Treatment Approach to Anterior Cruciate Ligament Injuries

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This report outlines the treatment approach to anterior cruciate ligament injuries to include the diagnosis, preoperative rehabilitation and planning for surgery, the surgical technique, postoperative rehabilitation, and the return to full activities. The use of a patellar tendon graft allows for reliable and predictable knee stability postoperatively. Many meniscus tears and chondral defects observed during anterior cruciate ligament reconstruction are asymptomatic and may not require treatment. Rehabilitation should be provided to allow for immediate full knee hyperextension and flexion, because the lack of normal knee range of motion is a preventable factor related to lower patient satisfaction in the long term. Most patients are able to return to full participation in sports, and the time of return to sports does not affect the incidence of subsequent injury.

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We have an orthopedic practice that specializes in the treatment of knee problems, and the practice set-up includes an in-house staff of physical therapists and athletic trainers who work individually with patients from the time of the initial injury to the full return to sports and activities. We use a surgical procedure that is reliable and predictable for obtaining good knee stability postoperatively. Through the years, it has been the preoperative and postoperative rehabilitation variables that have become the important factors to improve so that patients can obtain the optimum long-term outcome. The focus of our research has been to determine which parts of the rehabilitation were critical to success.

This report reviews our approach to anterior cruciate ligament (ACL) injuries with regard to the initial clinical examination and diagnosis, the surgical procedure and intraoperative approach to associated injuries, and the postoperative rehabilitation and return to sports.

Diagnosis

The diagnosis of an acute ACL tear can be strongly suspected by the typical patient’s history of the injury. In our practice, we hear the same description of the ACL injury, so much so that most of the time the person making the appointment for the patient knows that the patient has an ACL injury. Competitive athletes usually become injured when reacting to an opposing player, most commonly in the sport of basketball, soccer, volleyball, and football. The athlete usually was changing direction when running or some times landing off-balance from a jump. Many patients say they heard a “pop” or felt their knee come apart, and they will almost always fall to the ground. In most cases, the patient will not want to get up or walk on the injured leg, and if they do try to put weight on the leg, they will try to walk with a bent knee. Although the initial pain subsides, athletes rarely feel like they want to go back in the contest. If this description of the injury is given, we assume the patient has an ACL tear until proven otherwise.

When we see the patient in the office, we take a detailed history. The initial part of the examination is performed while we watch the patient walk to the examination room. If it is a recent ACL injury, it is rare for the patient to have a normal gait pattern. Plain radiographs are obtained that include the standing posteroanterior, lateral, and Merchant view radiographs.

The examination must be performed properly to obtain the best information, and the following factors need to be present for the best examination.

- The patient must be dressed in shorts that are at midlength so we can observe the way the patient moves his or her leg, if he or she holds the knee bent,
and whether there is a hemarthrosis or swelling in the knee compared with the other knee.

- The patient should be comfortable with his or her head placed on a pillow and should be lying on a long enough table to have both heels on the table easily.
- The examiner should evaluate the normal knee first. Be sure to tell the patient you’re going to do this and why.

First, we evaluate knee range of motion (ROM) and compare the difference in knee extension (to include hyperextension [Fig. 1]) and flexion between the injured and uninjured knees. Patients almost always lack symmetric extension and attempts at extending the involved knee are met with pain deep to the patella that is caused from the torn ACL stump being caught in the intercondylar notch.

We perform a gentle Lachman and flexion rotation and mild pivot shift tests. In our experience, we are able to say that the Lachman examination is positive or negative approximately 95% of the time. Other than in-season competitive athletes, the confirmed diagnosis of an ACL tear is not critical at the initial examination. In the few cases in which we’re not sure on the initial examination, the history is questionable, and the KT-1000 arthrometer testing is equivocal, we will have the patient work with our therapy staff to reduce swelling, regain full ROM, and then reexamine the patient at the next visit.

We believe that magnetic resonance imaging (MRI) scans are tremendously overused. If we cannot diagnose an ACL tear consistently with the history and physical examination, then how can we accurately tell after surgery if the ACL reconstruction worked to restore stability to the knee? If you are not routinely doing KT-1000 arthrometer testing on all your patients before and after surgery and you cannot determine if the ACL is completely torn from your physical examination, it will be impossible to be accurate with your assessment of success postoperatively based on your examination.

