Long Term Results of the Reconstruction of Maxillofacial Segmental Bone Defects with Bioactive Glass: Presentation of six cases

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Citation

Abstract
Reconstruction of the maxillofacial bone defects secondary to ablative surgery or because of trauma or congenital defects poses a challenge to the plastic surgeons. These defects can be reconstructed with autologous or synthetic materials. Biomaterials are widely used with success in the reconstruction of the craniofacial skeleton, due to accompanying problems of autogenous bone grafts like the potential donor site morbidity, time consumption, need for experience and possibility of graft resorption in the postoperative period.

In this report, we present our experience and long term results in reconstruction of maxillofacial segmental bone defects with bioactive glass (NovaBone, Porex Surgical, Newman, Ga.) in six patients in Adnan Menderes University Hospital, Turkey. The patients were followed for minimum 12 months post-operatively and the process of ossification was checked at 6-month intervals by means of clinical, radiological methods. Radiological examinations demonstrated conversion of the majority of the reconstructed defect to bone density within 6 months, new bone was palpable in first year of the operation. Only one patient was re-operated since her new bone was disrupted secondary to the trauma after first operation.

In conclusion, bioactive glass is very suitable material for the reconstruction of the bone defects in face. To the best of our knowledge the defect in the case with mandibular cyst presented in this report is the largest one which reconstructed with only bioactive glass in the literature.

BACKGROUND
Biomaterials are widely used with success in the reconstruction of the craniofacial skeleton, due to accompanying problems of autogenous bone grafts like the potential donor site morbidity, time consumption, need for experience and possibility of graft resorption in the postoperative period. The ideal biomaterial should be biocompatible with the surrounding tissue, radiolucent, easily shaped or molded, strong enough to endure trauma, stable over time, able to maintain volume, and osteoactive [1]. There are many alternatives in biomaterials, and bioactive glass particles are among the relative newest materials and just a few reports are present in the literature about application of bioactive glass. In this report, we present our experience and long term results in reconstruction of maxillofacial segmental bone defects with bioactive glass (NovaBone, Porex Surgical, Newman, Ga.) in six patients.

METHODS
Six patients with maxillofacial segmental bone defects in varying anatomical sites were treated with bioactive glass in Plastic and Reconstructive Surgery Department, Medical Faculty, Adnan Menderes University, Turkey. All patients were followed minimum 12 months maximum 36 months regularly. The process of ossification was checked at 6-month intervals by means of clinical, radiological methods. Radiological examinations demonstrated conversion of the majority of the reconstructed defect to bone density within 6 months, new bone was palpable in end of first year of the operation. Details of the patient were given in Table 1.
CASE 1

18-year-old female patient presented with frontal bone defects secondary to the motor vehicle accident (Figure 1). Four years ago, she was operated with multiple bone grafts from iliac crests. There were segmental bone defects in central frontal area. 3-D computed tomography was performed and bone defects were visualized (Figure 2). She did not accept bone grafting with autologous tissue. Bioactive glass was used. (Figure 3) There were no early post-operative complication but patient was re-operated in end of the post-operative one year due to fracture of the new bone secondary to the trauma. Porous polyethylene implant was used in second operation. Post-operative course of the patient was uneventful (Figure 4).
CASE 2

32-year-old male patient, who presented with pain and swelling over the right molar region. On CT scans there was a radiolucent cyst which expanded and destructed the inner cortices of mandible. Size of the cyst was 34x22 mm's. Pre-operative biopsy was performed and reported as “odontogenic keratinocyst” (OKC). The patient was operated as cyst enucleation, sequestered inner cortex was removed and the mandible was reconstructed with a reconstruction plate and 5 cc bioactive glass (Figure 5). Radiological examinations demonstrated conversion of the majority of the reconstructed defect to bone density within 6 months, new bone was palpable in second year of the operation (Figure 6). There was no recurrence or complication in post-operative period (Figure 7).
Figure 6
Figure 5: Operation of the patient with mandible cyst.

Figure 7
Figure 6: Post-operative view of the patient

Figure 8
Figure 7: a and b: Early post-operative X-Rays, c and d: Late post-operative X-Rays

CASE 3 AND 4
Patient with nasal bone defects secondary to the dermoid cyst were treated with cyst excision and reconstruction with bioactive glass (Figure 8). Patients were followed minimum 12 months regularly. The process of ossification was checked at 6-month intervals by means of clinical, radiological methods. Radiological examinations demonstrated conversion of the majority of the reconstructed defect to bone density within 6 months, new bone was palpable in end of first year of the operation.

