Clinical results after treatment of Large Sized Cartilage Lesions of the Medial Femoral Condyle (MFC) with Matrix Autologous Chondrocyte Transplantation (MACT)

Article - July 2017

CITATIONS 0
READS 36

3 authors:

Hani Eltair
University of Wuerzburg
14 PUBLICATIONS 3 CITATIONS
SEE PROFILE

Mohamed G. Montaser
Benha University
16 PUBLICATIONS 1 CITATION
SEE PROFILE

Andreas B. Imhoff
Technische Universität München
969 PUBLICATIONS 9,627 CITATIONS
SEE PROFILE

Some of the authors of this publication are also working on these related projects:

- Slope-reducing osteotomy on ACL-Graft load View project
Clinical results after treatment of Large Sized Cartilage Lesions of the Medial Femoral Condyle (MFC) with Matrix Autologous Chondrocyte Transplantation (MACT)

Eltair H., Montaser M. G., Imhoff A.B.

1 Department of trauma, hand, plastic und reconstruction surgeries, Julius-Maximilians University, Würzburg, Germany
2 Assistant Prof. of Orthopedic surgery, Benha University, Egypt
3 Prof. of Orthopedic and trauma Surgery, Director of Sports medicine department, Rechts der Isar hospital, Technical university, Munich

Abstract

Background: Isolated cartilage damage is the starting point of generalized joint disease because it lacks the ability to heal or regenerate. Several methods of autologous cartilage transplants (ACT) were described to reconstruct large cartilage defects with variable results. This study presents the clinical results after treating large sized cartilage lesions of the MFC with MACT, with regard to different clinical scores and patients’ satisfaction and to emphasize the results and efficacy of MACT shown in the literature.

Patients and Methods: 8 patients (6 males, 2 females) were treated with Matrix Autologous Chondrocyte Transplantation (MACT) in the knee joint at the medial femoral condyle. Mean age was 29.9 years (19-39 years), average size of the defect was 6.31cm² (ranged from 3cm² to 12cm²). The follow-up was done Postoperatively using Lysholm, VAS (visual analogue scale), IKDCS (International knee documentation committee score) and Tegner scores.

Results: The Lysholm score was improved by average 15.63 Points. The IKDC showed a clear improvement of the score by 20.1 points. The VAS had an average improvement of the score from 7.5 to 3.125. Tegner activity score improved from activity level 3 to level 5.

Conclusion: MACT can be considered as a very efficient and safe therapeutic method for the treatment of large sized cartilage defects of the knee. The best results have been reported after traumatic lesions and OCD.

Keywords: Matrix Autologous Chondrocyte Transplantation, large sized cartilage lesions, Medial Femoral Condyle.

Introduction:

Cartilage damage and the resulting cartilage lesions of the knee joint are among the most common diseases worldwide. Often isolated cartilage damage is the starting point for a later generalized joint disease, since such lesions often remain asymptomatic for a long time.¹

The cartilage tissue, particularly in adults, lacks the ability to heal or regenerate, so that isolated cartilage damage often leads to arthritis. Such defects should be repaired locally to avoid generalized joint disease later on. With the introduction of cartilage transplants (Autologous Chondrocyte Transplantation- ACT) by Peterson and Britterberg in the 1980s, a procedure was available for the first time, which made it possible to reconstruct large cartilage defects, whereby the repair tissue are very close to the original cartilage in many of its properties.²

The early method, described by Peterson and Britterberg is called the classical ACT in which the cartilage cells taken from the patient's knee are replicated in the lab to form a cell suspension which in turn will be inserted into the defective area and then covered by a periosteal flap that is sewn onto the defect, the aim of periosteal flap is to act as a watertight chamber to keep the cell suspension in place.³

This relatively complex surgical technique and co-morbidity clearly restricted the scope of the procedure. In many cases it was only possible to achieve the necessary watertight chamber by very expensive additional measures. A combination with other operative measures, such as meniscus trimming or ACL reconstruction, which are often necessary to be done in such cases, was not often possible due to the long operating times. In some cases, the defects were too large to be treated with this technique.³

The development and introduction of a carrier material was a decisive and necessary step to avoid the mentioned problems and to decrease the morbidity.⁴
Patients and Methods:
8 patients (6 males, 2 females) were treated in Klinikum rechts der Isar, Technical University in Munich, in the department of Sports medicine with MACT in the knee joint (at the medial femoral condyle), 5 right knees, 3 left knees. All the 8 patients received Matrix Autologous Chondrocyte Transplantation (MACT), 4 from them required corrective osteotomies (High Tibial Osteotomy). The mean age at the time of the operation was 29,9 years (19-39 years). The mean BMI was 24,42 at the time of the operation and was 23,37 postoperatively; Size defect average was 6,31cm² (ranged from 3cm² to 12cm²). The clinical outcome was assessed using Lysholm, VAS (visual analogue scale), IKDCS (International knee documentation committee score) and Tegner scores.

