthovita, Malvern, PA, USA) and approximately 20–30% of particulate autogenous bone mixed with blood coagulum was then introduced and carefully packed without excessive pressure into the posterior part of the sinus cavity and thereafter into the anterior part [Fig. 1b]. Following graft placement, implants were inserted and the remaining sinus space was completely packed with the Biogran™-bone mixture. Care was taken to pack the Biogran™-bone composite graft around the implant contours and 3 mm superiorly to the apices of the fixtures. In case adequate primary stability was not
Postoperative care
The patients were instructed not to wear their dentures for 2–3 weeks postoperatively until the prosthesis was relined with a soft liner (Sofreliner S, Tokuyama Corp., Tokyo, Japan). Antibiotics (Amoxicillin 500 mg 4 times per day) were prescribed for 10 days and analgesics as required. Sutures were removed 2 weeks following surgery. Patients with sinus membrane perforation evidenced during surgery were given decongestants for 1 week postoperatively. Patients who developed congestion and cold symptoms were advised against air travel until the symptoms had subsided. Post-surgical visits were scheduled at monthly intervals to check the course of healing.

Second stage surgery
After a healing period of 9–12 months, CT scans were repeated using the original surgical stents. Second stage surgery was carried out, stability of the fixtures verified, and healing abutments connected to the implants. When possible, horizontal bone cores were harvested from the lateral window area using a 2 mm diameter trephine under abundant saline irrigation. This was done only when the harvesting did not compromise the implants or the natural dentition. The biopsies were retrieved from coronal sites located between the fixtures about 7 mm from the margin of the alveolar ridge (n=7) and apical locations between the fixtures about 10 mm from the crestal bone (n=3). The cores were obtained to a mean depth of 8 mm.

Block specimens and histological processing
The bone cores were immediately fixed in a solution consisting of 1 part formaldehyde neutralized with CaCO3 (50 g/l) and 2 parts of ethanol 80%. The specimens were subsequently dehydrated in graded alcohol series and embedded in methylmethacrylate. Serial sections of 80–100 µm were obtained using a sawing microtome (Leitz, Wetzlar, Germany) and further ground to yield undecalcified sections of 20–40 µm in thickness (Mini-cut, Buehler Inc., Lake Bluff, IL, USA). The polished sections were stained using Giemsa, Paragon and a combination of Stevenel’s blue with Von Gieson picrofuchsin. With this method, the osteoid tissue stained green and the bone tissue red. Morphometric analysis of the sections was performed as a real measurement using a standard light microscope at ×40 magnification interfaced with a computerized morphometric system (Image-Pro Plus, Media Cybernetics, Silver Spring, MD, USA).

Prosthetic loading
All patients received provisional fixed implant-supported acrylic bridges 3 weeks following second stage procedure and over an initial phase of 4 months. Subsequently, the patients underwent definitive prosthetic rehabilitation by fixed bridges with gold occlusal surfaces.

Clinical and radiographical follow-up
The 1 year post-prosthetic loading success rate was evaluated using the success criteria of Albrektsson et al. [1986] for early assessment. Periapical radiographs were taken and evaluated for the presence of peri-implant radiolucency, and the radiographic distance from the implant shoulder to the alveolar bone crest was measured in mm at the mesial and distal aspects of the implants using the distance between the implant threads for reference. The changes in bone height were calculated and rounded to the nearest 0.5 mm. The fixed prosthetic reconstructions were removed to check individual implant mobility.

Comparison of the baseline CT scans and those obtained at 9–12 months postoperatively provided a quantitative assessment of the newly formed mineralized tissues in the sinus cavity. Comparison of the CT scan images was performed on the pre- and postoperative cuts located at the level of the same radiopaque markers of the surgical guides. The distance between a point located at the center of the implant shoulder (1 mm below the top of the cover screw) and the new sinus floor was measured along the central longitudinal axis of the implant on the postoperative CT scan cut. The corresponding preoperative cut was then superimposed upon the postoperative cut using the
outer outline of the crest and the radiopaque marker for references. The distance between the center of the crest to the original sinus floor was then measured along the line previously drawn on the postoperative cut (Fig. 2a, b).

