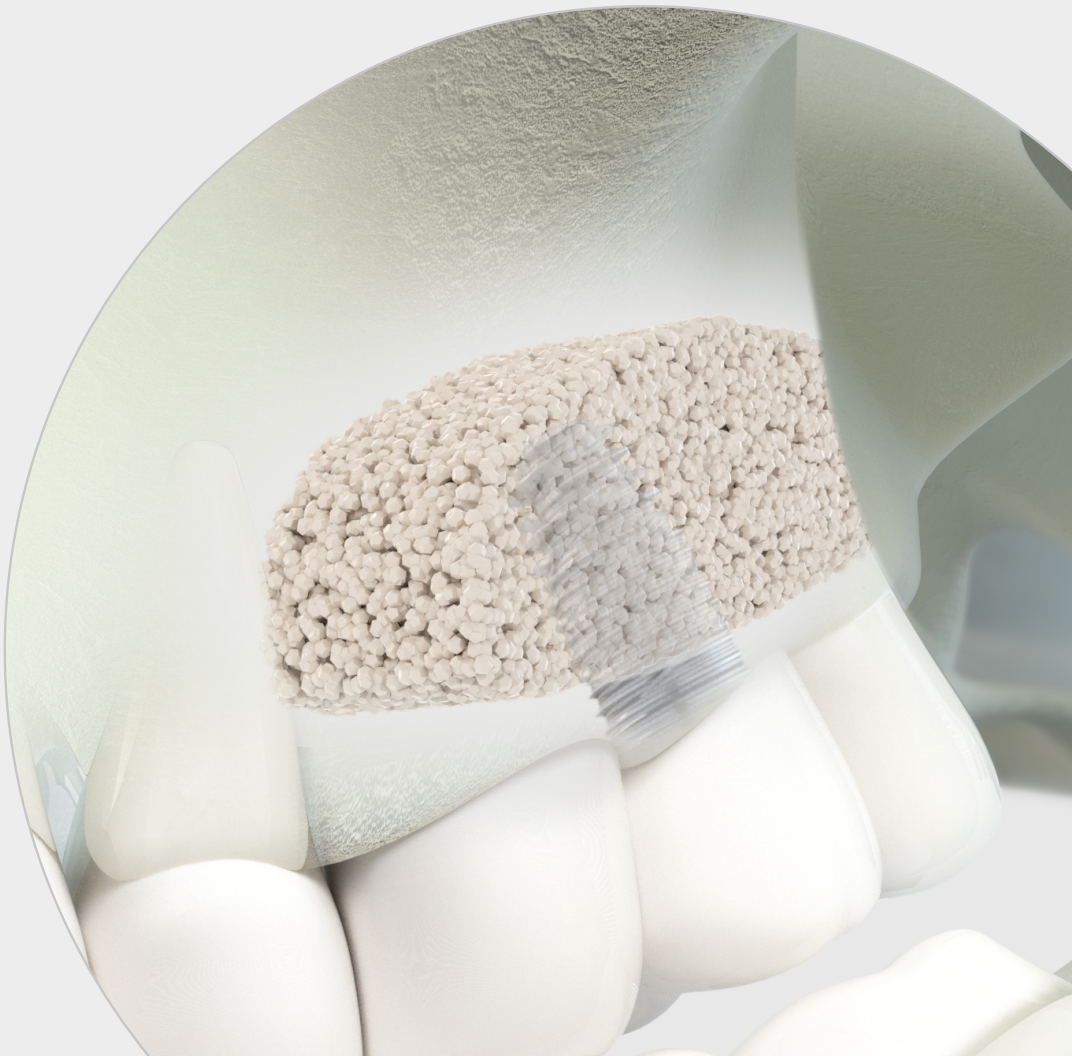
GlassBONE™

Bioactive bone substitute

CMF & ENT

SPECIALITIES

CLINICAL GUIDELINES FOR GLASSBONE™ INDICATIONS



State of the art

Cranio Maxillo Facial, including ENT surgery, specializes in treating many diseases, injuries and defects in the head, neck, face, jaw, mouth and skull. It is an internationally recognized surgical specialty. In some countries including the United States, Canada and Australia, it is a recognized specialty of dentistry; in others, such as the UK and most of Europe, it is recognized as both a specialty of medicine and dentistry and a dual degree in medicine and dentistry is compulsory.

