CLINICAL REPORT

Thigh compartment syndrome after intramedullary femoral nailing: Possible femoral nerve block influence on diagnosis timing

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KEYWORDS
Thigh compartment syndrome; Femoral fracture; Femoral intramedullary nailing; Fasciotomy; Regional anaesthesia; Femoral nerve block

Summary We report a case of anterior thigh compartment syndrome (TCS), which occurred after a closed femoral fracture internal fixation using an intramedullary rod. A 20 ml ropivacaine hydrochloride single-injection femoral block had preceded general anaesthesia to conduct the surgical procedure. The compartment syndrome diagnosis was made the morning after surgery when the level of pain was interpreted as disproportionate to the treated lesion; in addition, compartment pressure measure had increased to 54 mmHg. A compartment fasciotomy was performed. Diagnostic delays have previously been observed and attributed to nerve blocks in cases of tibial fracture. This patient’s report raises the question of whether a femoral block may be responsible for delays in diagnosing compartment syndrome, although no series have been published of such occurrences in large numbers. When nerve blocks are used, they should be more analgesic than anaesthetic. Careful patient monitoring remains important. © 2009 Elsevier Masson SAS. All rights reserved.

Introduction

Thigh compartment syndrome (TCS) is rare and, to our knowledge, has not been reported in the French literature after intramedullary nailing (IMN) of femoral fractures, but has been cited in the English literature (Table 1). According to Tarlow et al. [1], the three compartments of the thigh are large in comparison to those of the forearm and leg, and a significant increase in compartment contents is necessary to cause compartment syndrome. The anterior compartment is most often affected [2]. Several aetiologies have been proposed in the literature, often as isolated cases that included increased compartment volume due to bleeding, regardless of the cause, and extrinsic compression. Patients suffering from hereditary or acquired coagulopathy are at risk of developing TCS after minimal trauma [3]. Schwartz et al. [4] estimated the incidence of this pathology after IMN to be about 1%. Postoperative pain management after limb...
Table 1  Number of TCS cases associated with femoral fracture and femoral nailing reported in the literature.

<table>
<thead>
<tr>
<th>Author and year</th>
<th>Number of TCS cases reported</th>
<th>Number of cases associated with femoral fracture</th>
<th>Number of cases associated with IMN</th>
<th>Compartments</th>
<th>Associated lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clancey 1985 [6]</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>Posterior</td>
<td>Sciatic palsy</td>
</tr>
<tr>
<td>Tarlow et al. 1986 [1]</td>
<td>3</td>
<td>3</td>
<td>1 (the other 2 were treated orthopaedically)</td>
<td>Anterior</td>
<td>Lesion in superficial femoral artery branch</td>
</tr>
<tr>
<td>Moore et al. 1987 [7]</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>Anterior and posterior</td>
<td>NC</td>
</tr>
<tr>
<td>Holbein et al. 2000 [32]</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3 compartments</td>
<td>Patient was intubated and ventilated. Femoral and sciatic palsy</td>
</tr>
<tr>
<td>Uzel and Steinmann 2009</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>Anterior</td>
<td>None</td>
</tr>
</tbody>
</table>

TCS: thigh compartment syndrome; IMN: intramedullary nailing; NC: not communicated.

surgery increasingly requires locoregional analgesia (LRA) with peripheral plexus or nerve root blocks. The resulting deep analgesia can mask the main sign, abnormally intense pain during compartment syndrome, and can therefore delay its diagnosis with dramatic functional consequences. We report a case of anterior TCS after IMN, which was diagnosed and treated the day after the patient had a femoral block.

Observation

Mr. J., age 26 years (66 kg, 1.7 m), a motorcyclist, was hit by a car at around 3:00 P.M. He was admitted to emergency at the University Health Centre in Pointe-à-Pitre on the 5th of October 2006 at 6:00 P.M., presenting with a third-degree, closed transverse fracture of the middle third of the left femur. At 20:00, he was admitted to the Orthopaedics Service, continuous external traction was applied, and the limb placed in a Boppe splint. The initial workup showed: haemoglobin (Hb) 12.6 g/dL, hematocrit (Hct) 38.8%, platelets 203,000 G/L, prothrombin ratio (PR) 96%, partial thromboplastin time 31/31, and creatine phosphokinase (CPK) 576 IU/L.

