Case Report

Supracondylar femur fracture following multiligament knee reconstruction with Internal Brace® augmentation: A case report

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A R T I C L E   I N F O

A B S T R A C T

This a case report of a 40-year-old male with left knee dislocation Type III and associated peroneal nerve palsy underwent delayed allograft reconstruction of his multiligament knee injury (MKI) with Internal Brace augmentation. The patient returned to work at 6 months postoperatively. He then fell and sustained a displaced supracondylar left femur fracture at the site of the internal brace augmentation of his lateral collateral ligament (LCL) reconstruction for which he underwent placement of a retrograde femoral nail. At 2 years of follow-up the patient had no evidence of knee instability.

Level of evidence: V.

Introduction

Knee dislocations and multiligament knee injuries (MKI) represent a devastating spectrum of knee pathology, and carry a high rate of complications including arterial injury, peroneal nerve palsy, and compartment syndrome [1–3]. Numerous case reports have described fracture of the femur following anterior cruciate ligament (ACL) reconstruction. Multiple femoral tunnels, as often used in the surgical treatment of MKIs have been implicated as potential stress risers for fractures [4,5]. In theory, the addition of a semi-rigid Internal Brace suture augmentation construct in these tunnels may also increase the risk of injury. We present case of a 40-year old male with a remote femoral fracture following MKI reconstruction with internal brace ligamentous augmentation. The patient was informed that data concerning the case would be submitted for publication, and he provided consent.

Case report

The patient is a 40-year-old male without medical comorbidities who fell downstairs while intoxicated 3 months prior to evaluation at our institution. He was diagnosed with a left olecranon fracture (treated non-operatively) and a closed left knee dislocation (KD Type IIIL) with associated common peroneal nerve (CPN) palsy and complete foot drop. He underwent closed knee reduction at that time without surgical intervention. The patient worked as a longshoreman.

At time of presentation to our clinic, the patient ambulated with an antalgic left-sided steppage gait using a cane. Table 1 presents the physical examination and imaging findings. The left knee radiograph is shown in Fig. 1. The patient was scheduled for left knee reconstruction, but he decided to postpone the procedure until 6 months later.

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Table 1

Physical examination and imaging findings at the time of initial evaluation in our institution.

• No evidence of effusion or skin changes • Lateral joint line tenderness • Range of motion: full extension-120° • Anterior drawer test (+) • Lachmann test (+) • Posterior drawer test (+) • Varus stress at 30° and full extension: 3+ laxity • Valgus stress at 30° and full extension (−) • Dial test (prone) at 30° degrees and 90° degrees of flexion (+) • Neurovascular examination: unable to dorsiflex or evert his foot against gravity with dense sensory nerve palsy to the dorsum of the left foot	L Knee X-ray (Fig. 1): • Reduced tibia with subacute avulsion type fractures of the medial condyle and fibular head. • No osteoarthritic changes were noted. L knee MRI: • Complete rupture of the ACL, PCL, lateral collateral ligament (LCL) disruption, • Disruption to the PLC ligamentous complex • Intact medial collateral ligament (MCL) • No evidence of chondral injury on T1 or T2 weighted images.

Fig. 1. Anteroposterior radiograph of the left knee at the time of initial patient. Presentation (prior to knee reconstruction), showing avulsion fractures of the medial femoral condyle and fibular head (yellow arrows). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

On the day of surgery, left knee examination under anesthesia confirmed pre-operative findings consistent with PCL, ACL, LCL, and PLC disruption. During evaluation under fluoroscopy, valgus stress at full extension and at 30 degrees flexion revealed a stable endpoint equivalent to the contralateral side. Arthroscopic examination revealed Outerbridge grade 1 and 2 changes to the under-surface of the patella and medial femoral condyle [6]. The lateral meniscus had a tear at the red-white zone, which was subsequently repaired using an all-inside technique with 2 Smith and Nephew (Fort Worth, Texas) FasT-Fixes in vertical mattress configuration and one Arthrex 2-0 FiberWire.