Bony lesions in the oral and cranio-maxillo-facial region may be congenital or due to benign tumors, odontogenic or nonodontogenic cyst, trauma, or infections related to impacted teeth and periapical periodontitis.

EXAMPLES OF INDICATIONS :

- Dentoalveolar surgery: surgery to remove impacted teeth, difficult tooth extractions, extractions on medically compromised patients, bone grafting or preprosthetic surgery to provide better anatomy for the placement of implants, dentures, or other dental prostheses

- Surgery to insert osseo-integrated (bone fused) dental implants and maxillofacial implants for attaching craniofacial prostheses and bone anchored hearing aids.

- Cosmetic surgery of the head and neck: rhinoplasty, septoplasty, cheek augmentation, chin augmentation, genioplasty, etc

- Canal wall reconstruction and mastoid filling surgery

- Benign pathology: cyst, tumors

- Congenital craniofacial malformations such as cleft palate, cranial vault malformations such as craniosynostosis. (craniofacial surgery)

- Cholesteatomatous or non-cholesteatomatous chronic otitis media

- Temporomandibular joint disorders

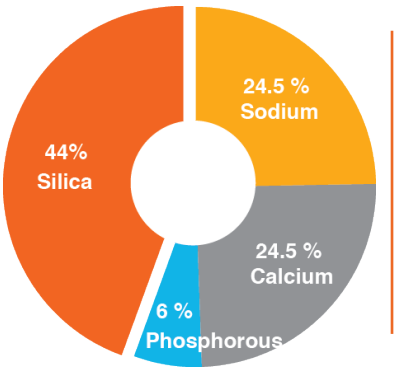
- Dysgnathia, orthognathic reconstructive surgery, maxillomandibular advancement, surgical correction of facial asymmetry.

- Hard tissue trauma of the oral and maxillofacial region: jaw fractures, cheek bone fractures, nasal fractures, LeFort fracture, skull fractures and eye socket fractures

Bioactive Glass

The bone substitute GlassBone is made of Bioactive Glass 45S5, a revolutionary ceramic, composed of minerals naturally present in the human body * :

COMPOSITION



- **Osteoconductive and improves the bone regeneration: natural matrix for cells to attach, differentiate and make new bone :**
  - **Bone Bonding**
  - **Soft tissue bonding ***
- **100 % synthetic**
- **Bioabsorbable**
- **Excellent biocompatibility ***

MECHANISM OF ACTION

1-3 : Calcium and Natrium ions on GlassBone surface rapidly exchange with bodily fluids. The reaction causes hydrolysis of silica groups and induces a local **increase of pH and osmotic pressure.**

3 : Soluble silica is transformed to **form a silica-gel layer** at the surface of GlassBone.

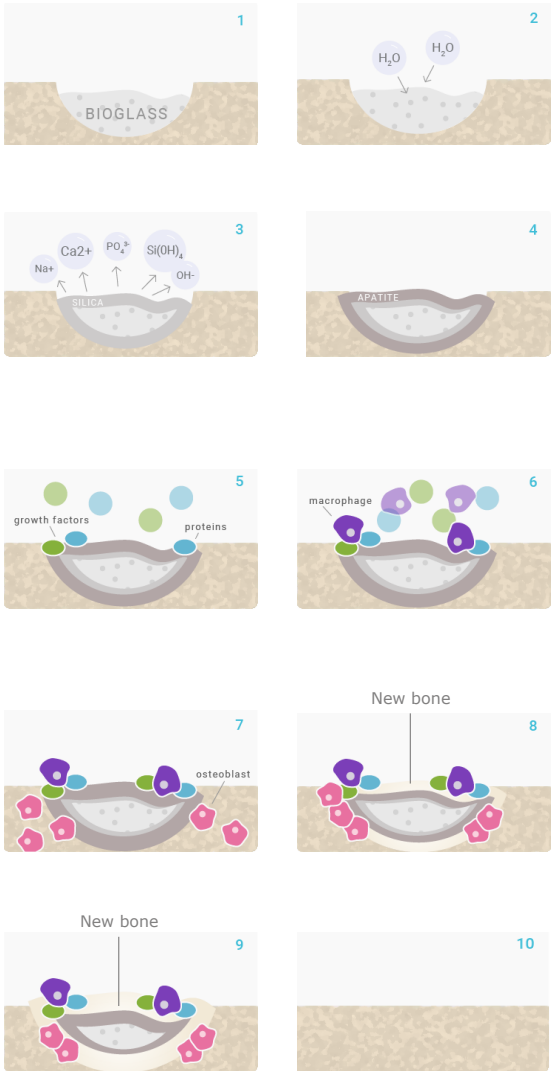
4 : On top of GlassBone, a layer is formed, **made of carbonated hydroxyl apatite (HCA),** which is the same component of the mineral phase of natural bone.