On the 6th of October 2006, centromedullary nailing was undertaken on an orthopaedics table, and boot traction was applied. Anaesthetic management combined a single-injection femoral block with 20 mL of ropivacaine hydrochloride (Naropeine® 75 mg/10 mL) at 12:15 P.M. and general anaesthesia. At this time, the laboratory work-up showed: Hb 11.2 g/dL, platelets 156,000 G/L, and CPK increased to 5,548 IU/L. Haemodynamics were stable; average blood pressure remained over 70 mmHg throughout the procedure. The patient was taken to the postoperative care unit at 2:05 P.M. and stayed there until 3:55 P.M. On his returning to the Orthopaedics Service, he had significant thigh pain requiring subcutaneous morphine.

The next day, on the 7th of October 2006, the surgeon was called at around 8:00 A.M. because the patient complained of unusually severe pain. The 8:44 A.M. laboratory work-up showed: Hb 8.6 g/dL, Hct 26%, platelets 156,000 G/L, and CPK increased to 5,548 IU/L. Haemodynamics were stable, and blood pressure was 120/60 mmHg. The patient’s pain estimate on the visual analogue scale was 9/10. The anterior thigh compartment was very taut, and there was no sensorimotor or vascular deficit. The clinical diagnosis was anterior TCS; the medial and dorsal compartments were supple. Pressure was measured in the operating room by inserting an intramuscular needle connected to an arterial pressure catheter in the ventral compartment facing the fracture area. It was found to be 54 mmHg in that compartment but was normal in the others: 26 and 24 mmHg, respectively, in the medial and dorsal compartments. Under spinal anaesthesia, fasciotomy of the anterior thigh compartment was performed by incising the fascia lata at its ventral part outside the sartorius muscle. Muscular extrusion was immediate, as evidenced by the distance between the two borders of the open fascia. Electrosurgical exploration of the muscles disclosed a well-coloured (red) quadriceps and tensor fascia with no necrotic plaques and contractile under the electric bistouri. The postoperative work-up on the same day showed a drop in CPK to 4,787 IU/L, which continued on the following days (CPK was 3,306 on the 8th of October 2006 and 168 IU/L on the 15th of October 2006).
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On the 9th of October 2006, the patient received a transfusion of two units of packed red blood cells. On the 14th of October 2006, under general anaesthesia, the fasciotomy borders were brought closer with a continuous, incomplete suture, i.e., to within 1 cm of each other. The patient had three follow-ups as an outpatient, and the fracture healed in 4 months. There was no postoperative infection, specifically at the fasciotomy site. In the fourth month, knee mobility was 0/130° bilaterally; the patient could walk without limping, muscle strength was identical to that of the opposite side, and the knee was stable. There was no muscle herniation and no sensory deficit. The patient was contacted by telephone (because he lived on a neighbouring island), in May 2008, at which time he did not complain of any functional deficits.

