Upper abdominal visceral injury resulting from blunt trauma to the pelvis: a specific variant of shockwave injury?

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Summary
Two patients who sustained severe blunt injury to the pelvis without external injury to the upper abdomen or lower chest, yet who were found to have a ruptured solid upper abdominal viscus, are reported. The first patient on delayed arrival revealed clinical features suggestive of intra-abdominal bleeding and was found to have a grade 3 ruptured spleen. With the second patient, upper abdominal injury (in this instance, a pancreatic laceration) was not initially suspected owing to the absence of clinical evidence of injury to the abdomen. It is postulated that both the splenic and pancreatic injuries were the result of a shockwave propagated through the abdomen following the severe external impact to the pelvis.

Case histories and imaging findings

Patient 1
While working underground in a goldmine, a 35-year-old man was struck on the right side of his upper pelvis by a large rock during a rock-fall. Owing to delays in the extraction process (he remained buried from the waist down for approximately 4 hours), the patient reached casualty approximately 7 hours following the acute injury. On arrival he was fully conscious and orientated, but had a low blood pressure of 84/56 and a pulse rate of 101. He complained of pain over the right ilium; external bruising and swelling was visible in the region. A pelvic radiograph demonstrated a comminuted but undisplaced fracture of the anterior portion of the body of the right ilium (Fig. 1). There was also a comminuted fracture of the left medial tibial plateau and evidence of a compartment syndrome involving the left calf. In addition, there was marked tenderness over the entire abdomen and intraperitoneal haemorrhage was suspected. The chest X-ray was clear and no rib fractures were shown. The patient was taken to theatre where a laparotomy revealed extensive intraperitoneal haemorrhage from a ruptured spleen. (In addition to the laparotomy, internal fixation of the left medial tibial plateau was performed; together with a medial fasciotomy of the left calf).

Patient 2
A 23-year-old man was struck on the right side of the pelvis by a large boulder following an underground rock-fall. He was haemodynamically stable on arrival in casualty. On physical examination, the right side of the pelvis was found to be unstable and a pelvic radiograph showed disruption of the right sacro-iliac joint and diastasis of the pubic symphysis (Fig. 2). As with Patient 1, the chest X-ray was clear and no rib fractures were shown. The upper abdomen was non-tender. Blood was found to be dripping from the penile meatus. A diagnosis of a ruptured (or possibly severed) urethra was made and a sonar examination was requested to examine the bladder for evidence of rupture and for localisation for the insertion of a supra-pubic catheter. On examination, the bladder was mildly distended with no visible injury to the bladder wall and no peri-vesical free fluid. Following examination of the pelvis, a full abdominal ultrasound examination was performed. A large fluid

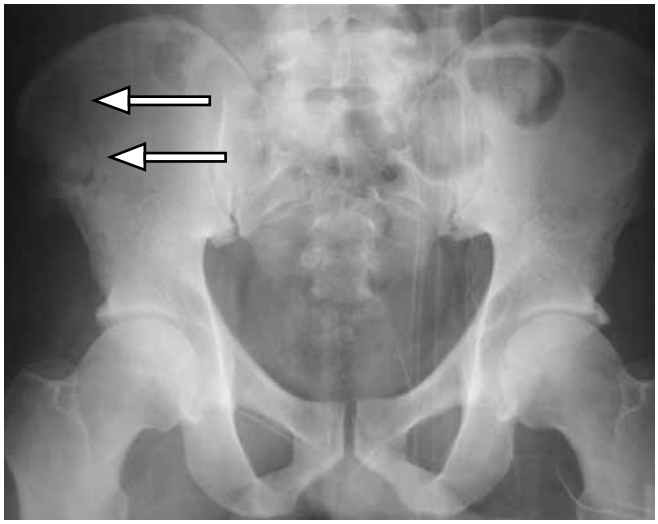

Fig. 1. X-ray of the pelvis showing fracture (arrows) of the right ilium in patient 1.