5-6 : **Growth factors** adsorb to the surface of GlassBone due to its structural and chemical similarities to hydroxyapatite. Growth factors activate M2 macrophages, to promote wound healing and initiate the migration of progenitor cells to the site.

6-7 : Triggered by M2 macrophage activation, **mesenchymal stem cells** and osteoprogenitor cells migrate to the GlassBone surface and attach to the HCA layer, in order to differentiate into osteogenic cells: **osteoblasts**.

7-8 : The attached and differentiated osteoblasts generate and deposit extracellular matrix (ECM) components, primarily **type I collagen,** the main protein component of bone.

9-10 : Following these reactions, bone growth continues as the newly recruited cells continue to function and facilitate tissue growth and repair. GlassBone continues to degrade and be converted to new ECM material.



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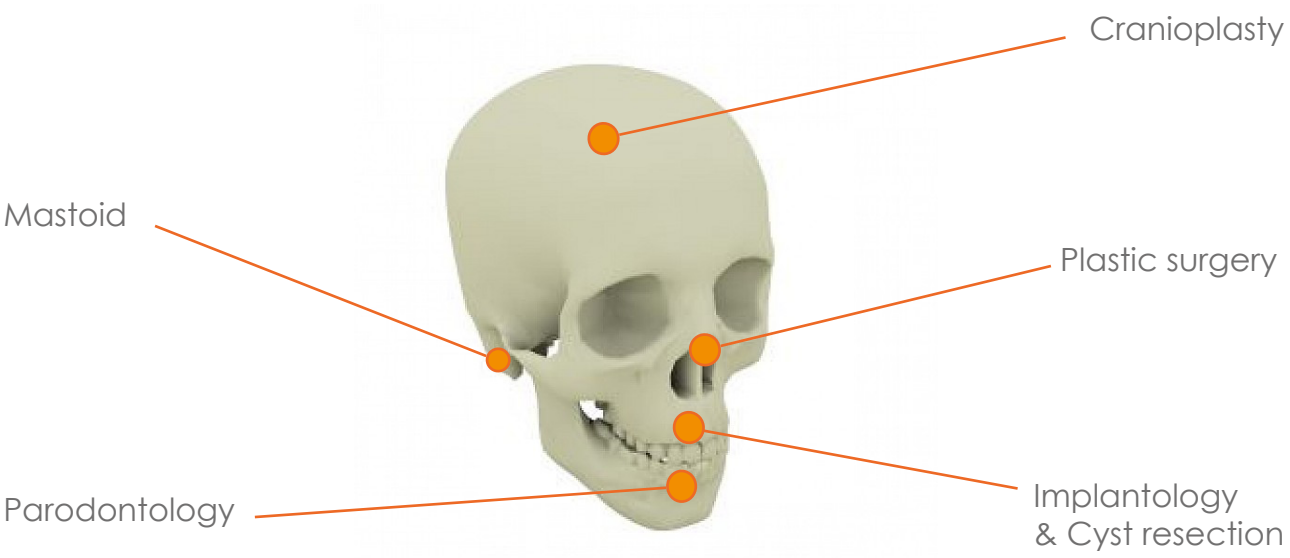
Indications