First, arthroscopic ACL and PCL reconstruction was performed. The tunnels for the PCL and ACL reconstructions were drilled using an inside-out technique. Arthrex Flip Cutters (Naples, FL) were used to drill all tunnels for the cruciate ligaments in the anteromedial tibia, medial, and lateral femur. Femoral tunnels for the PCL and ACL reconstructions were 10.5 mm and 9.5 mm in diameter respectively, and single bundle grafts were used. The diameter of tibial tunnels for the PCL and ACL reconstructions were 10.5 mm and
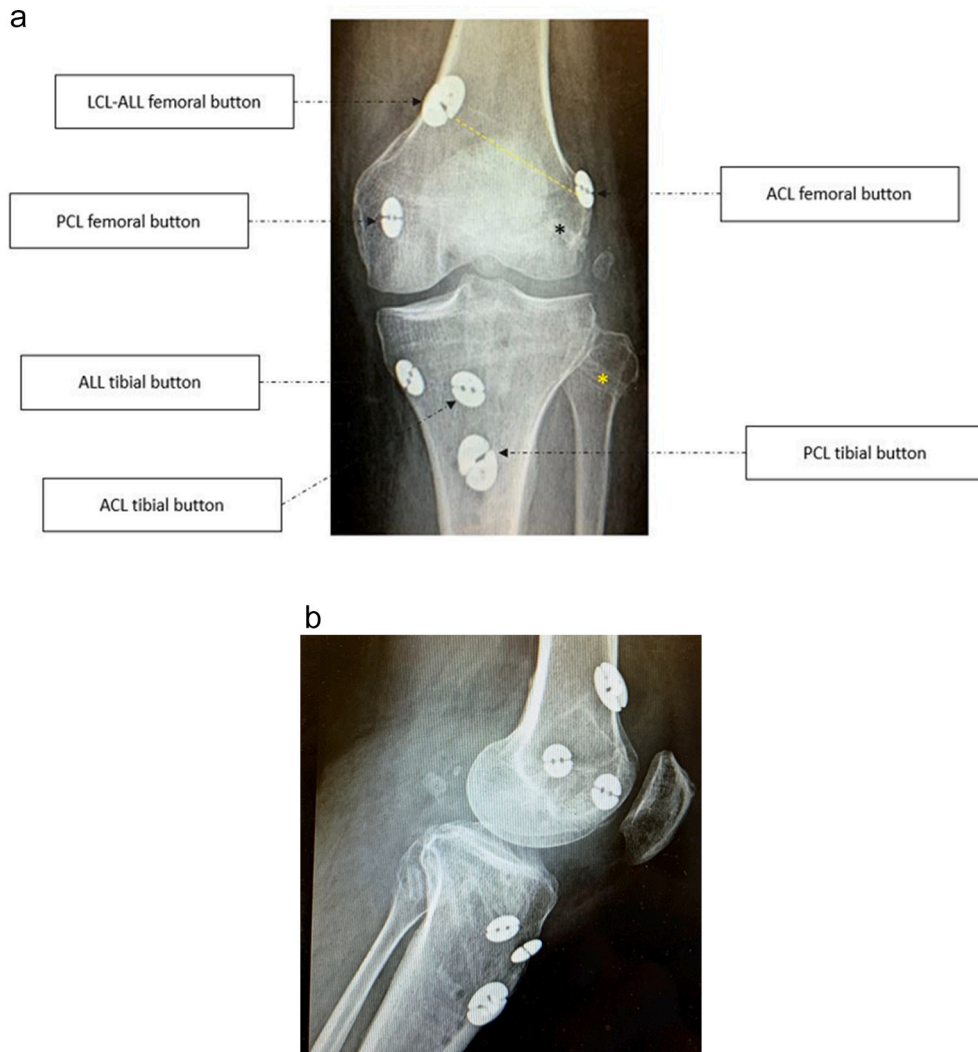
Fig. 2. Postoperative radiographs of the left knee showing the multiligament construct: (a) anteroposterior view (b) lateral view.
Blue line = LCL and ALL femoral tunnel Black * = popliteus femoral screw yellow * = LCL fibular screw.
LCL: lateral collateral ligament; ALL: anterolateral ligament; PCL: posterior cruciate ligament; ACL: anterior cruciate ligament. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

9.5, respectively.

