*G. Charles Roland, MD*
*Mariya Kopynets, BS*

## THE SAN DIEGO KNEE CLINIC

# THE KNEE AND RUNNING

## ARTICLE II: MENISCUS AND LIGAMENT INJURIES ARTHROSCOPY

**We will be offering counseling on diet and exercise. If interested, please contact my office and schedule a medically supervised *Health and Orthopedic Fitness* assessment appointment which will include a spine and joint health assessment evaluation. This assessment will not be covered by health insurance.**

G. Charles Roland, M.D.
Director of The San Diego Knee Clinic
Orthopedic, Arthroscopic and Reconstructive Surgery
Diplomate of the American Board of Orthopedic Surgeons
Fellow of the American Academy of Orthopedic Surgeons
San Diego Knee & Sports Medicine Fellowship

In the earlier issue of this running series, I discussed basic anatomy of the knee and the medical problem of chondromalacia patella (soft kneecap) or “runner’s knee.” In this issue, I will discuss injuries to the ligaments and menisci (cushions, cartilages) and what these injuries mean to the runner.

I will review the knee anatomy discussed in the last issue for the benefit of first time readers. The knee is a rotational hinge joint comprised of the following four bones (Figure 1): patella (kneecap), femur, tibia, and fibula.

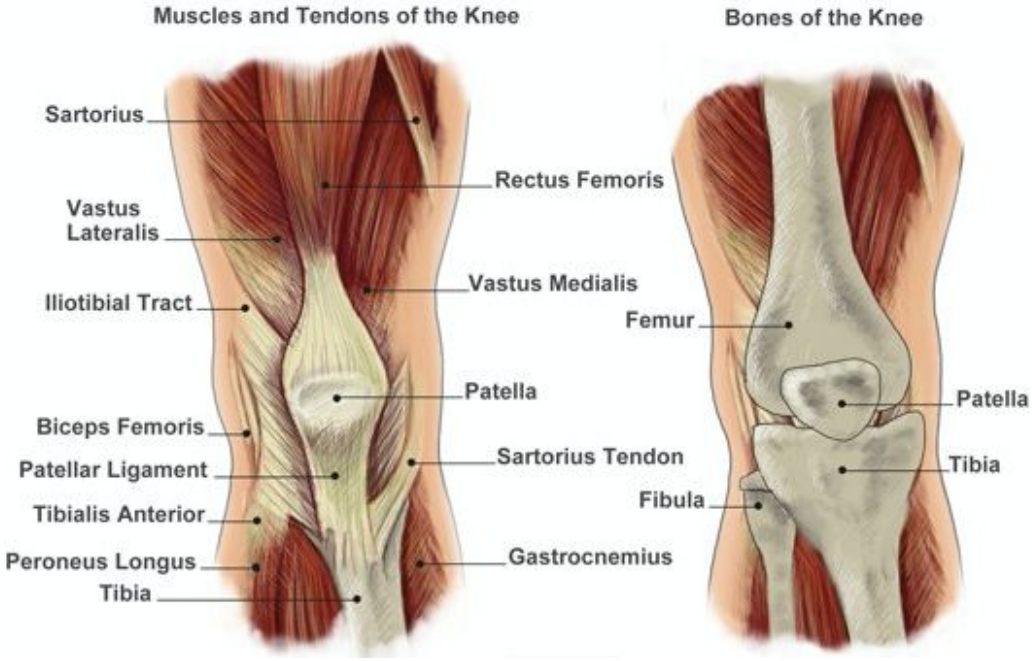


Figure 1. Knee Anatomy. Patella (kneecap), Femur, Tibia, and Fibula.

One can always tell the outside of the knee diagrammatically by finding the fibula. It is always on the outside or lateral aspect of the knee. Connecting the bones together are ligaments. At the knee, there are the following four main ligaments: medial collateral, connecting the femur and tibia together on the inside of the knee; the lateral collateral ligament, connecting the femur to the fibula; and two ligaments deep inside the knee called the cruciates. The cruciate ligaments connect the femur and tibia. The anterior cruciate is in front and more commonly injured, and is the most important ligament in the knee. The posterior cruciate is behind the anterior cruciate. The ligaments serve as check reins to control the motion on the knee that is powered by the muscles.

The two menisci (cushions, cartilages) are located between the femur and tibia. The inside meniscus is called the medial meniscus. The outside meniscus is called the

lateral meniscus. The menisci act as cushions or spacers between the femur and tibia. The meniscus is C-shaped, mobile, and easily injured. A meniscus injury is the most common serious knee injury. Complete tears of the meniscus can accelerate the aging process, and arthritis commonly develops (Brindle, 2001).

