Small Incision Fasciotomy in a Patient with Compartment Syndrome and Peripheral Arterial Occlusive Disease

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An 82-year-old man with a previous history of atrial fibrillation was admitted with acute limb ischemia. Emergent embolectomy was performed, but after the operation, the patient suffered from recurrent ischemic pain. Peripheral angiography revealed thrombosis of the distal popliteal artery due to pre-existing peripheral arterial occlusive disease. Bypass surgery of the popliteal artery and posterior tibial artery was then performed. Although peripheral blood flow was restored after the operation, he suffered from compartment syndrome the next day. The patient was treated with an emergent bedside fasciotomy using a small incision, achieving full recovery of blood flow to the distal artery. The wound closed secondarily without surgical closure. In a patient with peripheral arterial occlusive disease, fasciotomy should be performed at a lower compartment pressure due to a lack of peripheral perfusion pressure. Emergent small incision fasciotomy was effective in this patient with an acute compartment syndrome and an ischemic limb.

Keywords: compartment syndrome, reperfusion injury, fasciotomy, peripheral artery disease

Introduction

Acute compartment syndrome occurs when an increase in closed fascial compartment pressure causes microvascular compromise, resulting in muscle ischemia. As the duration and magnitude of the pressure increase, myoneural function is impaired and necrosis of the soft tissue eventually develops. Despite the risks of infection, hemorrhage, and nerve damage, fasciotomy should be performed early for limb salvage. The indications for fasciotomy have been described according to the measured pressure in the compartment. However, in a patient with pre-existing peripheral arterial occlusive disease, fasciotomy should be performed at a much lower compartment pressure due to the lack of perfusion. Furthermore, the procedure should be considered to minimize complications in these patients with chronic limb ischemia. Fasciotomy with a small incision was sufficient in this patient for spontaneous wound closure thus minimizing the risk of postoperative infection.

Case Report

An 82-year-old man with a previous history of atrial fibrillation was transferred with the sudden onset of leg pain. He had no history of claudication and anticoagulation therapy had not been given for atrial fibrillation. Although the femoral pulse was palpable, the limb below the knee was pale and was accompanied by paresthesias and a decreased range of motion. Ankle-brachial pressure index could not be determined, and ultrasound and contrast computed tomography scan were performed for further evaluation.
Both ultrasound and computed tomography showed the absence of blood flow in the distal popliteal artery (Fig. 1A–1D).

Although there was no thrombus formation in the left atrium, acute embolism of the popliteal artery was suspected due to the sudden onset of symptom with untreated atrial fibrillation. At 18 hrs after onset, the patient underwent emergent embolectomy with a Fogarty arterial embolectomy catheter balloon (Edwards Lifesciences, Irvine, CA, USA) under local anesthesia. Fresh thrombus was extracted from a small incision in the femoral artery and back-flow from the superficial femoral artery was confirmed. Although the pulses in the posterior tibial and dorsalis pedis arteries were not palpable, Doppler ultrasonography showed restoration of peripheral perfusion. His symptoms also improved, including improved skin color, sensation and motion. Although peripheral arterial occlusive disease was suspected due to the dissociation between his symptoms and arterial pulses, further investigation by peripheral angiography was not available. The patient was started on anti-platelet therapy and anti-coagulation therapy, and was scheduled to undergo further investigation by peripheral angiography.

However, he reported the sudden onset of ischemic pain on post operative day 2. Emergent angiography was performed which revealed thrombus formation from the distal popliteal artery, extending to the anterior tibial artery and the peroneal artery (Fig. 2A). Arterial stenosis at the tibioperoneal trunk was also confirmed with collateral arteries to the posterior tibial artery. Thrombectomy of the tibioperoneal artery was performed followed by percutaneous transluminal angioplasty (PTA) using a Jackal RX 4.0 × 20 mm PTA balloon (St. Jude Medical, St. Paul, MN, USA). (Fig. 2B–2D) Although his symptoms improved for one day, the blood flow was diminished by the next day. Because there was no thrombus formation in the left atrium on admission, recurrent thrombosis at the fractured plaque was suspected due to repeated manipulation by the Fogarty catheter and percutaneous transluminal angioplasty. The patient underwent emergent operation for restoration of peripheral perfusion.

Fig. 1 Computed tomography showed occlusion of the distal popliteal artery, suspected due to embolic occlusion of the artery secondary to atrial fibrillation.
Under general anesthesia, the popliteal artery (above knee) and posterior tibial artery were exposed. Bypass surgery using a saphenous vein graft was performed from the popliteal artery to the posterior tibial artery. Intraoperative bypass graft flow was measured by flowmeter (Oslo, Norway Medi-Stim AS) showing a flow rate of 44 ml/min and pulsatility index of 3.8.

Pulses in the posterior tibial artery and dorsalis pedis artery were restored, resulting in improvement of skin color and resolution of the rest pain. However, pulsation in the dorsalis pedis artery disappeared the next day. With the appearance of edema in the lower extremity, a compartment syndrome due to reperfusion injury was suspected. The pressure in the anterior compartment was measured with an 18 gauge needle connected to a continuous arterial blood pressure monitoring system. At a systemic blood pressure of 120/60 mmHg, the pressure in the anterior compartment was 22 mmHg. Due to ischemic changes in the anterior compartment, an emergent bed-side fasciotomy of the compartment was performed. Compartment syndrome of the posterior compartment was not suspected due to prior fasciotomy of the posterior compartment during the prior bypass operation.