The PCL graft and Internal Brace® construct consisted of semitendinosus quadruple looped hamstrings allograft (10.5 mm in diameter) fixed on either end with an Arthrex TightRope adjustable suspensory fixation device plus two separate #2 FiberTapes. The ACL graft construct was identical to the PCL construct except that only one # 2 FiberTape was used as an Internal Brace. The ACL graft and Internal Brace construct consisted of a semitendinosus quadruple looped hamstrings allograft (9.5 mm diameter) fixed on either end with an Arthrex TightRope adjustable suspensory fixation device plus a separate #2 FiberTape.

An open lateral approach to the LCL/PLC revealed the fibular head fracture was healed [7]. On identification and neurolysis of the peroneal nerve which found to be in continuity, the last could not be activated with a Checkpoint stimulator (Medtronic; Minneapolis, MN), indicating complete neurological dysfunction. The femoral LCL tunnel measured 6.5 mm in with and 40 mm in length. A second femoral tunnel was drilled 18 mm distal and anterior for the popliteus tendon reconstruction measuring 9 mm × 35 mm in size. The graft was fixed with a suspensory fixation device on the femur for the LCL using a large 20 mm Concave Attachable Button System (ABS; Arthrex, Naples, FL) and a PEEK interference screw for the popliteus tendon limb. The fibular head limb was then fixed with a PEEK interference screw.

Finally, the Anterolateral Ligament (ALL)/lateral capsule was reconstructed with internal brace technique. The Internal Brace construct was comprised of 1 FiberTapes docked in the LCL femoral tunnel over the same large 20 mm Concave Attachable Button System (ABS; Arthrex, Naples, FL) used for the LCL allograft, and fixed to the tibia via a swivelock anchor and a second independent internal brace construct created by interlocking 2 tight rope suspensory fixation devices together therefore functionally creating one
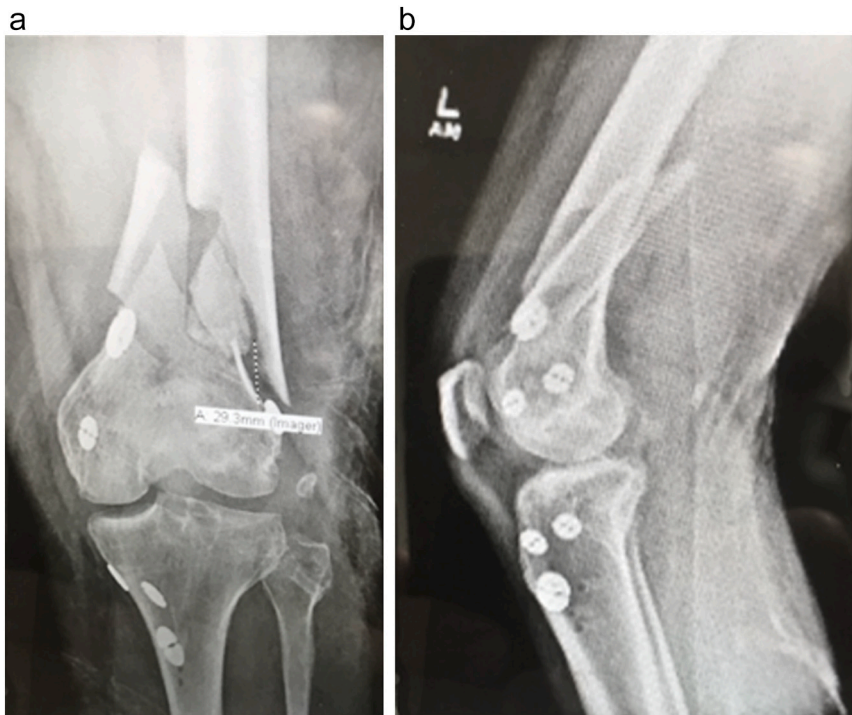
Fig. 3. Radiographs demonstrating the extra-articular distal diaphyseal left femur fracture which occurred at the internal brace construct in the lateral collateral ligament (LCL) femoral tunnel: (a) anteroposterior view (b) lateral view.
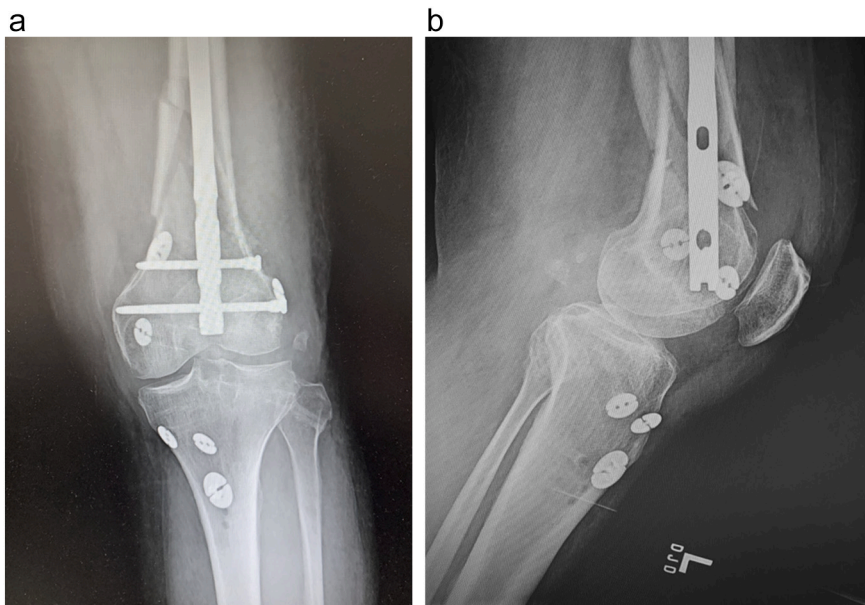

