Feasibility of arthroscopic placement of autologous matrix-induced chondrogenesis grafts in the cadaver hip joint

Fritz Thorey,[1] Stefan Budde,[2] Marco Ezechieli,[2] Urs Vito Albrecht,[3] Max Ettinger[2]

[1]Center for Hip, Knee and Foot Surgery, Sports Traumatology, ATOS Hospital Heidelberg; [2]Department of Orthopaedic Surgery, Hanover Medical School, Hanover; [3]Institute for Legal Medicine, Hanover Medical School, Hanover, Germany

Abstract

An assortment of clinical trials have been done presenting the effectiveness of autologous matrix-induced chondrogenesis (AMIC) for the regeneration of chondral leasions. The purpose of the study was to underline the accessability of the acetabulum and the femoral head through the known portals and prove i) the feasibility of placing the AMIC in the different zones of the hip joint and ii) check for dislocation after joint movement. Six human cadavers underwent hip arthroscopy on both hips. Two chondral lesions were set on each femoral head and two in the acetabulum to evaluate a total of 48 defects. After microfracturing an autologous matrix-induced chondrogenesis graft was placed on these lesions arthroscopically. After repeated joint movement the dislocation of the graft was checked. It was possible to place the AMIC graft in all 48 chondral lesions. The time needed for placing the graft was 8±2.9 minutes. A trend of time reduction could be detected throughout this study as the surgeon gained more experience. For the femoral head, after twenty cycles of joint movement 18/24 spots showed no displacement, 4/24 showed minor displacement (<3 mm) and 2/24 showed major displacement (>3 mm). None showed total displacement. For the acetabulum 22/24 spots showed no displacement and 2/24 showed minor displacement. A combined microfracturing and placing of an AMIC graft of focal chondral lesions of the hip joint can be done arthroscopically. Prospective randomized in vivo studies should compare the results of arthroscopilally placed AMIC grafts with microfracturing and microfracturing alone.

Introduction

Cartilage degeneration may be accompanied by pain, immobility, stiffness, loss of quality of life and can potentially lead to severe osteoarthritis in the long term. Recently, a variety of surgical techniques that aim for resurfacing and regenerating of the articular cartilage have been developed. Due to recent advances and studies performed in the last years the number of hip arthroscopies is constantly increasing. This development leads to an expansion of indications treating pathologies around the hip joint through hip arthroscopy.[1] One of these is the treatment of chondral lesions. The diagnosis and treatment is extremely difficult with the available non-invasive techniques. Early chondral splits are usually melted using a radiofrequency probe, unstable flaps are excised and the underlying-subchondral bone microfractured.[2] The outcome of these lesions depends mainly on how soon the diagnosis is made and the extent of damage. Philippon *et al*.[3] examined the use of arthroscopic microfracture for the treatment of full-thickness chondral lesions. In this level of evidence study a successful outcome rate of 89% is reported. Jerosch *et al*.[4] showed good to excellent outcome results in 82% of a case series. An assortment of clinical trials have been done presenting the effectiveness of autologous culture-expanded chondrocytes for the regeneration of chondral leasions.[5] These were all performed in the knee. Autologous Matrix Induced Chondrogenesis (AMIC) is an established method for the treatment of articular cartilage defects. Gille *et al*.[6] showed good results for AMIC in a mid-term follo-up study for focal chondral defects in the knee. Only one surgical technique has been presented for the use of AMIC in hip arthroscopy.[7]

We hypothesized that the results of this study would confirm the accessibility of the acetabulum and the femoral head to known portals and prove i) the feasibility of placing the AMIC in the different zones of the hip joint through standard arthroscopic portals and ii) check for dislocation after joint movement.

Materials and Methods

This study was approved by the local ethical board. We used 6 human cadavers (4 male and 2 female) that included the whole body. The mean age at time of death was 49.3±5.56 (range 42 to 57 years) with a mean weight of 76.6±9.5 kg (range 58 to 82 kg). The *post-mortem* time at the date of surgery was in mean 7.3±3.15 days (range 4 to 12 days). The bodies were cooled after death. These features guaranteed a good reproduction of data. We prepared a table with a winch for applying the needed traction on the hip and all the necessary tools to fix the body on a radiolucent table. After the body was fixed on the table and draped surgically, the leg was put under traction, while the contra lateral leg was also fixed to the table rigidly. For the arthroscopy of the hip different portals were performed and focal chondral lesions were placed in all areas of acetabulum and over the entire femoral head using a chisel.

First, the portals were established. Under fluoroscopic guidance, the 17-gauge stylet enclosed spinal needle was inserted into the joint. The stylet was removed and replaced by a nitinol wire. The spinal needle was now removed and a small longitudinal skin incision was made to insert the 5.0 mm trocar and scope cannula, which were then advanced under fluoroscopic guidance into the joint.

