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## Review

Haemodynamically unstable pelvic fractures<sup>☆</sup>Christopher E. White<sup>\*</sup>, Joseph R. Hsu, John B. Holcomb

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## ABSTRACT

Bleeding pelvic fractures that result in haemodynamic instability have a reported mortality rate as high as 40%. Because of the extreme force needed to disrupt the pelvic ring, associated injuries are common and mortality is usually from uncontrolled haemorrhage from extra-pelvic sources. Identifying and controlling all sources of bleeding is a complex challenge and is best managed by a multi-disciplinary team, which include trauma surgeons, orthopaedic surgeons and interventional radiologists. Once the pelvis is identified as the major source of haemorrhage, component therapy reconstituting whole blood should be used and the pelvic region wrapped circumferentially with a sheet or pelvic binder. Patients at risk for arterial bleeding who continue to show haemodynamic instability despite resuscitative efforts should undergo immediate arteriography and embolisation of bleeding pelvic vessels. If this is unavailable or delayed, or the patient has other injuries (i.e., head, chest, intra-abdominal, long bone), external fixation and pelvic packing, performed concomitantly with other life-saving procedures, may be used to further reduce pelvic venous bleeding. If however, the patient remains haemodynamically labile without apparent source of blood loss, transcatheter angiographic embolisation should be attempted to locate and stop pelvic arterial bleeding. Institutional practice guidelines have been shown to reduce mortality and should be developed by all centres treating pelvic fractures.

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Haemodynamically unstable pelvic fractures represent a difficult diagnostic and therapeutic challenge for the trauma team. Haemorrhage from cancellous bone surfaces, the presacral venous plexus and/or iliac arterial or venous branches may cause hypotension. In addition, pelvic fractures are a marker of excessive force applied to the human body and are often associated with extra-pelvic haemorrhage from other injuries (chest 15%, intra-abdominal 32%, long bones 40%) which further confounds the initial work-up.<sup>59</sup> Mortality rates in excess of 40% are reported with exsanguinating haemorrhage identified as the major cause of death during the first 24 h after injury, and with multi-organ failure (MOF) causing the majority of deaths thereafter.<sup>1,25,39,40,43,56,114,115,118</sup> One of the potential causes of this late mortality is most likely to be a direct result of the “bloody

vicious cycle” of continued haemorrhage and transfusion since blood transfusion is an independent risk factor for increased ICU length of stay, the development of MOF, and death.<sup>24,25,78,83,116,129</sup> Thus, urgent identification and control of haemorrhage is paramount to survival.

Pelvic fractures account for approximately 3% of all skeletal injury after blunt trauma. In large series, most result from motor vehicle crashes.<sup>12,27,43,76,81,105</sup> Though injuries combining mechanically unstable pelvic fractures with haemodynamic instability are rare, comprising less than 10% of all pelvic fractures presenting to Level I centres, they represent the bulk of mortality of this group.<sup>39,43,56</sup> To disrupt the integrity of the pelvic ring requires an instantaneous deceleration of approximately 30 miles per hour and as this energy dissipates, it often causes trauma to the head, chest, abdomen or extremities which adds to the over-all physiological burden of injury.<sup>54,96,105</sup> In fact, more than 80% of patients with unstable pelvic fractures will be found to have additional musculoskeletal injuries.<sup>25,54,80</sup> Injury severity score (ISS) is indicative of the degree of destructive energy applied to the body as a whole, and ISS, not type of pelvic instability, appears to be the most important factor in predicting

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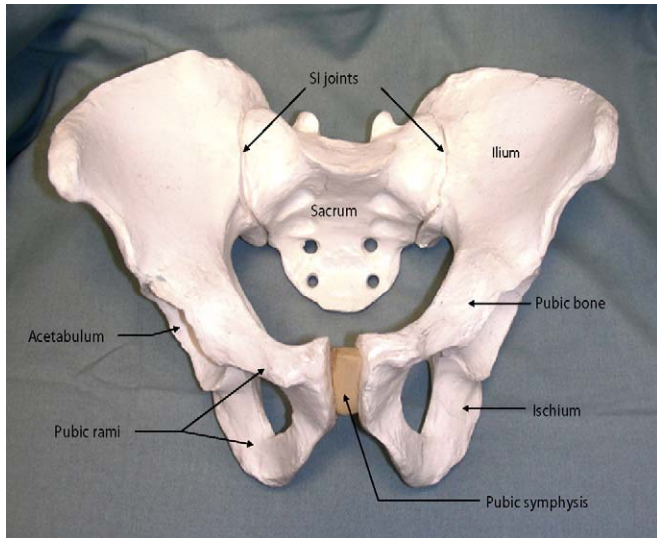


