

Knee - Articular Cartilage Procedures

Surgical Indications and Considerations

Anatomical Considerations: Articular cartilage covers the articular surfaces of synovial joints and provides a nearly frictionless surface for kinematics. It lacks blood supply and lymphatic supply, receiving its nutrients secondary to movement and stresses to the proteoglycans and collagen. Articular cartilage is composed of type II hyaline cartilage, which does not spontaneously reproduce and is naturally replaced with fibrocartilage following pathology. Fibrocartilage lacks the shock absorption and smooth characteristic of hyaline cartilage. Mechanical motion and loading have been found to increase chondrocyte activity and improve cartilage generation.

Pathogenesis: Research suggest that it may stem from a variety of causes including: post traumatic avascular necrosis, idiopathic avascular necrosis, overuse and repeated impact, blockage of a small artery, unrecognized injury, tiny fracture leading to cartilage damage, genetic predisposition (if multiple joints involved or family history), abnormal ossification, and acute trauma or shear force. Osteochondral defects are divided into five stages. Stage 0 - normal, Stage 1 - softening and/or superficial fissures, Stage 2 - injury extending to less than 50% of cartilage depth, Stage 3 - injury through 50% of cartilage depth and to subchondral bone, Stage 4 - Subchondral bone exposed, injury to subchondral bone or through to trabecular bone.

Epidemiology: Osteochondral defect is a common disorder of unclear etiology. Predisposing factors include high impact athletic activities, muscular weakness and instability, malalignment, and endocrine imbalance. The pathology is historically more common in males (thought to be secondary to activity level) with prevalence increasing in females, ages 10-40 years, and is known to occur in the knee, dome of the talus, capitellum, femoral head, and trochlea. Occurrence is greater in the weight bearing joints and may occur in the upper extremities with falling onto an outstretched arm.

Diagnosis:

- Patients present with varying pain levels from no complaints to non-relieving pain following trauma, sudden onset (loose body), gradual onset, or intermittent pain
- Pain is primary complaint, dull ache, poorly localized, rest alleviates, increases with activity.
- Swelling is often intermittent, increases with activity
- Grating in the joint
- Decreased range of motion, stiffness. Inconsistent range of motion could be indicative of a loose body
- Locking in the joint and giving way
- Plain film radiographs confirm lesion. MRI, CT, and US are used to diagnose stage of lesion. Arthroscopy is gold standard evaluation tool

Nonoperative Versus Operative Management:

Treatment of osteochondral lesions depends on the size, location, stability of the fragment, and skeletal maturity (epiphyseal plates). Research and history has shown that articular cartilage will not spontaneously heal. Stage 1 and 2 lesions are often treated conservatively because the surgery is invasive and reliability of techniques is indifferent. Surgical intervention is recommended for stage 3 and 4 lesions and occasional stage 2 lesions depending on level of activity of patient and physician's choice.

Surgical Procedures: Several surgical intervention options are available and chosen depending upon the condition of the lesion and goals of the patient. Arthroscopic debridement consists of removal of loose bodies, spurs, loose cartilage, and the cartilage surface is made smooth. Arthroscopic abrasion is utilized following debridement to expose bleeding surface of bone in order to stimulate cartilage healing – however, healing occurs with a less than optimal fibrocartilage layer. Arthroscopic micro fracture or drilling consists of drilling holes into the subchondral bone with the intention of stimulating articular cartilage formation from the subchondral bone. Drilling can be done either retrograde (does not touch the remaining cartilage) or antegrade (through the remaining cartilage). More invasive options include osteochondral autograft transfer (OAT) procedure that involves removing a graft and bone plug from a non weight bearing surface of the knee, usually the patella groove of the medial condyle. Holes are drilled into the osteochondral lesion and the plugs are then placed in the lesion. The articular surface is then hyaline cartilage from the plugs, but the space between the plugs is filled with fibrocartilage. The latest option is Autologous Chondrocyte Transplantation/Implantation (ACI) that requires a biopsy of healthy articular cartilage from a non weight bearing surface to be gathered and sent to the lab to culture hyaline cartilage. Cartilage is sent back to the physician. A periosteal graft is then taken from the tibia and inserted into the lesion with the new cartilage cells injected below it. The graft is sutured in place with flat sutures.