### Surgery Decision-Making

In general, we believe that all active school-aged athletes participating in sports should not try to live with an ACL-deficient knee. Investigators\(^1\)\(^-\)\(^3\) have shown that most young athletes cannot continue to compete without experiencing additional giving-way episodes. With these patients, we schedule subacute ACL surgery, meaning we will proceed with surgery when the knee is physically ready, the patient is mentally prepared, and the patient has the time schedule to allow for surgery and rehabilitation. Proceeding with surgery sooner rather than later is necessary with these patients because they usually have a timetable for when they would like to return to activities.

Other young patients who do not have a sports timetable to return can delay surgery until the most convenient time, but we still encourage them to refrain from participation in sports before the surgery. For older patients, we look at many other variables and decide whether and when to do surgery. Factors that are important include the occupation type and status, marriage status, number and age of children, what sports are played and how often or intense, and the patient’s willingness or not to change lifestyle habits to accommodate an ACL-deficient knee.

Age is not a factor for deciding whether a patient can have an ACL reconstruction. We allow the patient’s lifestyle, progress with rehabilitation, and willingness to change his or her lifestyle to dictate whether surgery is needed. To counsel patients in helping them make their decisions, we explain to them the outcome data that we have collected from performing more than 5000 ACL reconstruction in the past 26 years. We can offer statistics on our success rate, complication rate, subsequent injury rates, and patients’ abilities to return to preinjury activities.

### Preoperative Rehabilitation

An ACL reconstruction is not an emergency type of surgery, and the only reason to perform an acute ACL reconstruction is when the ACL injury is combined with a lateral side knee dislocation. Several investigators\(^4\)\(^5\) have shown that the rate of arthrofibrosis is greater when ACL reconstruction is performed acutely. Our goal with ACL reconstruction is to provide a surgery and rehabilitation that will allow the patient to have 2 symmetric knees and legs after surgery. The long-term outcome of ACL reconstruction depends on several factors, some of which we can control and others we cannot. Shelbourne et al.\(^6\) found that the most important factor related to a less-than-normal outcome at greater than 10 years after surgery was the lack of normal knee extension and flexion. Other factors known to reduce the long-term satisfaction with outcome are meniscectomy and articular cartilage damage.\(^7\)\(^-\)\(^10\) Although we have little control over meniscus tears and chondral damage, we do have control over proper rehabilitation before and after surgery to obtain full knee ROM. Therefore, we will not perform an ACL reconstruction unless the patient meets the following goals:
• The knee is in the proper state before surgery, to include full knee hyperextension, full flexion, and no swelling. Patient must have good leg control and a normal gait.
• The patient is mentally ready to have surgery by providing education regarding the procedure and rehabilitation goals. We want the patient to be positive and anxious to proceed with rehabilitation.
• The patient’s school or work schedules allow them the proper time to do the rehabilitation exercises.
• The patient has a caregiver available to help with his or her needs, especially during the first 5 days after surgery when he or she will be restricted to bed rest.

With these guidelines, our surgical procedure, and pre- and postoperative rehabilitation, we have been able to obtain full knee ROM in more than 94% of our patients during the last 10 years.

Acute vs Chronic Injuries

We define the type of ACL injuries differently than what is traditionally described. In the past, the label of an acute ACL reconstruction was when surgery was performed as soon as possible after the injury. We never perform surgery with this timing now. Instead, we perform semiaacute ACL reconstruction on patients who have completed their preoperative rehabilitation but who have not had any additional giving-way episodes. We define the patient to have a chronic ACL injury when he or she has had an additional giving-way episode since the time of the index ACL injury. It is possible for a patient to be 6 weeks from the initial injury and still be labeled as having a chronic injury if he or she has had episodes of instability.

The difference between the semiaacute and chronic injuries has mostly to do with the fact that patients with chronic injuries usually have a greater number and more severe meniscus tears and articular cartilage damage in the knee. Today, with our surgical technique, patients with chronic ACL injuries have equal stability after surgery as patients with semiaacute injuries. Furthermore, patients with chronic instability can achieve the same long-term outcome if they can avoid extensive intra-articular damage.