Histological evaluation
The following qualitative assessments were carried out: 1) nature of the newly formed tissues in the sinus cavity; 2) resorption pattern of the Biogran™ particles; and 3) bone relationship to the residual grafting material. The central section in each specimen was selected for quantitative assessment of different tissue components: mineralized bone, glass particles, osteoid, and fibrous tissue. These measurements were expressed as a percentage of the total surface area of the bone core section.

Results
Clinical observations
The 12 patients in this study included 8 women and 4 men ranging in age between 35 and 63 years with a mean of 48 ± 10 years. A total of 27 implants were inserted simultaneously with sinus augmentation with a subsinus bone height ≤5 mm and a bone quality of mainly Type 2 and Type 3. None of the patients had postoperative complications besides normal swelling and inflammation at the surgical sites. Perforation of the sinus mucosa was recorded in 2 procedures and resulted only in minor postoperative nasal bleeding. All implants were stable at the time of abutment connection which was performed after a mean healing period of 10.8 ± 1.1 months. One implant was lost during the prosthetic phase. All implants maintained stability at 12 months after loading, as tested after removal of the prosthetic reconstruction and on periapical radiographs.

Table 1. Data on the patient population, length of the healing period, changes of bone height in the augmented sinuses observed on CT scans, and radiographic peri-implant marginal bone levels at 1 year post-loading

<table>
<thead>
<tr>
<th></th>
<th>Age (years)</th>
<th>Healing period (months)</th>
<th>Bone height pre-operatively on CT scan (mm)</th>
<th>Bone height postoperatively on CT scan (mm)</th>
<th>Mineralized tissue height postoperatively on CT scan (mm)</th>
<th>Increase in mineralized tissue height on CT scan (mm)</th>
<th>Marginal bone level at 12 months (mm)</th>
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<tbody>
<tr>
<td>Mean</td>
<td>48.08</td>
<td>10.83</td>
<td>4.40</td>
<td>11.51</td>
<td>7.11</td>
<td>0.85</td>
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<tr>
<td>SD</td>
<td>9.94</td>
<td>1.11</td>
<td>0.63</td>
<td>1.62</td>
<td>1.57</td>
<td>0.33</td>
<td></td>
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<tr>
<td>Max</td>
<td>63</td>
<td>12</td>
<td>5</td>
<td>15</td>
<td>11</td>
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<td>Min</td>
<td>35</td>
<td>9</td>
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radiographs. Marginal bone resorption at 12 months after loading did not exceed 1.5 mm from the level measured at abutment connection (Table 1).

**CT scan results (Table 1)**

The CT scans carried out 9–12 months post-insertion showed a dense mineralized material in the sinus cavities surrounding the implants. In many cases it was difficult to delineate the border line between the original sinus floor and the newly formed tissues. The original bone height below the sinus floor as measured on the original CT scans ranged between 3 and 5 mm with a mean of $4.40 \pm 0.63$ mm. At the second CT scan evaluation 9–12 months post-surgery, the height of radiopaque tissues increased to 10–15 mm with a mean increase of $7.1 \pm 1.6$ mm (Fig. 2a, b).

**Histological and histomorphometrical results (Table 2)**

Ten bone biopsies were procured from 7 grafted sites in 6 patients. The biopsy cores contained a mean of 30.6% of bone, 11% of osteoid, 58.9% of fibrous tissue, and 9.4% of transformed bioglass particles in the coronal locations ($n=7$). The corresponding figures in the apical locations ($n=3$) were 14.2% of bone, 13% of osteoid, 69.8% of fibrous tissue, and 15% of transformed glass. The newly formed bone was predominantly of the woven type. In the vicinity of the pre-existing osseous wall, dense trabecular bone was evidenced with lacunae containing cells indicating viable bone. Marrow spaces were predominantly filled with a well-vascularized connective tissue with no signs of inflammation or foreign body reaction. In some specimens, layers of osteoid tissue covered with active osteoblasts were observed at the outer surface of the bone trabeculae.

Less mineralized tissue was evidenced in the biopsy cores retrieved from the deeper portions of the sinus (apical locations). Remnants of the glass particles were well integrated within the bone tissue in most specimens, although some of them appeared to be surrounded by fibrous tissue in the deeper locations [Fig. 3]. Many transformed glass particles showed bone and/or osteoid tissue in their excavated center and on their outer surface (Figs 3, 4). Only scarce remnants of the autogenous graft particles were visible in the grafted areas.