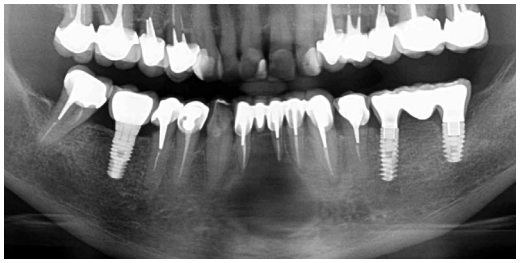


INDICATIONS GUIDE

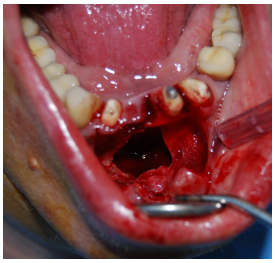
	GRANULES			INJECTABLE PUTTY			
	GB05.1/05	GB05.1/1	GB05.1/5	GB-IP1.0	GB-IP2.5	GB-IP5.0	GB-IP10
Mastoid resection			✓		✓	✓	
Cranioplasty				✓	✓	✓	✓
Plastic surgery (maxilla, face)				✓	✓	✓	
Cyst resection	✓	✓		✓	✓		
Implantology (sinus lift, post-extraction)	✓	✓		✓	✓		
Parodontology	✓	✓		✓			

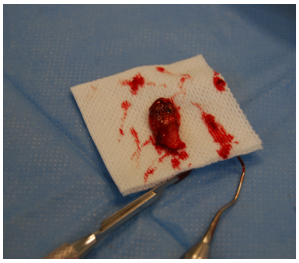
Apical cyst bone filling– Dr D. Carrotte (private practice, Villeurbanne 69)

A 57-year-old patient shows an apical cyst at the level of the mandibular symphysis due to a lack of effectiveness of orthodontic treatment. The treatment plan consists of exeresis of the bone lesion (position 41), the cleansing of the infected site, the cavity filling with Glassbone bone substitute and the fitting of a bridge.

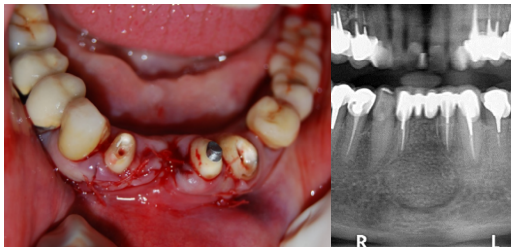


Dental cyst, probably due to orthodontic treatment of 31 incisor. Full thickness incision, with vertical discharges and gingiva detachment by vestibular approach of the infected teeth.

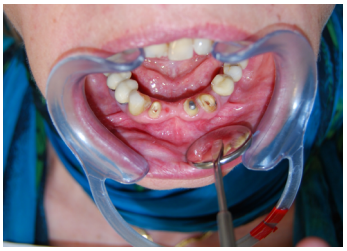


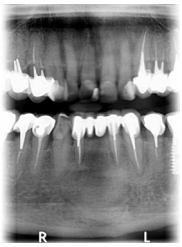


Site is cleaned with Betadine. The cystic membrane is removed without being damaged, ensuring a full removal of the infected site, limiting the risk of re-infection.

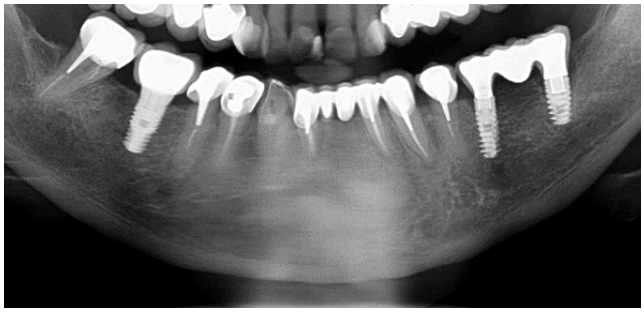


The bone cavity is filled with 2cc of Glassbone™ Granule. (Granule size 0.5-1mm).
Immediate post-operative CT scan shows the absence of bone void. The line below the cavity is due to the coagulum, it will be filled thanks to gravity.





3 months post-op : excellent healing of the tissues, with a good oral hygiene. The definitive prosthesis is sealed



Followed postoperative clinics

6 months post-op : Radiological and clinical signs of healing.

