CASE REPORT

Well leg compartment syndrome following penetrating abdominal trauma

D. Lui a,*, S. Boran a, H. Said b, E. Fogarty a, M. Corbally b

a Department of Paediatric Orthopaedic, Our Lady’s Children Hospital in Crumlin, Dublin, Ireland
b Department of Paediatric General Surgery, Our Lady’s Children Hospital in Crumlin, Dublin, Ireland

Accepted 21 December 2006

Background

Well leg compartment syndrome is a recognised complication following surgical procedures involving the lithotomy position. Review of the surgical literature shows that this complication has been seen in urological, gynaecological, and general surgical patients, but has not been widely reported in the orthopaedic population. However, this condition has never been described as a complication of abdominal injury and in a supine operating position.

The two main theories of WLCS are direct external compression and vascular insufficiency or hypoperfusion of the calf muscles, or a combination of the two. The common pathway may be hypo-oxygenation leading to local ischaemia, tissue oedema and then fulminant compartment syndrome.

Classically compartment syndrome occurs when pressure within a closed osseofascial compartment exceeds the perfusion pressure and results in cellular anoxia, muscle and nerve ischaemia. Two distinct conditions are recognised: acute and chronic (exertional) compartment syndromes. Compartment syndrome is a well described injury to the lower limb, but it not exclusive to this region. It can occur in any extremity as well as the abdomen. WLCS pathogenesis differs to classical compartment syndrome.

A variety of injuries and medical conditions may initiate acute compartment syndrome, including fractures, contusions, bleeding disorders, burns, trauma, post ischaemic swelling, and gunshot wounds. Diagnosis is primarily clinical, supplemented by compartment pressure measurements. Certain anaesthetic techniques, such as nerve blocks and other forms of regional and epidural anaesthesia, reportedly contribute to a delay in diagnosis. Basic science data suggest that the ischaemic threshold of normal muscle is reached when pressure within the compartment is elevated to 20 mm Hg below the diastolic pressure or 30 mm Hg below the mean arterial blood pressure. On diagnosis of impending or true compartment syndrome, immediate measures must be taken. Fasciotomy of all compartments involved is required to reliably normalise compartment pressures and restore perfusion to the affected tissues. Recognising compartment syndromes requires having and maintaining a high index of suspicion, performing serial examinations in patients at risk, and carefully documenting changes over time.

* Corresponding author at: Our Lady’s Children Hospital in Crumlin, Crumlin Road, Dublin 12, Ireland.
E-mail address: darrenflui@gmail.com (D. Lui).

Case presentation

A 9-year old was trespassing in a church. While playing, they were discovered and as his friend scrambled through the door he was climbing through a window and sustained a 3 cm, penetrating injury to his upper right quadrant of his abdomen from a shard of broken glass. Initially fully conscious, he presented to a regional hospital accident and emergency department with drowsiness. He had a pulse rate of 96 beats per minute, respiratory rate of 24/min, BP 117/67 mm Hg and Hb 13 g. An erect PFA showed air under the diaphragm.

He was brought for an emergency laparotomy. A Kocher’s incision was performed in the upper abdomen. At surgery large volumes of clot were removed and an anterior perforation of the pylorus of the stomach was discovered. This was repaired. However, there was significant haematoma surrounding the viscera and other sources of bleeding could not be clearly identified. The abdomen was packed to control the unidentified source of bleeding. He received four units of blood, was stabilised and then transferred to our paediatric trauma centre. On arrival the boy was intubated and ventilated. He had a HR 75, BP 137/90 On admission his Hb was 17 g.

Fifteen hours later, a second explorative procedure identified the full extent of the injury. He had sustained a through and through penetrating injury through the pylorus of the stomach. Although the previous hospital had noted the anterior perforation they had not repaired the posterior wound. Directly behind here lay the duodenum which was also perforated completely through to the inferior vena cava behind it. This was repaired and the child was admitted to the ICU.

On the second day post operative day the boy complained of severe right leg pain. Of note his morphine infusion was increased for his generalised pain also. On examination he was unable to dorsiflex his ankle or his big toe; and of note the calf was tender and swollen. Intra-compartmental pressures were increased to within 25 mm Hg of the diastolic pressure and he was brought to theatre for a two incision fasciotomy. Intraoperative findings revealed the anterior compartment muscles bulging with dark discolouration. No contraction of muscles could be elicited. The lateral, superficial and deep compartments showed no oedema and had healthy, pink, contracting muscles. Wound edges were approximated loosely with clips and vascular loops.

Post operative assessment showed no immediate recovery of lateral popliteal nerve as observed by lack of ankle dorsiflexion and extensor hallucis longus activity. This boy returned to the operating theatre for a sub atmospheric vacuum dressing, a split skin graft and wound review multiple times. There were no further complications.

At his 6 week follow up post injury this boy was receiving physiotherapy and was using a foot drop splint at night only. He had regained some ankle dorsiflexion and EHL activity showing that the lateral popliteal nerve was firing. The wounds were healing well. EMG studies were arranged. Currently he is able to walk and run without much complication and is being followed regularly.

