A PRACTICE MANAGEMENT GUIDELINE FOR THE
MANAGEMENT OF PELVIC HEMORRHAGE IN PELVIC FRACTURE

EAST Practice Parameter Workgroup

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I. Statement of Problem

The problem of pelvic hemorrhage in the face of pelvic fracture after trauma is a broad and difficult topic to address directly. There is a myriad of variations which preclude a direct assessment of the clinical situation. For this reason, the topic was honed down to three core questions.

1. Which patients warrant early external stabilization?
2. Which patients warrant pelvic angiography and possible embolization?
3. Which patients warrant urgent or emergent laparotomy?

II. Process

A. Identification of References

A computerized search of the world's literature was undertaken using Medline extending back to 1970 using the key words "pelvic fracture". The 459 citations were identified. The abstract for each was reviewed, and all papers having possible applicability to the guideline topic were retrieved and reviewed. General reviews, letters to the Editor, single case reports, and retrospective reviews of poor quality were excluded. This left 35 manuscripts which were felt to have sufficient merit to form the basis for the guidelines. These manuscripts were then specifically reviewed and categorized as Class I, II, or III references.

III. Recommendations

A. Level I

There are no Level I references upon which level I recommendations can be made.

B. Level II

1. Which patients with pelvic fracture warrant early external stabilization?
   a. Patients with evidence of unstable fractures of the pelvis associated with hypotension should be considered for some form of external pelvic stabilization.
   b. Patients with evidence of unstable pelvic fractures who warrant laparotomy should receive external pelvic stabilization prior to laparotomy incision.

2. Which patients warrant angiography and possible embolization?
   a. Patients with a major pelvic fracture who have signs of on-going
bleeding after non-pelvic sources of blood loss have been ruled out should be considered for pelvic angiography and possible embolization.

b. Patients with major pelvic fracture who are found to have bleeding in the pelvis which can not be adequately controlled at laparotomy should be considered for pelvic angiography and possible embolization.

c. Patients with evidence of arterial extravasation of intravenous contrast in the pelvis by computed tomography should be considered for pelvic angiography and possible embolization.

3. Which patients with pelvic fracture warrant urgent or emergent laparotomy?

a. Patients with hypotension and gross blood in the abdomen or evidence of intestinal perforation warrant emergent laparotomy. The diagnostic peritoneal tap appears to be the most reliable diagnostic test for this purpose.

b. Urgent laparotomy is warranted for patients who demonstrate signs of continued intra-abdominal bleeding after adequate resuscitation, or evidence of intestinal perforation.

C. Level III

1. Which patients with pelvic fracture warrant early external stabilization?

a. Patients with evidence of unstable fractures of the pelvis not associated with hypotension but who do require a steady and ongoing resuscitation should be considered for some form of external pelvic stabilization.

2. Which patients warrant angiography and possible embolization?

a. There are no level III recommendations.

