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Grand Rounds from HSS

MANAGEMENT OF COMPLEX CASES

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FROM THE EDITOR

This volume of *Grand Rounds from HSS* focuses on the management of severe knee injuries. Three cases highlighting the importance of recognizing all clinically significant pathology encountered with knee injury, and the combination of complex reconstructive procedures necessary to restore comfort and the possibility of durable knee function.

In the first case, **Scott Rodeo, MD,** describes his two-stage management of a 51-year-old female with compromising connective tissue laxity and an unstable knee after failed anterior cruciate ligament reconstruction. Effectively restoring knee function required much more than anterior cruciate ligament reconstruction and is achieved by understanding and sequentially addressing the combination of bone and soft tissue deficiencies necessary to effectively establish a stable knee.

Case two involves a young, powerful elite athlete. **Robert Marx, MD,** and **Aaron Daluiski, MD,** enable this motivated athlete, devastated by a knee dislocation resulting in multi-ligament and peroneal nerve injury, to not only recover knee stability and nerve function but to realize his ambitions to perform at a high level in college baseball.

In the third case, a wakeboarding injury resulted in posterior cruciate ligament tear in a 30-year-old female. Conservative care failed to relieve pain and instability due to a detached and ultimately extruded posterior root of the medial meniscus. The patient was referred to **Gregory DiFelice, MD,** who used minimally invasive techniques to reconstruct the torn posterior cruciate ligament and repair the medial meniscus.

This and past volumes of *Grand Rounds from Hospital for Special Surgery/Management of Complex Cases* are available on the HSS website, **www.hss.edu/complexcases**, where you will find additional images and references as well as links to related articles. We hope you find these cases to be of interest and the principles presented informative. Comments may be emailed to **complexcases@hss.edu** and are always welcome.

— Edward C. Jones, MD, MA, Assistant Attending Orthopaedic Surgeon

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CASE 1

Revision Anterior Cruciate Ligament Reconstruction in the Setting of Underlying Connective Tissue Laxity

Case presented by Scott Rodeo, MD and Brooks R. Crowe, BA

FIGURE 1

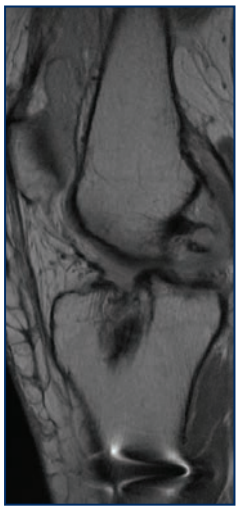

FIGURE 2

FIGURE 3

FIGURE 4

CASE REPORT: The case presented here illustrates challenges in revision ligament reconstruction in a patient with underlying connective tissue laxity. This case illustrates various issues that should be considered in patients with failed ligament reconstruction and strategies for management.

A 51-year-old female with a past medical history of mixed connective tissue disorder consistent with lupus and rheumatoid arthritis presented with right knee instability. Her inflammatory condition was managed with Golimumab (TNF-α blocker), prednisone, and plaquenil. She presented with recurrent knee instability after having undergone ACL reconstruction in 2009 using semitendonosis/gracilis tendon autograft.

On presentation, the patient was experiencing instability and buckling of the right knee along with medial joint pain. Examination revealed anterior cruciate ligament insufficiency in the setting of generalized ligamentous laxity, as evidenced by recurvatum of approximately 10°, with both varus and valgus laxity and patellar hypermobility. Conventional radiographs demonstrated early degenerative changes with tunnel enlargement from prior ACL reconstruction (Figure 1). Axial alignment was neutral and posterior tibial slope was not excessive. MRI demonstrated disruption of the ACL graft, mild anterior tibial translation, and a pronounced inflammatory synovitis (Figures 2 and 3).

Recurrent knee instability persisted despite a comprehensive strengthening program so it was elected to proceed with a two-stage revision ligament reconstruction. The first stage involved bone grafting of the femoral and tibial tunnels using demineralized cortical bone fibers (Musculoskeletal Transplant Foundation, Edison NJ) mixed with bone marrow aspirate. Graft incorporation and new bone formation in the tunnels is usually evident at four to five months. In this case the patient elected to proceed with revision ligament reconstruction twelve months after bone grafting of the femoral and tibial tunnels. Exam under anesthesia revealed a 3+ pivot shift, 3B Lachman, and 2+ valgus laxity. ACL reconstruction was done using Achilles tendon allograft and medial collateral ligament reconstruction was carried out using semitendinosus tendon allograft. Given the significant laxity and the high-grade pivot shift, it was elected to augment the ACL reconstruction with an anterolateral ligament (ALL) reconstruction. This was done using semitendinosus allograft. Attachment sites for the MCL and ALL reconstruction grafts were identified using both intraoperative fluoroscopy as well as isometry testing (Figure 4). Upon completion, exam revealed negative anterior drawer, Lachman, and pivot shift and restored valgus stability. At early 4-month follow-up, the patient is well satisfied with excellent stability and progressive function.

