

## Compartment syndrome of the calf following total knee arthroplasty—a case report of a highly unusual complication

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In April 2005, an otherwise healthy 43-year-old woman presented at an external elective orthopedic unit with a more than 10-year history of effort-related pain in the left knee. In her youth, she had been a hurdle runner at a competitive level. Preoperatively, there had been extensive discussions between the patient and her orthopedic surgeon because several arthroscopies and standard radiographical examinations had failed to demonstrate significant osteoarthritis, and no relevant deviation from the normal leg axis had been observed. Total knee arthroplasty was finally considered to be the appropriate solution for the patient's knee pain, however, and the procedure was performed after regular preoperative investigations showing normal values of hemoglobin, sodium, potassium and prothrombin time-international normalized ratio (PTT-INR), as well as normal blood pressure.

The procedure was performed under epidural anesthesia, which was continued postoperatively. A tourniquet was applied at 275 mm Hg for 65 min (equivalent to the total operating time) and the arthroplasty was carried out uneventfully through an anterior midline approach. The surgeon described degenerative changes in the lateral femoral condyle and in the lateral meniscus without further quantification, and concluded that there were few osteoarthritic changes. A cemented Freeman-Samuelson prosthesis (Zimmer Inc., Warsaw, IN) without patellar resurfacing was inserted. A lateral release was performed in order to achieve good patellar tracking; suction drains were not used. Preoperatively, the patient received 1 g cloxacillin i.v. three times, and 600 mg tranexamic acid intravenously. Anticoagulation started the evening before surgery by use of low molecular weight heparin (5,000 I.U. dalteparin subcutaneously).

Postoperatively, the patient received continuous epidural anesthesia with ropivacain combined with

sufentanil, and paracetamol and dextropropoxyfen by mouth. (The entire chain of events during the day of the procedure and the ensuing days, reconstructed from the charts of the elective orthopedic unit, is summarized in the Table). Loss of active toe extension on the ipsilateral side was observed early on the first postoperative day, but returned after the rate of epidural anesthesia had been reduced. However, when the symptom recurred later that day this was not considered to be a sign of compartment syndrome. Due to pain, additional analgesia with ketobemidon i.v. was used on the first postoperative day and the following night, but again no suspicion of compartment syndrome was raised at that point. On the second postoperative day, pain increased, swelling of the ipsilateral calf, and absence of the arteria dorsalis pedis pulse were noted. Doppler investigation showed no arterial signal distal to the popliteal artery. The patient was then referred to our hospital, because no emergency surgery could be carried out at the elective orthopedic unit where the index procedure had been carried out.

Under the diagnosis of compartment syndrome, acute fasciotomy was performed immediately after admission, and all 4 compartments of the calf were incised through medial and lateral incisions, revealing bulging, pale muscles in all compartments. Doppler signals from the arteria dorsalis pedis returned, and the foot immediately turned red and warm. The incisions were left open and dressed. No sensibility was noted in the foot immediately before and after this procedure, and complete paralysis of all muscle groups of the calf and foot was found. Radiographs of the left knee showed a correctly implanted prosthesis. No specific cause of the compartment syndrome—such as excessive hematoma or vascular injury—could be identified.

During the 5 ensuing weeks, 9 revisions with debridement of necrotic tissue from all compart-

## Record of per- and postoperative observations and events

Day	Time	Event	Anesthesia	Observation	Pain on VAS <sup>a</sup>	Action
0	12.35	Start of anesthesia	Spinal/epidural			
	13.30–14.35	Operating time = tourniquet time	"		0	
	14.50	Termination of OR observation	Continued epidural			
1	07.25	Nurse's control	"	No pain Cannot move feet	0 n.d. <sup>b</sup>	Rate of epidural anesthesia is reduced
	07.37	Nurse's control	"	Moves her feet	n.d.	
	08.00	Round	"	Hemoglobin 105 g/L	n.d.	Transfusion 2 erythrocyte units
	09.00	Nurse's control	"		1	
	11.26	Physiotherapy	"	No active toe extension, hypesthesia sole of foot	n.d.	
	11.40	Nurse's control	"	Pain	9	2.5 mg ketobemidon i.v.
2	19.14	Nurse's control	"	Pain	8	5 mg ketobemidon i.v.
	00.20	Nurse's control	"	Pain	8	5 mg ketobemidon i.v.
	08.00	Physiotherapy	"	Swelling of calf, no active toe extension	n.d.	
	08.30	Round	"	Swelling of calf	6	Doppler investigation is ordered
	12.30	Doppler investigation	"	No signals in ankle arteries	3	Transport to adjacent hospital for fasciotomy is ordered
	14.20–15.20	Fasciotomy				

