

# Rehabilitation Guidelines Following Osteochondral Allograft or Autograft Transplantation (OATS)

There are two types of cartilage in the knee—meniscus and articular cartilage. There are two menisci in the knee—a medial meniscus and a lateral meniscus. These menisci are semi-lunar wedges that sit between the femur (thigh bone) and tibia (shin bone). The menisci are primarily composed of fibrocartilage, with about 75% of the dry weight being Type I collagen. The function of the menisci is to protect the other type of cartilage in the knee—the articular cartilage.

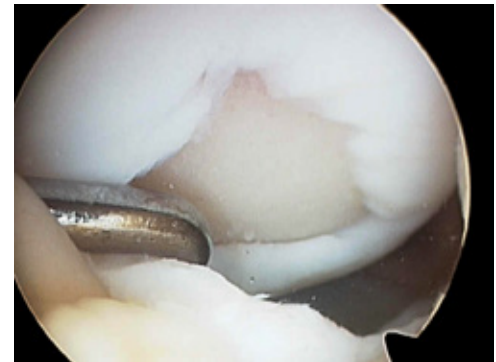
The articular cartilage is a layer of hyaline cartilage that covers the end of bones that articulate with other bones. In the knee you have articular cartilage on the end of the femur (femoral condyles), the top of the tibia (tibial plateau) and the back of the knee cap (patella). The articular cartilage has a frictional coefficient approximately one fifth of ice on ice (i.e. rubbing articular cartilage on articular cartilage would be five times smoother than rubbing ice on ice.) This allows for a very smooth gliding surface. A large portion of articular cartilage is fluid, which provides significant resistance to compressive forces.<sup>1</sup>

During athletic trauma or injury, focal areas of the articular cartilage can be damaged or torn, exposing the subchondral bone.

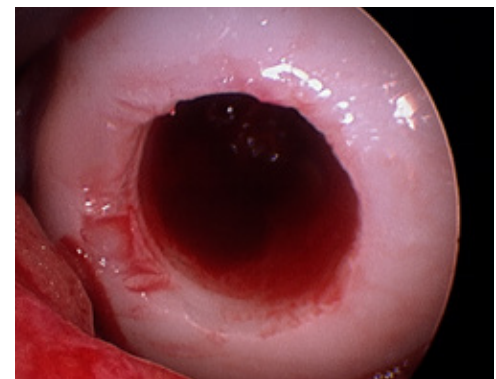
This is referred to as an articular cartilage lesion (Figure 1). When this happens you lose the normal smooth gliding articulation and the ability to resist compressive forces at the joint. These changes can cause pain, swelling, loss of motion, weakness and reduced function or performance.

The osteochondral autograft transplantation (OATS) procedure involves transplantation of plugs of bone with overlying articular cartilage (Figure 3) from areas of relatively no weight bearing (Figure 2) to weight bearing areas of the knee which have articular cartilage loss.<sup>2</sup> An allograft (cadaver) plug is also an option that can be used to fill the lesion. The size of the harvested plug is sized to match that of the injury/lesion. These plugs are then press fit into holes created at the lesion. This can be done with a single large plug (Figure 4) or several smaller plugs (Figure 5). Initially these plugs can be susceptible to getting pushed in further, thus weight bearing is restricted for the first six weeks to ensure that the cartilage plug heals “flush” with the rest of the cartilage surface.<sup>2</sup>

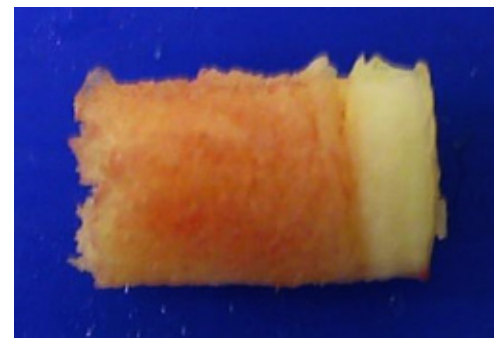
The OATS procedure is currently the only procedure that restores the normal hyaline articular cartilage to the injured knee. Microfracture and



**Figure 1** Full thickness articular cartilage lesion on the femoral condyle of the knee, exposing the subchondral bone plate