Fig. 1. Photograph of model of bony pelvis.

mortality in patients with pelvic fractures.<sup>3,39,76,80,96,114,118</sup> Only a small proportion of deaths are directly attributable to the pelvic fracture alone.<sup>31,90,95</sup>

The bony pelvis is composed of three bones: the two innominate bones articulate in the anterior midline through the pubic symphysis, and posteriorly with the sacrum forming the sacroiliac (SI) joints (Fig. 1). The SI joints are the strongest in the body and resist both vertical and anterior–posterior displacement; the pubic symphysis is the weakest link in the pelvic ring supplying only 15% of the intrinsic pelvic stability. The pelvic floor muscles and ligaments also contribute to pelvic stability; extensive disruption of this extraperitoneal compartment can lead to loss of tamponade, and uncontrolled haemorrhage and exsanguination.<sup>35,39,40,53,127</sup> Since the pelvis is a ring structure, significant disruption and displacement of one area are accompanied by the same in another and are usually the result of both bone and ligamentous disruption. Pelvic instability is defined as the inability of the pelvic ring to withstand physiological loading, and it is these high energy pelvic injuries, especially those involving posterior structures, that result in the greatest amount of blood loss.<sup>22,28,29,39</sup> This is commonly seen in the elderly where pelvic fracture are more likely to cause haemorrhage and require angiography.<sup>48,60,74,114,118,125</sup>

The primary source of haemorrhage from pelvic fractures is the posterior pelvic venous plexus or bleeding cancellous bone surfaces.<sup>66,112</sup> However, 10–15% of the time this haemorrhage is arterial and its usual source is from named branches of the internal iliac system with pudendal (anterior) and superior gluteal (posterior) arteries being the most commonly identified at arteriography.<sup>35</sup> Posterior fracture along the SI joints may cause disruption of a main iliac trunk, but is rare, occurring less than 1% of the time. These patients may present in extremis.<sup>71,113</sup> Force vectors and fracture patterns inconsistently predict those with arterial bleeding and need for subsequent angiography. This is most likely because radiographs can only capture the degree of displacement at the time of imaging, not that which was present at the time of impact. Exsanguinating haemorrhage can and does occur in all fracture patterns, even simple rami fractures, and may in fact be independent of the bony injury pattern to the pelvis altogether.<sup>11,28,35–38,42,57,58,62,82,114,115,123</sup>

The initial management of the patient with multiple injuries and suspected pelvic fracture largely follows Advanced Trauma

Life Support (ATLS) guidelines of the American College of Surgeons Committee on Trauma.<sup>1</sup> During primary survey, an airway is secured and resuscitation begun with intravenous crystalloid solutions while deliberate hypotension is maintained until all sources of haemorrhage have been identified and controlled.<sup>36,37,62</sup> The most important factor in the survival of patients with pelvic fracture is urgent haemostasis thus limiting the detrimental effects of both shock and high volume resuscitation.<sup>39,114</sup> Since bleeding from associated injuries significantly influences patient survival, prompt identification and management of all life-threatening injuries is essential to restoring normal haemodynamics.<sup>39,54,96</sup> Multiple injuries are the rule in this patient population, up to 89% in one series, and persistent resuscitation requirements often herald ongoing haemorrhage or missed injury.<sup>11,54</sup> Haemoglobin and/or haematocrit levels measured within minutes of patient arrival in the trauma bay may be a reliable marker of ongoing haemorrhage and need for massive transfusion, and an admission haematocrit of 30% or less has been shown to be a predictor of major pelvic haemorrhage.<sup>12,21</sup> Once resuscitation is begun, however, both haemoglobin and haematocrit are potentially spurious and should not be trusted to determine amount of blood lost. Furthermore, neither is an endpoint of resuscitation. High base deficits and lactate levels have correlated with mortality in pelvic trauma and those with base deficits  $\geq 5$  mmol/L on arrival were more likely to die.<sup>3,59</sup> Sequential measurements of base deficit and blood lactate in this early period of resuscitation may be a more rapid and reliable measurement of blood loss and further transfusion requirements than other more commonly used haemodynamic and/or laboratory parameters.<sup>30,40</sup> Additionally, improvement in base deficit and blood lactate signals amelioration of oxygen debt and reversal of the shock state.<sup>122</sup> This attests to a positive response to resuscitative measures.