The only difference in treatment between the 2 types is when a patient with chronic ACL instability has a locked bucket-handle meniscus tear. Shelbourne and Johnson showed that patients who underwent concomitant ACL reconstruction and treatment for a locked bucket-handle meniscus tear had a greater incidence of arthrofibrosis than patients who underwent staged procedures. Given the higher rate of arthrofibrosis and because this type of patient seeks treatment because of the meniscus injury and may not be prepared mentally and socially to undergo an ACL reconstruction, we perform an arthroscopy to treat the meniscus tear first. After rehabilitation to regain full ROM and reduce swelling, the patient may undergo an ACL reconstruction electively.

Operative Technique

We use an open 2-incision technique for ACL reconstruction. It has proved reliable over many years and offers many advantages to arthroscopic ACL reconstruction. The first advantage is excellent visibility as well as the ability to feel intra-articular landmarks to allow for accurate tunnel placement. Second, without the use of saline needed for the arthroscope, we are able to collect all the bone from the tunnel placement for use in filling the graft harvest. Finally, this technique allows for anatomic placement of the femoral tunnel because it is drilled independently of the tibial tunnel.

We use the autogenous patella tendon graft for ACL reconstruction and, whenever possible, we prefer to use the contralateral patella tendon. We prefer the autogenous patella tendon graft because it allows for quick and predictable bone-to-bone healing, is viable throughout the postoperative course, and responds to stress during rehabilitation. When combined with appropriate donor-site rehabilitation, the contralateral patella tendon graft allows a faster, more predictable recovery compared to the ipsilateral patella tendon graft. We primarily use the contralateral patella tendon, but will use the ipsilateral patella tendon at times when the patient requests or when the contralateral graft has been harvested for a previous surgery.

It is important to note that a previous patella tendon graft harvest does not eliminate the option of reharvesting the patella tendon in the event of a future revision surgery. We have reharvested the patella tendon in nearly 30 cases and have had results comparable to those of our primary ACL reconstructions. The decision to reharvest a patellar tendon graft should only be made after assessing the quality of the tendon on MRI. Also, palpation of the patella tendon should not reveal a defect and the patient should demonstrate symmetric isokinetic quadriceps muscle strength. When using the patella tendon for either primary or revision ACL reconstructions, we have not encountered any problems with inadequate graft material.

In our experience, the autogenous patella tendon graft has provided excellent stability and functional outcomes in more than 5000 cases. Therefore, we have no experience with double bundle reconstruction because we have not noted the problems that seem to have prompted its use.

Immediately before surgery, the knee is injected with a local anesthetic and a 30 mg bolus of ketorolac is administered for preemptive pain management. Then, 90 mg of ketorolac is mixed with 1000 mL of saline and an intravenous drip is started to run at 40 mL/h until completion of the dose. The ketorolac, supplemented with 1 g of acetaminophen every 6 hours, has provided excellent pain management for patients after the ACL reconstructive procedure.

Our surgical technique begins with an arthroscopy to examine the joint for meniscal tears and articular cartilage damage. These injuries are either treated or left in situ based on their location and potential for healing. We then redrape the patient’s knee and make a 6-cm incision along the medial side of the patellar tendon. A 3-cm lateral oblique incision is also made for the femoral exposure. The intercondylar notch is
then cleared of any ACL remnants and the distance between the posterior cruciate ligament (PCL) and the lateral femoral condyle is measured (Fig. 2). If this distance is less than 10 mm, a notchplasty is performed to allow the new 10-mm ACL graft to fit in the notch in full extension without any impingement (Fig. 3).

A guidepin is placed in the anteromedial tibia about 4 cm below the joint line. The guidepin is directed 5 mm medial to the tibial spine and at least 5 mm anterior to where the tibial plateau “drops off” in the sagittal plane. This ensures that the graft is in the appropriate posterior position and just lateral to the PCL, just like the native ACL. Even if the guidepin is placed slightly anterior, adjustments can be made to bring the tunnel entrance into the appropriate position. We can easily use a curette on the tibial tunnel so the position is always just lateral to the medial tibial spine and just anterior to the posterior slope of the tibial spine. A postoperative full extension lateral radiograph should show the tibial tunnel to be parallel and posterior to Blumensaat’s line. On the femoral side, the guidepin is positioned so the final tunnel opening is tangent to the PCL and just anterior to the posterior cortex.

