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Bone Grafts and Substitute Materials

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Introduction

The need for replacing bone lost through trauma, revision surgery or serious pathology has increased dramatically over the last 5 years. Conventionally replacement bone graft has been used either from elsewhere in the patient's own skeleton (autogenous) or from other patients as donors (autogenous). Use of such bone is not without problems.

Normal bone contains many differing bioactive materials all necessary for the growth of bone, including proteins, growth factors and cells providing a support matrix. Use of these materials in the graft promotes healing of the defect or fracture. Through advances in recent research, industry has developed many different types of bone replacement substitutes which are often applicable and thus allows greater choice in the operating theatre.

Autogenous Bone Graft

Bone for grafting defects may be harvested from the patients own skeleton. Perhaps the most common and easiest way that this is achieved is locally harvesting bone for elsewhere in the operative site. For example from the upper tibial during tibial osteotomy for leg realignment. This results in only a small extension of the scar and a degree of short term exacerbation of the local pain.

More extensive amount of graft can be harvested from the pelvis, usually from the prominent and superficial pelvic brim above the hip joint. This provides a good source of both cortical structural bone and cancellous bone which promotes rapid healing. Bone may also become available during joint replacement where the arthritic joint is excised and may be reused as bone graft.

Autogenous graft does not have problems of disease transmission in the same way as autograft. As the tissue is derived from the individual there is no tissue rejection, disease or virus introduction. However although unusual it is possible for the bone to become contaminated during its removal and infection in the graft is an occasional problem.

Allogenic Bone Graft: Allograft.

This bone is harvested form other individuals. This is most commonly harvested at the time an arthritic joint is removed for replacement. The removed bone may then be screened, stored and reused. Alternately bone may be harvested for unfortunate individuals who may die, usually as a result of trauma and who give their consent for organ donation. Bone, articular cartilage, meniscal cartilage and occasionally parts of a joint may be harvested for use in special situations at the same time as liver or kidney transplants are used.

The screening of transplanted tissue for infection, virus or other disease transmission is carefully controlled and regulated. Each laboratory will have a specific protocol for such techniques. Storage is also critical in terms of the storage medium, the temperature control, sterility and duration of storage. Generally the risk of disease transmission in many grafts which have been screened and stored properly has been estimated at less than 1 in 1,000,000.

Bone Graft Substitutes

Several categories of bone graft substitutes exist. These encompass varied materials, material sources, and origins both natural and synthetic. Bone graft substitutes are composed of various materials, and many are formed from composites of 1 or more types of material

Allograft-based bone graft substitutes involve the use of allograft bone used in combination with other materials (eg, AlloGro, Opteform, Grafton, Orthoblast).

Factor-based bone graft substitutes are natural and use the active constituents of allogenic cancellous bone graft. These factors may be purified into individual chemicals such as cellular growth factors such as transforming growth factor-beta [TGF-beta], platelet-derived growth factor (PDGF), fibroblast growth factor (FGF), and bone morphogenetic protein (BMP).

Cell-based bone graft substitutes use cells to generate new tissue alone or seeded onto a support matrix (eg, mesenchymal stem cells).

Ceramic-based bone graft substitutes include chemicals which replicate the mineral calcium hydroxyapatie of bone itself. These include calcium phosphate, calcium sulfate, and bioglass used alone or in combination (eg, OsteoGraf, Norian SRS, ProOsteon, Osteoset).

Polymer-based bone graft substitutes are artificial scaffold or matrixes which encourage the formation of bone. These may be both degradable and nondegradable are either used alone or in combination with other materials (eg, Cortoss, open porosity polylactic acid polymer [OPLA], Immix).

Indications

The most common need for bone grafts are in trauma and road traffic accidents. In such fractures often the bone is comminuted or mission and healing of the defect is assisted by bone grafting.

Other indications are in joint replacement. This is occasionally required in a normal primary joint replacement where the patient may have lost bone through the arthritic process and the joint replacement prosthesis requires additional bone support. This commonly occurs in hip replacement and the treatment of congenital dislocation of the hip joint. Revision of a failed primary joint replacement is an increasingly common surgical procedure as patient live longer, use their replaced joint more and have the primary replacement at an earlier age. In such revision procedure additional bone graft may be necessary to support the new implants.

The third common procedures which may require bone graft is the surgical correction of scoliosis and spinal deformities.

Like all healing fractures the incorporation and healing of bone graft takes a variable length of time, requires immobilisation, stability or rest of the joint or affected part.

Complications

Apart from the anaesthetic risks associated with any surgical procedure other risks with grafts or substitute bone includes: infection, a failure of the graft to heal and incorporate into the skeleton, and very occasionally disease transmission. Tissue rejection may occasionally present a problem in massive allograft of large parts of bones or joints. Compared to other transplants such problems are unusual in bone grafts.

Outcome and prognosis

This is entirely dependent on the type of graft or substitute used and the condition or procedure it was used upon. Any treating physician will be able to provide further information.

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