### Table 2. Means and standard deviations (SD) of bone, osteoid, fibrous tissue, and transformed glass particles in percentages found in the bone cores retrieved from the augmented sinus cavities in coronal and apical locations. Fibrous tissue refers to bone marrow, vascular elements, and fibrous tissue per se.

<table>
<thead>
<tr>
<th></th>
<th>Bone (%)</th>
<th>Osteoid (%)</th>
<th>Fibrous tissue (%)</th>
<th>Transformed glass (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Apical location</strong> ($n=3$) (mean±SD)</td>
<td>14.2±9.2%</td>
<td>1.3±0.1%</td>
<td>69.8±12.9%</td>
<td>15±13.6%</td>
</tr>
<tr>
<td><strong>Coronal location</strong> ($n=7$) (mean±SD)</td>
<td>30.6±5.7%</td>
<td>1.1±0.8%</td>
<td>58.9±10.4%</td>
<td>9.4±10.3%</td>
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**Discussion**

This study evaluated the performance of Biogran™-autogenous bone graft combination in one-stage sinus augmentation with simultaneous implant placement in patients with 3–5 mm of bone height prior to grafting. While numerous studies have recommended the 2-step procedure in patients with less than 5 mm of alveolar bone height in the posterior maxilla [Jensen et al. 1990; Smiler et al. 1992; Raghoebar et al. 1993; Marx 1994], the results of this investigation suggest that Biogran™-autogenous bone graft yields adequate bone quality and volume for predictable simultaneous implant placement in such patients. Similarly, Peleg et al. (1999) reported that the single-step procedure is feasible for patients with as little as 3 mm of alveolar bone height prior to augmentation grafting, using hydroxyapatite-coated implants and autogenous bone. The 1-step procedure offers the advantages of reducing the number of surgical procedures.
and the time needed to complete implant-supported prosthesis.

The need to perform sinus augmentation procedures was questioned by Ellegaard et al. (1997). The authors reported a good success rate with 38 implants inserted in premolar/molar areas with vertical bone height as low as 3 mm using a sinus lift procedure without grafting material. However, the low number of implants in this study along with the relatively short follow-up period (3–4 years) do not provide strong evidence of the superiority of this technique. The authors themselves in their conclusions pointed out that this technique should only be performed in patients with high standards of oral hygiene since “the relatively short implants increase the risk of early implant failure due to inflammation and loss of marginal bone”. Furthermore, animal studies (Wetzel et al. 1995; Haas et al. 1998) demonstrated a minor bone apposition along the base of the implant surface projecting into non-augmented sinus cavities. The relatively high bone-to-implant contact demonstrated in animal sinus grafting reports (Wetzel et al. 1995; Quinones et al. 1997; Hürzeler et al. 1997; Haas et al. 1998; Terheyden et al. 1999) justifies the use of sinus augmentation procedures in humans and the lack of a control group in the present study.

Various clinical investigations and case reports (Moy et al. 1993; Lundgren et al. 1996; Hürzeler et al. 1997; Lorenzetti et al. 1998; Valentini et al. 1998) have indicated that, although sinus augmentation can be clinically successful with various grafting materials, autogenous bone still provides the best osteogenic potential and biomechanical properties of the regenerated bone. However, the quantitative limitations of autogenous bone harvested from intraoral sites often constrain the clinician to combine the autograft with other types of grafts in order to obtain adequate amount of grafting material. Allografts used as an alternative to autografts have several problems mainly related to delayed resorption of demineralized freeze-dried bone particles, variable inductive properties, and the potential for disease transmission. Alternatives to autogenous and allogeneic bone grafts are anorganic bone mineral and biologically active glass. The osteoconductive properties of Biogran™, a bioactive glass with a narrow size range of particles, have been documented in a series of animal (Schepers et al. 1991; Schepers & Ducheyne 1993; Schepers & Ducheyne 1997) and clinical studies (Schepers et al. 1993; Furusawa & Mizunuma 1997). Schepers & Ducheyne (1997) demonstrated bone formation within protectively induced pouches created within the glass particles through gelation and corrosion phenomena arising from the interfacial ion exchange between the glass particles and the surrounding tissue fluids. This ion exchange reaction would lead, with time, to a partial resorption of the bioactive glass particles resulting in smaller transformed particles and a higher proportion of living tissues in the repaired area. New bone formation in the central excavations of the particles was often seen without a connection with the externally located bone tissue. The authors reported that these islands of newly formed bone function as nuclei for further bone repair. The histological examination of the biopsy specimens in the present study confirmed the osteoinductive properties of Biogran™, as documented by the close contact between this material and the newly formed bone and bone growth along the scaffold of the particles.