Once the pelvis is shown to be the major source of haemorrhage, component therapy simulating whole blood (i.e., haemostatic or damage control resuscitation) is promptly administered with transfusion of packed red blood cells (PRBC), fresh-frozen plasma (FFP) and platelets ideally in a 1:1:1 (pack) ratio.<sup>11,15,34,50,62,63,72,91</sup> As a result of tissue damage/destruction and resultant hypoperfusion, trauma-induced coagulopathy may be present in 25% of patients on Emergency Department (ED) admission and appears to increase linearly with ISS and risk of death.<sup>19,20,77</sup> Using this ratio of blood products has been shown to improve survival of patients requiring massive transfusions and may reduce the overall volume of blood transfused.<sup>15,34,63,67,68,77,91</sup> The on-call orthopaedic surgeon, blood bank, operating room (OR) and interventional radiologist (IR) are immediately notified and a massive transfusion protocol activated. Crystalloid use is then significantly limited and should serve mainly as a carrier to keep lines open between blood products.<sup>26,61,128</sup> Early transfusion of platelets as six packs to keep platelet counts above 100,000/ $\mu$ L during massive transfusion appears to provide a survival advantage.<sup>68,69,72,91</sup> Cryoprecipitate and recombinant factor VIIa (rFVIIa) may be used as adjuncts to haemostatic resuscitation especially in those patients who are coagulopathic as a result of delayed presentation or ongoing haemorrhage with tris-hydroxymethyl aminomethane (THAM) given to rapidly correct pH and acid base deficits.<sup>14,61,64,79,116,117,119</sup> Furthermore, every effort should be made to maintain the patient at normothermia either by passive means (warm trauma bay, warm blankets, space blanket, Bair Hugger<sup>®</sup>) or active means (FMS 2000<sup>®</sup> rapid infuser).

Focus should then be turned to reduction of venous bleeding by stabilisation of pelvic ring injuries. This is most expeditiously accomplished with a longitudinally folded bed sheet



Fig. 2. Photograph of sheeted pelvis.

wrapped circumferentially around the pelvis, placed between the iliac crests and greater trochanters, and secured anteriorly by clamping<sup>97,100,110</sup> (Fig. 2), or with simple commercially available devices which also provide circumferential pelvic stabilisation and may permit the applied reduction force to be controlled to a pre-determined level.<sup>27,100</sup> Both the improvised and commercially available binders stabilise the pelvis and allow for clot formation. While binders and external fixators may decrease the pelvic volume of “open-book” injuries,<sup>9</sup> it is controversial whether they can create a tamponade effect, since the retroperitoneum is disrupted.<sup>47,53</sup> The “splinting” of pathological pelvic motion is more likely to be the mechanism that aids in haemostasis. Moreover, the reduction in volume of the true pelvis is much less than expected. A large pubic diastasis of 10 cm only corresponds to a 35% increase in pelvic volume or 479 cm<sup>3</sup>.<sup>120</sup>

Pelvic binders also assure continued access to the abdomen, pelvis and lower extremities, do not require special training to place and are generally free from complications with short-term use. As such, ATLS guidelines recommend their placement by pre-hospital personnel and providers in rural settings before transport of these patients. In fact, the use of pelvic binders results in significantly lower transfusion amounts and length of hospital stay compared to external fixation.<sup>27</sup> Long periods of tight immobilisation may cause tissue necrosis, nerve injury and/or abdominal or extremity compartment syndrome(s) although this time course is not well defined.<sup>75,100,108,126</sup> There is a case report of skin breakdown affecting patient management secondary to circumferential anti-shock sheeting.<sup>106</sup> A recent study raised concerns about prolonged use of binders due to pressure over bony prominences.<sup>70</sup> Pelvic sheeting or compressive devices usually remain in place until the patient is haemodynamically stable and transfusion requirements have ceased, usually in one to two days, or if the patient continues to bleed and another intervention is necessary.<sup>11,123</sup> Military anti-shock trousers (MAST) trousers limit access to the traumatised regions and have also been associated with these complications with no evidence of benefit and should not be used for this purpose.<sup>32,43</sup>