FIGURE 1: Pre-operative radiograph demonstrating ACL tunnel enlargement.

FIGURE 2: Pre-operative MRI showing failed ACL reconstruction, anterior tibial subluxation, and synovitis.

FIGURE 3: Pre-operative MRI showing femoral ACL tunnel widening.

FIGURE 4: Post-operative radiograph demonstrating hardware used for graft fixation (ACL, MCL, ALL). Metallic hardware was used due to relative osteopenia.

DISCUSSION: This case demonstrates several important principles related to revision ACL reconstruction. The first is the two-stage approach with bone tunnel grafting prior to revision surgery. This allows accurate tunnel placement at the time of revision surgery. The second point is the importance of identifying and addressing other laxity patterns that may co-exist with ACL insufficiency. Excessive valgus laxity leads to increased stress on an ACL graft. Battaglia et al showed that the resultant load on the ACL was increased at 30° flexion with valgus load and internal rotation torque in a partial MCL tear cadaveric model [1]. Such additional laxity patterns should be considered as causes for ACL graft failure that should be addressed with revision surgery.

The last important point illustrated by this case is the potential role of the anterolateral ligament of the knee (ALL). Recent studies have described the anatomy and function of the ALL. This structure has a role in controlling anterior translation and internal rotation of the tibia, and may play a role in control-

Continued on page 5

CASE 2

Multi-Ligament Knee Injury with Common Peroneal Nerve Palsy

Case presented by Robert G. Marx, MD, MSc, FRCSC, and Aaron Daluiski, MD

CASE REPORT: An 18-year-old high school quarterback playing in his final game prior to starting his collegiate baseball career on a scholarship was tackled in the open field. He had his left foot planted and his knee gave way. Referred for consultation by his local orthopedic surgeon one month after the injury, and generally in excellent health, the patient was 6' 4" and weighed 225 pounds. There was a large effusion in the left knee with motion from 0 to 130 degrees. The knee was nontender. There was gross AP translation with the Lachman test. The medial side was stable but the lateral side opened grossly in full extension and at 30° of flexion. Motor function in the distribution of the common peroneal nerve was absent. Sensation in the distribution of the deep and superficial peroneal nerves was decreased but the patient could detect light touch in those distributions. Tibial nerve motor function and sensation were normal. Pedal pulses were normal.

MRI demonstrated obvious bi-cruciate disruption. There was avulsion of the long head of the biceps and iliotibial band. The structures of the posterior lateral corner were torn, including the fibular collateral ligament and popliteus tendon (Figure 1). MRI indicated large areas of bone contusion on the anterior medial femoral condyle and tibial plateau. The patient had an EMG which demonstrated no peroneal nerve muscle activation.

The patient was taken to the operating room for anterior and posterior cruciate ligament as well as posterolateral corner reconstruction, including biceps tendon repair by one surgeon (RGM). During the same procedure, another surgeon (AD) performed neurolysis of the common peroneal nerve.

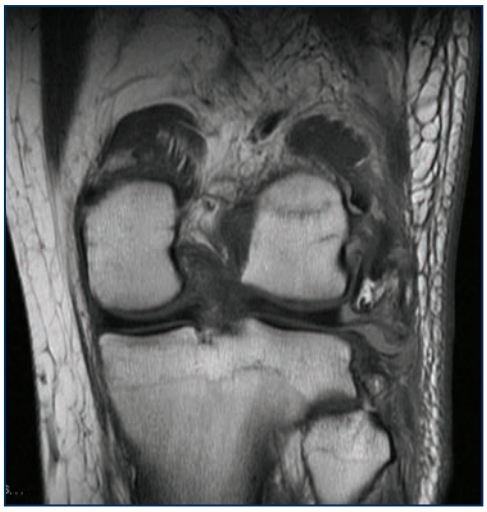

FIGURE 1

FIGURE 1: Coronal MRI demonstrating bi-cruciate and lateral side disruptions.

