

Recurrent Compartment Syndrome: 2 Cases and a Review of the Literature

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ABSTRACT

Compartment syndrome is a potentially devastating entity, and timely recognition is critical for appropriate management. Diagnosis is classically a clinical one and based largely on serial examinations. When clinical examinations are compromised, compartment pressure monitoring may be useful. These diagnostic measures, however, assume recognition of “at-risk” injuries or clinical scenarios. Rarely discussed is whether an open fasciotomy provides any degree of protection from redeveloping compartment syndrome.

To this end, we present 2 cases of recurrent compartment syndrome after previous fasciotomy. These reports illustrate a previously unreported at-risk population and demonstrate that compartment syndrome can recur in a previously released compartment. Therefore, prior fasciotomy should not be considered protective against acute compartment syndrome. These patients should be evaluated and managed no differently from patients with primary compartment syndrome.

Compartment syndrome (CS) is a potentially devastating complication of trauma, hemorrhage, traction, reperfusion, infiltration, burns, tight casting, gunshot wounds, and overuse.¹⁻⁴ If untreated, CS can result in devastating nerve and muscle dysfunction. Breakdown of ischemic cells may lead to myoglobinuria, renal failure, metabolic acidosis, hyperkalemia, and amputation.^{1,4-6} Given this high potential for morbidity, accurate and timely diagnosis and treatment is crucial.

The diagnosis of CS is classically a clinical one. Pain out of proportion to injury and exacerbation by passive stretch of the involved muscle compartment are the hallmark clinical findings. Pallor, pulselessness, and paresthesias

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are later and worrisome physical exam findings. Direct measurement of the intracompartmental pressures can aid in making an accurate diagnosis when the exam findings are equivocal or the patient is obtunded. A compartment pressure measurement within 30 mm Hg of diastolic blood pressure is generally accepted as diagnostic.^{1,7} Accuracy of measurements, however, may vary between device, needle types, and users' experience.⁸

Treatment is urgent fasciotomy of the affected compartments. Prior fasciotomy in the affected compartments does not appear to be protective. We report 2 cases of recurrent CS after previous fasciotomy.

Informed Consent: Written informed consent was obtained from both patients for de-identified documentation and publication of their condition.

CASE REPORTS

Case 1

A female soccer player in her early 20s was seen after sustaining an injury to her left leg during a collegiate game. During follow-through while kicking, she felt a snap in her planted leg. She had immediate pain and inability to bear weight.

The medical history was remarkable for exercise-induced compartment syndrome (EICS). She had previously undergone an open, 2-incision, 4-compartment fasciotomy after an acute episode of EICS did not relent. This was performed urgently and her incisions were closed 2 days later.

Examination findings after the soccer injury were remarkable for deformity and swelling. The injury was closed. Neurovascular examination found no deficit. The patient did not have significant pain with passive range of motion of the ankle or toes, and the compartments of her leg were soft.

Radiographs demonstrated a displaced, spiral, mid-shaft tibia fracture and a transverse fibula fracture



Figure. Case 1—Mid-shaft tibia fracture sustained during collegiate soccer competition.

(Figure). The fracture was reduced and splinted in the trauma bay. After discussion of the various treatment options, the patient opted for surgical rather than cast treatment of her fracture. She was taken to the operating room within 8 hours of her fracture for intramedullary nailing of the left tibia.

Compartments were soft postoperatively. In accordance with our institutional protocol, serial compartment checks were performed over the next 24 hours and stable exam findings were documented. On postoperative day 2, the anterior and lateral compartments were firmer. The patient required more narcotic pain medication and demonstrated increasing pain with passive range of motion of her ankle and toes. Compartment pressures confirmed CS, and a 2-incision, 4-compartment fasciotomy was emergently per-

formed. Operative findings included intact fascia over all compartments, muscle that bulged from his fascial incisions, and a (~40-mL) hematoma between the flexor digitorum profundus and flexor digitorum superficialis (FDS) tendons. The radial half of the FDS tendon was necrotic as demonstrated by pallorous coloring and the absence of twitch with electrical stimulation. Culture results were negative, and after an additional débridement, the incisions were closed on postfasciotomy day 4. He was discharged 48 hours later and has recovered without incident.

