Autologous Membrane Induced Chondrogenesis (AMIC) for the treatment of acetabular chondral defect

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Summary

***Background*: Acetabular chondral defect are very frequently associated to FAI. Treatment options are still questionable.**
***Methods*: Between 2008 and 2014, 201 patients over 583 have been arthroscopically treated with the AMIC procedure for grade III and/or IV acetabular chondral lesions. Patients age was between 18 and 50 years; acetabular chondral lesion size was between 2 and 4 cm^2; radiological Tönnis degree of osteoarthritis was ≤ 2.**
***Results*: The mean follow up of the entire group of 201 patients was 5 years (from 8 to 2). Significant improvement, as measured by the mHHS, was observed at 6 months in comparison to preoperative levels (80.3 ± 8.3) ($p<0.001$). Continuous improvement with respect to each previous evaluation time point was seen, reaching the highest improvement level at the three year follow-up (85.5 ± 7.2). The mean mHHS improvement recorded at the five year follow-up compared with preoperative scores was 39.1 ± 5.9.**
***Conclusions*: AMIC is a valid procedure to repair medium-sized chondral defects on the acetabular side of the hip found during treatment of FAI and lead to long-term favourable outcomes.**
Level of evidence: IV.

KEY WORDS: hip chondral defects, AMIC (Autologous Membrane Induced Chondrogenesis), FAI (Femoro Acetabular Impingemet), hip arthroscopy.

Introduction

During the past decade a dramatic change has occurred in the diagnosis and treatment of hip pathologies. While many new pathoanatomic features, such as femoroacetabular impingement (FAI), labral pathologies and developmental dysplasia have been described, hip arthroscopy has become popular as an attractive alternative to the more invasive open surgeries[1].
There is actually agreement in considering chondral lesions as a consequence of other pathological features such as trauma, osteonecrosis, dysplasia, labral tears, loose bodies, dislocation, previous slipped capital femoral epiphysis and Femoro Acetabular Impingement (FAI)[2,3]. In recent years, FAI in particular, gained growing attention and has been indicated as a cause of osteoarthritis of the hip[4,5]. According to this theory, the altered morphology of the femur and/or of the acetabulum results in abnormal contact against the joint, thereby leading to stress degeneration of the labrum and cartilage.
Many options for biologic joint reconstruction as an alternative to arthroplasty exist, such as microfractures, osteochondral autograft transplantation, mosaicplasty, autologous chondrocyte implantation, etc[6]. Most of these techniques have a long and successful clinical history[7-10].
In contrast, in the case of hip surgery, excellent results have been reported using the arthroscopic treatment of FAI, removal of symptomatic loose bodies and many other intra and extra articular hip pathologies. Nevertheless, concerns remain about the correct treatment of chondral lesions[11,12].
This article discusses the innovative option for the treatment of chondral lesions in the hip with the AMIC technique.

Material and methods

Between 2008 and 2014, 201 patients over 583 treated with hip arthroscopy, underwent an AMIC procedure for the treatment of grade III and/or IV acetabular chondral lesions, according to the Outerbridge classification[13]. All these 201 patients included in this retrospective, non randomized study have been selected according to the following inclusion criteria: chondral lesions were located in the superior area of the acetabulum; they were consequent to FAI; Patients age was between 18 and 50 years; acetabular chondral lesion size was between 2 and 4 cm^2; radiological Tönnis degree of osteoarthritis was ≤ 2. Exclusion criteria were: concomitant presence of femoral head chondral lesion; systemic rheumatoid diseases; dysplasia; femoral neck axial deviations; coxa profun-

da and/or protrusio acetabuli. For FAI cam-type, arthroscopic femoral head-neck resection arthroplasty was performed to restore the anatomic offset between the femoral head and neck. In case of FAI pincer-type, arthroscopic acetabular rim trimming was performed to reduce the bony overhang and to reshape the acetabulum into its normal contour. An eventual detached labrum was reattached to the superior acetabular rim with suture anchors. Intra operative dynamic tests were performed moving the hip along its full range of motion, checking the absence of any remaining bony impingement.

The AMIC procedure was performed arthroscopically in a single surgical stage[14,15]. The chondral defect was measured with an arthroscopic probe and standard microfracures (MFx) were carried out. Bone marrow bleeding from the holes was verified after removing the fluids from the joint space by continuous aspiration. Destroyed and unstable cartilage was removed using angled curettes or motorised shavers to achieve a well-contained defect. The Chondro-Gide® matrix, a resorbable bilayer collagen I/III membrane (ChondroGide®, Geistlich Pharma AG, Wolhusen, Switzerland), was cut to fit the size and the shape of the lesion and placed on the chondral defect with the porous layer facing the bone surface through an arthroscopic cannula (Figure 1). The post-operative rehabilitation programme started on the first post-op day. Patients began rehabilitation with isotonic and isometric quadriceps and gluteus contractions. Walking was allowed with the aid of two crutches with partial weight-bearing (30% of body weight) on the operated leg for three weeks. Cycling exercises started from post-operative day two, swimming was allowed after two weeks. At four weeks post-op, walking with the aid of one crutch opposite to the treated leg was allowed for seven days, then normal walking thereafter. Impact sport activity could resume at three months post-op and complete return to sport activities was allowed six months after surgery. All patients were assessed preoperatively and at follow-up after 6, 12 months and than yearly, using the modified Harris Hip Score (mHHS)[16]. The mHHS assesses hip function with a maximum score of 91. Our results were rated as follows: excellent (81-91), good (71-80), fair (61-70) and poor (less than 60)[17]. The study was approved by the IRB of the Institute and all patients gave their consent to the data collection and publication.

