

Case Report

Bilateral Leg Compartment Syndrome Complicating Prolonged Spine Surgery in the Kneeling Position

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A case of bilateral compartment syndrome of the legs complicating prolonged spine surgery in the kneeling-90-90 position. Aggressive treatment of the reperfusion injury prevented severe rhabdomyolysis, acute renal failure, and sepsis, although it could not avoid the permanently disabling muscular necrosis. Close postoperative surveillance facilitate an early diagnosis and expedite appropriate treatment.

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1. Introduction

Compartment syndrome (CS) has been associated to prolonged periods in several surgical positions including spine surgery, but there have been no previous reports of bilateral leg CS following surgery in the kneeling-90-90 position. A case of revision lumbar surgery and L1-S1 decompression and instrumented fusion was complicated by bilateral leg CS. Aggressive treatment of the reperfusion injury prevented severe rhabdomyolysis, acute renal failure, and sepsis, although it could not avoid the permanently disabling muscular necrosis. The development of bilateral leg CS following lumbar spinal surgery may be due to the combination of hypotension, venous congestion, direct compression on the calves and, perhaps, a tight elastic stocking. We must assume that although the kneeling position is generally safe, it can cause external compression of the legs, especially in lengthy procedures. Close postoperative surveillance and a high index of suspicion facilitate an early diagnosis and expedite appropriate treatment, although they not always can avoid consequences of devastating effects.

2. Case Report

A 49-year-old man (84 kg, 164 cm, body mass index of 31.23 kg/m²) presented with progressively incapacitating

lumbar pain and sensory-motor changes from L4 to S1. He was known to have Klippel-Feil syndrome, and had in the past undergone a previous L4 to S1 fusion. Magnetic resonance imaging (MRI) showed severe cervical stenosis, a large thoracic dural fistula, and lumbar stenosis with severe fibrosis over the lumbar arthrodesis.

It was decided to revise the fusion and decompress the lumbar spine in order to ameliorate neurological function. Under general anaesthesia, the patient was placed in a kneeling position with the hips and knees flexed to 90°. The patient wore thigh-length compression hosiery. Hypotension was induced and maintained at the surgeon's request; renal function remained stable throughout. Haemoglobin concentration was maintained over 26 g dL⁻¹ in the perioperative period. Oxygen saturation remained at 100%, with a respiratory frequency of 12 m⁻¹ and respiratory volume 7 l m⁻¹.

Surgery progressed uneventfully albeit slowly (10 hours 40 minutes) owing to the severe fibrosis. Removal of the previous lumbar instrumentation, decompressive laminectomy (L3-L4), and instrumented posterolateral fusion of the lumbosacral spine (L1-S1) were performed applying distraction to the proximal segments. Postoperatively, the patient was transferred to the recovery room.

Eleven hours after surgery, the patient developed bilateral sensory and motor loss below the knees, without pain. He had complete active range of motion of the hips and knees. Both lower legs were tense and swollen, but nontender. No pain was elicited on passive dorsiflexion of the ankles and toes. The extremities were warm, with normal pedal pulses and capillary refill. Perineal and rectal examination was normal.

The working diagnosis was canal compromise by the instrumentation or excessive dural distraction. A methyl prednisolone infusion was commenced. Image studies showing a malpositioned screw, placed medial to the L3 pedicle in the vicinity of the thoracic dural fistula, in an area with severe fibrosis.

The patient was transferred immediately to the operating room to remove the L3 screw. Further examination showed that his legs remained tense and swollen. Compartment pressures were measured using an intracompartment slit catheter (*Stryker Medical Intra-Compartment Pressure Monitor System-Indwelling Slit Catheter, Kalamazoo, Mich, USA*) in all four leg compartments bilaterally, and was diagnostic of CS (increased intramuscular pressure bilaterally in all four leg compartments >30 mm Hg). Bilateral four leg compartments fasciotomies were performed. The muscles were ischaemic and non-contractile to stimulation with electrocautery.

The patient required nine subsequent interventions for wound debridement, with muscle-loss bilaterally within all four compartments. Renal function remained stable and sepsis was avoided. A further six procedures were necessary for soft tissue coverage.