The most important structure in the knee is called articular (hyaline) cartilage, which is the spongy lining surface covering the articulating (opposing) surfaces of the femur, patella, and tibia. Articular cartilage receives nutrients by the pumping action of the knee. If we lose this spongy material, it may be replaced by another less resistant variety called fibrocartilage. More commonly, the articular cartilage is not replaced and eventually bone opposes bone, forming arthritis (Musumeci, 2014). Thus, we want to be very careful with pain about the knee, as an injury can lead to debilitating consequences.

Injuries to the ligaments of the knee in the runner are usually caused by falls or twisting events where the foot is caught and the ligaments are then stressed due to the stretching and finally the breaking point. Most ligament injuries are not severe. Even in less severe injuries, the clinical healing period is not short, usually taking four to six weeks. Rehabilitation time after the healing period may be another four to six weeks before running is permitted. Total time away from running may total two to three months, which is a disaster for the runner. In more severe ligament injuries with swelling within 24 to 48 hours of the initial injury and no fracture, MRI is performed and if positive for ACL or meniscus injury, arthroscopy and ligament testing under anesthesia is recommended. As I mentioned in Article 1, arthroscopy is a technique where a small microscope is inserted into the knee. It should be performed by an orthopaedic surgeon with extensive arthroscopic experience. The knee is inspected and surgery is performed through a small hole. In the case of the runner, arthroscopic surgery may permit him to return to running sooner. When the ligament injury is more severe and a total break in the ligament is found, then more major surgery is recommended. Major knee surgery usually means one or more large incisions about the knee. The ligaments are quite extensive, and the best results are seen after open

repairs. There are several sophisticated techniques available to the orthopaedic surgeon in repairing or replacing ligaments. When a complete rupture of the ligament is diagnosed, the ligament is repaired with suture material, and occasionally, tendons or artificial grafts are employed to reinforce the repaired ligament. The tendons are stronger than the damaged ligaments and offer reinforcement to the original damaged ligament. The reinforcing principle is based on the fact that torn ligaments heal with scar tissue, which is initially weaker than the original ligament (Hindocha, 2012). With time, usually several months, the scar tissue will become stronger and less resistant to stretching. We all know that scars on our skin stretch with time.The principle is the same with the scar formed at the ruptured/repaired ligament. It will stretch with time if not protected. The graft or transfer then really reinforces the scar, while the scar becomes mature and strong.

If the ACL is torn, then a reconstructive procedure is performed replacing the ruptured ACL with autograft, i.e., the patient's own tissues such as patellar tendon or hamstring. Sometimes, a allograft is used, i.e., someone else's tissues from a cadaver. I favor the use of the autograft usually, as the patellar tendon is one of the strongest constructs available.

Occasionally, the meniscus is damaged with the ligament. Current philosophy dictates that every attempt is made to repair damaged menisci. However, many damaged menisci are irreparable and are completely or partially removed (Sandmann, 2013). When ligaments and menisci are damaged at the same time, the best time for repair of both structures is within seven to ten days of the original injury. Remember, as stated earlier, the menisci are now thought to be the main protectors against premature degenerative arthritis of the knee and must be protected.

Now that the necessary arthroscopic and/or major ligament surgery is done what does this mean to the runner? It usually means six to twelve months until he is able to return to normal running. After the cast comes off at six to eight weeks, a brace or external support is worn for at least six months, preferably twelve months. “Why so long?” is a common question. The answer is simple. The healing process is not

theoretically and actually complete for one year after the injury/surgery, i.e., the healing tissue or scar is not strong enough to permit excessive activity for this period. Also, during the post surgical period, extensive physical therapy is initiated to regain lost strength and motion. The muscles about the knee become atrophic without normal use and require rehabilitation to return to normal. Many patients ask, “Why strengthen the muscles when the ligament or meniscus is torn?” The answer is again simple. Approximately fifty percent of the protection or strength of the knee joint is supplied by the stiffening ability of the muscles that surround and move the knee. Without adequate strength, we lose the protective effect of the knee muscles on the knee. A knee brace will also be supplied.