FIGURE 2: Lateral side reconstruction using a single Achilles tendon allograft.

FIGURE 3: Lateral x-ray left knee after reconstruction.

FIGURE 4: One year after surgery the patient began fielding and batting practice.

Single-bundle Achilles tendon allografts were used for both ACL and PCL reconstructions, with an arthroscopic, trans-tibial PCL technique. PCL tensioning was performed using a tensioning boot as described by Fanelli [1]. Lateral side reconstruction was performed using the anatomic technique described by Schechinger et al. with a single Achilles tendon allograft [2] (Figure 2). The bone plug of the Achilles was inserted in the popliteus origin at the anterior aspect of the popliteus sulcus. The soft tissue portion of the allograft was passed down through the popliteus hiatus and then from posteromedial to anterolateral through a 7-mm drill-hole in the fibular head. The graft was then passed back up under the iliotibial band, and the isometric point just proximal and posterior to the lateral epicondyle was identified by inserting a guide pin. With range of motion from zero to ninety degrees of flexion, the graft length was unchanged when measured to the pin. A 7-mm tunnel was reamed over the pin and the graft was inserted into the tunnel. Lastly, a posterolateral capsular plication was performed with multiple figure-of-eight # 2 ethibond sutures. Graft fixation was performed with metal screws for all grafts (Figure 3).

The peroneal nerve was extremely scarred to the surrounding tissue and extensive, meticulous common peroneal neurolysis was performed.

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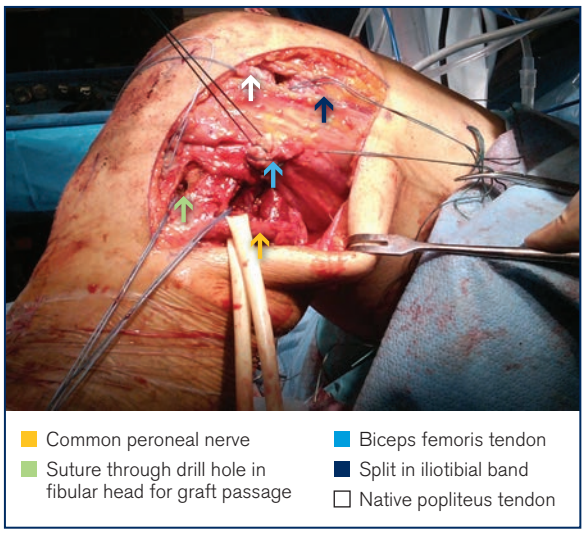

FIGURE 2

FIGURE 3

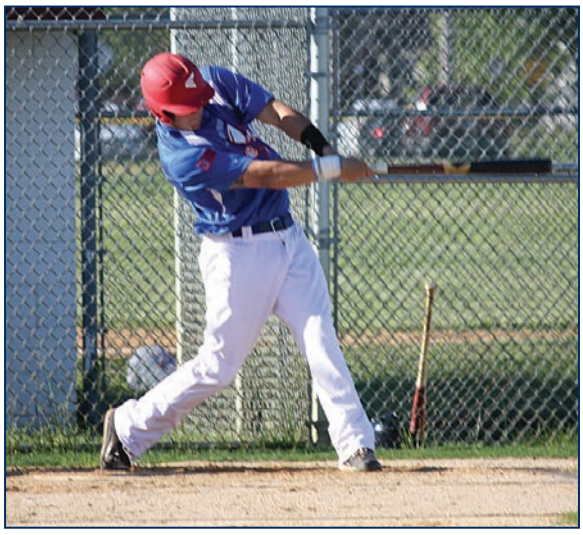

FIGURE 4

CASE 3

Posterior Cruciate Ligament Tear with Detachment and Extrusion of the Posterior Root of the Medial Meniscus

Case presented by Gregory S. DiFelice, MD, and Jacob Calcei, MD

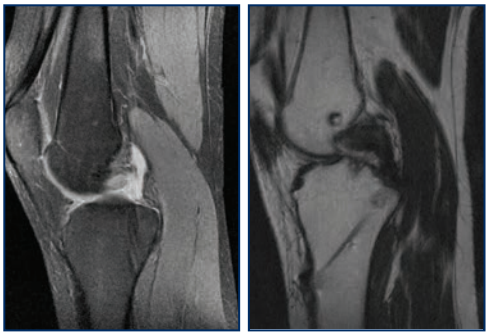

FIGURE 1: Pre-operative (left) and post-operative (right) sagittal MRI images. On the left, the proton density MRI image shows a high-grade chronic tear of the PCL. The post-operative T1-weighted MRI shows the PCL allograft anchored with a well-placed tightrope through the tibia and interference screw into the femur.

