

Acute Compartment Syndrome After Knee Manipulation Under Anesthesia for Post-Traumatic Arthrofibrosis

Andrew D. Kleven, DPT; Alexander R. Graf, MD; Scott E. Van Valin, MD

Children's Wisconsin, Department of Pediatric Orthopaedic Surgery, Milwaukee, WI

Abstract: The high risk of deep-vein thrombosis in polytrauma patients means that many of these patients are on medications for prophylaxis and may alter their risk profile for certain procedures. Arthrofibrosis of the knee is common in the setting of polytrauma, especially when early range of motion is limited by a patient's medical status or willingness to participate in rehabilitation. Manipulation of the knee under anesthesia is an effective treatment for this condition and is considered a safe procedure with minimal risk to improve range of motion and participation in rehabilitation. The purpose of the current case study is to present a patient with post-traumatic knee arthrofibrosis on therapeutic anticoagulation for a deep-vein thrombosis who developed acute compartment syndrome after manipulation under anesthesia to highlight a rare but significant complication following this common procedure.

Key Concepts:

- Pediatric polytrauma with delayed participation in rehabilitation is a risk factor for knee arthrofibrosis following lower extremity trauma as well as venous thromboembolism.
- Manipulation under anesthesia is an effective and generally well-tolerated procedure for knee arthrofibrosis but does have some rare but significant complications.
- Patients with abnormal coagulation profiles and local hypervascularity from fracture healing are at risk for hematoma and Acute Compartment Syndrome (ACS) following manipulation under anesthesia (MUA) and there should be consideration of holding anticoagulation or delaying manipulation.

Introduction

Knee arthrofibrosis is a common complication following lower extremity fracture in the setting of pediatric polytrauma injuries managed at Level 1 Trauma Centers, occurring in approximately 5% of patients.¹⁻³ Causes of arthrofibrosis include fractures and other surgeries around the knee.¹ Risk factors include barriers that limit early aggressive knee motion such as severe soft tissue injury, wound complications, and multiple surgical procedures.⁴

The treatment for arthrofibrosis varies from physical therapy, a continuous passive motion (CPM) machine and manipulation under anesthesia (MUA). Early

passive of range by physical therapists is a mainstay of preventing arthrofibrosis of the knee and noncompliance may hasten this condition.⁵ In addition, previous outcomes in the literature describe MUA as an important augment to postoperative rehabilitation, CPM and significantly improves knee range of motion, even when performed beyond 12 weeks from surgery.⁶⁻⁸

Although there is significant literature published regarding the techniques and outcomes following MUA, there is a paucity of information regarding the complications. Potential complications include physeal fractures, supracondylar femur fractures, hemarthrosis, pulmonary embolism, or wound dehiscence.⁹ Although

previous studies have shown MUA to be an exceedingly safe procedure, including in the setting of lower extremity trauma, strategies to mitigate these complications are not well described. Therefore, our aim is to present a case of acute compartment syndrome (ACS) that occurred following bilateral knee MUA in a pediatric polytrauma patient to better understand this rare but significant complication and hopefully prevent future occurrences.

Case Report

A 17-year-old otherwise healthy male presented to our Level 1 Trauma Center after being the unrestrained driver of a motor vehicle that collided with a semitruck trailer at highway speeds. Identified injuries on admission included a traumatic brain injury (TBI) with subsequent diffuse axonal injury, open facial and mandibular fractures, facial lacerations, pulmonary contusions with pneumomediastinum, and a grade 5 spleen laceration. He was subsequently stabilized and transferred to the intensive care unit (ICU) where radiographs revealed a closed right comminuted subtrochanteric femur fracture (AO 32-B3-1), as well as a closed left femoral shaft fracture (AO 32-B2-1) for which orthopaedic surgery was consulted (Figure 1).

Once resuscitated, the patient underwent uncomplicated retrograde intramedullary nailing for his left diaphyseal femur fracture and anterograde intramedullary nailing for his right subtrochanteric femur fracture on hospital days 1 and 3, respectively. He was admitted to the ICU and his postoperative course was complicated by an internal jugular vein thrombus precipitated by a central venous catheter which was removed and treated with therapeutic anticoagulation (60 mg Lovenox twice daily for a planned 3-month course). In addition, due to his prolonged ICU stay, physical therapy was delayed for 2 weeks from injury and limited further by his additional refusal to participate secondary to his TBI.

At 6 weeks post-op, the patient developed significant knee arthrofibrosis with passive and active range of motion



Figure 1. AP and lateral radiographs of the left and right hip and femur demonstrating bilateral femur fractures.

0-20 degrees, bilaterally. Radiographs showed interval healing of bilateral femur fractures, as well as robust callus formation (Figure 2). Due to his lack of progress and participation in physical therapy, a MUA to improve knee flexion was discussed with the family and they elected to proceed. The patient subsequently underwent gentle MUA that improved range of motion bilaterally to 0-135 degrees. Intraoperative femur and knee films showed no hardware failure, loss of fixation, or new fracture following manipulation. Postoperatively, the patient was placed in bilateral CPM machines to be worn 23 hours per day to encourage passive range motion of the knees.

Over the course of the next 48 hours, the patient reported worsening thigh pain that was not relieved with multimodal analgesia including narcotics. In addition,



Figure 2. AP and lateral radiographs of the left and right hip and femur demonstrating interval healing and robust callus formation after bilateral intramedullary nailing.

from postoperative day 1 to 2, his hemoglobin dropped from 10.1 to 3.7 g/dL with an increase in creatinine kinase to 2945 units/L (normal range 33-145 units/L). Lovenox was immediately discontinued.

