Biochemical and Cellular Assessment of Acetabular Chondral Flaps Identified During Hip Arthroscopy

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Purpose: To analyze chondral flaps debrided during hip arthroscopy to determine their biochemical and cellular composition. **Methods:** Thirty-one full-thickness acetabular chondral flaps were collected during hip arthroscopy. Biochemical analysis was undertaken in 21 flaps from 20 patients, and cellular viability was determined in 10 flaps from 10 patients. Biochemical analysis included concentrations of (1) DNA (an indicator of chondrocyte content), (2) hydroxyproline (an indicator of collagen content), and (3) glycosaminoglycan (an indicator of chondrocyte biosynthesis). Higher values for these parameters indicated more healthy tissue. The flaps were examined to determine the percentage of viable chondrocytes. **Results:** The percentage of acetabular chondral flap specimens that had concentrations within 1 SD of the mean values reported in previous normal cartilage studies was 38% for DNA, 0% for glycosaminoglycan, and 43% for hydroxyproline. The average cellular viability of our acetabular chondral flap specimens was 39% (SD, 14%). Only 2 of the 10 specimens had more than half the cells still viable. There was no correlation between (1) the gross examination of the joint or knowledge of the patient's demographic characteristics and symptoms and (2) biochemical properties and cell viability of the flap, with one exception: a degenerative appearance of the surrounding cartilage correlated with a higher hydroxyproline concentration. **Conclusions:** Although full-thickness acetabular chondral flaps can appear normal grossly, the biochemical properties and percentage of live chondrocytes in full-thickness chondral flaps encountered in hip arthroscopy show that this tissue is not normal. **Clinical Relevance:** There has been recent interest in repairing chondral flaps encountered during hip arthroscopy. These data suggest that acetabular chondral flaps are not biochemically and cellularly normal. Although these flaps may still be valuable mechanically and/or as a scaffold in some conductive or inductive capacity, further study is required to assess the clinical benefit of repair.

Advances in hip imaging (namely magnetic resonance arthrography) and arthroscopic instrumentation have fueled the recent growth of hip arthroscopy as an option for addressing intra-articular pathology. In comparison with other joints, full-thickness delamination injuries of the articular cartilage from the acetabular rim are relatively common findings in the hip, particularly in the setting of femoroacetabular impingement (FAI) (Fig 1).[1] The treatment of acetabular chondral flaps encountered during hip arthroscopy is still evolving. Closely mirroring the established practice patterns in knee arthroscopy, acetabular partial-thickness articular cartilage tears are often addressed with debridement/chondroplasty and full-thickness defects are often addressed with chondroplasty and microfracture.[2] Given the relative frequency with which these flaps are seen, the general appearance of these flaps as looking grossly normal, and the relatively poor long-term outcomes of microfracture, clinicians have sought alternative treatments to chondroplasty and microfracture for these patients. In the past few years, there has been an interest in preserving chondral flaps that appear grossly normal but are separated from the subchondral bone.

Recently, there have been publications describing techniques for repairing acetabular chondral flaps arthroscopically. In 2009 Sekiya et al.[3] described microfracture under a chondral flap followed by suture

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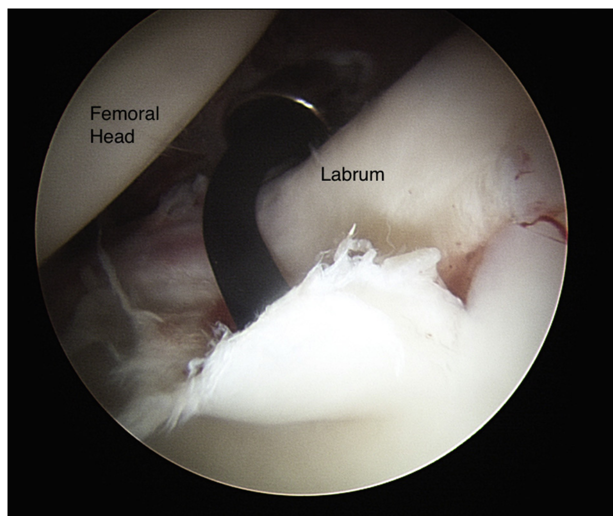

