ACL RECONSTRUCTION
Educational Information

INSERT LOEB ORTHOPAEDIC LOGO

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ACL injuries mostly occur as non-contact injuries in sports in which sudden stops, landing, and rotation maneuvers are repeatedly performed – as in soccer, volleyball, basketball, rugby, lacrosse and other field and court based sports. Female players suffer ACL injuries two to ten times more frequently than males. However, they are not a female fate. You can considerably lower your risk by performing a prevention protocol.

Injuries to the knee joint are common with ACL tear being one of the most commonly seen knee injuries in football. The anterior cruciate ligament (ACL) is one of the major stabilizing ligaments in the knee joint. This ligament basically prevents excessive movements of the lower leg against the thigh. Unlike most ligaments in the body, the ACL ligament can be injured without an external force being active. In fact, 70 % of all ACL injuries are non-contact in nature, while the remaining 30% involve an outside force such as an opposing player, a goalpost, or another object on the pitch.

While contact injuries cannot be foreseen and therefore leave little room to avoid them, a good understanding of injury mechanisms in non-contact ACL injuries might help to prevent them. Typical mechanisms in football involve a one step-stop deceleration, cutting tasks, a sudden change of direction, landing from a jump with the knee and hip at or near full extension - or simply a lapse of concentration.

Factors that could influence the occurrence of ACL tears in women are:

- There are multiple differences in knee architecture between men and women and it was assumed that they could explain the higher risk for female players. However, up to date, the evidence on the impact of these differences is inconclusive.
- Knee bracing: The effectiveness of functional knee braces in preventing non-contact ACL injuries is not proven and therefore braces are not encouraged.
- Playing surface and shoes: Uneven playing surfaces may play a role such as landing or stepping on an uneven surface like a hole in the grass or the foot of another player.
Weather: Cold weather seems to be associated with a lower knee and ankle injury risk in outdoor stadiums, both natural grass and turf.

Hormones: There seems to be no direct link of an increase in ACL injury to a predictable time within the menstrual cycle.

Muscular strength and balance are crucial to stabilize your knee. Basically, the muscle that extends the knee, the quadriceps, works “against” the ACL, while the ones that flex the knee, called the hamstrings, work “with” the ACL. At the same time, these two muscle groups should counteract each other when stabilizing the knee. If the hamstrings are weak in relationship to the quad or contract not exactly attuned to the quadriceps, the ACL may be at an increased risk for injury. The same applies for landing from a jump with extended hip and knee. Lastly, the gluteal muscles of the hip and buttocks, collectively the abductors, play a strong role in stabilizing the knee.

On average, you will miss approximately six to nine months of competitive play as a result of an ACL injury and undergoing reconstructive surgery and rehabilitation. In about two thirds of all complete ACL tears there is concomitant damage to the menisci and the cartilage of the knee joint. In addition, complete ACL tears can lead to long-term problems, including instability and an early onset of arthrosis of the knee. Arthrosis is normally found in elderly people as a consequence of ageing. Having your ACL reconstructed can significantly reduce your risk for later injuries and damage, but it cannot totally avert them. Therefore, you should aim to prevent ACL tears from occurring in the first place.

<table>
<thead>
<tr>
<th>Program Overview: Phase 7 Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1: Injury Diagnosis and Planning</td>
</tr>
<tr>
<td>Phase 2: Prehabilitation</td>
</tr>
<tr>
<td>Phase 3: The Surgical Intervention</td>
</tr>
<tr>
<td>Phase 4: Post Operative and safe zone</td>
</tr>
<tr>
<td>Phase 5: Conditioning, Proprioception</td>
</tr>
<tr>
<td>Phase 6: Return to Sports</td>
</tr>
<tr>
<td>Phase 7: Prevention</td>
</tr>
</tbody>
</table>

Rationale
In recent years, accelerated rehabilitation following ACL reconstruction has been the focus of many investigators. Shelbourne et al. Have been instrumental in the advancement postoperative rehabilitation following ACL reconstruction. His program advocated early weight bearing, full extension (knee straightening), closed chain exercises, and rapid return to sports (10). In his reports, closed chain activities, including the stationary bicycle, were introduced at 2 and 4 weeks postoperatively. The athletes were allowed to progress to athletics when isokinetic testing revealed quadriceps strength in the operated extremity to be 65% or greater of that of the opposite limb. ACL reconstruction followed by immediate cycling and accelerated rehabilitation is safe and effective without compromising graft stability.
The objectives of this 7 Phase program are to provide an effective diagnosis, an excellent surgical procedure and quality rehabilitation. The goal is to achieve optimal performance and prevent injury to the injured and the opposite limb; with the ultimate goal being the prevention of osteoarthritis.

**Steps of Program**

**Phase 1:** Characterization of your injury: What happened to my knee?

You have injured your knee. This is a very common problem in these times when individuals are active. It is important for us to understand how your knee was injured. Most knee injuries are associated with non-contact mechanisms. The sports skiing, basketball, soccer and football have the highest incidence of ACL tears. Statistically the female athlete in recent years has had approximately a 40% greater number in most sports. Why this occurs is a matter of theory, but most believe that there are physical, motor control and physiological explanations for this. There is a focus on the national level to best understand these mechanisms and then develop a strategy of prevention. In soccer where there has been a dramatic increase in the number of ACL injuries in the female athlete, many medical teams are taking steps to assure maximal strength agility, and motor control programs. We will need more time to see the impact that these strategies will have. It is probably safe to say at this time that optimal ACL protection should include a detailed program focused on aerobic and anaerobic fitness, strength, agility and flexibility.

It is sometimes difficult to describe how your knee was injured. In certain situations a friend, the trainer or coach can describe the specifics. In professional, club, collegiate sport videos are available that depict the injury. Most knee ACL injuries are non-contact or not caused by a collision. Most descriptions describe some loss of balance or some temporary loss of control. The foot twists balance is lost and the knee torques in a direction and position that is not compatible with the ligaments normal load potential. This results in a force and load that causes failure of the ligament(s). The athlete describes a variety of sounds and sensations. These include: pops, clicks, pain and tenderness. Subsequently you may have swelling, points of maximal tenderness and a painful range of motion. It is this complex of signs and symptoms that causes you to seek medical care. This event is quite common in the US and some have estimated 120,000/year. We will now help you to better understand normal and abnormal knee anatomy and function.
Knee Anatomy and Function

The knee joint is architected to allow synchronous load and motion. To achieve this the ultimate design rationale there is a complex relationship between bone, ligament, articular cartilage and meniscus fibrocartilage. Let us take a closer look at these structures and their function.

