Utilization of Fluorescence Microangiography in Pediatric Acute Compartment Syndrome: A Case Report

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Statement of Purpose

Isolated pedal compartment syndrome in the pediatric population has been seldom reported. Our case study demonstrates the utilization of serial microangiography to monitor progression of acute ischemia associated with acute pediatric compartment syndrome.

Literature Review

Acute compartment syndrome is a critical condition with many reported causes including high energy trauma, fractures, crush injuries, IV infiltration, and congenital hemangioma (1-7). Early recognition and emergent fasciotomy are imperative to prevent permanent functional damage. Diagnosis can often be delayed in the pediatric population due to communication barriers, fear and lack of participation during examination.

The average time from injury or hospital admission to surgical fasciotomy has been reported between 12.1 to 32.8 hours in pediatric patients (1,2,6). Studies have, however, shown excellent functional outcome scores in up to 87% of pediatric patients in cases of delayed surgical fasciotomy up to 72 hours post-injury (2,5,6).

Case Study

A 5-year old healthy female presented with her parents to our Emergency Department in May of 2017 approximately 30 minutes after sustaining an isolated crush injury to her left foot (Fig. 1). She dropped a 35 pound weight from chest height, resulting in immediate pain and swelling of the affected extremity.

Figure 1

Figure 2

Case Study Continued

She demonstrated no outward signs of agitation or anxiety and was vitally stable. Left lower extremity examination revealed edema and ecchymosis to the distal forefoot, absent capillary refill and protective sensation to digits 3, 4 and 5, pain with dorsiflexion and plantarflexion of digits 3, 4 and 5, as well as diffuse palpatory tenderness to the distal forefoot. A superficial abrasion overlying the third metatarsal shaft was present. Dorsalis pedis and posterior tibial pulses were palpable and all compartments of the foot were soft.

Plain radiographs revealed subtle displaced fractures of the fourth and fifth middle phalanx (Fig. 2). The patient was admitted for antibiotics and serial neurovascular examinations. She began hyperbaric oxygen therapy with serial fluorescence microangiography studies to monitor progression of ischemia.

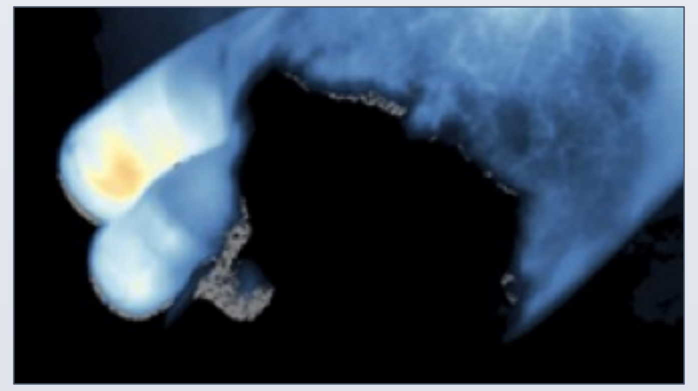

Figure 3

The first fluorescence microangiography study was performed at seventeen hours post-injury to evaluate tissue perfusion (Fig. 3). This demonstrated hypo-fluorescence to digits 3, 4 and 5, as well as the distal lateral midfoot which was thought to be caused in part by hematoma formation.

During a serial neurovascular exam 26 hours post-injury, she reported increased pain and was requesting pain medication for the first time. On exam, there was increased edema, pain on palpation and inability to plantarflex or dorsiflex all digits (Fig. 4). The decision was made to proceed emergently with surgical fasciotomy due to concern for compartment syndrome.

Figure 4

Case Study Continued

Fasciotomy was performed in the operating room through a single 6 centimeter dorsal incision overlying the third interspace (Fig. 5). The second, third and fourth interspaces were explored with no evidence of muscle necrosis. A large hematoma was evacuated and an active arterial bleed was identified and cauterized. Immediate visual improvement of digital perfusion was noted (Fig. 6); however, the distal most aspects of digits four and five remained dusky with a guarded prognosis. The incision was left open with anticipated closure via secondary intention.

Figure 5

Figure 6

Progress was monitored with serial microangiography studies at one and three weeks post-injury (Fig. 7, 8). These demonstrated normalized perfusion to the dorsal left foot and third digit. Perfusion was improved to digits 4 and 5; however, the distal tips remained dark with no indications of perfusion. By four month follow up, the fasciotomy incision was healed and she had successfully autoamputated the distal aspects of digits four and five without complication (Fig. 9, 10). At 12 month follow up she had returned to all pre-injury activities without pain, sensory deficits or functional disabilities.