15 months post op: CT scan shows a good osseointegration of the bony hood despite its thinness and stability of the prosthesis.

Alveoloplasty using bone substitute for alveolar cleft treatment

Authors : *Audrey Gallucci1, Nicolas Graillon, Nathalie Degardin*
Department of Pediatric Oral and Maxillofacial Surgery, Timone Children's Hospital , University Medical Center, Marseille, France Department of Pediatric Plastic Surgery, Timone Children's Hospital, , University Medical Center, Marseille, France.

INTRODUCTION

We already performed a retrospective study, between 2003 and 2009, with 33 patients suffering from alveolar cleft, operated for alveoloplasty, using iliac bone graft. Clinical and radiological outcomes were studied. Due to bone loss observed years after the surgery, it was decided to try a synthetic bone graft to validate its use in alveoplasty and to avoid autologous bone graft. The objective is to compare alveoplasty using GlassBone to traditional surgery using iliac bone graft, and to propose GlassBone as an alterative to aulologous graft

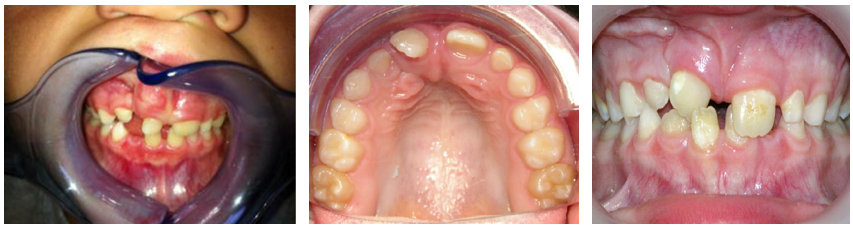


Figure 1: 7 years old child suffering from right labiomaxillary cleft with vestibular fistulae : preoperative picture (a) and 1 year postoperative pictures (b,c) showing good wound healing and fistulae closure.

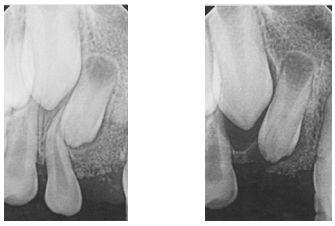


Figure 2: Retroalveolar radiographs : immediate postoperative (a) and 1 year postoperative (b) showing lateral incisor evolution throught the graft.

PATIENT AND METHODS

• Prospective study, started in 2010, 33 patients, aged between 4 and 12 years old
• Same surgical technique, same pre and post orthodontic treatments with GlassBone as with autologous iliac bone.
• GlassBONE is a synthetic bioceramic with osteointegration, osteoinduction and osteostimulation properties, used in cranio-maxillofacial and in pediatric orthopedic surgery.
• Evaluation of clinical outcomes : Wound healing, Oro-nasal fistulae closure , Graft exposure and loss, Post operative suits, radiological outcomes using CBCT and orthopantomogram pre and 1 year post operative; Evolution of the teeth adjacent to the cleft; Evolution of bone density into the alveolar cleft

RESULTATS

- **Social Outcomes:**
  - Shorter hospital stay : 24 hours against at least 72 hours with iliac bone graft
  - Shorter scholar eviction 7 days against 14 with iliac bone graft
  - Sport eviction (7 days against 21)

- No more donor site pain, less antalgic prescription

- Clinical outcomes (figure 1)

No immediate graft loss Good wound healing

- Radiological outcomes (figures 2, 3)

Possibility of eruption of adjacent teeth in the graft

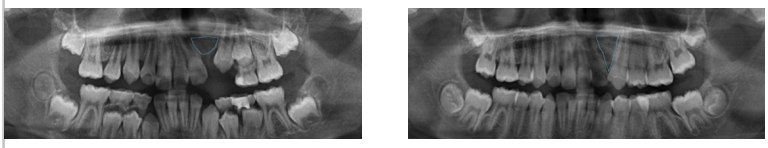


Figure 3: Orthopantomograms : immediate postoperative and 1 year postoperative showing filling of alveolar cleft abnd canine evolution through the graft

CONCLUSION

GlassBONE seems to be a good alternative to autologous bone graft for alveolar cleft closure to improve alveoloplasy tolerance and avoid donor site morbidity.

