ABSTRACT
Objective: To evaluate the functional results from the technique of mosaicplasty, in the knees of patients with osteochondral lesions. Methods: Between August 1999 and March 2005, 27 patients underwent mosaicplasty on their knees. Twenty-one were male and six were female. The patients’ ages ranged from 16 to 64 years (mean of 38.1 years). Seventeen lesions were located on the right knee and ten on the left knee. The lesion was located on the lateral femoral condyle in four patients (15%), on the medial femoral condyle in 18 patients (66.5%) and on the patella in five patients (18.5%). The lesion sizes ranged from 1 to 8 cm² (mean of 2.7 cm²). The patients were evaluated before and after the operation using Lysholm’s functional scale, with a mean follow-up of 2.5 years. Results: Before the operation, the mean was 62.7 points, and after the operation, the mean was 95.4 points. The patients who underwent mosaicplasty on the lateral femoral condyle presented a mean of 51.5 points before the operation, and a mean of 100 points after the operation. In relation to the medial femoral condyle, the mean before the operation was 64.1 points, and it was 95.4 points after the operation. In relation to the patella, the mean before the operation was 66.4 points, and it was 92 points after the operation. Conclusion: Mosaicplasty proved to be a good alternative for treating osteochondral lesions of the knee. It presented better evolution in relation to lesions of the femoral condyles than in relation to lesions located on the patella.

Keywords – Cartilage diseases/surgery; Joint cartilage/transplantation; Knee joint/surgery; Arthroscopy; Autologous transplantation

INTRODUCTION
Chondral and osteochondral lesions in the knee are still one of the biggest problems for knee surgeons, especially when they occur in young individuals and athletes. Preservation of the anatomical structure and physiological properties of the cartilage is a basic requisite for good functioning of the joint.

The capacity for cartilage regeneration is limited because chondrocytes do not have the capability to differentiate and multiply. These lesions can cause pain, edema and joint blockage. If they are not properly treated, they can cause osteoarthritis, particularly if they are located in load-bearing areas.

Several types of surgical treatment for these lesions exist. They are basically divided into reparative methods, which stimulate and enable the formation of chondrogenic or fibrochondrogenic tissue, and reconstructive methods, which treat the defect with autologous or homologous chondral or osteochondral grafts(1). The reparative techniques, such as debridement of the lesion, chondroplasty to treat abrasion, subchondral perforations and, more recently, treatment for microfractures have the aim of forming fibrocartilaginous tissue with a structure and biomechanical properties that are similar but inferior to those of normal cartilage(2). However, over the long term, this does not stop the pro-

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gression of the degeneration and, one year afterwards, the lesions already show new fiber degeneration and cell death\(^{(3,4)}\).

Other, alternative methods exist, such as periosteal grafting, synthetic osteochondral grafting, autologous osteochondral grafting (mosaicplasty) and chondrocyte transplantation\(^{(2)}\).

Macroscopic and microscopic evaluations on the technique of mosaicplasty, which was described by Hangody in 1992 and published in 1997, demonstrated that transplanted hyaline cartilage survived well. Eight weeks after grafting, a bed composed of 80% cartilage and 20% fibrocartilage had formed at the base of the bone defect, the graft had become integrated with the bone matrix of the recipient area, and the donor sites had become filled with spongy bone and covered with a cap of fibrocartilage\(^{(5,6)}\).

The technique consists of removing small bone cylinders from the periphery of the femoral condyle and intercondylar region and transplanting them to areas where there are chondral and osteochondral lesions, with the aim of maintaining the quality and structure of the cartilage that makes up this region\(^{(7)}\).

According to Hangody et al\(^{(5-8)}\), the literature provides both indications and contraindications for this type of surgery (Box 1).

The present had the aim of making functional evaluations on patients who underwent mosaicplasty to treat osteochondral lesions of the knee.

