The ‘silent’ compartment syndrome

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A B S T R A C T
Intractable pain out of proportion to the injury sustained is considered to be the earliest and most reliable indicator of a developing compartment syndrome. We report 4 cases where competent sensate patients developed compartment syndromes without any significant pain. The first patient developed a painless compartment syndrome in the well leg following surgery for femoral fracture on the other side. The second patient developed the silent compartment syndrome post-operatively following a tibial nailing for a tibial fracture. The third patient presented with the painless compartment syndrome following a tibial plateau fracture. Our prevailing culture of a high-index of clinical suspicion and surveillance prompted us to perform compartment pressure measurements. The surgical findings at immediate fasciotomy confirmed the diagnoses.

Our experience indicates that pain is not a reliable clinical indicator for underlying compartment syndrome, so in a competent sensate patient the absence of pain does not exclude compartment syndrome.

We believe that a high index of clinical suspicion must prevail in association with either continuous compartment pressure monitoring or frequent repeated documented clinical examination with a low threshold for pressure measurement.

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Introduction

All limb injuries, whether open or closed, can be complicated by compartment syndrome. Delayed diagnosis can lead to complications ranging from residual disability to amputation.3,7,8,11,13–15 A high index of suspicion is necessary to promote early diagnosis. The development of any of the classical signs (pain exacerbated by stretch, a tense swollen limb, paresis or pallor) implies the development of underlying significant ischaemia. The diagnosis may be confounded by the presence of associated nerve injuries with loss of sensation18,20 in the unconscious or locally anaesthetised patient or in the patient rendered incompetent by the extremes of age, intoxication or psychopathology. However in the sensate and competent patient, the development of pain that is out of proportion to the injury sustained and is not relieved by analgesia is traditionally considered to be the earliest reliable indicator of the development of an underlying compartment syndrome in any limb.

We report 4 cases in which competent patients developed compartment syndromes in their sensate leg without any significant pain. The implications are discussed.

Patients and methods

The patients, all competent sensate young males, presented with single closed lower limb injuries between 2004 and 2005. All patients underwent pre- and postoperative non-invasive clinical surveillance based on routine pain checks and clinical examination. Reportage of either pain out of proportion to that expected for the given injury or a palpably tense limb, with positive passive stretch test provoked immediate bedside pressure-gauge measurement. The decision to perform decompressive fasciotomies was made primarily on clinical grounds and supported by compartment pressure-gauge measurement as defined by Mubarak et al.12 All decompressive fasciotomies were performed using the 2-incision technique. Soft tissue coverage was achieved using the Martindale elastic band lace-up technique. The patients were returned to theatre at 48 h postoperatively for a ‘second look’ debridement and either wound closure or delayed split skin grafting. Follow-up in the clinics was at 1 week, 6 weeks and 3 months.

Case 1: Well leg compartment syndrome

An 18-year-old muscular male presented after a vehicular accident with a right sided closed high-energy femoral diaphyseal fracture. He underwent intramedullary nail fixation in the
hemilithotomy position on the fracture table within 8 h of presentation. The patient's muscular status and the petrotic nature of the pterrochanteric region precluded closed antegrade nailing despite several attempts by the consultant led team using both manual and powered instruments. A retrograde nailing procedure through the opened fracture site was necessary with an operative time of 3.5 h. Postoperatively, the patient's urine was dark and decreasing in volume. A transfusion reaction was ruled out by laboratory triple checks. The drowsy but competent patient did not communicate any abnormal discomfort in the recovery suite, in the subsequent nurse-led trauma ward (continuous monitoring phase) and on clinical review on the ward by the surgical team within 5 h of surgery. The operated limb was warm and well perfused. A myoglobinuric response to the high-energy injury and subsequent surgery to his massively muscled right thigh was presumed to be the cause of the dark coloured urine. The patient’s urine output continued to fluctuate despite appropriate fluid maintenance. He became hyperkalaemic and 8 h post-surgery on anaesthetic review, he complained, for the first time, of a 'dull ache' but no significant pain in his well-leg calf. Transfer was arranged to the Intensive Care Unit for further monitoring. When examined again 2 h later, no remarkable swelling or bruising was initially noted. His well leg was cool distally with no palpable or doppler sensitive pulses were recordable distal to the femoral pulses. Vascular team review confirmed the above findings. The patient still did not describe any significant pain. His calf however was by now swollen and tense. Compartment pressure testing in both deep and superficial posterior calf compartments recorded the right injured lower limb calf deep and superficial pressures at 26 mm of mercury while his 'well-leg' left calf pressures measured 100 and 110 mm in the deep and superficial posterior compartments respectively. The patient remained competent and sentient but was becoming haemodynamically unstable. Under sedation, open fasciotomies of all four compartments carried out in the intensive care unit. His muscles at that point looked dusky but were bleeding. Following decompression, the dorsalis pedis was palpable and the posterior tibial pulse was confirmed on Doppler examination. Both foot pulses were easily palpable within 5 h. The foot remained sensate. The patient was taken back to theatre 24 h post-fasciotomy. Most of the muscles in all four compartments were of dubious viability. All patently non-viable muscles were excised. The patient returned to theatre and a radical debridement of all muscles was needed to excise the necrotic tissue. Intraoperatively, the patient became metabolically unstable and his overall condition continued to deteriorate and following consultations with the vascular surgeons, a life saving above knee amputation was performed. The patient required cardiac, respiratory and renal support for recovery.

