

Major Pelvic Trauma – New guidance

1. INTRODUCTION

Major pelvic injuries are predominantly observed when there is a high-energy transfer to the patient such as might occur following road traffic collision,^{1,2} pedestrian accident, fall from height, or crush injury.³⁻¹¹

Less serious pelvic injuries may also occur following low-energy transfer events, particularly in the elderly^{4, 12, 13} (such as a simple fall), amongst patients with degenerative bone disease or receiving radiotherapy, and rarely as a direct consequence of seizure activity.^{14, 15}

The majority of pelvic injuries do not result in major disruption of the pelvic ring, but rather involve fractures of the pubic ramus or acetabulum.¹⁶ Presentation of these injuries is very similar to neck of femur fractures therefore please refer to the limb trauma guideline for management of these less serious pelvic injuries.

Mechanism of injury

- High energy transfer
- Fall from height
- Crush injury

Risk Factors

- Advancing age
- Degenerative bone disease
- Radiotherapy
- Obesity

2. INCIDENCE

Pelvic fractures represent 3% to 6% of all fractures in adults and occur in up to 20% of all polytrauma cases.¹⁷⁻²⁰ They display a bimodal distribution of age with most injuries occurring in the age ranges 15 to 30 and over 60 years⁷; up to 75% of all pelvic injuries occur in men.^{5, 6, 17, 21, 22}

Unstable pelvic fracture is estimated to occur in up to 20% of pelvic fractures; a further 22% of pelvic fractures will remain stable despite significant damage to the pelvic ring. The remaining 58% of pelvic fractures are less serious retaining both haemodynamic and structural stability.¹⁶

The incidence of pelvic fracture resulting from blunt trauma ranges from 5 - 11.9%,²³⁻³² with obese patients more likely to sustain a pelvic fracture from blunt trauma than non-obese patients.³³ Pelvic fracture associated with penetrating trauma is far less frequent.³⁴⁻³⁶ Open pelvic fractures are rare and account for only 2.7 - 4% of all pelvic fractures.^{5, 21}

3. SEVERITY AND OUTCOME

Major pelvic injuries can be devastating and are often associated with a number of complications that may require extensive rehabilitation. Pelvic trauma deaths frequently occur as a result of associated injuries and complications rather than the pelvic injury itself.^{17, 37}

Haemorrhage is the cause of death in 40% of all pelvic trauma victims and the leading cause of death (60% of fatal cases) in unstable pelvic fracture.^{18, 38-42} Bleeding is usually retroperitoneal, the volume of blood loss correlates with the degree and type of pelvic disruption.⁴³⁻⁴⁷

Reported mortality rates range from 6.4% to 30% depending on the type of pelvic fracture, haemodynamic status, and the nature of concomitant injuries and their complications.^{48, 49} The mortality rate among haemodynamically stable patients is around 10%,^{6, 40, 41, 50} whereas the mortality rate amongst haemodynamically unstable patients approaches 20-30% but has been reported to be as high as 50% in cases of unstable open fracture,^{24, 40, 41, 51, 52} combined mortality approaches 16%.⁴¹

4. PATHOPHYSIOLOGY

4.1 Skeletal anatomy

Increasing pelvic volume allows for increased haemorrhage; conversely, reducing pelvic volume reduces potential for bleeding by realignment of broken bone ends.⁵³

4.2 Classification of injury

As with other fractures, pelvic fractures may be classified as open or closed, and benefit from being further described as either haemodynamically stable or unstable. Patients who are haemodynamically unstable are at

greater risk of death and would benefit greatly from a suitable pre-hospital alert message.