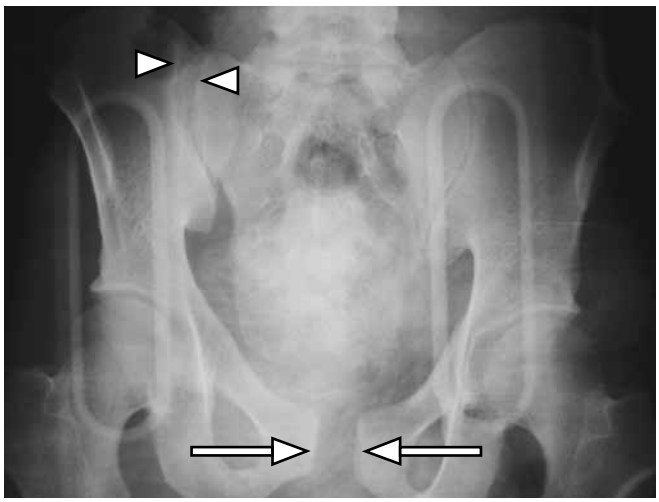

Fig. 2. Pelvic X-ray showing disrupted right sacro-iliac joint (arrow heads) and diastasis (arrows) of the pubic symphysis in patient 2.

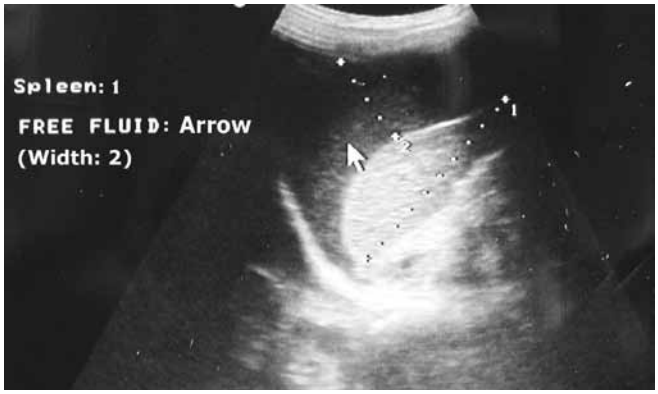

Fig. 3. Sonar image showing haematoma (arrow) around spleen.

collection (slightly echogenic, consistent with haematoma) was shown surrounding the spleen (Fig. 3). Although there was no visible splenic injury, a presumptive diagnosis of splenic rupture was made and the patient underwent immediate laparotomy. This revealed a rupture of the pancreas with extensive retroperitoneal and also intraperitoneal haemorrhage. The spleen was found to be intact.

Discussion

Tissue injury owing to the propagation of a shockwave is well described in ballistic injuries where the energy transfer from the missile to the tissue is responsible for the increased severity of the wound.[1] The relationship between kinetic energy and the projectile can be derived from the following formula:

Kinetic energy (KE) = 0.5 x mass x (velocity)^2

In the case of bullet wounds where the mass of the projectile is relatively small, the extent of the damage to the surrounding tissues is largely determined by the bullet velocity. Shockwave damage to body tissues has been described in association with blast injuries.[2] In addition, shockwave injury to adjacent tissue is a well-recognised complication of extracorporeal shockwave lithotripsy.[3]

In the patients described above, the falling rock – although non-penetrating – can be equated to a missile. In both these cases, the large (estimated to be between 50 and100 kg) mass, despite its relatively low velocity, had sufficient kinetic energy to cause bony pelvic injury.

In the first patient, the pelvic injury was relatively superficial and the splenic rupture could be explained by the propagation of a shockwave across the abdomen from the impact site inferiorly on the right to the left upper quadrant.

In the second patient, as the pelvic injury was predominantly retroperitoneal, it is postulated that the resulting shockwave might have propagated predominantly through the retroperitoneal tissues, resulting in the rupture of a retroperitoneal organ, i.e. the pancreas.

Conclusion

A syndromic pattern of injury is described where a direct blow to the pelvis resulted in rupture of a distant, upper abdominal viscus. Shockwave propagation across the abdomen is the likely explanation for this phenomenon.[4] The possibility of injury to an upper abdominal organ should be considered in all cases where there is a severe, direct blow to the pelvis.

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2. 2. Stapley SA, Canon LB. An overview of the pathophysiology of gunshot and blast injury with resuscitation guidelines. Current Orthopaedics 2006; 20:322-332.
3. 3. Ilnyckyj A, Hosking DH, Pettigrew NM, Bernstein CN. Extracorporeal shock wave lithotripsy causing colonic injury. Dig Dis Sci 1999;44(12):2485-2487.
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