Open pelvic fractures

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Abstract
Open pelvic fractures account for 2–4% of all pelvic fracture and are life-threatening injuries that provide a challenge to any trauma team. Patients who survive an open pelvic fracture are often left with long-standing or permanent disabilities which can be challenging to any healthcare system. They result from high-energy injury and are reported to have a mortality of between 10 and 25%. Complications arise from the various structures that are injured, including genitourinary, bowel, sexual and reproductive complications. Open pelvic fractures are one of the most devastating injuries to occur. They require early aggressive management with a multidisciplinary team including experts in the field of orthopaedics, general surgery, urology, plastic surgery and intensive care. The main priority should be to initially treat haemorrhage and prevent infection.

Keywords advanced trauma life support; ATLS; damage control surgery; open pelvis fracture

Introduction
Open pelvic fractures are an uncommon but life-threatening injury that provide a challenge to any trauma team. Early mismanagement can lead to a rapid death and an open pelvic fracture requires early treatment and decision-making to reduce the risk of death. The open injury has a broad spectrum of injury ranging from skin grazes over the bony prominence of the iliac crest through to massive soft tissue injury including damage to intra and retroperitoneal organs. Patients that survive an open pelvic fracture are often left with long-standing or permanent disabilities which can be challenging to any healthcare system.

Epidemiology
Open pelvic fractures account for 2–4% of all pelvic injuries. However, the consensus of expert opinion suggests that this could be underplaying the extent of open fractures due to the difficulty in hospital coding of admissions and fractures. Many people with open fractures also die before reaching hospital so do not count towards the numbers. Bircher has also proposed the theory of internal open fractures where a severe pelvic injury is associated with bowel or bladder rupture but without skin lacerations. These have a high incidence of infection and soft tissue complications and need to be treated as an open injury.1,2

Mechanism
Hanson et al.3 report that half of patients with an open pelvic fracture were pedestrians involved in collisions with cars. A common mechanism is of forced abduction of the hips leading to shearing and tearing of the perineum. This leads to disruption of the symphysis pubis and the sacroiliac joint. This effectively leads to an internal hemipelvectomy and massive internal bleeding.

Open pelvic fractures are also more common in motorcyclists. This group of patients often incur an anterior pelvic injury secondary to the petrol tank which sits between the motorcyclist’s thighs. This can lead to urethral or bladder disruption and is associated with the highest risk of late sepsis.4

Crush injuries can also cause open pelvic fractures but are often associated with unusual fracture patterns or a combination of multiple fracture patterns. They are often associated with internal organ disruption and lumbosacral nerve damage with or without associated acetabular fractures.

It has been reported that open fractures are more common in the paediatric population with the commonest mechanism being road traffic accidents. However, it has been speculated that the reason for a higher percentage is that the number of open fractures in children is not diluted by low-energy fractures which can occur in adults.1

Mortality and morbidity
Open pelvic fractures are traditionally associated with a high mortality rate and this was reported to be as high as 50% in the 1970s. This rate has undoubtedly reduced as care has improved and has been documented to be as low as 4.8% in the literature. However, the mortality rate of between 10 and 25% is generally accepted as accurate in the literature.1,2,6

Open pelvic fractures are associated with two peaks of death. The first peak occurs within the first few hours of the injury due to one or a combination of uncontrolled haemorrhage, head injuries and mediastinal or organ rupture. The second peak occurs some days or weeks later due to complications from multi-organ failure and/or sepsis.

However, as with many high-energy injuries, reporting of incidence can be difficult to interpret. Retrieval and transport times may have a role in determining the incidence of mortality reporting between different centres so this needs careful consideration when reviewing the literature.

Morbidity of open pelvic fractures is undoubtedly high. Most patients will be left with some disability due to the high-energy nature of the injury. The long-term disability is often because of both the fracture and the soft tissue injury. Problems with fractures of the pelvic ring can be due to malunion or non-union but also because of a limb length discrepancy or a residual pelvic obliquity which can lead to difficulty sitting and pain. Treatment strategies should consider anatomic, stable internal fixation to reduce the risks of above. There is an inherent aversion to

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internal fixation with high-energy, open pelvic fractures but lack of stable fixation can lead to less predictable results.\(^1\)

Chronic morbidity can result from injury to the soft tissues or neurological structures. This can be as a direct result of the initial injury or iatrogenic as a result of the multiple surgical procedures often required for the treatment of these complex injuries.