What can the runner do to ready himself to return to running? How can he stay fit? I recommend, after the initial surgical period, several modalities to maintain cardiovascular fitness:

Crutch walking or crutch running is permitted with the aid and instruction of the therapist. The runner is permitted to maintain a gentle pace with full weight bearing at three weeks from the time of his surgery. Swimming is also permitted and is probably the best exercise. A gentle swimming program is instituted, emphasizing upper arm work, pool walking, and gentle swimming to stimulate the cardiovascular system. Regular walking with a knee brace is permitted. Jogging is not permitted for at least three months, preferably twelve months.

Now, let’s discuss the case where the runner twists the knee, and there is pain at the joint with no swelling or very little swelling, and the ligaments are found to be normal on the physical exam. The most likely diagnosis is a torn meniscus. (For brevity’s sake we will not discuss other possible causes.) With an isolated torn meniscus, I feel there are two options. One is to recommend arthroscopic surgery to delineate the degree of injury and potentially operate on the meniscus, as it can be sewn together given the right type of tear in a vascular area. The second option is to wait and see what happens. If there is no swelling and no mechanical block or hindrance to the normal motion of the knee, I favor waiting and watching. Why? The answer is that many torn menisci will heal

without surgery. They heal because the blood supply is adequate to the area of the tear. I usually wait at least six weeks, especially when the patient is obviously improving. However, if a mechanical block or excessive pain with swelling develops, then I favor arthroscopy to make a diagnosis and treat the tear. Usually, a small part of the torn meniscus is removed. If the torn meniscus is left untreated in the wrong location, it can act as an abrasive and can severely damage the interior of the knee producing premature degenerative arthritis. Potentially, the torn meniscus can be sutured together if the tear is in the right location. If the meniscus is repaired, a brace is worn for four weeks, followed by a three- to four-week rehabilitation period. However, the success rate of healing with suture repair is around 80%. It the meniscus does not heal and the patient is still symptomatic, a second arthroscopy is performed and usually part of the meniscus is removed.

With an isolated meniscus injury amenable to arthroscopic surgery by an experienced surgeon the recovery period can be short, especially compared to open techniques. Recent scientific literature suggests that the least amount of torn meniscus should be removed, leaving the remainder of the meniscus to continue its protective weight bearing function (Cavanaugh, 2012). Depending on the location of the tear, partial meniscus regeneration is possible, however, the site of the tear must be close to the blood supply. After the surgery procedure patients return to running within six to eight weeks, depending on the severity of the injury. A licensed physical therapist or trainer recommends the runner strengthening exercises to enhance the recovery period.

## Platelet Rich Plasma

Platelet Rich Plasma (PRP) is a new technique we are using to promote faster and better healing after knee surgery especially in meniscus surgery. As there is evidence that PRP may accelerate the healing of residual meniscus tears in the knee. **Platelets** consist of proteins, cytokines, and other bioactive factors located in the peripheral blood. They contribute to the regulation of homeostasis and promote wound repair. **Plasma** contains clotting factors, proteins and ions. Recent literature suggests that for optimal therapeutic purposes physicians should use a platelet concentration of 1

million platelets per microliter and a 3- to 5-fold increase in growth factor concentration and cytokines" (Mehta, 2008). In the plasma, numerous proteins are contained, such as insulin-like growth factor (IGF), platelet-derived growth factor (PDGF), platelet factor interleukin (IL), platelet-derived angiogenesis factor (PDAF), epidermal growth factor (EGF), transforming growth factor (TGF), vascular endothelial growth factor (VEGF), and fibronectin (Lubkowska, 2012). In the dense granules of platelets such bioactive factors are also found, specifically calcium, dopamine, serotonin, histamine, and adenosine. Such non-growth bioactive factors control inflammation, proliferation, and remodeling in the process of wound healing (Boswell, 2012). PRP is also used in an attempt to slow down the arthritic degeneration process, preserve chondrocytes which are cartilage cells that line the joint. PRP also stimulates ligament, tendon tissue repair, and meniscal healing.

German and Swiss scientists confirmed that PRP percutaneous injections release therapeutic properties for pain relief and promote the decrease in grade 2 meniscal lesions progression in patients over the 6 months time period (Blanke, 2015).

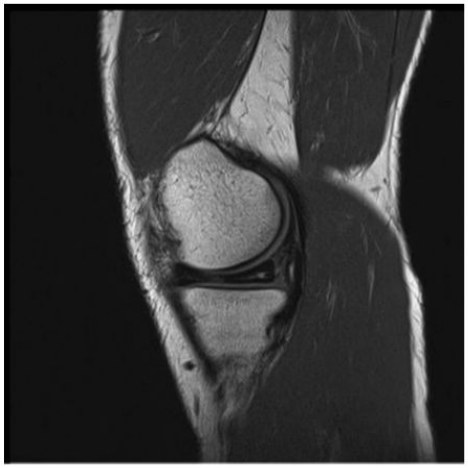

Figure 1. Meniscal lesion before injections (patient 7).