Once we have finished drilling the tunnels, we perform the graft harvest from either the contralateral or ipsilateral patellar tendon. We expose the tendon with care to preserve the paratenon. We use a 10 blade to outline the graft which is 10 mm in width. The bone plug is made to be 10 mm wide by 20 to 25 mm long. We score the proximal and distal portions of the bone plugs with an osteotome. An oscillating saw is used to cut the bone plugs. Next, we use an osteotome to remove the bone plug first from the patella and then the tibia. The graft is prepared in situ with a sizer between 10 mm and 11 mm on the patella bone plug and 10 mm on the tibial bone plug. We place 3 drill holes in each bone plug and place 3 no. 2 Tycron sutures in each bone plug. The graft is then removed from the knee. When a contralateral harvest is used, the wound is packed, local anesthetic (bupivacaine) is injected, the knee is wrapped with an ACE wrap, the tourniquet is deflated, and closure is performed at the same time as closure on the ACL-reconstructed knee.

The bone plug taken from the patella is guided into the tibial tunnel and the bone plug is placed at the level of the joint line. The sutures are tied loosely over the tibial button. The bone plug taken from the tibia is guided into the femoral tunnel, which has been drilled at an appropriate length to accommodate the remainder of the graft length, and tied over the lateral femur with the knee in 30 degrees of flexion. We then pull on the distal bone plug to firmly seat the tibial button. The sutures over the tibial button are then retied as tight as possible with a slip knot. The knee is then taken through a full ROM using the other knee as a guide. If the graft is too tight, it will loosen during this step. We then retie the sutures over the tibial button and the process is repeated until the tibial button remains tight on the tibia. This process ensures that the graft is tight enough to provide stability, but not so tight that it will inhibit ROM.

The button fixation offers many advantages over other fixation techniques. First, the bone plugs are suspended in the tunnels because there is nothing between the bone and the tunnel as there is with interference screws, so we are able to obtain an excellent press fit with the bone plug in the tunnel. The location of the bone plugs in the proximal tibia and distal femur allows for early incorporation of the bone plug. When doing arthroscopic ACL reconstruction, it is difficult to modify the bone plug to the appropriate size if it is too tight. This is much easier with an open technique. Given that our femoral fixation is on the lateral femoral cortex and the bone plug is seated well into the femur, there is no concern if the back wall is “blown out” when the femoral tunnel is drilled. This method and fixation is especially valuable when doing revision surgery.

Both knees are irrigated and electrocautery is used on bleeding vessels. Drains are placed into each incision and brought out through separate stab incisions. The bone saved from drilling the tunnels is placed in the defects and covered with the paratenon. The tendon defect is brought together with the paratenon. The subcutaneous and cutaneous layers are each closed with 3.0 Vicryl and a running 3.0 Prolene subcuticular stitch. Steristrips, a light dressing, and compres-

Figure 2 Calipers are used to measure the distance between the lateral border of the PCL and the lateral femoral condyle.

Figure 3 If the distance between the lateral border of the posterior cruciate ligament and the lateral femoral condyle is less than 10 mm, a notchplasty of the appropriate amount is performed to accommodate the 10-mm wide patellar tendon graft.
Medial meniscus tears
  Nondegenerative, nondisplaceable, peripheral tears
  Displaceable (torn part can be pulled into the intercondylar notch)
  Degenerative (ie, horizontal cleavage separation)

Lateral meniscus tears
  Peripheral vertical extending in front of popliteus and displaceable
  Posterior horn avulsion
  Middle third flap or radial tears

<table>
<thead>
<tr>
<th>Tear Type</th>
<th>Treatment</th>
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<tr>
<td>Trephine superiorly and inferiorly and leave in situ</td>
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<tr>
<td>Suture the middle third to stabilize tear, trephine posterior portion of the tear</td>
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<tr>
<td>Excise. These tears can heal with repair but are nonfunctional and have a high retear rate,22,23</td>
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<tr>
<td>Suture middle third back to the capsule anterior to popliteus tendon</td>
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<tr>
<td>Leave in situ</td>
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<td>Excise</td>
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Table 1 Treatment of Meniscus Tears

The treatment of patients with ACL tears and their associated injuries is not just a surgical problem but also a rehabilitation one. Treatment of the ACL, meniscus tears, and chondral injuries is being proposed more regularly without good long term evidence to determine whether treatment actually helps patients or could possibly be detrimental.

