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Management of extremity fasciotomy sites prospective randomized evaluation of two techniques

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ABSTRACT

Introduction: Morbidity from the treatment of extremity compartment syndrome is underappreciated. Closure technique effectiveness has yet to be definitively established.

Methods: A randomized non-blinded prospective study was performed involving patients who underwent an extremity fasciotomy following trauma. Shoelace wounds were strapped with vessel loops under tension and VAC wounds were treated with a standard KCI VAC dressing. After randomization, patients returned to the OR every 96 h until primarily closed or skin grafted.

Results: 21 patients were consented for randomization with 11 (52%) successfully closed at the first re-operation. After interim analysis the study was closed early with 5/5 (100%) of wounds treated with the shoelace technique closed primarily and only 1/9 (11%) of VAC wounds closed primarily ($p = 0.003$). Overall primary closure was achieved in 74% of patients.

Conclusions: Aggressive attempts at wound closure lead to an increased early closure rate. For wounds that remain open after the first re-operation, a simple shoelace technique is more successful than a wound VAC for achieving same hospital stay skin closure.

Summary: Primary closure of fasciotomy wounds is the optimal outcome for mechanical function and patient satisfaction. This prospective randomized controlled trial suggests primary closure can be achieved at rates better than previously reported in the literature, with a regimented approach to wound evaluation and a simple, cost-effective technique.

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Introduction

While the indications for fasciotomies are generally well

understood,¹ the morbidity associated with this potentially limb saving procedure is significant. Early complications include soft tissue infections, osteomyelitis, pain, and deep venous thrombosis related to immobility.² In addition, long term sequelae have been described including increased limb circumference, reduced range of motion, paresthesias, reduced muscle strength, chronic pain, pruritis, contractures, ulceration, edema, muscle herniation, discoloration, and general discontent with the injured limb.^{2–7} If altered sensation is included, these sequelae affect up to 95% of all patients, and even with the exclusion of paresthesias and anesthesias, 81% of fasciotomies have long-term complications.⁴

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The ability to cover lower limb fasciotomies with native, local skin is associated with improved functional and cosmetic outcomes. Unfortunately, as few as 23% of patients are able to undergo complete skin coverage by delayed primary closure.² This leaves up to 77% of patients requiring split thickness skin grafts (STSG) to provide appropriate site coverage. While some authors have increased the rate of successful delayed primary closure up to 51%, a significant number of patients are still left with difficult wound care issues.³ This fact has led to a number of mechanical assist devices which appear to increase closure rates to varying degrees.^{8–10} Unfortunately, these studies are limited by small patient numbers and are extremely institution dependant. As a result, the majority of trauma centers employ a limited number of techniques, with the most common being the “shoelace” technique, or a modification thereof.^{10–15} The advantage of this methodology is that it is simple, cost effective, ubiquitous and utilizes the skin's natural tendency for biologic creep. It is also possible to tighten the “shoelace” at bedside. With this technique, closure rate of up to 100% have been reported over 5–21 days.^{16–21}

A different technique that has significant proponents is the application of a negative pressure device (vacuum assisted closure – V.A.C r, KCI Systems San Antonio TX). This device has become commonplace in the management of wounds on the general and plastic surgery services, and is currently used as a standard option for assisting patients with the closure of their fasciotomy wounds.¹ Fasciotomy closure rates in the literature using the VAC device have been mixed. One retrospective study comparing VAC to dynamic tension created by the shoelace technique demonstrated a trend favoring VAC in the rates of primary closure; a second demonstrated significant increase in rates of STSG.^{22,23} Several studies of the VAC technique compared with historic controls reported a shorter time to skin coverage, but no significant reduction in the requirement for STSG.²⁴

We initiated a prospective randomized trial to examine the effectiveness of the “shoelace” technique and the VAC technique in achieving primary skin closure of fasciotomy wounds.

