1. Introduction

Pelvic ring injuries associated with massive haemorrhage carry a high mortality and significant morbidity. Rapid recognition of these problems prompted by a grasp of the mechanism of injury and the findings of the primary survey insures immediate action. Reduction of the increased intra-pelvic volume helps tamponade bleeding. The sooner this is done, the more likely it is to be effective, and binders can be applied safely in fully conscious patients, even in the presence of other lower limb fractures. Significant improvements in mortality have been described using this strategy, and this is recommended by the American College of Surgeons in Advanced Trauma Life Support (ATLS). Uncertainty has existed about how long a binder can be left in place for. This unit has always advocated exchange of the binder for appropriate external fixation as part of the initial damage control strategy. There are few case reports detailing minor complications relating to pelvic binder use, but this report describes catastrophic complications underlining the importance of early binder exchange.

2. Case report

A 27-year-old man was transferred into the Regional Plastic Surgery Unit 18 days following massive crush injuries sustained in an industrial accident. He was crushed in posterior to anterior direction at the level of the pelvis and briefly trapped. On admission he was fully conscious but in profound hypovolaemic shock. A laceration was noted anterior to the left hip and neurological examination of his lower limbs showed sensation intact with toe movement present bilaterally. Pelvic radiography demonstrated dislocation of both sacro-iliac joints and confirmed an open fracture of the left acetabulum. An improvised pelvic binder was applied and emergency laparotomy performed.

At operation, the rectus abdominis was found to be transected, the small bowel crushed and lacerated and the rectum avulsed. There was a large retroperitoneal haematoma with psoas transected, and the aorta lacerated at its bifurcation, along with multiple holes in the adjacent inferior vena cava (IVC). The urethra was also found to be divided but there was no renal or ureteric injury. The aorta was repaired with a long saphenous vein patch, and the IVC repaired with direct closure. The large bowel was defunctioned and a Hartmann's procedure performed, a supra-pubic catheter inserted, and the abdomen left open. The pelvic binder was left in place.

Further investigation revealed that there was an unstable right pedicle fracture of the fifth lumbar vertebra. Transfer to another centre for definitive fixation of the pelvis was delayed because of difficulty achieving stability during the following period of extended resuscitation. Throughout this time the pelvic binder was continued. On day 3 post injury the patient returned to theatre for change of dressings and placement of a feeding jejunostomy tube. The abdomen was covered with a vac dressing. It was subsequently noted that pressure areas were starting to develop under the binder at the level of the trochanters circumferentially. The patient was transferred to another centre and an external fixator was applied to the pelvic ring anteriorly on day 7. By this time the pressure areas around the buttocks had worsened and necrotic areas were debrided along with full-thickness damage to the skin from both trochanters to the anterior thighs, in line with the previous binder (Fig. 1).

The patient was transferred to the plastic surgery unit at day 18, still sedated and ventilated. The patient underwent serial massive debridements of skin and muscle over his buttocks and lower back. Each debridement was curtailed by bleeding which was contributed to by the rigid nature of the ischaemic muscle which...
limited vasoconstriction (Fig. 2). Both gluteus maximus muscles were debrided, along with gluteus medius on the right side. On the right side the sciatic nerve was exposed. The erector spinae muscles were similarly debrided, thereby exposing the spinal fractures. The previously noted skin damage in the line of the pelvic binder was limited to the superficial tissue on the left lower limb. However on the right side necrosis of all the muscles had occurred down to the femoral shaft, apart from some sparing of the adductor muscle group.

The resulting soft tissue defect extended from his mid thoracic region to his upper legs on both sides, with near circumferential exposure of the proximal right femoral shaft along with the femoral and sciatic nerves (Fig. 3). By this stage the patient was severely catabolic and clinically deteriorating. Urgent soft tissue cover for the massive wound was indicated. Denervation of the patients right leg was confirmed with EMG studies. Despite this, the distal limb was well perfused via the femoral vessels. 28 days following his original injury, definitive pelvic stabilisation and soft tissue cover was achieved. A myocutaneous flap was designed using the denervated right lower limb, with disarticulation of the hip and filleting of bones extending as far distally as to the dorsum of the foot, leaving a long pedicled flap on the dorsalis pedis artery. The dislocated sacro-iliac joints were stabilised prior to flap cover during the same procedure, using a combination of plate and cannulated screw fixation. The open left acetabular fracture was not operatively stabilised due to the length of time that had elapsed from injury to definitive surgery, and the spinal fractures were also managed non-operatively. The patient was nursed prone and ventilated for a further 3 weeks. The patient developed marked facial swelling during this period. However this resolved rapidly once conventional nursing could be resumed. The patients general condition rapidly improved and the open abdomen subsequently skin grafted. Despite these massive injuries, he has made excellent progress and has been able to resume an independent life.
3. Discussion

The use of external pressure to control internal haemorrhage can be very effective, but also carries risks. The use of pneumatic anti-shock garments have declined over the years due to significant problems associated with their use including lower limb compartment syndrome, fluid and electrolyte disturbances and deep venous thrombosis.\cite{1,6,11}

Pressure ulceration and skin necrosis has been observed in one instance in the past, due to circumferential pelvic binding, along with transient common peroneal nerve palsies from bandages applied at the level of the knees rather than the thighs.\cite{9,10} Correctly applied, a pelvic binder should simply hold a closed reduction as previously described.\cite{7} However in the presence of massive local trauma and profound shock with massive transfusion requirements, worsening oedema and thus increasing tissue pressure deep to the binder is inevitable. In this case the unstable pelvic injury was largely posterior. In such circumstances, anterior pelvic external fixation is largely ineffective in controlling such displacement. Exchange for a pelvic reduction clamp with percutaneous pins placed posteriorly, perpendicular to the displaced sacro-iliac joints may have been very helpful. However, accurate placement of the pins is difficult and not without risk.\cite{5}

The crush injury which this patient sustained undoubtedly contributed to the myonecrosis seen in the buttocks and the erector spinae. Although the latter were clearly away from the zone of binder application the damage to the skin bilaterally and the muscles of the right lower limb can only have been the result of sustained pressure from the binder.

The rapid surgical intervention and ITU care that this patient received clearly saved his life. The prompt application of the pelvic binder will have contributed to this. However failure to dispense with the binder in favour of a suitable form of external support most suitably in the form of a pelvic C-clamp resulted in severe additional myonecrosis and the associated denervation of the right lower limb.

Correct application of a pelvic binder must be regarded as an adjunct to the immediate resuscitation of the patient with hypovolaemic shock and an unstable pelvic injury with increased intra-pelvic volume. The binder buys time and should be exchanged for appropriate external fixation as soon as any other immediately necessary life-saving surgery has been completed.

References