Cartilage Arthroscopic Surgery – What is Important to Know?

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BACKGROUND

Articular cartilage lesions are frequently encountered during arthroscopic examination of the knee and other joints. These injuries are a significant cause of functional disability, and may be associated with progressive chondral damage and degenerative changes of the affected joint. Cartilage has limited intrinsic healing potential due to the avascular structure and low mitotic activity of constituent cells to repopulate damaged chondrocytes. A number of methods have been studied that are designed to provide a biological solution to repair injured articular cartilage. When applied arthroscopically, these techniques have the potential to accelerate rehabilitation and to reduce perioperative morbidity.

The ultimate goal of cartilage repair procedures is the restoration of chondral tissue with sufficient structural and biomechanical integrity, and with adequate durability to sustain proper function over the long-term. There are several techniques of cartilage repair that may be used arthroscopically, although the quality of repair tissue will vary depending on the capability of the technique to restore hyaline-like cartilage. Marrow stimulation techniques have a long history of arthroscopic use and are technically easy to perform, however, there is concern that repair tissue lacks durability. More recently, there have been advances in cell-based cartilage repair techniques that provide a method to repair cartilage in a minimally invasive fashion, and also encourages the restoration of hyaline-like repair tissue that is expected to have superior durability.

CONTENT

In preparation for performing arthroscopic cartilage repair procedures, a number of training methods have proven to be valuable. Computer simulation labs, cadaver labs, and similar workshops led by an experienced tutor provide a natural training environment to introduce surgeons to advanced techniques of cartilage restoration. These types of workshops provide the most realistic training environment, apart from the operating theatre. Unfortunately, regular access to such sessions involving cadaver specimens is typically limited. In addition to these preparatory training methods, improvements in the design of arthroscopic instruments for cartilage repair have been an important advancement. Training for all levels of practitioner using modern instruments designed specifically for cartilage lesion preparation and repair (eg. chondrectomes) has great benefit and likely improves the consistency and quality of cartilage repair procedures.

Ideal cartilage repair is a process that results in restoration of hyaline-like cartilage composed of predominantly type II collagen, and leads to basal and lateral integration of the repair tissue, without mineralization or advancement of the tidemark. Irrespective of the repair technique used, careful attention should be paid to the method of cartilage lesion preparation, as

improper technique will result in a suboptimal environment for repair tissue to form. Loose chondral tissue should be excised, and lesions should be debrided back to a stable peripheral margin, with surrounding cartilage walls perpendicular to the subchondral plate. Calcified cartilage at the base of the defect should be removed, without significantly damaging the subchondral plate.

Marrow stimulation techniques, such as microfracture and subchondral drilling, have been developed to stimulate the production of repair tissue within cartilage defects, and may be easily performed arthroscopically.[1] These techniques rely on the release of marrow elements containing precursor cells and a variety of growth factors from adjacent bone marrow. With respect to marrow stimulation techniques specifically, cartilage repair tissue tends to consist of predominantly fibrocartilage, as opposed to hyaline-like cartilage that would contain a preponderance of type II collagen. It is important to recognize the limitations of marrow stimulation procedures when treating cartilage injury, to optimize patient outcomes and to minimize risk of early treatment failure.

Regarding cell-based treatment options, cartilage repair may be performed in a multi-step manner using techniques such as matrix-assisted autologous chondrocyte implantation, or more recently, in a single-stage using scaffold-embedded bone marrow aspirate concentrate.[2,3] This technique relies on the presence of mesenchymal stem cells, as well as growth factors, in order to stimulate differentiation and proliferation of chondrocytes, potentially leading to restoration of hyaline-like cartilage. The technique of cartilage repair using a hyaluronic acid-based scaffold embedded with bone marrow aspirate concentrate (HA-BMAC) has demonstrated good medium-term clinical outcomes, superior to that of marrow stimulation, as is performed in a one-stage procedure, at a cost significantly lower than would typically be associated with autologous chondrocyte implantation.[2] The HA-BMAC technique, in properly indicated lesions, may be used in arthroscopic fashion to treat cartilage lesions within all three knee compartments.[4]

With respect to cartilage injury that is associated with significant damage or deficiency of subchondral bone, treatment options include osteochondral allograft transplantation, osteochondral autograft transfer, or cell-based methods of repair. The first cell-based technique using autologous chondrocyte implantation was termed a “sandwich” technique, and involves bone grafting of subchondral bone deficiency followed by implantation of autologous chondrocytes between layers of periosteum or biocompatible scaffolding. Recently, a one-stage cell-based procedure called biologic inlay osteochondral reconstruction (BIOR) has been developed, and may be used arthroscopically to treat cartilage lesions that require restoration of subchondral bone deficiency.[5]

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