The use of autogenous bone in combination with Biogran™ is dictated by the fact that this material is designed to replace the inorganic components required for bone formation. The organic components must be procured from the host vascular elements, from the added autogenous bone, or from added growth factors (Froum et al. 1998). Autogenous bone when used as a graft has an osteogenic potential related to the number of surviving osteoblasts and a potential osteoinductive effect brought about by the release of bone morphogenic proteins and other growth factors. Several authors have reported that addition of autogenous bone to porous hydroxyapatite allografts or xenografts significantly increases the amount of vital bone in biopsy cores retrieved from augmented sinus cavities (Quintones et al. 1997; Hürzeler et al. 1997; Froum et al. 1998).

When comparing percentage bone volume within biopsies retrieved from sinus cavities augmented with different particulated grafting materials, the results reported by various authors have shown large variations (Moy et al. 1993; Lundgren et al. 1996; Hürzeler et al. 1997; Lorenzetti et al. 1998; Valentini et al. 1998). The differences in percentage bone volume among the various aforementioned reports can be attributed to the bone healing pattern in different animal species and in humans, length of the postoperative healing period, sites of
bone biopsies, architecture, conformation and composition of the grafting material, ratio of autogenous bone in composite grafts, and potentially implant loading. Wheeler et al. [1996] found an increase in bone volume from 16.38% after 4–10 months of healing to 45.30% after 36 months in sinus augmented with porous hydroxyapatite alone. In a clinical case report, Wallace et al. [1996] documented the sequential healing process of a sinus graft in the same patient at 4, 8, 12, and 20 months. The authors observed slow bone formation in the sinus cavity augmented with a composite 80% anorganic bovine matrix (OsteoGraf) and 20% autogenous bone harvested from the tuberosities. A 12- to 20-month period was required to convert this composite graft into vital bone. Similar conclusions were reported by Lundgren et al. [1996] with sinus grafting with particulated mandible and by Froum et al. [1998] with anorganic bovine bone matrix. In the present investigation, the presence of bands of osteoid tissue in the biopsy cores indicated that bone formation was still taking place after a healing period of 9–12 months. The transformed bioactive glass particles present at this stage are smaller than those present originally at the implantation procedure because of their partial dissolution resulting from the ion exchange reaction [Scheipers & Ducheyne 1997]. As reported with other composite grafts [Wheeler et al. 1996; Waller et al. 1996; Lorenzetti et al. 1998], prolonged healing periods may be required to allow bone maturation and complete resorption and substitution by bone of all Biogran™ particles.

In the present study, less new bone formation was evident in the apical areas (mean of 14.2%) while a greater percentage of new bone was found in the coronal locations (mean of 30.6%) of the augmented sinus cavities. Although the number of biopsies is far too small to make a statistically significant comparison between bone biopsy sites, it appears from this histological trend and the findings of previous reports [Boyné & James 1980; Hürzeler et al. 1997] that the osteoprogenitor cells repopulating grafts are mainly derived from cells residing in the residual maxillary alveolar ridge and lateral bony walls of the maxilla and not from the sinus membrane which does not possess an osteogenic potential.

In conclusion, the results of the present investigation indicate that Biogran™/autogenous bone graft combination used for maxillary sinus augmentation with simultaneous implant placement in patients with less than 5 mm of crestal bone height in the posterior maxilla provided stable and predictable results in terms of implant success.