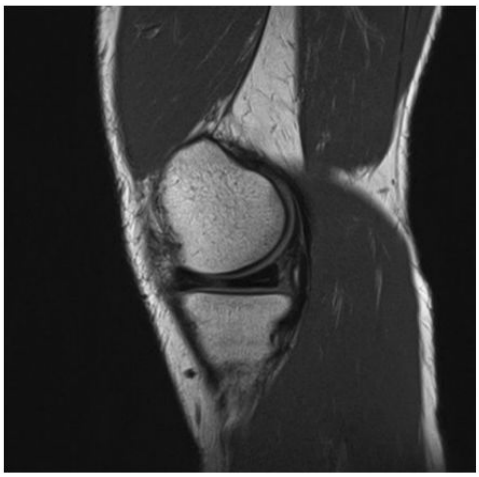

Figure 2. Meniscal lesion 6 months after injections (patient 7).

**Image Source:** Blanke, F., *Percutaneous injections of Platelet Rich Plasma for treatment of intrasubstance meniscal lesions.* Muscles, Ligaments and Tendons Journal 2015;5 (3):162-166

Another study on animals treated with PRP injections for meniscal tissue defects revealed the curative properties of PRP of the inner, avascular meniscus. Subjects treated with PRP showed significantly greater scores for the number of fibro-chondrocytes and production of extracellular matrix compared to the control group (Ishida, 2007). Moreover, several studies suggest the additive effect of PRP-containing growth factors for increased meniscal cells activity and augmentation of meniscal repair and healing during horizontal cleavage meniscal tears repaired via an open surgery. A team of surgeons from France in one such study invited 17 patients for open meniscal repair surgery of horizontal tears extending into the avascular zone-Group 1, and additional 17 patients underwent same surgery with introduction of PRP injections at the end of the open meniscal repair-Group 2 (De Chou, 2015).

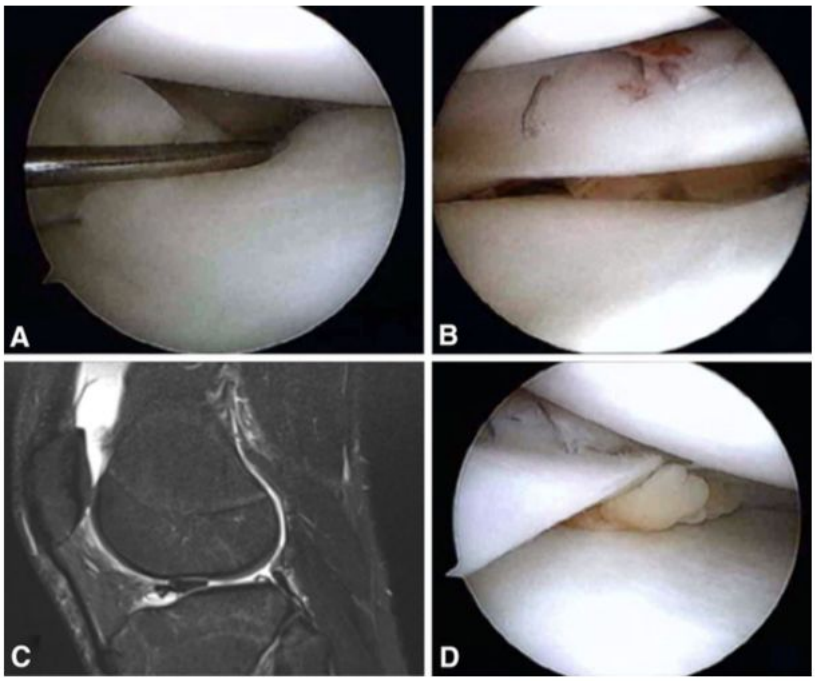


**Fig. 1A–D** (**A**) An intraoperative image of a displaced meniscus tear is shown. (**B**) An inside-out repair is performed with PRP augmentation. (**C**) MRI demonstrates a bucket-handle lateral meniscus tear and (**D**) PRP augmentation of this meniscus repair.

**Source:**Griffin, J.W., et al. *Platelet-rich Plasma in Meniscal Repair: Does Augmentation Improve Surgical Outcomes?* Clinical Orthopedics and Related Research. 2015. 472: 1665-1672.

