Rehabilitation of Tibial Plateau Fracture Following Anterior Cruciate Ligament Reconstruction: A Case Report

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ABSTRACT

Objective: The purpose of this case report was to describe the management of a tibial plateau fracture in a patient who had undergone anterior cruciate ligament (ACL) reconstruction 3.5 years earlier.

Clinical Features: A 36-year-old man presented with pain and edema following a fall from a height of approximately 2 m while skateboarding. The patient reported having undergone arthroscopic ACL reconstruction with allograft and bioabsorbable screws 3.5 years earlier. Computed tomography scan revealed a comminuted fracture extending through the graft tunnel, as well as evidence of tunnel widening and incomplete bone resorption and generation within the tibial tunnel.

Intervention and Outcome: A trauma surgeon repaired the plateau fracture with internal fixation. The patient was non-weight bearing for 8 weeks while undergoing rehabilitation in a chiropractic clinic (spinal manipulation, physiotherapy, nutritional support) twice per week and returned to full activity within 3 months.

Conclusions: The patient responded favorably to the treatment protocol, which included rehabilitation by a doctor of chiropractic and co-management with a trauma surgeon. (J Chiropr Med 2018;17:63-67)

Key Indexing Terms: *Tibia; Tibial Fractures; Anterior Cruciate Ligament Reconstruction; Chiropractic*

INTRODUCTION

Anterior cruciate ligament (ACL) repair surgery is commonplace. Although complications of ACL reconstruction surgery using autograft and allograft are rare, they may include infection, tunnel malposition, tunnel dimension mismatch, graft failure, and fracture.^{1,2} Several cases of fracture through either the femoral or the tibial tunnel following repair have been reported. These fractures have been attributed to a stress riser effect caused by bioabsorbable interference screws,^{3,4} bone resorption,³⁻⁵ and tunnel widening.²⁻⁵ Of the 9 cases of tibial tunnel fracture known to the authors, 8 were in patients that had received autografts. Seven of these patients had bone-patellar tendon-bone (BPTB) autograft,^{3,6-11} and 1 patient had gracilis-semitendinosus autograft.² In the cases of BPTB autograft, Delcogliano et al suggested that bony defects caused by the graft bone block and the tibial tunnel may act synergistically to create a stress riser greater than that produced by either defect alone.⁹ Only 1 case of

tibial plateau fracture has been reported in a patient that had repair with allograft.¹² The purpose of this case report was to describe a tibial plateau fracture following ACL reconstruction and the rehabilitation by a doctor of chiropractic and co-management with a trauma surgeon.

CASE REPORT

A 36-year-old man (first author, A.R.) presented to an orthopedic surgeon with right knee pain and edema following a fall from a height of approximately 2 m while skateboarding. The patient reported landing on the right foot with knee extended and was unable to bear weight on the affected leg since the time of the injury 2 days earlier. Three and a half years earlier, the patient had undergone arthroscopic ACL reconstruction with allograft and bioabsorbable screws. For that surgery, the tibial tunnel was drilled to 10 × 40 mm, and the bioabsorbable screw used to secure the graft measured 8 × 23 mm. After the ACL reconstruction, the patient completed an established program of physical therapy and returned to full activity within 3 months.

After reviewing the patient's history and conducting a limited physical exam (because of probable fracture), the orthopedic surgeon ordered radiographs and a computed tomography scan. Radiographs revealed a 2- to 3-mm comminuted fracture extending through the medial-proximal

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Fig 1. Sagittal computed tomography scan revealing a fracture through the tibial tunnel. The interference screw is indicated by the white arrow, and incomplete bony resorption and generation are indicated by the black arrow.

tibial tunnel, including the intercondylar eminence and terminating in the lateral plateau (Fig 1). There was evidence of bone resorption within the tibial tunnel (Fig 1), and the tunnel measured 13.5 mm in the transverse plane (Fig 2). Bone

Fig 2. Transverse computed tomography scan revealing a fracture through the tibial tunnel (indicated by arrow) and tunnel widening, from 10 mm at the time of reconstruction to 13.5 mm at the time of plateau fracture.

density was within normal limits. After review of the radiographs, the orthopedic surgeon referred the patient to an orthopedic trauma surgeon for surgical repair.