3. Which patients with pelvic fracture warrant urgent or emergent laparotomy?

a. There are no level III recommendations.
IV. Scientific Foundation

A. General

There are five essential body cavities into which a patient can lose a large volume of blood, the chest, the abdomen, the retroperitoneum, the muscle compartments, and the injury scene. The techniques avail to assess blood loss into the chest and abdominal cavities, the muscle compartments and at the scene are reasonably rapid and accurate, but the retroperitoneum has remained obscure. It is well recognized that there is a poor correlation between the architecture of the pelvic fracture and the need for emergency hemostasis, and the plain film radiograph can only be interpreted in light of dynamic and potentially difficult clinical decision making. The consequences of an incorrect assessment are considerable, as celiotomy for the sole indication of pelvic fracture hemorrhage control following blunt trauma is almost never the wisest choice. On the eve of the advent of pelvic angiography, Hawkins et al well summarized the current state of the management options for hemorrhage associated with pelvic fractures. In their own series of 192 patients with pelvic fractures from 1966-1969, 35 required laparotomy for hemorrhage or intra-abdominal injury. Seven of the patients (20%) died, and massive hemorrhage and transfusion requirements appears to have been the primary mortal factor in each. In the discussion, Hawkins iterates well the concern of “becoming involved with massive bleeding deep in the pelvis” as a major reason why surgeons were so loath to undertake laparotomy in this situation, and so dissatisfied with the efficacy of hypogastric artery ligation, that it was recommended to transfuse 20 units of blood before embarking on operative intervention. They outlined six parameters upon which to base the decision for laparotomy: 1) Evidence of intraperitoneal bleeding or visceral perforation, 2) intraperitoneal bladder rupture, 3) the size of a palpable expanding suprapubic hematoma, 4) location and severity of the trauma, 5) x-ray evidence of bony fragments within the pelvis, and 6) blood loss exceeding 2500 cc that can not be attributed to the associated injuries. As the authors lamented that they had no original suggestions to improve controlling deep pelvic bleeding, they re-emphasized the two critical questions that remain with us today: First, is laparotomy indicated, and second, how is bleeding deep in the pelvis best managed?

B. Which patients with pelvic fracture warrant early stabilization?

There are three basic types of pelvic stabilization to be considered; non-invasive techniques, external stabilization, and internal stabilization. Non-invasive techniques appear to be most appropriate for use in the trauma receiving area on patients found to have unstable pelvic fractures. The current popular options include the use of a
military anti-shock trouser (MAST), the use of a bed sheet tied tightly around the pelvis as manual reduction of the pelvic fracture is performed, or the use of proprietary devices specifically designed and marketed for such use. These options should be considered as temporizing measures bridging the gap from injury to more definitive stabilization.

The application of an external fixating device should be considered as early as possible in the treatment of unstable pelvic fractures associated with hypotension, and may be performed in the trauma receiving area, operating room, or intensive care unit, depending on the institution and the patient’s associated injuries. When the anterior external fixation device is being applied, the bridging bars should be placed inferiorly, that is over the groin area rather than over the lower abdomen to allow access into the abdomen should laparotomy be necessary. If laparotomy is to be performed in the presence of an unstable pelvic fracture, the external fixation device should ideally be placed prior to the initial skin incision as the anterior abdominal wall does contribute to limiting the degree of anterior pubic diastasis, and the pelvic volume will increase if the pelvis is not stabilized prior to the midline incision.

Internal stabilization should be considered definitive in nature and as such should be reserved for patients who have demonstrated hemodynamic stability. Possible scenarios for which exceptions might be made and early internal stabilization performed may include the open book pelvic fracture with pubic symphysis diastasis who has remained warm and hemodynamically stable through laparotomy, or the lateral compression or malgaigne fractures which remain unstable in spite of external fixation and angiography intervention.

The reason as to why pelvic stabilization is effective in promoting hemodynamic stability in patients with unstable pelvic fractures has not been fully elucidated. It was formerly believed that reducing the pelvis back to its normal conformation reduced pelvic volume, and therefore limited the amount of blood loss to the retroperitoneal pelvic hematoma. Further, keeping the pelvic volume small promoted tamponade of the bleeding sources in the pelvis. Current popular opinion favors a concept that returning the bony pelvic components back into apposition allows the hemostatic pathways to control venous bleeding from small vessels and raw bony surfaces. Maintaining them in stable, non-moving apposition prevents clot dislodgement, re-initiation of the thrombotic process, and consumption of clotting factors. It seems likely aspects of all these theories are correct.

