CASE REPORT

Acute compartment syndrome risk in fracture fixation with regional blocks

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Accepted 11 November 2015

SUMMARY

Acute compartment syndrome is a surgical emergency that most commonly occurs after trauma or reperfusion after prolonged arterial occlusion. It is caused by a build-up of blood and oedema fluid within a closed muscle compartment, and can be limb and life-threatening. It is therefore imperative that a prompt diagnosis is made. The risk of developing this condition is <1% in patients with distal radius fractures and 4–5% in those with tibial diaphyseal fractures. Pain management is an important aspect of treatment following any fracture. Regional anaesthesia can be used during surgical fixation of the fracture and has the potential to reduce the need for specialist postoperative care and analgesia, as well as to shorten the length of hospitalisation. With this case report, we hope to highlight the potential risk of masking symptoms of compartment syndrome while using regional blocks, as this can cause a delay in diagnosis and treatment, leading to associated complications.

BACKGROUND

Acute compartment syndrome (ACS) is a surgical emergency most commonly occurring when there is increased pressure within an enclosed space compromising the perfusion and function of tissues within that space.^{1–3} ACS is often seen with significant trauma to extremities, with legs and forearms being the commonest sites. However, it can also occur in the thighs, feet, hands, arms and abdomen.

With an ever-increasing demand for trauma beds in the National Health Service, patients are being discharged early. Adequate pain control is required to facilitate early discharge from hospital and anaesthetists are turning increasingly to peripheral blocks either as a primary anaesthetic or as a supplement to general anaesthesia.^{4 5}

Multimodal pathways have been established in most hospitals to achieve adequate pain control, minimise opioid use and shorten the length of hospital stay. Regional anaesthesia, nerve blocks and continuous local anaesthetic infiltration play a significant role in these pathways.⁶ These modalities are designed to improve patient outcomes and to avoid further risk.

CASE PRESENTATION

A 75-year-old man presented to the emergency department, with a history of a fall on his outstretched, non-dominant left hand. On further assessment, he appeared to have sustained a distal

radius fracture with volar displacement ([figure 1](#)) and no other bony injuries. He was haemodynamically stable and his wrist was supported by a below elbow volar slab. His medical history included heart failure with mild to moderate symptoms, sleep apnoea, recurrent urinary tract infections, recurrent falls, moderate osteoarthritis of the right hip, blindness in the left eye and impaired vision in the right eye. The patient was not on any anti-coagulant medications.

He was later reviewed by the orthopaedic team personnel, who explained the different treatment options, and a collective decision was made to manipulate the fracture under general anaesthesia, and to carry out a percutaneous K-wire fixation. A plaster slab was also applied for additional support ([figure 2](#)).

He was reviewed in outpatient clinic for 2 weeks after the surgery, reporting pain along the pin-sites. Clinically, there were no signs of active infection, and one of the wires appeared to be loose—at that stage, the backslab was changed to a full below elbow synthetic cast. A week later, all the wires had become loose, hence they were pulled out in the clinic and the plaster cast was re-applied.

Two weeks after removal of the wires, the patient reported increasing pain in the wrist. A further radiograph showed further volar displacement of the distal radius fragment with significant

Figure 1 Anteroposterior and lateral view of extra-articular distal radius fracture with volar displacement and shortening.

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To cite: Marappa Ganeshan R, Mamooowala N, Ward M, et al. *BMJ Case Rep* Published online: [please include Day Month Year] doi:10.1136/bcr-2015-210499

Figure 2 Intraoperative images of K-wiring with satisfactory restoration of radial height and volar displacement.

shortening (figure 3). It was decided to perform an internal fixation with a volar peri-articular locking plate (figure 4). The procedure was carried out under an axillary nerve block and the patient was discharged the same day, as he was pain free and comfortable.

Twenty-four hours after discharge, he again presented to accident and emergency department, this time reported not being able to feel his fingers; he had also noticed multiple swellings over the forearm and hand. On examination, his left arm, distal to the elbow, was oedematous, with multiple haemorrhagic blisters along the surgical wound, forearm and hand (figure 5). Active movements of the fingers and wrist were absent and passive movements were painful and limited. Passive extension of the fingers caused severe pain. Capillary refill was over 4 s in his fingers and there was reduced sensation along the median nerve distribution. A tachycardia was also noted.

INVESTIGATIONS

- ▶ X-ray
- ▶ Compartment pressure monitoring
- ▶ Full blood count and inflammatory markers.

Figure 3 Significant shortening and volar displacement with clinical deformity of wrist.

Figure 4 Intraoperative images of volar plating.

DIFFERENTIAL DIAGNOSIS

- ▶ ACS
- ▶ Infection
- ▶ Iatrogenic arterial and nerve injury intraoperatively.

