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Arthroscopic mosaicplasty: Long-term outcome and joint degeneration progression

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ABSTRACT

Background: This study aims to document the long-term results in a group of patients treated with arthroscopic mosaicplasty for knee cartilage lesions, both in terms of clinical outcome and joint degeneration progression, evaluated by radiographs.
Methods: 26 patients (19 men and 7 women, mean age 29 years, mean BMI 23) treated arthroscopically with mosaicplasty for cartilage defects of the femoral condyles (mean/median/mode size 1.9 standard deviation, SD 0.6 cm^2) were prospectively evaluated at 12 years follow-up. The clinical outcome was analyzed with IKDC and Tegner scores. Range of motion, transpatellar and suprapatellar circumferences were also measured. Radiographs with weight-bearing antero-posterior and Rosenberg projections were used for radiological evaluation in 18 patients, applying both Kellgren–Lawrence score and a direct joint line measurement to assess osteoarthritis.
Results: A significant improvement in all clinical scores was obtained from the basal evaluation to the 12-year follow-up (IKDC subjective score from 36.8 standard deviation, SD 13.0 to 77.3 standard deviation, SD 20.6, $P < 0.0005$; Tegner score from 2.9 standard deviation, SD 1.3 to 5.2 standard deviation, SD 2.5, $P < 0.0005$), and better results in patients with a higher pre-injury activity level and those requiring fewer plugs. The radiographic evaluation showed significantly poorer Kellgren-Lawrence scores and a reduction of the joint line in the treated compartments. Knees with 3–4 plugs presented a significantly higher joint degeneration level with respect to those implanted with 1–2 plugs.
Conclusions: Mosaicplasty is an effective surgical option for small lesions of the femoral condyles. Although joint degeneration progression was present at 12 years, this did not affect significantly the clinical outcome which was satisfactory at long-term follow-up.
Level of evidence: IV, case series.

1. Background

Surgical strategies for the treatment of chondral or osteochondral lesions are numerous and heterogeneous. Among these, cell-based treatments or scaffold-based procedures have been proposed, and new approaches using biomimetic scaffolds or mesenchymal stem cells are currently being studied to address both chondral and osteochondral lesions [1,2]. However, the complex biomechanical features of hyaline cartilage are difficult to replace or reproduce, and the properties of healthy cartilage tissue are still unmatchable by any available treatment [3].

Treatment goals should be to restore the articular surface in the most anatomical way possible, thus re-establishing the physiological properties of the entire osteochondral unit to achieve a more predictable repair tissue, that closely resembles the native structures and remains durable over time. In this light, osteochondral autograft transplantation has been proposed to provide in a single-stage procedure, an immediate reliable tissue transfer of a viable osteochondral unit [4]. Moreover, it also aims to capitalize on bone-to-bone healing, since the mature cartilaginous tissue has limited healing potential and heals with difficulty to surrounding cartilage. The mosaicplasty technique involves the use of multiple small diameter osteochondral plugs that can also be implanted through an arthroscopic approach to reduce risks and increase the indications for this technique [5].

Therefore, whereas new approaches are gaining increasing interest by claiming to regenerate the articular surface without the limits of donor site morbidity of autologous osteochondral transplantation, it is important to have as a reference point the results obtainable with the transplantation of autologous mature hyaline cartilage in the long

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term, both in terms of clinical improvement and prevention of articular degenerative processes.

The purpose of this study is to show the clinical outcome of a homogeneous cohort of patients at long-term follow-up treated with mosaicplasty technique for knee cartilage lesions and prospectively evaluated at 12 years follow-up, and in particular to evaluate, through a radiographic analysis, whether the transplantation of viable osteochondral units is successful in preventing joint degeneration.

The hypothesis is that this technique may offer good results at long-term follow-up for the treatment of small femoral condyles lesions.

2. Materials and methods

2.1. Patient selection

The study was approved by the local Ethics Committee and Internal Review Board, and informed consent of all patients was obtained before each surgical procedure.

Indication criteria were: focal grade III–IV (ICRS evaluation package [6]) chondral knee defects involving medial or lateral femoral condyle, in patients complaining of clinical symptoms (pain, swelling, locking, and giving way). Exclusion criteria were: patello-femoral lesions, untreated limb misalignment or knee instability, diffused arthritis or bipolar ("kissing") lesions, and those with other general medical conditions (diabetes, rheumatoid arthritis, etc.). Patients who presented with an anterior cruciate ligament (ACL) lesion at the time of surgery underwent the combined ACL reconstruction procedure in the same surgical session with cartilage harvesting.

