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BONE GRAFTS IN DENTISTRY

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Abstract

Background: *bone grafting is a surgical procedures that substitutes lost or removed bone from patient's own body, a human donor, an animal donor or an artificial substance. Bone grafting is possible because the bone tissue can restore completely if a scaffold is provided for it to grow. Natural bone grows and it generally substitutes the graft material, resulting in a fully integrated region of the new bone. Bone defects in the maxillofacial region can vary from minor periodontal defects to the larger defects resulting from trauma, surgical excision or congenital deformity. Such 3-dimensional defects require careful planning in order to restore the skeletal defects.* ***Aim of the work :*** *this study aimed to detect bone graft material for replacing lost or missing bone. Bone grafting, or transplanting of bone tissue, is beneficial in fixing bones that are damaged by trauma, cancer or congenital deformities.* ***Methodology:*** *we conducted this review by using a comprehensive search of MEDLINE, PubMed and EMBASE from January 1947 to March 2017. The following search terms were used: autografts, allografts, alloplast, xenografts, osteoconduction, osteoinduction and osteogenesis.* ***Result:*** *Keeping satisfactory facial aesthetics is another unique consideration in the treatment of facial defects, which cannot be undervalued. This branch of surgery has come up more recently with advanced surgical technique, and bone grafting has become a regular job for maxillofacial surgeons in the reconstruction of acquired or congenital jaw defect*

Keywords: *Bone Grafts, Osteoconduction, Osteoinduction, Osteogenesis*

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HISTORY:

The earliest record of a bone grafting comes from Amsterdam by a surgeon named **Meekeren** [1]. He reported that he had restored a cranial defect from the cranial graft of a dead dog. **Macewen** [2] published the first case report of successful use of bone allograft. He reconstructed a humeral defect in a small child with tibial bone wedges taken from 3 different donors. Following this, several other clinical reports proved the efficiency of autogenous bone graft for bone defect reconstruction [3-5].

MECHANISM of ACTION of BONE GRAFTS:

Bone growth at the recipient site happens through one or more of the following mechanisms: osteoconduction, osteoinduction and osteogenesis [6].

Osteoconduction:

The term means that bone grows on a surface. Then bone graft serves as a framework onto which the native bone is formed from either end. Osteoblasts from both edges of defects migrate on the graft material and generate new bone. Every bone graft should be at least osteoconductive [7].

Osteoinduction:

In this case, the primitive, undifferentiated and pluripotent (BMP's) stem cells are stimulated to form osteoblasts which in turn deposit new bone. BMP's are most commonly researched as osteoinductive cell mediators. Such a bone graft not only serves as a framework for new bone formation, but also stimulates the formation of new bone cells and thus faster bone formation [8].

Osteogenesis:

This bone graft material has its vital osteoblasts that contribute to bone formation. It similarly serves as a scaffold and also has osteoinductive properties. This makes it the best type of bone graft material [8].

METHODOLOGY:

- **Data Sources and Search terms**

We conducted this review by using a comprehensive search of MEDLINE, PubMed and EMBASE, from January 1947 to March 2017. The following search terms were used: autografts, allografts, alloplast, xenografts, osteoconduction, osteoinduction, osteogenesis

- **Data Extraction**

Two reviewers had independently reviewed the studies, abstracted data and disagreements were resolved by consensus. Studies were evaluated for quality and a review protocol was followed throughout.

This study was done after approval of ethical board of King Abdulaziz University Hospital.

TYPES OF BONE GRAFTS:

Autografts:

Graft procured from the same individual is known as autograft or autogenous graft. Nonessential parts of bone can be obtained both intra-orally and extra-orally. A block graft with autogenous origin is most favoured due to lesser chances of rejection as the graft is from the patient's own body. It acts by osteogenesis, osteoinduction and osteoconduction. Nevertheless, there are drawbacks such as another surgical site, and more postoperative pain [8].

Isografts are relocated between identical twins/ genetically matched in humans. They have the same benefits and complications as autografts [8].

ALLOGRAFTS:

Allografts are grafts relocated among genetically unidentical humans. Allografts can be taken either from live donors or cadavers where they are stored in a bone bank. They are subdivided into [11]:

1. Fresh or fresh-frozen bone
2. FDBA (Freeze-dried bone allograft)
3. DFDBA (Demineralised freeze-dried bone allograft)

Fresh bone has not only the most osteogenic potential, but also carries the risk of disease transfer and antigenicity. Therefore, these grafts are reduced in size, cleaned, decontaminated using hydrogen peroxide. They are further treated with antimicrobial solutions, froze at -80C and finally sterilized (FDBA). To further pave the way for osteogenic proteins, grafts can also be demineralized in a hydrochloric acid bath (DFDBA) [9].

XENOGRAFT:

Animal-derived tissues for human tissue reconstruction are called xenografts. Xenografts are usually deproteinized to avoid the risk of antigenicity and disease transfer. This causes them to lose their osteogenic potential and solely act as osteoconductive material. They are usually obtained from bovine, porcine or coralline sources and can be used either alone or with artificial carriers [10].

ALLOPLASTS:

They are synthetic graft material. They come in powder, pellet or putty form but they all are only

osteoconductive. They do offer several advantages such as no immune reaction or pathogen transfer. Alloplast is made from minerals that naturally exist in human bone. Most commonly available is hydroxyapatite because of its strength and acceptability by bone. Other available forms are tricalcium phosphate dicalcium phosphate and calcium sulphate [11].