The natural history of isolated articular cartilage lesions seen with ACL reconstruction has been reported.24 In a series of 101 patients who had Outerbridge grade 3 or 4 defects that ranged in size from 0.5 to 6.5 cm², good-to-excellent clinical and subjective outcomes were found at a mean of 8.7 years after surgery. The defects were treated by debriding the edges of the defect and sometimes a pick arthroplasty was performed. The postoperative rehabilitation was not altered because of this treatment.

Although current enthusiasm is present for elaborate treatment of these defects, we believe our current treatment remains the best treatment for patients, even though some lesions may cause problems for the patients in the long-term, because we do not believe that the outcomes from the extreme procedures of cartilage restoration justify the time, rehabilitation changes suggested, and expense vs our minimal treatment approach.

It has become apparent from long-term ACL surgery follow-up studies5-10 that some patients develop arthritic changes in their knee in the future, and these arthritic changes have been related to meniscectomy and chondral damage in the knee. Surgeons have been examining different ways to treat these injuries, hoping that different treatments might lead to less long-term problems. Unfortunately, these treatment changes are being done empirically without knowing if they might help or possibly make the long-term results worse.

In a minimum 10-year objective follow-up study of ACL reconstruction in 502 patients, Shelbourne and Gray6 performed a regression analysis to determine what objective factors were related to lower subjective scores. They found that the lack of normal knee ROM (extension and flexion separately) compared with the opposite normal knee was the most important factor. Meniscectomy and chondral injuries also were significant factors, but the loss of normal knee ROM in addition to these intra-articular injuries caused subjective scores to be statistically significantly lower.

The main things we have learned about treatment and surgery for meniscus tears are that (1) the rehabilitation does not need to be altered after repair postoperatively to protect the repair, and (2) menisci that are stable (ie, less than half the circumference of the meniscus) do not need suture fixation to allow them to heal. Weight-bearing activity pushes the meniscus against the capsule and is beneficial for healing. Trephination of stable meniscus tears allows for better healing than leaving the tear alone. Our current recommendations for treatment of meniscus tears seen at the time of ACL surgery are shown in Table 1.22,23

The best treatment of meniscal tears seen at the time of ACL surgery is still unknown because degenerative changes that develop in the joint caused by the meniscectomy may take longer than 10 years before symptoms will occur. Many meniscus tears found in acute or semiacute ACL reconstruction are asymptomatic and do not need treatment. Meniscus tears are overtreated because the surgeon feels compelled to treat the tear because he or she can. Through the years, we have documented the types of tears observed with ACL reconstruction and the treatment provided. With regular follow-up of patients, we have been able to determine the types of tears that require repair vs removal or no treatment at all.

With acute ACL injuries, lateral meniscus tears are more common than medial meniscus tears, whereas, medial meniscus tears are more common with chronic ACL injuries and are degenerative in nature.17,19 These facts show that many lateral meniscus tears seen with acute ACL injuries can heal without treatment.20,21

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problems when these goals are not achieved. Intraoperatively, because studies have shown a greater incidence of ROM effusion, good leg strength and control, and a normal gait gone preoperative rehabilitation to obtain full knee ROM, no not perform ACL reconstruction until the patient has undergone rehabilitation which is centered on this goal. We do symmetric to the opposite normal knee, the preoperative and come after ACL surgery is the restoration of full knee ROM. Given that the most important factor related to a good outcome after ACL surgery is the restoration of full knee ROM symmetric to the opposite normal knee, the preoperative and postoperative rehabilitation is centered on this goal. We do not perform ACL reconstruction until the patient has undergone preoperative rehabilitation to obtain full knee ROM, no effusion, good leg strength and control, and a normal gait because studies have shown a greater incidence of ROM problems when these goals are not achieved. Intraoperatively, after the graft is placed, we obtain full knee extension and flexion before wound closure is performed. Postoperatively, rehabilitation involves 2 separate focuses. One focus is with the ACL graft in the reconstructed knee, which involves limiting a hemarthrosis, obtaining full knee ROM, and then providing enough stimulation to the graft to promote graft healing and maturation. The second focus is with rehabilitation of the graft donor site from harvesting the middle third of the patellar tendon. The rehabilitation for the donor site involves obtaining full ROM in the knee and providing high repetition/low resistance exercise to stimulate the graft site to regenerate. These 2 goals can be achieved consecutively when a graft is taken from the ipsilateral knee or simultaneously when taken when a graft is taken from the contralateral knee. The overall plan for rehabilitation is found in Table 2.

