The role of angiographic embolization in bleeding pelvic fractures

Jan Lindahl
Department of Orthopaedics and Traumatology,
Helsinki University Central Hospital, Helsinki, Finland

Major pelvic injuries are associated with a high risk for venous and arterial bleeding (1). The most pressing issue in the treatment of bleeding pelvic injuries is the ability to rapidly control blood loss (2). Bleeding usually originates from the presacral venous plexus or directly from the bony edges and can be quite massive. However, venous bleeding eventually stops, because it is a low-pressure system, particularly when intra-abdominal pressure exceeds venous pressure. Arterial bleeding occurs in up to 30 % of hemodynamically unstable patients and often requires a combination of mechanical stabilization and angiographic embolization (3,4).

Bleeding pelvic injuries

Massive pelvic bleeding is most frequently seen in severe open fractures and vertically unstable pelvic ring fractures (AO type C), but can be seen in rotationally unstable open book injuries (AO type B1 and B3), and in isolated acetabular fractures (both column fractures in our series).

Source of arterial bleeding

Severe bleeding in patients with pelvic injury from blunt trauma is usually from the internal iliac artery or its main branches (5–7). In our own material 85 % of the patients had injuries to the internal iliac artery or its main branches. Arterial bleeding originated occasionally from the external iliac artery (2 %) or circumflex femoral artery (2 %). 11 % of patients had bleeding from internal iliac artery or its main branch and from circumflex femoral artery. 59 % of the patients had more than one bleeding arteries, and one third of the patients have arterial bleeding from both sides of the pelvic ring.

