CHAPTER 17

OSTEOCHONDRAL GRAFT SUBSTITUTES

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Osteochondral defects and lesions are common pathologic entities that present to the podiatric surgeon for diagnosis and treatment. These lesions can develop on any articular surface, but are commonly seen in the first metatarsophalangeal joint with conditions such as hallux limitus and talar dome lesions. Historically, treatment options for osteochondral lesions include marrow-stimulating techniques such as simple debridement with or without fenestration, or abrasion arthroplasty. Other techniques for repair include osteochondral transplants or grafting. These include such procedures as OATS, MosaicPlasty, and COR type procedures. All of these procedures have indications, advantages, and potential disadvantages, and have been developed using the pretense that hyaline cartilage was not reproducible unless new cells where grafted or transplanted.

When a graft is not chosen, then an attempt is made to form fibrocartilage. OsteoBiologics, Inc. has developed a line of porous, resorbable scaffolds that are designed to support normal biologic healing. These grafts are hydrophilic and absorb blood cells, marrow, and proteins, which allow cells that are able to differentiate into bone or cartilage to do so because they have been placed in the proper environment. As a result, hyaline cartilage similar in strength and composition to native cartilage is formed. Different options will be discussed, and the potential advantages and disadvantages of each will be presented.

Marrow stimulating techniques such as abrasion arthroplasty, fenestration, or microfracture offer the advantage of having only one procedure, have a low morbidity, and no additional costs. This is the most common procedure for these issues (Figure 1). The disadvantages are the unpredictable results, are limited to relatively small lesions, and depending on the anatomic location, may require nonweightbearing with or without the use of a continuous passive motion machine. Osteochondral transplant procedures such the OATS, MosaicPlasty, and COR are indicated for well-defined lesions where there is no global osteoarthritis, good alignment of the joint, and no greater than grade II lesion on the opposite surface. The advantage of these procedures is the formation of viable hyaline articular cartilage if the procedure is successful. The disadvantages are limited plug size, donor site morbidity, and cost.

The TruFit BGS plug is a synthetic cylindrical implant that is designed to be press fit into defects and maintain space. The TruFit BGS plug is composed of polylactide-co-glycolide (PLG) copolymer for providing structure, and calcium sulfate for enhancing bone growth. The copolymer is amorphous (non-crystalline) and resorbs in 6-9 months. In addition, polyglycolide (PGA) fibers are incorporated for strength, and surfactant is added to allow fluids to be easily absorbed into the scaffolds. The PGA fibers are aligned in one direction and like rebar in concrete, they add structure and strength. The pores provide the space for nutrients at first and then for ingrowth of bone and cartilage and acts like stepping stones. These are all clinically proven materials commonly found in other medical devices. The scaffolds are structurally sound to effectively fill defects left by surgery, trauma, or disease, and due to their porous nature provide conduits for tissue ingrowth. These multilayered products address three critical portions of osteochondral healing: articular cartilage, tidemark, subchondral bone. Each layer is designed to match the physical and mechanical properties of the adjacent tissue. As implant strength decreases, new tissue is conditioned.

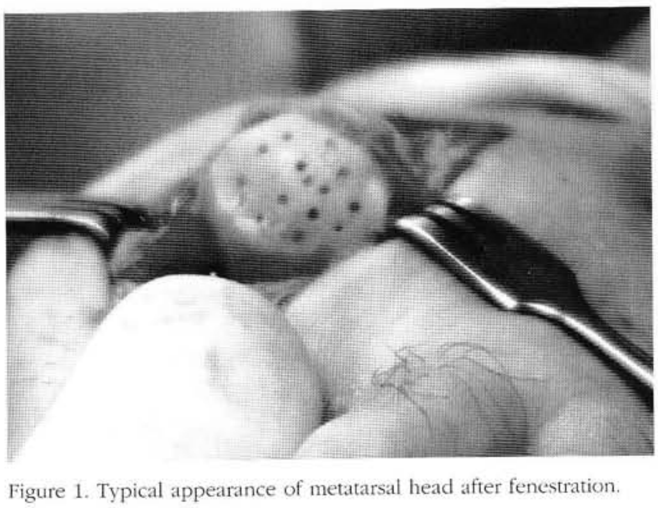

Figure 1. Typical appearance of metatarsal head after fenestration.

The technique for these implants is simple. Instrumentation is provided that allows the subchondral plate to be removed allowing the inflow of blood and marrow with progenitor cells, into the implant. The diameter of the implant matches the diameter of the instrumentation used to remove the diseased bone and cartilage. The implant is then cut to fit and pressed into place. These plugs are hydrophilic, which allows fluids to be wicked into pores and held in place where they provide nutrients for the healing process.