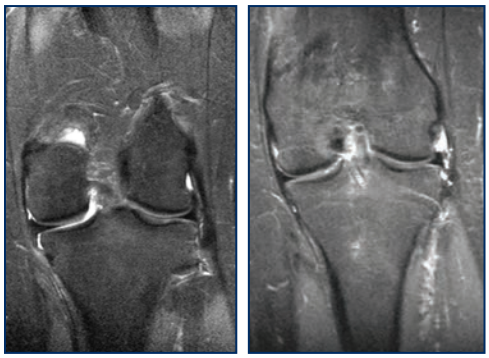

FIGURE 2: Pre-operative (left) and post-operative (right) coronal STIR MRI images. The injury MRI shows extrusion of the medial meniscus consistent with root detachment. The post-repair image on the right shows no evidence of meniscal extrusion.

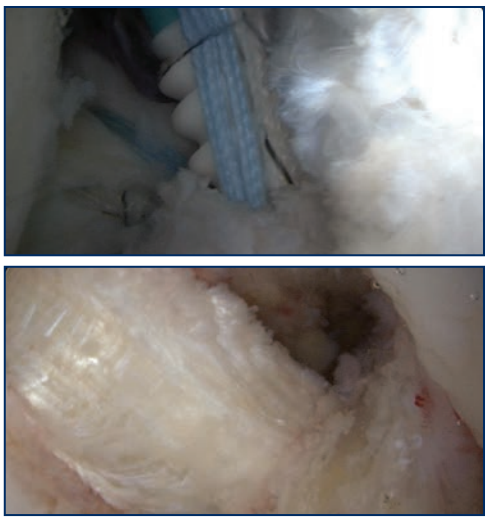

FIGURE 3: Intraoperative images showing the suture anchor fixation of the medial meniscal root (top) and the well-placed PCL allograft (bottom).

CASE REPORT: An otherwise healthy, 30-year-old female presented for a second opinion with complaints of persistent pain and instability in her left knee 5 months after a wakeboarding injury. She had no prior injuries or surgeries to the left knee. An MRI of the left knee obtained soon after her injury (Figures 1 and 2) revealed a high grade PCL tear, detachment of the posterior horn of the medial meniscus, and a mildly depressed impaction fracture of the anterior tibial plateau extending to the proximal tibial diaphysis. Following her injury the patient had been treated conservatively with a period of immobilization, pain control and outpatient physical therapy, resulting in little improvement of her symptoms.

On initial presentation in the office, the patient reported continued pain and a sensation of instability in her left knee, which had been limiting her in her daily activities. Her symptoms were most severe with jogging, although she was able to use a stationary bike. She denied any significant swelling, clicking or locking in the injured knee, and was not taking medications for pain.

Physical examination revealed a healthy, well-developed young woman. She ambulated with a normal gait and had normal alignment of her spine and lower extremities. On her knee exam, she was noted to have no effusion, full ROM, and an otherwise normal exam except for a dramatically (3+) positive posterior drawer test. A repeat MRI was obtained (Figures 1 and 2), and confirmed a complete, chronic rupture of the posterior cruciate ligament and medial meniscus posterior root tear with extrusion.

Given the patient's persistent instability and pain in the injured knee, she was offered surgical intervention. Arthroscopic exam confirmed a chronic PCL rupture with detachment of the posterior root of the medial meniscus with extrusion. The PCL was reconstructed with an arthroscopic tibial inlay technique using an Achilles tendon allograft. PCL inlay tightrope fixation was used on the tibia, and a BioComposite interference screw was used on the femur. Reattachment of the posterior horn of the medial meniscus was addressed via an accessory posteromedial portal using a suture anchor technique. Two #2 FiberWire looping sutures were passed through the root using suture passers, and these were affixed to the tibia with a 4.75 BioComposite Swivelock. The medial meniscus was well fixed without extrusion and the patient had full range of motion with a negative posterior drawer test (Figure 3).