**Box 1 – Indications and contraindications**

| INDICATIONS | ABSOLUTE CONTRAINDICATIONS | RELATIVE CONTRAINDICATIONS |
|-------------|-----------------------------|-----------------------------|
| Focal chondral and osteochondral lesions on the joint surface in loaded areas | Tumors, infections, neumatoid arthritis, advanced osteoarthritis | Age between 40 and 50 years |
| Age less than 50 years | Lack of donor area available | Defects between 4 and 8 cm\(^2\) |
| Lesion area between 1 and 4 cm\(^2\); it may be up to 8 cm\(^2\) in particular cases as a salvage procedure | Age greater than 50 years | Intermediate arthritis |
| Concomitant or previous treatment for instability, misalignment or meniscal lesions | Lesions greater than 8 cm\(^2\) | |
| Patient’s acceptance of cooperation in postoperative loading of weight | | |

**METHODS**

Between August 1999 and March 2005, 27 patients with osteochondral lesions in their knees underwent mosaicplasty. The patients’ mean age was 31.1 years (range: 16-64 years). Among these patients, 21 were male and six were female. Sixteen patients underwent operations on the right knee and ten on the left knee.

The mean size of the defect was 2.7 cm\(^2\) (range: 1-8 cm\(^2\)). Regarding the lesion site, four were located on the lateral femoral condyle, 18 on the medial femoral condyle and five on the patella (Table 1).

**Table 1 – Characterization of the sample**

| Variables | n = 27 |
|-----------|--------|
| Age (years) − mean (sd) | 38.1 (13.1) |
| minimum – maximum | 16 – 64 |
| Sex – n (%) | |
| Female | 6 (22.2) |
| Male | 21 (77.8) |
| Side operated n (%) | |
| Right | 17 (63.0) |
| Left | 10 (37.0) |
| Lesion location n (%) | |
| Medial femoral condyle | 18 (66.7) |
| Lateral femoral condyle | 4 (14.8) |
| Patella | 5 (18.5) |
| Lesion size (cm\(^2\)) − mean (sd) | 2.7 (1.8) |
| minimum – maximum | 1 – 8 |
| Time elapsed since operation (years) − mean (sd) | 2.3 (1.5) |
| minimum – maximum | 0.3 – 6.0 |

The patients were evaluated before and after the operation using Lysholm’s functional scale, with a mean follow-up of 2.5 years.

The simplified scoring scale used in Lysholm’s functional questionnaire was as follows: excellent, if the total score was between 95 and 100; good, between 84 and 94; moderate, between 65 and 83; and poor, if lower than 64.

Among the 27 patients, five had undergone previous surgery. One of these had undergone three procedures: removal of the Hoffa fat, chondroplasty and lateral release by means of drilling the patella. The other four
had respectively undergone free-body removal, drilling of the medial femoral condyle, partial meniscectomy of the medial meniscus and partial meniscectomy with excision of a meniscal cyst (Figure 1).

Eleven patients underwent treatment concomitantly with treatment of other lesions. Among these, there were four procedures of meniscectomy, three procedures of valgizing osteotomy with fixation using Puddu plates, two reconstructions of the anterior cruciate ligament and two reconstructions of the anterior cruciate ligament in association with valgizing osteotomy, with fixation using Puddu plates (Figure 1).

The mosaicplasty technique consists of obtaining small osteochondral cylinders from an area subjected to minimal load bearing, and transplanting these to defective areas of load-bearing regions. By using different combinations of graft sizes, 90 to 100% of the defect can be filled (Figure 2).

The technique can be carried out as open surgery, through miniarthrotomy (Figure 3), or arthroscopically (Figure 4), with similar procedures that differ only in certain steps(7).

Among the 22 cases of osteochondral lesions without previous surgery, six were treated using the technique of miniarthrotomy and 16 using arthroscopy. The other five cases were of patients who had undergone previous operations.