Pelvic ring disruptions (as identified by in-hospital imaging) can be subdivided into four classes by mechanism of injury: antero-posterior compression (APC), lateral compression (LC), vertical shear (VS), and combined mechanical injury (CMI), a combination of the aforementioned classes.⁵⁴

4.3 Vascular injury

The arteries most frequently injured are the iliolumbar arteries, the superior gluteal, and the internal pudendal because of their proximity to the bone, the sacro-iliac joint and the inferior ligaments of the pelvis.⁵⁵ Bleeding from the venous network after a pelvic fracture is more frequent than arterial bleeding because the walls of the veins are more fragile than arteries. Blood may pool in the retroperitoneal space and haemostasis may occur spontaneously in closed fractures, especially if there is no concomitant arterial haemorrhage.^{56 57}

4.4 Other injuries

The incidence of urogenital injury ranges from 23% to 57%.^{5 35 58-60} Urethral and vaginal injuries are the most common injuries.⁶¹⁻⁶² Vaginal lacerations result from either penetration of a bony fragment or from indirect forces from diastasis of the symphysis pubis. Injuries to the cervix, uterus and ovaries are rare.^{59 63} Bladder rupture occurs in up to 10% of pelvic fractures.⁶⁴

The incidence of rectal injury ranges from 17% to 64% dependent upon type of fracture.^{5 35 58-60} Bowel entrapment is rare.⁶⁵

Pelvic injury is commonly associated with concomitant intra-thoracic and or intra-abdominal injury.⁶⁶

5. ASSESSMENT

Assess:

- **AIRWAY**
- **BREATHING**
- **CIRCULATION**
- **DISABILITY** (mini neurological examination).

Evaluate whether patient is **TIME CRITICAL** or **NON-TIME CRITICAL** following criteria as per trauma emergencies guideline. If patient is **TIME CRITICAL, correct A and B problems, stabilise the pelvis on scene, and rapidly transport to nearest suitable receiving hospital.** Send a **Hospital Alert Message.** En-route, continue patient management of pelvic trauma (*see below*).

In **NON-TIME CRITICAL** patients perform a more thorough patient assessment with a brief Secondary Survey.

5.1 Specifically consider

Pelvic fracture should be considered based upon the mechanism of injury.⁶⁷

Clinical assessment of the pelvis includes observation for physical injury such as bruising, bleeding, deformity or swelling to the pelvis. Shortening of a lower limb may be present (see also limb trauma guideline).⁶⁸

Assessment by compression or distraction (e.g. springing) of the pelvis is unreliable and may both dislodge clots and exacerbate any injury and should not be performed.⁶⁹⁻⁷¹

Any patient with a relevant mechanism of injury and concomitant hypotension **MUST** be managed as having a **time critical pelvic injury** until proven otherwise.

Reduction and stabilisation of the pelvic ring should occur as soon as is practicable whilst still on scene, as stabilisation helps to reduce blood loss by realigning fracture surfaces, thereby limiting active bleeding and additionally helping to stabilise clots.^{67 72} Reduction of the pelvis may have a tamponade affect, particularly for venous bleeding; however there is little evidence to support this belief.⁷³

Log rolling of the patient with possible pelvic fracture should be avoided as this may exacerbate any pelvic injury;⁶⁷ where possible utilise an orthopaedic scoop stretcher to lift patients off the ground and limit movement to a 15° tilt.

6. MANAGEMENT

6.1 Oxygen Therapy

Major pelvic injury falls into the category of critical illness and requires high levels of supplemental oxygen regardless of initial oxygen saturation reading (SpO₂). Maintain high flow oxygen (15 litres per minute) until vital signs are normal; thereafter reduce flow rate, titrating to maintain oxygen saturations (SpO₂) in the 94-98% range (**refer** to oxygen guideline).

6.2 Pelvic Stabilisation

There is currently no evidence to suggest that any particular pelvic immobilisation device or approach is superior in terms of outcome in pelvic trauma and a number of methods have been reported.^{32 74-86} Effective stabilisation of the pelvic ring should be instigated at the earliest possible opportunity, preferably before moving the patient, and may be achieved by:

- use of an appropriate pelvic splint^{32 74-78}
- application of circumferential support, however care must be taken to ensure that over-compression does not occur.⁷⁹⁻⁸²

Expert consensus suggests the use of an appropriate pelvic splint is preferable to improvised immobilisation techniques. In all methods, circumferential pressure is applied over the greater trochanters⁸⁷ and not the iliac crests. Care must be exercised so as to ensure that the pelvis is not reduced beyond its normal anatomical position.