**Figure 2** Donor site from area of relatively no weight bearing



**Figure 3** A harvest bone plug with overlying articular cartilage (removed from donor site, Figure 2)

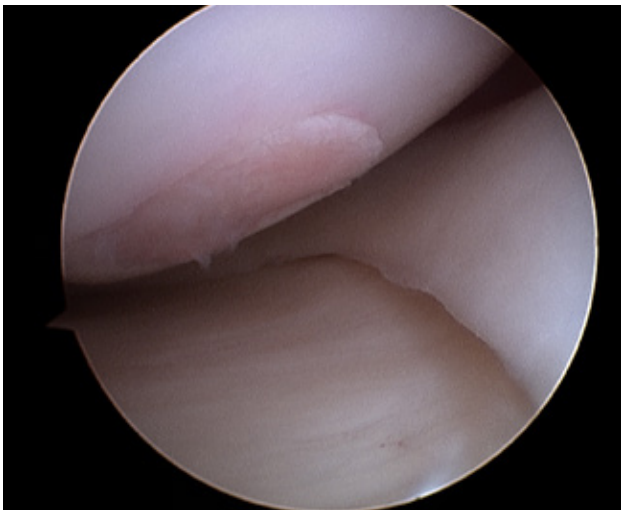
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chondroplasty procedures attempt to fill in the chondral defects with fibrocartilage. Research has shown that fibrocartilage is more likely to deteriorate over time, and that the chance of returning to sports is greater with the OATS procedure. A study by Gudas et al<sup>3</sup> found that 93% of patients who had an OATS procedure were able to return to their pre-injury level of sports versus 52% who underwent microfracture. The ability to return to sport is also dependent on the size of the lesion (or degree of injury), patient age, patient size (BMI), associated injuries and length of time that the injury has been present. For some patients the goal will be to return to daily activities without pain, for others it

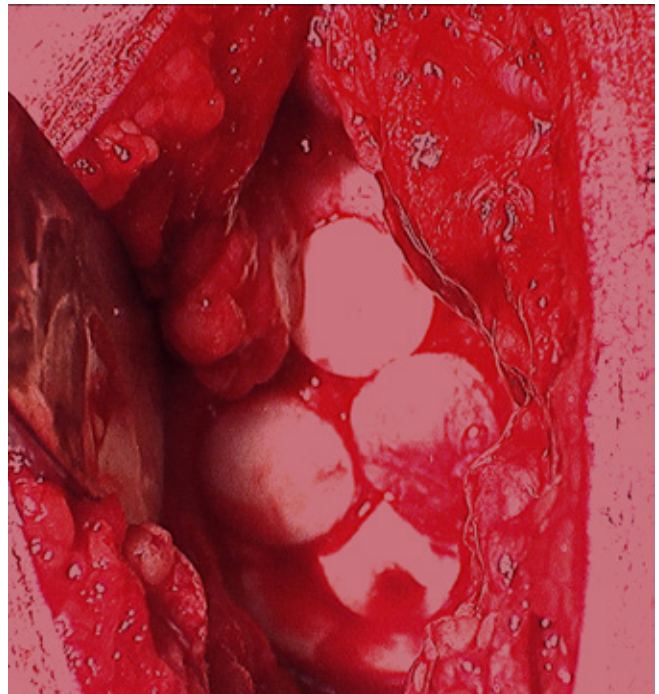
may be returning to sports.

Initially post-operative rehabilitation will focus on regaining range of motion and protecting the healing plugs. As the rehabilitation progresses the focus shifts to regaining strength and movement control. Developing the muscular ability to reduce force will help decrease stress to the articular surfaces. In the final phase of rehabilitation the athlete will work on regaining movement control with change of direction activities, such as cutting and pivoting. This is imperative to prevent increase shear stresses on the articular cartilage. The rehabilitation guidelines are presented below in a criterion based progression. Specific time frames,

restrictions and precautions are given to protect healing tissues and the surgical repair/reconstruction. General time frames are also given for reference to the average, but individual patients will progress at different rates depending on the size and location of the chondral lesion, their age, associated injuries, pre-injury health status, and rehabilitation compliance. Specific attention must be given to impairments that caused the initial problem. For example if the patient is status post medial compartment OATS procedure and they have a varus alignment, post-operative rehabilitation should include correcting muscle imbalances or postures that create medial compartment stress.