Fig. 4. Radiographic evaluation of the left knee 2 years following the multiligament reconstruction surgery. (a) Anterolateral view (b) lateral view.

long TighRope construct. The TightRope to TightRope construct (TR/TR) was secured in the femoral LCL allograft tunnel over the same large 20 mm Concave Attachable Button System (ABS; Arthrex, Naples, FL) as used for both the LCL allograft and the FiberTape Internal Brace, and fixed to the tibia by a 14 mm Concave Attachable Button System (ABS; Arthrex, Naples, FL).

Fig. 2 shows the postoperative left knee radiographs. The patient was placed into a Donjoy X-Act ROM Post-Op Knee Brace (Vista, CA) and he was discharged on post-operative day two. He remained toe-touch weight initially with advancement with therapy toward full weightbearing at 6 weeks. He was given an additional Ankle-Foot-Orthosis to aid in his ambulation. The patient's immediate post-
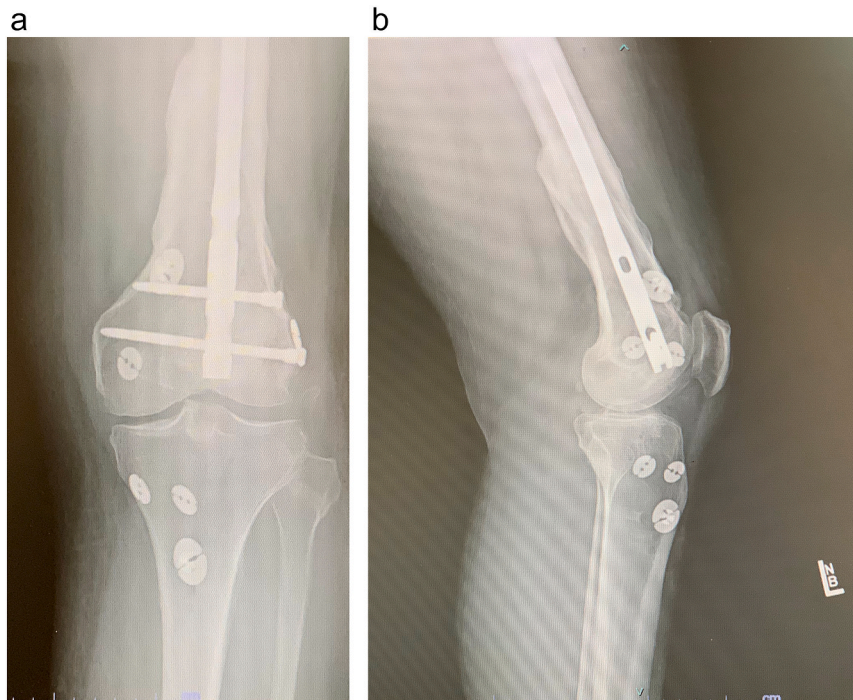
Fig. 5. Radiographic evaluation of the left knee on 2 years postoperative follow up following placement of a retrograde femoral nail exhibiting fracture union: (a) anteroposterior view (b) lateral view.
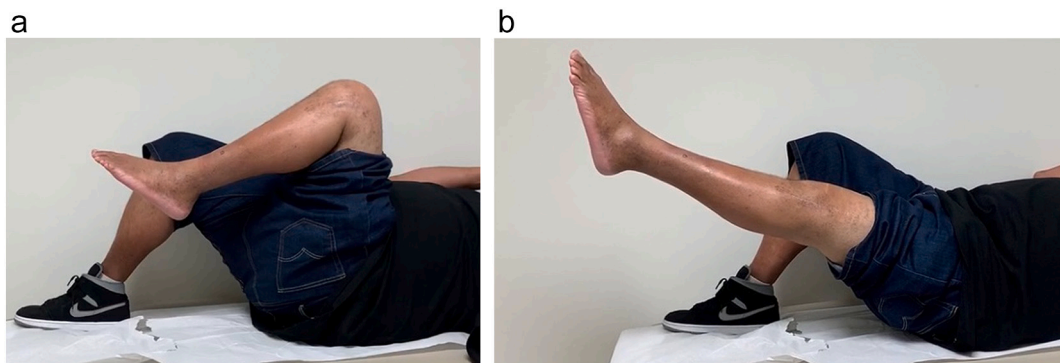

Fig. 6. Knee range of motion at 2 years postoperative follow up following placement of retrograde femoral nail (a) flexion (b) extension.

operative course was uncomplicated, and he regained full range of motion (0–130°) by 4 months. His left foot drop did not resolve; however, he did develop paresthesia in previously numb areas of the foot during this time. He had returned to work by his 6-month post-operative visit.