<sup>a</sup> VAS: pain visual analogue scale.  
<sup>b</sup> n.d.: not documented.

ments had to be performed, and in none of the compartments could muscle activity be stimulated by mechanical or electrical means. Meshed skin grafts were applied to the medial and lateral incisions, and primary healing of these grafts eventually occurred. Circulation in the foot and calf remained normal, whereas sensibility in the foot and motor activity in any muscle distal to the knee did not return. Angiography 1 month after the index procedure showed normal caliber of the superficial femoral, popliteal and anterior tibial arteries, whereas the fibular and posterior tibial arteries appeared filiform. Transtibial amputation was then discussed as an option but due to the fact that axonal regeneration could not be excluded on electrophysiological investigation, the limb was preserved.

2 months after the index procedure, the patient had developed flexion contracture of the knee and contract pes equinovarus despite orthosis, necessitating closed mobilization of the knee joint and

application of external fixation in order to mobilize the ankle joint. Correction of the foot deformity was successful, with the foot returning to a neutral position 3 months later, and external fixation was replaced by orthosis.

1 year after the index procedure, the patient walks with a cane, has no pain and full active extension of her knee joint with an active flexion of 100 degrees. A few degrees of pes equinus, complete plegia of all muscle groups distal to the knee, and anesthesia of the sole of her foot with some sensibility on the dorsum persist. The patient has not returned to her previous work as a shop assistant.

## Discussion

The occurrence of compartment syndrome after arthroplasties of various joints has been reported, but appears to be very rare. One reason must be

that these procedures rarely engage the compartments surrounding a joint, and subsequent bleeding will eventually find its way into the joint cavity or outside the body without congesting adjacent compartments. Even so, total knee arthroplasty has been followed by compartment syndrome of the gluteal region in 2 cases (Pacheco et al. 2001) and of the thigh in 2 cases (Nadeem et al. 1998, Smith et al. 1997). Compartment syndrome of the calf following total knee arthroplasty has been reported in 1 patient (Tang and Chiu 2000). In some cases, fasciotomy prior to cessation of peripheral pulses prevented total muscle necrosis and deleterious outcomes such as the one we describe (Nadeem et al. 1998, Tang and Chiu 2000). Compartment syndrome has also been reported in rare cases after hip arthroplasty, either in the gluteal region (Pai 1996), in the thigh or in the calf (Nicholl et al. 1996, Nadeem et al. 1998, Mai et al. 2000).

It has been suggested that anticoagulation by full heparinization or warfarin contributes to the development of compartment syndrome after arthroplasty (Nadeem et al. 1998). In our case, routine anticoagulation by low molecular weight heparin was performed using regular doses, and neither preoperative laboratory investigations nor intraoperative findings suggested aberrant coagulation with associated massive bleeding as a reason for the patient's condition.

The diagnosis of compartment syndrome is not always easy, particularly when the history and clinical findings are uncharacteristic. The true incidence of compartment syndrome is not known, but in Sweden (with 9 million inhabitants) 4 cases of undiagnosed compartment syndrome are reported annually to the national health agency (Socialstyrelsen 2006). It has been proposed previously that the postoperative use of epidural anesthesia can mask the symptoms of compartment syndrome, thereby preventing early diagnosis and rapid treatment. In cases of compartment syndrome following total hip or knee arthroplasty, continuous epidural anesthesia prevented pain sensation—but clinical suspicion was raised due to swelling, and fasciotomy was performed (Nicholl et al. 1996, Tang and Chiu 2000). In the only previously described case of compartment syndrome following total knee

arthroplasty, measurement of intracompartmental pressure confirmed the diagnosis prior to revision (Tang and Chiu 2000).

In summary, compartment syndrome after arthroplasty is an extremely rare condition. A common denominator in the cases that have been reported is the presence of severe pain. The symptoms of compartment syndrome following total knee arthroplasty can be masked by continuous postoperative epidural anesthesia, as in our case, giving severe consequences. In our opinion, postoperative epidural anesthesia should be avoided after all types of orthopedic surgery of the lower extremities, in order to allow early detection of compartment syndrome. In addition, awareness of the possibility of compartment syndrome following arthroplasty and early measurement of intracompartmental pressures may prevent this disastrous complication.

#### *Contributions of authors*

All authors were involved in the care of the patient and wrote the manuscript together.

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