The role of angiographic embolization in bleeding pelvic fractures

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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 intrabdominal 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).

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 noarterial 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 hematomata 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)

Hemodynamically Unstable Patient with Unstable Pelvic Fracture
TAPE KNEES

CHEST X-RAY + PELVIS-AP

FAST

Positive

Negative Type-B Lateral Compression

LAPAROTOMY (Operating theatre)

Unstable

EXTERNAL FIXATION (Operating theatre)

Unstable

ANGIOGRAPHY/EMBOLIZATION

Negative Type-B Lateral Compression

EXTERNAL FIXATION (Trauma room)

Unstable

ANGIOGRAPHY/EMBOLIZATION

Unstable

FAST

Positive

LAPAROTOMY (Operating theatre)

Trauma CT is not performed in exsanguinating patients before the control of hemorrhage.
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 bleed-

**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