In the 12 hips used in this study, chondral lesions were set throughout the femoral heads using a scraper. On each femoral head two different lesions were set which gave us the opportunity to examine 24 chondral lesions. Ilizaliturri *et al*.[8] divided the femoral head in 6 different zones (Figure 1) and proofed the reliability and reproducibility in a cadaveric study. In line with this we set the lesions in these zones. In each zone, 4 lesions were set overall throughout this study. The lesions averaged in diameter between 21±6×15±7 mm. Afterwards a micro fracturing of the lesion was performed and the AMIC was inserted arthroscopically through the scope cannula (Figure 2). The two lesions of each femoral head were treated in

Correspondence: Fritz Thorey, Center for Hip, Knee and Foot Surgery, ATOS Hospital Heidelberg, Bismarckstrasse 9-15, 69115 Heidelberg, Germany.
Tel. +49.6221.983.190 - Fax: +49.6221.983.199.
E-mail fritz.thorey@atos.de

Key words: hip, hip arthroscopy, chondral leasion, autologous matrix-induced chondrogenesis.

Contributions: FT, SB, MEz, MEt, data collecting and analyzing; FT, UVA, and MEt, manuscript writing.

Conflict of interests: the authors declare no potential conflict of interests.

Received for publication: 9 July 2013.
Accepted for publication: 22 July 2013.

Orthopedic Reviews 2013; 5:e26
doi:10.4081/or.2013.e26

the same session. Ilizaliturri *et al*.[8] divided the acetabulum into six zones as well. In each zone, 4 lesions were created randomly throughout this study. The lesions diameter averaged between 19±4 × 17±5 mm.

The time needed to place the grafts on the defects was measured. Following this, the joint was moved in extension/flexion (0-0-90°), internal and external rotation (10-0-20°) as well as adduction/abduction (20-0-30°) overall 20 times.

After manipulation a second look arthroscopy, to asses the dislocation grade using gas, was performed to check the dislocation of the AMIC graft. The degree of displacement was rated in four categories (overlapping of the collagen membran with the adjacent cartilage boarder): i. no displacement, ii. minor displacement (less that 3 mm), iii. major displacement (more than 3 mm) and iv. total displacement (complete loss of contact between the graft and the defect).

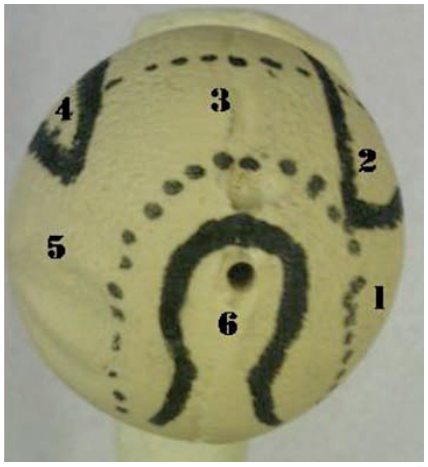

Figure 1. Each femoral head was divided in 6 different zones according to Ilizaliturri *et al*.[7]

Results

It was possible to place the AMIC graft in all 24 chondral lesions. The time needed for placing the graft after microfracturing was in mean 8±2.9 min. A trend of time reduction could be detected throughout this study as the surgeon gained more experience (Figure 3).

After 20 cycles of joint movement 4/4 spots in zone 1 of the femoral head showed no dislocation. In zone two 2/4 showed no displacement, 1/4 minor displacement and 1/4 showed major displacement. In zone two all spots showed no displacement. In zone three 3/4 spots showed no displacement and one spot showed minor displacement. In zone four 3/4 spots showed no displacement and 1/4 spots showed minor displacement. In zone five 4/4 spots showed no displacement. In zone six 2/4 spots showed no displacement, 1/4 spots showed minor displacement and 1/4 spots showed major displacement.

For the acetabulum in zone one 2/4 showed no displacement and 2/4 minor displacement. In all other zones no displacement could be detected.

Discussion

The most important findings of this study are, that all areas with chondral defects could be provided with the AMIC graft arthroscopically and that excellent to very good results – in terms of dislocation– could be found.

The higher rate of dislocations on the femoral side might be a result of bringing the defect with the AMIC graft with full range of motion near the labrum and therefore outside the acetabulum. This can lead to a higher friction and abrasio of the graft and lead to dislocation. On the acetabular side all AMIC graft were not exposed to these shear forces. Addinionally, the slight incongruency of femoral head and acetabulum might also be an advantage for placing the AMIC in acetabular defects.

