

Autologous Chondrocyte Transplantation

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BACKGROUND

- Chesterman and Smith (1968):
the first to isolate and culture chondrocytes free of the matrix
- Peterson et al (1984): results of ACT in rabbit model
- Drs. Lars Petersen & Anders Lindahl (1994). : The first clinical results in 23 pts
- In Sweden, autologous chondrocyte transplantation combined with a periosteal graft has been used in approximately 1200 patients since 1987, and, worldwide, variants of ACT or implantation have now been tried in approximately 10,000 patients.

INDICATIONS

1. Focal full thickness chondral lesions and OCD of femoral condyles, trochlea (FDA)
 - 10 to 40 mm in diameter extending down to the subchondral bone.
 - Contained lesions have a better prognosis than uncontained lesions.
 - The decision based on the indications for ACT is made during A/S evaluation.
(visualization, probing, assessment of the depth and size of the defect)
2. Ages: 15-50 (55) years
3. Advancing indication: Patella
4. Not indicated for osteoarthritis, bi-polar exposed bone
5. Less clear indications: tibial defects, kissing defects, multiple defects

Prerequisites

1. Ligamentous stability
2. Biomechanical alignment
3. Meniscal function adequate: previous total meniscectomy would be an indication for meniscal transplant, either staged or concomitantly with ACI.
4. Motion and muscle strength
5. Patient compliance factors

ACT SURGICAL TECHNIQUE

Chondral Biopsy for Chondrocyte Culture

1. Arthroscopic assessment and treatment
2. Chondral Biopsy: NWB area (superomedial edge) of MFC, LFC, intercondylar notch ? three or four slices, 3 to 4 mm × 10 to 12 mm (8 to 12 cm²)
 - The healing time for the harvest area is about 3 months.
3. Cartilage tissue sent for tissue culture
4. Cultivation leading to 10-fold increase in chondrocytes
5. 10 to 12 million cells available for transplant, (.3 to .4 ml volume)

Surgical Approach

- standard medial or lateral parapatellar incision and arthrotomy

Debridement of the Defect

- Thoroughly debridement of all unhealthy cartilage surrounding the lesion, including all fissures and undermined cartilage in addition to any fibrocartilage present in the base of the defect.
- Avoid penetrating the subchondral bone plate (bleeding)

Three steps: 1) place neuropatties with epinephrine and thrombin

2) fibrin glue

3) electrocautery (5 to 8W)

- Measurement of the dimension: template (sterile paper or aluminum)
 - oversizing by 1 to 2 mm
- Adding 1 to 2 mm in size when cutting the periosteal graft allows for the tendency of the periosteum to shrink after harvest

Periosteal Harvesting

- Site:

- 1) separate incision from the proximal medial tibia, two fingers distal to the pes anserinus and MCL insertion on the subcutaneous border.
- 2) Distal femoral periosteum (the synovium should be repaired)
 - All fat and fascia layers must be removed from the periosteum
 - The periosteum is a white glistening tissue, if there is an offwhite or shaded appearance to the periosteum, the fascia may still remain over the periosteum.
 - increased risk of periosteal hypertrophy.

Securing the Periosteal Patch

- be kept moist, preserving the viability of the cambium layer.
- Should not be handled with surgical gloves.
- The cambium layer facing into the defect.
- Through the periosteum from outside to inside, 2 mm from the edge of the periosteum
- Immersed in sterile glycerin
- Manhole-cover appearance
- Knots tied on the side of the periosteum

Implantation of Autologous Chondrocytes

- Any concomitant procedures should be completed before implanting the chondrocytes.
- A sterile 18-gauge catheter
- If drain is applied, it should not be placed inside the joint.

COEXISTING KNEE PATHOLOGY

- Coexistent knee pathology can be addressed in a staged surgical procedure before ACT, or concomitantly with ACT.
- Concomitant procedures facilitate the healing process of the hyaline-like repair tissue by unloading overloaded compartments, ensuring proper tracking, and balancing soft tissues.

