

Treatment of articular cartilage injuries in the knee with transplantation of autologous chondrocytes – Long term follow-up and long term durability

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Introduction

Trauma, twists or impacts, both occasional and repetitive, can cause damages to both the articular cartilage and the subchondral bone in a joint. The reparative response to articular cartilage injuries is very limited. The cartilage lacks blood vessels so an injury does not cause bleeding and forming of a fibrin clot that possibly could fill the cartilage defect. Instead the chondrocytes near the lesion proliferate and increase the synthesis of matrix molecules, but not enough to fill a defect (1). Untreated acute lesions to the articular cartilage of the knee likely progress to early degenerative osteoarthritis (2). Osteoarthritis is an irreversible process (3) and may lead to considerable disability for the patient.

If a lesion penetrates the subchondral bone a bleeding occurs and a fibrin clot may be formed. Experimental studies have shown that the bony part of a defect has a capacity to heal with new bone. However, the cartilage part of a defect does not heal well. The repair tissue rarely fills the defect, its mechanical properties are not similar to articular cartilage and it usually wears down leaving exposed subchondral bone (1).

In 1994 Brittberg et al. (4) presented a pilot study of treatment of deep cartilage defects in the knee with transplantation of autologous chondrocytes (ACT). 23 patients with chondral or osteochondral lesions were included in the study, 16 with femoral condyle lesions and 7 with patellar lesions. The treatment was a two-stage surgery; chondrocytes were arthroscopically harvested from a minor load-bearing area on the upper medial femoral condyle of the damaged knee. The cartilage was enzymatically digested and the chondrocytes were isolated and cultured for two to three weeks. Under general anaesthesia a medial or lateral parapatellar arthrotomy was performed to expose the cartilage defect. After

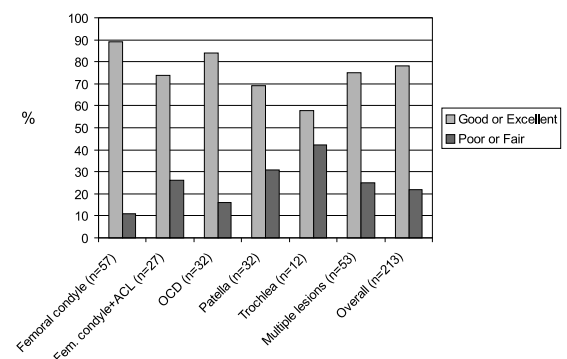


Fig. 1.

Tab. 1.

| | Evaluated | Operated |
|-----------------------|-----------|----------|
| Femoral condyle | 57 | 62 |
| Femoral condyle + ACL | 27 | 27 |
| OCD | 32 | 32 |
| Patella | 32 | 32 |
| Trochlea | 12 | 13 |
| Multiple lesions | 53 | 53 |
| Overall | 213 | 219 |

Tab. 2. Femoral condyle

| | <i>n</i> | Good | Excellent | Cincinnati | Brittberg/Peterson | Tegner/Wallgren |
|----------------------------|----------|------|-----------|------------|--------------------|-----------------|
| Preoperative | 19 | 0 | 0 | 1.2 | 84.5 | 7 |
| 2 year | 19 | 5 | 12 | 8.9 | 14.2 | 9.8 |
| 5 - 11 years (mean 7.4) | 19 | 5 | 12 | 9.2 | 12.2 | 10 |

Tab. 3. Femoral condyle + ACL

| | <i>n</i> | Good | Excellent | Cincinnati | Brittberg/Peterson | Tegner/Wallgren |
|----------------------------|----------|------|-----------|------------|--------------------|-----------------|
| Preoperative | 11 | 0 | 0 | 2.3 | 83.2 | 7 |
| 2 year | 11 | 4 | 6 | 7.5 | 25.9 | 9.6 |
| 5 - 11 years (mean 7.4) | 11 | 3 | 6 | 7.6 | 24.2 | 9.8 |

