Joint Diseases and Related Surgery

Jt Dis Relat Surg
2023;34(2):497-502

ORIGINAL ARTICLE

Comparison of dermatotraction and negative pressure wound therapy for closure of cruris fasciotomy after 2023 Kahramanmaras earthquake

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ABSTRACT

Objectives: This study aims to evaluate the results of patients who underwent cruris fasciotomy for acute compartment syndrome (ACS) after the 2023 Kahramanmaras earthquake and used subcuticular polydioxanone (PDS) method or negative pressure wound therapy (NPWT) with vacuum-assisted closure (VAC) for fasciotomy follow-up and closure of the defect.

Patients and methods: Between March 2023 and April 2023, a total of 52 patients (31 males, 21 females; mean age: 29±14.8 years; range, 5 to 74 years) were retrospectively analyzed. The patients were divided into two groups as the dermatotraction (PDS) group (Group 1, n=30), and the VAC group (Group 2, n=22). Data including demographic, clinical, and operative data such as fasciotomy closure time, graft need, and infection rate were recorded.

Results: More grafts were needed to close the fasciotomy in patients followed with VAC. The mean closure time of the fasciotomy was 25.9±3.8 days in the PDS group and 27.3±3.5 days in the VAC group, indicating no significant difference between the groups (p=0.738). There was no significant difference in the rate of wound infection between the two groups (p=0.482).

Conclusion: Our study results suggest that more grafts are needed to close the fasciotomy in patients followed with VAC; however, it seems to increase the cost of the treatment.

Keywords: Acute compartment syndrome, dermatotraction earthquake, fasciotomy, negative pressure wound therapy.

Acute compartment syndrome (ACS) is an emergency situation in which tissue perfusion is impaired and requires early surgical intervention due to life-threatening risks. With early surgical intervention, it is aimed to save the tissue without necrosis. Nearly 75% of cases of compartment syndrome encountered in our daily practice develop with fractures or for reasons such as tight plaster cast treatment after fracture surgery. Much more rarely, compartment syndrome may develop due to reasons such as anticoagulant use or bleeding disorder.[1]

In addition to progressive swelling of the extremity after a fracture, crush injury increases the mass within the myofascial compartment due to the accumulation of blood and fluid. As the muscle fascia is inelastic, the increased mass causes increased pressure within the compartment. With the onset of cellular death, cell membrane lysis releases osmotically active cellular contents into the interstitial space, causing further accumulation of fluid and a further increase in the intracompartmental pressure.[2] Fasciotomy is the main treatment method owing to its short surgical time and rapid decrease of compartment pressure.

Received: March 24, 2023
Accepted: April 23, 2023
Published online: May 18, 2023

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Citation: Kılıçarslan K, Erdoğan Y, Karaman Y, Alkan H, Biçici V. Comparison of dermatotraction and negative pressure wound therapy for closure of cruris fasciotomy after 2023 Kahramanmarasearthquake.JtDisRelatSurg2023;34(2):497-502.doi: 10.52312/jdrs.2023.1119. doi: 10.52312/jdrs.2023.1119.

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Timing of fasciotomy after ACS is critical. Fasciotomy should be performed, before an irreversible damage occurs. In the literature, it has been emphasized that fasciotomy should be opened directly in patients with suspected compartment syndrome by clinical examination, and that the surgeon should be in favor of opening fasciotomy to avoid irreversible losses.[2]

However, the care of the skin defect after fasciotomy and its closure in a timely manner is a challenge for many surgeons. The resulting defect poses a serious risk for the development of other complications, such as infection. In addition, the reasons such as an extremely high number of cases in natural disasters such as earthquakes, interruptions in healthcare services due to natural disasters, and delayed interventions due to the prolonged and difficult recovery from the wreckage also affect the recovery process. Therefore, the follow-up and closure of fasciotomy defects become even more important. Many closure methods have been described in the literature for the care and closure of fasciotomy defects, such as negative pressure wound therapy (NPWT) using vacuum-assisted closure (VAC), various dermatotraction methods such as vessel sling, shoelace, intracutaneous approximation or subcuticular polydioxanone (PDS). However, there is no consensus on which method is more effective.[3-5]

In the present study, we aimed to evaluate the results of patients who applied to our hospital with ACS and underwent fasciotomy after the 2023 Kahramanmaras earthquake, which affected 11 provinces of Türkiye, and used subcuticular PDS method or NPWT for fasciotomy follow-up and closure of the defect.

PATIENTS AND METHODS

This single-center, retrospective study was conducted at Ankara Bilkent City Hospital, Department of Orthopedics and Traumatology between March 2023 and April 2023. Patients who were referred to our center and underwent fasciotomy due to ACS were included. The diagnosis of ACS was made based on the physical examination findings. Pain, pulselessness, paralysis, paresthesia and pallor were evaluated. The presence and progression of tension over the compartment was examined. The patients who were diagnosed with cruris compartment syndrome in our hospital, who underwent double-incision (medial and lateral) fasciotomy, and who were referred to our hospital after double-incision fasciotomy was performed within the first 48 h for compartment syndrome in the earthquake area were included in the study. Patients with fractures of the tibia or fibula, open injury to the cruris, or patients who underwent repair due to vascular damage and developed compartment syndrome were excluded from the study. There were 57 patients who met the criteria and five patients who underwent three dermatotraction and two NPWT were excluded from the study due to amputation during follow-up. Finally, a total of 52 patients (31 males, 21 females; mean age: 29±14.8 years; range, 5 to 74 years) were included. The patients were divided into two groups as the dermatotraction (PDS) group (Group 1, n=30), and the VAC group (Group 2, n=22). Data including demographic, clinical, and operative data such as fasciotomy closure time, graft need, and infection rate were recorded.