The **femur** is the upper portion of the knee joint. It is covered with a surface of **articular cartilage** that allows weight bearing and motion with a very low coefficient of friction. This articulates with the lower portion of the knee which is the **tibia**. The tibia is also covered with articular cartilage that has two semilunar fibrocartilages (medial and lateral menisci) that sit on the surfaces. The menisci are resilient structures, but only have blood supply in the outer third. The menisci function to distribute load, to lubricate and to provide additional stability for this articulation. The ligaments work in concert with these structures to achieve optimal stability through a range of motion. The **Anterior Cruciate Ligament or ACL** has an attachment to the femur in the back and to the tibia in the front. The major function of the ACL is to prevent the tibia from moving forward or anteriorly. The ACL also provides some stability to rotational forces. Thus when the ACL is torn the tibia moves more easily anteriorly, or is considered to have greater laxity and instability. This is a major problem for an athlete who desires pivoting, cutting and changing direction as part of their athletic lifestyle, for workers whose job demands require similar function, and for the rest of us who suffer from instability after injury with even seemingly minor activity. These functions are required for sports such as skiing, soccer, football, basketball, and volleyball. These functions are not as important for sports such as jogging and bicycle riding. The **Posterior Cruciate Ligament or PCL** attaches the femur and tibia and is principally responsible to stabilize the tibia moving backward on the femur. It is most commonly during sports, when the knee is bent or during motorcycle and motor vehicle accidents. Several studies have demonstrated that it is possible to do quite well in sports even if the PCL is torn. Specifically, this is dependent on the severity and the injury to other structures in the knee. The **Medial Collateral Ligament or the MCL and the Lateral Collateral Ligament or the LCL** are primarily responsible for maintaining side to side or varus and valgus stability.
It is through this interaction that the forces of compression, tension and shear are distributed effectively. Once the integrity of this system is lost or diminished there is a resultant functional disability, or instability and a higher potential for degeneration of the joint (arthritis). It is here that we must understand what the,

Goals of the Sports Medicine Orthopaedic Surgeon are: The Spectrum of Care
- Injury care
- Injury prevention
- Performance maximization
- Prevention of the next problems including osteoarthritis!
- Keep the patient exercising.

In order to accomplish these goals it is imperative to make an efficient diagnosis leading to an effective treatment.

- Making the Diagnosis

You have injured your knee. Each knee problem is associated with a spectrum of pain, decreased range of motion, swelling, stiffness, and an inability to perform your activities or sports.
- Subjectively you will go over how the injury happened, what has happened since, things you have attempted to fix the knee, and how the knee feels like day to day.
- Objectively, a physical examination will help us define your point of maximal tenderness, range of motion and the degree of laxity or instability.
- X-rays are routinely done to evaluate bone injury and for the presence of abnormal alignment. When this is complete this is considered the primary evaluation. Utilizing the history, the physical examination and the x-rays we are able to develop a preliminary diagnosis of your problem. At this point we may decide that more information is necessary.
- Secondary diagnostic techniques include MRI or Magnetic Resonance Imaging, Bone Scan and CT scan. MRI, a technique developed for the knee in 1984 allows depiction of normal and abnormal anatomy with excellent accuracy (80-95%). This test is best used to confirm the primary diagnosis. There are times that we feel that this is necessary and others it is not. These are judgments we will make dependent on the situation. The variables include the type and severity of the problem as well as cost efficiency. The Bone Scan is rarely used but can help define fractures that are not visualized on routine x-rays. The CT scan is best used to define an occult fracture or help understand a difficult fracture pattern. These secondary tests will have to be scheduled at a later date than the original visit.
- Once you have had the test you will return to the office to review the scan and the interpretation with us. At this time we will make the final determination and diagnosis of your problem. It is also important that we understand the severity of the injury and the damage to the menisci and other structures. No two injuries are the same.
- There are two important ramifications and consequences of tearing your ACL.
  - The first is the functional instability and consequent athletic disability and loss of dysfunction.
• The second is the potential development of articular degeneration and arthritis that can evolve over years.

• What are your options?

We have determined that you have injured your ACL. We have arrived at this diagnosis using a systematic and comprehensive approach. Your initial response to this may be frustration, disbelief, anger or depression. All of these responses are appropriate and expected. Once recognizing your emotional and psychological response it is important to get on with a decision making progression to find out;

• What is best for you? There are several principles that must be understood,
  • First, there is no rush to any decision. Allow this to be an evolution. For some this is easy, others it is more difficult. Take a deep breath and allow your judgment to surface.
  • Second, you must define for us your athletic goals. Try to define the type of sports you wish to return to. What are your requirements at work and at home? How old are you? Where on the spectrum are you from low level recreational to high demand? Only you can define that for us. Remember it is not appropriate to say “I am not a professional athlete” to rationalize your objective. Every individual must be dealt with as a separate situation that must be personalized with post-operative, rehabilitative and restoration programs customized for only your problems, your goals, needs and timing!
  • Third, timing is an essential factor. The timing of injury and care must be matched to your agenda, season, goals and priorities. Once all these issues are considered we are ready to evaluate the options. Timing can be anything…most of the time it is everything.
  • Communication is critical. We need to communicate all details to you. You will need to convey essential details to us. Others also may be critical include:
    • Your primary care physician
    • Your athletic trainer, manager or coach
    • Your agent
    • Your supervisor at work
    • Your family and friends.