**Figure 4** A large single plug press fit into a hole created at the site of the lesion



**Figure 5** Several smaller plugs press fit into a hole created at the site of the lesion

## Rehabilitation Guidelines for Osteochondral Allograft or Autograft Transplantation (OATS)

### PHASE I (Surgery to 6 weeks after surgery)

<b>Appointments</b>	<ul style="list-style-type: none"> <li>• Rehabilitation appointments begin within 3-5 days after surgery and meet about once per week</li> </ul>
<b>Rehabilitation Goals</b>	<ul style="list-style-type: none"> <li>• Protection of the post-surgical knee</li> <li>• Restore normal knee range of motion and patellar mobility</li> <li>• Eliminate effusion</li> <li>• Restore leg control</li> </ul>
<b>Weight Bearing</b>	<ul style="list-style-type: none"> <li>• Week 1-3 = non-weight bearing</li> <li>• Week 4-6 = touchdown to 25% weight bearing</li> <li>• 0-6 weeks = locked extension lock splint brace</li> </ul>
<b>Range of Motion Exercises</b>	<ul style="list-style-type: none"> <li>• Full knee extension                             <ul style="list-style-type: none"> <li>- Knee extension on a bolster</li> <li>- Prone hangs</li> </ul> </li> <li>• Passive Knee Flexion                             <ul style="list-style-type: none"> <li>- Supine wall slides</li> <li>- Assisted heel slides</li> <li>- Continuous passive motion machine</li> </ul> </li> <li>• Week 1-2 = 0-90°</li> <li>• Week 3-4 = 0-110°</li> <li>• Week 5-6 = 0-125°</li> <li>• Biking (week 4)– use contra-lateral leg to create ipsilateral passive range of motion</li> </ul> <p>NOTE: range of motion exercises should be carried out frequently throughout the day with high repetitions to help remodel and contour the healing cartilage. The optimal goal during the first 6 weeks is to do 4-6 hours of range of motion exercises per day.</p>
<b>Suggested Therapeutic Exercise</b>	<ul style="list-style-type: none"> <li>• Quadriceps sets</li> <li>• Straight leg raises</li> <li>• Four way leg lifts in standing with brace on for balance and hip strength</li> <li>• Patellar mobilizations</li> <li>• Soft tissue mobilization</li> </ul>
<b>Cardiovascular Exercise</b>	<ul style="list-style-type: none"> <li>• Upper body circuit training or upper body ergometer</li> </ul>
<b>Progression Criteria</b>	<ul style="list-style-type: none"> <li>• Patients may progress to Phase II if they are 6 weeks post-operative, have met the above stated goals, have trace to no effusion and full knee extension</li> </ul>

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### PHASE II (begin after meeting Phase I criteria, usually 7 to 12 weeks after surgery)

<b>Appointments</b>	<ul style="list-style-type: none"> <li>• Rehabilitation appointments are once a week</li> </ul>
<b>Rehabilitation Goals</b>	<ul style="list-style-type: none"> <li>• Single leg stand control</li> <li>• Normalize gait</li> <li>• Good control and no pain with functional movements, including step up/down, squat, partial lunge (staying less than 60° of knee flexion and avoiding excessive weight bearing at position of the lesion)</li> </ul>
<b>Precautions</b>	<ul style="list-style-type: none"> <li>• Avoid post-activity swelling</li> <li>• Avoid loading knee a deep flexion angles</li> <li>• No impact activities until 12 weeks after surgery</li> </ul>
<b>Weight Bearing</b>	<ul style="list-style-type: none"> <li>• Begin progressive weight bearing as tolerated with axillary crutches and no brace</li> </ul>
<b>Suggested Therapeutic Exercise</b>	<ul style="list-style-type: none"> <li>• Weight shifting</li> <li>• Begin pool program – gait drills and initiation of protected weight bearing strengthening exercises</li> <li>• Double leg balance and proprioceptive drills</li> <li>• Stationary bike</li> <li>• Gait drills (start with pool)</li> <li>• Protected weight bearing hip and core strengthening</li> <li>• Stretching for patient specific muscle imbalances</li> <li>• Quadriceps strengthening – closed chain exercises short of 60° knee flex</li> </ul>
<b>Cardiovascular Exercise</b>	<ul style="list-style-type: none"> <li>• Non-impact endurance training, swimming (stiff knee flutter kick), deep water run, upper body circuits</li> </ul>
<b>Progression Criteria</b>	<ul style="list-style-type: none"> <li>• Patients may progress to Phase II if they have             <ul style="list-style-type: none"> <li>- Normal gait on level surfaces</li> <li>- Full range of motion</li> <li>- No effusion</li> <li>- Ability to carry out functional movements without unloading affected leg or pain, while demonstrating good control</li> <li>- Single leg balance greater than 15 seconds</li> </ul> </li> </ul>