Post-operatively, the patient was placed in a brace locked in extension and maintained non-weight bearing. Her range of motion was initially restricted to allow the PCL allograft and meniscal root to heal. At one month post-op, gentle range of motion was started along with gradual progression to full weight bearing. The patient progressed nicely. MRI at 3 months after surgery confirmed intact allograft reconstruction of the PCL and repair of the posterior root of the medial meniscus with no extrusion (Figures 1 and 2). She is currently one year post-op, stable (1+ posterior drawer), and has resumed full activities without pain or instability.

DISCUSSION: The majority of isolated PCL tears, including grade 3 tears, are treated conservatively with a period of immobilization and early rehabilitation consisting of quadriceps-strengthening and knee range-of-motion. The length of the period of immobilization is dependent on the severity of the tear [1]. Patients typically recover well with some residual posterior laxity that, in general, is minimally symptomatic. However, it is important in this case to recognize that the combined injury to the medial meniscal root attachment makes this a much more complex injury pattern. The meniscus serves as a shock absorber, bearing hoop stresses and decreasing contact stresses on the articular cartilage, while meniscal root detachment and extrusion leads to increased contact stresses [2,3]. Menisci also act as secondary stabilizers in the sagittal plane. In this case, in light of the posterior root detachment and meniscal extrusion, the stabilizing effect was lost, likely playing a role in the dramatic posterior drawer on physical exam and causing the patient's symptoms during ADLs.

Tibial inlay PCL reconstruction has classically been performed via a combined open and arthroscopic approach. However, in this case, an all-arthroscopic PCL tibial inlay technique was used that minimizes the morbidity of the procedure while maintaining the benefits [4]. Arthroscopic meniscal

Continued on page 5

CASE 1 CONTINUED

ling the pivot shift. It was first described by Segond in 1879 [2], and recent studies indicate that the "Segond fracture", which is accepted as pathognomic for ACL injury, is a bony avulsion of the ALL [3]. Reconstruction of this ligament may be considered in cases of excessive anterolateral instability in order to control the pivot shift. Although uncommonly indicated, we elected to reconstruct this ligament given the high grade pivot shift and underlying generalized ligamentous laxity in our patient.

In conclusion, this case illustrates the importance of a comprehensive approach in the evaluation and management of failed ACL reconstruction. The treating surgeon should consider the presence of other anatomical factors, such as bony malalignment, meniscus absence, and additional ligament laxity patterns that may contribute to ACL graft failure. Optimization of the revision reconstruction may require a two-stage approach with bone tunnel grafting, as well as concomitant ligament reconstruction to address other laxity patterns and to augment the revision ACL reconstruction. ■

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AUTHOR DISCLOSURES:
Dr. Scott Rodeo does not have a financial interest or relationship with the manufacturers of products or services.

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CASE 2 CONTINUED

The patient was immobilized in full extension and non-weight bearing for four weeks, followed by physical therapy, range of motion exercises and progressive weight bearing as tolerated. At 6 months, he began to have early return of peroneal motor function, specifically dorsiflexion. One year after surgery, he had normal, symmetrical peroneal eversion strength with slight weakness of dorsiflexion power on the left. Sensation on the dorsal aspect of the foot was improved, but not quite normal.

One year after surgery the patient began fielding and batting practice, with excellent left knee stability and function. At 16 months following surgery he returned to baseball competition, playing his usual position, first base, for his college team (Figure 4).

DISCUSSION: Multi-ligament knee injury is a complex and difficult injury to manage, particularly when there are associated nerve or vascular injuries. In this case, despite complete palsy of the common peroneal nerve following the injury, the patient had near full motor recovery. We believe factors that allowed for recovery include meticulous neurolysis as well as the patient's age, which has been shown to be a predictor of peroneal nerve recovery following knee dislocation [3]. While return to high-level athletics is not expected following knee dislocation, with careful surgical technique and a motivated, dedicated patient, it can be achieved. ■

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- Salary, royalty, honoraria: *The ACL Solution* and *Revision ACL Surgery*

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CASE 3 CONTINUED

root repair is commonly performed using a transosseous pull-out technique, where sutures attached to the posterior meniscal root are pulled through tibial tunnels and tied-off, restoring the meniscal root attachment [5,6]. However, this technique relies upon suspensory fixation with its associated limitations. Suture anchor fixation of the root at the site of its attachment to the tibia, although technically more challenging, provides a reliable, well-tensioned fixation and an overall stiffer construct in our experience [7]. It was critically important to this patient that the meniscus was repaired to both protect the cartilage and add additional secondary stabilization to this complex, unstable knee. ■

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