Case 2: Postoperative compartment syndrome

A 23-year-old powerfully built male rugby player presented with a closed short oblique tibial diaphyseal high-energy sports injury. He reported pain of an intensity of 5/10 on routine pain scale monitoring and was comfortable with routine analgesia. Uneventful intramedullary nailing was performed within 24 h with an operative time of 45 min. Postoperatively the patient was comfortable with analgesia. He was examined prior to discharge the following morning and found to have some blunting of sensation in the dorsal 1st web space and MRC grade 4 paresis of his extensor hallucis longus (EHL). Compartment pressure of 70 mm Hg in the lateral compartment was recorded. An emergency decompressive fasciotomy to the dusky but bleeding muscles was carried outdone. Reinspection and partial closure of the wound was performed 48 h later. Eventually skin grafting was required to promote wound healing. The first webspace blunted sensation and the EHL weakness persisted limiting his recreational sport.

Case 3: Post-traumatic compartment syndrome

A 43-year-old male tree surgeon presented to the hospital as a tertiary referral 8 h after falling, harnessed, some 5 m from a broken bough and swinging against the tree-trunk sustaining a closed lateral tibial plateau fracture. The patient presented with visual analogue score of 5/10 and was comfortable with analgesia resting his splinted limb elevated on a Brauns frame and reading when routinely assessed by the senior resident on night rounds. Despite his relative comfort and sparse analgesic requirement, his moderately tense calf raised the suspicion of the compartment syndrome. Pressures of 35 mm in the anterior compartment of the leg and 85 mm in the lateral compartment of the leg were recorded. Emergency fasciotomy was carried out. The leg was operated in the flexed knee position without the use of a tourniquet. Significant colour changes in the posterior compartment of the leg were noted confirming early changes of the compartment syndrome. The fracture was reduced and fixed by extending the lateral incision upwards. Postoperatively the patient remained comfortable and was managed as a routine tibial plateau fracture fixation undergoing reinspection with secondary wound closure at 48 h. The patient made a complete recovery with a good range of motion of his knee and ankle movements returning to his occupation at 12 weeks post-injury.

Case 4

A 48-year-old male lorry driver sustained a closed, extra-articular multifragmentary fracture of the right proximal tibia and fibula when a large metal sheet fell onto his leg. Initial assessment revealed significant swelling of the right leg associated with fracture blisters, but no neurovascular deficit. He was managed with back-slab splintage, bilateral AV boots, Brauns frame elevation and routine analgesia with a view to surgical fixation when the swelling had sufficiently reduced. At 48 h, despite increasing swelling, the patient remained at ease on regular oral analgesia following an initial single dose of 10 mg subcutaneous morphine on admission. Although passive extension of the toes did not provoke remarkable discomfort, a high index of suspicion honed by previous experience and further promoted by the crush component associated with his particular injury, prompted diagnostic compartment pressure measurement. Compartment studies revealed pressures of 45 and 50 mm respectively in the posterior and antero-lateral compartments with BP of 100/60 mm of Hg. Emergency fasciotomy revealed tight compartments with significant muscle changes consistent with compartment syndrome, albeit with no frank necrosis requiring muscle excision. The fracture was stabilised with a locking plate. Following two further debridement procedures, the fasciotomy wounds were closed with secondary suturing at 8 days. Partial foot drop was noted on rehabilitation.

