

## TECHNICAL NOTE

# MODIFIED SHOELACE TECHNIQUE FOR DELAYED PRIMARY CLOSURE OF THE THIGH AFTER ACUTE COMPARTMENT SYNDROME

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**The authors report a case of acute compartment syndrome in the thigh in a 19-year-old man with multiple injuries including fracture of the femoral diaphysis. Decompressive fasciotomy was performed emergently. Complete progressive closure of the wound without split-thickness skin grafting was achieved using a modified shoelace technique : sutures were run inside wide drains placed in contact with the muscles and were then tightened over the skin. These drains enlarged the contact area between sutures and muscles, preventing damage to muscles.**

**Keywords :** thigh ; compartment syndrome ; skin closure.

**Mots-clés :** cuisse ; syndrome des loges ; fermeture cutanée.

## INTRODUCTION

Acute compartment syndrome (ACS) is a well recognized complication of injuries to the leg (3) and forearm. Compartment syndrome in the thigh is an uncommon condition, infrequently reported. It may develop as a result of a sudden increase in the volume of contents or in the external pressure over a given compartment. The most common causes are fractures of the femur and severe soft-tissue injuries following blunt trauma (9). Drug intoxication may also lead to such complications (7). Lastly, ACS has been reported after intensive weight training in athletes (2). We report a case of ACS in the thigh in a young patient with multiple trauma including bilateral femoral fracture.

## CASE REPORT

A 19-year-old man was involved in a traffic accident and was admitted to the hospital with multiple injuries : bilateral displaced fracture of the middle third of both femurs, fracture of the right humerus and severe closed injury of the head. Vascular examination of the lower extremities was normal. Neurologic examination was impossible because the patient was under anesthesia when he was admitted to the emergency room. The right thigh was markedly swollen and tender. The circumference of the right thigh was 55 centimeters and that of the left 40 centimeters. Radiological examination showed a comminuted fracture of the middle third of the right femur (fig. 1). Compartment pressures could not be measured because of a technical problem. Nine hours after the injury, orthopedic injuries were treated in the operating room under general anesthesia. Closed intramedullary nailing was done on both femurs (fig. 2). Following operation, pressure in the right thigh tissues further increased. Initial laboratory studies showed incipient rhabdomyolysis : creatine phosphokinase level was 10,000 IU ; renal function was preserved. The diagnosis of acute compartment syndrome of

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*Fig. 1.* — Radiograph showing a comminuted fracture of the middle third of the right femur in a 19-year-old man.

the thigh was made, and fasciotomy of both the anterior and posterior compartment was done through a lateral incision, as described by Tarlow *et al.* (10): the skin incision extended from the intertrochanteric line to the lateral epicondyle, the anterior compartment was opened by incising the fascia lata, the vastus lateralis was retracted medially and the lateral intermuscular septum was incised, decompressing the posterior compartment. On incision of the fascia lata, the vastus lateralis bulged and appeared edematous, but the muscles appeared viable and contracted on stimulation. The creatine phosphokinase level peaked at 50,000 IU on the third postoperative day, but all the muscles appeared viable and of a normal color. Biological and clinical outcome were progressively favorable. The problem was closing the fasciotomy.



*Fig. 2.* — Radiograph showing intramedullary nailing of the femur in the same patient.

## DISCUSSION

The inextensible intermuscular septa of the thigh explain the occurrence of ACS when volume and pressure increase inside compartments (secondary to muscular edema, capillary infiltration or intensive use of muscles). Compartment syndrome in the thigh is an uncommon condition mainly associated with closed femoral fractures and blunt soft

tissue trauma. Drug intoxication may lead to compartment syndrome (7). Cases of ACS after intensive weight lifting are also reported in the literature (2). ACS must be suspected in the case of severe pain in the thigh with neuromuscular deficits. In patients who are unconscious or are under general anesthesia, diagnosis is more difficult. Measurement of compartment pressure is useful in such cases according to some authors (8) but this remains controversial. The pressure level necessitating fasciotomy of the thigh is unclear in the literature (5, 10); values ranging from 30 mm Hg to 75 mm Hg have been proposed. Such measurements may help for diagnosis, but clinical examination remains essential, especially in the presence of tense swelling of the thigh. Tense swelling of the muscles is often the only detectable sign as in our case, because early clinical symptoms such as pain, paresthesias and paresis cannot be detected in a ventilated and sedated patient. Early decompressive fasciotomy is necessary because the morbidity caused by fasciotomy in a borderline compartment syndrome is far outweighed by the morbidity that may follow an undiagnosed and untreated compartment syndrome. In our case, fasciotomy of both the anterior and posterior compartment was done through a lateral incision, as described by Tarlow *et al.* (10). The anterior compartment was opened by incising the fascia lata, the vastus lateralis was retracted medially and the lateral intermuscular septum was incised, decompressing the posterior compartment. When decompressive fasciotomy is performed, closure of the fasciotomy wound is a major problem. Controversy exists as to which method is the best. Primary closure is often impossible owing to tissue retraction and edema. There is often concern before and after performing fasciotomy about the cosmetic appearance and prolonged hospital stay if split-grafting is required to cover the skin defect (4). Split-thickness skin grafting leaves a thin, insensate and unesthetic tegument (6). The shoelace technique (1) has been used with success for several years to close open fasciotomy wounds. This technique for gradual closure involves running a silastic vessel loop through skin staples placed at the skin edge along the initial fasciotomy incision.