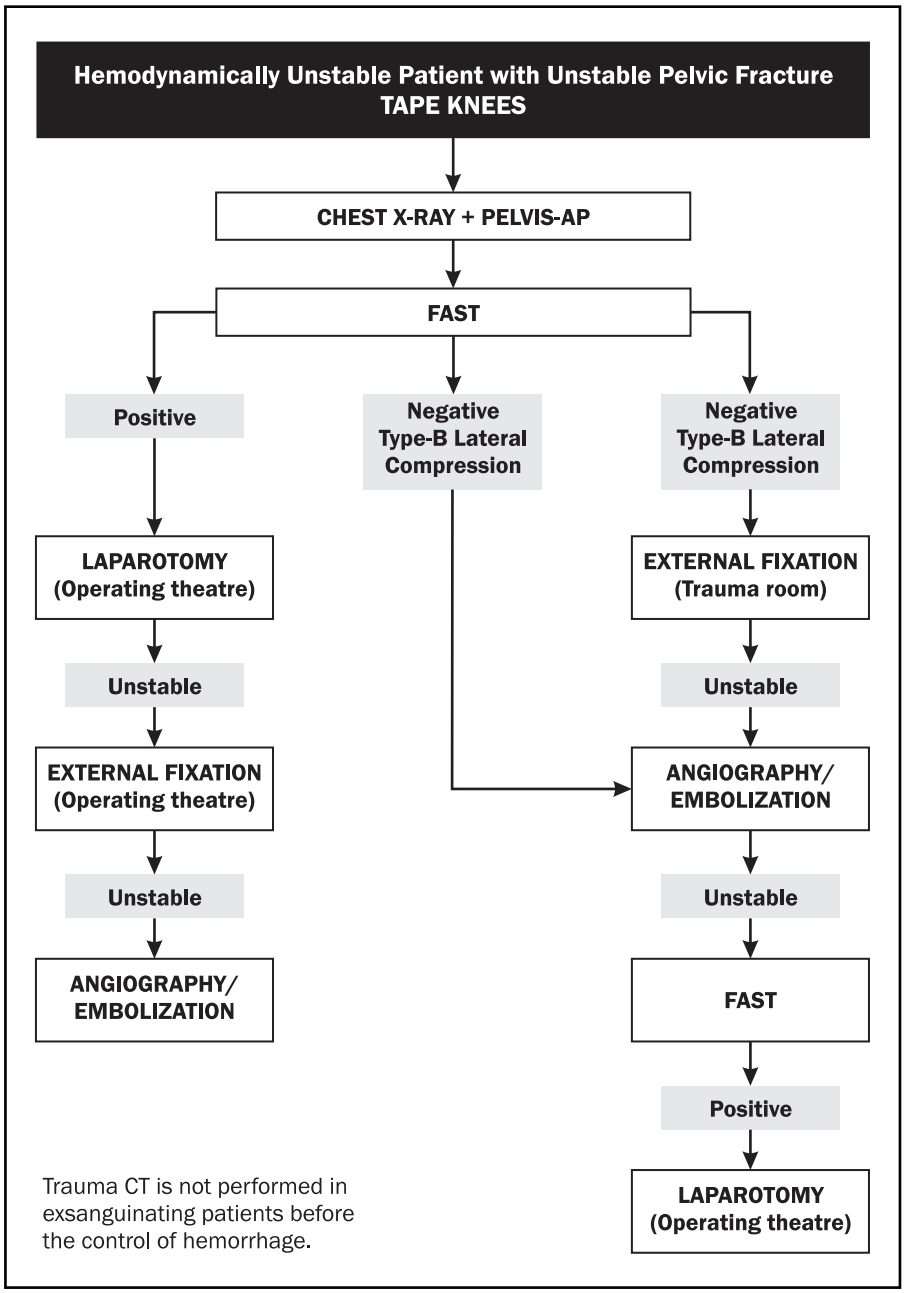
Initial fracture stabilization

Pelvic fracture bleeding can be temporised with a sheet or a pelvic binder or an external fixator. A 15–20 cm wide sheet or a pelvic binder (for example PelvicPinder®) is applied around the trochanteric region. Before tightening the external device the injured hemipelvis (in type C pelvic ring fractures) is reduced by traction and internal rotation of the lower extremities (external rotation deformity of the injured hemipelvis in open book and type C injuries). An external fixator can restore pelvic bony stability in most (but not all) pelvic fracture types, but its application is more time consuming (8). Closure of the pelvic cavity with an external fixator seems to improve tamponade by reducing and maintaining the pelvic volume (9–11). A sheet or a binder or external fixator effectively tamponades non-arterial bleeding from bone edges and pelvic veins but it does not stop arterial bleeding. Pelvic sheet or binder is kept for maximum 1 day and after that either definitive pelvic internal fixation or temporary external fixation is carried out.

Surgical control of arterial bleeding

The operative ligation of the internal iliac artery is fraught with hazard. Direct visualization of its main branches is difficult. Direct exploration of the retroperitoneal hematoma releases any tamponade and allows small arterioles and veins that had been tamponaded to bleed again. Thus, transcatheter embolization has become the standard method of treating

Figure 1. An algorithm for control of pelvic hemorrhage (Töölö Hospital)



blunt pelvic bleeding from the internal iliac artery or its branches or circumflex femoral artery (12,13). However, repair of injuries to the external iliac or femoral arteries should always be attempted to avoid the loss of the limb (14,15).

Angiographic embolization

Arterial bleeding usually requires angiographic embolization (16–18). In patients in whom bleeding can be identified with angiography, transcatheter embolization definitively treats this bleeding. In our material no rebleedings were seen. Usually the bleeding vessels are catheterised selectively and embolized with coils or glue. If this is not possible because of multiple bleeding vessels or uncontrolled bleeding, embolization of internal iliac artery with coils is performed. Because of extensive collateral circulation, even the main internal iliac artery can be occluded bilaterally.

Intra-abdominal and pelvic bleeding

The patients who have concomitant intra-abdominal and pelvic bleeding present a special problem. Massive intraperitoneal bleeding indicates laparotomy as well as increasing amount of blood in repeated ultrasound examination of abdomen in hypovolemic blunt trauma patients (Figure 1). Usually, when an urgent laparotomy results in ongoing hemorrhage from pelvic vessels, the best course of action is to effectively pack the pelvis (pelvic packing), terminate the laparotomy with rapid skin closure, stabilize the pelvis with an external fixator, and transfer the patient to the angiography suite for immediate postoperative angiographic embolization. Temporary effective pelvic packing may control small arterial bleeders, but often fails to control a major arterial bleeding.

Extra-peritoneal pelvic packing

Direct packing via a retroperitoneal approach to control major pelvic fracture bleeding is an option especially when angiography service is not available. It has been used in patients who are exsanguinating and are not transportable to the angiography suite (3,4,19). After laparotomy, when intra-abdominal bleeding is under control, the control of arterial retroperitoneal bleeding with pelvic packing should be considered. The swabs are directed toward branches of the internal iliac artery and the retroperitoneal pelvic venous plexus. Both sides should be packed in the same manner. A pelvic binder or external fixator is maintained postoperatively. The definitive control of bleeding pelvic arteries is carried out with angiographic embolization.