TREATMENT

On the basis of the clinical presentation, ACS was diagnosed. It was confirmed with compartment pressure measurements using a Stryker pressure monitoring kit. Two separate compartment pressure readings of 46 and 50 mm Hg in the anterior compartment and a reading of 22 mm Hg in the posterior compartment of the forearm were noted. The patient was taken to the operating theatre within an hour of presentation, for emergency forearm decompression.

Fasciotomy of the flexor compartment of the forearm and carpal tunnel release were performed. Dusky looking, unhealthy muscle tissue was excised. The surgical wound was left open

Figure 5 Multiple blisters over the swollen forearm and hand.

Figure 6 Fasciotomy wound appearance after second washout.

and the limb kept elevated; no additional vacuum-assisted dressing was used. Four hours after surgery, the patient was able to actively move the wrist and all fingers, but still had impaired sensation along the medial nerve distribution. He underwent two further forearm fasciotomy wound debridements (figure 6) until the swelling completely subsided, allowing closure of the wound.

OUTCOME AND FOLLOW-UP

The patient was regularly followed up in the orthopaedic and hand-physiotherapy clinics. At 4 months, he noticed significant improvement in his left hand grip strength, measured using a Jamar Hand Dynamometer, though it was 25% less compared with his right hand. By 9 months, he had regained most of the sensation in his left hand, apart from a patch of numbness over the thenar eminence, and, at 12 months, grip strength had gradually improved to 18% less compared with the right hand.

DISCUSSION

In 1872, Richard Von Volkmann published an article on nerve injury and subsequent contracture deformity in the forearm following supracondylar fractures, and attributed the condition to tight plasters. He also suggested, in a later publication, in 1881, that blood supply interruption led to the paralysis and contractures.⁷ Over the next 80 years, more case reports were published, prompting further studies, and, in the 1970s, compartment pressure measurements were correlated to compartment syndrome.

Mubarak and Hargens⁸ described compartment syndrome as “a condition in which high pressure within a closed fascial space reduces capillary blood perfusion below the level necessary for tissue perfusion and viability.” The cardinal signs and symptoms are pain, altered or loss of sensation, pallor or pulselessness, and paralysis or poikilothermy.⁹ Quite often, these signs are variable and appear late. A high index of suspicion is needed; severe pain, out of proportion to the injury or insult sustained, is the key to identifying and treating ACS.

The compartment pressure in healthy muscle is around 10 mm Hg. A retrospective review of 1184 patients with tibial diaphyseal fracture and compartment syndrome with continuous compartment pressure monitoring, by McQueen *et al*,¹⁰ showed that a differential pressure of <30 mm Hg is 94% sensitive and 98% specific in diagnosing compartment syndrome, where the differential pressure is the difference between the compartment

pressure and diastolic blood pressure at the time of measurement.

Hyder *et al*,¹¹ identified a patient who was given a nerve block for intramedullary nailing of a tibial fracture. The patient reported increasing pain in the leg but compartment pressures were not measured until 48 h postprocedure, by which time they were found to be significantly elevated; the patient underwent emergency fasciotomy. The authors suggest that the nerve block masked the patient's pain and subsequently led to a delayed diagnosis of compartment syndrome. These findings are similar to those of Noopuri *et al*,¹² who described a patient who underwent forefoot revision arthroplasty for rheumatoid arthritis and was given an ankle block. The patient was comfortable in the immediate postoperative period but developed severe pain in the subsequent 12 h. Later, the patient underwent emergency fasciotomy and, fortunately, suffered no long-term effects.

Uzel and Steinmann¹³ reported a case of compartment syndrome of the anterior thigh after intramedullary fixation of a femoral shaft fracture, for which the patient had a femoral nerve block with 20 mL ropivacaine hydrochloride single injection, prior to having general anaesthesia. Pain was reported 4 h postoperatively, but this was managed with further opioid analgesia. The day after the procedure, further reports of disproportionate pain prompted investigation, which revealed elevated anterior thigh compartment pressure. On this basis, the patient was taken for emergency fasciotomy. Even though there had not been many case series published with similar events at the time, the authors suggested monitoring patients closely when nerve blocks were used, as the blocks could be responsible for a delay in diagnosis of compartment syndrome.

On the contrary, Cometa *et al*¹⁴ described a patient who developed pain in the lower extremity after undergoing proximal tibial and distal femoral osteotomies under cover of continuous femoral and sciatic nerve blocks, which were then changed to oral analgesia. The patient developed pain on passive ankle dorsiflexion. The calf was also noted to be tense on the operated side. After confirming high compartmental pressures, the patient underwent emergency fasciotomy. The authors concluded that nerve blockade did not delay diagnosis here, as compartment syndrome developed during or after the transition from anaesthetic infusion to oral analgesia.