Figure 9

Figure 10

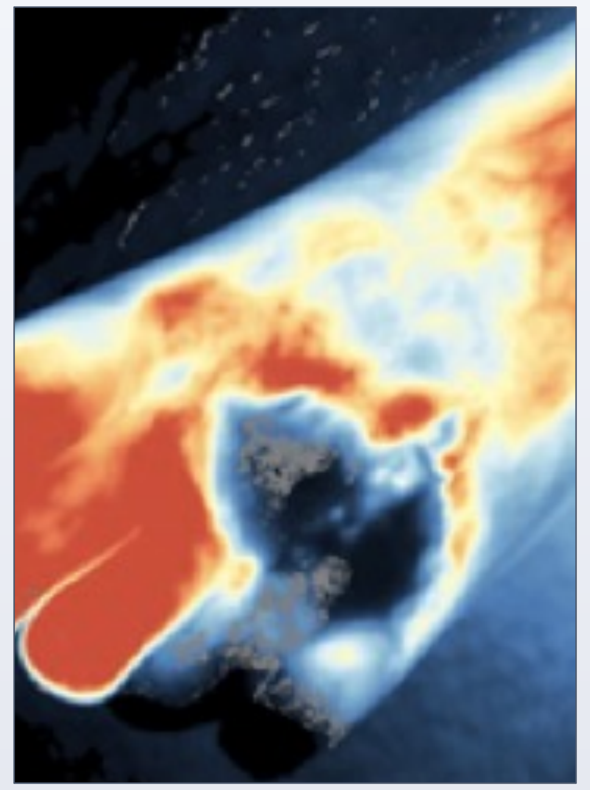

Figure 7

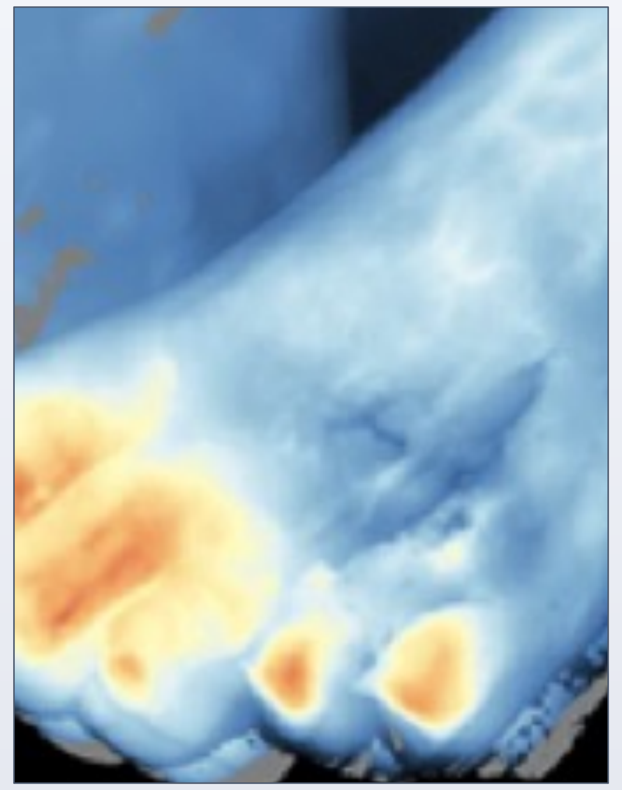

Figure 8

Analysis and Discussion

The use of fluorescence microangiography has been widely reported in cardiovascular, ophthalmologic, transplant and plastic and reconstructive surgery (8-10); however, it has more recently been recognized as a valuable tool in limb salvage (11-12). Emergent hyperbaric oxygen therapy as well as serial microangiography studies have become an important cornerstone of the treatment algorithm for lower extremity crush injuries at our facility.

Fluorescence microangiography utilizes indocyanine green (ICG) fluorescent dye and near-infrared laser camera technology to provide real-time angiographic images representing tissue viability within 3-5mm of skin surface. ICG is metabolized in the liver, making it safe to use in cases of large crush injuries in which renal dysfunction due to rhabdomyolysis or acute tubular necrosis is of concern (11-12).

Once ICG enters the bloodstream, it rapidly binds to plasma proteins, entering the microcirculation around and within the wound. The machine's central processing unit then transforms this information into real time images of tissue perfusion, displaying these on the viewing screens. These images are then used to assess wound healing progress and further guide wound management to optimize attempts at limb salvage (8).

Analysis and Discussion Continued

Trauma is the most common cause of acquired distal extremity amputations in the pediatric population (9). Discussing amputation in the setting of acute trauma can be a difficult conversation to lead. Serial fluorescence angiography can be useful for predicting outcomes of acute ischemia, including ultimate level of amputation. This can be a useful tool to help guide these difficult discussions and visually represent probable outcomes to patients and their families.

In conclusion, compartment syndrome is a critical, time-sensitive condition that requires a high index of suspicion as well as emergent evaluation and treatment. Standard care including early fasciotomy, local wound care, serial examinations and pressure monitoring is well established. Further adjunctive considerations should include the use of hyperbaric oxygen therapy and monitoring of acute ischemia with serial fluorescent microangiography studies.

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