Options
  • #1-Conservative, Rehabilitative and non-operative
    The conservative option is best for those individuals who are lower demand or non-athletes who do not do aggressive and pivoting types of sports such as skiing, football, soccer, basketball, tennis racquetball or martial arts. This option starts immediately. You may be given a brace immediately to facilitate a gentle range of motion of your knee and healing of other structures that we call secondary stabilizers. Early on your range of motion will have some restrictions at the extremes. As pain begins to decrease and you begin to achieve better motion, Physical Therapy will be initiated. The purpose of physical therapy is to gradually improve motion, strength, and agility and progressively return you functional activities. Most often you will be asked to work with a Physical Therapist who will create a comprehensive program. This will include in-house sessions 2-3 times /week in concert with home and gym
workouts which include stationary bicycling and swimming laps with flutter kick only. Overtime you will phase into a program that allows you independence and diversification of your activities. This program will be reviewed and practiced with your therapist. During the execution of this option you will periodically see us in the clinic to assess your progress. There are times we will have to make some course corrections or even select a different option based on your clinical or symptomatic response. Bracing during sports is a controversial issue. There are excellent arguments on both sides pro and con. In our practice, each situation is dealt with individually and we are always open for discussion. If a decision is made to obtain a brace we will write a prescription and create a time that the vender can fit you. Remember in most circumstances you can change your mind at anytime to other options. So if you decide this is the best option for you at one time. It is no problem to progress to surgery if the decision is made accordingly.

• #2-Knee Arthroscopy and Meniscus care only

This option should be selected for those individuals who have a documented (MRI) meniscus tear and do not want ligament reconstruction. In addition, there are other situations where the spectrum of injury, such as a displaced meniscal tear of there is concurrent multiligamentous situations when this is preferable. This procedure is performed as an outpatient. It includes an examination under anesthesia to objectively determine the severity of instability and laxity, followed by arthroscopy. At this time we can make an exact determination of articular cartilage damage, meniscus and ligament tears. Our objective is to preserve meniscal tissue at all times. There are times it is best to suture repair or fixate the meniscus, but it is well understood that meniscus suture repairs in ACL deficient knees fail at a higher rate. There are some small meniscal tears in the periphery where there is good blood supply that heal spontaneously. Partial menisectomy is performed if the meniscus tear is not amenable to suture or fixation repair. When this procedure is completed you will review the finding and photos so you optimally understand the situation. Postoperatively you will start Physical therapy when it is optimal. You will then progress as in option #1. Remember at any point you can make a decision to go to option #3.

• Option #3 Arthroscopic ACL Reconstruction

This option is preferable for mid and high level recreational, elite and professional athletes, as well as those whose job requirements mandate full function of their knee. The rationale for this procedure is that with arthroscopic techniques we can stabilize the knee adequately and preserve athletic and performance function. This procedure has evolved over a 20 year period to a level that we are 90-95% successful in returning athletes to sport and other high activity levels. The procedure involves an outpatient surgery followed by an accelerated rehabilitation program, with restoration and prevention components. The surgical procedure defines the precise anatomic location of your natural ACL or the “isometric position” and then a substitution graft is placed. In our field orthopaedic surgeons have evolved and fine tuned science, concept and technology. In review of all science of methodology of what is the best procedure? It appears that issues of allograft vs. autograft, anatomic vs. non-anatomic and numbers of tunnels, bundles and angles have been evaluated. It appears that with respect to graft type there are some potential advantages and disadvantages. One thing is clear that the
The graft needs to be placed anatomically at the appropriate angles coupled to a post operative program that allows adaptations, restorations and return to sports. The numbers of bundles and tunnels is not critical to outcome as long as the graft is placed in its “anatomic home”.

There are several options for the graft substitution:

- **Autograft Patellar Tendon**
  Over the years this has been the most common procedure presently performed in this center and the world. It involves removing a 10-11mm center portion of the patellar tendon with bone blocks on either side. The harvest site heals with minimal to no pain, but some 5-10% may have soreness especially when the muscles have not been strengthened. The graft is then placed in bone tunnels that are placed in the anatomic and isometric position, or the position and location of the old ACL. The graft is then fixated with bioabsorbable interference screws that are made of a biological composite that will transform to bone over time. It is the anatomic position in combination with fixation that allows complete range of motion as soon as possible.

- **Allograft Patellar Tendon**
  The use of the allograft or cadaveric tissues in medicine has been gaining tremendous popularity in recent years. Over the last decade increasing numbers of surgeons have utilized allograft tissue as a primary option, for revision ACL and multiligamentous reconstructive surgery. The success of this technique has been comparable to the other ACL techniques. One might argue that the success for allografts has caused it tremendous rise in popularity. We would say that rates of failure and successful outcomes are about equal to autograft techniques. In recent studies using a systematic review analysis we have not been able to prove superiority or inferiority of graft type. In our experience most patients like allograft the best is since it makes the knee feel more normal and hurt less than autograft in the short and long term. Several studies have documented the allograft efficacy and safety.

There still remain several issues that are important to consider:

  - In recent years the allograft has been fresh frozen and can be biologically sterilized using a Biological Cleansing process or irradiated to sterilize for bacterial and viral particles. The recent advance of the Biocleanse process has allowed complete sterilization without weakening a graft that we sometime see with irradiation of grafts.
  - Previously, the allografts were treated with chemicals such as ethylene oxide that damaged the graft and host tissues. Utilizing the biological cleansing removes this side effect.
  - Anytime the concept of allograft or human transplantation is discussed it is imperative to understand there is a probability of HIV, hepatitis, and other bacterial and viral transmission. To date, all specimens are comprehensively screened and negative results are documented in a very fastidious and compulsive system. The accepted probability for
these infections is 1 in 1.5 million. If you have any further questions regarding these issues please bring it up.

- **Autograft Semitendonosis**
  The use of the “hamstrings” including the semitendonosis and the gracilis has gained increased popularity in recent years. This technique utilizes these tendons to substitute the ACL and is fixated with screws, fixation cords or specialized buttons. The postoperative protocols are identical to the patellar tendon techniques. The overall success rates from this technique are similar but not identical to the patellar tendon technique. Some physicians' concerns, which I share, using this technique are in female athletes as the medical literature reveals a higher failure rates using the hamstrings and some patients whose sports would suffer from a lack of hamstring strength which is possible after hamstring harvest.