Discussion

Well leg compartment syndrome is a recognised complication following surgical procedures involving the lithotomy position. Review of the surgical literature shows that this complication has been seen in urologic, gynaecologic, and general surgical patients, but has not been widely reported in the orthopaedic population. However, this condition has to this authors knowledge not been described as a complication of abdominal injury with the patient in a supine operating position. It has however been described in an elective breast procedure in bilateral lower limbs in the supine position.

Lower limb compartment syndrome can be caused by abnormal increases in intracompartmental pressures within a non expansile fascial space and has been recognised after prolonged elevation of the lower limbs during surgical procedures in the lithotomy position. Reports of WLCS are limited. A recent survey of UK consultants regarding this complication was reported in 2005. Replies from 261 (of 520) consultants were obtained (50.2%). In total there were 65 cases of compartment syndrome and they occurred after radical cystectomy and urinary diversion in 51 cases. It was rare in procedures lasting less than 4 h. The incidence of WLCS after cystectomy was estimated to be 1 in 500 cases, whereas it had been estimated at 1 in 3500 cases. Risk factors for its development included perioperative blood loss, peripheral vascular disease and obesity. They concluded that WLCS after use of lithotomy position may be more common than generally appreciated and was underreported.

In these cases WLCS presents as post operative leg pain out of proportion to the clinical findings. The classic signs of calf swelling, paraesthesia, weakness of toe flexion and pain during passive toe extension are late signs. They often indicate established compartment syndrome. An important caveat is that a palpable dorsalis pedis pulse, or one identifiable on Doppler does not show that the
compartment is well perfused. An absent pulse altogether is a sign of late compartment syndrome.

The normal range of compartment pressure during an operation is between 0 and 10 mm Hg. Definitive diagnosis is performed by measuring compartmental pressures directly with a pressure transducer tipped catheter or a conventional fluid filled device. Although there is no exact agreement for when intervention should occur, the general consensus is to base it with clinical findings. Once the decision is made, a four compartment fasciotomy must be made to be effective.

The orthopaedic literature also contains reports of this complication in legs positioned on a fracture table in the hemilithotomy position involving femoral nailing with injury to the contralateral leg. In one case report the authors advocate a modified hemi-lithotomy position is proposed. That avoids extreme elevation of the leg and diminishes the hip and knee flexion required while allowing adequate fluoroscopy. In another the authors report two cases of unilateral compartment syndrome in a well leg during femoral nailing of the contralateral leg.

Meyer et al. positioned healthy volunteers on a fracture table. Intramuscular pressures were continuously measured with a slit catheter in all four compartments of the left leg with the subject supine, in the hemilithotomy position with the calf supported, and in the hemilithotomy position with the heel supported but the calf free. Blood pressure was measured intermittently with use of automated pressure cuffs.

Meyer et al. found that the combination of increased intramuscular pressure due to external compression from the calf support and decreased perfusion pressure due to the elevated position caused a significant decrease in the difference between the diastolic blood pressure and the intramuscular pressure when the leg is placed in the hemilithotomy position in a well-leg holder on a fracture table. Combined with a prolonged surgical time, this position may cause an acute compartment syndrome of the well leg. Their conclusions were to leave the calf free, instead of using a standard well-leg holder, which increases the difference between the diastolic blood pressure and the intramuscular pressure. This may decrease the risk of acute WCLS.

Compartment syndrome is thought to be due to prolonged impairment of lower limb perfusion secondary to a rise in compartment pressure. A reduction in perfusion pressure causes tissue ischaemia. This is compounded by an ischaemia reperfusion injury causing capillary leakage and tissue oedema. This in turn causes more tissue oedema and further perfusion impairment.

The two main theories are direct external compression and vascular insufficiency or hypoperfusion of the calf muscles, or a combination of the two. The common pathway may be hypo-oxygenation leading to local ischaemia, tissue oedema and fulminant compartment syndrome. Support for direct compression comes from the evidence of well leg holders which advocate the most important cause for increased compartment pressure as the decreased perfusion pressure in an elevated leg. The high correlation between high body mass index and calf pressures further strengthens this side of the debate. The second theory is based on lower mean arterial pressure due to hydrostatic pressures and venous stasis in a raised leg.

This case report highlights support for vascular insufficiency or hypoperfusion theory. Venous stasis almost certainly occurred in this case and could have occurred partially due to packing the abdomen and secondly from haemorrhage into the abdomen. As well as this he sustained significant hypovolaemia and release of the packing may have caused a serious ischaemia reperfusion injury.

Ultimately prevention of WCLS is the best practice. Key issues in management should be awareness of bony or soft tissue injury to the well leg or an obese patient. Time spent in lithotomy type positions should be minimised or avoided. The leg should be abducted and extended on a fracture table in orthopaedic cases and if necessary regularly taken down in those with a high index of suspicion. Continuous compartment pressure monitoring could be conducted.

In this particular case, of a 9-year old boy with low BMI and no lower limb pain or injury, the index of suspicion was low. However, it would be prudent in cases of penetrating injury where the abdomen must be packed to facilitate rapid transfer to a tertiary centre that the receiving team be acutely aware of possible reperfusion injury in the lower limbs and that hypovolaemia be treated aggressively.

References