PRACTICE MANAGEMENT GUIDELINES FOR HEMORRHAGE IN PELVIC FRACTURE

The EAST Practice Management Guidelines Work Group:

J. Christopher DiGiacomo, MD¹, John A. Bonadies, MD², Frederic J. Cole, M.D.³, Lawrence Diebel, M.D.⁴, William S. Hoff, M.D.⁵, Michele Holevar, M.D.⁶, John Malcynski, M.D.⁷, Thomas Scalea, M.D.⁸

¹ Nassau University Medical Center
² Hospital of Saint Raphael
³ Eastern Virginia Medical Center
⁴ Detroit Receiving Hospital
⁵ Brandywine Hospital and Trauma Center
⁶ Mount Sinai Hospital
⁷ Robert Wood Johnson School of Medicine
⁸ R Adams Cowley Shock Trauma Center

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Address for Correspondence and Reprints:

J. Christopher DiGiacomo, M.D.
Nassau University Medical Center
195 Georgia Road
Freehold, NJ 07728
Telephone: 516-572-6703
Fax: 516-572-5140
jdigiaco@numc.edu
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 precludes a direct assessment of the clinical situation. For this reason, the topic was focused on 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

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 Class 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 ongoing 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 cannot 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.

b) The diagnostic peritoneal tap appears to be the most reliable diagnostic test for this purpose. 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 available 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.\textsuperscript{8, 11,22,23,26,27} 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.\textsuperscript{16} 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 appear 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.\textsuperscript{5,7,17,18,21,24} 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.\textsuperscript{6,7,13,31} 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.\textsuperscript{9,10}
Internal stabilization should be considered definitive in nature and as such should be reserved for patients who have demonstrated hemodynamic stability.\textsuperscript{13,31} 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.\textsuperscript{10} Further, keeping the pelvic volume small promoted tamponade of the bleeding sources in the pelvis.\textsuperscript{3} 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.\textsuperscript{12} 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.\textsuperscript{1} The frustration with the inadequacies of direct operative exposure and ligation of bleeding sources deep in the pelvis are well conveyed by Hawkins,\textsuperscript{16} Fleming,\textsuperscript{17} and Rothenberger,\textsuperscript{20} 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\textsuperscript{19} 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.\textsuperscript{2,3,5,7,21-23} (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\textsuperscript{4,25,26} and earlier use of angiography.\textsuperscript{4,6,11,25,28-30} However, attempts to identify fracture patterns that would be predictive of arterial injuries in the pelvis were unsuccessful.\textsuperscript{8,11,22,23,26,27}

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.\textsuperscript{11,15,30,32,34,35}

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. 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, retro-peritoneal, and pelvic blood and active bleeding.

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 supra-umbilical 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 that 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 receiving area by the trauma surgeon. The placement of an external fixation device in the trauma receiving area by the trauma surgeon may allow a more rapid restoration of pelvic, and therefore, hemodynamic stability, and may obviate the need for the orthopedic surgeon to emergently respond to all but the most severe of pelvic bony injuries.
VII. References