More invasive means for emergency stabilisation of unstable pelvic fracture can be accomplished by anterior external fixation (EX-FIX) or a pelvic C-clamp. Anterior external fixator application usually limits blood loss by direct compression of bleeding vessels at the fracture site or SI joint disruption for rotationally unstable pelvic fractures that involve partial disruption of the

posterior elements. Unfortunately, stability and haemorrhage control for vertically unstable patterns with complete disruption of the posterior elements are limited.<sup>44</sup> Application of EX-FIX may take place in the emergency department; however, it is most often placed in the OR and should be fairly rapid in experienced hands. The EX-FIX should be placed in such a manner that it does not limit access to the abdomen or limit the ability of the abdomen to expand. When used in conjunction with pelvic packing, it is helpful to stabilise the pelvis first with the fixator.<sup>25,115</sup> The external fixator can be placed with pins in the iliac crests or in the supra-acetabular region. There is a slight biomechanical advantage to supra-acetabular pin placement, but there is no data to suggest the technique improves survival.<sup>45,46,55,73,92</sup>

In those patients with posterior pelvic ring disruptions, the major source of bleeding is often from the cancellous bone and/or the presacral venous plexus.<sup>111</sup> In these injuries, rapid reduction and posterior stabilisation can be performed with the pelvic C-clamp, which consists of two pins applied to the ilium in the region of the SI joints. It may be applied in the emergency department, but it is preferable to place the device in the operating room under fluoroscopic control.<sup>44,49</sup> Moreover, it may be superior to other forms of pelvic fixation since it directly addresses the most frequent bleeding site(s). However, the C-clamp requires specific training for its successful application and serious complications (fracture displacement, pin site infection or perforation, nerve injury) have been reported from its use.<sup>10,16,94,107</sup> Anteroposterior (AP) view of the pelvis should be obtained in the trauma bay to<sup>33,86,98,99</sup> determine the extent of pelvic injury. Anterior injuries (pubic rami diastasis/fractures) are more easily identified than those affecting posterior structures, which may be missed in up to 22% of cases. Overall, AP films of the pelvis have a sensitivity of only 78% for identification of pelvic fractures in the acute trauma patient and may be the result of poor film quality or clinician inexperience.<sup>33,86,98,99</sup> Additionally, fracture pattern has inconsistently predicted blood loss and need for transcatheter arterial embolisation (TAE).<sup>12,42,57,82,104,105,114</sup>

Clinically, a palpable haematoma above the inguinal ligament, on the proximal thigh, and/or over the perineum (Destot sign) may indicate pelvic fracture with associated bleeding; ecchymosis about the flank (Grey Turner sign) is associated with retroperitoneal haemorrhage. Pelvic springing involves applying alternating compression and distortion over the iliac wings to detect pelvic ring instability and is a poor predictor of the presence or absence of pelvic fracture. Additionally, it may dislodge adherent clot further exacerbating haemorrhage, is painful to the conscious patient and should therefore be avoided.<sup>52,59</sup>

As the injured pelvis is addressed, a search for extra-pelvic sources of haemorrhage continues as most patients in this group will have at least one associated injury. In fact, 30% of the time bleeding is from extra-pelvic sources.<sup>25</sup> Obvious injuries found on physical examination during primary and secondary survey are addressed according to ATLS guidelines. AP chest X-ray is obtained along with ultrasound evaluation of the pericardium to exclude intra-thoracic injury.

