Restoring Knee Function with Arthroscopic Particulated Juvenile Articular Cartilage Allograft Implantation: Two-Year Outcomes

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INTRODUCTION: High-grade osteochondral lesions of the knee can cause persistent pain, functional loss, and progression to osteoarthritis if left untreated. Particulated juvenile articular cartilage (PJAC) implantation is a single-stage cartilage restoration technique with encouraging short-term outcomes, but data on its performance using an entirely arthroscopic approach is limited. We hypothesized that arthroscopic PJAC implantation would produce significant improvement in patient-reported outcomes at 24-month follow-up.

METHODS: This IRB-approved retrospective cohort study included 77 patients (40 female, 37 male) with 86 total lesions from two institutions who underwent primary arthroscopic implantation of PJAC for high-grade osteochondral lesions (International Cartilage Repair Society grade IV) of the knee from 2019 to 2024. Informed consent was obtained from all participants. Patient demographics, surgical details, and nine Knee injury and Osteoarthritis Outcome Score (KOOS) subscales, including three derived from the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), were collected preoperatively and 24 months postoperatively. Pre- and postoperative scores were compared with Wilcoxon signed-rank tests. Multivariable linear regression models (MLRMs) identified associations between 24-month outcomes and demographic or surgical variables, and linear mixed-effects models (LMMs) evaluated for associations longitudinally.

RESULTS: Mean age was 41.9 years (SD 11.1) and mean BMI was 28.8 kg/m² (SD 5.4). 49% of lesions involved the right knee and 51% the left, with a mean area of 2.87 cm² (SD 1.66). 22% of lesions were in the medial compartment, 54% patellofemoral, and 24% lateral; 12% of knees involved lesions at two sites. All nine KOOS subscales improved from baseline to 24-month follow-up (all $p<0.002$). Both MLRMs and LMMs found no consistent associations between lesion area, location, or demographic variables and KOOS scores across subscales. The most notable, was that higher BMI was associated with lower scores in 3 of 9 subscales (KOOS Activities of Daily Living, KOOS Quality of Life, and WOMAC Function), with an average 0.77-point decrease per 1-unit BMI increase. All other statistically significant associations were less frequent. No cases of acute graft displacement were observed. Two patients experienced late graft failure with delamination, occurring at 2.3 and 3.1 years postoperatively, requiring revision procedures.

DISCUSSION: This demographically diverse cohort demonstrated significant improvement across all KOOS domains at 24 months. Thus, arthroscopic implantation of PJAC provides significant symptomatic relief for patients with high-grade knee osteochondral lesions. These results were not consistently affected by lesion size, location, or other demographics. Higher BMI, though, was loosely associated with a negative impact on outcomes, suggesting patients with elevated BMI may derive less symptomatic benefit and warrant targeted counseling. Despite concerns that arthroscopic implantation may increase acute graft displacement risk due to intraoperative lavage, no such events were observed. Study limitations include modest sample size, relatively short follow-up, and lack of a comparator group. Extended follow-up and comparative arms are needed to assess this technique's durability.

SIGNIFICANCE/CLINICAL RELEVANCE: High-grade osteochondral lesions of the knee remain challenging to treat, and evidence supporting minimally invasive cartilage restoration options is limited. This study demonstrates that arthroscopic PJAC implantation can provide durable, clinically meaningful improvement across diverse lesion sizes and locations without increasing the risk of acute graft displacement, supporting its potential role as a safe and effective treatment option.

REFERENCES:

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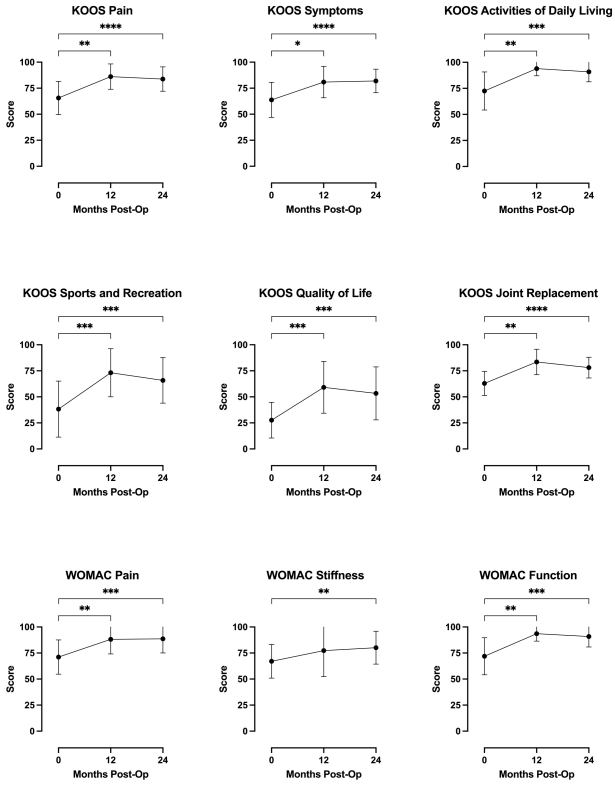

IMAGES AND TABLES:
Figure 1. Knee injury and Osteoarthritis Outcome Score (KOOS) results for each subscale, during follow-up period.