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Case Report

Ruptured ACL Repaired with Autologous Platelet-Rich Plasma and Bone Marrow Aspirate Concentrate

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Abstract

The anterior cruciate ligament (ACL) is a major stabilizing ligament in the knee. Rupture of the ACL can lead to significant pain, functional limitations and accelerated joint degeneration due to knee instability. Because of the inherent limitations in spontaneous healing, repair of this structure has traditionally involved surgical reconstruction using a graft. Surgical repair is a valuable technique but has a prolonged recovery and known sequelae of increased joint stress because of mechanical alterations. In recent years, use of percutaneous, autologous biologic therapies have been suggested for repair of ACL tears that retain close approximation of the proximal and distal fibers. We present a case of ACL repair using bone marrow aspirate concentrate and platelet-rich plasma in a situation where the ruptured ACL fibers showed significant separation.

Keywords: *ACL Rupture; ACL Repair; BMAC; BMC; PRP; Regenerative Medicine*

Abbreviations

ACL: Anterior Cruciate Ligament; BMAC: Bone Marrow Aspirate Concentrate; MRI: Magnetic Resonance Imaging; PRP: Platelet-Rich Plasma

Introduction

The anterior cruciate ligament (ACL) is a major stabilizing ligament in the knee. Rupture of the ACL can lead to significant pain, functional deficits and accelerated joint degeneration due to knee instability [8]. Tissues such as cartilage, tendons and ligaments have inherent limitations in healing and regeneration. This may be, in part, due to the avascular nature of these tissues. Subsequently, ACL tears and ruptures are not thought to routinely demonstrate spontaneous healing [5]. Because of this, ACL tears can lead to a chronically deficient structure with the potential for increased tissue damage. Surgical reconstruction is the current gold standard for ruptured ACLs [10]. This is a valuable technique where a surgically implanted graft generally provides improved stability and joint protection. This therapy, however, it is not without potential sequelae. This surgery can adversely affect joint biomechanics through alteration of muscle balance and altered proprioception from impaired mechanoreceptors [3,4,12,13]. These changes can lead to impaired function along with the increased potential for early and accelerated degenerative changes [4,7,914].

The current paradigm creates a treatment gap between non-treatment which leads to chronic instability, and surgical repair which precipitates biomechanical dysfunctions. Both paths increase the potential for arthritic changes. More recently, the use of Orth biologic therapies have been proposed to help fill this treatment gap. With this strategy, percutaneous injections of biologic agents, such as autologous platelet rich plasma (PRP) and/or bone marrow aspirate concentrate (BMAC), have been used to promote tissue repair in tissues that otherwise have a limited capacity for spontaneous healing [1,11]. These autologous biologic products can be used to induce, or promote, tissue healing through focal delivery of growth factors, cytokines and RNA. Ligaments, such as the ACL, otherwise have extremely limited delivery of these essential proteins and growth factors because of the avascular nature of the tissue.

Centeno., *et al*. demonstrated repair of ACL ruptures that have close approximation of the torn fibers [1]. This study had an inclusion criteria of ACL ruptures with less than 1 cm of retraction between the ends of the ruptured segments. We present a case of ACL repair using percutaneous injections of BMAC/PRP in a situation where the ruptured ACL fibers showed greater than 20 mm of retraction.

Case Report

A 29-year-old male presented to our clinic with right knee pain that began after a fall while wakeboarding. On examination, he had significant right knee swelling and stiffness. There was pain with passive and active motion. Knee stability could not be full assessed due to swelling. He had tenderness to palpation of the anteromedial knee, medial joint-line and pes anserine. He was neurologically intact.

The patient was prescribed an ACL brace and sent for an MRI. The MRI revealed a complete rupture of the ACL with > 20 mm separation of the free fragments (Figures 1, 3a). He was also noted to have medial (Figure 4a, b) and lateral meniscal tears, a sprain of the MCL, along with a focal impaction fracture of the lateral femoral condyle (Figure 3b).

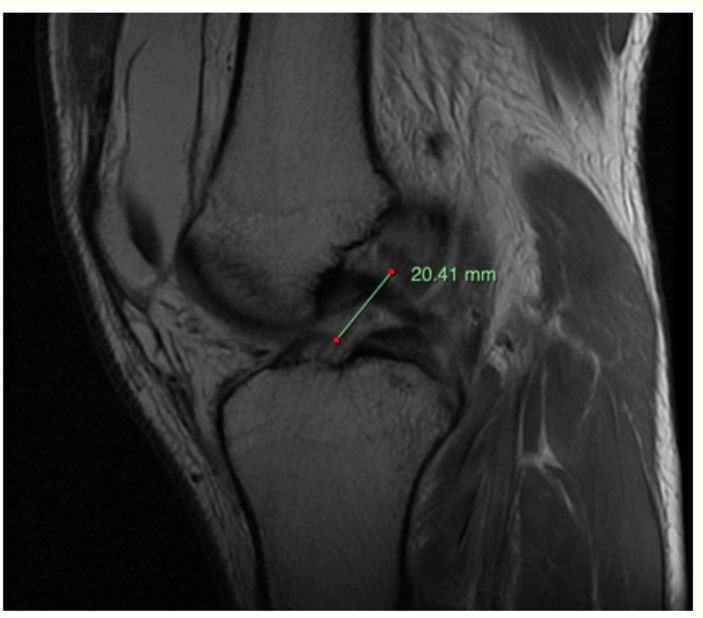

Figure 1: *Sagittal PD MRI slice showing a grade III ACL tear with over 20mm of retraction between the proximal and distal segments.*