Discussion

The diagnosis of compartment syndrome is traditionally considered to be a clinical one with intractable pain out of proportion to that expected for a given injury. The diagnosis is clinched if the pain is aggravated on passive stretching of the affected compartments. Diagnostic pressure monitoring confirms the diagnosis in those with clearly suggestive clinical symptoms and signs of compartment syndrome.

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Some studies have advocated an intracompartmental pressure of greater than 30 mm Hg as diagnostic of compartment syndrome. Others cite the difference of pressures between the diastolic blood pressure and the intracompartmental pressure as indications for decompressive fasciotomy. Whatever modality is used, compartment pressure monitoring proves invaluable when the routine high index of clinical suspicion is further raised in patients rendered incompetent by means of extreme age, psycho-pathology, intoxication, or general or regional anaesthesia.

The importance of pressure monitoring in the obtunded patient is well reported. McQueen et al. recommended all patients with tibial fractures should have continuous compartment monitoring. Others have proposed compartment pressure monitoring in patients with multiple injuries,2,10,19,20,22,23,24,25 and intoxication. However Triffitt et al. cautioned against routine monitoring in the absence of symptoms. Accordingly, there is no consensus on compartment pressure surveillance monitoring in competent sensate patients. The emphasis with these patients remains on clinical surveillance. This traditionally relies on the predominantly patient-driven diagnostic cornerstone of unexpected intractable pain instigating further clinical examination and pressure measurement.

This case series shows that the traditionally held reliable signal of intractable or even significant pain may be absent even in a fully alert patient with a sensate limb. The diagnostic compartment pressure measurements and the surgical findings of muscle necrosis at the time of fasciotomies confirmed the diagnosis of compartment syndrome in all four patients.

The first patient developed compartment syndrome in the well leg. Although drowsy, he remained orientated and communicative only requiring modest analgesia during his close postoperative clinical surveillance. He did not report any significant discomfort even when his tense well-leg calf pressures were over 100 mm Hg. This patient incurred a well-leg amputation.

The second patient, a young heavily muscled rugby player, despite pre-discharge consultant examination, only alerted suspicion of his underlying 70 mm Hg compartment pressure by complaining of slight first dorsal web-space tingling prior to transfer to the discharge lounge. Following surgery and eventual skin grafting, he returned to limited sport albeit with minimal residual EHL weakness and paraesthesia.

The third patient, a slimmer but super-fit tree surgeon, was diagnosed on routine evening rounds as he sat in bed reading, with limb elevated, on modest analgesia, and awaiting ‘routine’ trauma compartment syndrome. Others cite the difference of pressures between the diastolic blood pressure and the intracompartmental pressure as a determinant for the need of fasciotomy. Clin Orthop 1975;113:43–9.

The fourth patient, the more subtle anatomic signs of disability at clinical follow-up?


3. Is the silent compartment syndrome usually well tolerated or distressing? To what extent, if any, does silent compartment syndrome contribute to late or missed diagnosis? Is the silent compartment syndrome usually well tolerated or does overall functional competence obscure our observation of the more subtle anatomic signs of disability at clinical follow-up? Is the silent compartment syndrome transient, and if so, should it be decompressed immediately or its trajectory closely monitored?

Conclusion

Occult compartment syndrome may occur in non-competent, distracted or insensate patients. We believe that a true ‘silent compartment syndrome’ occurs when a compartment syndrome is confirmed in a competent sensate patient in the absence of pain which is out of proportion to that expected for a given injury. Young super fit high muscle mass patients appear prone to compartment syndrome. We believe that a high index of clinical suspicion must prevail in association with either continuous compartment pressure monitoring or, as we prefer, frequent repeated documented provocative clinical examination with a low threshold for bedside pressure measurement. Awareness of the silent compartment syndrome promotes early diagnosis and prevents disability.

References


16. Triffitt PD, Konig D, Harper WM, et al. Compartment pressures after closed tibial fractures should have continuous compartment monitoring.