Pressure sores and soft tissue injuries may occur when immobilisation devices are incorrectly fitted.⁸⁸

6.3 Fluid Therapy

There is little evidence to support the routine use of IV fluids in adult trauma patients; please refer to the fluid therapy guideline for specific guidance.

6.4 Pain Management

Patients' pain should be managed appropriately (**refer to pain management guidelines**); analgesia in the form of Entonox (**refer to Entonox drug protocol for administration and information**) or morphine sulphate may be

appropriate (**refer to morphine drug protocol for dosages and information**).

7. REFERRAL PATHWAY

7.1 The following cases should ALWAYS be transferred to further care:

- any patient with hypotension and potential pelvic injury **MUST** be treated as a **TIME CRITICAL** pelvic injury until proven otherwise
- any patient with sufficient mechanism of injury to cause a pelvic injury.

7.2 The following cases MAY be considered suitable/safe to be left at home:

- none.

8. SPECIAL CONSIDERATIONS FOR CHILDREN (see also paediatric trauma guideline)

- Pelvic fractures represent 1%-3% of all fractures in children, thus there is a lower incidence compared with adults.^{89 90}
- In children, pelvic injuries have a lower mortality accounting for 3.6% – 5.7% of trauma deaths, with fewer deaths occurring as a direct result of pelvic haemorrhage;^{89 91} blood loss is more likely to be from solid visceral injury than the pelvis.⁸⁹
- Different injury patterns – multi-system injuries in 60%,⁹¹ greater incidence of diaphragmatic injury.⁹⁰⁻⁹¹
- Principles of management are the same, with the exception of fluid and oxygen therapy (**refer to fluid and oxygen therapy guidelines**).
- Clinical examination of children less than four years of age is unreliable.⁹²

9. AUDIT INFORMATION

- Incidence of suspected/actual pelvic fracture.
- Incidence of concomitant hypotension.

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- Frequency of pelvic immobilisation when pelvic fracture suspected.
- Method of pelvic immobilisation.

Key Points - Pelvic Trauma

- Pelvic fracture should be considered based upon mechanism of injury.
- The majority of pelvic fractures are stable pubic ramus or acetabular fractures.
- Any patient with hypotension and potentially relevant mechanism of injury **MUST** be considered to have a **TIME CRITICAL** pelvic injury.
- 'Springing' or distraction of the pelvis must not be undertaken.
- Pelvic stabilisation should be implemented as soon as is practicable whilst still on scene.
- Consider appropriate pain management.

REFERENCES:

1. Brown JK, Jing Y, Wang S, Ehrlich PF. Patterns of severe injury in pediatric car crash victims: Crash Injury Research Engineering Network database. *Journal of Pediatric Surgery* 2006;41(2):362-367.
2. O'Brien DP, Luchette FA, Pereira SJ, Lim E, Seeskin CS, James L, et al. Pelvic fracture in the elderly is associated with increased mortality. *Surgery* 2002;132(4):710-4; discussion 714-5.
3. Dalal SA, Burgess AR, Siegel JH, Young JW, Brumback RJ, Poka A, et al. Pelvic fracture in multiple trauma: classification by mechanism is key to pattern of organ injury, resuscitative requirements, and outcome. *Journal of Trauma-Injury Infection & Critical Care* 1989;29(7):981-1000; discussion 1000-2.
4. Demetriades D, Murray J, Brown C, Velmahos G, Salim A, Alo K, et al. High-level falls: type and severity of injuries and survival outcome according to age. *Journal of Trauma-Injury Infection & Critical Care* 2005;58(2):342-5.
5. Ferrera PC, Hill DA. Good outcomes of open pelvic fractures. *Injury* 1999;30(3):187-90.
6. Gustavo PJ, Coimbra R, Rasslan S, Oliveira A, Fregoneze M, Mercadante M, et al. The role of associated injuries on outcome of blunt trauma patients sustaining pelvic fractures. *Injury* 2000;31(9):677-82.
7. Kimbrell BJ, Velmahos GC, Chan LS, Demetriades D. Angiographic embolization for pelvic fractures in older patients. *Archives of Surgery* 2004;139(7):728-32.
8. Stein DM, O'Connor JV, Kufera JA, Ho SM, Dischinger PC, Copeland CE, et al. Risk factors associated with pelvic fractures sustained in motor vehicle collisions involving newer vehicles. *Journal of Trauma-Injury Infection & Critical Care* 2006;61(1):21-30; discussion 30-1.
9. Demetriades D, Karaiskakis M, Toutouzas K, Alo K, Velmahos G, Chan L. Pelvic fractures: epidemiology and predictors of associated abdominal injuries and outcomes. *Journal of the American College of Surgeons* 2002;195(1):1-10.
10. Inaba K, Sharkey PW, Stephen DJG, Redelmeier DA, Brenneman FD. The increasing incidence of severe pelvic injury in motor vehicle collisions. *Injury* 2004;35(8):759-65.
11. Tarman GJ, Kaplan GW, Lerman SL, McAleer IM, Losasso BE. Lower genitourinary injury and pelvic fractures in pediatric patients. *Urology* 2002;59(1):123-6; discussion 126.
12. Hill RM, Robinson CM, Keating JF. Fractures of the pubic rami. Epidemiology and five-year survival. *Journal of Bone & Joint Surgery - British Volume* 2001;83(8):1141-4.
13. Demetriades D, Murray J, Martin M, Velmahos G, Salim A, Alo K, et al. Pedestrians injured by automobiles: Relationship of age to injury type and severity. *Journal of the American College of Surgeons* 2004;199(3):382-387.
14. Boufous S, Finch C, Lord S, Close J. The increasing burden of pelvic fractures in older people, New South Wales, Australia. *Injury* 2005;36(11):1323-9.
15. Baxter NN, Habermann EB, Tepper JE, Durham SB, Virnig BA. Risk of pelvic fractures in older women following pelvic irradiation. *Journal of the American Medical Association* 2005;294(20):2587-93.

