Autologous Chondrocytes and Next-Generation Matrix-Based Autologous Chondrocyte Implantation

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KEYWORDS

• Knee • Cartilage • Cartilage repair • Autologous chondrocyte implantation
• Transplantation • Autologous • Chondrocytes/*transplantation • Articular/*surgery

KEY POINTS

- Identify type of lesion (traumatic or idiopathic).
- Evaluate associated lesions (malalignment, meniscal lesion, and ligamentous instability).
- Long length alignment radiograph and MRI are important complementary studies.
- Conservative measures should be exhausted before proceeding with surgical treatment.
- Autologous chondrocyte implantation is indicated for the treatment of medium to large, full-thickness cartilage defects (>2 cm^2).

INTRODUCTION

Focal chondral defects of the knee are common and can significantly impair quality of life. Studies have demonstrated chondral or osteochondral lesions in up to 61% to 66% of patients undergoing knee arthroscopy.[1–3] A recent systematic review estimated the overall prevalence of focal chondral defects of the knee specifically in athletes to be 36%.[4] However, the true incidence and prevalence is difficult to determine because a large percentage of defects are asymptomatic. If left untreated, these defects can lead to osteoarthritis.[5,6]

Surgical techniques to restore articular cartilage have the goal to increase quality of life by improving pain and function, and also potentially delay or prevent the need for knee arthroplasty. Autologous chondrocyte implantation (ACI) was first described in 1994.[7] It is a 2-stage procedure: the first procedure includes the arthroscopic

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evaluation of the chondral defect(s) and an articular cartilage biopsy, and the second stage is the implantation of the cultured chondrocytes.

The ACI technique has evolved over the past 20 years: the first-generation technique involved the use of a periosteal patch (pACI) harvested from the proximal tibia.[7] This early periosteal patch technique resulted in a high rate of graft hypertrophy often requiring reoperation for arthroscopic debridement.[8,9] The second-generation technique (cACI) uses a type I/III collagen membrane The newest third-generation technique seeds and cultivates the collagen membrane with chondrocytes before implantation and is referred to as matrix-induced autologous chondrocyte implantation (MACI).[10] These techniques and their outcomes are discussed in this article.

PATIENT EVALUATION OVERVIEW

Clinical Evaluation: History and Physical Examination

Unfortunately, neither history nor clinical examination is sensitive or specific for cartilage defects versus other intra-articular derangements, such as meniscal tears.

Clinical complaints:

- Knee pain: important to identify location (medial, lateral, anterior, or posterior), position of the knee (flexion or extension), and situations that increase or decrease pain (weight-bearing vs non–weight-bearing, stairs vs flat ground, specific activities).
- Swelling: important to know degree, frequency, and related activities.
- Mechanical symptoms: catching and locking may be present as well as a feeling of instability.

Traumatic etiologies are often associated with a specific event, such as a fall or twisting injury during sports; for example, patellar dislocation, ACL tear, or direct blunt force trauma. Idiopathic lesions and those associated with repetitive microtrauma may have more of an insidious onset without an event the patient can recall.

Physical examination:

- Gait analysis
- Tibiofemoral malalignment and patellar maltracking (static varus or valgus, dynamic valgus with single leg squat; increased Q-angle and rotational malalignment, with increased femoral anteversion and in-toe or out-toe pattern)
- Patellar malalignment/maltracking (lateral position and lateral tilt, patella alta; and J-sign and subluxation with quadriceps contraction in extension)
- Muscle strength, flexibility, and atrophy (core: abdomen, dorsal and hip muscles; and lower limb: quadriceps, hamstrings, and gastrocnemius)
- Effusion
- Crepitus
- Active and passive range of motion (spine, hips, and both knees)
- Location of pain/tenderness to palpation (medial, lateral, distal, or retropatellar)
- Ligamentous and soft tissue stability/imbalance (tibiofemoral and patellar: apprehension, glide test, and tilt test)

Imaging

Imaging studies allow characterization of the lesions, identification of associated lesions (ligaments and meniscus), and alignment. In the tibiofemoral joint, the alignment is evaluated by the mechanical axis. Tibial or femoral deformities should be noted. Patellofemoral joint alignment is evaluated by patellar height, tilt, and tibial-tubercle trochlear-groove distance (TT-TG).