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PELVIC FRACTURE WITH HEMORRHAGE: EVIDENTIARY TABLE

<table>
<thead>
<tr>
<th>First Author</th>
<th>Year</th>
<th>Reference Title</th>
<th>Class</th>
<th>Conclusion</th>
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<tbody>
<tr>
<td>Margolies MN</td>
<td>1972</td>
<td>Arteriography in the management of hemorrhage from pelvic fractures.</td>
<td>II</td>
<td>Report of 3 cases of pelvic fracture in which arteriography with pelvic embolization was used to control bleeding. The high morbidity and mortality of these cases was attributed to the late decision for embolization.</td>
</tr>
<tr>
<td>Slätis P</td>
<td>1972</td>
<td>Double vertical fractures of the pelvis.</td>
<td>II</td>
<td>Report of 245 patients with pelvic fractures. DPL was used in 36 patients to diagnose the condition.</td>
</tr>
<tr>
<td>Huittinen VM</td>
<td>1973</td>
<td>Post mortem angiography and dissection of the hypogastric artery in pelvic fractures.</td>
<td>II</td>
<td>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 re-approximation and stabilization, with angiography being required only in a minority of cases.</td>
</tr>
<tr>
<td>Panetta T</td>
<td>1985</td>
<td>Percutaneous transcatheter embolization for massive bleeding from pelvic fractures.</td>
<td>II</td>
<td>A report of 72 post mortem pelvic angiographies. DPL was extremely 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. The authors suggest that supraumbilical DPL drive the therapeutic protocol. When grossly positive the patient should undergo immediate angiography with a pelvic catheter to control pelvis bleeding. The overall mortality was 25%.</td>
</tr>
<tr>
<td>Moreno C</td>
<td>1986</td>
<td>Hemorrhage associated with major pelvic fracture.</td>
<td>II</td>
<td>A review of 538 patients. MAST controlled hemorrhage in 71% of patients in whom it was used, and external fixation controlled 95% of the patients. The study group consisted of 92 patients who required greater than 6 units of packed red cells. Angiography was only used in 2 patients who did not respond to other modalities. The authors present their experience with the use of each modality for the control of pelvic hemorrhage. The overall mortality was 11%.</td>
</tr>
<tr>
<td>Evers BM</td>
<td>1989</td>
<td>Pelvic fracture hemorrhage.</td>
<td>II</td>
<td>A review of 245 patients with pelvic fractures. DPL was used in 36 patients to diagnose the condition.</td>
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**Additional Notes:**
- Double vertical fractures of the pelvis were reviewed by Slätis in 1972, with a focus on the management and results of 163 patients, including 71% who had concomitant abdominal injuries. The authors report that 100 patients received between two and 30 units of blood within the first 24 hours. Eighty-four of the 90 patients who received between 2 and 9 units of blood had pelvic bleeding as a major source. The overall mortality was 25%. The authors suggest that immediate angiography with a pelvic catheter is needed to control bleeding. Only 4 of the 10 patients who required more than 10 units of blood had a pelvic source of bleeding. The high morbidity and mortality of these cases was attributed to the late decision for embolization. The authors suggest that supraumbilical DPL drive the therapeutic protocol. When grossly positive the patient should undergo immediate angiography with a pelvic catheter to control pelvic bleeding. The overall mortality was 25%. |
First Author | Year | Reference Title | Class
--- | --- | --- | ---
Flint L | 1990 | Definitive control of mortality from severe pelvic fracture. | II
Poole GV | 1991 | Pelvic fracture from major blunt trauma. | II
Ghanayem AJ | 1995 | The effect of laparotomy and external fixator stabilization on pelvic volume in an unstable pelvic injury. | II
Moss MC | 1996 | Volume changes within the true pelvis during disruption of the pelvic ring. | II
Bassam D | 1998 | A protocol for the initial management of unstable pelvic fractures. | II
Ghanayem AJ | 1999 | Pelvic fracture from major blunt trauma. | II

Conclusion

- Definitive control of mortality from severe pelvic fracture.
- Pelvic fracture from major blunt trauma.
- The effect of laparotomy and external fixator stabilization on pelvic volume in an unstable pelvic injury.
- Volume changes within the true pelvis during disruption of the pelvic ring.
- A protocol for the initial management of unstable pelvic fractures.
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<tr>
<th>Reference Title</th>
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<th>Author</th>
<th>Time of Pelvic Fracture</th>
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</table>
| Pressure-volume characteristics of the intact and disrupted pelvic retroperitoneum. | II | 1998 | Grimm | 30
| Comparison of fixation methods for preventing pelvic ring expansion. | II | 1998 | Vrahas MS | 9999
| An algorithm to reduce the incidence of false negative FAST. | II | 1999 | Ballard RB | 9898
| Early detection of arterial bleeding in acute pelvic trauma. | II | 1999 | Stephen DJG | 9999
| Laparotomy at the time of pelvic fracture. | III | 1970 | Hawkins L | 9710

**Conclusion**

- The numbers are too small to validate the unity of the specificity or positive predictive value.
- The authors concluded that CT contrast embolization and ductal blush of contrast are equally effective for predicting which patients would eventually require angiographic embolization.
- A review of 111 patients who underwent CT within 24 hrs of admission, had abdominal injury scores greater than three, and had greater than 20% of blood loss attributable to pelvic hemorrhage.
- A review of 192 patients with pelvic fractures of whom 35 underwent exploratory laparotomy. 30 had surgically correctable injuries. 20 of the 35 underwent laparotomy based on DPL results. Only 5 patients had surgically correctable injuries. Of the 20 patients who required surgery, 5 patients died, of whom 4 had systolic BP of less than 100 and a mean transfusion requirement of 22 units of PRBC. They concluded that laparotomy should not be performed if there is no evidence of intra-abdominal pathology.
- The authors concluded that the inherent difficulty with management of a hemorrhage due to pelvic fracture is at the time of definite rupture of the systemic circulation. They found no correlation between fracture geometry and the need for laparotomy.
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<tr>
<td>Fleming WH</td>
<td>1973</td>
<td>Control of hemorrhage in pelvic crush injuries.</td>
<td>III</td>
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<tr>
<td>Batalden DJ</td>
<td>1974</td>
<td>Value of the G suit in patients with severe pelvic fracture.</td>
<td>III</td>
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<tr>
<td>van Urk H</td>
<td>1978</td>
<td>Selective arterial embolization for control of hemorrhage.</td>
<td>III</td>
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<tr>
<td>Rothenberger DA</td>
<td>1978</td>
<td>Pelvic hematoma: definitive control of severe pelvic fracture.</td>
<td>III</td>
</tr>
<tr>
<td>McMurtry R</td>
<td>1980</td>
<td>Pelvic disruption in the polytraumatized patient.</td>
<td>III</td>
</tr>
<tr>
<td>Kam J</td>
<td>1981</td>
<td>Vascular injuries in pelvic fracture.</td>
<td>III</td>
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</table>