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16. Hauschild O, Strohm PC, Culemann U, Pohlemann T, Suedkamp NP, Koestler W, et al. Mortality in patients with pelvic fractures: results from the German pelvic injury register. *Journal of Trauma-Injury Infection & Critical Care* 2008;64(2):449-55.
17. Gansslen A, Pohlemann T, Paul C, Lobenhoffer P, Tschernhe H, Gansslen A, et al. Epidemiology of pelvic ring injuries. *Injury* 1996;27 Suppl 1:S-A13-20.
18. Moreno C, Moore EE, Rosenberger A, Cleveland HC. Hemorrhage associated with major pelvic fracture: a multispecialty challenge. *Journal of Trauma-Injury Infection & Critical Care* 1986;26(11):987-94.
19. Mucha PJ, Farnell MB. Analysis of pelvic fracture management. *Journal of Trauma-Injury Infection & Critical Care* 1984;24(5):379-86.
20. Siegel JH, Mason-Gonzalez S, Dischinger P, Cushing B, Read K, Robinson R, et al. Safety belt restraints and compartment intrusions in frontal and lateral motor vehicle crashes: mechanisms of injuries, complications, and acute care costs. *Journal of Trauma-Injury Infection & Critical Care* 1993;34(5):736-58; discussion 758-9.
21. Brenneman FD, Katyal D, Boulanger BR, Tile M, Redelmeier DA. Long-term outcomes in open pelvic fractures. *Journal of Trauma-Injury Infection & Critical Care* 1997;42(5):773-7.
22. Poole GV, Ward EF, Muakkassa FF, Hsu HS, Griswold JA, Rhodes RS. Pelvic fracture from major blunt trauma. Outcome is determined by associated injuries. *Annals of Surgery* 1991;213(6):532-8; discussion 538-9.
23. Salvino CK, Esposito TJ, Smith D, Dries D, Marshall W, Flisak M, et al. Routine pelvic x-ray studies in awake blunt trauma patients: a sensible policy? *Journal of Trauma-Injury Infection & Critical Care* 1992;33(3):413-6.
24. Koury HI, Peschiera JL, Welling RE, Koury HI, Peschiera JL, Welling RE. Selective use of pelvic roentgenograms in blunt trauma patients. *Journal of Trauma-Injury Infection & Critical Care* 1993;34(2):236-7.
25. Yugueros P, Sarmiento JM, Garcia AF, Ferrada R, Yugueros P, Sarmiento JM, et al. Unnecessary use of pelvic x-ray in blunt trauma. *Journal of Trauma-Injury Infection & Critical Care* 1995;39(4):722-5.
26. Ham SJ, Van Walsum ADP, Vierhout PAM. Predictive value of the hip flexion test for fractures of the pelvis. *Injury* 1996;27(8):543-544.
27. Heath FR, Blum F, Rockwell S. Physical examination as a screening test for pelvic fractures in blunt trauma patients. *West Virginia Medical Journal* 1997;93(5):267-9.
28. Kaneriyia PP, Schweitzer ME, Spettell C, Cohen MJ, Karasick D. The cost-effectiveness of routine pelvic radiography in the evaluation of blunt trauma patients. *Skeletal Radiology* 1999;28(5):271-3.
29. Tien IY, Dufel SE. Does ethanol affect the reliability of pelvic bone examination in blunt trauma? *Annals of Emergency Medicine* 2000;36(5):451-5.
30. Duane TM, Tan BB, Golay D, Cole FJJ, Weireter LJJ, Britt LD. Blunt trauma and the role of routine pelvic radiographs: a prospective analysis. *Journal of Trauma-Injury Infection & Critical Care* 2002;53(3):463-8.
31. Gonzalez RP, Fried PQ, Bukhalo M, Gonzalez RP, Fried PQ, Bukhalo M. The utility of clinical examination in screening for pelvic fractures in blunt trauma.[see comment]. *Journal of the American College of Surgeons* 2002;194(2):121-5.
32. Croce MA, Magnotti LJ, Savage SA, Wood li GW, Fabian TC. Emergent Pelvic Fixation in Patients with Exsanguinating Pelvic Fractures. *Journal of the American College of Surgeons* 2007;204(5):935-939.
33. Boulanger BR, Milzman D, Mitchell K, Rodriguez A. Body habitus as a predictor of injury pattern after blunt trauma. *Journal of Trauma-Injury Infection & Critical Care* 1992;33(2):228-32.
34. Perry JFJ. Pelvic open fractures. *Clinical Orthopaedics & Related Research* 1980(151):41-5.
35. Hanson PB, Milne JC, Chapman MW. Open fractures of the pelvis. Review of 43