- **What are the risks of surgery?** It is our responsibility to make sure that you have a realistic understanding of the risks and potential complications. They are the following:
  - **Risks of Anesthesia.** As a general rule all anesthesia options are safe and effective. Regardless of the option selected complication rates are very low. In our contemporary times of outpatient surgery, anesthetic protocols have been much more efficient. The primary goals are to minimize or eliminate pain, nausea and vomiting while allowing our patients to return home in a timely fashion. The most important issue is making sure that you are healthy and then there are no underlying medical conditions that can influence this. In some situations you will be asked to see your general physician for a preoperative medical History and Physical Exam that defines these issues. You will review these again with our anesthesiologists.
  - **Infection.** Probability approximately 1/200-300. To minimize this risk potential you will receive pre and postoperative antibiotics.
  - **Recurrent laxity and graft failure.** 2-5/100.
  - **Chronic Stiffness.** 1-2/100.
  - **Re-operation** 5/100 for any reason which can include pain, decreased range of motion, hardware problems.
  - **Nerve and/or Blood Vessel injury** 1/500
  - **Deep Vein Thrombosis or blood clots** 1/500

- **Making Your Decisions**

  It is usually a difficult process of you understanding exactly what you have done to your knee and what to do about it. This is something that we do all of the time but you have little or no experience in these matters. This is the main reason we have created this manual. There are some important principles to guide you:

  - There is absolutely no rush to make a decision.
  - It is important that you understand each option in full detail, if you don’t, ask again if this is necessary?
Timing is an important issue!

Regardless of the option that you ultimately select it is important to start the following protocol:

- **You may be given a brace** by our staff to support the knee through a range of motion. This should be worn when you are up and around and not in bed. It is for comfort and to reduce pain. We will let you know when you can discontinue its use.
- You will start **exercise** including leg lifts, quad sets, and range of motion exercises immediately. The first major objective is to achieve a full range of motion. In most individuals, insurance permitting we will have you work with the physical therapists.
- To alleviate swelling and pain we recommend that you **ice your knee** with an ice bag or a bag of frozen peas as much as possible. We also may use specialized machines with ice flow and pressure. Early on, this can be at all times, thereafter 15 minutes 4 times a day. In addition, we recommend a non-steroidal anti-inflammatory drug. Early on prescription medications Toradol and Relafen will be utilized. Subsequently over the counter medications such as Advil 2 tabs 3x/day, Celebrex 200 mg per day, Aleve 2 tabs 2x/day or Naprosyn 500mg 2x/day, or whichever medicine you prefer or tolerate can be used. Remember that each of these medications can affect your stomach. If previously you have had ulcers or similar problems make sure you tell us. If while you are taking these medicines you have stomach problems, **Stop at once and call us!**

**Phase 2: Prehabilitation..Injury to Surgery**

It is imperative to begin to think about movement of the knee as soon as possible after incurring the injury. This can be implemented with a Physical Therapist and completed in conjunction with a Stationary bike program and other basic strengthening exercises. Other safe activities may include the pool for swimming and even aqua jogging. For those who have chosen non-operative options you will be focused on a systematic program.

- **The Timing of Surgery**

Once you have made a decision to proceed with surgery, we must define the optimal time. There have been several studies that suggest that it is optimal to wait at least 3 weeks after injury for ACL reconstruction. As a general policy this is our practice. There are exceptions to this rule and they include:
  - The elite, high level or professional athlete. It is in this group that the time from injury to full return is vitally important.
  - In the situation where there is a displaced meniscus tear or multiligamentous injury that won’t allow a full range of motion

- **The Preoperative visit** The purpose of this visit is to:
  - further help you understand your options
  - Review the risks of surgery and to go over informed consent.
• review all logistical issues
• Discuss prescription medications including:
  • Hydrocodone (Norco) for pain. This is an excellent pain reliever that is a combination of a codeine analogue plus Tylenol. You can take one tablet every 4-6 hours as necessary.
  • Toradol (ketorolac). This is a pain medicine and anti-inflammatory used in days 1 and 2. You take one pill 3x/day.
  • Keflex (cephalexin). This is an antibiotic to be taken as a prophylactic or preventive medicine 4x/day for one day.
  • Relafen (nabumetone). This will be taken after you finish the Toradol from days one and two. This will be continued one pill twice a day for approximately two weeks.
• Make sure that we have adequately screened you medically with respect to physical exam, blood and other tests
• Provide follow up appointment dates and times.

• Anesthesia Options
  • Local with sedation. This option is reserved for those individuals to have arthroscopy with meniscus care only.
  • General. Also widely accepted and used for ACL reconstruction. Today’s outpatient techniques are much easier than before allowing for less pain, less nausea and a very efficient discharge back to your home. This will often be combined with a regional anesthetic where the entire leg is numbed to minimize pain in the first 8-12 hours.
  • Spinal/Epidural. Now this is rarely used for ACL Reconstruction.

• The Day of Surgery… What to Expect
  All patients have a level of nervousness in the days prior to surgery. It is not uncommon to wake up dreaming about the procedure. The best thing to do about all of these reactions is to talk with friends, family for us. We have been there many times and we want to make this an enjoyable as we can. There are some important rules that you must follow:
  • Do not eat or drink or eat after midnight. There are some situations that you can but we will tell you if it is OK!
  • Make sure you have someone to take you to the facility and pick you up. The staff will review for you what the best times are.
  • Read all the materials we have given you once again the night before surgery. Make sure you understand all logistics, your options, the risks, the benefits in full detail. If there are any questions it is important you ask. Remember the key to an optimal result is information, comfort and confidence.
Phase 3: The Surgery ACL Reconstruction
This is the surgical part of the process where the surgeon’s objectives are to:

1. Stabilize the joint by ligament repair and or reconstruction arthroscopically.
   a. The graft must be Anatomic and Isometric
   b. There must be Stable fixation of the new ACL (graft) with interference screws
   c. There must be excellent range of motion - especially with full extension
2. Repair the torn meniscus – if necessary
3. Resurface or repair the damage to the articular cartilage which covers the ends of the long bones of the leg.
4. Reduce swelling and pain
   a. Drains if needed
   b. Toradol intra-articular
   c. Pain control pre-emptive to minimize pain during all times in the post operative period
   d. Early stimulation of Quads/HS doing basic exercises at home
   e. PWB with Crutches with early weight bearing
   f. No brace is required after the first week or two in most patients

- Your surgery is completed!