## Rehabilitation Guidelines for Osteochondral Allograft or Autograft Transplantation (OATS)

### PHASE III (begin after meeting Phase II criteria, usually about 4 months)

<b>Appointments</b>	<ul style="list-style-type: none"> <li>• Rehabilitation appointments 1 time every 1-2 weeks</li> </ul>
<b>Rehabilitation Goals</b>	<ul style="list-style-type: none"> <li>• Good control and no pain with sport and work specific movements, including impact</li> </ul>
<b>Precautions</b>	<ul style="list-style-type: none"> <li>• Post-activity soreness should resolve within 24 hours</li> <li>• Avoid post-activity swelling</li> <li>• Avoid knee pain with strengthening</li> </ul>
<b>Suggested Therapeutic Exercise</b>	<ul style="list-style-type: none"> <li>• Functional leg strengthening                             <ul style="list-style-type: none"> <li>- Squats</li> <li>- Lunges – all three planes</li> <li>- Step backs</li> <li>- Retro step ups</li> <li>- Single leg leg press</li> </ul> </li> <li>• Single leg balance and proprioception progression                             <ul style="list-style-type: none"> <li>- Hip and core strengthening</li> <li>- Mini band drills</li> <li>- Physioball</li> </ul> </li> <li>• Stretching for patient specific muscle imbalances</li> </ul>
<b>Cardiovascular Exercise</b>	<ul style="list-style-type: none"> <li>• Non-impact activities; stationary bike, elliptical, Nordic track, swimming</li> </ul>
<b>Return to Sport/Work Criteria</b>	<ul style="list-style-type: none"> <li>• Dynamic neuromuscular control with multi-plane activities, without pain or swelling</li> </ul>

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### PHASE IV (begin after meeting Phase III criteria, usually about 6 months after surgery)

<b>Appointments</b>	<ul style="list-style-type: none"> <li>• Rehabilitation appointments 1 time every 1-2 weeks</li> </ul>
<b>Rehabilitation Goals</b>	<ul style="list-style-type: none"> <li>• Good control and no pain with sport and work specific movements, including impact</li> </ul>
<b>Precautions</b>	<ul style="list-style-type: none"> <li>• Post-activity soreness should resolve within 24 hours</li> <li>• Avoid post-activity swelling</li> <li>• Avoid knee pain with impact</li> </ul>
<b>Suggested Therapeutic Exercise</b>	<ul style="list-style-type: none"> <li>• Impact control exercises beginning 2 feet to 2 feet, progressing from 1 foot to other and then 1 foot to same foot</li> <li>• Movement control exercise beginning with low velocity, single plane activities and progressing to higher velocity, multi-plane activities</li> <li>• Sport/work specific balance and proprioceptive drills</li> <li>• Hip and core strengthening</li> <li>• Stretching for patient specific muscle imbalances</li> </ul>
<b>Cardiovascular Exercise</b>	<ul style="list-style-type: none"> <li>• Replicate sport or work specific energy demands</li> </ul>
<b>Return To Moderate Impact Sport Criteria (Jogging, Aerobics)</b>	<ul style="list-style-type: none"> <li>• 8 months post surgery; and</li> <li>• Good dynamic neuromuscular control with multi-plane activities, without pain or swelling</li> </ul>
<b>Return To High Impact Sport Criteria (Basketball, Soccer)</b>	<ul style="list-style-type: none"> <li>• 10 months post surgery; and</li> <li>• Good dynamic neuromuscular control with multi-plane activities, without pain or swelling</li> </ul>

These rehabilitation guidelines were developed collaboratively between Marc Sherry, PT, LAT, CSCS and UW Sports Medicine physician group.

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### REFERENCES

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2. Reinold MM, Wilk KE, Macrina LC, Dugas JR, Cain EL. Current concepts in the rehabilitation following articular cartilage repair procedures in the knee. *J Orthop Sports Phys Ther.* Oct 2006;36(10):774-794.
3. Gudas R, Kalesinskas RJ, Kimtys V, et al. A prospective randomized clinical study of mosaic osteochondral autologous transplantation versus microfracture for the treatment of osteochondral defects in the knee joint in young athletes. *Arthroscopy.* Sep 2005;21(9):1066-1075.

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