- cases. *Journal of Bone & Joint Surgery - British Volume* 1991;73(2):325-9.
36. Malangoni MA, Miller FB, Cryer HM, Mullins RJ, Richardson JD. The management of penetrating pelvic trauma. *American Surgeon* 1990;56(2):61-5.
37. Chong KH, DeCoster T, Osler T, Robinson B. Pelvic fractures and mortality. *Iowa Orthopaedic Journal* 1997;17:110-4.
38. Cryer HM, Miller FB, Evers BM, Rouben LR, Seligson DL. Pelvic fracture classification: correlation with hemorrhage. *Journal of Trauma-Injury Infection & Critical Care* 1988;28(7):973-80.
39. Evers BM, Cryer HM, Miller FB. Pelvic fracture hemorrhage. Priorities in management. *Archives of Surgery* 1989;124(4):422-4.
40. Heetveld MJ, Harris I, Schlaphoff G, Sugrue M. Guidelines for the management of haemodynamically unstable pelvic fracture patients. *Australian and New Zealand Journal of Surgery* 2004;74(7):520-9.
41. Heetveld MJ, Harris I, Schlaphoff G, Balogh Z, D'Amours SK, Sugrue M. Hemodynamically unstable pelvic fractures: Recent care and new guidelines. *World Journal of Surgery* 2004;28(9):904-909.
42. Poole GV, Ward EF. Causes of mortality in patients with pelvic fractures. *Orthopedics* 1994;17(8):691-6.
43. Burgess AR, Eastridge BJ, Young JW, Ellison TS, Ellison PSJ, Poka A, et al. Pelvic ring disruptions: effective classification system and treatment protocols. *Journal of Trauma-Injury Infection & Critical Care* 1990;30(7):848-56.
44. Failing MS, McGanity PLJ. Unstable fractures of the pelvic ring. *Journal of Bone & Joint Surgery - American Volume* 1992;74(5):781-791.
45. Henry SM, Tornetta Pr, Scalea TM. Damage control for devastating pelvic and extremity injuries. *Surgical Clinics of North America* 1997;77(4):879-95.
46. Rothenberger DA, Fischer RP, Perry JFJ. Major vascular injuries secondary to pelvic fractures: an unsolved clinical problem. *American Journal of Surgery* 1978;136(6):660-2.
47. Richardson JD, Harty J, Amin M, Flint LM. Open pelvic fractures. *Journal of Trauma-Injury Infection & Critical Care* 1982;22(7):533-8.
48. Wubben RC. Mortality rate of pelvic fracture patients. *Wisconsin Medical Journal* 1996;95(10):702-4.
49. Grotz MRW, Gummerson NW, Gansslen A, Petrowsky H, Keel M, Allami MK, et al. Staged management and outcome of combined pelvic and liver trauma. An international experience of the deadly duo. *Injury* 2006;37(7):642-51.
50. Starr AJ, Griffin DR. Pelvic ring disruptions: mechanisms, fracture pattern, morbidity and mortality. An analysis of 325 patients. *Orthopaedic Trauma Association Annual Meeting*. Texas, US, 2000.
51. Sriussadaporn S. Abdominopelvic vascular injuries. *Journal of the Medical Association of Thailand* 2000;83(1):13-20.
52. Khoury G, Sfeir R, Khalifeh M, Khoury SJ, Nabbout G. Penetrating trauma to the abdominal vessels. *Cardiovascular Surgery* 1996;4(3):405-7.
53. Moss MC, Bircher MD. Volume changes within the true pelvis during disruption of the pelvic ring--where does the haemorrhage go? *Injury* 1996;27 Suppl 1:S-A21-3.
54. Rowe SA, Sochor MS, Staples KS, Wahl WL, Wang SC. Pelvic ring fractures: implications of vehicle design, crash type, and occupant characteristics. *Surgery* 2004;136(4):842-7.
55. Ben-Menachem Y, Coldwell DM, Young JW, Burgess AR. Hemorrhage associated with pelvic fractures: causes, diagnosis, and emergent management. *American Journal of Roentgenology* 1991;157(5):1005-14.
56. Fleming WH, Bowen JCr. Control of hemorrhage in pelvic crush injuries. *Journal of Trauma-Injury Infection & Critical Care* 1973;13(6):567-70.
57. Dyer GSM, Vrahas MS. Review of the pathophysiology and acute management of haemorrhage in pelvic fracture. *Injury* 2006;37(7):602-13.
58. Davidson BS, Simmons GT, Williamson PR, Buerk CA. Pelvic fractures associated with open perineal wounds: a survivable