Abdominal injury is the associated injury that most substantially affects patient outcome, and its diagnosis is difficult in the hypotensive patient with pelvic fractures.<sup>39</sup> The presence of intra-abdominal haemorrhage can be evaluated by ultrasound, diagnostic peritoneal lavage (DPL) and/or CT scanning. When performed by properly accredited staff as part of the Focused Assessment with Sonography for Trauma (FAST), abdominal ultrasound is a rapid and accurate means of diagnosing haemoperitoneum and should serve as the primary screen-

ing modality in the emergency department.<sup>11,17,85,88,102,103</sup> Additionally, it may be repeated for serial assessment of the patient after transfer to an angiography suite or intensive care unit (ICU). Supra-umbilical diagnostic peritoneal lavage (DPL) may be used in cases of equivocal ultrasound findings, which may be caused by anatomic distortions of the retroperitoneum from injury, or to differentiate haemoperitoneum from uroperitoneum, as between 4% and 8% of patients with pelvic fracture will have an associated bladder injury.<sup>121</sup> Used alone in this patient population however, DPL is associated with a high number of false positive results, non-therapeutic laparotomy and negative impact on outcome.<sup>39,54,65</sup> Those identified to have significant *haemoperitoneum* by FAST and/or DPL are transferred to the OR for pelvic fixation and abdominal exploration and treatment of associated injuries. At laparotomy, pelvic packing as described by Ertel et al. may be attempted to affect tamponade of haemorrhage after skeletal fixation has been achieved. This has met with some success in those patients who are too unstable for immediate transport to angiography.<sup>40,93</sup> However, direct ligation of bleeding pelvic vessels should not be attempted as results have been universally poor.<sup>84,124</sup>

Although highly sensitive and specific for intra-abdominal bleeding, haemodynamic instability limits the use of CT scan in this patient population. In fact, for those able to undergo pelvic CT angiography, this modality may be more sensitive for arterial injury than catheter based angiography.<sup>4,101</sup> A contrast blush may be seen in up to 10% patients with pelvic fractures undergoing CT and the size of this blush or presence of a large pelvic haematoma may predict those who will benefit from TAE;<sup>12,13,18,23,82,101</sup> however, the need for angiography should be based on the patient's haemodynamic status and transfusion burden as described below.

The initial management of unstable pelvic fracture depends on the haemodynamic status of the patient after resuscitative measures have been employed. The majority of patients will cease bleeding after appropriate resuscitation and pelvic stabilisation and this may select for those who now have effective tamponade of their pelvic venous bleeding. However, up to 76% of patients who have persistent haemodynamic instability despite resuscitation with two units PRBC/FFP, pelvic compression and exclusion of associated injuries, will have arterial bleeding and should undergo angiography if *immediately* available.<sup>2,39,82</sup> The success rate of TAE when bleeding is identified in the setting of pelvic fracture has been reported to be 85–100% and has a reasonable safety profile.<sup>42,125</sup> TAE appears to work by stopping arterial bleeding and allowing the haematoma to tamponade the venous component of haemorrhage. Early angiography, especially when performed within 3 h of admission in this subgroup of patients, appears to confer a survival advantage and it may be assumed that this benefit derives from rapid cessation of arterial bleeding and checked transfusion needs.<sup>2,39,82,89</sup> However, this requires experienced interventional radiologists with “at-ready” angiography suites which concomitantly serve as surrogate ICUs and are staffed/equipped as such, not to mention the transport of critically ill patients between sites. The importance of early communication and coordination between specialties cannot be overemphasised and multi-disciplinary clinical pathways with alert rosters developed for this purpose have been shown to improve patient outcomes.<sup>5,11</sup> TAE must be considered a *part* of the ongoing resuscitative efforts under the “damage control” doctrine and as such must control haemorrhage while minimising intervention/insult. However, mean time between admission and TAE has been reported to be 10 h and run-times for TAE can average over 90 min (between 50 and 150 min in one study).<sup>43,82</sup> If the patient remains haemodynamically