Tab. 4. OCD

| | <i>n</i> | Good | Excellent | Cincinnati | Brittberg/Peterson | Tegner/Wallgren |
|----------------------------|----------|------|-----------|------------|--------------------|-----------------|
| Preoperative | 14 | 0 | 0 | 1.7 | 80.1 | 6 |
| 2 year | 14 | 3 | 9 | 8.2 | 21.8 | 8.8 |
| 5 - 11 years (mean 7.4) | 14 | 2 | 10 | 9.0 | 19.4 | 9.8 |

Tab. 5. Patella

| | <i>n</i> | Good | Excellent | Cincinnati | Brittberg/Peterson | Tegner/Wallgren |
|----------------------------|----------|------|-----------|------------|--------------------|-----------------|
| Preoperative | 17 | 0 | 0 | 1.6 | 68.1 | 5.5 |
| 2 year | 13 | 4 | 7 | 6.8 | 27.3 | 9.2 |
| 5 - 11 years (mean 7.4) | 17 | 6 | 7 | 6.8 | 27.8 | 8.8 |

excision to healthy cartilage and debridement of the pathological cartilage, a periosteal flap harvested from the upper medial tibia was sutured over the defect to

create a watertight integrity. The cultured chondrocytes were implanted under the periosteal flap and the wound was closed in separate layers. Two years after the trans-

plantation 14 of the 16 patients with femoral condyle lesions clinically graded Good or Excellent. However, the seven patients with the patellar lesions did not show as promising results, only two was graded Good or Excellent three years after the transplantation. The poor results in the patella group was thought to be due to the different etiology of patellar lesions compared to femoral condyle lesions, for example malalignment or patellar subluxation, and to not surgically correcting these when needed.

Material And Method

Between November 1987 and February 1996 219 patients were treated with ACT for symptomatic chondral or osteochondral lesions in the knee. 213 of these were evaluated 2 - 10 years after surgery. Based on an overall assessment they were graded Poor, Fair, Good or Excellent. Depending on location of the treated cartilage defects and possible concomitant reconstruction of the anterior cruciate ligament (ACL) the patients were divided into subgroups (tab. 1).

The durability of the treatment was also studied. 61 patients were included and divided into the subgroups femoral condyle (n=19), femoral condyle with ACL-reconstruction (n=11), osteochondritis dissecans (OCD) (n=14) and patella (n=17). After treatment with ACT they were evaluated two years after surgery and reevaluated 5 - 11 years after surgery. The patients were assessed clinically and three scoring systems were used: Cincinnati knee score, Brittberg-Peterson functional VAS and Tegner-Wallgren activity score (5). Based on an overall assessment including Cincinnati and Brittberg-Peterson the patients were graded Poor, Fair, Good or Excellent. In the patella group 17 patients were included, but four of these did not show up for the 2-year follow-up.

Results

Overall 167 (78%) of the evaluated 213 patients were clinically graded Good or Excellent at the follow-up. Of the subgroups the femoral condyle and OCD presented the best results with 89% and 84% Good or Excellent. The treatment of the patients in the patella and trochlea subgroups was less successful with 69% and 58% Good or Excellent (fig. 1).

In the different subgroups when studying the durability all patient were graded Poor before the surgery. At 2-year follow-up

