A new perspective on guided bone regeneration in foot surgery with heterologous materials

Guided bone regeneration (GBR), developed in 1976 by Melcher, is a surgical procedure used to increase the amount of bone volume. It uses barrier membranes with or without particulate bone grafts or/and bone substitutes. The basic principle of osseous regeneration by GBR is that different cells that migrate to the bone defect in the healing process have different speed potentials. A mechanical barrier prevents the ingrowth of unwanted cells (e.g. fibroblasts from surrounding soft tissue) and allows the passage of desired cells (e.g. pluripotential and osteogenic cells). The membranes can be non-resorbable or resorbable, with the obvious elimination of the need for membrane removal of the later.

In GBR for bone defect fulfillment, four primary types of bone graft materials can be used: autologous bone graft, allogenous bone graft, heterologous bone and synthetic materials. An autograft is tissue transferred from one location, mostly form iliac crest, to another within the same individual and is the gold standard in grafting procedures. Autografts are very successful, since they are highly osteogenic (they trigger bone formation even in the absence of undifferentiated mesenchymal stem cells), but it is difficulty of obtain sufficient amount of graft material and there can be possible complications at the donor site. Allografts are tissues transferred from one individual to another genetically different individual of the same species. The main advantage is the avoidance of secondary donor site, but possibility of disease transmission remains a problem. Heterologous grafts (materials from another species) are osteoconductive fillers (they act as scaffold for deposition of new bone from the surrounding bone), so when they are integrated into the human bone, they are slowly replaced by newly formed bone. The main problem is the possible risk of a host-immune response. Synthetic materials (calcium carbonate, calcium sulfate, synthetic hydroxyapatite and tricalcium phosphate) are strictly osteoconductive.

We reported a single case where we used guided bone regeneration with heterologous materials in a 62-year-old Caucasian woman with comminuted calcaneal fracture and depression of Böhler's angle that needed primary subtalar arthrodesis. This procedure is a good option for comminuted calcaneal fractures, since most end in post-traumatic subtalar arthrosis and pain. In primary subtalar arthrodesis the subtalar joint is fixed with hardware and bone graft is added to fill the void. Since our patient had multiple fractures and consequently multiple operations from her injury, we treated her with heterologous materials instead of autologous graft to avoid complications at the possible donor site. We also used a resorbable collagen membrane to maintain tissue guidance during regeneration and to avoid potential non-union. The resorbable collagen membrane plays a key role in bone regeneration process, since (1) it acts as a substrate for platelet activation and aggregation, (2) helps in the differentiation for mesenchymal cells in the bone marrow, (3) increases the proliferation rate of osteoblasts and (4) stimulates tissue healing. The graft was fully incorporated 12 weeks after the procedure and almost two years after the injury, she has no pain and walks without limping.

Overall, we present a new application of GBR for extensive bone defects after comminuted calcaneal fractures. The rapid incorporation of the heterologous bone graft, which was enhanced by the collagen membrane, and the lack of any complications, supports the efficacy of the described method.

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