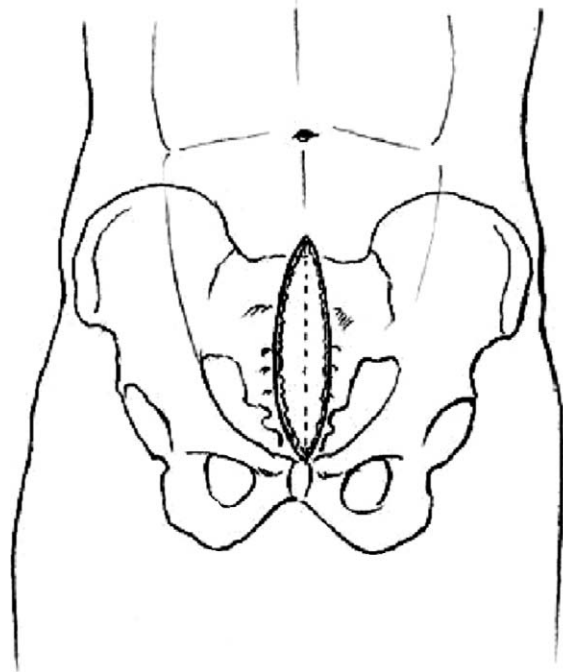


Fig. 3. Illustration of preperitoneal pelvic packing: incision in relation to symphysis pubis and umbilicus.

unstable despite a “quiet or negative” angiogram, this implies venous bleeding or missed injury, in which case urgent laparotomy with pelvic packing and/or preperitoneal pelvic packing (PPP) as described below, should be performed. Some also advocate immediate pelvic venogram to rule out iliac vein injury.<sup>71,82,89</sup>

Recurrent arterial haemorrhage may occur after successful TAE or after normal initial angiogram as evidenced by continued transfusion needs. This is more likely in patients who had multiple arterial injuries on initial angiogram (and therefore larger insult) and may be the result of release of vessels from vasospasm during further resuscitation and warming. Alternatively, it may be caused by dislodgement of the embolisation material. Recurrence is associated with significant increases in morbidity and mortality, and patients at high risk should have an arterial sheath left in place for 48–72 h to be restudied if signs of haemorrhage recur.<sup>51,109</sup>

In cases when angiography is not readily available, the unstable patient should then be taken urgently to the OR where skeletal fixation of the pelvis is performed. In small series, PPP of the pelvis as described by Cothren et al. and Totterman et al. has been shown to stabilise the patient, buying valuable time until angiography is available or obviating the need for angiography altogether.<sup>25,123</sup> In short, a 6–8 cm mid-line incision is made from the symphysis pubis extending cranially (Fig. 3). The linea alba is incised and the peritoneum left intact. The pelvic haematoma encountered here has often dissected the pre-peritoneum and prevesical space to the presacral region. After delivering the haematoma, three surgical laparotomy sponges are placed on each side of the true pelvis below the pelvic brim (Figs. 4 and 5). The fascia and skin are then closed and the packs removed after 24–48 h. For patients requiring concurrent laparotomy, the incisions are kept separate. Total time for packing procedure should be less than 20 min.<sup>115</sup> Intrapelvic infections appear to be the major complication.<sup>25,123</sup> After PPP and associated injuries have been addressed, the patient should be transported

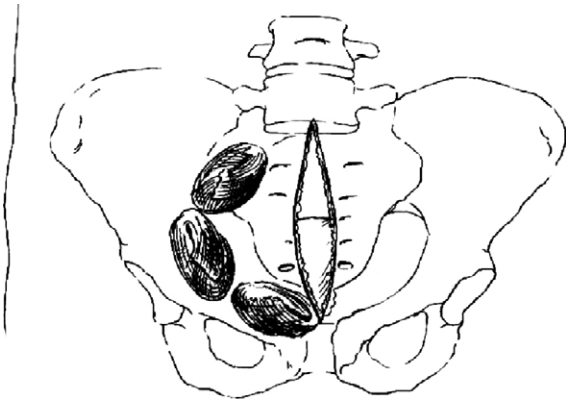


Fig. 4. Illustration of pre-peritoneal packing: placement of laparotomy sponges.

to the angiography suite for “follow-on” angiography and TAE if necessary.

Packing is standard technique in damage control surgery to control bleeding in situations such as massive liver trauma when ligation is difficult or impossible and the patient is haemodynamically compromised. Trans-abdominal retroperitoneal pelvic packing, in which surgical sponges are placed in the paravesical and presacral space, has been used with some success in cases of “torrential” haemorrhage despite surgical fracture reduction.<sup>40,93</sup> When used in a similar fashion, PPP may serve as a temporising measure and may actually rescue up to 1/3 of patients who have hypotension caused solely by venous bleeding. Moreover, it compares favorably to trans-abdominal retroperitoneal pelvic packing and may spare the patient unnecessary laparotomy and its physiological consequences. The majority of these patients will still have arterial haemorrhage that will continue unabated by packing alone. Therefore, patients who demonstrate persistent hypotension and/or transfusion requirements after PPP or retroperitoneal pelvic packing will need TAE for definitive arterial control.