C. Which patients warrant angiography and possible embolization?

The first report by Margolies in 1972 on the use of angiography in the management of pelvic fracture associated hemorrhage represented a fundamental change in the approach to pelvic fracture associate
hemorrhage. The frustration with the inadequacies of direct operative exposure and ligation of bleeding sources deep in the pelvis are well conveyed by Hawkins, Fleming, and Rothenberger, and their manuscripts are worth reviewing. The addition of selective angiography and embolization to the armamentarium represented an entirely new modality in the treatment of bleeding secondary to pelvic fracture and rapidly became widespread. Initially, angiography was reserved for those patients who, after initial resuscitation and pelvic immobilization, demonstrated signs of ongoing bleeding without an apparent source. (It should be remembered that computed tomography was still a new modality as well, and lacked the resolution to identify bleeding sources.) The successes of the early experiences lead to broader indications and earlier use of angiography. However, attempts to identify fracture patterns which would be predictive of arterial injuries in the pelvis were unsuccessful.

As the resolution power of computed tomography improved, CT developed the ability to identify arterial extravasation of intravenous contrast. The recognition of this fact in the pelvis has moved angiography out of the empiric and diagnostic role to a more strictly therapeutic role.

D. Which patients with pelvic fracture warrant urgent or emergent laparotomy?

The indications for laparotomy in the face of pelvic fracture and hypotension remain the same indications for laparotomy in the absence of pelvic fracture, predominantly intra-abdominal hemorrhage and perforation of the gastro-intestinal tract. This discussion focuses on the issue once other sources of hypotension have been ruled out, such as tension pneumothorax, pericardial tamponade, hypovolemia, and volume resuscitation has been initiated.

There are four modalities available to help decide if the hypotensive patient with a pelvic fracture warrants laparotomy to control hemorrhage; diagnostic peritoneal lavage, diagnostic peritoneal tap, ultrasound, and computed tomography.

The use of diagnostic peritoneal lavage to diagnose surgical intra-abdominal bleeding has been demonstrated to be inaccurate based on traditional parameters of a positive lavage in patients with pelvic fracture. Diapedesis of the red blood cells across the peritoneal renders a high percentage of false positive results. However, basing the decision on the findings of a supra-umbilical diagnostic peritoneal tap is sufficiently accurate to be an appropriate triage tool. In the absence of 5-10 cc of gross blood on the tap, the decision to explore should be based on other diagnostic modalities, which may include the microscopic assessment of the lavage effluent for evidence of intestinal perforation.

The use of ultrasound in the form of the focused assessment for the sonographic examination of the trauma patient (FAST) continues to
evolve, and the literature of the impact of pelvic fracture on the accuracy of FAST is limited. In 1999, Ballard reported 70 patients with pelvic fractures who were evaluated with FAST, 35 which involved the pelvic ring.\textsuperscript{14} Overall, the FAST had an sensitivity of 24\%, specificity of 100\%, and an accuracy of 81\%. The positive predictive value was 1.0 (based on four true positive and no false positive studies) and the negative predictive value was 0.8. Even more significant as the fact that 10 of the 13 patients with false negative studies had pelvic ring fractures. Four required laparotomy, and one patient died, although the authors do not comment whether this death is related to the false negative study. Ultrasound does not appear to be ideal diagnostic modality in the presence of fractures of the pelvic ring.

With strong emphasis on the caveat that the CT scan is not a tool for diagnosis in the acutely hypotensive or unstable patient, computed tomography is highly accurate in identifying intra-abdominal, retroperitoneal, and pelvic blood and active bleeding.\textsuperscript{15,32}

V. Summary

Hypotension associated with major pelvic fractures continues to represent one of the most challenging injury patterns to address. In conjunction with the potential associated injuries, a straightforward outline to the therapeutic options or treatment algorithm becomes so complex as to not be useful in practice. The fundamental issues in addressing hypotension and hemorrhage associated with pelvic fracture have remained constant, however. First, is laparotomy indicated, and second, how is bleeding deep in the pelvis best managed. Based on the review of the literature, the decision for laparotomy should be based on the traditional signs of intra-abdominal bleeding or intestinal perforation. The suprumbilical diagnostic peritoneal tap appears to be the most reliable test for intra-abdominal hemorrhage which requires laparotomy. Perforation would be addressed through the microscopic evaluation of the lavage fluid. Management of pelvic hemorrhage appears best managed by initial stabilization of the pelvic bones with re-apposition of the fracture followed by pelvic angiography and possible embolization based on the response to pelvic stabilization.