- injury. *Journal of Trauma-Injury Infection & Critical Care* 1993;35(1):36-9.
59. Govender S, Sham A, Singh B. Open pelvic fractures. *Injury* 1990;21(6):373-6.
60. Sinnott R, Rhodes M, Brader A. Open pelvic fracture: an injury for trauma centers. *American Journal of Surgery* 1992;163(3):283-7.
61. Barach E, Martin G, Tomlanovich M, Nowak R, Littleton R. Blunt pelvic trauma with urethral injury in the female: a case report and review of the literature. *Journal of Emergency Medicine* 1984;2(2):101-5.
62. Bottlang M, Simpson T, Sigg J, Krieg JC, Madey SM, Long WB. Noninvasive reduction of open-book pelvic fractures by circumferential compression. *Journal of Orthopaedic Trauma* 2002;16(6):367-73.
63. Smith RJ. Avulsion of the nonpregnant uterus due to pelvic fracture. *Southern Medical Journal* 1989;82(1):70-3.
64. Sandler CM, Hall JT, Rodriguez MB, Corriere JNJ. Bladder injury in blunt pelvic trauma. *Radiology* 1986;158(3):633-638.
65. Lunt HR. Entrapment of bowel within fractures of the pelvis. *Injury* 1970;2(2):121-6.
66. Reiff DA, McGwin GJ, Metzger J, Windham ST, Doss M, Rue LW. Identifying injuries and motor vehicle collision characteristics that together are suggestive of diaphragmatic rupture. *Journal of Trauma-Injury Infection & Critical Care* 2002;53(6):1139-45.
67. Lee C, Porter K. The prehospital management of pelvic fractures. *Emergency Medicine Journal* 2007;24(2):130-3.
68. Waydhas C, Nast-Kolb D, Ruchholtz S. Pelvic Ring Fractures: Utility of Clinical Examination in Patients with Impaired Consciousness or Tracheal Intubation. *European Journal of Trauma and Emergency Surgery* 2007;33(2):170-175.
69. MacLeod M, Powell JN, MacLeod M, Powell JN. Evaluation of pelvic fractures. Clinical and radiologic. *Orthopedic Clinics of North America* 1997;28(3):299-319.
70. Fox MA, Mangiante EC, Fabian TC, Voeller GR, Kudsk KA. Pelvic fractures: an analysis of factors affecting prehospital triage and patient outcome. *Southern Medical Journal* 1990;83(7):785-8.
71. Sauerland S, Bouillon B, Rixen D, Raum MR, Koy T, Neugebauer EAM. The reliability of clinical examination in detecting pelvic fractures in blunt trauma patients: a meta-analysis. *Archives of Orthopaedic & Trauma Surgery* 2004;124(2):123-8.
72. Waikukul S, Harnroongroj T, Vanadurongwan V. Immediate stabilization of unstable pelvic fractures versus delayed stabilization. *Journal of the Medical Association of Thailand* 1999;82(7):637-42.
73. Grimm MR, Vrahas MS, Thomas KA. Pressure-volume characteristics of the intact and disrupted pelvic retroperitoneum. *Journal of Trauma* 1998;44(3):454-9.
74. Vermeulen B, Peter R, Hoffmeyer P, Unger PF, Vermeulen B, Peter R, et al. Prehospital stabilization of pelvic dislocations: a new strap belt to provide temporary hemodynamic stabilization. *Swiss Surgery* 1999;5(2):43-6.
75. Bottlang M, Krieg JC, Mohr M, Simpson TS, Madey SM. Emergent Management of Pelvic Ring Fractures with Use of Circumferential Compression. *Journal of Bone and Joint Surgery - American volume* 2002;84(suppl_2):S43-47.
76. Jowett AJL, Bowyer GW. Pressure characteristics of pelvic binders. *Injury* 2007;38(1):118-21.
77. Connolly B, Gerlinger T, Pitcher JD. Complete masking of a severe open-book pelvic fracture by a pneumatic antishock garment. *Journal of Trauma-Injury Infection & Critical Care* 1999;46(2):340-2.
78. Krieg JC, Mohr M, Ellis TJ, Simpson TS, Madey SM, Bottlang M. Emergent stabilization of pelvic ring injuries by controlled circumferential compression: a clinical trial. *Journal of Trauma-Injury Infection & Critical Care* 2005;59(3):659-64.
79. Routt MLJ, Simonian PT, Swiontkowski MF. Stabilization of pelvic ring disruptions. *Orthopedic Clinics of North America* 1997;28(3):369-88.
80. Simpson T, Krieg JC, Heuer F, Bottlang M. Stabilization of pelvic ring disruptions with