3. Discussion

The success of all surgical procedures depends upon satisfactory exposure of the operative site, which sometimes involves the positioning of patients in physiologically challenging positions. Under anaesthesia, postural insults may occur that would normally not be tolerated in awoken patients [1]. CS has been described in spinal surgery [2–9].

CS is a condition in which myoneural anoxia results from a prolonged increase in tissue pressure within a closed osseofascial space. This compromises local blood flow of the skeletal muscle, at the microvascular level, resulting in ischaemia and necrosis. Local blood flow to the muscle compartments may be impaired by (A) an increase in the pressure of the compartment, as might occur after the application of a tight bandage or external direct compression [10]; (B) a decrease in arterial flow, as might occur after controlled anaesthetic hypotension, blood loss, hypothermia with vasoconstriction, pre-existing arterial disease, and anaemia/hemodilution; and (C) an increase in venous pressure as might occur because of the prolonged flexion of the knees or for compression of the pelvic blood vessels, sloping position, and/or infusion of large quantities of intravenous fluids. Any of these causes can modify Starling's formula. The use of compression hosiery for prophylaxis of thromboembolic disease is universally accepted in orthopaedic surgery, including spine surgery. Nevertheless, the elastic stocking can produce external

pressures greater than 25 mm Hg [11, 12] and result in a decrease in skin oxygen tension in the supine position [13]. Although not all the compression from the elastic stocking will be transmitted to the muscle compartments, this will have an additive effect to the other factors compromising local blood flow [14, 15].

Warner et al. [16] reviewed 572,498 surgical procedures and in 13 patients no apparent pre-existing cause for CS was found (2.3 per 100,000 surgical episodes). Their common feature was a relatively long surgical procedure, with an average duration of 7.2 hours. The authors suggest that perioperative CS can occur in apparently conventional conditions of care, and for ill-defined reasons. Our patient's history of smoking and hepatic fatty degeneration may have contributed to increased capillary fragility, mirroring a case report by Stotts et al. [8].

Because CS is a reperfusion injury, clinical features may develop insidiously rather than immediately. It may manifest during the postoperative phase when the level of clinical observation may be less intense if the patient is not in a high dependency area [17]. The first signs usually occur after the patient has regained consciousness and left the recovery room [18]. In some series, the average time from the end of surgery to the first noted symptoms was 40 hours (range, 6–78 hours) [1].

Although the canal invasion by the malpositioned screw apparently did not cause clinical sequelae, the need for re-intervention could have distorted the initial clinical symptoms (absence of pain) and, besides, could have aggravated or accelerated its development due to the second procedure in the kneeling position. The diagnosis of CS in our patient was made within 16 hours, well past the ischaemic threshold [18], and can explain that the permanently disabling muscular necrosis could not be prevented. Repeated wound debridement and prompt fluid therapy assisted in averting myoglobinuria and renal failure. The only systemic complication was malnutrition and hypoproteinaemia due to pre- and postsurgical fasting as well as the protein losses sustained through the surgical wounds.

4. Conclusions

That CS occurred after prolonged surgery in the kneeling position lends support to the idea that the combination of hypotension, venous congestion, compression on the calf, and, perhaps, a light tight bandage is sufficient to compromise local blood flow. We must assume that although the kneeling position is generally safe, it can cause external compression of the legs, particularly in large patients undergoing lengthy procedures.

The benefits of using compression hosiery must be weighed against its risks. Although there is no supporting evidence, it may be safer to avoid compression stockings when the kneeling position is used in lumbar surgery. Also, it may be safer to monitor calf compartment pressure during prolonged lumbar surgery.

A high index of suspicion of CS facilitates an early diagnosis and expedites appropriate treatment. The aggressive treatment of the reperfusion injury can avoid severe

rhabdomyolysis, acute renal failure, and sepsis, although it cannot avoid the permanently disabling muscular necrosis.

The devastating effect of CS, whether life threatening or permanently disabling, should be considered as another limiting factor at the time of indicating a spine revision procedure.

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