Obliteration of the frontal sinus cavity with bioactive glass

Authors : Peltola 1998: Peltola M, Suonpää J, Aitasalo K, Varpula M, Yli-Urpo A, Happonen RP. . Head Neck (1998), Volume 20, No 4:315-9.

Background
Bioactive glass (BG) is a glass ceramic material. It has been used as surgical bone replacement material in ear and oral surgery, orthopedics, and dentistry.

Methods
Bioactive glass was used as obliteration material in a series of osteoplastic frontal sinus operations on 10 patients suffering from chronic frontal sinusitis, which other, more-conservative treatment modalities had failed to cure.

Results
Bioactive glass is easy to handle, and complete obliteration of all sinusal recesses and excavations is easily achieved. No adverse effects of the implant material have been seen over a mean follow-up period of 5.0 years. One patient with a local recurrent infection in the outer table of the sinus was reoperated on 5 months after primary surgery. Repeated postoperative computed tomographic scans analyzed by digital region-of-interest (ROI) selection showed no remarkable changes in the frontal sinus cavities but a slight, yearly decrease in the density of the occlusion material. Laboratory monitoring of patients and histopathologic examination of two postoperative biopsy specimens indicated that the material is well tolerated and stable.

Conclusion
Bioactive glass is a promising and well-tolerated bone graft suitable for osteoplastic frontal sinus operations. Total accurate obliteration of the sinus is achieved with different sizes of granules and blocks. The results of the obliteration are maintained owing to the stability of the material.

Bioactive glass obliteration of the mastoid significantly improves surgical outcome in non-cholesteatomatous chronic otitis media patients.

Authors : Vos 2017: Vos, J; de Vey Mestdagh, P; Colnot, D; Borggreven, P ; Orelio, C; Quak, J. 2017;274(12):4121-4126.

Abstract

This retrospective follow-up study evaluates the efficacy and safety of bioactive glass (BAG) S53P4 when applied as filler material in mastoid obliteration surgery performed on non-cholesteatomatous chronic otitis media (NC-COM) patients with chronically discharging ears despite conservative therapy. 94 Patients (96 ears) were included. Patients underwent either intact canal wall (ICW) or canal wall down (CWD) mastoid surgery between 2005 and 2015. The intervention group comprised 23 patients (23 ears) who were treated with additional mastoid obliteration using BAG S53P4; the remaining 71 patients (73 ears) were considered controls. All patients underwent preoperative CT scanning of the mastoid. Primary functional outcome, as defined by control of suppuration, was assessed using Merchant's scale. Hearing results as measured by air-bone gap and the incidence of adverse events were assessed as secondary outcomes. Thirty-two ears (44%) in the control group (n = 73) achieved complete control of infection at the most recent postoperative clinic visit vs 17 (74%) in the S53P4 obliteration group (n = 23). Comparing these outcomes yielded an odds ratio (OR) of 3.6 (p = 0.012, 95% CI 1.3-10.3). Complete failure to manage infection significantly differed (p = 0.048) between the control group (11 ears; 15%) and the S53P4 obliteration group (0 ears). No adverse events were observed in either group. Pre- and postoperative ABG results did not differ significantly between groups. Obliteration of the mastoid cavity using BAG S53P4 along with mastoidectomy in patients with chronically discharging NC-COM significantly improves the achievement of a dry and safe ear as compared to mastoidectomy alone. Importantly, no adverse events were observed with S53P4 BAG obliteration.

Outcomes of cranioplasty with synthetic materials and autologous bone grafts

Authors : Piitulainen 2015 : Piitulainen JM, Kauko T, Aitasalo KM, Vuorinen V, Vallittu PK, Posti JP. . World Neurosurg (2015), Volume 83, No 5:708-14.

Background
Using current surgical methods, cranioplasty is associated with a high complication rate. We analyzed if there are preexisting medical conditions associated with complications and compared the effect of different implant materials on the degree of complications.