Because the plateau fracture would not be repaired until 10 days after the injury, the patient sought chiropractic care for symptomatic relief and early initiation of rehabilitation. Over these 10 days, the patient received 15 minutes of low-voltage AC sine-wave stimulation (pulse width = 200 μ s at 50% V_{max} , current = 0.25 A) of the quadriceps under the care of a doctor of chiropractic. Intensity of muscle contraction was low to avoid further bony displacement, yet adequate to help ease muscle spasm and pain, as well as minimize flexion contracture caused by extension lag. Range of motion (ROM) was not assessed in this period because of the severity of the injury. On the day of surgery, the doctor of chiropractic was present for the presurgical consultation with the patient and debriefed the trauma surgeon regarding treatment rendered. In theater, the fracture was repaired arthroscopically using internal fixation, and the surgeon observed the ACL graft to be intact. Range of motion the day after surgery was 2° in extension and 113° in flexion. Also on the day after surgery, the surgeon, the doctor of chiropractic, and the patient met for a postsurgical visit prior to the patient's release from hospital.

The surgeon instructed the patient to perform 20 repetitions each of 6 different closed kinetic chain home exercises 5 times per day and allowed only 20 pounds of weight bearing on the right leg for the next 8 weeks. The surgeon and the doctor of chiropractic decided that the patient could continue receiving chiropractic treatments twice per week. Each treatment included lumbopelvic spinal manipulation to support normal biomechanics and movement patterns. Passive care modalities included low-voltage AC sine-wave stimulation of the quadriceps (moderate intensity), low-level laser therapy (40J at 810 nm), and soft-tissue mobilization to support normal muscle activation patterns and healing. The patient was also given nutritional recommendation for the following supplements: 600 IU of vitamin D, 1250 mg of calcium, 500 mg of magnesium, 375 mg glucosamine, 300 mg chondroitin, and 375 mg methylsulfonylmethane (MSM) per day. Nutritional supplementation was aimed at reducing inflammation and cartilage loss and expediting bone growth.

Passive range of motion at 18 days postoperation was 0° in extension and 124° in flexion. At the 2-month postoperative follow-up, ROM was -3° in extension and 146° in flexion, which was greater than 90% of the unaffected leg (-5° in extension and 160° in flexion). No additional physical therapy was prescribed by the surgeon, and the patient was allowed to gradually return to normal activities. The surgeon and the doctor of chiropractic agreed, via interoffice communication, that the patient could continue with chiropractic care. The patient could walk without the assistance of crutches, climb stairs, bike, and surf within the days following. At 3 months postoperation, the patient returned to more vigorous activities (eg, running, skateboarding). Between 3 and 24 months

postoperation, the patient continued with daily nutritional supplementation and chiropractic care (spine manipulation, soft-tissue mobilization, cold laser). At 3 years postoperation, the patient had no further complications and continues vigorous activities with no limitations; ROM has improved to -5° in extension and 150° in flexion. The patient gave consent to publish this case report.

DISCUSSION

Tunnel fracture, especially through the tibial plateau, following reconstruction appears to be a multifactorial phenomenon. Bioabsorbable interference screws, bone resorption, and tunnel widening appear to create a stress riser within the tunnel and increase the risk for fracture in the years following reconstruction. These factors, combined with an inflammatory process associated with allograft, may have contributed to a stress riser effect in our patient.

Long-term studies suggest that it can take up to 10 years for bioabsorbable screws to completely degrade and that complete bony ingrowth can take even longer. Although the need for rehabilitation following ACL reconstruction surgery is well recognized, doctors and patients need to be aware of the long-term risk of fracture when using bioabsorbable interference screws, especially in those athletes participating in high-impact activities similar to those in which the patient described here participated. The use of bone growth stimulators following reconstruction may also assist in the reduction of future fracture and warrants investigation.