Table I. Baseline characteristics of the study groups

AMIC (n=201) p
• Sex (M/F) 13/18
• FAI-cam (n) 21
• FAI-plncer (n) 16
• FAI-comblned (n) 6
• Preoperative mean age (years) 36.4±10.3 (18-55)
• Preoperatlve mean defect slze (cm2) 2.9±0.8 (2-4)
• Preoperative mean mHHS 44.9±5.9 (38-60)

Results

The mean follow up of the entire group of 201 patients was 5 years (from 8 to 2). The average age was 36.4±10.3 years. The mean defect size was

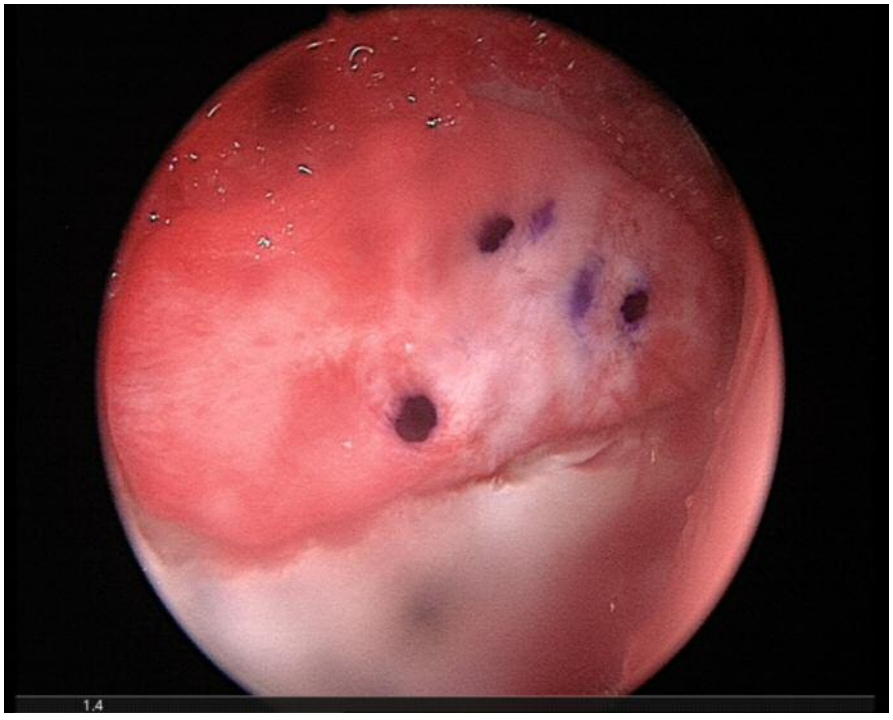

Figure 1. Chondro gide membrane is applied to cover the acetabular chondral defect. The implant has been marked on its smooth surface to allow the correct placement of its rugh face in contact with the subchondral bone.

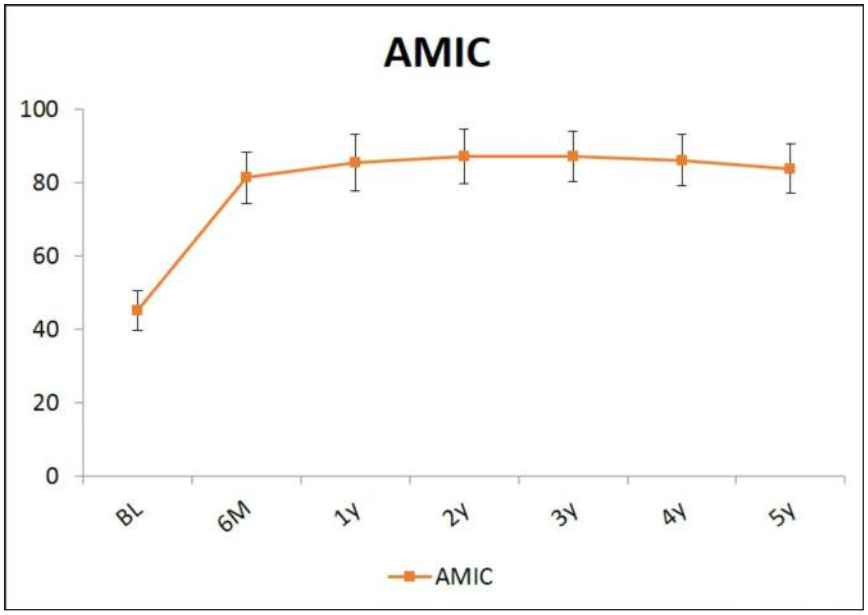

Figure 2. Pre-operative mHHS and up to 5 years after AMIC.