Of utmost importance to obtaining symmetric knee ROM is limiting or preventing a knee hemarthrosis. Although our rehabilitation has been labeled “accelerated,” the first 5 days of the rehabilitation for the ACL-reconstructed knee is contrary to that concept. Patients are kept on bed rest except for bathroom privileges as a means to keep the ACL-reconstructed leg elevated with a cold/compression device applied to the knee. The patient performs leg control and ROM exercises regularly during these first 5 days, but we instruct patients to stay in bed to keep the knee above the level of the heart. Once patients get past this initial stage where a hemarthrosis could form, they can progress with rehabilitation and leg strengthening as prescribed.

**Return to Activities and Sports**

Our goal is to allow patients to progress through rehabilitation as quickly as possible to be able to return to whatever activities they would like, with certain goals in mind. Some patients have the goal just to return to normal everyday activities and work as their main goal and may participate in recreational sports. Other patients are young competitive athletes with a goal to return to sports as early as possible.

In our experience, our rehabilitation program that emphasizes limiting the hemarthrosis postoperatively allows patients to achieve full knee ROM quickly and patients can easily progress to their every day activities. Because patients can return to feeling normal quickly with their everyday life, we have been presented with the dilemma as to how quickly to allow patients to start sport-specific tasks and then eventually return to full sports.

When patients start sport-specific drills, we instruct them to do the activity every other day initially as a way to monitor knee ROM and swelling. All patients will be sore with the new activity when they begin, but they want to ensure they keep swelling to a minimum and maintain full knee ROM. Patients must also work consistently to increase leg strength while also performing sport-specific drills, with the goal in mind to achieve symmetric leg strength before returning to full sports participation. The gradual increase from sport-specific drills to full participation in sports can take as little as 2 months or as much as 6 months-8 months and the time is truly individual to the patient and the sport. As long as the

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**Figure 4** Patients who had less than normal ROM had statistically significantly lower (*) International Knee Documentation Committee (IKDC) subjective scores than patients who had normal knee ROM in the same meniscus group. MED-Rem, medial meniscectomy; LAT-Rem, lateral meniscectomy; BOTH-Rem, both medial and lateral meniscectomy.