The PDS group patients were rinsed and debrided after fasciotomy and closed with sterile wet dressing (dressing containing nitrofurazone-rifamycin). After waiting for three days and the excessive edematous process subsided, dermatotraction was started with the subcutaneous suture method using a round-tipped 1 size PDS (Neoxone, Izmir, Türkiye). It was closed with a wet dressing (Figure 1). Dermatotraction was continued with washing and debridement and subcuticular PDS application in the operating room setting every three days. In each session, it was aimed to bring the fasciotomy a little closer according to the tissue status (tissue edema, circulation of the skin tissue) in the cruciate. After each approach, the patients were closely followed for ACS.

The VAC group patients were applied immediately after fasciotomy in continuous mode with a pressure of 100 mmHg. Debridement was performed in the operating room setting every three days and, after rinsing, the wound was closed again with the NPWT method (Figure 2).



FIGURE 1. Dermotraction method with subcuticular polydioxanone.



FIGURE 2. After vacuum-assisted closure, the granulation tissue.

Tissue culture was sent during debridement in both groups. In case of reproduction, appropriate antibiotics were initiated based on the consultation to the Clinical Microbiology and Infectious Diseases.

Statistical analysis

Statistical analysis was performed using the SPSS version 18.0 software (SPSS Inc., Chicago, IL, USA). Descriptive data were presented in mean ± standard deviation (SD), median (min-max) or number and frequency, where applicable. Categorical variables were compared using the chi-square or Fisher exact test. Pairwise comparisons were made using the Mann-Whitney U test. A p value of <0.05 was considered statistically significant.

RESULTS

There was no statistically significant difference in the age of the patients between the two groups (p>0.05).

According to the fasciotomy closure method, 14 (46.6%) of 30 patients in Group 1 were closed primarily, while 16 (53.4%) patients were closed with skin grafts. In Group 2, four (18.18%) patients were closed primarily, while 18 (81.81%) patients were closed with skin grafts. The rate of primary wound closure was statistically significantly higher in Group 1 than Group 2 (p=0.02).

According to the closure time of the fasciotomy, the mean closure time was 25.9±3.8 days in Group 1 and 27.3±3.5 days in Group 2. There was no statistically significant difference between the two groups in terms of closure time of the fasciotomy defect (p=0.738).

Sixteen (53%) of the patients in Group 1 and 10 (45%) patients in Group 2 had infection at the wound site. Microorganisms grown in tissue

TABLE I
Patients with positive culture test results

Patients	Group 1 (Dermotraction)	Patients	Group 2 (VAC)
1	*Enterococcus faecium*	1	*Pseudomonas aerugonisa*
2	*Acinetobacter baumanni*	2	*Enterococcus faecium*
3	*Acinetobacter baumanni*	4	*Acinetobacter denitrificans*
4	*Pseudomonas aerugonisa*	5	*Serratia marcescens*
9	*Acinetobacter baumanni*	6	*Pseudomonas aerugonisa*
12	*Acinetobacter baumanni*	8	*Stafilococcus haemolyticus*
13	*Klebsiella pneumoniae*	10	*Proteus miabilis*
18	*Pseudomonas aerugonisa*	11	*Pseudomonas aerugonisa*
20	*Klebsiella pneumoniae+acinetobacter baumanni*	14	*Acinetobacter baumanni*
21	*Acinetobacter baumanni*	16	*Pseudomonas aerugonisa*
23	*Acinetobacter baumanni*		
26	*Pseudomonas aerugonisa*		
27	*Enterobacter cloacea*		
28	*Pseudomonas aerugonisa*		
29	*Acinetobacter baumanni*		
30	*Klebsiella pneumoniae*		

VAC: Vacuum-assisted closure.

TABLE II
Closure time, graft need, infection rate

	Closure time (day)	Graft need		Infection rate
		n	%	%
Group 1	25.9	16	53.4	53
Group 2	27.3	18	81.18	45

culture samples taken from the fasciotomy line of the patients in each group are given in Table I. There was no statistically significant difference in the rate of infection between the groups (p=0.482).

DISCUSSION

In the present study, we evaluated the results of patients with ACS who underwent fasciotomy with subcuticular PDS method or NPWT for the closure of the defect. The main finding of our study was that the need for skin grafts was less in patients who underwent dermatotraction with subcuticular PDS compared to the patients followed with VAC, and that more patients could be closed with primary closure.[6] This result indicates that patients undergoing fasciotomy with the dermatotraction method have reduced need for skin graft or other soft tissue reconstructions. Another important finding of our study was that there was no significant difference in terms of tissue closure times and wound infection between the groups. Therefore, both methods are equally effective in terms of wound closure time and protection from infection.