Figure 9
Figure 8: Application of the bioactive glass to the patient with nasal dermoid cyst.
CASE 5 AND 6

10 years old patient with painless immobile mass located in midline of the mentum was operated for the median mandibular cyst. Orthopantogram and computed tomography was performed and result was same: intramandibular symetric radiolucent median cyst in size of 15 X 17 mm (Figure 9). Patient was operated under the general anesthesia with intraoral approach. Cyst was enucleated with curettage and defect was reconstructed with bioactive glass. Since the outer cortices of the mandible were destructed miniplate was also applied. Histology showed a cyst lined-up by stratified squamous epithelium. Post-operative period was uneventful. There was no recurrence in post-operative first year. New bone formation was seen conventional X-Ray at the end of six month (Figure 10).

DISCUSSION

Autogenous bone is the usual choice for treatment of bone defects in craniofacial surgery, but this is not always available or suitable for particular cases, such as large areas of bone needing to be replaced or in patients who have already had multiple procedures for bone reconstruction. In these cases, synthetic bone substitutes can be chosen. Unfortunately, because of their higher complication and failure rates, there have been concerns in trying these new materials [1]. In the last 30 years various modes of treatment have been introduced to reconstruct the bone defects in maxillofacial region including bridging plates, free autogenous block bone grafts, particulate cortico-cancellous bone grafts using various scaffolds and mixtures with xenografts or biomaterials [2]. Using bone grafts as part of the reconstructive process in the craniofacial region was a major force that directed the development of the new frontier of craniofacial surgery [3]. Bone grafting and the use of bone substitutes are now performed by various surgical specialties and surgeons have become adept at harvesting bone, accomplishing its application, and evaluating the outcome of procedures and materials used. Bioactive glasses were developed during the past few decades. 45S5 Bioglass® (Novabone-C/M®, Porex Surg., Newman, GA) has been a promising alternative for bone replacement and augmentation because of its bone-binding and osteoconductive properties. Clinically, it has been used in orthopedic surgery and in oral surgery. It has not commonly
been applied in craniomaxillofacial surgery. The few reports in this field consisted of post-trauma and post-tumor resection reconstruction of limited areas, from contour refinements to onlay augmentation [1]. Nova Bone is a synthetic bioactive glass particulate consisting of 45% silica dioxide, 45% sodium oxide, 5% calcium, and 5% phosphate, which is believed to be bioactive toward the production of new bone within the biomaterial. We did not mix the material with autogenous bone graft as described in the literature [4] but edges of bone defects were freshened with rasp. Application of the material was quite easy, after mixed with blood it contoured to the shape of the defect, since it is negatively charged, particles adhered to the defect site, preventing migration. Although Novabone has been used to reconstruct ear ossicles and dental and alveolar ridge defects [5], there is no report about the application of the bioactive glass in greater defects without autogenous bone graft.

odontogenic keratinocyst (the cyst in our patient #2) is classified as a developmental, non-inflammatory odontogenic cyst that arises from the cell rests of dental lamina. Treatment options include surgical resection of the mandible or surgical enucleation with curettage [6]. To the best of our knowledge the defect in this case is the largest one which reconstructed with only bioactive glass in the literature.

Also, the median mandibular cyst presented in this study is a very rare condition occurring in the midline of the mandible, believed to be caused by inclusion of the epithelium trapped in the central groove of the mandibular process, or by cystic degeneration of a supernumerary tooth germ. There are few reports in the English literature and there is confusion about the definition of this cyst. The median mandibular cyst does not appear to exist as an entity. All cysts reported as such are probably odontogenic [7]. In previous reports on median mandibular cysts, undue emphasis has been placed on the “vitality” of adjacent teeth. According to the study of Rapidis and Langdon median cysts of the jaws (median mandibular and median palatine) are currently classified as fissural cysts. Their existence as distinct clinical and histological entities has been the cause of debate. It is the purpose of this paper to point out that from present evidence in published case reports and reviews of the literature, the presence of these cysts in the midline of the jaws is a random finding [8]. Since the median mandibular cyst is an extremely rare lesion, there is difficulty in determining the nature and origin of this entity. An additional case of a median mandibular cyst is described and an attempt is made to clarify the confusion associated with the diagnosis of this lesion [9]. Because of the mother of our patient had same cyst in same localization heredity may be a role in the pathogenesis of this cyst. Reconstruction of the median mandibular cyst was performed with bioactive glass and results were excellent.

Finally, we believe that bioactive glass is very useful reconstructive alternative especially in facial region.

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