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ORIGINAL ARTICLE

Autologous osteochondral transplantation (mosaicplasty) in articular cartilage defects of the patellofemoral joint: retrospective analysis of 33 cases

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Abstract
Objective The purpose of this retrospective study was to evaluate the results of osteochondral autografting (mosaicplasty) in isolated articular cartilage defects of the patellofemoral joint.
Materials and methods Thirty-three patients who underwent mosaicplasty for patellofemoral (either patella or trochlea) cartilage defects (modified Outerbridge classification: grades III and IV) of the knee joint were retrospectively reviewed. There were 25 male and 8 female patients with a mean age of 31.3 ± 6.7 (range 22–47) years. The average size of the lesion was 2.4 ± 0.55 cm^2 (range 1.5–4.0). Patients with patellofemoral malalignment were excluded. All patients were followed at least one year with a mean of 19.3 ± 4.3 months (range 12–24 months) using Lysholm knee score.
Results The mean preoperative Lysholm knee score was 51.9 ± 2.6 (47–58) points and increased to 85.5 ± 4.2 (75–89) points at the final follow-up. There was a significant increase in Lysholm score during follow-up period ($p = 0.0001$). The results were good in 24 cases and fair in 9 cases. No patients had poor results. No patients had infection. Five patients had postoperative mild painful hemarthrosis. Of these patients, four were treated with rest, ice, compression (elastic bandage) and elevation and the remaining one was treated by aspiration. No patients needed secondary open or arthroscopic drainage. No systemic complications occurred during the follow-up.
Conclusions Mosaicplasty is an effective technique for the treatment of articular cartilage defects of the patellofemoral joint knee which restores the joint function in a short period of follow-up. However, a meticulous surgical technique should be followed to restore the native articular surface and the congruity of the joint.

Keywords Mosaicplasty · Osteochondral lesion · Articular cartilage defect · Knee

Introduction

Autologous osteochondral transplantation (AOT), also called '*mosaicplasty*,' involves transplantation of cylindric osteochondral plugs harvested from the non-weight-bearing periphery of the femoral condyles at the level of patellofemoral joint to the preformed drill holes to the damaged cartilage area [1]. This technique is advantageous in many aspects such as being a single-stage procedure, transplantation of mature hyaline cartilage, relatively simple technique and brief rehabilitation, and cost-effective [2]. Since its presentation, several studies reported good and excellent results of this technique [3–8].

As the cartilage lesions are more common in femoral condyles and tibial plateau, most of the studies reported the

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results involving these localizations. However, use of mosaicplasty for the cartilage lesions involving patellofemoral joint has been rarely reported in the literature [9, 10]. The purpose of this study was to present the results of 33 consecutive patients with isolated cartilage lesion at the patellofemoral joint who were treated with mosaicplasty.

Materials and methods

Patients

We retrospectively reviewed 33 prospectively followed consecutive patients who underwent mosaicplasty for isolated patellofemoral cartilage defects of the knee joint at our institution. There were 25 men and 8 women with a mean age of 31.3 ± 6.7 years (range 22–47 years) at the time of operation. Cartilage lesions were classified according to the modified Outerbridge classification [11]. Twenty-one cases were classified as grade IV and remaining 12 were classified as grade III. Cartilage lesions were located in trochlea in 26 cases, and patellar lesion was present in seven cases. The average size of the lesion was 2.4 ± 0.5 cm^2 (range 1.5–4.0 cm^2). Preoperatively, all patients were evaluated with clinical knee examination, knee plain radiographs including patellar tangential views and knee magnetic resonance imaging (MRI) (Fig. 1). During clinical examination, patellar maltracking and instability were evaluated. Furthermore, TT-TG distance, patellar tilt and sulcus angle were measured in knee MRI. Patients with MPFL rupture and patellofemoral malalignment (based on clinical and MRI evaluation) or patients requiring additional procedures such as ACL reconstruction or meniscal rupture were excluded from the study. All patients in this series had isolated patellofemoral cartilage lesion. Demographic and clinical characteristics of the patients are presented in Table 1.