When chondral lesions of the hip joint appear, young active adults may be involved to a high percentage. These defects may lead to progressive joint destruction accompanied with steadily increasing discomfort such as pain, joint stiffness and slacken of the activity level. As this topic is of high interest for orthopaedic surgeons, no study provides an arthroscopic procedure placing an AMCI graft in the hip joint.

Good mid-term results, concerning the patients level of satisfaction, of AMIC have been presented by Gille *et al*.[6] for chondral defects in the knee. As it becomes more and more apparent that including the whole osteochondral unit into regenerative cartilage surgery, rather than focusing on cartilage alone, is indispensable,[9] the authors focused on including this aspect into the present study. The AMIC procedure was initially developed as a one-step procedure that combines microfracturing with condrocyte differentiation from MSCs (Mesenchymal Stem Cells) on a collagen matrix. The initially formed blood clot, produced by the microfracturing procedure, may be protected by the collagen membrane.[10] Compared to autologous chondrocyte implantation (ACI), the AMIC procedure has many advantages: without the need of harvesting and culturing the chondrocytes after the first surgery and implantation in a second surgery, cartilage defects can be treated in an one-stage surgery in combination with microfracturing. This procedure can be performed in any arthroscopy center without the need for a special certification for a ACI. The surgeon can decide during surgery, if there is a need to treat a cartilage defect with AMIC or other techniques. Due to a one-stage surgery, there is a lower risk of patient complications and the treatment is more cost effective than ACI.

Figure 2. The AMIC (a) was inserted arthroscopically through the scope cannula (b) and placed on the chondral lesion (c).

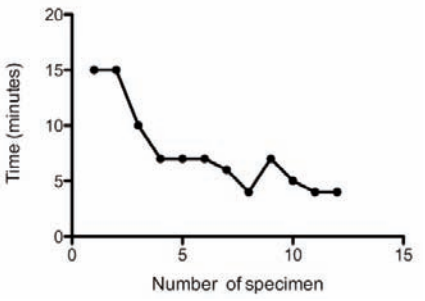

Figure 3. The time needed for placing the graft was 8±2.9 minutes. A trend of time reduction could be detected throughout this study as the surgeon gained more experience.

As this study was performed on human cadavers, one limitation of this study was that no blood clot could be produced my microfracturing and therefore the protecting effect of the collagen membrane could not be seen. Furthermore, no cartilage repair over time could be analysed. However, there is a need for prospective randomized studies in the future to compare the results of arthroscopilally placed AMIC grafts with microfracturing and microfracturing alone.

Conclusions

A combined microfracturing and placing of an autologous matrix-induced chondrogenesis graft (AMIC) of chondral lesions of the hip joint may be done arthroscopically. There is a higher dislocation rate of the graft on the femoral than the acetabular side.

References

1. Lubowitz JH, Poehling GG. Hip arthroscopy: an emerging gold standard. Arthroscopy 2006;22:1257-9.
2. Stevens MS, Legay DA, Glazebrook MA, Amirault D. The evidence for hip arthroscopy: grading the current indications. Arthroscopy 2010;26:1370-83.
3. Philippon MJ, Schenker ML, Briggs KK, Maxwell RB. Can microfracture produce repair tissue in acetabular chondral defects? Arthroscopy 2008;24:46-50.
4. Jerosch J, Schunck J, Khoja A. Arthroscopic treatment of the hip in early and midstage degenerative joint disease. Knee Surg Sports Traumatol Arthrosc 2006;14:641-5.
5. Ossendorf C, Kaps C, Kreuz PC, et al. Treatment of posttraumatic and focal osteoarthritic cartilage defects of the knee with autologous polymer-based three-dimensional chondrocyte grafts: 2-year clinical results. Arthritis Res Ther 2007;9:R41.
6. Gille J, Schuseil E, Wimmer J, et al. Mid-term results of Autologous Matrix-Induced Chondrogenesis for treatment of focal cartilage defects in the knee. Knee Surg Sports Traumatol Arthrosc 2010;18:1456-64.
7. Fontana A. A novel technique for treating cartilage defects in the hip: a fully arthroscopic approach to using autologous matrix-induced chondrogenesis. Arthrosc Tech 2012;1:e63-8.
8. Ilizaliturri VM Jr., Byrd JW, Sampson TG, et al. A geographic zone method to describe intra-articular pathology in hip arthroscopy: cadaveric study and preliminary report. Arthroscopy 2008;24:534-9.
9. Gomoll AH, Madry H, Knutsen G, et al. The subchondral bone in articular cartilage repair: current problems in the surgical management. Knee Surg Sports Traumatol Arthrosc 2010;18:434-47.
10. Benthien JP, Behrens P. Autologous matrix-induced chondrogenesis (AMIC). A one-step procedure for retropatellar articular resurfacing. Acta Orthop Belg 2010; 76:260-3.