2.9±0.8 cm^2. Pre-operative mHHS had a mean score of 44.9±5.9. Significant improvement, as measured by the mHHS, was observed at 6 months in comparison to preoperative levels (80.3±8.3) ($p<0.001$). Continuous improvement with respect to each previous evaluation time point was seen, reaching the highest improvement level at the three years follow-up (85.5±7.2). The mHHS then remained stable over time until the final years follow-up (Figure 2). At each of the 12, 24, 36, 48 and 60 months time points, the mHHS was significantly higher in comparison to the 6 month values. The mean mHHS improvement recorded at the 5 years follow-up compared with preoperative scores was 39.1±5.9. No patient had a poor post-operative mHHS (>60).

No significant complications were reported and no failure resulting in hip arthroplasty was detected in any of these patients during the five year follow-up.

Discussion

Our study reports on long-term clinical outcomes for repair of 2-4cm^2 chondral lesions with the AMIC technique, assessed by mHHS. Significant improvements were demonstrated up to the 5 years follow-up, demonstrating that AMIC can be reliably extended to 4 cm^2 defects. Several arthroscopic techniques have been used to treat full-thickness chondral defects of the hip in the past few decades. However, due to the introduction of hip arthroscopy for the treatment of FAI, published outcome studies on hip cartilage repair are scarce and comprehensive evidence-based treatment guidelines for chondral lesions of the hip remain to be defined. MFx is still currently the first choice treatment for both acetabular and femoral head small chondral defects (≤ 2 cm^2) as it is not invasive and very rarely has it been associated with major post-operative complications. Satisfactory clinical results after MFx of the hip[2,11,18-20], including athletes[9,21], have been recently reported; however, the follow-up reported for MFx in the hip did not exceed two years[9,19,22]. Thus, clinical data relating lesion size, treatment choice and evaluation of cartilage repair procedures beyond two years are of critical importance to determine predictable and sustainable therapy for chondral cartilage defects of the hip. Literature on the use of MACI for the treatment of medium-sized chondral defects in the hip is particularly scarce. The first case report by Akimau et al.[23] described the treatment of an extensive loss of cartilage and osteonecrosis in the hip treated with bone grafting and MACI using Chondro-Gide®. Larger controlled retrospective studies, comparing arthroscopic AMIC with debridement[14] and with MFx[24] for the treatment of grade III/IV acetabular chondral defects larger than 2cm^2, have been recently reported demonstrating very good results at 5 years of follow up in the group treated with the AMIC technique.

The AMIC technique spares donor site morbidity since effective cartilage regeneration can be stimulated in a single surgical intervention without the need for harvesting cells from a second site. AMIC exploits the regenerative potential of mesenchymal progenitor cells deriving from subchondral bone. The collagen type I/III matrix used in AMIC protects the blood clot and supplies the regenerating site with a proper microenvironment supporting cell adhesion, growth and differentiation. Collagen matrices have previously been shown to support chondrogenic differentiation of mesenchymal stem cells[25] and to maintain chondrocyte phenotype[26], in particular when the matrix is composed of collagen types I and III[27]. The AMIC technique is further beneficial because it eliminates

the need for specialised centres and laboratory support to cultivate cells, in turn reducing total therapy time and overall cost, compared to two-stage procedures such as MACI. Our findings are in line with the results deriving from the treatment of cartilage defects of the knee and talus with the AMIC technique[28-31]. Gille et al.[28] showed that patients affected by large grade IV chondral lesions experienced significant improvement in terms of five different evaluation scores at 12 months and up to 24 months after the AMIC procedure. Satisfactory outcomes were also reported for osteochondral lesions of the talus treated by AMIC[32,33].

Until now, long-term outcome data for the treatment of chondral defects of the hip using the AMIC treatment were not available. One of the limitations of our study is that it is a retrospective analysis of data collected over years of treatment. Another limitation is that clinical improvement was evaluated based only on the mHHS. Although this test has high validity and reliability[16], it is most suitable for assessment of functionality in elderly arthritic patients and might not be sensitive enough to assess subtle changes in function in young, otherwise healthy patients. Nevertheless, the improvement in these scores suggests that AMIC provides clinical benefits to patients affected by a chondral lesion consequent to femoral acetabular impingement.

Other parameters like age and weight of the patient and morphology of the hip and soft tissues have not been deeply evaluated in this study. Those factors can influence the the results and should be taken in consideration.

The study was conducted according to international the ethical standards[34].

Conclusions

In conclusion, the AMIC technique allowed a marked clinical improvement in patients affected by chondral defects due to FAI. This study suggests that AMIC is a valid procedure to repair medium-sized chondral defects on the acetabular side of the hip found during treatment of FAI and lead to long-term favorable outcomes. AMIC, due to its minimal invasiveness, single-stage procedure and proven safety, may be considered as a first choice treatment with respect to minimizing therapy time and costs.

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