Daily tightening of the shoelace permits gradual reapproximation of the skin edges until complete closure is attained. Closure is then possible in 5 to 10 days. The advantages over split-thickness grafting include avoidance of donor-site morbidity and better cosmesis. This technique is useful for fasciotomy wounds on forearms or legs, but may appear to be less adapted to close a fasciotomy on the thigh as in our case. Skin retraction was too important (more than a 10-cm gap) and a vessel loop would not have withstood the tension generated by soft-tissue swelling. We therefore used a modified protocol for fasciotomy wound management. Simple skin sutures (Peterlon® blue polyamide monofilament decimal 4) were progressively tightened every two days until closure of the skin defect. To avoid the risk of damaging muscles, especially the vastus lateralis, the polyamide monofilament sutures were run inside wide drains placed in contact with the muscles and were then sutured over the skin. These 4-mm wide drains enlarged the contact area between sutures and muscles, preventing damage to muscles (figs. 3, 4). Closure without skin or muscles lesions was possible after 15 days and 7 dressing changes (fig. 5).



**Fig. 3.** — Lateral view of the thigh 4 days after fasciotomy. Note the drains in contact with the vastus lateralis in the middle of the wound and simple skin sutures at the edges of the wound. This technique involved running the blue polyamide monofilament decimal 4 Peterlon inside wide drains placed in contact with the muscles and then sutured on the skin. These drains (4-mm wide) permitted an increase in the contact area between sutures and muscles and avoided damage to these muscles.



**Fig. 4.** — Lateral view of the thigh after 10 days. Gradual closure of the wound using elasticity of the skin.



**Fig. 5.** — Complete closure of the wound after 15 days

No further complications occurred in our case. Morbidity and cost associated with skin graft or secondary closure were avoided with this adapted shoelace technique.

Recognition of the signs and symptoms of acute compartment syndrome is essential. Morbidity can be avoided if a high level of suspicion is maintained and fasciotomies are performed early. Fasciotomy entails incision of the overlying skin and underlying fascia of the compartment to relieve pressure and enhance tissue perfusion. Delayed primary closure is ideal but is usually impossible in the thigh ; because of the extent of skin edge retraction, the open wound must either heal secondarily or be closed with a split-thickness skin graft. Adaptation of the shoelace technique to the thigh using wide drains allowed us to completely close a fasciotomy wound in the thigh without skin graft with its cosmetic and functional sequelae.

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## SAMENVATTING

*L. GALOIS, J. PAUCHOT, F. PFEFFER, I. KERMARREC, R. TRAVERSARI, D. MAINARD, J. P. DELAGOUTTE. Progressieve primaire sluiting van een wonde van de dij voor acuut compartmentsyndroom met een aangepaste schoenveterstechniek.*

In dit artikel wordt de behandeling van een acuut compartmentsyndroom van de dij besproken na polytrauma, waaronder femurschaftfractuur. Een urgente decompressieve fasciotomie werd verricht. De wond werd vervolgens met een originele schoenveterstechniek progressief gesloten : de snoerhechtingen werden geleid door brede drains, zodat de druk op de openliggende spiermassa beter werd verspreid en spierbeschadiging werd voorkomen.

### RÉSUMÉ

*L. GALOIS, J. PAUCHOT, F. PFEFFER, I. KERMARREC, R. TRAVERSARI, D. MAINARD,*

*J. P. DELAGOUTTE. Adaptation de la technique du lacet pour la fermeture d'une aponévrotomie de cuisse après syndrome des loges.*

Nous rapportons le cas d'un syndrome des loges de la cuisse chez un jeune homme de 19 ans polytraumatisé. Une aponévrotomie a été effectuée en urgence. Une fermeture complète de la fasciotomie a pu être effectuée, de façon progressive, sans greffe de peau associée, en utilisant un procédé original de fermeture : les fils de sutures ont été enfilés au travers de drains de Redon de gros calibre placés au contact des muscles, puis ont été suturés à la peau. Ces drains ont permis d'élargir la surface de contact entre les muscles et les sutures, évitant ainsi les lésions musculaires.