PELVIC INJURY MODULE

Introduction

Pelvic injury is associated with significant morbidity and mortality through complications of major haemorrhage, soft-tissue infection and associated injury to intra-abdominal organs – particularly the bladder, bowel and genitalia. It is primarily caused by to blunt trauma with MVA and falls accounting for the majority of injuries.

Overall mortality of pelvic fractures is 16%. Open pelvic injuries are particularly devastating, with mortality rates of up to 55%.\(^1\)

Pelvic Anatomy

The pelvis has a rich collateral blood supply, especially across the sacrum and posterior ileum. The close proximity of major arteries, veins and highly vascularised cancellous bone increases the risk of severe haemorrhage.\(^1\) The pelvic peritoneum (which theoretically should eventually limit and tamponade the bleeding pelvis), can accommodate more than 3 L of blood.\(^2\) The volume of a mechanically unstable pelvis (i.e. pubic diastasis) increases further, reducing the tamponade effect of the retroperitoneal tissues and intraperitoneal organs.

![Diagram of the pelvis showing the proximity of arteries](image)

Figure 1  The proximity of the arteries in relation to the pelvis: IL iliolumbar artery; SG superior gluteal artery; LS lateral sacral artery; IP internal pudendal artery; O obturator artery\(^1\)

Culprit arterial bleeding sites in pelvic fractures:\(^1\)

<table>
<thead>
<tr>
<th>Location</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anteriorly (43% total)</td>
<td></td>
</tr>
<tr>
<td>Internal pudendal a</td>
<td>27%</td>
</tr>
<tr>
<td>Obturator a</td>
<td>16%</td>
</tr>
<tr>
<td>Posteriorly (57% total)</td>
<td></td>
</tr>
<tr>
<td>Superior gluteal a</td>
<td>25%</td>
</tr>
<tr>
<td>Lateral sacral a</td>
<td>23%</td>
</tr>
<tr>
<td>Inferior gluteal a</td>
<td>9%</td>
</tr>
</tbody>
</table>

The culprit venous bleeding site is the Iliolumbar Vein in up to 60% of cases\(^3\)
Classification of Pelvic Fractures

There are many classifications systems in use. The Young-Burgess classification system is based on direction of force and is also useful in determining the likelihood of intrapelvic injury and haemorrhage.

Young – Burgess Classification

<table>
<thead>
<tr>
<th>Anterior Posterior Compression (APC)</th>
<th>Characterised by pubic diastasis with or without SIJ disruption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>&lt; 2.5cm symphysis diastasis with no significant posterior injury</td>
</tr>
<tr>
<td>Type II</td>
<td>&gt; 2.5cm symphysis diastasis with anterior opening of SI joint</td>
</tr>
<tr>
<td>Type III</td>
<td>Disruption of the pubic symphysis and posterior ligaments with hemipelvis displacement</td>
</tr>
</tbody>
</table>

Lateral Compression (LC)
Characterised by transverse pubic rami # with varying degrees of posterior injury

| Type I                              | Posterior compression of the SIJ with oblique pubic ramus # |
| Type II                             | Rupture of the SI ligaments, crush # sacrum, internal rotation of the hemipelvis and oblique pubic ramus # |
| Type III                            | Type II features and AP compression injury to contralateral hemipelvis |

Vertical Shear (VS)
Complete ligament or bony disruption of hemipelvis with vertical displacement

Figure 2  Young-Burgess classification based on direction of force

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**Assessment**

These patients are often extremely unstable or at high risk of rapidly becoming unstable. Rapid diagnosis of pelvic and non-pelvic injury and associated sources of bleeding is critical, in order to facilitate the management of the haemodynamic instability and expedite delivery of definitive care.

The fracture pattern does not reliably predict associated retroperitoneal haemorrhage, however the risk of pelvic haemorrhage increases with severity of fracture.

<table>
<thead>
<tr>
<th>Category</th>
<th>Severe Haemorrhage (%)</th>
<th>Bladder Rupture (%)</th>
<th>Urethral Injury (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type I</td>
<td>0.5</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Type II</td>
<td>36</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Type III</td>
<td>60</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>APC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type I</td>
<td>1</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Type II</td>
<td>28</td>
<td>11</td>
<td>23</td>
</tr>
<tr>
<td>Type III</td>
<td>53</td>
<td>14</td>
<td>36</td>
</tr>
<tr>
<td>VS</td>
<td>75</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Mixed</td>
<td>58</td>
<td>16</td>
<td>21</td>
</tr>
</tbody>
</table>

Adapted from Tintinalli°

The goals of assessment in patients with pelvic injuries are:

a. Identification of life-threatening haemorrhage (both pelvic and non-pelvic)

b. Identification of associated injuries
   - Bladder
   - Bowel
   - Genitalia

**History & Examination**

- Mechanism of injury with focus on directional forces to pelvis
- Haemodynamic parameters to quantify extent of haemorrhage
- Inspection for bruising, deformity and compound wounds.
- Gently palpate the skeletal structures – ‘springing’ the pelvis is not advised as it can potentially exacerbate haemorrhage
- Examine lower limbs for length discrepancy, ischaemia or neurology
- Abdominal examination for signs of peritonism
- PR / PV for evidence of bowel / genital injury which would indicate a compound injury
- MINIMISE unnecessary patient movement so to avoid disruption of clot formation

**Investigations**

**Bedside:**

- VBG to quantify extent of haemodynamic compromise & baseline Hb
- FAST to identify concurrent haemoperitoneum

**Bloods:**

- FBC baseline Hb & plts if DIC
- ELFT, lipase associated renal, liver or pancreatic insult
- Coags coagulopathy of trauma / DIC
- G&H & CXM to facilitate type-specific blood and component transfusion where necessary
βHCG to identify associated pregnancy
ROTEM if activating MTP, for goal-directed resuscitation

Imaging:

Pelvic XRay

CT / CT angiogram:
CT Angiography of the pelvis characterises the extent of pelvic injury, identifies associated injuries and identifies potential culprit vessels which may be amenable to angiographic intervention in situations of ongoing haemorrhage. Active bleeding can visualised as contrast extravasation (blush). In consultation with a multidisciplinary trauma team, CT / CTA is often undertaken at PAH even in critically unwell patients given the invaluable information provided and the impact on planning definitive intervention (IR / OT).