Inclusion criteria:
- Young age of the Patient (usually between 18 and 40 years old).
- Encapsulated, full-layer, knee-joint defects.
- No corresponding kissing lesions
- Defect size between 3 and 12 cm².
- At least 2/3 of the Meniscus size is remaining.

Exclusion criteria:
- Ligamentous instability of the knee.
- Osteoarthritis.
- Inflammatory articular disease or septic arthritis.
- Chronic joint diseases as Rheumatoid arthritis or gouty arthritis.
- Patients undergoing Immunosuppression treatment as well as patients suffering from Malignancy.

The patients were first clinically assisted at the outpatient clinic; MRI was performed preoperatively to all the patients to emphasize the diagnosis.
In all patients an arthroscopy of the knee joint was first performed. The intraoperative findings were then checked to confirm the diagnosis and indication. (Fig.1)

Surgical technique:
This technique is composed of 2 steps; during the first step of the procedure 2-3 cartilage-bone punching cylinders with a diameter of 4 mm were taken arthroscopically from a non-loading region in the joint (Fig.2-3). The lateral or medial notch edge was preferably chosen. These punching cylinders are harvested from the patient’s Knee during the first operation and then sent in a sterile nutrient solution to be processed in the laboratory. (5)

(Fig. 1) Arthroscopic picture of a cartilage lesion of the medial femoral condyle.

(Fig. 2) During harvesting of the cartilage sample

(Fig. 3) Arthroscopic picture showing the knee after harvesting the cartilage samples.
The cultivated cells are then distributed on the collagen membrane; the membrane consists of 2 different surfaces. The cell-free surface, which is tear resistant and tough, this layer also prevents the entry of nonspecific cells from the synovial fluid into the matrix tissue, which could develop into fibroblasts. The aim is to prevent the formation of a mixed tissue in the defect. The second surface of the membrane is called the cell-bearing surface, which is a three-dimensional collagen that contains the cultivated cells that will face the defect. (Fig. 4)

(Fig.4) The membrane in its holding metallic frame before transplantation.

The defect is exposed in the second step of the procedure after 2 weeks through a medial parapatellar incision (Fig. 5) and then the defective residual cartilage is removed with a special curette so that the subchondral bone lamella was completely freed and a stable cartilage shoulder formed at the edge of the defect (Fig. 6). The collagen membrane is then trimmed according to the size of the lesion and then sutured into the defect by means of 6,0 PDS and fibrin glue (Fig. 7).

(Fig.5) Exposure of the defect at the medial femoral condyle (MFC) through medial parapatellar incision.

(Fig. 6) Removal of the residual cartilage in the defect by special curette.

(Fig.7) The collagen matrix after fixation

By means of this new carrier-supported method (so-called matrix-associated autologous chondrocyte transplantation, MACT), it is now also possible to combine several operative procedures, for example, corrective osteotomies as well as meniscus operations, which are usually done with the first step. (6)

In the course of the follow-up, a close follow-up was done by series of clinical examinations of the patients. The IKDC score (7) was used as a basis for examination for all patients postoperatively. Both clinical findings (effusion, mobility, band stability, functional tests) as well as subjective data of the patient flow into this scoreboard. The subjective assessment of the health status, the general activity level, pain level and the knee function before and after the therapy is queried via standardized questionnaires.
Postoperative Physiotherapy treatment consists of 4 consecutive phases:

**Phase I:** starts from the first postoperative day till the end of the 6th week, during which the patient learns how to move with crutches, only allowed to weight-bear the non-operated side, learns how to perform some trainings in home, the goal of this phase to decrease the sensation of pain and swelling and to avoid the loss of joint functions, in this phase the allowed range of motion should be as follows Flexion/Extension 90-0-0°.

**Phase II:** starts from the 7th Postoperative week till 12th postoperative week, during which the patient is allowed to begin with weight bearing on the operated side and should be increased weekly by 20kg with allowance of free range of motion (if tolerated).

**Phase III:** from the 3rd Month postoperatively the patient can begin riding bicycles, crawl swimming und running on flat-soft surfaces.

**Phase IV:** from 6-12 Months postoperatively, during which it’s allowed for the patient to start contact sports gradually.