Methods
A retrospective review of the medical records of all patients who underwent cranioplasty for cranial bone defects during the period 2002-2012 was conducted, and 100 consecutive cranioplasty procedures that met eligibility criteria were identified. Patients were analyzed in 4 groups, which were created based on the cranioplasty material: autograft (n = 20), bioactive fiber-reinforced composite (n = 20), hydroxyapatite (n = 31), and other synthetic materials (n = 29).

Results
During a median follow-up time of 14 months (interquartile range 3-39 months), 32 of 100 patients (32.0%) developed at least 1 complication. A minor complication occurred in 13 patients (13.0%), whereas 19 patients (19.0%) developed a major complication, which required reoperation or removal of the implant. In the autograft subgroup, 40.0% of patients required removal of the cranioplasty. The 3-year survival of the autograft subgroup was lower compared with other subgroups of synthetic materials. In hydroxyapatite and bioactive fiber-reinforced composite groups, fewer complications were observed compared with the autograft group.

Conclusion
Based on these results, synthetic materials for cranial bone defect reconstruction exhibit more promising outcomes compared with autograft. There were differences in survival rates among synthetic materials.

Craniofacial bone reconstruction with bioactive fiber-reinforced composite implant.

Authors : Aitasalo KM, Piitulainen JM, Rekola J, Vallittu PK. Head Neck (2014), Volume 36, No 5:722-8.

Background
A novel, bioactive, fiber-reinforced composite implant is a solution to address the shortcomings in craniofacial bone reconstruction. A longitudinal clinical investigation with a follow-up time of 4 years was conducted.

Methods
A cranial bone reconstruction with the implant was performed on 12 patients. In these patients, the reasons for craniotomies resulting in craniofacial bone defects were traumatic and spontaneous intracranial bleeding as well as infections to the primary reconstruction material. The implant material consisted of a supporting fiber-reinforced framework, porous inner layers, and a bioactive glass (BG; S53P4) filling. The framework and the porous layers were made of a bisphenol-a-glycidyl methacrylate and triethyleneglycol-di-methacrylate (pBisGMA-pTEGDMA) resin matrix, which was reinforced with silanized E-glass.

Results
In clinical examinations and skull X-rays, the implants were in original positions providing the expected functional and aesthetic outcome at all time points.

Conclusion
The implants functioned appropriately, which would provide a potential solution for craniofacial bone reconstruction in the future

Bioactive glass S53P4 in frontal sinus obliteration: a long-term clinical experience

Authors : Peltola 2006: Peltola M, Aitasalo K, Suonpää J, Varpula M, Yli-Urpo A.
Head Neck (2006), Volume 28, No 9:834-41.

Background
Synthetic, osteoconductive, and antimicrobial bioactive glass (BAG) has been used in many surgical applications.

Methods
BAG was used as obliteration material in a series of osteoplastic frontal sinus operations on 42 patients suffering from chronic frontal sinusitis, which could not be cured with other means of treatment.

Results
Accurate obliteration of sinuses was achieved in 39 patients. Uneventful recovery and clinical outcome were seen in 92% of the patients. Histopathologic samples harvested at 1, 5, and 10 years after obliteration revealed a healing process progressing from the fibrous tissue phase to bone formation with scattered fibrous tissue and bony obliteration maintaining BAG granule remnants. Fourier-transform infrared (FTIR) studies showed bone produced by BAG to be similar to natural frontal bone. Micorobiologic cultures obtained with histologic samples revealed no growth of bacteria.

Conclusion
BAG appears to be a reliable frontal sinus obliteration material, providing favorable conditions for total bony sinus obliteration.

Bioactive glass hydroxyapatite in fronto-orbital defect reconstruction

Authors : Aitasalo 2007: Aitasalo KM, Peltola MJ.
Plast Reconstr Surg (2007), Volume 120, No 7:1963-72.

BACKGROUND:
Synthetic bioactive ceramics and glasses have osteoconductive properties. These materials are capable of chemically bonding to the bone tissue. In addition, special bioactive glasses do not favor microbial growth. In this study, the clinical outcome of bioactive glass and hydroxyapatite in head and neck surgery was evaluated.

METHODS:
In a retrospective series of 150 patients, 62 patients underwent reconstruction with frontal sinus obliteration after chronic frontal sinusitis, 65 patients were operated on for fronto-orbital traumas, and 23 patients underwent reconstruction after fronto-orbital tumor resections. These patients were evaluated for surgical procedures, reconstruction materials, complications, and functional outcomes.