Other soft tissue sequelae can include incontinence from urethral injury, sexual dysfunction and impotence from either an injury to nerves or the penile and testicular injury. Females suffering an open pelvic fracture can often be left with long-term pelvic floor laxity. Lumbosacral nerve injury has been reported to as common as 50% in vertical shear injuries (open and non-open injuries) and this can lead to leg weakness and paralysis.\(^6\)

**Classification**

Most pelvic fracture classifications do not focus on the soft tissue injury and so can be used for both closed and open pelvic fractures. They are excellent at describing the bony anatomy but they fail to appreciate or communicate the severity of the open pelvic fracture. A good classification system should help decide treatment strategy, give a good idea of prognosis and allow easy comparison for the purposes of audit and research. Few classifications for open pelvic fractures have been proposed until Bircher and Hargrove\(^7\) produced a classification system for open pelvic fractures that considers an association between skeletal injury, vector of force and of soft tissue trauma (Table 1).

This classification is by no means perfect but does allow some attempt at classification of open pelvic fractures. Crush and penetrating injuries need to be considered carefully as can often lead to any type of soft tissue injury. The authors of the classification system in Table 1 admit that it still requires consensus and the formation of a pan-European pelvic society can help data collection and validation of the classification system proposed by Bircher and Hargrove.\(^7\)

**Management**

Management of an open pelvic fracture should commence as soon as possible using advanced trauma life support (ATLS) protocols. Specific management of the open pelvic fracture should involve early an experienced and balanced multidisciplinary team as early as possible. Orthopaedic, general, plastics and urology surgeons should have an input and their presence can be tailored to the needs and injuries that the patient has suffered.

Patients with an open pelvic fracture should be transferred to a tertiary centre or a major trauma centre at the earliest most reasonable opportunity, preferably straight from the scene of the accident. A pelvic binder should be applied based on the mechanism of injury. Binding of the knees should be considered to allow internal rotation of the hips which stabilizes the pelvis. During assessment of the pelvis, the perineum should be inspected and if wounds are present digital rectal and vaginal examinations should be undertaken to ascertain whether the open wounds communicate with the relevant internal structures. Macro-debridement of obvious foreign debris should be undertaken. Early broad spectrum intravenous antibiotics such as co-amoxiclav (or clindamycin if the patient is allergic to penicillin) should be administered and tetanus toxoid cover should be ensured. Resuscitation should be undertaken throughout the ATLS assessment and management. Whole blood should be the

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**Table 1**

<table>
<thead>
<tr>
<th>Open classification</th>
<th>Primary skin lesion</th>
<th>Additional soft tissue injury</th>
<th>Bony tile/AO</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Penetrating trauma, e.g. bullet</td>
<td>Dependent on velocity, character of missile and its path</td>
<td>A</td>
</tr>
<tr>
<td>A2</td>
<td>‘Outside in’ injury (iliac crest)</td>
<td>Superficial skin abrasion</td>
<td>A</td>
</tr>
<tr>
<td>A3</td>
<td>‘Outside in’ injury</td>
<td>Extensive skin loss and soft tissue damage; soft tissue cover needed</td>
<td>A</td>
</tr>
<tr>
<td>B1</td>
<td>‘Inside out’ injury</td>
<td>No obvious external soft tissue damage; bladder, urethral, or vaginal penetration</td>
<td>B (lateral compression)</td>
</tr>
<tr>
<td>B2</td>
<td>‘Inside out’ injury</td>
<td>Extensive degloving tissues (Morel–Lavelle); bladder penetration</td>
<td>B (lateral compression)</td>
</tr>
<tr>
<td>B3</td>
<td>Perineal splits</td>
<td>Partial genito-urinary (GU) injury; relatively little skin loss; partial urethral injury; posterior elements often intact</td>
<td>B (open book)</td>
</tr>
<tr>
<td>C1</td>
<td>Perineal and sacral shear and split</td>
<td>Some skin loss; bladder/urethral complete lesion; faecal contamination</td>
<td>C</td>
</tr>
<tr>
<td>C2</td>
<td>Hemipelvis destabilization</td>
<td>Extensive degloving and shearing of tissues; a contamination of a B2 injury with complete GU lesions, bowel laceration with faecal contamination</td>
<td>C</td>
</tr>
<tr>
<td>C3</td>
<td>Pelvic crush</td>
<td>Massive soft tissue injury both inside and out; complex comminuted bony damage (associated acetabular fractures)</td>
<td>C</td>
</tr>
</tbody>
</table>

A potential classification and assessment system for open pelvic fractures. Reproduced from\(^7\) with permission.
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