VI. Future Investigations

A. Future investigations comparing protocols of external fixation versus angiography seem impractical considering the myriad of fracture patterns which can occur. Prospective randomized trials would require overwhelming time and numbers.

B. The use of FAST in patients with major pelvic fracture.

The diagnostic phase would be considerably simplified if ultrasonic signs could be identified which had high predictive value for either identifying
those patients who require laparotomy, or those who do not.

C. Placement of external fixation devices in the trauma recieving area by the trauma surgeon.

The placement of an external fixation device in the trauma recieving area by the trauma surgeon may allow a more rapid restoration of pelvic, and therefore, hemodynamic stability, and may obviate the need for the orthopaedic surgeon to emergently respond to all but the most severe of pelvic boney injuries.
VIII. Bibliography

20. Flint LM, Brown A, Richardson JD, Polk HC: Definitive control of bleeding from
severe pelvic fractures. Annals of Surgery 1979;189:709-716


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<tr>
<th>Reference Title</th>
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<tr>
<td>Margolies MN</td>
<td>1972</td>
<td>First Author</td>
<td>Pelvic Fx &amp; Bleeding</td>
<td>Arteriography in the management of hemorrhage from pelvic fractures. Report of 3 cases of pelvic fracture in which arteriography with pelvic embolization was used to arrest bleeding from pelvic fracture. The high morbidity and mortality of these cases was ascribed to the late decision for embolization. The management in the remaining 2 cases was successful with double vertical fractures. Angiography was only useful if stabilization and treatment were given to control bleeding. The overall mortality was 26%. The specific indications for the use of each modality were not discussed.</td>
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<tr>
<td>Slätis P</td>
<td>1972</td>
<td>First Author</td>
<td>Pelvic Fx &amp; Bleeding</td>
<td>Double vertical fractures of the pelvis. A review which encompassed 538 patients. The study group consisted of 92 patients. A report of management scheme for hemodynamically unstable pelvic fractures or hemodynamically stable pelvic fracture patients with blood transfusion requirements of 2 to 3 units of packed cells. It was the use of angiographic embolization to control pelvic bleeding once intraoperatively stable pelvic fracture patients with pelvis transfusion requirements of 2 to 3 units of packed cells were approached for management. The authors suggest that their data supports the belief that the majority of pelvic fracture bleeding comes from the cancellous bone, and therefore should respond to reapproximation and stabilization, with angiography being required only in a minority of cases.</td>
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<tr>
<td>Huittinen VM</td>
<td>1973</td>
<td>First Author</td>
<td>Pelvic Fx &amp; Bleeding</td>
<td>Post mortem angiography and dissection of the hypogastric artery in pelvic fractures. The authors performed 27 post mortem angiographies and identified contrast extravasation in 23 cases. Only 3 involved named branches of the hypogastric artery. The authors suggest that their data supports the belief that the majority of pelvic fracture bleeding comes from the cancellous bone, and therefore should respond to reapproximation and stabilization, with angiography being required only in a minority of cases.</td>
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<td>Panetta T</td>
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<td>First Author</td>
<td>Pelvic Fx &amp; Bleeding</td>
<td>Percutaneous transcatheter embolization for massive bleeding from pelvic fractures. A report of a management scheme for hemodynamically unstable pelvic fractures or hemodynamically stable pelvic fracture patients with blood transfusion requirements of 2 to 3 units of packed cells. It was the use of angiographic embolization to control pelvic bleeding once intraoperatively stable pelvic fracture patients with pelvis transfusion requirements of 2 to 3 units of packed cells were approached for management. Embolization successfully controlled bleeding in 87% of the patients. Of the 11 deaths in the series, 3 did not respond to pelvic embolization. The authors suggest that their data supports the belief that the majority of pelvic fracture bleeding comes from the cancellous bone, and therefore should respond to reapproximation and stabilization, with angiography being required only in a minority of cases.</td>
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<td>Moreno C</td>
<td>1986</td>
<td>First Author</td>
<td>Pelvic Fx &amp; Bleeding</td>
<td>Hemorrhage associated with major pelvic fracture. A review which encompassed 538 patients. The study group consisted of 92 patients. A report of management scheme for hemodynamically unstable pelvic fractures or hemodynamically stable pelvic fracture patients with blood transfusion requirements of 2 to 3 units of packed cells. It was the use of angiographic embolization to control pelvic bleeding once intraoperatively stable pelvic fracture patients with pelvis transfusion requirements of 2 to 3 units of packed cells were approached for management. Angiography was only used if stabilization and laparotomy failed to control bleeding. The authors performed 27 post mortem pelvic angiographies and identified contrast extravasation in 23 cases. Only 3 involved named branches of the hypogastric artery. The authors suggest that their data supports the belief that the majority of pelvic fracture bleeding comes from the cancellous bone, and therefore should respond to reapproximation and stabilization, with angiography being required only in a minority of cases.</td>
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Pelvic Fx & Bleeding