RESULTS:
Three of the 62 frontal sinus occlusions underwent operation (4.8 percent) during the follow-up of 5 years. The reoperations were caused by a new mucocele. In fronto-orbital reconstructions, we have reoperated on the orbital floor in four cases (7 percent). All 12 benign tumor patients and six of 11 malignant tumor patients survived during a follow-up of 3 years. Two of the 23 (9 percent) complicated tumor and trauma patients underwent reoperation because of a local mucocele.

CONCLUSIONS:
Treatment of severe head and neck defects with biomaterial is a suitable alternative to conventional methods. Bioactive materials seem to be stable and reliable at clinical follow-up. The reconstructions with bioactive glass and hydroxyapatite are associated with good functional and aesthetic results without donor-site morbidity. However, more long-term outcomes of studied biomaterials are needed to determine whether they are capable of competing with traditional tissue grafts.

Osteotomy Site Grafting in Bilateral Sagittal Split Surgery With Bioactive Glass S53P4 for Skeletal Stability.

Authors : Stoor 2017: Stoor, P; Apajalahti, S. J Craniofac Surg. 2017;28(7):1709-1716.

Abstract

In orthognathic surgery, the aim of the treatment is to achieve a good occlusion and a satisfying aesthetic outcome. In large mandibular advancements insufficient healing at the mandibular inferior border may lead to loss of support for the overlaying tissue at the osteotomy site. Augmentation can be performed to improve stability, bone regeneration, and the aesthetic outcome. The purpose of this prospective clinical study was to evaluate the use of a novel material for this indication; granules of the antibacterial, osteoconductive, and slowly resorbing bioactive glass S53P4 as filling material in large mandibular advancement in bilateral sagittal split osteotomies. The authors treated 25 patients who underwent bilateral sagittal split osteotomies due to class II dentoskeletal deformities. The mandibular osteotomy site defects (8-15mm) were augmented with bioactive glass S53P4. The average clinical follow-up was 33 months and the average radiological follow-up with cone beam computerized tomography was 24 months. The clinical and radiological results were good with regard to healing, bone regeneration, and stability of the osteotomy sites. The recontouring of the inferior mandibular border provided a good soft tissue support followed by an excellent aesthetic outcome in 96% of the osteotomy sites. The occlusion was stable in 88% of the patients. The authors' results show that bioactive glass S53P4 is a safe grafting material for osteotomy site defects in significant mandibular advancements with reliable bone regeneration, providing long-term stability at the osteotomy site and at the inferior mandibular border.

Regeneration of Cystic Bone Cavities and Bone Defects With Bioactive Glass S53P4 in the Upper and Lower Jaws.

Authors : Stoor 2017: Stoor, P; Apajalahti, S; Kontio, R. J Craniofac Surg. 2017;28(5):1197-1205.

Abstract

Cysts and tumors are common lesions in the jaws. To be able to retain a good volume of the alveolar ridge during healing as well as strengthening the angle and body of the mandible and provide an instant improved support for adjacent teeth, reliable long-term bone regeneration is needed. The purpose of this prospective study was to promote bone regeneration by filling bony defects in the upper or lower jaw with granules of the bioactive glass S53P4 (BAG), which have osteostimulative and antimicrobial properties.The authors treated 20 patients (21 defects) surgically; benign tumors, cysts, or infection related to impacted teeth in the maxilla or mandible. The tumor or cyst was removed or enucleated and thorough cleaning of the infected area was performed. The bone cavity was filled with granules of the BAG S53P4 despite signs of chronic infection in the area at the time of surgery. The patients were followed up for an average of 34 months clinically and with cone beam computerized tomography for 28 months. In 20 defects the final outcome was successful. Despite infection at the time of surgery in 65% of the patients, no material associated infection was seen during the follow-up. The BAG S53P4 granules were radiologically remodeled into bone after 2 years follow-up. The use of granules of the BAG S53P4 in the treatment of large bone defects provides infection-free reliable bone regeneration despite chronic infection at the time of surgery, which improves the prognosis of adjacent teeth.

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