Table 1 Demographic and clinical characteristics of the patients

Variable	Result
Number of patients	33
Age (years ± SD)	31.3 ± 6.7 (range 22–47)
Gender (M/F)	25 M, 8 F
Size of the lesion (cm^2 ± SD)	2.4 ± 0.55 (range 1.5–4.0)
Lesion grade (outerbridge classification)	21 Grade IV, 12 Grade III
Localization of the lesion	26 T/7 P

M male, *F* female, *P* Patella, *T* trochlea

Surgical technique and rehabilitation

Under spinal anesthesia and tourniquet control, a diagnostic arthroscopy was performed using standard portals. After evaluation of the cartilage lesions, a mini-arthrotomy was used to expose the trochlea. In case of patellar cartilage defects, patella was everted laterally and a larger incision was used. Standard mosaicplasty procedure was performed as described by Hangody et al. [1]. The lesion was debrided and measured. Grafts were harvested from the periphery of the femoral condyles at the level of the patellofemoral joint and transplanted to corresponding burr holes in the defect. A meticulous surgical technique was performed to simulate the articular surface contour of the

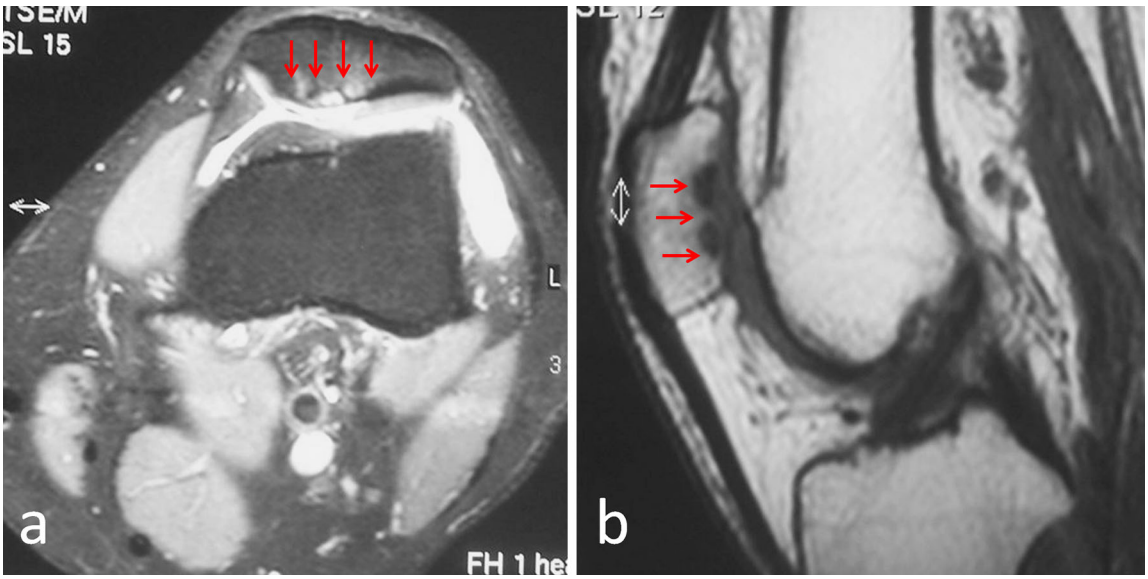

Fig. 1 Preoperative axial (**a**) and sagittal (**b**) MRI of a patient with isolated patellar cartilage lesion (*red arrows* show the cartilage lesion)