Discussion

Aetiology and frequency

Compartment syndrome is a surgical emergency that occurs more rarely in the thigh than in the leg or forearm because of the larger volume of its compartments [1], its relatively more elastic fascia, and contact of the thigh compartments with the gluteal region allowing fluid extravasation [4]. The lateral inter-muscular septum is thicker, less compliant than the medial and the posterior which are thinner [1]. The influence of bore hole depth is not found in the literature. Allen et al. [5] reported the association of TCS after femoral fracture and leg compartment syndrome without fracture in the final stage. Femoral fracture, IMN and thigh contusion are probably the etiological factors that potentiate each other in causing compartment syndrome. These three elements were present in our motorcyclist patient. Fracture reduction, with restored thigh tension and reestablishment of limb length after femoral fracture by traction or internal fixation, would diminish the volume of the thigh compartments and contribute to the onset of TCS [6,5]. The diagnostic difference between a simple contusion and TCS is difficult, considering the volume of the thigh compartments and their great compliance [7]. The level of intramuscular pressure that irreversibly threatens muscle tissue is a controversial subject in the literature [8]. It varies based on various physiopathological factors, such as diastolic blood pressure, the state of tissue oxygenation, which relates to arterial oxygenation and Hb concentration [9], and interindividual sensitivity to ischemia [10]. TCS in a patient suffering from an isolated thigh trauma is rare [4]. Polytomatized patients, in whom hypotension, vascular lesions, severe trauma, external compression fractures, and coagulopathy are often found, are more at risk of developing TCS [4]. Muscular necrosis seems to appear later despite intra-compartmental pressures that are as high as those in leg compartment syndromes [11]. Alcohol ingestion and holding the limb above the level of the heart aggravate compartment syndrome [12].

Diagnosis

The diagnosis of TCS in both the forearm and the leg is basically clinical. It is necessary to differentiate TCS in an injured person who is unconscious and one who is conscious [4]. In the latter case, the clinical examination must investigate pain intensity, spontaneously elicited with passive mobilization of the knee in flexion and extension to test the quadriceps and hamstrings, respectively [4]. As in our case, pain, disproportionate to the trauma and not relieved by normally effective analgesics, should alert the clinician. Mithofer et al. [13] described the pain as 100% intolerable among the conscious patients in their series. Examination of the thigh showed a compartment that was taut, not very depressible and painful on palpation. Sensorimotor disorders appear only secondarily. It is necessary to look for possible hypoesthesia in sensitive areas affecting one of the compartments and reduced motor skills, but these occur later. The presence or absence of distal pulses does not have any diagnostic value [11]. Clinical symptoms are crucial in estimating the value of interstitial pressure that is critical for each patient [4]. Measurement of compartment pressures, the positive diagnosis, is even more important in unconscious, injured patients. There is no consensus about pressure level for a formal diagnosis of TCS or which indicates the need for fasciotomy. Values are between 30 and 55 mmHg [4,8,9,14]. Whiteside et al. [9] recommended, as monitoring criteria, the differential between diastolic and interstitial pressure, with the critical value of 20 mmHg indicating fasciotomy. In our case, this value was 6 mmHg. Schwartz et al. [4], in their 21-case review of TCS, noted that the average pressure measured in the anterior compartment was 56 mmHg and the pressure in each case was over 50 mmHg in at least one of the three compartments. It is necessary to compare these values with those found on the contralateral thigh and to remember that it is simply a diagnostic aid for unconscious subjects [11]. The role of LRA in the diagnostic delay of TCS should be brought up even if, as in our case, despite LRA, an analgesic complement of subcutaneous morphine was required before the nerve block wore off. Even imperfect analgesia, that does not affect the entire operated or traumatized area (as is the case with femoral block that impacts only the anterior part of the thigh), could diminish the pain and thereby delay the diagnosis of compartment syndrome. All types of analgesia techniques could be incriminated. Hyder et al. [15] reported a case of leg compartment syndrome, the diagnosis of which was delayed due to triple block of the thigh.

Richards et al. [16] described four cases of diagnostic delay after leg nailing involving patient-controlled analgesia (PCA) with morphine. They recommended using it intermittently with pressure monitoring. According to Mubarak and Wilton [17], peridural analgesia should prompt increased surveillance and postoperative monitoring, making it possible to discontinue local anaesthetics in doubtful cases of compartment syndrome. However, in a review of the literature, Mar et al. [18] did not find sufficient proof implicating only the administration of PCA morphine or LRA in the diagnostic delay of compartment syndrome. Lack of monitoring, particularly the absence of muscle pressure measurements in the event of clinical suspicion, is probably also a significant element. The clinical practice recommendations of the French Society of Anaesthesia state that "the risk of occurrence of compartment syndrome is not a contra-indication for performing a block, subject to adapted monitoring, because pain is not the only diagnostic criterion for compartment syndrome."
syndrome’’ (level IV and V evidence) [19]. Regarding frac-
tures of the femur shaft, there is no proof that femoral
block delays the diagnosis [20]. Instead of contraindicat-
ing a postoperative analgesic technique whose effectiveness
has beneficial consequences that are established in medico-
economic terms, Davis et al. [21] recommended increasing
and codifying postoperative monitoring through increased
collaboration between surgeons, anaesthetists and the post-
operative training team.