Evers BM
1989
Pelvic fracture hemorrhage.

A retrospective multiple regression analysis correlating outcome with severity of injury in patients with pelvic fractures. 226 patients were reviewed with a 7.6% mortality and only a single death due to hemorrhage.  Regression analysis showed pelvic fracture patients with pelvic fractures. 226 patients were reviewed with a 7.6% mortality and only a single death due to hemorrhage.  Regression analysis showed pelvic fracture patients were more accurate when negative and a strong indicator of life threatening intra-abdominal hemorrhage when grossly positive. Microscopic positive DPL was unlikely to reflect intra-abdominal hemorrhage as a source of hemodynamic instability. They suggest that supraumbilical DPL drive the therapeutic protocol. When grossly positive the patient should have immediate laparotomy with placement of an external fixation device either during or after laparotomy and the patient undergo pelvic angiography if the hemodynamic instability persists or if a large retroperitoneal hematoma is identified at laparotomy. When the supraumbilical is grossly negative, whether microscopically positive or negative, patients should undergo initial placement of an external fixation device followed by pelvic angiography. The study demonstrated that the vast majority of patients with severe bleeding from pelvic fractures will stop bleeding with progressive resuscitation including blood products and pelvic stabilization. The study demonstrated that the vast majority of patients with severe bleeding from pelvic fractures will stop bleeding if managed with a protocol which first employed pelvic stabilization in the form of MAST or external fixation of the pelvis. Ten patients required further treatment with angiography to control arterial bleeding. The study demonstrated that the vast majority of patients with severe bleeding from pelvic fractures will stop bleeding if managed with a protocol which first employed pelvic stabilization in the form of MAST or external fixation of the pelvis. Ten patients required further treatment with angiography to control arterial bleeding. These patients were managed with a protocol which first employed pelvic stabilization in the form of MAST or external fixation of the pelvis. Ten patients required further treatment with angiography to control arterial bleeding. These patients were managed with a protocol which first employed pelvic stabilization in the form of MAST or external fixation of the pelvis. Ten patients required further treatment with angiography to control arterial bleeding. These patients were managed with a protocol which first employed pelvic stabilization in the form of MAST or external fixation of the pelvis. Ten patients required further treatment with angiography to control arterial bleeding. These patients were managed with a protocol which first employed pelvic stabilization in the form of MAST or external fixation of the pelvis. Ten patients required further treatment with angiography to control arterial bleeding.

Flint L
1990
Definitive control of mortality from severe pelvic fracture.