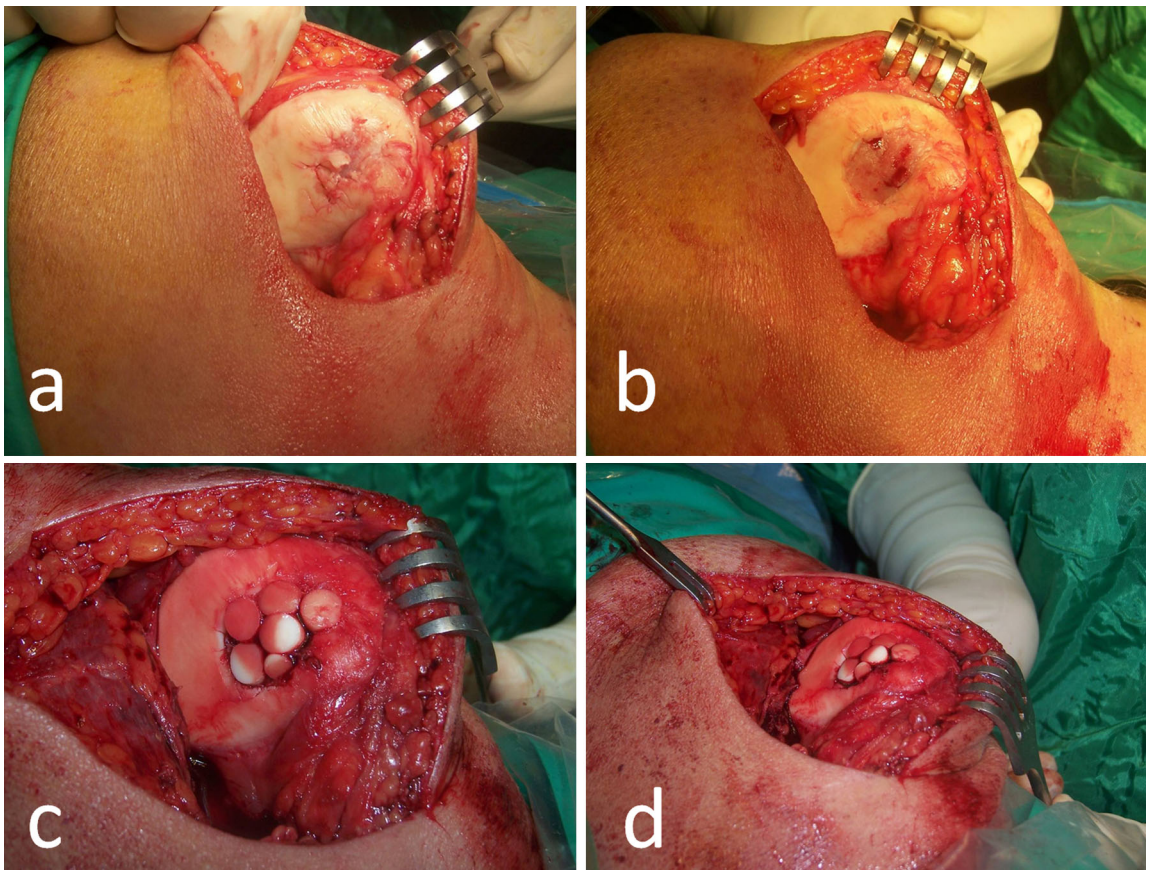

Fig. 2 Operative technique. **a** Medial parapatellar arthrotomy, **b** removal of the cartilage down to subchondral bone, **c**, **d** insertion of bone plugs simulating the native joint congruency

Table 2 Functional results during the follow-up

Variable	Preoperative	6 th Month	Final Follow-up	Significance
LKS	51.9 ± 2.6 (47–58)	81.7 ± 4.5 (72–89)	85.5 ± 4.2 (75–89)	0.001

LKS Lysholm knee score

damaged zone. The burr holes were created perpendicular to the surface; bone plugs were inserted at the level of native cartilage (Fig. 2). A drain was placed into the knee, and compressive bandage was used to prevent hemarthrosis. Drains were removed at the second postoperative day. Active range of motion exercises was started immediately after the removal of the drain. Range of motion (ROM) was gradually increased as tolerated by the patient. Full weight bearing was allowed 3 weeks after the surgery.