At 9 months post operatively, the patient was walking at night without his AFO and tripped over his left foot, landing on his left knee. He was unable to bear weight and taken again to his local hospital. Initial radiographs demonstrated an extra-articular distal diaphyseal left femur fracture which occurred at the internal brace construct in the LCL femoral tunnel (Fig. 3). He underwent placement of a retrograde femoral nail at his local hospital. Discussion with the operating surgeon revealed that patient's left knee showed no sign of ligamentous instability post-intramedullary rod fixation. This was confirmed in our clinic post operatively shortly thereafter. There was no radiographic evidence of displacement of the suspensory fixation from the previous left knee multi-ligament reconstruction (Fig. 4), the fracture occurred at the internal brace construct which spanned the distal femoral metaphysis from medial to laterally.

The patient had no evidence of instability at the left knee at 1-year follow-up. His femur maintained appropriate mechanical limb alignment after union of his fracture and had no tenderness. At 2-year follow-up, the patient continued with full-time work. Fracture union was apparent on follow-up imaging of the left knee (Fig. 5). Physical examination at the 2-year follow up visit reveal knee flexion range of motion from full extension to 125°, negative Lachman, anterior drawer and posterior drawer tests while the patient's knee was

Table 2
Patient reported outcomes at 2-years postoperatively.