- When this arthroscopic procedure is completed the graft is evaluated and photographed. The knee is then further anesthetized with local medications that will allow early range of motion and exercise with hopefully minimal amounts of pain.
- You are in the recovery room. Perhaps you are groggy and are just waking up or still somewhat sedated from the regional anesthesia. In this period it is essential that we:
  - Have minimized pain and nausea.
  - Initiate an active exercise program that allows gentle early active range of motion. You will be asked to do the following exercises
    - The first step in this “Active Exercise Motion” program is to gently flex and extend your knee. This will begin after your first postoperative visit
      - Straight leg lifts. 10 repetitions times 15-20 sets in the first day and thereafter.
      - Range of motion exercises 0 degrees to 100 degrees. 10 repetitions times 15-20 sets in the first day and thereafter.
      - There may be a small plastic tube called a drain in your knee to remove excess blood and fluid. This drain will be removed either 1 or 2 days after surgery by your physician. You will be instructed how to trouble shoot the drain. The key is to keep the fluid, clots and blood flowing. If it clogs then the fluid will come into the dressing and you will see it. If that happens massage the bulb where the 2 tubes come out of your knee. Once the clog moves into the collector it will drain freely.
• Ice your knee to minimize swelling and pain. In some patients we will use a special machine that circulates ice water to the knee and compresses your knee concurrently. For others this may not be necessary or feasible due to insurance issues. In these situations ice packs will be placed on your knee at all times.
• When you are feeling good enough to go home you will be discharged. The nurse will once again will review all issues including exercises, icing protocols, medications, drain care and follow up appointments.

• **The Night of Surgery**
  o Pain Control-Our goal is to **minimize or eliminate pain** with this procedure. You will have prescriptions for:
    • Hydrocodone. You can take one tablet every 4-6 hours if you need. Do not take other medications that contain Tylenol (acetaminophen) as your pain medication also contains this.
  o Antibiotic Prophylaxis- Keflex 500 mg 4 times a day for one day. This is in addition IV antibiotics given prior to surgery.
    • Important specific potential problems include:
      • **Penicillin allergy.** You must review for us what this means. Have you had a severe allergic reaction? If so we will modify these medications as necessary.
      • **Heart Murmurs or Valvular Heart Disease.** If you know about this consult your general physician as to exact recommendations since you may require a different method of prophylaxis.

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Phase 4: **Post Operative**

• **Day 0 to the 1st post op visit:**
  Aggressive rehabilitation of the quadriceps and hamstrings is vital to ensure an optimal outcome. In an ACL injured knee, there is a failure of receptors in the ligament that are responsible for muscular reflexes and joint stability, thereby increasing joint laxity. Exercise has been shown to improve the function of the muscle receptors, which thereby protect the knee. Early active motion and a functional rehabilitation program are implemented to maximize overall fitness levels, muscular function and stability. This conditioning program will increase overall strength and hopefully prevent further knee injury later on.

  • **The Detailed Early Rehabilitation Protocol**
    Goal: range of motion 0-90 degrees.

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1-60 days
Activities: The immediate recruitment of the quadriceps and hamstrings leads to a more expedient recovery time. Exercises in the immediate post-operative period include:

- Quadriceps sets to strengthen the thigh muscles
- Straight leg lifts
- Heel slides: 0 to 100 degrees (10 repetitions times 15-20 sets per day for each exercise)
- Maintain the leg fully straight with yoga style hamstring stretch.

Weight bearing: partial weight bearing for 14 days. Advance to full-weight bearing status (unless there has been and articular cartilage or meniscal repair procedure, then it is 6 weeks)

Modalities: Ice for compression and cooling to minimize swelling, improve range of motion, and diminish pain.

Days 1 to 7

The Postoperative Visit

- Welcome back! This visit we will:
  - Make sure medications are effective and not causing problems
  - Change your dressings and remove the drain if present.
  - You will have an ace bandage placed and continue your TED hose
  - Review the basic exercises again
  - Give you the rehabilitative protocol in full detail.
  - Review the operative findings, procedures, and photos.
  - Schedule physical therapy visits. We will give you the referral and appropriate authorizations as needed. Schedule follow up visit in approximately 7-10 days. After this the interval varies from 3-4 weeks.
  - Make sure you have all necessary notes and documentation for school or work
  - Temporary disability for the DMV for handicapped parking.
  - The program over the next week
    - **Goal:** Range of motion 0-90 degrees. The dressing is changed and drains removed.
    - **Activities:** Continue the basic exercises, which are quad sets, leg lifts, heel slides, and hamstring stretching.
    - **Modalities:** Ice for compression and icing. Box drill everyday for proprioception if appropriate
    - **Weight bearing:** Full weight bearing starts now with assistance from your crutches. You will still be using crutches for a total of 14 days. If you have had a cartilage repair – the usage of crutches will be extended for 6 weeks.
    - Your next appointment is 7-10 days later.

Days 7-10: The second clinical visit

**Goal:** Return to the clinic for suture removal
Activities: Begin use of an upright or recumbent stationary bike for 10 minutes per hour. Increase at one minute intervals each session to achieve 30 mins/day. Once at 30 minutes with no resistance begin alterations of adding resistance and adding time, with a goal of one hour/day by the six week mark.

Weight Bearing: Full. Discontinue the crutch usage on day 14.

Modalities: Ice and ace bandage for compression and swelling control. The TED hose will be discontinued at this visit as will the brace in most people. Box drill everyday for proprioception.

Physical Therapy to formally start this week!

- Days 10 to 60: Early Post Operative Phases

Goal: Be careful not to walk too much in the first 6 weeks: no shopping or standing for long periods of time. This will cause unnecessary swelling and discomfort.

Activities: Continue with biking and mat strengthening exercises

Weight Bearing: Full

Modalities: Continue icing to address pain and swelling as needed, especially after completing your exercises. The ACE bandage can be discontinued at 14 days after surgery.