Preoperative Rehabilitation:

- Conservative treatment to return patient to highest level of function. If conservative fails to meet the desired outcomes and/or expectations, then surgery is implicated
- Lower extremity strengthening and arm bike to maintain cardiovascular strength
- Patient education in use of crutches and weight bearing status as appropriate
- A controlled motion brace may be appropriate with symptoms of instability
- Instructions and review post-operative plan and educate on long recovery period

POSTOPERATIVE REHABILITATION

Note: The following rehabilitation protocol is a summary of guidelines for post-operative articular cartilage procedures provided by Fitzgerald and Irrgang and published in Clinical Orthopaedic Rehabilitation by Brotzman and Wilk. Please refer to the publication for details on the progression, potential impairments, and goals of the rehabilitation plan.

ARTHROSCOPIC DEBRIDEMENT

Phase I: Early post-operative protection phase: 0-6 weeks

Goals: Protection of healing tissue from shear forces
Restoration of full passive knee extension
Gradual improvement of full knee flexion
Re-establish voluntary quadriceps control
Adhere to weight bearing status

Intervention:

- Full extension at 1 wk
- Full flexion at 3 wks
- Initiate isometric exercises
- Open chain resisted exercises as tolerated
- Closed chain exercise as tolerated in accordance to weight bearing status
- Weight bearing as tolerated crutch training
- Initiate walking program: 3-6 weeks
- Stationary bike: 3-6 weeks
- Swimming program: 3-6 weeks
- Elevate and ice

Phase II: Intermediate Phase: 6-12 weeks

Goals: Full active range of motion should be achieved by this time
Return to full activities.

Intervention:

- Exercises to maintain full active range of motion
- Progress to open and closed chain resisted exercises as tolerated
- Agility and sport specific skill training at 50% effort is initiated, progress to full effort as tolerated
- Initiate return to full activity as these activities do not induce pain or effusion
- Elevate and ice as needed

OSTEOCHONDRAL AUTOGRAFT PROCEDURE

Note: The following rehabilitation protocol is a summary of guidelines for post-operative articular cartilage procedures provided by Kevin Wilk and was presented at a Northeast Seminars symposium in Los Angeles in 2003. Please refer to the publication for details on the progression, potential impairments, and goals of the rehabilitation plan.

Phase I: Protection Phase: 0-6 weeks

Goals: Protection of healing tissue from shear forces
 Restoration of full passive knee extension
 Gradual improvement of knee flexion
 Re-establishment of voluntary quadriceps control

Intervention:

- Brace locked at 0 degrees during ambulation for 4 weeks, sleep in brace 2-4 weeks
- Weight bearing- toe touch for 2 weeks, 25% body weight 3-4 weeks, 50-75% 5-6 weeks
- Immediate motion
- Patellar mobilization
- Full passive knee extension
- Passive knee flexion, active assisted range of motion:
 - 0-90° week 1
 - 0-100° week 2
 - 0-110° week 3
 - 0-115° week 4
 - 0-125° week 6
- Isometric quadriceps sets
- Straight leg raises
- Isometrics in multiple angles for quads
- Electrical muscle stimulator to quads if poor recruitment
- Bicycle as range of motion permits
- Active knee extensions: Week 3
- Mini squats 0-50 degrees: Week 3
- Leg press: Week 3
- Gradual return to daily activities as tolerated, reduce if symptoms occur

Phase II: Transition Phase: 6-12 weeks

Goals: Gradual increase range of motion
 Gradually improve lower extremity strength and endurance
 Gradually increase functional activities

Intervention:

- Full weight bearing: Weeks 6-8
- Knee range of motion: 0-125°
- Progress resistive exercises
- Initiate closed chain exercises including step ups and wall squats to 70 degrees
- Stationary bike
- Balance and proprioception drills
- Pool program
- Initiate isotonic strengthening program: Weeks 6-8
- Gradual increase in walking and standing, as swelling and pain allows

Phase III: Maturation Phase: 12-20 weeks

Goals: Improve muscular strength and endurance
Increase functional activities

Intervention:

- Leg press 0-90°
- Bilateral squats 0-60°
- Unilateral step ups and step downs, 2"-8"
- Forward lunges
- Walking program
- Stationary bike
- Balance and proprioceptive drills
- Pool program
- Stairmaster
- Initiate light running program – DETERMINED BY PHYSICIAN

Phase IV: Return to Activity Phase: 20-26 weeks

Goals: Gradual return to full unrestricted functional activities

Intervention:

- Progress exercise program
- Squats 0-65°
- Leg press 0-90°
- Step ups, step downs
- Front lunges
- Bike
- Gradual increase to running and agility drills
- Low impact sports 4 months
- Moderate impact sports 5 months

- High impact sports 6-7 months

AUTOLOGOUS CHONDROCYTE IMPLANTATION

Note: The following rehabilitation protocol is a summary of guidelines for post-operative articular cartilage procedures provided by Kevin Wilk and was presented at a Northeast Seminars symposium in Los Angeles in 2003. Please refer to the publication for details on the progression, potential impairments, and goals of the rehabilitation plan.

Phase I: Protection Phase: 0-6 weeks

Goals: Protection of healing tissue from load and shear forces
 Restoration of full passive knee extension
 Gradual improvement of knee flexion
 Regain quad control

Intervention:

- Brace locked at 0 degrees during ambulation for 4 weeks, sleep in brace 2-4 weeks.
- Weight bearing: non weight bearing for 2 weeks, toe touch 3-4 weeks, 25% 5 weeks
- Immediate motion
- CPM first 4-12 hours: 0-40° for 2-3 weeks, increase as tolerated 5-10 degrees per day
- Patellar mobilization
- Full passive knee extension
- Passive knee flexion 0-90° at 2 weeks, 0-105° at 4 weeks, 0-120° at 6 weeks
- Stretch hamstrings, calf, quads
- Theraband resisted ankle pumps
- Isometrics for quads
- Active knee extension 90-40 degrees, no resistance
- Straight leg raises
- Stationary bike
- Biofeedback as needed
- Isometric leg press at week 4
- Gradual return to daily activities
- Elevation and ice

Phase II: Transition Phase: 6-12 Weeks

Goals: Gradual increase in range of motion
 Gradually improve quad strength and endurance
 Gradual increase in functional activities

Intervention:

- Discontinue brace at 4-6 weeks

- Progress knee flexion to 125°
- Patella mobilization and soft tissue work
- Continue stretching
- Mini-squats 0-45°
- Closed chain exercises, leg press
- Calf raises
- Open chain resistance, 1#/week
- Stationary bike
- Balance
- Front and lateral step ups
- Increase functional activity as pain and swelling allow
- Walking program

Phase III: Maturation Phase: 12-26 weeks

Goals: Improve muscular strength and endurance
Increase functional activities

Intervention:

- Range of motion to 0-125/135
- Leg press 0-90°
- Squats 0-60°
- Unilateral step ups 2"-8"
- Forward lunges
- Walking program
- Open chain extension 0-90°
- Bike
- Stairmaster
- Swimming
- Nordic track
- Light running at end of phase

Phase IV: Functional Activity Phase: 26-52 weeks

Goals: Gradual return to full unrestricted activities

Intervention:

- Progress resistance as tolerated
- Progress agility and balance drills
- Impact and loading program to build to patients requirements

- Progress sport programs as necessary
- Low impact sports at 6 months
- Moderate impact sports at 8-9 months
- High impact sports at 12 months

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