In the arthroscopic procedure, the siting of the ports is an extremely important matter. The patient was positioned supinely, with the knee free to flex up to 120 degrees. We used a needle to find the best position for the port, such that the lesion would be reached through the port perpendicularly to the instrument that would be used to remove the osteochondral cylinders and then transplant them(7).
These ports are usually more medial than the normal ports. Lesions in the medial femoral condyle caused by osteochondritis dissecans, in their most common locations, are dealt with better through a lateral port. On the other hand, a central port crossing the patellar tendon enables good access to the internal regions of the medial and lateral femoral condyles.

Once the lesion has been identified, it is debrided until viable subchondral bone below it has been exposed. Using a test guide, the size of the lesion is measured and the quantity and size of the cylinders to use are calculated (Figures 5 and 6).

Using an instrument suitable for resection, we removed cylinders of different diameters, all of 15 mm in length, until reaching the quantity needed to fill the lesion. We took the final sulcus as the lower anatomical limit for resection of the grafts from the lateral femoral condyle (Figures 7, 8 and 9).

Turning to the receptor area, the lesion was perforated using a trephine, down to the desired depth, and then a dilator of the size of the graft was used under pressure to regularize the tunnel, always perpendicularly to the defect that existed. Using an appropriate instrument, the graft was gently placed in the defect, with the aim of avoiding damage to the osteochondral cylinder. This procedure of milling, dilation and placement was performed as many times as needed, until completely filling the location of the lesion with osteochondral cylinders (Figures 10, 11 and 12).

For lesions of the patella, we always performed open procedures. Using lateral arthrotomy, the patella was tilted to view the lesion and the procedure described earlier was performed. In these cases, we always used the lateral femoral condyle as the donor area.

Independent of the route, after placement of the osteochondral cylinders, the knee was flexed and extended to verify the excursion of the structures in the grafted area, with subsequent layer-by-layer closure up to the skin.

We used drains in all the patients and removed them 24 hours after the end of the operation.

With regard to rehabilitation, the patients were released for performing a passive arc of movement after removal of the drain on the second day after the operation. They were allowed to flex the knee freely, as much as they could tolerate, but did not place any load on it for six weeks. Over the subsequent two weeks, we released the patients to place partial loading on the knee, attaining full loading in the eighth week. The patients returned to sports activities four to six months after the operation.

The values obtained were subjected to statistical analysis, using the Wilcoxon and Mann-Whitney tests.

RESULTS

The patients underwent pre and postoperative functional evaluations and were classified according to Lysholm’s questionnaire. They were followed up for a
mean of 2.5 years. The most recent assessment available for each patient was taken to be the definitive final result.

The mean preoperative value for the 27 patients was 63 points (poor) and the mean postoperative value was 95 points (excellent).

Comparison between the pre and postoperative applications of Lysholm’s scale showed that there was a statistically significant difference (p < 0.001). All the patients presented higher scores on the scale after the operation than they did before it, with a mean increase of 59.9% (SD = 40.6%), with a range from 11.3% to 135.7% (Table 2).

Evaluation of the patients according to the location of the lesion (patella, lateral femoral condyle or medial femoral condyle) showed slight variation. For lesions in the patella, the patients presented a preoperative score of 66 points (moderate) and a postoperative score of 92 points (good). The patients with lesions in the lateral femoral condyle had a preoperative score of 51 points (poor) and a postoperative score of 100 points (excellent). For the patients with lesions in the medial femoral condyle, the preoperative score was 66 points (moderate) and the postoperative score was 95 points (excellent).

Analysis on these values in relation to location, there was no statistically significant difference between the groups regarding scores on Lysholm’s scale for preoperative applications (p = 0.147), postoperative applications (p = 0.060) or the Δ% change (p = 0.125) (Table 3).
Division of the sample according to lesion size did not show any statistically significant difference between the groups regarding scores on Lysholm’s scale for preoperative applications ($p = 0.693$), postoperative applications ($p = 0.066$) or the $\Delta\%$ change ($p = 0.657$) (Table 4).

Analysis according to age showed that the patients under 40 years of age presented a preoperative score of 64 points and a postoperative score of 94 points, while the patients aged 40 years or over presented a preoperative score of 60 points and a postoperative score of 92 points. There was no statistically significant difference between the age groups regarding the scores on Lysholm’s scale for preoperative applications ($p = 0.464$), postoperative applications ($p = 0.392$) or the $\Delta\%$ change ($p = 0.367$) (Table 5).