Several factors have been implicated in tunnel fracture following ACL reconstruction. Bony defect from the use of bioabsorbable interference screws,^{3,4} bone resorption,³⁻⁵ and tunnel widening²⁻⁵ appear to create a stress riser effect, thus predisposing the patient to fracture.^{2-5,9} This was probably the case in our patient as the fracture clearly occurred through a widened tibial tunnel, a bioabsorbable screw was used in ACL reconstruction, and there was evidence of incomplete resorption and integration on the computed tomography scan. However, most cases of tibial tunnel fracture have occurred within 7 to 18 months post-ACL reconstruction. The patient reported herein was 3.5 years post-ACL reconstruction. The only other case of fracture this late was reported by Thaunat et al³ in a BPTB autograft patient at 4 years. The time for complete resorption of bioabsorbable screws is highly variable and can depend on multiple factors (eg, screw type).^{3,13,14} Some authors report as little time as 1 to 3 years, whereas other authors have reported 3 to 5, 7, 10, and >10 years.¹⁴⁻²³ Considering that fat and fibrous tissue occupy the tunnel in this time,¹⁴⁻¹⁶ a stress riser may exist within the plateau for up to 10 years post-reconstruction. Although there was some evidence of bony regeneration in the patient presented herein, there was still a moderate amount of fibrous tissue

within the tunnel. This weakness likely contributed to the fracture.

Tunnel widening and graft type may have also contributed to fracture in our patient. Tunnel widening caused by necrosis of the bone surrounding the tunnel may result from tunnel drilling, graft necrosis, and inflammation.^{5,24} Tunnel widening has been reported to occur with all graft types. Bach et al reported that at least with BPTB autograft and allograft, this widening appears similar in size.¹⁴ However, the incorporation of BPTB allograft is delayed compared with that of BPTB autograft and could increase the likelihood of post-reconstruction fracture.⁴ Increased inflammation, caused by a greater immune response to allograft than to autograft, may partially explain this observation.⁵ Cytokine-induced resorption would also contribute to tunnel widening and compound the existing bony weakness.⁵ At the time of surgical repair of the fracture, the allograft in our patient was intact, but increased inflammation associated with the use of allograft may still have caused tunnel widening and bony weakness. El-Hage et al reported the only other case of tibial plateau fracture following allograft.¹² This fracture occurred just 18 months following reconstruction surgery using a freeze-dried Achilles tendon, and the authors concluded that a stress riser effect caused by the tibial tunnel was a contributing factor.

For tunnel fracture, the patient in this case required surgical intervention. As no specific treatment protocol existed for the patient's injury, we reasoned that established chiropractic rehabilitation protocols for similar lower-extremity injuries may be beneficial. Our multimodal approach included spinal manipulation, electrical stimulation, and soft-tissue mobilization to help preserve biomechanics, ROM, and neuromuscular integrity²⁵⁻²⁷; calcium, vitamin D, magnesium, and low-level laser therapy to help support bone growth²⁷⁻²⁹; and glucosamine, chondroitin, and methylsulfonylmethane to help support bone growth, preserve cartilage, reduce pain and inflammation, and increase ROM.³⁰⁻³⁴ We considered the use of proteolytic enzymes to help reduce inflammation, but patient allergy prevented their use. The patient achieved normal ROM and return to activity milestones 1 month earlier than expected for this injury,³⁵ did not require pain medication outside of the immediate postoperative recovery room, missed only 2 days of work (surgery days), and had no complications at 3 years postoperation. We conclude that the patient responded favorably to the combined treatment offered by both surgical and chiropractic practitioners.

Limitations

As with all case reports, a limitation of this study is the inability to extrapolate our conclusions to other similar patients. The patient (first author, A.R.) was healthy, active, and motivated and had above-average access to multiple health care disciplines. However, we feel that this only

highlights the need for increased awareness and early prevention, especially in populations considered to be at high risk for fracture (eg, athletes, osteoporosis patients).

CONCLUSIONS

The patient responded favorably to the treatment protocol, which included surgical intervention by a trauma surgeon and rehabilitation by a doctor of chiropractic. Co-management of musculoskeletal injuries may result in improved outcomes.

FUNDING SOURCES AND CONFLICTS OF INTEREST

No funding sources or conflicts of interest were reported for this study.

CONTRIBUTORSHIP INFORMATION

Concept development (provided idea for the research): A.R.

Design (planned the methods to generate the results): A.R., J.D.L.

Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): A.R.

Data collection/processing (responsible for experiments, patient management, organization, or reporting data): A.R., J.D.L.

Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): A.R., J.D.L.

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Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): A.R., J.D.L.

Practical Applications

- Early co-management may lead to good outcomes.
- The patient in this case responded favorably to a chiropractic treatment plan that included lumbo-pelvic adjustment, electrical stimulation, low-level laser therapy, soft-tissue mobilization, and nutritional supplementation.

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