Bone morphogenetic proteins (BMPs)

These growth factors along with other growth factors normally regulate bone growth in the human body. These factors can be implanted into various carrier biomaterials (metals, ceramics, polymers and composites) and delivery systems (hydrogel, microsphere, nanoparticles and fibres) [11;12].

Platelet-rich plasma (PRP)

The autogenous concentration of platelets in a small volume of plasma is considered to be an extremely rich source of autogenous growth factors. PRP can be used alone or mixed with a graft material used for many reconstructive oral procedures [12].

Table 1: Properties, functions and costs of various forms of bone grafts and substitutes [13;14]

	Osteoconductive	**Osteoinductive**	**Osteogenic**	**Structural**	**Disadvantages**
Autograft					
cancellous	+++	+++	+++	+	Donor site morbidity, increased OR time
cortical	+	+	+	+++	As above
Vascularised Bone	++	+	++	+++	As above
Bone marrow aspirate	+/-_	++	+++		As above
Platelet rich plasma	-	+++	_	_	Unproven efficacy
Allograft					
cancellous	+	+/-	-	+	Potential infection, rejection
Cortical	+	+/-	-	+++	As above
DBM	+	++	-	-	No strcutural propetry
Synthetic					
Calcium sulphate	+	-	-	++	Rapid resorption
Calcium phospahte	+	-	-	+++	Osteoconductive only
Tricalcium phosphate	+	-	-	++	Same as above
Others					
rhBMPs	+/-	+	+	-	Expensive, limited FDA approval

SOURCES of AUTOGENOUS BONE GRAFTS:

Iliac Crest

Iliac crest graft can offer large segments of cortical, corticocancellous or cancellous bone that can be used for different-sized defects. It offers good surgical accessibility with low risk. Anterior crest can be obtained using two surgical teams, one working on the facial end and other at iliac region resulting in the shorter procedure. Iliac crest contains two thick cortices with ample cancellous bone with similar size and thickness to that of the mandible. The graft has a good survival rate with evidence of osseointegration in cases of dental implants [15,16,17]. Despite its advantages, Iliac grafts are known to cause more donor site morbidity than intra-oral sites. Seroma, Hematoma, Lateral cutaneous femoral nerve sensory disorders, and gait disturbances are a few examples [18].

Calvarial Graft

One of the most commonly used is cortical bone grafts in craniofacial reconstruction because it resorbs slowly and has mechanical superiority.8 It is ideal in cases of facial augmentation, orbital roof, and floor reconstruction, and covering of cranial defects. Usually, the outer cortex is retrieved, but full thickness graft is also taken and split into two. The graft can be split into multiple strips and used to reconstruct the mandible. The usually grows until the age of 8 but continues to thicken until the age of 20. It is thickest at the parietal region that can provide ~8 × 10 cm of bone and is considered the safest to harvest [19].

Chin Graft

Up to 4ml of bone can be osteotomized from the symphysis of the mandible intraorally. This is enough for small defects such as extracted tooth sockets and maxillary sinus floor augmentation. It also is used for reconstruction of the orbital floor due to its slow resorption [20].

Retromolar Graft

Behind the mandibular wisdom teeth, a small cortical-cancellous graft can be harvested. It is reserved for very small defects such as extracted tooth sockets. It is an intraoral procedure and causes no extraoral deformity [20].

Tibial Graft

A large volume (40ml) of cortico-cancellous bone can be harvested anterior plateau of the tibia.

It is indicated in sinus lifting and alveolar augmentations. Tibia fracture and gait disturbances are possible complications [19].

Rib Graft

It was the first autograft used in the reconstruction of the mandible [21]. Bony, as well as cartilaginous segments, can be harvested from 5th to 7th ribs. They are known as costochondral grafts and are popular in ramal and condylar reconstructions [22,23]. Unpredictable growth rate leading to facial asymmetry, as well as pleural injury and pneumothorax, are common complications [23].

Vascularised Bone Grafts

Vascularized bone grafting is thought to be the benchmark for large mandibular defect reconstruction where the donor vascular pedicle is anastomosed to recipient vascular supply.

It is helpful especially in cases of compromised vascularity as seen in cases of post radiotherapy patients. The success rate of vascularised bone grafts is much higher in primary reconstruction than non-vascularized ones. Another advantage is the simultaneous procurement of soft tissue graft as well. Nevertheless, vascularised bone grafts are very technically demanding to require microvascular surgery for vessel anastomoses leading to longer operation time and thus higher morbidity and mortality [21].

CONCLUSION:

Bone grafts are the gold standard for surgical reconstruction of bone defects. Surgeons are tirelessly working to reconstruct continuity defect in the maxillofacial region for more than a century. Enormous progress has made especially over the last 40 years. A technique such as microvascular autogenous graft procedures have proved better options for reconstructing large and complex defects, but morbidity associated with harvesting bone graft is a major disadvantage. Alternatively, use of tissue engineering showed exciting, promising results at the preclinical level and in the limited clinical trial. Refinement of the technique and identification of the ideal scaffolding are necessary before wider clinical application. Further studies are required to produce an evidence-based practice in tissue bioengineering clinically. This could have a significant impact on the reconstruction of maxillofacial defects due to bone loss following trauma or cancer resection.

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