The patient's history and examination were limited by his pain and TBI. However, given his polytraumatic injuries, a focused physical examination was significant for tachycardia, an absence of respiratory distress and a benign abdominal exam. The left thigh was firm and tense while the right thigh had significant swelling. The patient had palpable dorsalis pedis and posterior tibial pulses, bilaterally. He had severe pain and anxiety with passive range of motion of the knees, bilaterally. Therefore, a bedside ultrasound was performed that

revealed a large fluid collection deep to the left vastus medialis measuring 15.1 cm long and 4.8 cm by 2.7 cm thick suggestive of a hematoma (Figure 3). In addition, bilateral thigh compartment measurements were obtained using a Stryker STIC device (Stryker, Mississauga, Ontario, Canada) that measured 56 mm Hg and 30 mm Hg for the left and right thigh anterior compartments, respectively. Diastolic pressure immediately prior to the procedure was 55 mm Hg, resulting in delta pressures of 1 and 25 mm Hg, respectively. Therefore, the patient was taken to the operating room where bilateral lateral thigh fasciotomies were performed with evacuation of 300 and 100 mL of clotted hematoma on the left and right, respectively. All muscle was viable and there was no active bleeding. The



Figure 3. Cross-sectional view of ultrasound of left anterior thigh compartment showing probable hematoma.

iliotibial fascia was loosely approximated and both incisions were closed over a drain. A postoperative CT angiogram was obtained which confirmed no active bleeding in bilateral lower extremities or abdomen given his previous splenic laceration. The patient tolerated the procedure well and was subsequently transferred back to the ICU for further resuscitation which entailed transfusion of 5 units of packed red blood cells, 1 unit of fresh frozen plasma, and 1 unit of platelets. Postoperatively, his therapeutic anticoagulation was held for 4 days and CPM use was discontinued. He was transferred to the floor in stable condition on postoperative day 2. Drains were removed postoperative day 8. He was subsequently discharged to a rehabilitation facility 10 weeks after his initial injury.

At 4-month follow-up from his initial injury, the patient regained baseline strength and sensation in bilateral lower extremities. He had well healed fasciotomy incisions without evidence of infection. His passive knee range of motion measured 0-85 degrees on the right and 5-80 degrees on the left. He required no narcotic pain medication. He was discharged from inpatient rehabilitation after 6 weeks and is receiving outpatient physical therapy for strengthening and range of motion.

Discussion

MUA for knee arthrofibrosis is common and, fortunately, rarely associated with complications. However, this case illustrates not only a rare cause of arthrofibrosis in a pediatric patient but also an exceedingly rare complication of acute compartment syndrome following MUA. While previous studies have documented ACS following knee MUA for arthrofibrosis after total knee arthroplasty, this is the first case to the authors' knowledge to be described after post-traumatic arthrofibrosis.¹⁰

In our case report, we hypothesize that ACS was precipitated by disruption of adhesions and highly vascular scar tissue near his fracture sites during the manipulation and, due to his anticoagulation, lead to hematoma formation and ACS.

In hindsight, the presence of highly vascular and robust callus at the fracture sites in the setting of a closed head injury, the patient's current therapeutic coagulation for venous thromboembolism, and age under 35 years old, put him at risk for ACS following MUA.¹¹⁻¹⁶ Holding his anticoagulation and having a higher index of suspicion for risk of ACS developing given his other risk factors should have been considered. In addition, his TBI, which limited his participation in rehabilitation, also put him at risk for arthrofibrosis which perhaps could have been prevented by CPM use after his femur fracture treatment or more aggressive range of motion.¹⁷ Ultimately, failure to recognize these unique patient factors increased the risk of this rare complication.

Another learning point from this case is the importance of prompt diagnosis and intervention in suspected ACS, even if the clinical context is atypical (2 days after a gentle MUA) and especially for patients who are unable to provide a reliable history or exam, such as our patient with a TBI. In our case, prompt clinical evaluation with physical exam aided by ultrasound to identify a source of hematoma responsible for such a dramatic decrease in hematocrit and, ultimately, measurement of

intracompartmental pressures enabled prompt diagnosis and resolution of the problem, which prevented what could have been a life- or limb-threatening complication.

This case highlights that every procedure requires thoughtful preoperative planning and discussion of risks and benefits with patients and their families. Although MUA for knee arthrofibrosis is a common procedure with very few major complications reported in the literature, we recommend surgeons take caution when performing MUA for post-traumatic knee arthrofibrosis when the patient does not have a normal coagulation profile, has a recent femur fracture inducing local hypervascularity, and has concomitant neural impairment which prevents participation in postoperative therapy and monitoring for postoperative vascular complications—no matter how rare.

Additional Links

1. Pediatric Orthopaedic Society of North America Academy - Video on Pediatric Acute Compartment Syndrome:

http://www.posnacademy.org/media/0_u3v8mu2p

2. American Academy of Orthopaedic Surgeons - Management of Acute Compartment Syndrome Clinical Practice Guideline: <https://www.aaos.org/aaos-home/newsroom/press-releases/american-academy-of-orthopaedic-surgeons-approves-clinical-practice-guideline-for-management-of-acute-compartment-syndrome/>

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