A report of 279 patients with pelvic fractures, of whom 42 met criteria for severe bleeding. These patients were managed with a protocol which first employed pelvic stabilization and involved patients with pelvic fracture of whom 42 met criteria for severe hemorrhage. They suggest that supraumbilical DPL drive the therapeutic protocol. When grossly positive the patient should have immediate laparotomy with placement of an external fixation device either during or after laparotomy and the patient undergo pelvic angiography if the hemodynamic instability persists or if a large retroperitoneal hematoma is identified at laparotomy.

Poole GV
1991
Pelvic fracture from major blunt injury.

A retrospective multiple regression analysis correlating outcome with severity of injury in patients with pelvic fractures. 236 patients were reviewed with a 7.6% mortality and only a single death due to hemorrhage.  Regression analysis showed pelvic fracture patients were more accurate when negative and a strong indicator of life threatening intra-abdominal hemorrhage when grossly positive. Microscopic positive DPL was unlikely to reflect intra-abdominal hemorrhage as a source of hemodynamic instability. They suggest that supraumbilical DPL drive the therapeutic protocol. When grossly positive the patient should have immediate laparotomy with placement of an external fixation device either during or after laparotomy and the patient undergo pelvic angiography if the hemodynamic instability persists or if a large retroperitoneal hematoma is identified at laparotomy.

Conclusion

Pelvic fracture hemorrhage.

