Histologic Analysis of Failed Osteochondral Allografts of the Talus

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Summary: Osteochondral allografting of talar chondral defects is associated with good-to-excellent outcomes at 12-24 months. Despite this success, mechanical collapse of grafts remains a common failure mechanism. The biologic mechanism surrounding graft collapse are poorly understood. As such, a retrieval study was undertaking to characterize the structural features of graft failure. Histologic analysis of failed osteochondral allografts showed necrotic graft bone, and osteoclastic bone resorption localized to the region of mechanical graft fixation.

Introduction: Osteochondral transplantation is a viable treatment option for patients with large, full-thickness chondral defects of the talus. Despite good-to-excellent patient outcomes at 12-24 months, long-term radiographic and clinical follow-up of osteochondral allografts demonstrates a common failure mechanism; graft collapse. While the exact cause of osteochondral allograft failure remains controversial, it is believed to be associated with insufficiency of supporting subchondral bone, failure of chondral incorporation, and failure of osseous incorporation. The goal of this retrieval study is to examine the structural characteristics of failed osteochondral allografts of the talus. A secondary goal of this study is to identify histologic differences in the failed graft tissue as a function of the fixation method used (i.e. metal screw vs. bioabsorbable pin).

Methods: In accordance with an IRB-approved protocol, failed osteochondral allografts of the talus were collected from five patients at the time of revision surgery. All allografts demonstrated radiographic signs of collapse at a duration of implantation greater than one year. Following removal, failed grafts were immersed in zinc formalin and processed for histologic analysis. After fixation, all tissues underwent H&E staining, as well as Safranin-O/Fast Green staining to assess proteoglycan content. A minimum of six slides of each stain were taken from each retrieved specimen and analyzed by phase contrast microscopy equipped with digital image acquisition.

Results: Three of the five allograft specimens exhibited subchondral bone with empty lacunae, indicative of necrotic osseous tissue. All five specimens demonstrated significant chondrocyte apoptosis in the deep layers of cartilage, characterized by abnormal clustering of cells as shown in Figure 1. The interface of the host tissue and graft showed evidence of bone-to-bone healing, with osteoclast-mediated resorption most prominent towards the interior of the graft. Four of the five talar grafts in this study were fixed to the native talus using titanium screws in the inferior to superior direction, while the fifth specimen was fixed to the host tissue utilizing a bioabsorbable pin in the transverse direction. In all five specimens, the screw/pin holes were sites characterized by inflammatory infiltrate and intense osteoclastic bone resorption. In two of the five specimens, clusters of dark particulate, presumably titanium debris from the screw, were engulfed by inflammatory cells. The tissue surrounding the bioabsorbable pin was also characterized by a thick layer of fibrous tissue, with an inner ring of inflammatory infiltrate and multinucleated cells.

Conclusion: From this histologic investigation of failed osteochondral allografts of the talus, collapse of the graft is preceded by chronic inflammation and osteoclastic resorption. While osteoclastic activity is necessary for proper remodeling and incorporation of the graft with host bone, the exact cause of the over-exuberant resorptive activity caputina ting graft collapse remains unknown. Bioabsorbable pin fixation was associated with the presence of a periphery of fibrous tissue around the site of pin insertion, which may indicate that polymer degradation and/or micromotion at the pin-tissue interface plays a role in graft fixation. As the vast majority of osteoclastic bone resorption was localized to the region of mechanical fixation, it is hypothesized that the mode and material used for osteochondral allograft fixation plays a significant role in mid- to late-term failure.