In the aforementioned cases, though there is a strong association between peripheral nerve blocks and the incidence of compartment syndrome in the extremities, it is debateable whether the nerve blocks had actually resulted in delaying the diagnosis of ACS. As all the patients aforementioned above were still in the hospital or within a clinical setting, and the clinicians intervened promptly with pressure monitoring and surgical decompression, significant long-term complications were prevented.

In comparison, our patient was discharged home with the regional block still ‘in effect’, and was not able to appreciate the extent of his signs and symptoms until multiple large blisters started appearing, which in turn raised his concerns. Although it was not standard practice to discharge patients with regional blocks on the same day of surgery, surgeons at our institution are now more cautious while discharging them, and ensure that patients have regained distal sensation and movement prior to discharge.

Following acute injury leading to long bone fractures, there will be insult to surrounding soft tissues, resulting in swelling and bruising. Any surgery to fix such a fracture would contribute additional trauma to the soft tissues and further increase the risk of swelling and bleeding. In the case discussed above,

compartment syndrome developed after the revision distal radius fixation, as initial closed reduction and K-wire stabilisation failed, with significant displacement of the fracture fragments, which required extensive dissection and soft-tissue release. This case shows that care is needed when using regional blocks during and after surgical fixations, in particular when extensive dissection is carried out.

Regional blocks are effective in controlling pain, but are not necessarily the safest option in patients with significant trauma requiring surgery on long bones and in those being discharged early.

Learning points

- ▶ Caution needs to be exercised when using regional anaesthesia or peripheral nerve blocks in trauma patients and in those requiring long bone surgeries.
- ▶ Awareness of compartment syndrome and a high index of suspicion is required for early diagnosis and management.
- ▶ An early discharge plan for patients with nerve blocks still 'in effect' is not necessarily the safest strategy.

Contributors RMG identified and wrote the case report and was involved in treating the patient; MW and DS helped with the literature review and provided guidance with writing; NM edited the report.

Competing interests None declared.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

- 1 McQueen MM, Gaston P, Court-Brown CM. Acute compartment syndrome: who is at risk. *J Bone Joint Surg Br* 2000;82:200–3.
- 2 Abraham R. Medscape. [Online]; 2015 [cited 20 August 2015]. <http://emedicine.medscape.com/article/307668-overview> \l "a3."
- 3 Duckworth AD, McQueen MM. Bone and Joint Education. [Online]; 2011 [cited 12 December 2014]. <http://boneandjoint.org.uk/content/diagnosis-acute-compartment-syndrome>
- 4 Court-Brown CM, Caesar B. Epidemiology of adult fractures: a review. *Injury* 2006;37:691–7.
- 5 van Staa TP, Dennison E, Leufkens HM, et al. Epidemiology of fractures in England and Wales. *Bone* 2001;29:517–22.
- 6 Bourne M. Analgesics for orthopedic postoperative pain. *Am J Orthop (Belle Mead NJ)* 2004;33:128–35.
- 7 Klennerman L. The evolution of the compartment syndrome since 1948 as recorded in the JBJS (B). *J Bone and Joint Surg Br* 2007;89:1280–2.
- 8 Mubarak SJ, Hargens AR. Acute compartment syndromes. *Surg Clin North Am* 1983;(63):539–65.
- 9 Rensburg LV. Royal College of Surgeons, Edinburgh. [Online]; 2006 [cited 15 January 2015]. http://www.rcsed.ac.uk/fellows/lvanrensburg/classification/commonfiles/compartment_syndrome.htm
- 10 McQueen M, Duckworth A, Aitken S, et al. The estimated sensitivity and specificity of compartment pressure monitoring for acute compartment syndrome. *J Bone Joint Surg Am* 2013;95:673–7.
- 11 Hyder N, Kessler S, Jennings A, et al. Compartment syndrome in tibial shaft fracture missed because of a local nerve block. *J Bone Joint Surg Br* 1996;78:499–500.
- 12 Noopuri B, Shahane S, Getty C. Acute compartment syndrome following revisional arthroplasty of the forefoot: the dangers of ankle-block. *Foot Ankle Int* 2000;21:680–2.
- 13 Uzel A, Steinmann G. Thigh compartment syndrome after intramedullary femoral nailing: possible femoral nerve block influence on diagnosis timing. *Rev Chir Orthop Traumatol* 2009;95:309–13.
- 14 Cometa M, Esch A, Boezaart A. Did continuous femoral and sciatic nerve block obscure the diagnosis or delay the treatment of acute lower leg compartment syndrome? A case report. *Pain Med* 2011;12:823–8.

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