Of the 37 patients treated arthroscopically with mosaicplasty technique in our institute from 1997 to 2000, all consecutive patients that could be contacted after a minimum of 11 years were considered for the study; among these, no one refused the study's clinical examination. Twenty-six patients were prospectively evaluated at 12 years' follow-up (minimum 11, maximum 13). Among this group 19 patients were men and 7 women, with a mean age of 29.3 standard deviation, SD 8.4 years and a mean BMI of 23.0 standard deviation, SD 3.0. The site of the defects was the medial femoral condyle in 16 cases, and the lateral femoral condyle in 9 patients, in 1 case both condyles were involved. The mean/median/mode size of the defects was 1.9 standard deviation, SD 0.6 cm^2. The etiology was traumatic in 6 cases and microtraumatic/degenerative in 20 cases. For microtraumatic/degenerative patients surgery was performed at least after six months from symptoms onset, whereas traumatic acute lesions where treated starting from three weeks after injury. 14 patients were treated surgically for the first time, whereas 12 patients presented previous surgeries: seven meniscectomies, 7 ACL reconstructions, one debridement, and one loose body removal. In 16 patients, combined procedures were performed: 10 meniscectomies, eight ACL reconstructions and one medial collateral ligament repair.

2.2. Surgical procedure and postoperative management

Arthroscopic mosaicplasty was performed using Autogenous Osteochondral Grafting System (Smith & Nephew) surgical instrumentation. Damaged cartilaginous and fibrous tissue was excised. The lesion was then measured for size and location. Recipient holes 15 mm deep were made perpendicular to the cartilage surface. After preparing the defect area, osteochondral grafts were harvested. The donor site was preferentially the superolateral ridge of the femoral condyle, whereas the superomedial ridge was used only when four grafts were necessary. Tubular chisels were then used to harvest the graft: 8.5 ad 6.5 mm diameter grafts were harvested and, with a smooth cannula, the grafts were then delivered into the defect. The stability of the plugs was tested by cyclic bending of the knee while the grafts were visualized.

In the first postoperative month the patients were kept non-weight bearing, to minimize the risk of dislodging and damaging the grafts, however, complete range of motion was allowed. During the second month, partial progressive weight bearing was allowed and patients gradually began to walk with full weight bearing. Over the 3 months after the operation, the patients followed a progressive strengthening program to recover leg-muscle strength. Subsequently, when the complete range of motion and good muscular strength were achieved, and if there was no effusion or significant pain, running was gradually allowed. Full athletic activity was permitted after 4 months (contact and traumatic sports were allowed after 6 months), and return to sport at the preoperative level was usually attempted after 6–8 months.

2.3. Patient evaluation

The clinical outcome was analyzed using the Cartilage Standard Evaluation Form as proposed by ICRS (International Cartilage Repair Society) [6]. A functional knee test was performed according to the IKDC Knee Examination Form and patients were classified as normal, nearly normal, abnormal or severely abnormal. Objective evaluation was also performed through the measurement of range of motion (active and passive) and transpatellar and suprapatellar circumferences at both the injured knee and the contralateral one as control. Activity level was evaluated by the Tegner score [7] at 2 years and at the final follow-up, and it was compared with pre-symptoms and pre-treatment levels. For failed patients, the last clinical evaluation before re-operation was considered.

Radiographs were used for radiological evaluation in 18 patients. Bilateral weight-bearing antero-posterior and Rosenberg projections were performed at 12 years' follow-up, and used to assess the progression of the articular degeneration, using the contralateral healthy knee as the control. To assess osteoarthritis we applied both the Kellgren–Lawrence score [8] and a direct measurement of the joint line. Measurements were performed by two blinded researchers (one radiologist and one orthopaedic surgeon) and the mean/median/mode of the two measurements was used for the analysis.

2.4. Statistical analysis

All continuous data are expressed in terms of mean SD, categorical variables are expressed as proportions or percentages. The Kolmogorov Smirnov test was performed to test the normality of continuous variables. The paired *t*-test was performed to compare normally distributed scores at the different follow-up times. The Wilcoxon non-parametric test was performed to compare not normally distributed scores at the different follow-up times. The ANOVA test was performed to assess the between groups differences of continuous and normally distributed and homoscedastic data, the Mann Whitney test was used otherwise. The Spearman rank correlation was used to assess the correlation between scores and continuous data, the Kendall Tau correlation was performed to assess correlation between ordinal scores. The Fisher chi square test was performed to investigate the relationships between grouping variables. All the non-parametric analyses were evaluated by the Exact method for small samples. For all tests $P < 0.05$ was considered significant. The analysis was carried out using the Statistical Package for the Social Sciences (SPSS) IBM software version 19.0.

3. Results

There were 3 failures, which were treated with autologous chondrocyte transplantation. All failures (2 patients with 3 plugs, and 1 with 4 plugs) occurred within the first two years of follow-up.

The IKDC subjective score improved significantly from 36.8 standard deviation, SD 13.0 (range 10.3–60.9) pre-operatively to 77.3 standard deviation, SD 20.6 (range 25.3–100.0) at 12 years follow-up ($P < 0.0005$) (Fig. 1). The Tegner evaluation score showed a significant improvement from 2.9 standard deviation, SD 1.3 (range 1–7) pre-treatment to 6.3 standard deviation, SD 3.0 (range 1–10) at 2 years ($P < 0.0005$) and 5.2 standard deviation, SD 2.5 (range 1–9) at final follow-up ($P < 0.0005$); however, we noticed poorer results with respect to the pre-symptoms level (7.1 standard deviation, SD 2.2, range 3–10; $p = 0.001$) and reduced sport activity over-time (2 vs 12 years;