Treatment

Robinson and Halperin [22] and Riede et al. [23] recom-
ended conservative management by monitoring pressure
when TCS was caused by isolated contusion. However, Riede
et al. [23] did not propose this treatment when TCS was
due to a femoral fracture or vascular lesions among elderly
patients or in cases of multiple traumas.

Tarlow et al. [1] suggested a single lateral incision to
decompress the anterior and posterior compartments; the
anterior compartment was decompressed by longitudinal
incision of the fascia lata and the posterior compartment by
an incision of the lateral intermuscular septum. According
to the technique they recommended, which is interesting
mostly because it allows the simultaneous decompression
of two compartments, a mediolateral flap remains from
the entire hemicircumference of the fascia surrounding the
thigh made rigid by the iliotibial band. It seems to us that
fasciotomy of the anterior compartment through an ante-
orior approach could better decompress this compartment,
because, in such cases, it is open medially and laterally in
two equal parts that are apart from each other, and the
iliotibial band, the lateral stabilizer of the knee, is not
damaged. If the compartment still appears taut after this
type of incision, two displaced longitudinal incisions of the
iliotibial band could be made in the ventral-dorsal plane,
which we did not do. Schwartz et al. [4] again measured
pressure in the medial compartment after decompressing
the other compartments, and decompressed the adductor
compartment only when necessary. Fasciotomy of only the
anterior compartment was often performed [1,5,24]. Kuri
and Difelice [25] created an isolated anterior pathway in
a ruptured quadriiceps tendon because the clinical signs for
this compartment and pathway facilitated repair of the ten-
don.

Oseo et al. [26] and Kwong et al. [27] created a
direct posterior pathway for decompressing the dorsal compartment
in hamstring rupture. On the seventh day, the
fasciomytomy edges were brought closer together with a sim-
ple, continuous suture, in our case up to 1 cm apart.

Schwartz et al. [4] did not perform cutaneous closure
before the fifth day. Galois et al. [28] used a modified
Shoelace technique with a suture (Peterlon® blue polyamide
monofilament decimal 4) introduced into a drainage tube
4 mm in diameter, helping to protect the underlying muscle
from the secondary effect of cutting through the tissue like
butter, while closing the edges and achieving complete clo-
sure on the 15th day. For Lee et al. [29], vacuum-assisted
wound closure can reduce the waiting period for cutaneous
closure while diminishing the suction times and by applying
a pressure dressing in the event of significant suction.

Evolution

Mithöfer et al. [30] studied the factors influencing the func-
tional outcome of TCS. According to their study, factors
resulting in poor functional outcome — where 64% of patients
continued to have reduced muscle strength — were age over
30 years, femoral diaphysis fractures, coronary disease, fas-
ciotomy performed after the 8th hour, and the presence of
myonecrosis. Schwartz et al. [4] reported 66% of cases devel-
oping superinfection of the fasciotomy zones, promoted
by immunosuppression, especially among polytraumatized
patients. Mortality varied according to concurrent patholo-
gies, from 47% to 11% [13]. The occurrence of osteoma has
been noted, but as part of TCS after contusion [31].

Conclusion

Although TCS is rare, we should not forget its possible occur-
rence after femoral fracture nailing. Early diagnosis and
treatment guarantee functional recovery. The clinical diag-
nosis predominates with the presence of intense abnormal
pain, and pressure measurements confirm the diagnosis.
Delayed diagnosis can affect patient survival; at the very
least, it can affect function by causing necrosis of the large
volume thigh muscles, which seems to arise later than in the
leg. Patient monitoring under postoperative LRA-analgesia
must be reinforced.

Conflict of interests

None.

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