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<tr>
<td>Ghanayem AJ</td>
<td>1995</td>
<td>The effect of laparotomy and external fixator stabilization on pelvic volume in an unstable pelvic injury.</td>
<td>II</td>
<td>This study performed in non-embalmed cadavers assessing pelvic volume in a cadaveric study in which unilateral open-book pelvic ring injuries were created in 5 fresh cadaveric specimens and the pelvic volume measured for the intact pelvis, disrupted pelvis with both a laparotomy incision opened and closed, and disrupted pelvis stabilized and reduced using an external fixator with the laparotomy incision closed. The average volume increase between a non-stabilized pelvis with the abdomen closed and then subsequently opened was 15%, or 423 cc. The average volume increase between a stabilized and reduced pelvis and non-stabilized pelvis, both with the abdomen open, was 26% or 692 cc. The public diastasis increased from 3.9 to 9.3 cm in a non-stabilized pelvis with the abdomen closed and then subsequently opened. Application of a single-pin anterior-frame external fixator reduced the pubic diastasis anatomic and reduced the average pelvic volumes to within 3-8% of the initial volume. They concluded the intact abdominal wall has a somewhat stabilizing effect on pelvic fracture, and the pelvis should be stabilized prior to laparotomy incision. A cadaveric study in which unilateral open-book pelvic ring injuries were created in 5 fresh cadaveric specimens and the pelvic volume measured for the intact pelvis, disrupted pelvis with both a laparotomy incision opened and closed, and disrupted pelvis stabilized and reduced using an external fixator with the laparotomy incision closed. The average volume increase between a non-stabilized pelvis with the abdomen closed and then subsequently opened was 15%, or 423 cc. The average volume increase between a stabilized and reduced pelvis and non-stabilized pelvis, both with the abdomen open, was 26% or 692 cc. The public diastasis increased from 3.9 to 9.3 cm in a non-stabilized pelvis with the abdomen closed and then subsequently opened. Application of a single-pin anterior-frame external fixator reduced the pubic diastasis anatomic and reduced the average pelvic volumes to within 3-8% of the initial volume. They concluded the intact abdominal wall has a somewhat stabilizing effect on pelvic fracture, and the pelvis should be stabilized prior to laparotomy incision.</td>
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<tr>
<td>Moss MC</td>
<td>1996</td>
<td>Volume changes within the true pelvis during disruption of the pelvic ring.</td>
<td>II</td>
<td>Using a model of cadaver pelvis with balloon in the true pelvis to measure volume, fractures were simulated by opening the symphysis pubis to measure volume by specified distances and measuring the volume. Similar measurements were made with varying sacroiliac joint and combined symphysis/sacroiliac joint separations. They concluded that changes in the pelvic volume resulting from pelvic fractures were much smaller than previously reported. Volume changes in the pelvis resulting from pelvic fractures were much smaller than previously reported.</td>
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<td>Bassam D</td>
<td>1998</td>
<td>A protocol for the initial management of unstable pelvic fractures.</td>
<td>II</td>
<td>A review of the protocol-driven management of 15 patients with pelvic fracture after abdominal bleeding had been treated or excluded. Anterior fractures underwent external fixation and posterior fractures underwent angiography. Bleeding was primarily abdominal, and measuring the volume of volume by measuring the volume of pelvic blood. Measurements were made with various sacroiliac joint and combined symphysis/sacroiliac joint separations. They concluded that changes in the pelvic volume resulting from pelvic fractures were much smaller than previously reported. Volume changes in the pelvis resulting from pelvic fractures were much smaller than previously reported.</td>
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<td>Vrahas MS</td>
<td>1998</td>
<td>Comparison of fixation methods for preventing pelvic ring expansion.</td>
<td>II</td>
<td>Three methods of internal fixation and external fixation were compared in a cadaveric study. Wh ile open intra-peritoneal -fixation provided the most reliable control of pelvic expansion, pour of the 6 non -explored patients died as compared to 2 of the 5 explored patients. A small case series of 11 patients with pelvic crush injuries, 5 of whom were underw...</td>
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<td>Stephen DJG</td>
<td>1999</td>
<td>Early detection of arterial bleeding in acute pelvic trauma.</td>
<td>II</td>
<td>A review of 111 patients who (1) underwent CT scan within 24 hrs of admission, (2) had an abdominal injury score greater than 3, and (3) had greater than 20% of blood loss attributable to pelvic fracture. The presence of a high density blush of contrast on an abdominal CT scan greater than the e...</td>
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<td>1970</td>
<td>Laparotomy at the time of pelvic fracture.</td>
<td>III</td>
<td>A review of 192 patients with pelvic fractures of whom 35 underwent exploratory laparotomy. 30 had surgically correctable intraperitoneal injuries. 20 of the 35 underwent laparotomy without injury. 7 patients died, of whom 6 had a systolic BP of less than 100 and a mean transfusion requirement of 22.4 units of blood. They concluded that laparotomy was based on DPL results. Only 5 patients underwent laparotomy for...</td>
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<td>Control of hemorrhage in pelvic crush injuries.</td>
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<td>A small case series of 11 patients with pelvic crush injuries, 5 of whom were underw...</td>
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<td>Value of the G suit in patients with severe pelvic fracture.</td>