Exercise:
- Quad sets to achieve full extension to make sure the knee can totally straighten. It is crucial to get the knee straight during this phase.
- Stationary bike progresses to 1hr/day. By the end of 6 weeks, you can move to an outdoor bicycle following same progression. However, you cannot use LOOK or SPD cleats. Flat pedals or cages only!
- Sports specific agilities.
- Box Drill: to optimize restoration of proprioceptive function. Use good technique and do not let you knee cave inward. This will be demonstrated in clinic.
  - This is set up with 4 cones, 5 yards apart making a box. The box is initially walked slowly, then walked rapidly, then jogged and then sprinted.
  - The box is progressively enlarged to 10, 20 and 40 yards by 90 days and at this time should be walked; then jogged and sprinted in a stepwise progression.
  - Basketball athletes start in the gym walking around the court, shooting foul shots, and shagging balls.
  - Tennis players are instructed to begin to hit balls against a backboard.
  - Volleyball athletes will begin gently hitting at week 2.
- A gentle walk/jog program was incorporated at week 6-8 depending upon the individual progress. You will begin on a treadmill or stable surface (no grass or uneven trail).
  - Walking with no limp is the first step. When this is achieved, build up to walking for 30 minutes normally; then walk for 5 minutes and jog for 1 minute; then walk 5 minutes and jog for 5 minutes; then walk for 5 minutes and jog for 10 minutes and so on.
- Pool Program (Table 1): Swimming is encouraged as early as 2 weeks post-operatively for cross training once the wounds are closed. The freestyle is
ideal. Avoid the breaststroke – it is too stressful on the knee. Aqua jogging with a belt or vest is also excellent exercise.

**NOTE:** If flying long distances on flight greater than 2 hours, please discuss this with us prior to flying! It is necessary to use a blood thinner prior to flying in order to avoid a DVT (deep vein thrombosis) from occurring.

### Phase 5: Conditioning

**Days 60-120**

**Goal:** Gym and PT (see Table 2)

- Core strengthening: Pilates mat or reformer, Swiss ball activities
- Pool and Swimming progression 1 hour (see table 1)
- Continuation of Bike 1hr/day with progression of time, load and speed
- Stairmaster, Elliptical to enhance cross training diversity.
- Box progressions daily in house
- Walking minimal for exercise on safe, stable surface

**Training Phases**

**Days 90 to 120**

- Gym and Physical Therapy (see table 2)
- Pool and Swimming progression
- Continuation of Bike 1hr/day with progression of time, load and speed
- Stairmaster, Elliptical to enhance cross training diversity.
- Box progressions on field or court. Start at 15 minutes. Box at 10 yards and 40 yards. Clockwise and Counterclockwise. Start slow jog and progressively increase the pace with and without the ball. Should be sprinting by 120 days. This is confidence building activity, endurance, proprioceptive and game and practice simulation.

### Phase 6: Return to Sports and Prevention

**Days 120-180**

- Gym and PT (see table 2)
- Pool and Swimming progression 1 hour Including Aqua jogging with Buoyancy vest (table 1)
- Continuation of Bike 1hr/day with progression of time, load and speed
- Stairmaster, Elliptical to enhance cross training diversity.
- PEP program to start as a 15 -20 minute warm up 3x /week to all field training, all elements (See table 4) Begin this at the 5 month mark
- Continue run and sprint box progressions on field or court. Start at 15 minutes. Box at 10 yards and 40 yards must be able to sprint box both ways by 120 days. **Once you are at full speed on the box drill** then it is a green light for may play, the next step. **Must continue box on daily basis** even though move into practice!
- Practice/May play criteria on field progressions ⇒ **non-contact drills only** during practice x 14 days
- Practice/May play criteria on field progressions ⇒ **contact drills only** during practice x 14 days once safely and effectively passed non-contact drills
  a. Gym and PT (see table 2)
  b. Pool and Swimming progression 1 hour Including Aqua jogging with Buoyancy vest (table 1)
  c. Continuation of Bike 1hr/day with progression of time, load and speed
  d. Stairmaster, Elliptical to enhance cross training diversity.
  e. PEP program (Table 4) to start as a 15 -20 minute warm up 3x /week to all field training, all elements (See table 4)
f. Continue run and sprint box progressions on field or court. Start at 15 minutes. Box at 10 yards and 40 yards must be able to sprint box both ways by 120 days. Once you are at full speed on the box drill then it is Green light for May play to the next step. **Must continue box on daily basis** even though move into practice!

g. Practice May play criteria on field progressions → **contact drills only** during practice x 14 days once safely and effectively passed contact drills then ready for competition progression, can progressions start games 15 minutes, 20, 25, 30. The goal is to get to 90 minutes of practice by 180 days. **Full release when one can play 90 minutes with comfort both in your knee and from a fitness perspective.**

### Phase 7: Prevention 180 days +
All reconstructed players must be treated differently than normal player

- They must have workouts include all details of less is more and more cross training
- PEP prevention programs to prevent graft and other knee!
- Perhaps some orthobiological management including Hyaluronic acid and PRP in specific cases.
- Glucosamine Sulfate 1500 and Chondroitin Sulfate 1200 mg /day to help protect the joint for always as a preventative in most patients.
# TABLE 1 - POOL REHABILITATION PROTOCOL

## EARLY EXERCISES (from 2 to 6 weeks after surgery)

**Gait training (about 10 min):**
- High knee walking using a correct gait cycle (stance, pre-swing, swing), forward, backward & combined.

**Stretching and ROM exercises:**
- Stretching of the hamstrings and quadriceps – hold for 30 seconds
  - Use both deep & lower water levels, using resistance belts if possible
  - Stretching exercises are performed several times during rehab session, particularly after strength exercises
- Hydro-bike in high water
- ROM recovery without forcing for 10 min
- Seated passive knee motion
- Manual mobilization of the kneecap at the pool side at the end of the session (up-down and side-to-side)

**Muscular strengthening (usually 5 set of 15):**
- CKC exercises with board or lifebelt (without recruiting ST-G muscles for hamstring grafts)
- Hip abduction and adduction with no weight added and progressively using resistance
- Hip extension with resistance
- Flex-extension and active ankle circumduction in supine position
- Toe raises in high water – progress to single leg toe raises
- Exercises for obliques, transverse and rectus abdominal muscles

**Proprioception and sport skill exercises:**
- Sitting exercises with proprioceptive board without weight bearing in multiple planes
- When full weight bearing is reached, perform exercises in standing position – bilateral and unilateral
- Proprioceptive exercises for the trunk sitting on wobble board or Bosu™
- Exercises with specific tool (using a ball: heading, practice with hands, passing,...)

