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Compartment syndrome as a donor-site complication of anterolateral thigh free flap: a case report

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Compartment syndrome (CS) occurs infrequently as a complication at the donor site of an anterolateral thigh free flap (ALT-FF). We treated a 26-year-old male patient who was a professional soldier with large thigh muscles. A defect on the right ankle was reconstructed with a 30×10-cm² ALT-FF. By the pinch test, the flap width was designed to be sufficient for primary closure of the donor site. However, on postoperative day 8, severe pain, tension, and purulent discharge were found at the donor site. We diagnosed CS clinically, and immediately performed incision and drainage. Various extrinsic and intrinsic factors can influence the development of CS. Therefore, in patients with these contributing factors, such as young men with high muscle mass, a higher level of suspicion for CS is needed. Moreover, it would be safer to design the flap width to be smaller than the pinch test would indicate or to cover the donor site with a skin graft.

Keywords: Compartment syndrome, Free tissue flaps, Postoperative complications, Surgical flaps

Introduction

The anterolateral thigh free flap (ALT-FF) is one of the fasciocutaneous flaps in the thigh based on the septocutaneous or musculocutaneous perforators derived from the lateral circumflex femoral system. The ALT-FF has become one of the major flaps for reconstruction of skin and soft tissue defects since Song et al. [1] first described it in 1984. This flap has gained great popularity due to its versatility, large size, consistent anatomy, and length and caliber of the vascular pedicle, ability for a two-team approach, and minimal donor-site morbidity [2].

However, excessive tension of the donor can lead to wound dehiscence, distal deep venous thrombosis, delayed healing, and the development of an unsightly scar. Although the occurrence of CS as an ALT-FF donor-site complication is infrequent, the consequences can be fatal for the patient.

The maximum width of the flap that allows direct closure of the donor site is not absolutely defined. It is likely to depend upon the entire circumference of the thigh, the relative laxity of the skin and subcutaneous tissue, and various other factors. It is common to allow for a relatively tight donor-site closure. A preoperative pinch test should be performed to assess whether the donor site is capable of primary closure.

In this article, we report a case in which CS developed as a complication at the donor site of ALT-FF in a young male with large muscle mass despite flap width being adequately assessed by the pinch test.

Case report

A 26-year-old male had a right distal tibia and lateral malleolus fracture (Gustilo IIIC) with rupture of Achilles tendon and vessel injuries due to a traffic accident. Two of the three major vessels in the lower extremity, posterior tibial artery, and deep peroneal artery were damaged. After initial treatments from the orthopedic and vascular surgery department, he had a soft tissue defect in his right ankle that was circumferential and exposed to all structures. The defect was reconstructed with a contralateral fasciocutaneous ALT-FF with a size of $30 \times 10 \text{ cm}^2$ (Fig. 1).

The donor site was closed with primary repair. By the pinch test, the flap width was designed to allow primary closure of the donor site. There was a slight resistance during the donor-site closure, but there was no significant difference from our usual surgery.

Postoperative pain relief was delivered by patient-controlled analgesia (PCA) consisting of fentanyl until the postoperative day (POD) 2, and thereafter, conventional analgesics such as nonsteroidal anti-inflammatory drugs and tramadol were used. The patient rested in bed for 5 days to stabilize the surgical site.

On POD 8, purulent discharge was found between the sutures on the donor site. A physical examination revealed severe tenderness and severe pain with passive flexion and rotation of the thigh. The thigh was red, tense, and firm. Accordingly, we immediately made a clinical diagnosis of CS. He had severe pain in the donor site before POD 8, but he did not inform the medical staff because he thought it was normal pain after surgery, and eventually the diagnosis of CS was delayed. Fluctua-

tion on palpation was confirmed, and we immediately performed an incision and drainage (I&D) for decompression and exploration. There was more purulent discharge and muscle necrosis in the thigh, and we performed a necrotic tissue debridement. The superficial muscle at the base of the wound seemed viable. There was no sign of hematoma.

In the laboratory studies, serum creatine phosphokinase (CPK) was elevated to 1,955 unit/L on the POD 3. Thereafter, it gradually decreased and was within the normal range on the POD 9 of I&D. There was leukocytosis (14,860 cells/ μL) with neutrophilia (88.7%). Liver function test showed elevated aspartate transaminase of 127 unit/L on the POD2 and elevated alanine aminotransferase of 120 unit/L on the POD 9. Other examination findings such as kidney function test, lactate dehydrogenase, electrolyte test, and urinalysis were unremarkable.