Finally, we divided the patients into three groups: individuals who underwent mosaicplasty alone (group 1), individuals who underwent mosaicplasty with other concomitant procedures (group 2) and individuals who had already undergone other procedures prior to mosaicplasty (group 3). From this, we obtained the following result: group 1 presented a mean preoperative score of 62 points, which became 97 points after the operation; group 2 had 59 points before the operation and 95 points after the operation; and group 3 had 71 points before the operation and 91 points after the operation. There were no statistically significant differences between these three groups (Figure 13).

With regard to complications, two patients presented infectious conditions during the immediate postoperative period. Both of these patients had undergone valgizing osteotomy using the Puddu plate technique. One patient presented superficial infection and was treated with antibiotic therapy and local cleaning. The other patient, with deep infection at the osteotomy site, was treated with removal of the lyophilized graft, surgical cleaning and antibiotic therapy. Both of these patients evolved well, and the infection was cured.

**DISCUSSION**

The technique of mosaicplasty was chosen for treating these cartilage lesions on the basis of findings in the literature. A multicenter randomized study carried out by Hangody et al. compared four different techniques.
for treating cartilage lesions (drilling, abrasion arthroplasty, microfracture and mosaicplasty) and showed that there was a substantial clinical and functional improvement among the patients who underwent mosaicplasty, in relation to other reparative techniques, especially after three, four and five years.

From a multicenter randomized study comparing mosaicplasty and the reconstructive technique of chondrocyte transplantation, Dozin et al\textsuperscript{(10)} concluded that the two techniques were functionally and clinically similar, with full recovery for 85% and 68% of the patients who underwent mosaicplasty and chondrocyte transplantation, respectively. In another randomized prospective study on 100 patients, Bentley et al\textsuperscript{(11)} achieved good results for 78% and 69% of the patients who underwent chondrocyte transplantation and mosaicplasty, respectively.

We used mosaicplasty because we believe that this technique is superior to the reparative techniques cited above, while presenting results that are similar results to those from chondrocyte transplantation, which has the main drawbacks of the difficult access and high cost of the procedure.

The follow-up achieved in this study (2.5 years) was not long enough for us to definitively assess the durability of the results and the survival of the grafts, but the results showed that this is a safe and effective technique over the short and medium terms.

The results from the evaluations using Lysholm’s scale showed that the patients presented a statistically significant functional improvement, from a mean of 62.7 points (poor) to 95.4 points (excellent).

These results are in line with reports in the literature by several authors such as Marcacci et al\textsuperscript{(1)}, who found good results in 78.3% of their cases, Jakob et al\textsuperscript{(2)}, with 100% improvement in function and 93% with good results, Hangody et al\textsuperscript{(7)} with good results from around 90% of their 831 procedures, and Kouhalis et al\textsuperscript{(12)}, with good results in 90% of their cases three to six months after the operation.

With regard to the access route, Hangody et al\textsuperscript{(5)} recommended the arthroscopic route only for lesions of up to 2 cm\textsuperscript{2}, with a maximum of four to six osteochondral cylinders to be grafted, in their initial description of the technique. For larger lesions, they indicated open surgery (miniarthrotomy). In more recent papers, they indicated open surgery only in cases in which the lesion site was difficult to access because of its location or because of limitations on knee flexion.

There are reports in the literature showing good results from the use of open surgery alone, such as Jakob et al\textsuperscript{(2)}, and from the use of the arthroscopic route alone, such as Marcacci et al\textsuperscript{(1)}. We used the arthroscopic approach or miniarthrotomy for condylar lesions, while we always used lateral miniarthrotomy for lesions of the patella.