DISCUSSION

Compartment syndrome occurs when pressure in a closed fascial compartment decreases vascular perfusion to the point at which tissue ischemia occurs.⁹⁻¹¹ This threshold is dictated

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formed. Operative findings included intact fascia over all 4 compartments, tense compartments, and healthy underlying muscle that bulged from her incisions. The clinical picture improved, and the incisions were closed without the use of skin graft on postfasciotomy day 2. The patient was discharged the following day with normal neurologic lower extremity function.

Case 2

A man in his mid-30s was bitten by a stray cat in the right volar forearm. He was admitted to an outlying hospital for IV antibiotics and observation after developing significant cellulitis, swelling, and lymphatic streaking. Over the next several days, he continued to experience significant pain and increased swelling despite gradual resolution of the cellulitis. He was transferred to our institution because the referring hospital lacked the surgical capabilities that might be required and because of concern for impending compartment syndrome.

The patient’s medical history included bilateral 2-incision forearm fasciotomies secondary to a crush injury sustained on a construction site approximately 1 year earlier. His incisions were closed 5 days after the fasciotomy without skin grafting and he suffered no residual deficit.

Initial evaluation revealed significant swelling and tight dorsal and volar compartments. The patient had significant pain with passive stretch of the volar compartment. Two-point discrimination and motor function were intact in all dermatomes and myotomes, respectively. His hand was well perfused with demonstrable independent flow through the ulnar and radial arteries as determined by Allen’s testing. Forearm compartment pressures were within 30 mm Hg of the diastolic pressure. He was taken urgently to the operative room for a forearm 3-compartment fasciotomy.

A 2-incision fasciotomy utilizing his previous scars was

by several factors, including the ischemic tolerance of the affected tissue and the magnitude and duration of the insult.⁴ Sequelae of missed compartment syndrome can be devastating and irreversible.^{2,4-6,12,13} Because of this, early diagnosis and decompression are imperative.

Few guidelines exist to definitively make the diagnosis. It also remains difficult to differentiate traumatic pain from compartment syndrome.⁵ The often-cited diagnostic criteria of pain “out-of-proportion” exacerbated by passive stretch can be difficult if not impossible to render in obtunded patients, further complicating and potentially delaying the diagnosis.^{7,14-16} Sensory, motor, or vascular dysfunction is a late sequela of compartment syndrome. The sole objective criterion available is measurement of intracompartmental pressures. Though helpful, measured pressures may vary significantly by location of measurement, user variability, and type of device used.^{1,17-19} Therefore, experience and clinical suspicion remain integral to an accurate and timely diagnosis.

To our knowledge, acute compartment syndrome occurring after a previous fasciotomy has not been described. Among EICS patients, 11% were found to experience recurrent exercise-induced pain after fascial release.²⁰ Several of these recurrences were attributed to scarring together of fascia after subcutaneous release. This type of release was noted to be significantly less effective than open techniques, and nearly 80% of these failures were relieved by repeat open fasciotomy.²⁰⁻²² None of these reported cases developed fulminant CS or required acute release.

In each of our cases, the patient had previously undergone open fasciotomy. After subsequent injury, they developed recurrent, acute compartment syndrome in the previously released compartments. At surgery, the fascia overlying the affected compartments was intact, appeared normal,

and required release to alleviate the CS. Unfortunately, a sample of the fascia was not sent to pathology for microscopic evaluation. The time for the fascia to heal or remodel is unknown. In the reported cases, the recurrent CS was separated by several months from initial CS. It is our assumption that the time needed for the fascial layer to heal may parallel the time needed for normal tissue healing.

It is important to be aware that compartment syndrome can recur after previous fascial release, and in our experience, the clinical picture is similar to a primary CS. As the fascia appeared normal at reoperation, it is our opinion that these patients should be treated as if they have a primary, acute CS, and they require urgent fasciotomy.

CONCLUSIONS

Compartment syndrome is a potentially devastating problem. The diagnosis is primarily a clinical one and requires careful assessment and suspicion. These reports illustrate a previously unreported at-risk population. CS can recur in a previously released compartment. Prior fasciotomy is not protective against acute CS, and these patients should be evaluated and managed no differently from patients with primary CS.

AUTHORS' DISCLOSURE STATEMENT

The authors report no actual or potential conflict of interest in relation to this article, including employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding in relation to this submission.