<td>Batalden DJ</td>
<td>1974</td>
<td>III</td>
<td>A report of 7 patients. 6 of whom had combined internal/external fixation. 4 died due to large bone fragments and angiographic embolization for small bone vessels. The failure of patients to respond promptly suggests unusual bleeding which warns.</td>
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<td>Selective arterial embolization for control of traumatic pelvic hemorrhage.</td>
<td>van Urk H</td>
<td>1978</td>
<td>III</td>
<td>A technical manuscript describing what was, at the time, a revolutionary new modality. It described the potential efficacy of performing pelvic angiography and embolization.</td>
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<td>Rothenberger DA</td>
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<td>Flint LM</td>
<td>1979</td>
<td>III</td>
<td>A review of 22 patients with severe pelvic trauma and experimental hemorrhage occurred in only 1% of the study group but 8% of the mortality.</td>
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<td>Pelvic disruption in the polytraumatized patient.</td>
<td>McMurtry R</td>
<td>1980</td>
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<td>A technical manuscript describing what was, at the time, a revolutionary new modality. It described the potential efficacy of performing pelvic angiography and embolization.</td>
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<td>Kam J</td>
<td>1981</td>
<td>Vascular injuries in blunt pelvic trauma.</td>
<td>III</td>
<td>A review of 69 blunt trauma patients with pelvic fractures. The posterior ring fractures were associated with unstable injuries and dissections required more blood transfusions in the first 24 hours. The authors concluded that the pelvis fractures were unstable in 4 of 69 blunt trauma patients with pelvic fractures. The authors were unable to correlate angiographic findings to the mechanism of injury or fracture pattern. The authors were unable to correlate angiographic findings to the mechanism of injury or fracture pattern.</td>
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<td>Namm NH</td>
<td>1983</td>
<td>Major pelvic fractures.</td>
<td>III</td>
<td>A review of 102 patients of whom only 11 had major hemorrhage. The authors conclude that MAST, external fixation, and angiography were useful in management of these patients.</td>
</tr>
<tr>
<td>Gordon RL</td>
<td>1984</td>
<td>Control of massive retroperitoneal bleeding associated with pelvic fractures by angiographic embolization.</td>
<td>III</td>
<td>A review of 243 consecutive patients with pelvic fractures. Pelvic fractures were classified based on the Pennel and Sutherland classification scheme and correlated with blood replacement. Patients with unstable fractures had blood loss greater than 4 units by 50 and 70% of the time. Patients with stable fractures required less than 4 units by 50 and 70% of the time. The authors concluded that the pelvic fractures were unstable in 4 of 243 consecutive patients with pelvic fractures. Pelvic fractures were unstable in 4 of 243 consecutive patients with pelvic fractures.</td>
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<td>Diagnosis and treatment of retroperitoneal hematoma in multiple trauma patients.</td>
<td>III</td>
<td>A review of 20 patients with arterial pelvic bleeding complicating pelvic fracture who underwent pelvic arteriography and embolization. Patients underwent arteriography after failing to achieve hemodynamic stability with aggressive volume resuscitation or without laparotomy. The 9 survivors had a mean time interval to angiography of 7 days. The 11 patients who died received 30.7% more blood in transfusion than the 5 who survived.</td>
</tr>
<tr>
<td>Gruen GS</td>
<td>1994</td>
<td>The acute management of hemodynamically unstable multiple trauma patients with pelvic ring fractures.</td>
<td>III</td>
<td>A review of 312 patients with pelvic fractures seen over a 5 year period. External fixation was used in 66 patients. In 10 of these 66 patients, subsequent angiography was not useful. 8 patients underwent angiography if hemodynamic instability persisted despite volume resuscitation for 24 hours. The paper demonstrated that unstable pelvic fractures can be successfully managed without the use of external fixation.</td>
</tr>
<tr>
<td>Poole GV</td>
<td>1994</td>
<td>Causes of mortality in patients with pelvic fractures.</td>
<td>III</td>
<td>A review of 348 patients with pelvic fractures, 90 of whom were mechanically unstable. External fixation was used in 66 patients. In 10 of these 66 patients, subsequent internal fixation was necessary even though external fixation allowed the internal fixation to develop. Of the 10 patients who died, only 3 had arterial bleeding present.</td>
</tr>
<tr>
<td>Díezcomayo JC</td>
<td>1994</td>
<td>Pelvic Fx &amp; Bleeding</td>
<td>III</td>
<td>Pelvic Fx &amp; Bleeding</td>
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<td>First Author</td>
<td>Year</td>
<td>Reference Title</td>
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<tr>
<td>Agolini SF</td>
<td>1997</td>
<td>Arterial embolization in pelvic fracture. III A review of 806 patients with pelvic fractures managed with an algorithm utilizing early angiography on hemodynamically unstable patients. 35 patients underwent angiography and 15 required embolization. There was a 100% success rate with embolization.</td>
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<tr>
<td>Perez JV</td>
<td>1998</td>
<td>Angiographic embolization in pelvic fracture. III A 10 year review of 721 patients with pelvic fractures of whom 8 patients underwent angiography and 15 required embolization. There was a 100% success rate with embolization.</td>
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**Conclusion**

Arterial embolization is a rapid and effective technique for controlling pelvic fracture hemorrhage.