Fig 1. Viewing from a posterior portal, the probe is elevating a chondral delamination flap encountered during right hip arthroscopy.

repair of the flap. In 2010, following the guidelines established for knee arthroscopy, Yen and Kocher[2] described chondroplasty for partial-thickness tears of the articular cartilage and microfracture for full-thickness defects encountered during hip arthroscopy. In 2010 Tzaveas and Villar[4] described microfracture beneath the flaps followed by securing the flaps to the subchondral bone with a fibrin adhesive (Tisseel Kit; Baxter Healthcare, Norfolk, England) with the joint "dry" (i.e., fluid evacuated). At a minimum of 1 year of follow-up of 43 patients using this technique, there was significant improvement in pain and function scores.[5] Recently, Villar[6] has reported repair of these chondral flaps with FasT-Fix suture anchors (Smith & Nephew, Andover, MA) in 36 patients with a minimum of 2 years' follow-up.

However, before further pursuing the path of developing and recommending techniques for chondral repair, it is prudent to first study the composition of these flaps to ascertain whether they are indeed worthy of preservation. Whereas the biochemistry and cellular viability of knee cartilage have been studied in the setting of repair techniques, similar work has not been performed in hips. The purpose of this study was to analyze chondral flaps debrided during hip arthroscopy to determine their biochemical and cellular composition. Our hypothesis was that the acetabular chondral flaps would be healthy based on their biochemical composition and cellular viability.

Methods

Biochemical Analysis

From August 2008 to April 2009, the senior author (M.R.S.) prospectively retrieved all full-thickness acetabular chondral flaps encountered during hip arthroscopy performed for any reason in patients with underlying FAI. There were no patient exclusion criteria. Institutional review board approval was obtained.

The senior author (M.R.S.), along with a sports and joint arthroplasty fellowship–trained orthopaedic surgeon coauthor and colleague (S.H.), independently reviewed and characterized the flaps. Flaps were characterized as "thick" if they were over 75% of the thickness of the patient's normal acetabular cartilage; the rest were described as "thin." The surrounding cartilage was characterized as "normal" if the edge of the defect after debridement was a fairly vertical wall and "degenerative" otherwise. If the determinations were not the same, a further joint re-review of the imaging and discussion ensued until an agreement was achieved. Although these are subjective characterizations, phenotypic descriptions may be helpful to the practicing clinician intraoperatively deciding whether to repair a patient's articular cartilage.

The acetabular chondral delamination flaps were stored in phosphate-buffered saline solution at 4°C until the samples were tested. A papain digest was then performed. As detailed in the Appendix, these samples were then prepared and analyzed for concentrations of DNA (an indicator of chondrocyte content), hydroxyproline (OH-Pro, an indicator of collagen content), and glycosaminoglycan (GAG) (an indicator of chondrocyte biosynthesis). Larger numbers in these measures indicate better cartilage health.

An extensive review of the literature showed a lack of normal reported values of DNA, GAG, and OH-Pro concentrations for human acetabular cartilage for comparison with the biochemical values of the specimens retrieved in this study. As a result, the literature was searched to seek normative values in animal models: infant calf knees for DNA,[7] human femoral heads for GAG,[8] and rabbit femoral heads and condyles for OH-Pro.[9]

Cellular Analysis

From June 2010 to August 2010, the senior author (M.R.S.) prospectively retrieved all full-thickness acetabular chondral flaps encountered during hip arthroscopy performed for any reason in patients with underlying FAI. There were no patient exclusion criteria. Institutional review board approval was obtained.

The chondral specimens were prepared as detailed in the Appendix. Images were captured using a Zeiss Axio Observer Z1 (Carl Zeiss, Jena, Germany) at 10 times magnification. Images were analyzed in the Zeiss AxioVision 4.8 program (Carl Zeiss) in all cases. A Zeiss add-on module provided automated measuring for cell counting. Cell viability was determined by dividing the

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