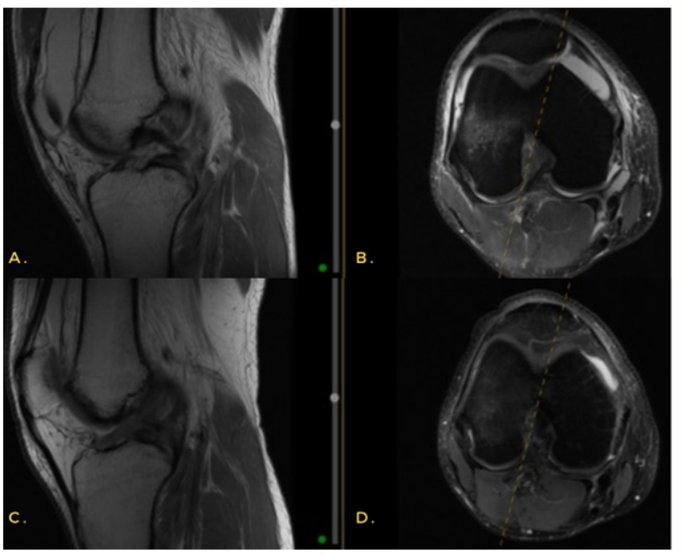

Figure 2: *Initial sagittal (a) and axial (b) PD MRI images show complete ACL rupture along with impaction fracture of the lateral femoral condyle. Post-procedure sagittal (c) and axial (d) PD MRI images show restoration of ACL fibers and interval healing of the impaction fracture.*

On follow-up examination, the swelling was somewhat reduced and he was found to have significant laxity of the ACL > MCL. We had a thorough discussion over treatment options including watchful waiting with no treatment, bracing, physical therapy, medications for symptomatic relief, surgical consult for ACL repair and regenerative medicine using percutaneous BMAC/PRP.

The patient had a past medical history significant for a left ACL rupture and medial meniscal tear. He underwent an ACL reconstruction along with meniscectomy. He had a prolonged recovery and, what he considered, a suboptimal clinical outcome due to ongoing pain and instability. Because of this, he wanted to explore non-surgical options for his right knee injury. The patient opted to pursue regenerative medicine with BMAC/PRP in hopes of a non-surgical repair. He also hoped this therapy would help promote meniscal repair and improve the outcomes of any potential surgery if the orthobiologic treatment failed. He understood this was an unproven technique that is considered experimental. We agreed to pursue two treatments followed by a repeat MRI to monitor progress.

The patient underwent the first injection of BMAC/PRP approximately 2wks after his initial injury. 120 cc of fresh, whole venous blood was collected and processed in our in-house laboratory to produce 18 mL of PRP at a 10x concentration. This was diluted, with platelet-poor plasma, to a 5x concentration for treatment. The PRP is prepared using a double centrifugation method in our in-house laboratory similar to that described by Dhurat., *et al* [2]. Under the MARSPILL classification described by Lana., *et al.* our PRP preparation would be considered *HA-/RBC-P/Sp2/Plt 4-6/G+/Lc-R/A*-[6]. 50 cc of bone marrow was extracted from the patient's posterior iliac crest using fluoroscopic guidance. This was concentrated to 8 mL using direct centrifugation and the BMAC was injected in the same procedure. Under fluoroscopic-guidance, the ACL was targeted using a medial sub-patellar intraarticular approach. Contrast was noted to infiltrate the distal portion of the ACL stump without evidence of flow to the proximal segment (Figure 4a). This segment was injected with 1 mL of BMAC/PRP. The proximal segment was then targeted and injected in a similar manner (Figure 4b). After this, the remaining intraarticular joint was injected with 4 mL of PRP and 4 mL of BMAC. Additionally, injections of PRP and BMAC were injected along the medial tibial plateau and pes anserine.

A second BMAC/PRP treatment was performed in a similar manner 3 weeks later. The patient tolerated these procedures well. He had expected, moderate post-procedure soreness for about 5 days after the injections. This was controlled with a short course of hydrocodone/acetaminophen. There were no other adverse effects.