Outcome measurement and follow-up

Following the rehabilitation program and full weight bearing, patients came for clinical follow-up at the sixth month and the final follow-up. The patients were clinically evaluated with Lysholm knee scores before the treatment and at each visit [12]. Throughout the treatment, all complications were monitored and recorded.

Statistical analysis

Continuous variables were stated as mean and standard deviation and categorical variables as percentages and frequency distribution. Repeated measurements were compared with paired sample t test. A p value <0.05 was considered statistically significant.

Results

All patients were followed at least one year with a mean of 19.3 ± 4.3 months (range 12–24 months). The mean preoperative Lysholm score was 51.9 ± 2.6 (range 47–58)

points and increased to 81.7 ± 4.5 (range 72–89) points at the sixth month follow-up. At the final follow-up, the mean Lysholm score was 88.2 ± 2.5 points. There was a significant increase in Lysholm score during follow-up period ($p = 0.0001$) (Table 2). The results were good in 24 cases and fair in nine cases (Fig. 3). No patients had poor results.

Complications

No patients had infection. Five patients had postoperative mild painful hemarthrosis. Of these patients, four were treated with rest, ice, compression (elastic bandage) and elevation and the remaining one was treated by aspiration. No patients needed secondary open or arthroscopic drainage. No systemic complications occurred during the follow-up.

Discussion

Results of our study revealed that mosaicplasty is a good option for the treatment of patellofemoral cartilage lesions. All of the patients had benefit from the surgery and remained asymptomatic during the follow-up. However, some technical points should be precisely followed for a good result.

There is little number of patients who underwent mosaicplasty for patellofemoral joint in most of the studies that report the results of this technique in the current literature. Panics et al. evaluated 61 football players who underwent mosaicplasty and followed the patients with an average of 9.6 years. There were five patellofemoral cartilage lesions in their series (4 patella, 1 trochlea). None of the patients could return to their professional sport life after the treatment compared to 79% return in case of condylar lesions [13]. Ollat et al. evaluated 142 patients with various cartilage lesions regarding location. They found significantly least favorable results in patellofemoral joint group (11 patients) compared to femoral condylar group [14]. Similarly, Hangody et al. [8] reported good to excellent results in 91% of femoral mosaicplasties, 86% of tibial, 92% of talar and 74% of patellofemoral mosaicplasties. In our study, there was no comparative group, but the results are promising because there were no patients with poor results. Although mosaicplasty in patellofemoral joint may end with less favorable results compared to other locations, we believe that it is still a viable option.

There may be some reasons for less favorable results in patellofemoral joint mosaicplasty such as patient selection and technical considerations.

Patient selection is an essential issue to achieve a long-lasting successful outcome in mosaicplasty technique. The location, size and depth of the lesion are important. However, treatment of accompanying instability, malalignment, and meniscal and ligament tears should be performed simultaneously [1]. Thus, preoperative evaluation and detection of such conditions are beneficial and should be kept in mind during decision making. Regarding this basic rule, alignment of the extensor mechanism should be carefully evaluated in patients who are candidates for patellofemoral joint mosaicplasty. In our series, all patients had no pathology of the extensor mechanism such as trochlear dysplasia or traumatic MPFL rupture. If there is patellar malalignment, either in a previous surgical session or during the same session, this pathology should be corrected. Mosaicplasty and patellar alignment surgery can be performed during the same surgery. Gewada et al. reported 19 patients who underwent simultaneous correction of patellar malalignment (lateral release, medial placation and tibial tubercle medialization) and chondral lesion treatment with mosaicplasty [15]. Visona et al. reported six cases with patellar osteochondritis in young athletes. They performed simultaneous alignment surgery in their three cases. Although the recovery period was prolonged, the results were good and excellent in both of these studies [16].