- a circumferential sheet. *Journal of Trauma-Injury Infection & Critical Care* 2002;52(1):158-61.
81. Melamed E, Blumenfeld A, Kalmovich B, Kosashvili Y, Lin G, Israel Defense Forces Medical Corps Consensus Group on Prehospital Care of Orthopedic I. Prehospital care of orthopedic injuries. *Prehospital & Disaster Medicine* 2007;22(1):22-5.
82. Katsoulis E, Drakoulakis E, Giannoudis PV. (iii) Management of open pelvic fractures. *Current Orthopaedics* 2005;19(5):345-353.
83. Brunette DD, Fifield G, Ruiz E. Use of pneumatic antishock trousers in the management of pediatric pelvic hemorrhage. *Pediatric Emergency Care* 1987;3(2):86-90.
84. Scurr JH, Cutting P. Tight jeans as a compression garment after major trauma. *British Medical Journal Clinical Research Ed* 1984;288(6420):828.
85. Salomone JP, Ustin JS, McSwain NEJ, Feliciano DV. Opinions of trauma practitioners regarding prehospital interventions for critically injured patients. *Journal of Trauma-Injury Infection & Critical Care* 2005;58(3):509-15; discussion 515-7.
86. Friese G, LaMay G. Emergency stabilization of unstable pelvic fractures. *Emergency Medical Services* 2005;34(5):65.
87. Nunn T, Cosker TDA, Bose D, Pallister I. Immediate application of improvised pelvic binder as first step in extended resuscitation from life-threatening hypovolaemic shock in conscious patients with unstable pelvic injuries. *Injury* 2007;38(1):125-8.
88. Krieg JC, Mohr M, Mirza AJ, Bottlang M. Pelvic circumferential compression in the presence of soft-tissue injuries: a case report. *Journal of Trauma-Injury Infection & Critical Care* 2005;59(2):470-2.
89. Ismail N, Bellemare JF, Mollitt DL, DiScala C, Koepfel B, Tepas JJr, et al. Death from pelvic fracture: children are different. *Journal of Pediatric Surgery* 1996;31(1):82-5.
90. Junkins EPJ, Nelson DS, Carroll KL, Hansen K, Furnival RA, Junkins EPJ, et al. A prospective evaluation of the clinical presentation of pediatric pelvic fractures. *Journal of Trauma-Injury Infection & Critical Care* 2001;51(1):64-8.
91. Silber JS, Flynn JM, Koffler KM, Dormans JP, Drummond DS. Analysis of the cause, classification, and associated injuries of 166 consecutive pediatric pelvic fractures. *Journal of Pediatric Orthopedics* 2001;21(4):446-50.
92. Junkins EP, Furnival RA, Bolte RG. The clinical presentation of pediatric pelvic fractures. *Pediatric Emergency Care* 2001;17(1):15-8.

METHODOLOGY

Refer to methodology section:
<http://www2.warwick.ac.uk/fac/med/research/hsri/emergencycare/prehospitalcare/jrcalcstakeholderwebsite/a-z/trauma/pelvic>