Arthroscopic Repair of Acetabular Cartilage Lesions by Chitosan-Based Scaffold: Clinical Evaluation at Minimum 2 Years Follow-up

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Purpose: To evaluate the functional outcome of using chitosan-based material in our patients after 2 years of follow-up. **Methods:** Nonarthritic nondysplastic femoroacetabular impingement patients with an acetabular chondral lesion, 18 to 55 years of age, were included for arthroscopic repair between May 2013 and July 2015. Full-thickness chondral defects $\geq$2 cm^2 were filled with chitosan-based implant after microfractures. Follow-up consisted of alpha angle assessment and clinical outcome in the form of the Non Arthritic Hip Score (NAHS), International Hip Outcome Tool 33 (iHOT33), Hip Outcome Score of Activities of Daily Living (HOS-ADL), and Hip Outcome Score of Sports Specific Scale (HOS-SSS). **Results:** Twenty-three patients were included. The mean follow-up was 38.4 $\pm$ 7.0 months (range, 24-50 months). The mean defect size was 3.5 $\pm$ 1.0 cm^2, principally involving zone 2 and to a lesser extent in zones 1 and 3. Using femoroplasty, the alpha angle was corrected from a mean 70.5 $\pm$ 6.3° to 44.3 $\pm$ 4.9° (P = .00001). Significant improvement occurred comparing the preoperative to the first-year postoperative patient-reported outcomes: P = .00001 for the NAHS, P = .00004 for the iHOT33, P = .00005 for the HOS-ADL, and P = .0002 for the HOS-SSS. No statistically significant change has been observed in the patient-reported outcomes obtained at the endpoint when compared with the first-year values (P = .13 for the NAHS, P = .21 for the HOS-ADL, and P = .29 for the HOS-SSS), except for the iHOT33, which showed further significant improvement (P = .02). Up to 91% of the patients met or exceeded the minimal clinically important difference. One patient needed total hip arthroplasty. Perineal hypoesthesia occurred in 3 patients, who recovered within 2 to 6 weeks, and 1 patient needed a prolonged physiotherapy program for postoperative muscular stiffness. **Conclusions:** The arthroscopic combined treatment of microfractures and chitosan-based scaffold has maintained satisfactory clinical outcomes in 91% of the patients with s large ($\geq$2 cm^2) full-thickness acetabular chondral defect associated with femoroacetabular impingement at a mean follow-up of 38.4 months. The study could not definitely draw any conclusion regarding the safety of chitosan-based material for use in the hip joint. **Level of Evidence:** Level IV, case series.

Acetabular cartilage damage occurs in association with femoroacetabular impingement (FAI) owing to the abnormal shear stresses, mostly in the anterosuperior area, leading to chondral delamination and labral tears.[1,2] This continuous pathologic process in young active patients may lead to early osteoarthritis.[3]

Lesion size and severity are considered primary determining factors for the strategy of management and the expected prognosis.[4,5] One of the treatment procedures is the technique of microfractures, which depends on stimulation of the subchondral bone marrow through liberating the progenitor cells, and finally formation of a fibrocartilage patch that covers the defect, but this fibrocartilage tissue has poor biomechanical properties.[6,7] When the defect is large in size, the fibrocartilage repair patch tends to shrink over time and separate from the surrounding structures.[7,8]

Scaffold augmentation techniques have emerged to enhance the biomechanical and biochemical properties of cartilage repair tissue after microfractures. Different scaffold materials, such as polyglycolic acid/hyaluronan, chitosan-glycerol phosphate blood, and chondroitin

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sulfate/hydrogel composites, have been studied in experimental animal trials and have shown a significant improvement in the mechanical properties and a histologic structure similar to the native cartilage.[8-11] Clinical trials of chitosan-based scaffold for treating chondral defects in the femoral condyle of human knees showed adequate safety for clinical practice and presented favorable histologic and functional results.[12,13]

In our work, we used the technique of scaffold augmentation, using chitosan-based implant, for treatment of large full-thickness acetabular cartilage lesions associated with FAI. This study was conducted to evaluate the functional outcome of using chitosan-based material in our patients after 2 years of follow-up. Depending on the previous studies, we hypothesized that the technique will give satisfactory clinical results and improvement in the patient-reported outcome (PRO) scores.