## LATE EXERCISES (from 6 to 8-10 weeks after surgery)

**Gait training (about 10 min):**
- Low water walking using a correct gait cycle (stance, pre-swing, swing), forward-backward-combined.

**Stretching and ROM exercises:**
- Bilateral stretching exercises of the hamstrings and quadriceps (same as early phase):
- Hydro-bike in high water
- ROM recovery without forcing for 10 min
- Active flex-extension of the knee - lying in back position with the trunk, head and calves supported

**Muscular strengthening (usually 6 set of 20):**
- Leg press with resistance
- Active flexion with light weights (90 – 40 degrees)
- Hip extension, abduction and adduction using resistance tubing or weight
- Bilateral plantar flexion exercises in high water -- eccentric
- Exercises for recruitment of obliques, transverse and rectus abdominal muscles

**Proprioception exercises:**
- Exercises with proprioceptive board with full weight bearing in multiple planes
• Exercises with proprioceptive board increasing their difficulty with external inputs (destabilizations, throwing a ball…)
• Proprioceptive exercises for the trunk sitting on a wobble board or Bosu™

**Sport specific and skill exercises:**
• Aerobic reconditioning exercises: bicycle (try to reach 15 min), Backstroke with flippers, Step, Running in high water.
• Skip forward/backward/side-to-side
• Sport specific exercises using proper equipment (using a ball: heading, practise with hands, passing,…)
• High water jumping focusing on the landing phase – soft landing on ball of foot – toes visible – weight backward (using gluteals and hamstrings). Do not let the knees cave into valgus (no knock knees).
• Jumps with short run followed by skipping and take-off (phase)

**Table 2 – Physical Therapy REHABILITATION PROTOCOL**

**Physical Therapy:**
• Low level laser therapy, pulsed ultrasound, TENS, Ice

**Massage Therapy:**
• Draining massage (lymph drainage) of knee and calf
• Massage therapy: quadriceps, popliteus. Cross friction of the ITB, IPT and QT
• Massage of hamstrings muscles starting from week 2-3 for patients treated with ST-G grafts (hamstring) or starting from week 1 (patients treated with BPTB grafts).

**ROM exercises and joint mobilization:**
• Passive mobilization of the patella
• Manual mobilization of the tibia in order to improve flex-extension & internal – external rotation
• Active mobilization to encourage full knee extension

**Stretching:**
• Hamstrings
• Quadriceps (to achieve 130° flexion)
• Iliopsoas, TFL, and piriformis

**Strength recovery:**
• Electrostimulation (VMO and RF)
• Quadriceps/hamstrings and Abductor/adductor co-contractions
• Hip Flexors, adductors, abductors and hip extensors with weights and tubing
• Gastrocnemius & Soleus (calf musculature) – concentric and eccentric
• Knee flexors starting from week 4-5 (patients treated with ST-G grafts) or from week 3 (patients treated with PT grafts)
• Closed Kinetic Chain exercises: 0/45°’s
  o Leg press with elastic resistance from week 2-3
  o Leg press with weights, wall slide, step-up from week 4-5
• Open Kinetic Chain exercises: 90/40°’s
  o Last 30° knee extension (VMO) performed with natural weight from week 2-3, then using weights (from proximal to distal position)
  o Leg extension ROM 90-40° from week 5
• Full weight-bearing exercises:
  o Plantar flexion of the foot with full weight bearing in eccentric-concentric mode
  o Step-up & step-down avoiding excessive anterior translation & varus/valgus deviation
  o Strengthening exercises for trunk and abdominal muscles (core stability)
Eccentric control exercises for hamstrings, gastroc, soleus, gluteals

**Proprioception:**
- Walking using a correct gait cycle; no limping
- Proprioceptive board without weight bearing progressing to double and single leg stance
- Progress board from single axis, circular, foam and/or Bosu™ &/or Core Board
- Proprioceptive exercises for trunk muscles – stability ball (core stability)
- Reintroduce kneeling activities through knee: partial WB to full WB

**Sport specific and skill exercises:**
- Running and skip on bouncer
- Bilateral and unilateral jumps on Pilates reformer
- Aerobic training: bicycle, stepper, cross trainer, running on treadmill at slow speed

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**Precaution:** For Airplane travel 6 weeks post op, most situations require prophylaxis with blood thinners such as Lovenox prior to travel! To prevent DVT!
TABLE 3: General On-field Phases and Progressions

First phase
- Confidence acquisition for the environment
- Running without shoes in place – gravity removed (Pilates reformer, leg press, or Total Gym™)
- Slow running on straight line
- Backward jogging on a straight line, keeping hips and knees slightly bent
- Advanced proprioceptive drills on foam, wobble boards, Bosu™ &/or Core Board™
- Double leg jumps with proper mechanics – soft landing, hips and knees bent, buttocks back and toes are visible (do not let your knees translate over your toes).

Second phase
- Proceed with running patterns and coordination exercises
- Increasing difficulty and speed of proprioceptive drills
- Increasing speed of straight line running with deceleration and speeding up built in
- Circle running around cones
- High skipping or bounding exercises
- Begin to kick a soccer ball – under 10 yards

Third phase
- Running at different speeds with slow changes of direction and deceleration
- High Skips & bounding (different patterns)
- Single leg jumps and landing (side to side, forward and backward, and diagonal patterns)
- Kicking ball – under twenty yards
- Lateral movements (cone drills – side shuffle with push off)
- Technical and specific skill training:

Forth phase
- Proceed with technical exercises with ball
- Running with faster changes of direction on different pathways (diagonal runs)
- Anaerobic training with sprinting and fast change of direction with ball (100m repeats)
- Small matches (neutral player) 3 vs. 3 or 1 vs. 1, corner kicks; kick-offs, etc...