Biomechanical Alignment

- Check the full length films from hip to ankle
- Unloading osteotomy

Patellofemoral Malalignment

- abnormal patellar tracking and patellofemoral contact forces

Ligamentous Insufficiency

- If performed concomitantly, ACL reconstruction should be precede autologous chondrocyte implantation.

Meniscal Deficiency

- Whenever possible, it should be preserved or repaired.
- When performing a meniscal allograft concomitantly with ACT, the meniscal allograft should be placed and secured, followed by completion of the ACT

Bony Deficiency

- Bone graft to the defects with bony loss greater than 8 millimeters
- Bone graft can be done at the same time of A/S evaluation and chondral biopsy.
- Another option (Sandwich technique)

Filled with B/G + periosteum + cultured chondrocytes + periosteum

UNCONTAINED CHONDRAL LESIONS

- Does not have a peripheral cartilage border on one side to suture the periosteal graft (ex. A chondral lesion that extends into the intercondylar notch)
- Using the synovium as the peripheral margin
- Options for periosteal fixation
 - 1) multiple peripheral drill holes
 - 2) mini-Mitek (Mitek, Inc, Norwood, MA)
 - 3) Two or three cylindrical autologous osteochondral plugs
 - Hard-to-reach compartments

REHABILITATION

- As there is a degree of individual variation with the rehabilitation process, the program should be designed according to the patient's status and needs, as well as such factors as the size and location of the lesion and any possible concomitant procedures performed.
- Principles: graft protection, mobility and motion exercises, muscle strengthening, progressive weight bearing, and patient education
- CPM: 0 to 40 degrees
- Isometric quadriceps training and ROM training is started the day after surgery.
- Gradually increase the weight bearing (FWB at 6 weeks)
- Progressive closed-chain exercises after 3weeks
- Open-chain exercises around 8th week
- Running 8th or 9th month
- Rehab for patella or trochlear lesions requires special considerations

COMPLICATIONS

- 1) Periosteal overgrowth or hypertrophy

- the most common / due to friction at motion / overlaps from the repair area to the normal cartilage in the direction of motion (ant. or post. To the defect)
 - catching, popping, swelling (pain \pm) / 20% of 2nd A/S ---50% Sx(+)
 - 5 to 9 months post-ACL
 - arthroscopic evaluation and debridement
- 2) Graft failure
- a result of graft lamination
 - cause of failure: mechanical overload & genetic disposition of the patient
 - marginal, partial, complete delamination
 - debridement of the loose part of the graft & abrasion or microfracture
- 3) Overload of the maturing graft
- 4) Intraarticular adhesions or arthrofibrosis: 2%
- high risk of occurring in those patients who are undergoing concomitant procedures
 - aggressive ROM therapy program
 - arthroscopic adhesiolysis

CLINICAL RESULTS

- More than 85% successful results (Bahuaud, Cole & D' Amoto, Gillogly & Hamby, Minas, Brittberg, Gersoff)
- Peterson et al (2000): 2 to 9 F/U of first 100 pts.
 - Isolated femoral condyle 23/25 (92%)
 - OCD 16/18 (89%)
 - multiple lesions (67%)
- long term durability(Peterson et al 2002): 96% durability factor at 2 and 7.5 years.
- Minas et al (2001): 235 pts./ 87% success rate over a 6-year period.
- Gillogly(Atlanta Sports Medicine and orthopaedic Center): 112 Pts./91%
 - There was a statistical diff. injury or onset of symptoms than in chronic defects present for more than 1 year.
- The Cartilage Registry Report(2001)
 - 78 % of all defects treated with ACI improvement
(81% of isolated femoral condyle defects had improved)
 - Clinician evaluations : 79% improvement for all lesions
 - 85% for femoral condyles
 - 80% for trochlea lesions
 - The M/C adverse event: I/A adhesions (2%)
 - Graft detachment (1.4%)
 - Hypertrophic tissue(1.3~17%)

Catching/popping(1.0%)

- The overall adverse event rate and safety profile less than 7%.

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