Methods

Patient Selection

From May 2013 to July 2015, we included patients between 18 and 55 years old who had a clinical diagnosis and radiologic evidence of FAI associated with an acetabular chondral lesion. Exclusion criteria were inflammatory joint disease, radiologic signs of osteoarthritis (Tönnis grade $\geq$2), or hip dysplasia (lateral center edge angle of Wiberg $<25^{\circ}$, acetabular index angle of Tönnis $>10^{\circ}$). Final inclusion in the study was decided during the arthroscopic procedure when the patient had a full-thickness acetabular cartilage lesion $\geq$2 cm^2 after adequate debridement.

Arthroscopic treatment was indicated primarily for patients who presented with groin pain related to hip motion and a clinical examination suggestive of impingement (limited range of motion [ROM], mainly internal rotation, and tests for flexion, adduction, and internal rotation, flexion abduction external rotation, and dynamic internal rotation, as well as the dynamic external rotatory impingement test).[14,15] Diagnosis was confirmed by radiologic assessment. Initially, plain radiographs in the standard anteroposterior view and 45° Dunn lateral view were obtained. The lateral center edge angle of Wiberg and acetabular index angle were measured in the anteroposterior view to exclude dysplastic cases. The alpha angle was measured in the 45° Dunn view (which correlates with the 1:00-2:00 o'clock position) to determine the cam morphology.[16,17] All patients were investigated preoperatively by magnetic resonance angiography to evaluate the labrum and the articular cartilage.

All patients who had indications for the procedure and met the inclusion criteria received an adjuvant treatment of the acetabular chondral lesion by microfracture and chitosan-based scaffold, in addition to treatment of the underlying FAI. Primary treatment of FAI consisted of arthroscopic femoroplasty for cam deformity, acetabuloplasty for pincer impingement, and repair of associated labral tears.[18-20] All patients participating in the study provided a written informed consent after fulfilling the rules of the Ethical Committee of Clinical Research.

Surgical Technique

The technique of application of chitosan-based implant has been described by Tey et al.,[21] which provided a guide for the surgical procedure in the current study. The operations were performed by 2 senior surgeons (M.T., J.M.), who strictly followed the original technique and steps. Diagnostic hip arthroscopy began with exploration of the central compartment with the patient in the supine position, and appropriate traction was applied to the operating limb. The acetabular cartilage was classified according to the Outerbridge classification[22] (as a standard method) and Beck's system[1] (as a hip-specified system). Full-thickness acetabular cartilage lesions (Outerbridge IV or Beck's III, IV) were treated by full debridement and microfracture (Figs 1 and 2). A motorized shaver and a curette were used for removal of the damaged cartilage and exposure of subchondral bone, then microfractures were performed by 60° arthroscopic awl with a depth of 2 to 3 mm every 5 mm through the entire defect. After adequate debridement, the size of the defect was measured by a calibrated arthroscopic probe and the lesion was localized according to the geographic zone method.[23] Lesions $\geq$2 cm^2 were further treated by the

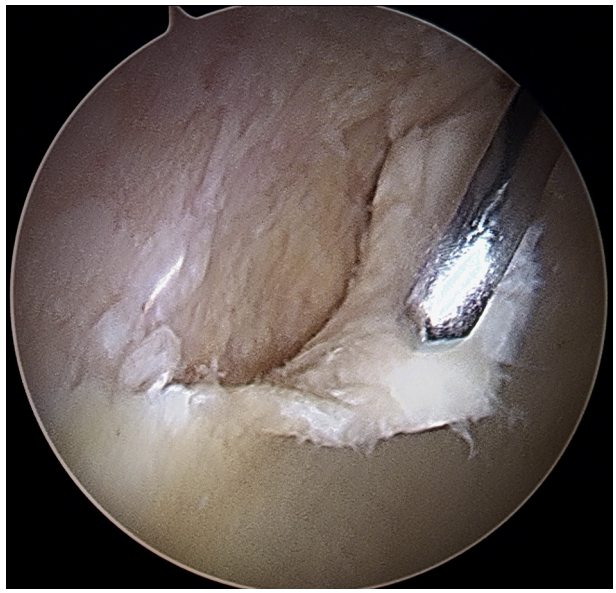

Fig 1. Arthroscopic image of a right hip (viewed from the anterolateral portal) demonstrating delaminated chondral flap in the acetabular cartilage involving zone 2. A full-thickness lesion can be seen exposing the subchondral bone.