The MRI results of this study demonstrated that 5 patients from Gr 2 had full disappearance of hypersignal within the repaired meniscus at 24 months postoperative time-frame (De Chou, 2015). Such evidence suggest the additive effect of PRP to improve outcome results after open meniscal repair surgery. Due to patient's individual meniscal injury variations, PRP can be injected in the knee at the time of surgery or fairly soon after surgery. Meta-analysis of PRP technology confirms that PRP treatment promotes more robust healing in an attempt to preserve the meniscus tissue and to provide faster and better healing of the residual meniscus and knee joint tissues, including the ACL and PCL ligaments.

Currently health insurance coverage does not pay for PRP treatment. We will discuss various payment options to receive this treatment if it is felt to be advantageous to your condition(s).

## Hyaluronic Acid

Hyaluronic Acid (HA) is also used in either post-surgery cases or in non-surgical cases applied within the joint to ameliorate arthritis-associated pain.

Hyaluronate or hyaluronan is contained in cartilage and the synovial fluid. HA is a large viscoelastic glycosaminoglycan molecule that is contained in synovial fluid and cartilage matrix. Chondrocytes (cartilage cells), fibroblasts (collagen producing cell) and the synovial cells all secrete HA into the joint. HA Is approved by the The Food and Drug Administration (FDA) and is either generated from bacterial fermentation in vitro or from harvested rooster combs. Such HA contain Hylan G-F 20, sodium hyaluronate, and high-molecular weight hyaluronan (McArthur, 2012). In healthy patients, synovial fluid contains a normal HA amount or concentration and serves as a viscous lubricant for healthy knee movements, much like a lubricant in a car.

There is a decreased amount of HA in the synovial fluid of OA patients (Trigkilidas, 2013). In OA patients, where the synovial membrane secretes abnormal proteases, free radicals, and cytokines which leads to the disruption of organic HA synthesis and contributes toward the progression of OA (Brockmeier, 2006). A healthy

level of HA is crucial in providing anti-inflammatory properties to regulate cartilage homeostasis, and to slow the chondrocyte apoptosis (cell death) which occurs with OA.

## Stem Cell Technology

Mesenchymal stem cells (MSCs) exhibit properties both in multipotent differentiation (cells that may develop into more than one cell type) and immunomodulation (immune response alteration to a desired level) (Wyles, 2015). Based on these unique properties, stem cells have the therapeutic potential to treat osteoarthritis (OA). Since 1990 there have been promising clinical trial results from the U.S., India, Germany, Singapore, and Iran that the intra-joint injection of MSCs can be an effective therapy for treating OA (Sarabi, 2016). Furthermore, clinical trials in Spain have illustrated MSCs injected with more advanced stem cells technology for localized treatment of OA, using bioabsorbable material (hydrogel) as a vehicle carrier (Lamo-Espinosa, 2016). Many of these clinical trials were performed with bone marrow derived MSCs, but other MSCs derived from adipose and the umbilical cord can also have great potential to treat OA, as they share similar characteristics to bone marrow MSCs (Uth, 2014). In general, adipose and umbilical cord MSCs have a higher culture life expansion potential (have a higher duration to secrete regenerative factors) and may be more readily available, but not necessarily exhibit strong therapeutic regenerative (ability to heal damaged tissue) potential as BM-MSCs.

Interestingly, both allogeneic (donor cells) and autologous (host cells) MSCs have therapeutic potential to treat OA, and it may be that allogeneic MSCs may be a more convenient “off-the-shelf” therapy to utilize due to the immune-evasive nature of MSCs lacking HLA antigens (does not stimulate the host immune response as a foreign substance) and other co-stimulatory molecules to elicit an immune rejection response (Gupta, 2012). Lastly, dosages from 10–100 million MSCs per intra-articular injection are recommended for a therapeutic response to treat OA corresponding to the severity of disease or injury, and the patient’s Body Mass Index (BMI) (Lamo-Espinosa, 2016), but potentially a smaller dosage of MSCs could be used in a scaffold (hydrogel) to have a stronger localized treatment effect.

I consider the stem cell technology as a new technique in orthopedic surgery, aimed to rejuvenate joint and body parts. We are currently researching the use of stem cell techniques in joints, muscles, and tendons. It appears based on the current literature that the technique is promising. We are moving forward, starting to apply the stem cell technology in practice. And I am currently using advanced arthroscopic techniques to stimulate the body's own stem cells, while performing various complex surgical arthroscopic procedures.

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