Early fasciotomy is the most important step in the treatment of compartment syndrome.[7,8] However, fasciotomy wounds significantly prolong hospital stay and pose a serious challenge for skin closure or reconstruction. The fasciotomy wound should be closed as soon as possible to reduce infection and scar tissue formation after the compartment pressure decreases and tissue edema regresses.[9] The primary goal in wound closure is primary closure. Theoretically, better functional and cosmetic results are obtained with primary closure. However, it is not always possible due to reasons such as edema in the muscles, skin retraction, and herniation of the muscles.[10] In such cases, VAC closure method is another alternative method, as it provides ease of application and patient follow-up. In the literature, there are different results between dermatotraction and successful primary closure rates. Taylor et al.[11] and Wiger et al.[12] achieved 100% primary closure with the dermatotraction method in their study, while Janzing and Broos[13] achieved 60% primary closure. In the VAC closure method, the primary closure rate is lower. Zannis et al.[14] evaluated 370 cruris fasciotomy cases and reported that the primary closure rate was 79% in patients used with VAC. Similarly, Kakagia et al.[15] reported a primary closure rate of 86% in 42 patients. In a meta-analysis by Jauregui et al.,[5] including 23 studies of patients with post-fracture compartment syndrome and fasciotomy, the success rate of fasciotomy closure with dermatotraction method without the need for grafts was found to be 92% on average, while this success rate in VAC closure was 78%. In the study of Révész et al.,[16] 81.6% of the grafts were needed after VAC. In our study, the graft was needed in 81.81% of the patients in the VAC group, while this rate decreased to 53.4% in the PDS group. Although more primary closure can be achieved in patients undergoing dermatotraction, the need for grafts after fasciotomy was found to be higher in our earthquake victims, unlike those who underwent fasciotomy after fracture in the literature.

Furthermore, there was no significant difference between the two groups in terms of infection development in our study. Infection is an important complication due to the difficulty of wound care in patients after fasciotomy. Negative pressure wound therapy creates a closed environment that protects the wound from the external environment.[17] In addition, VAC is a method that increases wound healing by stimulating angiogenesis and cell division, removing bacteria-rich exudate from wound edges and eliminating edema.[18,19] Kakagia et al.[15] reported infection in 24% of the patients in the VAC group and in 16% of the patients followed with an approximation suture. In a study by Gabriel et al.,[20] none of the patients using VAC developed infection. Contrary to the literature, infection was seen in 53% patients in Group 1 and 45% patients in Group 2 in our study, indicating higher rates than the literature. However, similar to the literature, there was no statistically significant difference between the two groups. While there are mostly case series of patients undergoing fasciotomy after fracture in the literature, the fact that our patient series consisted of those who underwent fasciotomy after an earthquake may explain the high rate of infection. We believe that the prolonged intensive care unit stay of earthquake victims and the high severity of trauma may have played a role in the increased infection rates.

There are many studies in the literature on wound closure with the dermatotraction method. In a study by Kakagia et al.[15] including patients who

developed compartment syndrome after fracture, the mean fasciotomy closure time was 15.1±3.8 days in the dermatotraction group and 19.1±6.1 days in the VAC group. In the study of Weaver et al.,[21] the mean time to closure of fasciotomy was reported as 14.7 days in the patients who underwent VAC fasciotomy. In another study by Fowler et al.,[22] median fasciotomy closure time was reported as 19.2 days in the dermatotraction group. In our patients, the mean duration was 25.9±3.8 days in Group 1 and 27.3±3.5 days in Group 2. The fact that the mean time in our study was longer in both groups compared to the literature can be attributed to the fact that the intervention time may be longer than that of a normal trauma patient, exposure to high-energy trauma under the dent, and consequently increased muscle damage.

Nonetheless, there are some limitations to our study. First, the number of our patients is relatively low, which limits the results of the study. Second, our hospital is not located in the earthquake zone and patients reach our center only by the referral method. Third, the fact that our patients have different durations of being under the dent and the severity of the trauma they are exposed to affects the severity of the injury. In addition, there was a difference in the timing of the intervention due to the different arrival times to our hospital. Finally, some patients were hospitalized in the intensive care unit at different times, which may have affected the probability of infection.

In conclusion, there is still no treatment modality that provides a distinct advantage among different treatment modalities for patients with ACS. In our study, patients who underwent dermatotraction were primarily closed more often, although there was no significant difference in terms of other parameters. Further large-scale, prospective, randomized studies are needed to determine the most ideal method for fasciotomy closure.

Ethics Committee Approval: The study protocol was approved by the Ankara City Hospital Ethics Committee (date: 08.03.2023, no: E1-23-3353). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient and/or parents or legal guardians of the patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Idea/concept: K.K., Y.E., V.B.; Design, control/supervision: K.K., V.B.; Data collection and/or processing, writing the article: Y.E., Y.K.; Analysis and/or interpretation: K.K., Y.E.; Literature review: Y.E.; Critical review: V.B.; References and fundings, materials: Y.K.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

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