The results were divided into two groups according to the patients’ ages: one group under 40 years of age and the other, 40 years and over. On the other hand, Hangody et al\textsuperscript{(7)} only recommended treatment for individuals up to the age of 40 years. They considered that ages between 40 and 50 years constituted a relative contraindication and they contraindicated treatment for patients over the age of 50 years. We did not find any statistical difference in the results between the two groups that we evaluated, although the literature shows better results from younger patients\textsuperscript{(1,7,8)}.

With regard to the size of the lesion, Hangody et al\textsuperscript{(7)} indicated the procedure preferentially for lesions of 1 to 4 cm\textsuperscript{2}, while it could also be performed in some salvage cases with an area of up to 8 cm\textsuperscript{2}. In our study, we carried out procedures on lesions of 1 to 8 cm\textsuperscript{2} in area and, to evaluate the results, we divided the lesions into two groups, with lesions of up to 2 cm\textsuperscript{2} and lesions greater than 2 cm\textsuperscript{2}. We did not find any statistically significant difference between these two groups, although there was a tendency towards better results from lesions greater than 2 cm\textsuperscript{2} in area. In this respect, the literature does not provide any clear definition. Some authors like Marcacci et al\textsuperscript{(1)} reported that the smaller the lesion was, the better the result was, and Hangody et al\textsuperscript{(7)} had better results from lesions between 1 and 4 cm\textsuperscript{2}. On the other hand, other authors such as Jakob et al\textsuperscript{(2)} reported that there was no difference in the results in relation to lesion size.

With regard to the location of the lesion, our results did not show any statistically significant difference, although they tended to be better from condylar lesions than from patellar lesions. Condylar lesions located in the lateral condyle evolved better than those in the medial condyle, thus confirming the reports in the literature\textsuperscript{(1,6)}.

We also analyzed the results by dividing the sample into three groups: one with patients who underwent mosaicplasty alone; another with patients who underwent mosaicplasty with another procedure concomitantly; and a third group of patients who underwent mosaicplasty but had already undergone previous procedures on the same knee. We did not find any statistically significant differ-
ence between the three groups, but we observed that the results were better among the patients who underwent mosaicplasty alone. There was a significant improvement among the patients who underwent other concomitant procedures, while the results were worse among the patients who had undergone previous surgery. These trends in our results are in agreement with the literature, in which Jakob et al\(^2\) reported better results among patients who underwent mosaicplasty alone. Marcacci et al\(^1\) also reported greater functional improvement among patients who underwent concomitant procedures, in relation to those who underwent mosaicplasty alone, while they had worse results among the group of patients who had undergone surgery previously.

We believe that the functional improvement among the patients who underwent concomitant procedures was due not only to the mosaicplasty, but also to the treatment provided for associated lesions. On the other hand, the worse results from cases with previous surgery may have occurred because the lesions were more severe in these cases and were sometimes unsuccessfully treated, which may have compromised the joint in other ways. In addition, such patients may have been skeptical about obtaining good results, which would have altered their subjective assessment on the functional scale.

With regard to rehabilitation, we based our protocol on personal experience with other procedures for treating cartilage lesions, along with protocols for treating concomitant lesions. Comparing the protocols in the literature, we observed that they are very similar. Hangody et al\(^8\) recommended completely passive movement without loading for three weeks, followed by partial loading for another two to three weeks. Jakob et al\(^2\) advised passive movement of up to 100° until the third week and full movement thereafter, with partial loading for four to eight weeks, depending on the size of the lesion, and a return to sports activities or heavy work after four to six months. We agree with early passive mobilization, but we prefer to keep the patient without loading for six weeks, because we think that it is difficult for patients to establish what partial early loading should consist of, and for them to control this. In this manner, we eliminate the risk of applying full loading before the appropriate moment.

**CONCLUSION**

Mosaicplasty was shown to be a good alternative for treating osteochondral lesions of the knee. Age up to 65 years and lesion size were not limiting factors. There was better evolution of lesions of the femoral condyles, in relation to patellar lesions, although we did not find any statistically significant difference in this respect. Other surgery performed concomitantly or previous operations did not make it impossible to perform the procedure that we studied.

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