A 40 mm incision was made lateral to the anterior border of the tibia and 20 mm below the tibial tuberosity. Subcutaneous tissue was divided and a fasciotomy with surgical scissors was performed by sliding the scissors subcutaneously along the anterior border of the tibia. The wound was left open.

After fasciotomy, the pulsation in the dorsalis pedis artery was again present. Creatine-kinase reached 7566
Fig. 3  Serum levels of creatinine kinase and lactate dehydrogenase increased after surgery. Creatinine kinase and lactate dehydrogenase showed improvement after bypass surgery on post operative day 3 (POD3a; before surgery, POD3b; after surgery). On postoperative day 4, the serum level was once again elevated. Resolution was once again seen after fasciotomy. (①: Emergent thromboembolectomy; ②: Percutaneous angioplasty; ③: Bypass from the femoral artery to the posterior tibial artery; ④: Fasciotomy due to compartment syndrome).

IU/l which decreased after the fasciotomy (Fig. 3). The wound was washed with normal saline daily, and was kept moist. After relief of tissue edema from the reperfusion injury, prostaglandin was administered to the wound bed which resulted in wound closure at 4 months (Fig. 4).

Discussion

Reperfusion injury may occur after revascularization of ischemic tissue. Following prolonged ischemia, reintroduction of oxygen into the ischemic tissue results in an increase in reactive oxygen metabolites, initiating an acute state of inflammation. These reactive metabolites serve as a trigger to increase the overall rate of cellular apoptosis and necrosis, as well as an increase in capillary permeability causing edema. Furthermore, there are reports suggesting amplification of the inflammatory reaction in a partial ischemic environment in contrast to complete ischemia due to continued perfusion with oxygenated blood. Recurrent occlusion of the popliteal artery, and delay in adequate reperfusion of the peripheral artery may have contributed to a persistently ischemic environment, thus amplifying the inflammatory reaction and activation of neutrophils.

The swelling caused by reperfusion results in increased compartment pressure, leading to irreversible nerve and muscle damage. Early studies suggested irreversible nerve and muscle damage begin 5 to 6 hours following the onset of ischemia, while recent clinical studies revealed that muscle necrosis occurs within the first 3 hours.

The indications for fasciotomy are discussed elsewhere. Absolute compartment pressures of 30 mmHg or higher, 40 to 55 mmHg, or 55 mmHg or higher have been suggested as guidelines for intervention. Others suggested using the difference between the measured intra-compartmental pressure and the diastolic or mean systemic pressure (the so-called “delta pressure”) as an indication for surgical intervention. These studies suggested that a delta pressure of less than 30 to 40 mmHg is an indication for fasciotomy. Although the compartment pressure was only 22 mmHg in the present case, fasciotomy was performed due to his symptoms. Compared to patients without peripheral arterial occlusive disease, a patient with peripheral arterial occlusive disease may need a fasciotomy at a much lower compartment pressure due to an insufficient perfusion pressure of the peripheral limb. Fasciotomy at a lower compartment pressure was successful showing improvement in capillary refill and resulted in recovery of the pulse in the dorsalis pedis artery.

Fasciotomy, however, has associated risks including infection, hemorrhage and nerve damage, especially to the superficial peroneal nerve laterally and the saphenous vein medially. To prevent complications from fasciotomy, evaluation of the precise location of the muscle edema may be useful for using a minimal incision. Ikeya et al. reported using magnetic resonance imaging to evaluate muscle edema.
Furthermore, many suggestions have been proposed for the surgical procedures and wound management. Clasper et al. reported need for full length incisions in these patients to allow adequate decompression of the compartment.\(^1\) In contrast to this, there are reports suggesting endoscopically assisted fasciotomy to prevent wound complications.\(^{17,18}\) Matsushima et al. reported the “shoelace technique” enabling approximation of the skin edges gradually; resulting in successful wound closure without a skin graft.\(^{19}\)

Patients with peripheral arterial occlusive disease are at a higher risk for infection and wound complications due to diminished skin perfusion pressure. In these patients, an endoscopically assisted fasciotomy may be a better option. However, if an endoscope is not available, or in a patient requiring an emergent fasciotomy, the method described here was sufficient.

Although there was a risk of nerve damage and hemorrhage, we were able to release the elevated compartment pressure using an emergent small incision bed-side fasciotomy without the need for an endoscope, thus minimizing time loss, lowering the risk of infection as well as enabling spontaneous wound closure.

**Conclusion**

In patients with peripheral arterial occlusive disease, a fasciotomy should be performed at a much lower compartment pressure due to lower peripheral artery perfusion. Bed-side fasciotomy with a small incision was useful in minimizing time loss, lowering the risk of infection as well as enabling spontaneous wound closure.

**Disclosure Statement**

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**References**