Fifth phase
- Proceed in fast running with sprints and fast change of direction
- High intensity exercises with and without ball in game-like situations
- Full intensity little matches 3 vs. 3, 2 vs. 2, 1 vs. 1, full swing kicking 20 + yard passing.
- Return to full play when the following goals can be achieved:
  - Jump/landing on one leg without the knee caving inward or extending over the toes
  - Single leg step down with aforementioned criteria
  - Sprint with deceleration without forward translation of shin.
  - Single leg jump: distance covered within 3 inches of contralateral limb
  - Double leg squat with good gluteal and lateral hip control
  - No swelling (joint effusion) of knee
  - No patellofemoral tracking issues or anterior knee pain complaints.
**Table 4 PEP Program: How to protect your ACL (4 months after surgery)**

This prevention programme consists of a warm-up, stretching, strengthening, plyometrics, and football specific agilities to optimise the strength and coordination of the stabilizing muscles around your knee joint. It is important to use the proper technique during all of the exercises. Therefore, you need to pay full attention to correct posture, avoid excessive side-to-side movement when jumping and ensure soft landings. This program should be completed 2 to 3 times a week at a minimum and should take approximately 15 minutes to complete.

The PEP Program – Prevent injury and enhance your performance

1. **Warm-up**: Warming up and cooling down are a crucial part of a training program. The purpose of the warm-up section is to prepare your body for activity. By warming up your muscles first, you greatly reduce the risk of injury.

   A. **Jog line to line (cone to cone)**: *Instruction*: Complete a slow jog from near to far sideline.

   B. **Shuttle Run (side to side)**: *Instruction*: Start is an athletic stance with a slight bend at the knee. Leading with the right foot, sidestep pushing off with the left foot (back leg). When you drive off with the back leg, be sure your hip/knee/ankle are in a straight line.

   C. **Backward Running**: *Instruction*: Run backwards from sideline to sideline. Stay on your toes and keep the knees slightly bent at all times.

2. **Strengthening**:

   A. **Walking Lunges (3 sets x 10 repetitions)** *Instruction*: Lunge forward leading with your right leg. Push off with your right leg and lunge forward with your left leg. Drop the back knee straight down. Make sure that your keep your front knee over your ankle. Control the motion and try to avoid your front knee from caving inward. If you cannot see your toes on your leading leg, you are doing the exercise incorrectly.

   B. **Russian Hamstring (3 sets x 10 repetitions)** *Instruction*: Kneel on the ground with hands at your side. Have a partner hold firmly at your ankles. With a straight back, lean forward leading with your hips. Your knee, hip and shoulder should be in a straight line as you lean toward the ground. Do not bend at the waist. You should feel the hamstrings in the back of your thigh working. Repeat the exercise for 3 sets of 10, or a total of 30 repetitions.

   C. **Single Toe Raises (30 reps x 2 repetitions)** *Instruction*: Stand up with your arms at your side. Bend the left knee up and maintain your balance. Slowly rise up on your right toes with good balance. You may hold your arms out ahead of you in order to help. Slowly repeat 30 times and switch to the other side. As you get stronger, you may need to add additional repetitions to this exercise to continue the strengthening effect of the exercise.
3. Plyometrics - These exercises are explosive and help to build, power, strength and speed. The most important element when considering performance technique is the landing. It must be soft! When you land from a jump, you want to softly accept your weight on the balls of your feet slowly rolling back to the heel with a bent knee and a straight hip.

A. Lateral Hops over Cone Stand with a 2” cone to your left. Hop to the left over the cone softly landing on the balls of your feet land bending at the knee. Repeat this exercise hopping to the right.

B. Forward/Backward Hops over cone Hop over the cone softly landing on the balls of your feet and bending at the knee. Now, hop backwards over the ball using the same landing technique. Be careful not to snap your knee back to straighten it. You want to maintain a slight bend to the knee.

C. Single Leg hops over cone Hop over the cone/ball landing on the ball of your foot bending at the knee. Now, hop backwards over the ball using the same landing technique. Be careful not to snap your knee back to straighten it. You want to maintain a slight bend to the knee. Now, stand on the left leg and repeat the exercise. Increase the number of repetitions as needed.

D. Vertical Jumps with headers Stand forward with hands at your side. Slightly bend the knees and push off jumping straight up. Remember the proper landing technique; accept the weight on the ball of your foot with a slight bend to the knee. Switch sides.

E. Scissors Jump Lunge forward leading with your right leg. Keep your knee over your ankle. Now, push off with your right foot and propel your left leg forward into a lunge position. Be sure your knee does not cave in or out. It should be stable and directly over the ankle. Remember the proper landing technique; accept the weight on the ball of your foot with a slight bend to the knee.

4. Agilities

A. Shuttle run with forward/backward running. Starting at the first cone, sprint forward to the second cone, run backward to the third cone, sprint forward to the fourth cone (etc.).

B. Diagonal runs (3 passes) Face forward and run to the first cone on the left. Pivot off the left foot and run to the second cone. Now pivot off the right leg and continue onto the third cone. Make sure that the outside leg does not cave in. Keep a slight bend to the knee and make sure the knee stays over the ankle joint.

C. Bounding run (40 yds) Starting on the near sideline, run to the far side with knees up toward chest. Bring your knees up high. Land on the ball of your foot with a slight bend at the knee and a straight hip. Increase the distance as this exercise gets easier.

Training session with team (60 to 90 minutes)

5. Stretching: It is important to warm-up prior to stretching: Never stretch a "cold muscle". By doing the exercises outlined here, you can improve and maintain your range of motion, reduce stiffness in your joints, reduce post-exercise soreness, reduce the risk of injury and improve your overall mobility and performance.

- Don't bounce or jerk when you stretch. Gently stretch to a point of tension and hold.
• Hold the stretch for 30 seconds. Concentrate on lengthening the muscles when you're stretching.

A. Calf stretch (30 seconds x 2 repetitions)
B. Quadriceps stretch (30 seconds x 2 repetitions)
C. Figure Four Hamstring stretch (30 sec x 2 repetitions)
D. Inner Thigh Stretch (20 sec x 3 repetitions)
E. Hip Flexor Stretch - (30 sec x 2 repetitions)

**PEP Program:** Prevent injury and Enhance Performance
Field Set-Up

Fig 1: The field should be set up 10 minutes prior to the warm-up. This will allow for a smooth and quick transition between all of the activities.
Bibliography