Résumé

Cette étude a été entreprise pour 1) évaluer l’utilisation du Biogran™ de verre bioactif combiné avec de l’os autogène comme matériel de greffe pour l’épaississement du plancher sinusial avec le placement simultané d’implants en utilisant la radiologie et l’histologie, 2) de documenter le succès à court terme après la charge des implants insérés dans des cavités sinusal-les épaissies avec ce matériel. Une augmentation tant unilatérale que bilatérale a été effectuée chez douze patients avec une hauteur osseuse alvéolaire de 3 à 5 mm dans la région maxillaire postérieure avant la greffe. Les sinus ont été greffés avec du verre bioactif mélangé avec une portion 41 avec de l’os autogène. Simultanément deux à trois implants en titane fileté ont été insérés dans ces sinus épaissis. Une seconde chirurgie a été effectuée neuf à douze mois après la mise en place des implants. Lors de la connexion des piliers, dix biopsies complètes ont été préllevées de différentes sites greffés et évaluées histologiquement. Les 27 implants étaient cliniquement stables lors de la seconde étape. Une augmentation moyenne de la hauteur tissulaire minéralisée de 7,2 ± 1,6 mm était mise en évidence en comparant les images de scanner CT préchirurgicaux avec ceux pris 9 à 12 mois après l’épaississement du plancher sinusial. L’évaluation histologique a mis en évidence une moyenne de 30,6 ± 5,7% de tissu osseux dans les sites greffés. Un implant a échoué durant la phase protéosique tandis que les 26 autres sont restés stables pendant douze mois après la mise en charge. Cette étude suggère que la combinaison de la greffe osseuse autogène avec le Biogran™ utilisée dans un processus d’épaississement du plancher sinusial en une étape apporte un tissu minéralisé de qualité et une quantité suffisante pour le placement simultané d’implants chez des patients qui n’avaient au départ qu’une hauteur osseuse de 3 à 5 mm au niveau du plancher sinusial.

Zusammenfassung

Diese klinische Studie wurde unternommen um: 1) mit Hilfe von Röntgenaufnahmen und Histologie den Einsatz von bioaktiven Glas (Biogran™) in Kombinati- on mit autologen Knochen als Transplantatmaterial bei der Sinusbodenelevation und gleichzeitiger Im- plantation zu untersuchen, und 2) um Angaben über die Kurzzeitprognose von Implantaten, die in mit die- sem Material aufgefüllte Kieferhöhlen eingesetzt wer-


Resumen

Este estudio clínico se llevó a cabo para: 1) evaluar el uso cristal bioactivo Biogran™ combinado con hueso autógeno como material de injerto para elevación del seno maxilar con colocación simultánea del implante usando radiografías e histología, y 2) documentar el éxito a corto plazo tras la carga de implantes inserta- dos en las cavidades de los senos elevados con este material. Se llevó a cabo la elevación del seno unilate- ral o bilateral en doce pacientes con una altura de la cresta alveolar de 3 a 5 mm en el maxilar posterior antes de injertarse. Los senos se injertaron con cristal bioactivo mezclado en una relación 4:1 con hueso au- tógeno. Simultáneamente, se insertaron de 2 a 3 im- plantes roscados de titanio en los senos elevados. Se llevó a cabo la cirugía de segunda fase a 9 a 12 meses tras la implantación. En el momento de la conexión del pilar se tomaron diez biopsias de diferentes lugares del injerto y se evaluaron histológicamente. Todos los 37 implantes estaban estables en el momento de la segunda cirugía. Se evidenció un incremento medio de la altura del tejido de 7,2 ± 1,6 mm cuando se com- paró con los escáneres CT prequirúrgicos con aquellos realizados 9 a 12 meses tras el procedimiento de eleva- ción del seno. La evaluación de las biopsias tuvo un rendimiento medio de 30,6 ± 5,7% de tejido óseo en los lugares injertados. Un implante fracasó durante la fase protésica mientras que los 26 implantes restantes es- taban estables doce meses tras la carga. Este estudio sugiere que la combinación de injerto de Biogran™/ hueso autógeno usado en elevaciones de seno produce suficiente calidad y volumen de tejido mineralizado para una colocación simultánea predecible de implan- tes en pacientes con una altura ósea de 3 a 4,5 mm antes del injerto.
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