Patients & methods

This study was reviewed and approved by the Emory University Institutional Review Board (IRB). All patients who met standard institutional criteria for undergoing an extremity fasciotomy following traumatic injury were considered for inclusion in this study. This included patients with primary compartment syndrome from their injury, or secondary extremity compartment syndrome after fluid resuscitation. Patients less than 18 years of age and prisoners were excluded. Informed consent for the study was obtained from the patient or the patient's surrogate between the initial operation and the first return to the operating room.

Fasciotomy wounds were dressed with wet gauze dressings at the time of the initial operation, per standard institutional practice. Within 72 h from the initial decompression, the patient was taken back to the operating room, at which time the attempt was made to primarily close the wound. If the wound could not be closed, the patient was at this time randomized to either V.A.C. or shoelace dressings (Fig. 2). The patient was then returned to the operating room approximately every 96 h to attempt closure; if this failed, the same dressing was reapplied. Attempts at closure continued until the treating team was successful, or considered it futile, at which time a split thickness skin graft was performed. Between closure attempts, the VAC dressing was changed every 48 h, and patients with the Shoelace closure had their superficial dressings changed and the shoelaces tightened as appropriate every 48 h. A condensed flow diagram for this study is presented in Fig. 1. Futility of treatment arm was left at the discretion of the operative surgeon of the

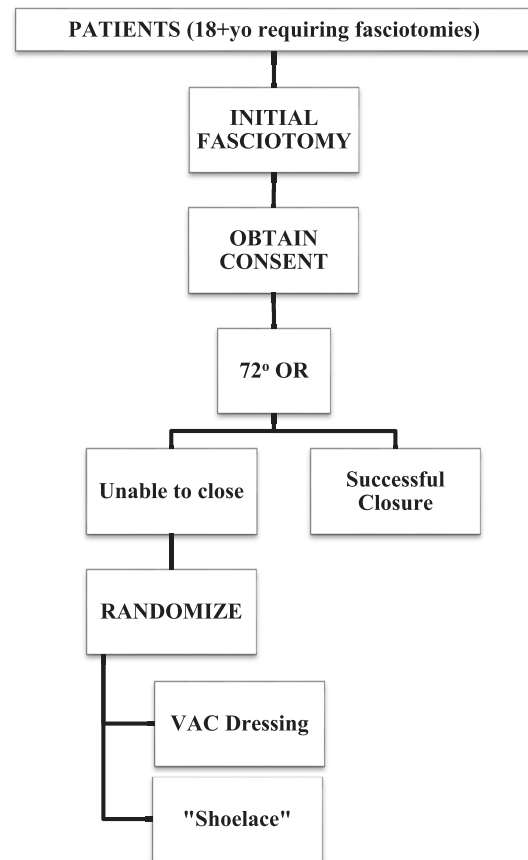


Fig. 1. Enrollment protocol flow diagram.

day; patients who did not undergo primary closure underwent skin grafting.

The primary outcome measure was primary wound closure; secondary measures included time to definitive closure and number of trips to the operating room. Previous, but limited literature on the closure of lower extremity fasciotomies suggested a failure rate of the VAC procedure approximating 27%. In the absence of better data regarding rates of closure in these patients, this was assumed to represent the event rate. A rate of 0.50 in the shoelace patients was assumed. Thus the study was powered as a trial of equivalence with an event rate difference of 0.27 between study groups. In order to detect a difference of 0.27 in the outcome rate, with an alpha of 0.05, and a Power of 90% ($B = 0.10$), the enrollment target was 17 patients in each group.

This study was approved by the Emory Institutional Review Board.

Results

Twenty one patients were enrolled in this study prior to early termination (see below). The mean age was 32 ± 13 years, with 9.5% of patients female. The injury patterns were primarily penetrating (76% penetrating, 24% blunt), with an average ISS of 9.4 ± 6.7 . All fasciotomies done were therapeutic rather than prophylactic, and all were performed by the same general surgery group. There were a total of 47 separate wounds, with an average wound size of $240 \pm 85 \text{ cm}^2$; 15% (7/47) wounds were upper extremity forearm fasciotomies, 4% (2/47) were thigh fasciotomies, and the remaining 81% (38/47) were leg fasciotomies. All leg fasciotomies were performed using a two incision approach.

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