It is well known that joint surface congruity is essential for a smooth range of motion. Furthermore, the distribution of pressure on the cartilage in a native joint can be simulated with only restoration of the native joint anatomy [17]. Cartilage wear may increase and early degeneration may result when these points are underestimated. Both the trochlea and the patellar articular surface have distinct anatomy; particularly, the patella has several facets. Several authors examined the effect of surface plug incongruity on articular contact pressures [18–20]. The grafts should be parallel and at the same level with the joint surface. Grafts inserted 0.5 mm higher than the cartilage surface increase 50% peak contact pressure on the cartilage [19]. The most important factor that determines the success of the treatment is the correct placement of the bone plugs. In this series, we used divergent plug insertion in trochlea and convergent plug insertion in patellar surface to obtain the joint congruity (Figure). The depth of the cartilage layer on the donor side should adopt the depth of the cartilage at the recipient location. The patellar cartilage is the thickest cartilage in the knee joint and even among all synovial joints [21]. Discrepancy in cartilage thickness between the donor and the recipient site may be a reason.

There are strengths and limitations of this study. This is one of the largest series which reported the isolated patellofemoral joint mosaicplasty in the current literature. Lack of a control group and short follow-up may be listed as major limitation of this study. Furthermore, the outcome of this procedure is solely based on patient-reported outcome measurement (PROMs) using a functional score.

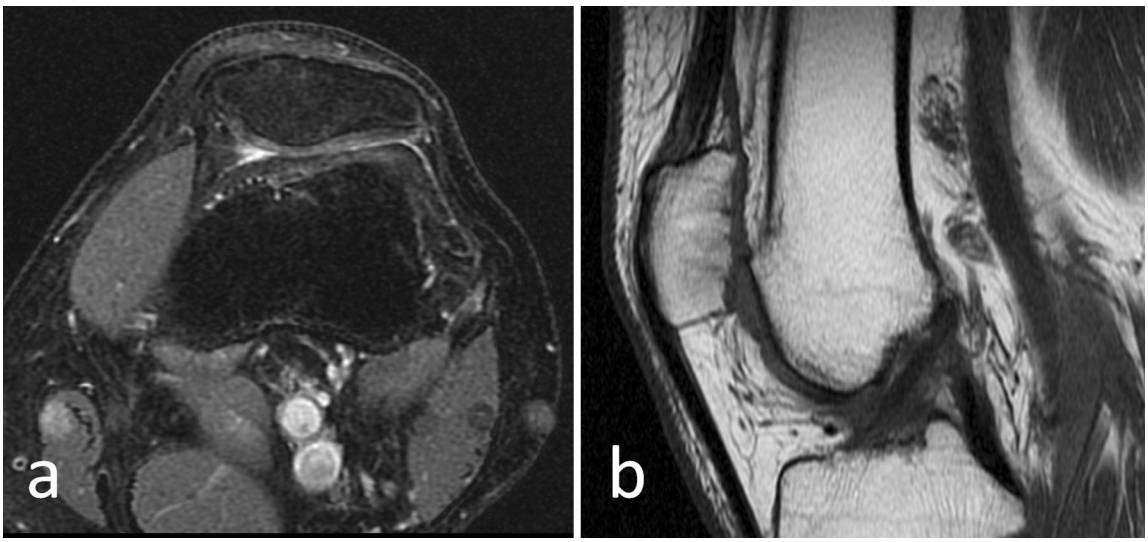

Fig. 3 Final MRI examination, axial (**a**) and sagittal (**b**), of the patient shown in Fig. 1 at 24th month follow-up. Note the healing of the cartilage, consolidation and integration of the bone plugs

Second look arthroscopy would be much more objective outcome measure; however, it is not always easy to find this opportunity in patients with a good result.

In conclusion, mosaicplasty is a good option for patellofemoral cartilage lesions. A good result can be expected when performed in appropriately selected patients and the surface anatomy is restored that simulates the native articular surface.

Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

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