PPP may “bridge” patients to TAE, either when TAE is not available or delayed, the patient requires operation to address associated injuries (i.e., craniotomy, thoracotomy, and/or laparotomy) and/or the patient will not tolerate transport to the angiography suite. Before TAE is performed for definitive control of arterial bleeding, PPP may increase systolic blood pressure and thus reduce transfusion requirements and stabilise



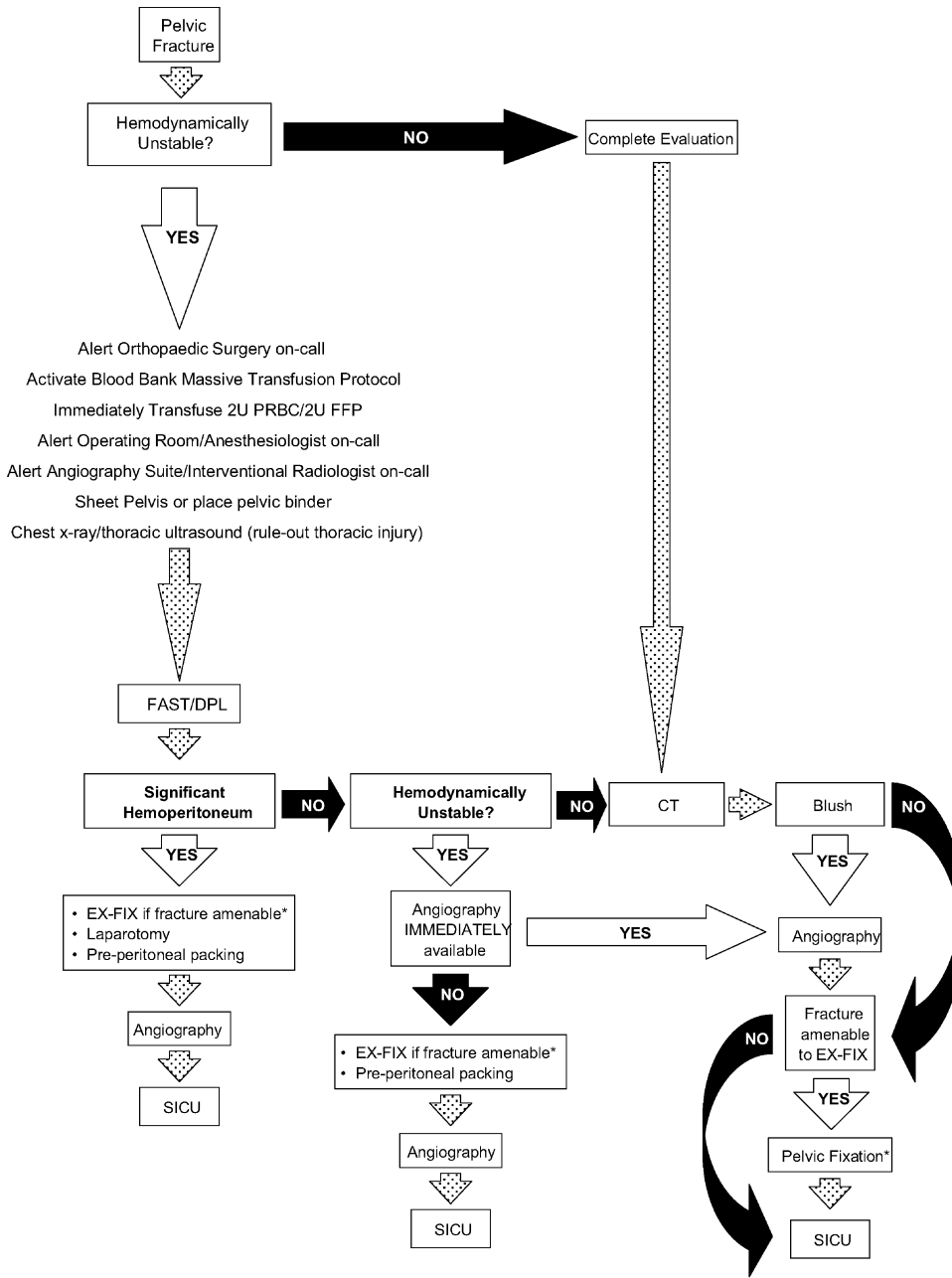
Fig. 5. Radiograph of pelvis after preperitoneal pelvic packing.