Retrograde urethrogram can be performed if there is suggestion of a urethral injury. A retrograde cystourethrogram may be indicated to delineate injury to the urethra and bladder.

Management

Goals of management:

I. Address hypovolaemia and hypoperfusion from both pelvic and non-pelvic sources
II. Expedite definitive therapy for haemostasis
III. Address associated bladder, bowel or genital injuries
IV. Co-ordinate the required multi-disciplinary approach

Resuscitation

Major haemorrhage needs to be anticipated. Definitive control (via surgery or interventional radiology) is the major endpoint which needs to be expedited.

- Activate multi-disciplinary trauma system response
- If not already in place, apply pelvic binder/splinting device.
- Regarding pelvic binders:
  - Pelvic binders have a definite role if evidence of pubic diastasis. They act to close the pelvic ring, reducing the potential pelvic volume and theoretically allowing for retroperitoneal tissue and intrapelvic organs to promote tamponade. Binding the pelvis also reduces movement, which probably decreases venous bleeding and cancellous ooze, but likely has minimal benefit with regard to reducing arterial bleeding.
  - Pelvic binders can be deleterious in lateral compression injuries.
- Activate massive transfusion protocol and ROTEM pathway
- Commence warmed haemostatic resuscitation via large bore IV access to meet end-points of:
  - palpable radial pulse; or
  - SBP > 85 or MAP > 60
- Administer Tranexamic Acid 1g bolus followed by infusion (1g over 8 hours)
Specific therapy

An algorithm for the management of the haemodynamically unstable patient with pelvic trauma has been developed with multi-disciplinary endorsement at the PAH. This algorithm is presented below.

In summary, the haemodynamically unstable patient with isolated pelvic trauma (that has a negative FAST) and arterial bleeding (blush on CTA) amenable to interventional radiology needs urgent transfer to the IR lab to control haemorrhage. IR is the intervention of choice at PAH for these patients rather than mechanical stabilisation (Ex-Fix) and pelvic packing. It is the philosophy of our trauma and orthopaedic teams that mechanical fixation and pelvic packing, while appropriate for venous bleeding and bleeding from the bony fracture sites, is less likely to tamponade arterial bleeding. Pelvic packing may be considered if there is a delay to IR.

The haemodynamically unstable patient with pelvic trauma and evidence of haemoperitoneum, or with a compound pelvic fracture, should proceed to OT urgently to address the intra-abdominal injury. The pelvis can be packed during the laparotomy. If this fails to control the haemorrhage, iliac vessels can be ligated. If necessary, such patients can proceed to IR following initial laparotomy for ongoing attempts at haemorrhage control.
• A single pass gentle insertion of an IDC is safe in the setting of a potential urethral injury. If this fails a suprapubic catheter (SPC) is required. In the setting of significant retroperitoneal haemorrhage this is a difficult procedure and and urology should be involved

• IV cephazolin (or equivalent if cephalosporin allergy) should be administered if evidence of compound injury (broaden to include gram negative and anaerobic cover if evidence of bowel injury)

• Ensure current tetanus prophylaxis

**Supportive therapy**

- Keep patient warm
- Correct any coagulopathy

**Disposition**

Disposition will be largely dictated by patient stability and presence or absence of concurrent injuries. The haemodynamically stable patient with an isolated pelvic injury is usually admitted to the orthopaedic ward.

The unstable patient needs urgent transfer to OT or IR with subsequent admission to ICU or trauma HDU.

**Additional Information**

• Pelvic binders are thought to reduce fractures, provide stabilisation and reduce pelvic volume thereby limiting haemorrhage. There is no evidence to suggest one proprietary binder is superior to any other. A simple sheet can be used (Appendix 1). Ideally the pelvic binder device should allow access for laparotomy and femoral vessels for potential angiography.

• Urethral injury is suggested by the presence of perineal bruising, blood at the urethral meatus or high-riding prostate. Less specifically haematuria or difficulty voiding may occur.

**Future Directions**

• Hybrid suite – this would allow angiographic and operative interventions to occur simultaneously in this select group of patients, minimising movement and transfer

• REBOA – Resuscitative Endovascular Balloon Occlusion of the Aorta is a temporising technique to gain haemorrhage control for patients who are in haemorrhagic shock from a pelvic and / or intra-abdominal source. Placement of a balloon above the diaphragm (Zone 1) for patients with haemoperitoneum or above the bifurcation of the aorta (Zone III) for pelvic haemorrhage may promote stabilisation of the patient prior to transfer to theatre or IR for definitive haemorrhage control
Further reading


- Life in the Fastlane has a series of pages on pelvic trauma by Chris Nickson & a podcast by Scott Weingart which are worth having a look at
  
  http://lifeinthefastlane.com/2012/04/trauma-tribulation-027/
  http://lifeinthefastlane.com/2012/04/trauma-tribulation-028/
  http://lifeinthefastlane.com/2012/04/weingart-on-pelvic-trauma/

References

7. Fehr A, Beveridge J, D’Amours S et al. The potential benefit of a hybrid operating environment amongst severely injured patients with persistent haemorrhage: How often could we get it right? *J Trauma*. Dec 2015 Published ahead of print.