**Results:**
The average defect size was 6,31 cm² (range from 3cm² to 12cm²). The localization in the treated 8 Patients was in the medial femoral condyle (MFC). Six Patients had grade IV and 2 Patients had grade III according to International cartilage repair society classification (ICRS classification). Two Patients had straight leg axis. Two patients had Valgus of 1° that required no correction. Four Patients had Varus Knee, 3 of them undergone open-wedge High Tibial Osteotomy at the same time of the first step of the procedure while the fourth patient had only 2° Varus that required no correction. The causes of cartilage damage in our patients can be summarized as follows:

Two cases (25%) suffered traumatic incidents while in the other 6 cases (75%) a definite traumatic incident was not identified. Osteochondritis dissecans (OCD) was reported in 1 case (12,5 %) and cartilage degeneration was reported in the other 7 cases (87,5%). The Lysholm score was improved by average 15,63 Points. The average Preoperative value of all Patients was 74,62 and the average postoperative value was 90,25. (Table 1)

<table>
<thead>
<tr>
<th>Score</th>
<th>Average Preoperative</th>
<th>Average Postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAS</td>
<td>7,5</td>
<td>3,125</td>
</tr>
<tr>
<td>Lysholm</td>
<td>74,62</td>
<td>90,25</td>
</tr>
<tr>
<td>Tegner</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>IKDC</td>
<td>39,9</td>
<td>60</td>
</tr>
</tbody>
</table>

The IKDC score includes both objective and subjective examination criteria. Here, it showed a clear improvement of the score by 20.1 points between preoperative and postoperative value. The average preoperative value of all patients in this group was 39.9 points. Postoperatively, the score is improved to an average of 60 points.

The subjective assessment was also determined by means of VAS (Visual analogue scale). There was an average improvement in the score from 7,5 to 3.125 (the higher value represents a poorer health condition in VAS).

The activity level was assessed by Tegner activity score with average improvement from activity level 3 to level 5.

The mean operative time in the second step (incision-stitch time) was 39 min.

**Complications:**
In the operated group there was no recorded postoperative infection, failure of membrane, arthrofibrosis, locking or free foreign body. Effusion was recorded in 2 cases.

**Discussion:**
Articular cartilage is friction-less tissue with special biomechanical properties. It has limited capacity for repairing itself with normal hyaline cartilage; the current reparative procedures as MACT provide a hope to normal or nearly normal regenerate tissue. We should always remember that the success of this method depends on many factors as body weight, activity level and joint abnormality.

Classical ACT has been used since 1987 as the first biological approach to treat large full thickness cartilage repair, it was based on the implantation of cartilage-cell suspension under tightly sealed periosteal flap from the medial surface of the tibia. However the use
of ACT was limited due to the complexity of surgical procedure, long operating time, multiple morbidity sites as well as the biological response and hypertrophy of the periosteal flap.\(^\text{(12)}\)

It was mentioned in many researches the inferiority of other cartilage treatment procedures as Microfracture (MF), which has pooper outcome, shorter durability duration than MACT specially in large lesion (>3cm\(^2\)), as well as the resultant regenerate tissue is fibrocartilage that has lower biomechanical properties in comparison with hyaline cartilage. \(^\text{(13)}\)

Many clinical studies have shown that the MACT has been able to refill medium and large cartilage defects with a good result by means of a sufficient nearly normal regenerate. \(^\text{(14-16)}\)

The use of a carrier material (Collagen membrane) has brought considerable simplifications and advantages, for example shortening of the operating-time and the ability to use it in very deep and large cartilage defects as in OCD (Osteochondritis dissecans) or as in very large defect without intact cartilage margins, as well as avoiding the harvesting of periosteal flap from Proximal tibia which in turn will decrease the morbidity of the knee. \(^\text{(17)}\)

Also the significant improvement of the IKDC score after MACT has its correspondence also in other studies. \(^\text{(18,19)}\) In comparing the complications’ data of MACT with complication data for the old generation classical ACT from the literature, it can be clearly seen that the MACT is associated with less complications as absence of complications such as hypertrophy of the membrane, adhesions and arthrofibrosis. \(^\text{(20)}\)

The results so far show a very predominantly positive picture, with the hyaline-like cartilage replacement and gaining stability with regard to its mechanical properties. In order to confirm these results, it is necessary to carry out further studies with larger numbers of cases and over longer periods of follow up; Multicenter studies are recommended.

It is anticipated that new biological reconstruction procedures will be developed in the future, which will deal with the use of targeted cells and other methods of "tissue engineering". The aim is to be able to avoid osteoarthritis and, thus, surgical procedures such as the Endoprosthetic replacement, by early restoring the cartilage surfaces of the knee joint.

**Conclusion:**

With reference to the published results as well as our results, MACT can be considered as a very efficient and safe therapeutic method for the treatment of large sized cartilage defects of the knee. The best results have been reported after traumatic lesions and OCD. Patients’ selection and technical expertise as well as postoperative rehabilitation are important factors that contribute to the success of the procedure.

In order to achieve successful outcome; any other co-morbidity in the knee should be addressed and well treated e.g. meniscus lesions and mal-alignment, as both are contraindications to cartilage restoration procedures. Corrective osteotomy should be done to restore the mechanical axis of the knee in addition to meniscus surgeries to assure the success of the cartilage restoration procedure.

**References:**