the patient in the interim.<sup>25,123</sup> The positive effect of PPP on haemodynamic stability may be the result of controlling the venous component of dual venous/arterial pelvic injuries. Since combined injuries are common, PPP may therefore complement TAE.<sup>71,123</sup> The effect of these therapies may then stay the benefit derived from early angiography in those with unstable pelvic fractures and simultaneous intra-abdominal and pelvic haemorrhage thus making immediate exploratory laparotomy with PPP the unequivocal choice.<sup>39</sup> Because angiography is not universally available, PPP should be considered before transport of patients with unstable pelvic fractures to tertiary care centres.

Patients with unstable pelvic fracture are at risk of developing abdominal compartment syndrome (ACS). This can result from retroperitoneal haematoma, associated abdominal injuries and/or massive resuscitation and is a predictor for both MOF and mortality.<sup>8</sup> Up to one-third of all patients who undergo damage control laparotomy develop ACS and those with combined injuries to the abdomen and pelvis have a significantly higher incidence and more rapid onset of ACS compared to those with isolated injuries.<sup>41,87</sup> The amount of crystalloid volume infused into the patient prior to ICU admission is an independent risk factor for ACS and this appears to be an early phenomenon in the shock resuscitation process beginning in the trauma bay.<sup>6,7</sup> Furthermore, retroperitoneal packing may also increase the risk of ACS and require repacking at decompression<sup>40</sup>; however, no cases were reported with PPP.<sup>25,123</sup> ACS in the setting of damage control laparotomy is most often related to primary fascial closure at completion of initial operation. In these cases, the abdominal fascia is routinely left open by any of several techniques (i.e., Bogata Bag, Wound VAC<sup>®</sup>). Additionally, monitoring of intra-abdominal pressure is mandatory in any patient who has undergone damage-control laparotomy as well as high volume resuscitation and when elevated, prompt decompression is performed even in the absence of overt physiological consequences.

In summary, to improve survival of haemodynamically unstable patients with pelvic fracture, haemorrhage must be stopped expeditiously. All patients with suspected unstable pelvic fracture should be managed by a multi-disciplinary team at a Level I trauma centre. Pelvic compression is attempted before transfer to tertiary centre and is most easily accomplished by sheeting the pelvis. Damage control resuscitation is begun early and monitored through serial base deficits and blood lactate levels. Associated injuries are rapidly identified and treated and the abdomen is screened by FAST for intraperitoneal blood. Patients requiring operation undergo definitive skeletal fixation based on fracture type and either retroperitoneal pelvic packing or PPP. If laparotomy is required, the abdominal fascia is left open at the conclusion of the operation. If no associated injuries are identified during secondary survey, the response to initial resuscitation and pelvic compression is measured; those who remain haemodynamically unstable or continue to require blood/blood products should undergo immediate angiogram with TAE for pelvic arterial bleeding. If angiography is not immediately available, PPP may stabilise the patient in the interim. Stable patients proceed to CT angiography and if large pelvic haematoma or contrast blush is seen are then triaged based on haemodynamic status to angiography. Patients presenting *in extremis* should undergo immediate pelvic stabilisation and laparotomy with retroperitoneal pelvic packing. All patients with unstable pelvic fractures should be monitored for ACS and decompressed when necessary. Clinical pathways (Fig. 6) have been shown to reduce mortality and should be developed by all centres which treat unstable pelvic fractures.

Pelvic Fracture Key Clinical Pathway



\*Pelvic binder (placed low across trochanters) also acceptable for short-term application

Fig. 6. Flow diagram for multi-disciplinary clinical pathway for pelvic fractures.

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