Intra-abdominal compartment syndrome

Damage control surgery in the abdomen and/or pelvis might result in acute compartment syndrome of the abdomen. A large retroperitoneal hematoma causes the risk of increasing intra-abdominal pressure. Patients need to be monitored carefully and repeated measurement of the pressure in the bladder must be performed to diagnose the abdominal compartment syndrome. In such a case a laparotomy or relaparotomy should be performed and the midline incision (upper part) should be left open and covered with a sterile plastic film (Bogota bag).

Open pelvic fractures

Pelvic bleeding from soft tissue defects particularly in the perineum and inguinal region is controlled by packing. Large swabs are used in the wounds for tamponade.

Venous injuries

Venous injuries, in the patient requiring damage control techniques, might be treated by ligation. External iliac and common iliac veins can be ligated with relative low complication rate (12,15). The internal iliac venous bleeding is often controllable with pelvic packing. Venography might be used for detecting severe venous bleeding. This is performed with a balloon placed in the infrarenal inferior vena cava and injection of contrast medium into the iliac veins. Intravenous stents may be used to control venous bleeding.

References

1. Mucha Jr P, Welch TJ: Hemorrhage in major pelvic fractures. Vascular Trauma. 1988;68: 57-773.

2. Alonso JE, Jackson L, Burgess AR, Browner BD: The management of complex orthopedic injuries. Surg Clin of North Am. 1996;76:879-903.

3. Smith WR, Moore EE, Osborn P, Agudelo JF, Morgan SJ, Parekh AA, et al: Retroperitoneal packing as a resuscitation technique for hemodynamically unstable patients with pelvic fractures: Report of two representative cases and a description of technique. J Trauma. 2005;59:1510-1514.

4. Tötterman A, Dormagen JB, Madsen JE, Klow N-E, Skaga NO, Roise O: A protocol for angiographic embolization in exsanguinating pelvic trauma. A report on 31 patients. Acta Orthop. 2006;77:462-468.

5. Agnew SG: Hemodynamically unstable pelvic fractures. Clin Orthop North Am. 1994;25:715-721.

6. Lindahl J, Hakala P, Hirvensalo E, Porras M: Embolisaatio massiivisesti vuotavien lantionmurtumapotilaiden hoidossa. Suom Ortop Traumatol. 1997;20:286-291.

7. Lindahl J: Monivammapotilaan lantionmurtuma – massiivin vuodon hoitoperiaatteet. Suom Ortop Traumatol. 2002;25:26-30.

8. Lindahl J: The role of external fixation in the treatment of pelvic injuries. Suom Ortop Traumatol. 2004;27:35-38.

9. Evers BM, Cryer HM, Miller FB: Pelvic fracture hemorrhage. Priorities in management. Arch Surg. 1989;124:422-424.

10. Riemer BL, Butterfield SL, Diamond DL, Young JC, Raves JJ, Cottington E, et al: Acute mortality associated with injuries to the pelvic ring: The role of early patient mobilization and external fixation. J Trauma. 1993;35:671-677.

11. Ghanayem AJ, Wilber JH, Lieberman JM, Motta AO: The effect of laparotomy and external fixator stabilization on pelvic volume in an unstable pelvic injury. J Trauma. 1995;38:396-401.

12. Henry SM, Tornetta P III, Scalea TM: Damage control for devastating pelvic and extremity injuries. Surg Clin North Am. 1997;77:879-895.

13. Scalea TM, Sclafani S: Interventional techniques in vascular trauma. Surg Clin North Am. 2001;81:1281-1297.

14. Weaver FA, Papanicolaou G, Yellin AE: Difficult peripheral vascular injuries. Surg Clin North Am. 1996;76:843-859.

15. Hoyt DB, Coimbra R, Potenza BM, Rappold JF: Anatomic exposures for vascular injuries. Surg Clin North Am. 2001;81:1299-1330.

16. Margolies MN, Ring EJ, Waltman AC, Kerr WS, Baum S: Arteriography in the management of hemorrhage from pelvic fractures. N Engl J Med. 1972;7:317-321.

17. Piotin M, Herbreteau D, Guichard JP, Houdart E, Reizine D, Aymard A, et al: Percutaneous transcatheter embolization in multiply injured patients with pelvic ring disruption associated with severe hemorrhage and coagulopathy. Injury. 1995;10:677-680.

18. Hakala P, Lindahl J, Alberty A, Tanskanen P, Nieminen H, Porras M: Massive transfusion exceeding 150 units of packed red cells during the first 15 hours after injury. J Trauma. 1998;44:410-412.

19. Pohlemann T, Gänsslen A, Bosch U, Tscherne H: The technique of packing for control of hemorrhage in complex pelvic fractures. Techniques in Orthopaedics. 1995;9:267-270.