The open area of the thigh was subjected to secondary healing because the patient opted out of additional surgery such as skin graft. Some areas were again primarily closed. The remaining areas were treated with betadine wet dressing daily for 5 days, and negative-pressure wound therapy application for 2 weeks. At POD 90 follow-up at the outpatient clinic, the donor site had healed, but a $3 \times 6 \text{ cm}$ wide scar remained (Fig. 2). Weakness of the anterior thigh compartment was noted late.

Written informed consent for publication of the clinical images was obtained from the patient.

Discussion

One of the greatest advantages of the ALT-FF is low do-

Fig. 1. (A, B) A 26-year-old male had a right distal tibia and lateral malleolus fracture (Gustilo IIIC), with rupture of Achilles tendon and vessel injury. (C) A $30 \times 10 \text{ cm}^2$ anterolateral thigh free flap harvested from the contralateral thigh. (D, E) The flap after inset.

Fig. 2. At the donor site, compartment syndrome was diagnosed clinically on postoperative day (POD) 8, and incision and drainage were performed immediately. (A) On POD 10, muscle necrosis and pus-like discharge were still present. After primary suture of the proximal area, secondary wound healing occurred in the remaining area. (B) Scars on POD 90.

nor-site morbidity.[2] In a study by Collins et al. [3], of the possible complications, lateral thigh paresthesia was the most common, and severe complications such as CS were described as rare. Other complications were musculoskeletal dysfunction, hypertrophic scarring or wound dehiscence, donor-site pain, seroma, and infection.

Another advantage of ALT-FF is that it can be used as a large flap. In a study by Pachón Suárez et al. [4], the ALT-FF donor site has been reported to be capable of primary closure for flaps less than 8 cm wide, or less than 16% of the total thigh circumference. Even in a study by Yildirim et al. [5], the ALT-FF has been shown to be reliable even when harvested with a very large skin paddle of up to 20 cm in width. However, Addison et al. [6] reported on two cases of CS occurring after primary closure of the donor site for ALT-FF 10 cm and 12 cm wide.

The standard technique for preoperatively determining the possibility of direct wound closure is the pinch test. After marking the design of the required flap on the donor's leg, tighten the edges of the flaps together and perform a pinch test. If it is easily achieved, direct closure is attempted and most often achieved. Nevertheless, it is necessary to evaluate the tightness of the actual wound closure. This is subjective, and surgeons will often find that the closure can be tight. When an extensive donor site is forced to primary closure, CS as a donor-site complication of ALT-FF is rare but possible.

CS is a disease in which tissue pressure within the closed space, most commonly the deep fascia compartment of the limb, exceeds the capillary perfusion pressure, ultimately leading to tissue ischemia and necrosis. For this reason, acute CS (ACS) is considered a surgical emergency, and a definite treatment, like fasciotomy, requires in a timely manner. ACS of the

extremities is diagnosed on the basis of the history, examination findings. A notable finding is severe pain out of proportion to the injury. The objective physical finding is the tense, or “wood-like” feeling of the involved compartment, pain with passive stretching. However, it may not be reliable in some patients [7]. Classical findings associated with arterial insufficiency (five ‘P’s: pain, pallor, pulselessness, paresthesias, and poikilothermia [cold skin temperature]) are often described as signs of ACS, but these are inaccurate [7]. In particular, in traumatic ACS, workup for rhabdomyolysis by measuring CPK, renal function studies, urinalysis, urine myoglobin can be considered. Also, compartment pressure measurements are an important adjunct in the diagnosis of ACS. However, in a patient with the classic CS presentation and physical examination findings, no laboratory workup or pressure measurement is needed.

ACS can occur with any condition that restricts the intracompartmental space or increases the fluid volume in the intracompartmental space. The former factors are classified as extrinsic and the latter factors are classified as intrinsic [8]. First, extrinsic factors include the ratio of flap width to thigh circumference, skin laxity, and thickness of subcutaneous fat, compression from a cast or bandages. The laxity of the skin is affected by the patient's age and smoking habits. Second, intrinsic factors include postoperative swelling, muscle volume and tone. Postoperative swelling may be associated with the development of postoperative hematoma due to inadequate hemostasis or drainage due to use of anticoagulants. Muscle volume and tone were generally increased in the younger, athletic population, especially men, and it may have contributed to the problem of tight wound closure. ACS occurs more frequently in patients younger than 35 years of age [7]. This can be ex-

plained by the fact that, compared to the fascia, which does not change in size once growth is completed, the muscles of young men contained within the fascia can be relatively larger [7].