A repeat MRI was performed 4 weeks after the second BMAC/PRP treatment. This study showed interval healing of the anterior cruciate ligament with continuous fibers seen throughout its course (Figure 2c). Also noted, was interval healing of the posterior horn of the medial meniscus and MCL (Figure 3c, 3d) along with nearly resolved compression fracture and improved joint effusion (Figure 2d). He was found to have an increased prominence of the tear in the central posterior horn of the lateral meniscus. Because of the latter finding, he opted to pursue further regenerative medicine treatments in hopes of promoting further healing of the menisci. We performed one additional BMAC/PRP procedure. Follow-up MRI was not performed, but the patient reported improved symptoms. Upon follow-up examination the ACL (and MCL) showed good ligamentous stability and the patient had very little tenderness to palpation throughout the knee. His pre-procedure WOMAC score was 54.2% and his final WOMAC was 7.3%. He had returned to most functional activities without limitations. Follow-up was left to an as needed basis.

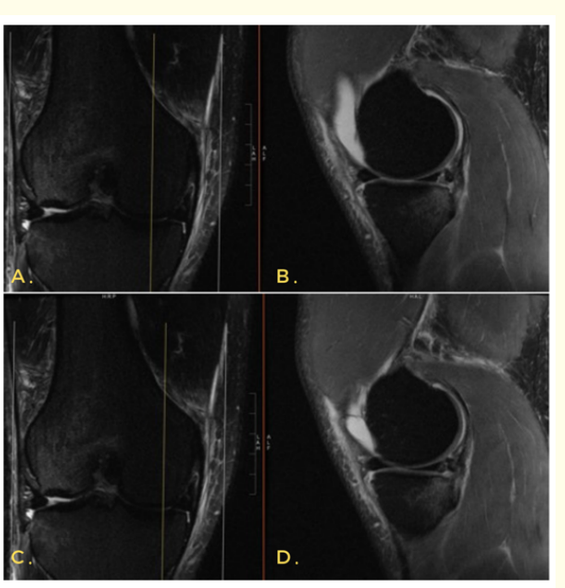

Figure 3: *Initial coronal T2 (a) and sagittal PD (b) MRI images show a complex predominantly vertical tear of the posterior horn of the medial meniscus. Post-procedure coronal T2 (c) and sagittal PD (d) MRI images again note a tear of the posterior horn of the medial meniscus, however the previously seen fluid intensity of the tear is now intermediate density. Intermediate signal intensity is now seen to nearly continuously bridge.*

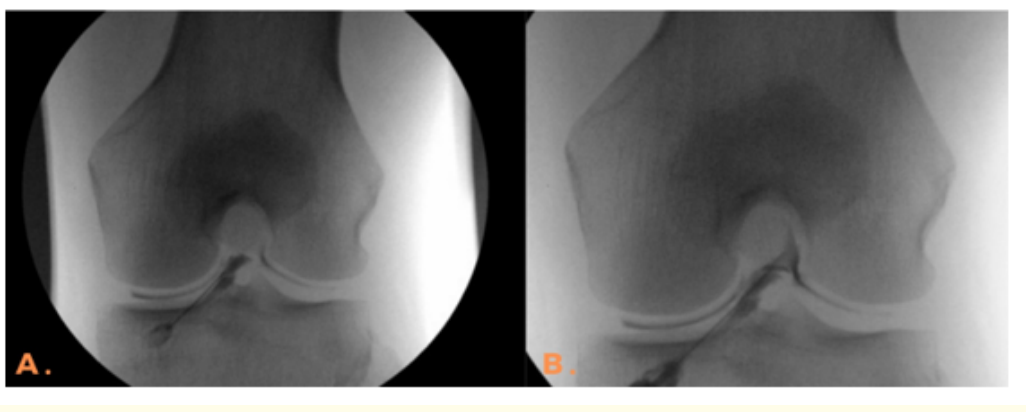

Figure 4: *Images of fluoroscopically-guided percutaneous injections of the distal (a) and proximal (b) segments of the ACL.*

Discussion

This case demonstrates excellent structural improvements with percutaneous applications of autologous BMAC/PRP to the damaged tissues in the knee. The repair of the ruptured ACL was a particularly notable finding given the paucity of evidence for spontaneous healing or repair of ACL ruptures with significant retraction between the proximal and distal segments.

Treatment with autologous BMAC and PRP is a same day procedure intended to accentuate, or initiate, the body's natural healing processes. The concentrated platelets and bone marrow aspirate that is injected can be considered a more robust version of extravagated bone marrow and platelets that occurs with traumatic knee injuries. Although there is expected post-procedure soreness, this treatment is considered very safe and generally does not exclude other treatment options if the treatment fails.

Conclusion

Surgical reconstruction remains the gold standard for ACL ruptures. The potential sequelae of this surgery, however, should be taken into consideration when discussing treatment options with the patient. This case illustrates the need for further research evaluating the use of biologic treatments for orthopedic injuries such as ACL repair. Regenerative medicine treatment of ACL ruptures may help fill the treatment gap between non-treatment, or bracing alone, and surgical reconstruction.

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