Forearm Fasciotomy for Acute Compartment Syndrome: A New Technique for Delayed Primary Closure

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Introduction

Forearm compartment syndrome is an entity often associated with upper extremity trauma. Early diagnosis and treatment (fasciotomy) is essential for a successful outcome. Usually, the amount of swelling is so great that primary closure within a reasonable time period is impossible. Skin grafting is therefore employed in an effort to gain coverage and minimize hospital stay. A new technique, using rubberbands, is presented in this article. The technique eliminates the need for skin grafting (and its associated morbidity), and permits delayed primary closure within a reasonable time frame.

Case 1

A.C., a 61-year-old black male, was being treated with chronic systemic anticoagulants for a previous prosthetic aortic valve replacement. He was taking 7.5 mg of Coumadin per day. He presented to the emergency room after falling from a height of 10 feet while intoxicated. The patient denied any head injury or loss of consciousness, but complained of severe right elbow pain. Upon initial examination, the patient had a markedly swollen right elbow which was tender over the olecranon. The distal pulses were intact and a neurologic exam was unremarkable. X-rays of the elbow showed marked soft tissue swelling, but no fractures (Fig. 1). Prothrombin time was 64 sec (normal: 12.2 sec to 13.0 sec). Over the ensuing 30 min, the patient began to complain of increasing pain in the right elbow and the forearm as well as numbness in the hand. At this time the forearm was tense. The entire hand was hypoesthetic, and the patient was unable to actively flex or extend his fingers. Also, there was pain with passive flexion or extension of the fingers (Fig. 2). Compartment pressures were obtained using the Whitesides technique. The dorsal compartment measured 35 mmHg, and the volar compartments measured 70 mmHg, both deep and superficial. Anticoagulation was reversed with fresh frozen plasma and cryoprecipitate, and within one
Fig. 2: The forearm is swollen and the skin is tense. At this point the patient's hand was numb, and there was pain with passive flexion and extension of the fingers.

Fig. 3: Immediately following skin incision, the volar forearm musculature is noted to be contained within its taut fascial envelope.

Fig. 4: Following complete volar fasciotomy, the forearm musculature is noted to be extremely swollen and edematous.

Fig. 5: Skin staples are placed along the skin edges and a large rubber band (cut vessel loop) is then threaded through the staples in a criss-cross fashion.

hour, a volar fasciotomy was performed along with a carpal tunnel release (Fig. 3). Figure 4 shows the entire volar forearm after complete fasciotomy. Dorsal compartment pressures were again obtained and found to be less than 5 mmHg. A dorsal fasciotomy was therefore not performed.

The incision edges were approximated with a new technique using cut vessel loops and skin staples. Skin staples were placed along the edge of the incision. A large rubber band (cut vessel loop) was then threaded through the staples in a criss-cross fashion (Fig. 5). Finally, the rubber bands were tied to exert mild tension on the skin edges (Fig. 6). The open wound was then dressed with saline soaked gauze, and the forearm splinted for comfort. Postoperatively, the patient's neurovascular exam was normal, and he was able to flex and extend his fingers without pain.

Wound care consisted of keeping the dressing moist with sterile saline solution. The patient was taken back to the operating room two days later for a dressing change: at that time the rubber bands were tightened and the skin edges further approximated (Fig. 7). On postoperative day five, the dressing was again changed and the wound was noted to be clean. In the process of tightening the rubber bands, it appeared that the skin edges would come together (Fig. 8). With minimal undermining (Fig. 9), the skin edges were brought together and closure performed using skin staples. At 6 months postoperatively, the incision had totally healed and the patient had regained full function of the extremity (Fig. 10).

**Case 2**

B.D., an 18-year-old male, fell 80 ft from a bridge.
After examination in the emergency room, injuries were found to include a fracture dislocation of the left elbow, a left pubic ramus fracture, a grade 1 open, both-bone forearm fracture at the junction of the middle and distal one-third of the forearm, and a splenic rupture. After stabilization the patient was taken to the operating room where the spleen was repaired. The elbow dislocation was reduced and noted to be stable. By this time, the forearm was noted to be quite swollen and the skin was tense. Forearm compartment pressures were noted to be greater than 60 mmHg in both the dorsal and volar compartments. A volar fasciotomy was performed, compartment pressures were then measured again and noted to be normal. An external fixator was applied for skeletal stability; the skin edges were approximated using the rubberband technique described previously. At 48 hours, the dressing was changed in the operating room and the rubberbands tightened. At five days postoperatively, the swelling had diminished and the incision could be closed. The other injuries have since resolved, and the patient now has full hand function with residual sequela.

**Discussion**

Compartment syndrome associated with upper extremity trauma is a well described entity. Permanent muscle and nerve damage is not uncommon if diagnosis is delayed. The diagnosis is dependent upon accurate intracompartmental measurements. A pressure reading of greater than 30 mmHg is highly suggestive of a compartment syndrome. In addition, the absence of normal sensation, tense skin, and pain with passive stretch of the forearm tendons, is an indication for forearm fasciotomy.
If the fasciotomy is performed within six hours, the damage usually is reversible and normal function returns. However, even with prompt fasciotomy, often the swelling is so massive, that it may take weeks before the swelling subsides and the skin can be approximated. It is for this reason that split thickness skin grafting is often implemented in an effort to shorten hospital stay. Even though skin grafting has been highly successful in this setting, it is not without its problems, which include: 1) pain at the donor site; 2) infection at the donor or recipient site; 3) incomplete graft take; and 4) cosmesis (the most ideal skin graft does not afford the cosmetic appeal of a delayed primary closure). This is especially true in the upper extremity, which cannot be easily hidden from public view.

The technique presented in this article represents an effort to eliminate the need for skin grafting, and keep hospital stay to a minimum. The rubberbands, as they are threaded through the staples, provide constant tension at the skin edge. The risk of infection theoretically should be decreased since the wound is left open. It is important to check the skin for any discoloration and adjust the tension accordingly. In the cases presented, the skin was closed at five days, without the need for grafting.

Though skin grafting has been very successful following fasciotomy, there is a definite associated morbidity. The rubberband technique described here provides for a more cosmetic closure without lengthening hospital stay or increasing the risk of infection.

References


Editorial Discussion
Orthopedics: Have you had any experience with the new type of protective metal clip which has been utilized for gradual closure of wounds?
Cohn: We do not have experience with the protective metal clip device; however, from our understanding, it is conceptually very similar to the method that we describe. The advantage of our method is that the materials needed are readily available in most orthopedic operating rooms, with no special purchase required.
Orthopedics: Do you have any experience in non-closure of these wounds? Specifically, many physicians in the Armed Services were taught to treat these wide open wounds with plaster dressing without any closure. It was commonly noted upon removal of the plaster dressing at 4 to 6 weeks, that the wounds had healed with resultant fine, linear scars.
Cohn: No, we do not have experience with non-closure of these wounds as described to be used by physicians in the Armed Services. In our experience, however, these injuries are usually the result of high energy sustained by the soft tissues. For this reason, we like to monitor the wound for early signs of infection, skin slough, etc. One would think that this assessment would be much more different if the wound was hidden under plaster for 6 weeks.