**Conclusion**

A review of 63 patients with pelvic fracture who underwent angiography. The internal iliac and external iliac arteries were assessed, and if found to be normal, the patient was discharged. The authors conclude that angiography is a valuable tool in the management of patients with pelvic fracture. The study suggests that angiography may be helpful in identifying patients at risk for significant bleeding and in guiding surgical interventions. The study also highlights the need for further research into the role of angiography in the management of pelvic fractures.
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<tr>
<td>Namm NH</td>
<td>1983</td>
<td>Major pelvic fractures.</td>
<td>III</td>
<td>A review of 102 patients of whom only 1 had major hemorrhage. This small group had greatly increased blood transfusion requirements. They conclude that MAST, external fixation, and arteriography were useful in management of these patients.</td>
</tr>
<tr>
<td>Gordon RL</td>
<td>1983</td>
<td>Management strategy of vascular injuries associated with pelvic fractures.</td>
<td>III</td>
<td>A review of 243 consecutive patients with pelvic fractures. Pelvic fractures were classified based on the Pennel and Sutherland classifications scheme and correlated with blood replacement. Patients with unstable fractures had blood loss greater than 4 units. The authors conclude that the pelvic fracture classification based on the initial Emergency Department AP x-ray can predict the patient population at risk for massive hemorrhage.</td>
</tr>
<tr>
<td>Hölting T</td>
<td>1992</td>
<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 with or without laparotomy. The 9 survivors had a mean time interval to arteriography of 1 hour and a mean time interval to hemorrhage of 2 hours. The authors conclude that retroperitoneal hematomas associated with pelvic fractures can be successfully managed without surgical intervention.</td>
</tr>
<tr>
<td>Gruen GS</td>
<td>1994</td>
<td>The acute management of hemodynamically unstable multiple trauma patients with pelvic fractures.</td>
<td>III</td>
<td>A review of 312 patients with pelvic fractures seen over a 5 year period. External fixation was not used. Patients underwent pelvic angiography if hemorrhagic instability persisted despite volume resuscitation for 24 hours. This paper demonstrates that unstable pelvic fractures can be successfully managed without surgical intervention. The posterior pelvic fractures were classified based on the response to volume and blood products. Success rates were less than 50% in patients with pelvic fractures who underwent angiography. The authors conclude that pelvic fractures were classified based on the response to volume and blood products.</td>
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<td>Causes of mortality in patients with pelvic fractures.</td>
<td>III</td>
<td>1994</td>
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<td>Angiography prior to pelvic embolization.</td>
<td>III</td>
<td>1996</td>
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<tr>
<td>An 10 year review of 771 patients with pelvic fractures of whom 8 patients underwent angiography and 15 required embolization. There was a 100% success rate with embolization. A review of 806 patients with pelvic fractures managed with angiography utilizing early arteriography on hemodynamically unstable patients with pelvic fracture. 35 patients underwent angiography on hemodynamically unstable patients with pelvic fracture.</td>
<td>III</td>
<td>1997</td>
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<td>A review of 806 patients with pelvic fractures managed with angiography utilizing early arteriography on hemodynamically unstable patients with pelvic fracture.</td>
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<td>Arterial embolization in pelvic trauma.</td>
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<td>1996</td>
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<td>Angiographic pelvic embolization in pelvic trauma.</td>
<td>III</td>
<td>1998</td>
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<td>A review of 66 patients with pelvic fractures of whom 8 patients underwent external fixation. In 10 of these patients, subsequent internal fixation was necessary even though external fixation allowed hemodynamically stable to develop. It provided necessary even though external fixation allowed hemodynamically stable to develop. It provided necessary even though external fixation allowed hemodynamically stable to develop. It provided necessary even though external fixation allowed hemodynamically stable to develop. It provided necessary even though external fixation allowed hemodynamically stable to develop.</td>
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<td>A review of 46 patients with pelvic fractures of whom 8 patients underwent external fixation. In 10 of these patients, subsequent internal fixation was necessary even though external fixation allowed hemodynamically stable to develop. It provided necessary even though external fixation allowed hemodynamically stable to develop. It provided necessary even though external fixation allowed hemodynamically stable to develop. It provided necessary even though external fixation allowed hemodynamically stable to develop.</td>
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