**Figure 5** Patients who had less than normal ROM had statistically significantly lower (*) IKDC subjective scores than patients who had normal knee ROM in the same articular cartilage group. Also, there was no statistically significant difference in IKDC scores between patients who had normal articular cartilage and less than normal ROM (80 points) and patients who had damaged articular cartilage and normal ROM (81 points).
<table>
<thead>
<tr>
<th>Time Guideline</th>
<th>Ipsilateral Graft</th>
<th>Donor-Site Rehab</th>
<th>ACL Graft</th>
<th>Donor-Site Rehab</th>
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<tbody>
<tr>
<td><strong>Day of surgery to 1 week</strong></td>
<td>Cold/compression and elevation except during exercises</td>
<td>Cold/compression and elevation except during exercises</td>
<td>Cold/compression and elevation except during exercises</td>
<td>Cold pack; knee elevated on pillow</td>
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<td>postoperatively</td>
<td>Exercise sessions 4×/d: CPM set at maximum flexion for 1 min; heel slides for flexion; straight leg raises; heel prop × 10 min; towel stretches for full passive hyperextension; active terminal extension</td>
<td>Cold/compression and elevation at least 3×/d for 30 min.</td>
<td>Exercise sessions 4×/d: CPM set at maximum flexion for 1 min; heel slides for flexion; straight leg raises; heel prop × 10 min; towel stretches for full passive hyperextension; active terminal extension</td>
<td>Cold pack after after exercises sessions</td>
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<td><strong>Week 2 (7 to 14 days postoperatively)</strong></td>
<td>Cold/compression and elevation at least 3×/d for 30 min.</td>
<td>Cold/compression and elevation at least 3×/d for 30 min.</td>
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<td>Cold pack after exercise sessions</td>
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<td>Exercise sessions 3×/d: wall slides and heel slides for flexion; heel prop×10 min; towel stretches; active terminal extension</td>
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<td>Cold pack as needed</td>
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<td></td>
<td>Exercise sessions 3×/d as described previously to achieve full, symmetric ROM</td>
<td>Exercise sessions 3×/d as described above to achieve full, symmetric ROM</td>
<td>Exercise sessions 3×/d as described above to achieve full, symmetric ROM</td>
<td>Cold pack as needed</td>
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<td>Stop strengthening exercises if ROM decreases</td>
<td>Stationary bike, elliptical machine, or Stairmaster 5-7×/wk; step-down exercise, single leg press, and knee extension exercises (high reps/low resistance) every-other-day</td>
<td>Stationary bike, elliptical machine, or Stairmaster 5-7×/wk; continue leg press, knee extensions, and step-downs</td>
<td>Cold pack as needed</td>
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<td></td>
<td>Cold/compression as needed</td>
<td>Cold/compression as needed</td>
<td>Cold/compression as needed</td>
<td>Functional progression from agility drills, sport-specific drills, to competition once ROM and strength are symmetric</td>
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<tr>
<td><strong>Weeks 4 to 8</strong></td>
<td>Exercise sessions 3×/d as described above to achieve full, symmetric ROM; sit on heels</td>
<td>Exercise sessions 3×/d as described above to maintain full, symmetric ROM; sit on heels</td>
<td>Exercise sessions 3×/d as described above to maintain full, symmetric ROM; sit on heels</td>
<td>Cold pack after exercise</td>
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<td></td>
<td>Stop strengthening exercises if ROM decreases</td>
<td>Individual, light sports activities introduced</td>
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<td>Functional progression from agility drills, sport-specific drills, to competition once ROM and strength are symmetric</td>
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<td></td>
<td>Cold/compression as needed</td>
<td>Continue with strengthening program described above</td>
<td>Cold/compression as needed</td>
<td>Cold pack as needed</td>
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<tr>
<td><strong>Weeks 8 to 12</strong></td>
<td>Exercise sessions 3×/d as described previously to maintain full, symmetric ROM; sit on heels</td>
<td>Continue with strengthening program described above</td>
<td>Exercise sessions 3×/d as described above</td>
<td>Cold pack as needed</td>
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<td></td>
<td>Cold/compression as needed</td>
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<td>Functional progression continued to full sports participation</td>
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<td>Exercise sessions as needed</td>
<td>Cold pack after exercise</td>
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<td><strong>from 3 months after surgery</strong></td>
<td>Cold/compression as needed</td>
<td>Continue with strengthening program described previously; switch to bilateral strengthening once strength is symmetric. Functional progression from agility drills, sport-specific drills, to competition once ROM and strength are symmetric.</td>
<td>Continue with strengthening program described above</td>
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CPM, continuous passive motion; ROM, range of motion; reps, repetitions.
patient keeps the goals of full knee ROM and minimal swelling in mind, he or she should be able to be in charge of their own schedule for return to sports, but the coach and athletic trainer at the school must also understand the goals and work with the athlete to allow for times of rest and specific training to achieve the goals.

There is much controversy as to when it is safe to return to sports after ACL reconstruction. In our experience, we have not found a time that is limiting for patients to return to sport. Shelbourne et al.\textsuperscript{26} found that athletes of all ages who returned to sports before 6 months after surgery were not at any increased risk for injury than athletes who returned to sports after 6 months. The mean time to subsequent ACL-graft tear in the study was 19 months, whereas the mean time to return to full competitive sports was between 4 months and 6 months, depending on the age group of the patients. If returning to full sports quickly was a factor for reinjury, one would expected to see a high rate of ACL-graft tears soon after the return to sports, and this is not what we have found in our data.\textsuperscript{26}

Conclusions

This overview for the treatment of ACL injuries is centered on providing a surgical and rehabilitation plan that restores the knee to full function that is symmetric to the opposite normal knee. The patellar tendon graft for ACL reconstruction allows for reliable and predictable knee stability postoperatively. However, achieving stability is only a small part of the process that affects how patients do in the long-term. Many meniscus tears and chondral defects seen during ACL reconstruction are asymptomatic and may not require treatment. The loss of normal knee ROM is a factor related to less than optimum outcome after ACL reconstruction. The loss of normal knee hyperextension and/or flexion compounds other factors of meniscectomy or articular cartilage damage related to lower subjective scores at long-term follow-up. Most patients are able to return to full participation in sports and the time of return to sports does not affect the incidence of subsequent injury.

References