Outcome score	Domain: score
Multi-Ligament Quality of Life questionnaire (ML-QOL)	Physical impairments: 0.25 Emotional impairments: 0.283 Activity limitations: 0.375 Societal involvement: 0.208
Patient-Reported Outcomes Measurement Information System (PROMIS) computer adaptive testing (CAT)	Pain interference: 7 Physical function: 13 Mobility: 11

stable at varus stress testing (both in full extension and 30° of flexion) (Fig. 6).

The Multiligament Quality of Life (MLQOL) questionnaire and Patient-Reported Outcomes Measurement Information System (PROMIS) computer adaptive testing (CAT) were administered at the latest follow up visit (Table 2). The patient did not receive treatment for his drop foot, but his reconstructed knee was stable on physical examination. The patient reported that he rarely has episodes of mild pain in his left knee and he does not feel that his knee is giving away; however, his activity is limited due to his foot palsy. The functional outcome scores reported were likely lower than they otherwise may have been due to patient's foot drop resulting in deficits in functional movement. However, the patient exhibited good range of motion overall and ultimately returned to full un-restricted duties at work.

As foot drop and inconsistency in wearing AFO brace, were likely the main contributory factors to the fall and resulting fracture, the patient was referred to a foot and ankle specialist for consultation regarding a tendon transfer procedure, which he initially declined. However, the patient unfortunately went on to have another fall resulting in a minimally displaced ipsilateral patellar fracture, underwent subsequent ORIF, and has now recovered. After this second fall and sustaining a fracture requiring surgery, patient agreed to undergo a tendon transfer for his foot drop and is now scheduled for surgery.

Discussion

Previous case reports have discussed femoral fractures following arthroscopic ACL reconstruction [4,8]. This is the first case report of a supracondylar femur fracture following a MKI reconstruction using an Internal Brace augmentation. We hypothesized that the semi rigid internal brace construct occupying the LCL femoral tunnel acted as a stress riser at the distal femur and allowed for a distal lateral fracture propagation. Additionally, the patients persistent drop foot – while difficult to address in the acute postoperative phase – and history of substance abuse clearly placed him at higher risk for falls.

A recent biomechanical study by Han et al. [5] evaluated load to failure in fourth generation sawbone femurs undergoing double-bundle ACL reconstruction. They showed that femurs with additional drill tunnels significantly decreased the load to failure. Further, they observed that femur fractures propagated through the tunnels in the double-bundle group, but this was not true in the single femoral tunnel group drilled at either 8 mm or 10 mm in diameter. The tunnel combinations necessary for MLI reconstruction provided multiple weak points in both medial and lateral cortices.

Tunnel widening and non-biologic augmentation have been implicated as a potential risk for ACL-related supracondylar fractures, but not for the PCL [9,10]. Our PCL tunnel, combined with the Internal Brace was drilled to a diameter of 10.5 mm, so the increased diameter necessary to accommodate the Internal Brace material was likely less responsible for weakened the medial cortex. As the construct is incorporated to the suspensory button fixation proximally and requires additional cortical fixation distally, we would have expected the tibial plateau to be at higher risk. Comparative data for fracture risk between suspensory and interference fixation is lacking.

However, in this case the fracture did not involve either the ACL or PCL tunnels, but occurred at the internal brace portion of the LCL femoral tunnel. Interestingly this portion of the LCL tunnel is proximal to the location of the LCL allograft and tunnel is less than 4 mm in diameter in this location. In fact, the only contents in this proximal portion of the LCL femoral tunnel were the double FiberTape limbs from the Internal Brace, the proximal Tight Rope from the TR/TR internal brace construct, and the Tight Rope from the LCL allograft.

Conclusion

Periprosthetic fractures can occur at an Internal Brace suture augmentation site. Due to the rigid nature of the Internal Brace suture augmentation construct, providers should be aware that Internal Brace can act as a stress riser and predispose to adjacent bone injury.

Acknowledgements

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