Viability and Expression of Chondrocytes Harvested During Arthroscopic Treatment of Femoroacetabular Impingement

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INTRODUCTION:

Chondral lesions of the hip pose a unique and challenging entity to hip preservation surgeons. These lesions can be encountered frequently during arthroscopic and open hip preservation procedures; however, their clinical significance and definitive management remain controversial. Cartilage restoration procedures within the hip can be invasive and challenging based on the relative difficulties in access and articular surface contour matching in this joint. Cell-based cartilage restoration techniques have become popular for clinical use in other joints. Autologous cartilage implantation (ACI) and membrane-delivered ACI (MACI) allow the patient's chondrocytes to be delivered into articular defects and have consistently resulted in favorable outcomes in the knee. As such, cell-based techniques involving chondrocyte implantation may be useful to treatment of articular defects in the hip joint. During surgery for femoroacetabular impingement, there is often need for resection of an osteochondral cam lesion; while causing impingement, cam lesions may also contain viable chondrocytes that could be appropriate for use in cell-based cartilage restoration. The purpose of our study was to arthroscopically collect resected cam-lesion tissues that would otherwise be discarded for subsequent cell culture as a proof of concept for clinical feasibility.

METHODS:

Patient Selection:

Institutional Review Board approval (#2016684) and informed consent were obtained for collection of otherwise-discarded tissues from patients indicated for surgical management of labral tears and/or femoroacetabular impingement (FAI). The primary criterion for inclusion was patients undergoing arthroscopic FAI surgery who had failed nonoperative management. Exclusion criteria included inability to provide informed consent, lateral center edge angle (LCEA) <20, concomitant open procedures, prior failed arthroscopic hip surgery, hip arthroscopy for reasons other than FAI, and absence of CAM lesion requiring bony debridement. Surgical procedures were performed by two fellowship trained hip preservation surgeons at a single institution. Patient enrollment began December 28, 2021.

Surgical Technique:

Standard three-portal hip arthroscopy was performed on a post-less suspension table. Labral repair was performed with number of anchors determined at the discretion of the operating surgeon. Femoroplasty was performed based on the patient's pre-operative alpha angle, and resected tissue was collected using a motorized shaver with a commercially available in-line suction filter (Graftnet, Arthrex Inc., Naples, FL). Capsular closure was performed at the discretion of the operative surgeon. A standardized post-operative management and rehabilitation protocol was initiated.

Tissue Recovery and Chondrocyte Cell Culture:

A total of 6 female patients (mean age 30.07 (21.5-45.2), mean body mass index (BMI) 25.87 (21.5-28.4)) have been included to date.

Collected tissues were transported to the in-house laboratory, aseptically weighed, and up to 200 mg exposed to collagenase type II (750 U/mL in 10 mL of 10% FBS DMEM media) for 16-24 hours to release chondrocytes from the matrix. Isolated cells were counted and seeded onto T-25 flasks in Dulbecco's modified eagle medium (DMEM) (Thermo Fisher Scientific, Waltham, MA) supplemented with 10% Fetal Bovine Serum (FBS) at 5% CO_2, 37°C, and 95% humidity. Media were changed every 3 days until passage 0 reached >90% confluency. At confluency, cells were counted and seeded onto a T-175 flask in DMEM supplemented with 10% FBS at 5% CO_2, 37°C, and 95% humidity for first passage. Media were changed every 3 days until reaching >90% confluency. Cells were counted, and if the total did not surpass 20 million based on minimum number needed for cell-based treatments, then the cells were split and placed onto two T-175 flasks in DMEM supplemented with 10% FBS at 5% CO_2, 37°C, and 95% humidity for an additional passage. Media were changed every 3 days until second-passage flasks reached >90% confluency. Cells were counted after passage 2 for the final passage as the predetermined limit for cell expansion based on maintenance of chondrocyte phenotype.

Analysis:

Tissue weight collected, initial cell number, and days to reach >20 million cells were calculated. Means ($\pm$SD) and medians are reported.

RESULTS:

Mean weight of the arthroscopically collected tissues was 175 +/- 44.61 mg (median = 180 mg). Of the 6 samples, 4 reached total cell counts of >20 million cells by confluency in passage 2. Of the two that failed to reach the minimum threshold, one did not have sufficient cells following digestion to establish primary cell culture and the other did not

progress toward confluency for passage 1. Collected tissue weights for the two failed samples were 200 mg and 90 mg, respectively. Of the samples which successfully expanded, mean initial cell seeding was 475,000 +/- 189,297 cells (median = 550,000 cells). For successful expansions, two samples reached the predetermined threshold by confluency in passage 1, while the other two reached the threshold by confluency in passage 2. The predetermined threshold of 20 million total cells was reached at a mean of 24.5 +/- 4.8 days (median = 24 days).

DISCUSSION AND CONCLUSION:

This proof-of-concept study supports clinically relevant feasibility for arthroscopic collection of otherwise-discarded tissue from cam lesions resected for surgical treatment of FAI to allow for cell culture and expansion sufficient for use in autologous chondrocyte implantation procedures. Ongoing studies in our laboratory are aimed at standardization of this technique for subsequent optimization towards cell-based cartilage restoration options for hip preservation.