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

**Corresponding author:**

Waed shaker Alshaikh,
Cairo university,
Email: Waed-shaker@hotmail.com
Mobile: 0560054093

Please cite this article in press Waed shaker Alshaikh et al., Bone Grafts In Dentistry, Indo Am. J. P. Sci, 2018; 05(12).
HISTORY:
The earliest record of a bone grafting comes from Amsterdam by a surgeon named Meekeeren [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 -80°C 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
osteoc conductive. 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 structural property                    |
| **Synthetic**    |                 |                |            |            |                                           |
| Calcium sulphate | +               | -              | -          | ++         | Rapid resorption                          |
| Calcium phosphate| +               | -              | -          | +++        | Osteoconductive only                      |
| Tricalcium phosphate | +          | -              | -          | ++         | Same as above                             |
| Others           | +/-             | +              | +          | -          | Expensive, limited FDA approval           |
| rhBMPs           | +/-             | +              | +          | -          |                                           |

**SOURCES of AUTOGENOUS BONE GRAFTS:** Iliac Crest
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.

**REFERENCES:**

1. Meekeren JJ (1682): [Observationes Medico-Chirurgicae]. Amsterdam: Ex Officina Henrici & Vidnae Theodori Boom, 82:539-546
2. Macewen W (1881): Observations concerning transplantation of bone illustrated by a case of inter-human osseous transplantation, whereby over two-thirds of the shaft of humerus was
restored. Proc Roy Soc Lond., 32:232–247.
3. Albee F H (1923): Fundamentals in bone transplantation: experiences in three thousand bone graft operations. JAMA, 81:1429–1432.
4. Phemister D B (1915): The fate of transplanted bone and regenerative power of its various constituents. Surg Gynecol Obstet., 19:303–333.
5. Phemester D (1947): Treatment of un-united fractures by only bone grafts without screw or tie fixation and without breaking down of fibrous union. J Bone Joint Surg Am., 29:946–960.
6. Giannoudis PV, Dinopoulos H and Tsiridis E (2005): Bone substitutes: An update. Injury, 36:20–7.
7. Laurencin C, Khan Y and El-Amin SF (2006): Bone graft substitutes. Expert Rev Med Devices, 3:49–57.
8. Conrad EU, Gretch DR, Obermeyer KR, Moogk MS, Sayers M and Wilson JJ (1995): Transmission of the hepatitis-C virus by tissue transplantation. J Bone Joint Surg Am., 77:214–24.
9. Centres for disease control and prevention (2001): Septic arthritis following anterior cruciate ligament reconstruction using tendon allografts: Florida and Louisiana, 2000. MMWR Morb Mortal Wkly Rep., 50:1081–3.
10. Laurencin C T, El-Amin S F (2008): Xenotransplantation in orthopaedic surgery. J Am Acad Orthop Surg., 16:4–8.
11. Valdes MA, Thakur NA, Namdari S, Ciombor DM and Palumbo M (2009): Recombinant bone morphogenic protein-2 in orthopaedic surgery: A review. Arch Orthop Trauma Surg., 129:1651–7.
12. Mulconrey DS, Birdwell KH, Flynn J, Cronen GA and Rose PS (1976): Bone morphogenic protein (RhBMP-2) as a substitute for iliac crest bone graft in multilevel adult spinal deformity surgery: Minimum two-year evaluation of fusion. Spine, 33:2153–9.
13. Roberts TT, Rosenbaum AJ (2012): Bone grafts, bone substitutes, and orthobiologics: the bridge between basic science and clinical advancements in fracture healing. Organogenesis, 8(4):114-24.
14. Meikle M C (2007): On the transplantation, regeneration and induction of bone: the path to bone morphogenetic proteins and other skeletal growth factors. Surgeon, 5:232–243.
15. Sanan A, Haines S (1997): Repairing holes in the head: a history of cranioplasty. Neurosurgery, 40:588-603.
16. Güven O (2007): Rehabilitation of severely atrophied mandible using free iliac crest bone grafts and dental implants: report of two cases. J Oral Implantol., 33:122–126.
17. Laine J, Vähätalo K, Peltola J, Tammisalo T and Happonen R P (2002): Rehabilitation of patients with congenital un repaired cleft palate defects using free iliac crest bone grafts and dental Implants. Int J Oral Maxillofac Implants, 17:573–580.
18. Sekine J, Sano K, Ikeda H and Inokuchi T (2006): Rehabilitation by means of osseointegrated implants in oral cancer patients with about four to six years follow-up. J Oral Rehabil., 33:170–174.
19. Nkenke E, Neukam FW (2014): Autogenous bone harvesting and grafting in advanced jaw resorption: Morbidity, resorption and implant survival. Eur J Oral Implantol., 7:203-17.
20. Frodel J L (2002): Calvarial bone graft harvesting techniques: considerations for their use with rigid fixation techniques in the craniomaxillofacial region. In: In: Greenberg A, Prein J, editor. Craniomaxillofacial Reconstructive and Corrective Bone Surgery. New York: Springer-Verlag., pp. 700–712.
21. Ehrenfeld M, Hagenmaier C (2002): Autogenous bone grafts in maxillofacial reconstruction. In: In: Greenberg A, Prein J, editor. Craniomaxillofacial Reconstructive and Corrective Bone Surgery. New York: Springer-Verlag., pp. 295–309.
22. Medra A M (2005): Follow up of mandibular costochondral grafts after release of ankylosis of the temporomandibular joints. Br J Oral Maxillofac Surg., 43:118–122.
23. Poswillo D E (1987): Biological reconstruction of the mandibular condyle. Br J Oral Maxillofac Surg., 25:100–104.