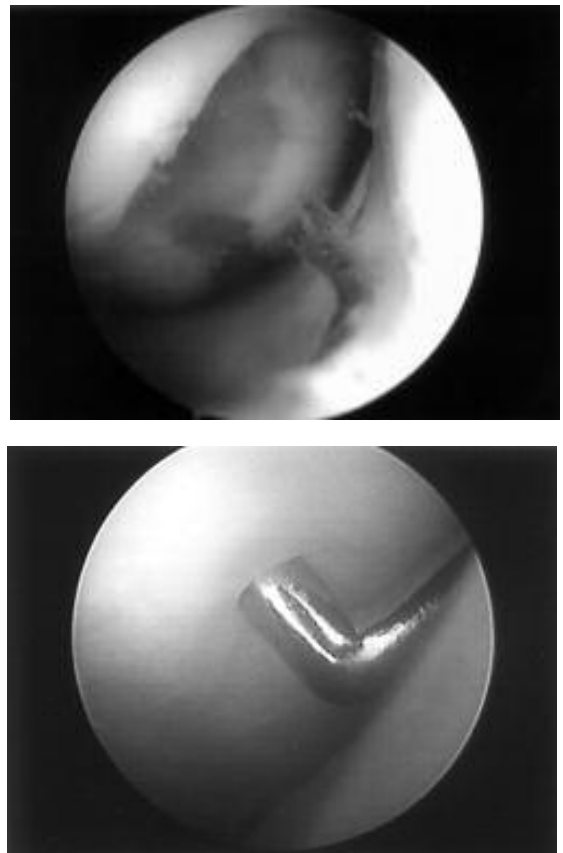


Fig. 2 a,b. Arthroscopic picture of 33-year-old woman showing a full thickness chondral defect in the femoral condyle. The lesion was treated with ACT and a concomitant ACL-reconstruction was performed. 21 months after surgery the repair tissue shows good integration to subchondral bone and surrounding cartilage and with a stiffness close to that of normal cartilage.



Fig. 3.

17 of the patients in the femoral condyle group graded Good or Excellent and at the 5–11-year follow-up 17 patients still graded Good or Excellent (tab. 2). Ten patients in the femoral condyle with ACL-reconstruction group graded Good or Excellent at 2-year follow-up and at 5–11-year follow-up 9 graded Good or Excellent (tab. 3, fig. 2). In the subgroup with osteochondritis dissecans 12 of the 14 patients were graded Good or Excellent 2 years and 5–9 years after the treatment (table 4). The patella group included 17 patients, but only 13 of these participated in the 2-year follow-up. Eleven patients showed Good or Excellent results at 2 years and after 5–11 years 13 were Good or Excellent (tab. 5). Fifty-one patients were Good or Excellent at second follow-up (fig. 3).

Discussion

Most treatments for chondral and osteochondral injuries show initially promising results but deteriorate over time.

In this study the results of 2–11-year follow-up after autologous chondrocyte transplantation are presented. Patients who were Good or Excellent at 2-year follow-up were followed for 5–11 years. In the isolated femoral lesion group no deterioration over time was seen. In the femoral condyle with ACL-reconstruction one patient went

from Good to Fair. One of the patients in the OCD group went from Good to Excellent. In the patella lesion group 4 patients were missing at 2-year follow-up but all were included in the second follow-up. Two presented with Good results and 2 with Fair.

Interestingly the activity score showed a tendency to increase over the years especially in the ACL and OCD groups, and stayed stable in the other groups.

Patients with chondral and osteochondral defects treated with ACT in a follow-up of 5–11 years showed persistent Good and Excellent results and stayed active at high levels. No deterioration occurred, but in one patient in with an isolated femoral condyle lesion and ACL-reconstruction. 84% of the OCD patients had a Good or Excellent result in spite of 3 surgeries in average previous to the actual ACT surgery.

References

1. Buckwalter JA: Chondral and osteochondral injuries: mechanisms of injury and repair responses. *Oper Tech Orthop* 1997; 7 (4): 263–269.
2. Dzioba RB: The classification and treatment of acute articular cartilage lesions. *Arthroscopy* 1998; 4 (2): 72–80.
3. Suh J-K, Årøen A, Muzzonigro TS, Disilvestro M, Fu F: Injury and repair of articular cartilage: related scientific issues. *Oper Tech Orthop* 1997; 7 (4): 270–278.
4. Brittberg M, Lindahl A, Nilsson A, Ohlsson C, Isaksson O, Peterson L: Treatment of deep cartilage defects in the knee with autologous chondrocyte transplantation. *N Eng J Med* 1994; 331: 889–895.
5. Peterson L, Minas T, Brittberg M, Nilsson A, Sjögren-Jansson E, Lindahl A: Two- to 9-year outcome after autologous chondrocyte transplantation of the knee. *Clin Orthop Rel Res* 2000; 374: 212–234.

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