In this case, the patient was a 26-year-old young male who is a professional soldier with a lot of exercises. The patient had a moderate physique with a height of 180 cm, a weight of 76.1 kg, and a body mass index of 23.49 kg/m². For extrinsic factors, the thigh circumference was 60 cm and the flap width was 10 cm, and the ratio of flap width to thigh circumference was 16.7% that was slightly over 16% of the ratio that enabled the primary closure of the donor site of the ALT-FF. However, the width of the flap was confirmed as a possibility of primary closure through a pinch test. For other extrinsic factors, elasticity of the skin was high, and the thickness of the fat was thin. According to his study, the average thickness of ALT-FF in men is 9.9 mm. This patient was 6.9 mm, thinner than the average of men (Fig. 3) [9]. For intrinsic factors, although anticoagulant was used after surgery, there was no hematoma when the donor site was opened for an I&D. This patient had a lot of muscle mass. Therefore, in the patient, contributing factors to the development of CS were the wide flap width as an extrinsic factor and a large muscle mass as an intrinsic factor.

Fig. 3. Computed tomography image of the preoperative donor site (left thigh), showing a large amount of muscle mass. The flap thickness was 6.9 mm.

In our case, he showed severe pain, pain following passive muscle stretching, and tightness and tension. We diagnosed CS based on these clinical symptoms and physical examination results. There was no paresthesia or poikilothermia, possibly because the severe pain was masking these other symptoms. In addition, the patient had severe pain, but the diagnosis was delayed because the medical staff was not informed. This may be because the patient tolerates the pain well, or the symptoms have been blurred by pain control with PCA after surgery. Elevations in CPK may suggest muscle breakdown from ischemia, damage, or rhabdomyolysis. However, renal function tests, urinalysis were normal. Therefore, it can be interpreted that it did not cause rhabdomyolysis.

A limitation in our study is that no additional laboratory studies or pressure measurements were available to support the diagnosis of CS. The urinalysis result was normal, but the test was performed only on the first day of surgery, and urine myoglobin was not measured. In addition, pressure measurement was not performed to aid in the diagnosis of CS. However, we determined that the patient's symptoms and physical examination results were sufficient for a clinical diagnosis of CS. In addition, there was fluctuation during palpation at the time, and pus-like discharge accumulated inside the donor site was confirmed, so immediate surgical treatment was required rather than additional examination.

CS, a possible complication at the donor site of ALT-FF, has a low incidence. However, there are various extrinsic or intrinsic factors that can influence the development of CS. For patients with these factors, a higher level of suspicion is required to ensure that the diagnosis and treatment of this fatal complication is not delayed. As in our case, particular attention should be paid to CS in young, athletic male patients who require large flaps. Moreover, even if the possibility of primary closure is confirmed through the pinch test, it may be safe to set the flap width smaller than that. Alternatively, even with less satisfactory aesthetic and functional outcomes, it may be safe to cover the donor site with a skin graft.

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Conflicts of interest

The authors have nothing to disclose.

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References

1. Song YG, Chen GZ, Song YL. The free thigh flap: a new free flap concept based on the septocutaneous artery. *Br J Plast Surg.* 1984;37:149-59.
2. Wolff KD, Kesting M, Thurmüller P, Böckmann R, Hölzle F. The anterolateral thigh as a universal donor site for soft tissue reconstruction in maxillofacial surgery. *J Craniomaxillofac Surg.* 2006;34:323-31.
3. Collins J, Ayeni O, Thoma A. A systematic review of anterolateral thigh flap donor site morbidity. *Can J Plast Surg.* 2012;20:17-23.
4. Pachón Suárez JE, Sadigh PL, Shih HS, Hsieh CH, Jeng SF. Achieving direct closure of the anterolateral thigh flap donor site-an algorithmic approach. *Plast Reconstr Surg Glob Open.* 2014;2:e232.
5. Yildirim S, Avci G, Aköz T. Soft-tissue reconstruction using a free anterolateral thigh flap: experience with 28 patients. *Ann Plast Surg.* 2003;51:37-44.
6. Addison PD, Lannon D, Neligan PC. Compartment syndrome after closure of the anterolateral thigh flap donor site: a report of two cases. *Ann Plast Surg.* 2008;60:635-8.
7. Boca R, Kuo YR, Hsieh CH, Huang EY, Jeng SF. A reliable parameter for primary closure of the free anterolateral thigh flap donor site. *Plast Reconstr Surg.* 2010;126:1558-62.
8. An HS, Simpson JM, Gale S, Jackson WT. Acute anterior compartment syndrome in the thigh: a case report and review of the literature. *J Orthop Trauma.* 1987;1:180-2.
9. Seth R, Manz RM, Dahan IJ, et al. Comprehensive analysis of the anterolateral thigh flap vascular anatomy. *Arch Facial Plast Surg.* 2011;13:347-54.