In regard to talar ridge defects, OsteoCure Extremity Plugs have an angled roof design to mimic anatomy of talar ridge. This allow for treatment of osteochondral defects of the medial or lateral aspect of the talus.

Several animal studies have examined the healing of osteochondral defects in the knee joint of adult goats filled with these scaffolds. Gross observations at various time points up to 1 year demonstrated no significant cratering or osteophytosis, indicating a stable articulating joint. The osteochondral defect repair was established throughout the course of this study and there was minimal cartilage flow, with no zone of influence. The histologic analysis confirmed the gross observations that the predominant repair tissue is mostly hyaline cartilage.

Similar clinical evaluations have been performed in human models were the graft sites were re-evaluated from 5-21 months post-operatively because of the need for additional surgery near the original implant site. These studies showed that cartilage had grown into the repair site and it was true hyaline cartilage. This was based on different staining techniques that allow differentiation of collagen and cartilage fibers. Also, the cartilage displayed the same physical characteristics of native cartilage.

In conclusion, these synthetic implants allow for repair of osteochondral lesions, which not only provides for repair of the damaged bone, but cartilage as well. Until recently this benefit required an osteochondral graft from either another harvest site or fresh frozen or bone bank bone. By not requiring an additional harvest site or use of bone graft, cost is decreased and certain risks and complications can be avoided, including donor site morbidity. The graft absorbs in 6-9 months, and

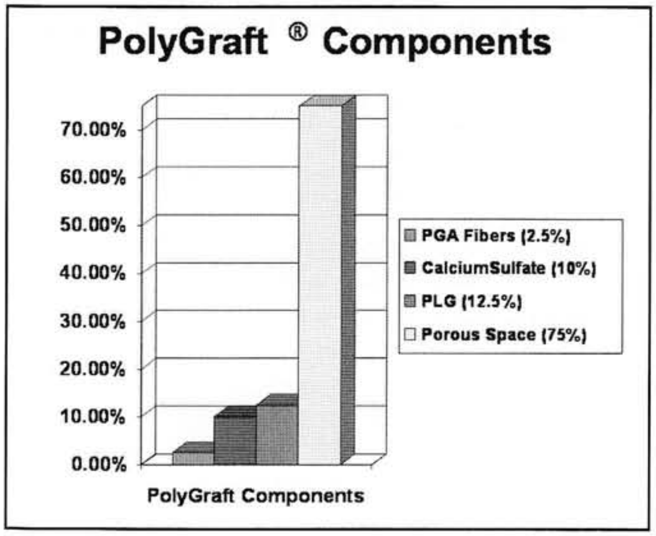

Figure 2. The components of the graft.

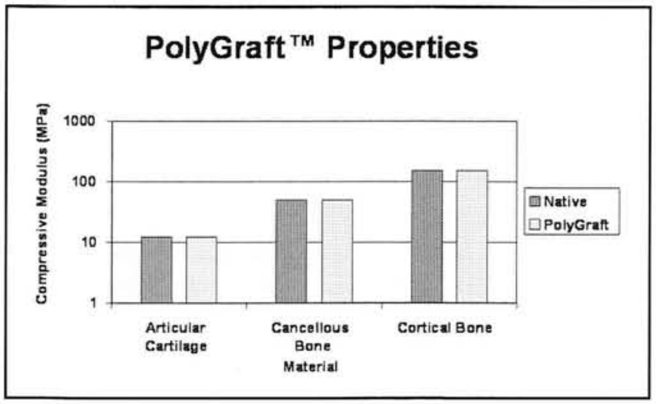

Figure 3. The mechanical properties of the graft.

patients quickly return to normal activities. The author believes that these grafts will cause a paradigm shift in how osteochondral defects are surgically treated.

BIBLIOGRAPHY

Bauer TW, Muschler GF. Bone graft materials: an overview of the basic science. *Clin Orthop Rel Research* 2000;317:10-27.

Friedlaender GE. Current concepts review bone grafts: the basic science rationale for clinical applications. *J Bone Joint Surg Am* 1987;69:786-90.

Jackson DW, Scheer MJ, Simon TM. Cartilage substitutes: overview of basic science and treatment options. *J Am Acad Orthop Surg* 2001;9:37-52.

Niederauer GG, Slivka MA, Leatherbury NC, Korvick DL, Harroff, HH, Ehler WC, et al. Evaluation of multiphase implants for repair of focal osteochondral defects in goats. *Biomaterials* 2000;21:2561-74.