REFERENCES

1. Olson SA, Glasgow RR. Acute compartment syndrome in lower extremity musculoskeletal trauma. *J Am Acad Orthop Surg*. 2005;13(7):436-444.
2. Weiner G, Styf J, Nakhostine M, Gershuni DH. Effect of ankle position and a plaster cast on intramuscular pressure in the human leg. *J Bone Joint Surg Am*. 1994;76(10):1476-1481.
3. Shakespeare DT, Henderson NJ. Compartmental pressure changes during calcaneal traction in tibial fractures. *J Bone Joint Surg Br*. 1982;64(4):498-499.
4. McQueen MM, Gaston C, Court Brown CM. Acute compartment syndrome: who is at risk? *J Bone Joint Surg Br*. 2000;82(2):200-203.
5. McQueen MM, Christie J, Court-Brown CM. Acute compartment syndrome in tibial diaphyseal fractures. *J Bone Joint Surgery Br*. 1996;78(1):95-98.
6. Forabeck CH. The treatment of compartment syndromes of the leg. *J Bone Joint Surg Br*. 1984;66(1):93-97.
7. McQueen MM, Court-Brown CM. Compartment monitoring in tibial fractures. The pressure threshold for decompression. *J Bone Joint Surg Br*. 1996;78(1):99-104.
8. Boody AR, Wongworawat MD. Accuracy in the measurement of compartment pressures: a comparison of three commonly used devices. *J Bone Joint Surg Am*. 2005;87(11):2415-2422.
9. Bernot M, Gupta R, Dobrasz J, Chance B, Heppenstall RB, Sapega A. The effect of antecedent ischemia on the tolerance of skeletal muscle to increased interstitial pressure. *J Orthop Trauma*. 1996;10(8):555-559.
10. Har-Shai Y, Silbermann M, Reis ND, et al. Muscle microcirculatory impairment following acute compartment syndrome in a dog. *Plast Reconstr Surg*. 1992;89(2):283-289.
11. Heckman MM, Whitesides TE Jr, Grewe SR, Judd RL, Miller M, Lawrence JH 3rd. Histologic determination of the ischemic threshold of muscle in the canine compartment syndrome model. *J Orthop Trauma*. 1993;7(3):199-210.
12. Gelberman RH, Szabo RM, Williamson RV, Hargens AR, Yaru NC, Minter-Convery MA. Tissue pressure threshold for peripheral nerve viability. *Clin Orthop*. 1983;178:285-291.
13. McQuillan WM, Nolan B. Ischemia complicating injury: a report of thirty-seven cases. *J Bone Joint Surg Br*. 1968;50(3):482-492.
14. Forabeck CH, Bourne RB, Fowler PJ, Finlay JB, Nott L. The role of tissue pressure measurement in diagnosing chronic anterior compartment syndrome. *Am J of Sports Med*. 1988;16(2):143-146.
15. Whitesides TE, Haney TC, Morimoto K, Harada H. Tissue pressure measurements as a determinant for the need for fasciotomy. *Clin Orthop*. 1975;113:43-51.
16. Ouellette EA. Compartment syndrome in obtunded patients. *Hand Clin*. 1998;14(3):431-450.
17. Heckman MM, Whitesides TE Jr, Grewe SR, Rooks MD. Compartment pressure in association with closed tibial fractures. The relationship between tissue pressure, compartment, and the distance from the site of the fracture. *J Bone Joint Surg Am*. 1994;76(9):1285-1292.
18. Moed BR, Thorderson PK. Measurement of intracompartmental pressure: a comparison of the slit catheter, side-ported needle, and simple needle. *J Bone Joint Surg Am*. 1993;75(2):231-235.
19. Seiler JG 3rd, Womack S, De L'Aune WR, Whitesides TE, Hutton WC. Intracompartmental pressure measurements in the normal forearm. *J Orthop Trauma*. 1993;7(5):414-416.
20. Turnipseed W, Detmer DE, Girdley F. Chronic compartment syndrome: an unusual cause for claudication. *Ann Surg*. 1989;210(4):557-563.
21. Detmer DE, Sharpe K, Sufit RL, Girdley FM. Chronic compartment syndrome: diagnosis, management, and outcomes. *Am J Sports Med*. 1985;13(3):162-170.
22. Detmer DE. Diagnosis and management of chronic compartment syndrome of the leg. *Semin Orthop*. 1988;3(1):223-233.

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