Pelvic Hemorrhage
(Treatment of traumatic and non-traumatic bleeding)

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Nessun conflitto di interessi

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Pelvic Hemorrhage

- TRAUMATIC
- NON TRAUMATIC
Pelvic Hemorrhage

• TRAUMATIC

• NON TRAUMATIC
Pelvic Fracture-Related Hemorrhage

• Over the past 4 decades, angioembolization has revolutionized how we care for trauma patients.

• This modality is over 90% effective in controlling hemorrhage in the abdomen and pelvis from both blunt and penetrating trauma.

• The main applications for angioembolization in trauma patients are of the pelvis, liver, kidneys, and spleen, but this modality has been used for a variety of other injury locations.

Klein EN, Kirton OC. Curr Trauma Rep 2015;1:26–34
### Pelvic Fracture-Related Hemorrhage

- **Like any surgical treatment, variations exist in the indications and techniques** for performing angioembolization in trauma patients.

- **Outcomes differ** as a result of these variations.

- As evidence by the wealth of publications concentrated over the previous decade, **the modality remains in evolution**.

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*Klein EN, Kirton OC. Curr Trauma Rep 2015;1:26–34*
The role of angio-embolization in the acute treatment concept of severe pelvic ring injuries

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KEYWORDS
pelvic fracture
management
mechanical pelvic stabilization
angiography
embolization

ABSTRACT

Background: In recent years a wide variety of strategies to treat the haemodynamically unstable patient with pelvic ring fractures have been proposed. This study evaluates our institutional management of patients with severe pelvic fractures and analyses their outcomes.

Methods: Retrospective review of all severely injured trauma patients with pelvic ring injuries admitted to a level I trauma centre from 2007 to 2012. Patient records were documented prospectively in a trauma database and evaluation was performed by SPSS.

Results: During the study period, a total of 173 patients with pelvic ring fractures were admitted and formed the basis of this study. Overall, 46% of the patients had suffered a type A fracture, 25% a type B fracture and the remaining 29% a type C pelvic ring fracture. Surgical treatment was required in 21% of the patients (pelvic C-clamp, n = 6; supra-pectinal external fixation, n = 32; pelvic packing, n = 12; definitive plate osteosynthesis of the pubis symphysis, n = 6). Angio-embolization was performed in 16 patients (9%). In 8 patients it was the only specific treatment for the pelvic injury on day 6 and in 8 patients it was performed immediately post-operatively. The overall mortality rate was 12.7% (n = 22).

Conclusions: Angiographic embolization as a first-line treatment was only performed in haemodynamically stable patients or in patients responding to fluid resuscitation with the finding of an arterial blush in the CT scan. In haemodynamically unstable patients, pre-pectoral pelvic packing in combination with mechanical pelvic stabilization was immediately carried out, followed by angio-embolization post-operatively if signs of persistent bleeding remained present.

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Introduction

Pelvic fractures represent a significant challenge for the trauma surgeon in terms of life-threat and functional outcome. An increased recognition of pelvic fractures as a marker of injury severity, as well as improved algorithms for resusciation, skeletal fixation, and critical care monitoring, have done much to advance the care of these often severely injured patients [1]. However, mortality still remains significantly high; the overall mortality rate of patients with pelvic fracture ranges between 5-10% [2-6], in haemodynamically unstable pelvic ring fractures it is up to 50% [7-9] and in patients with open pelvic fractures as high as 70% [10,11].

While in recent years a wide variety of strategies to treat the haemodynamically unstable patient with pelvic fractures have been proposed [2,12-20], there is still no clear consensus as to the best management strategy for these patients. Basically, two different fundamental treatment modalities have been advocated to address persistent haemodynamic instability due to pelvic fractures: angiography with sequential embolization controlling arterial hemorrhage versus pelvic packing, which mainly controls venous bleeding and bleeding from the fracture sites. However, the establishment of gold standard treatment guidelines is difficult due to the associated multisystem injury pattern in these patients. Recently, our group published our institutional management algorithm for patients with severe pelvic fractures, basically describing the integration of angio-embolization into the early clinical treatment protocol based on the contrast media extravasation in the initial CT-scan [18]. This study evaluates our management decisions in patients with severe pelvic fractures, in particular in the light of the current controversy with regards to the optimal emergent treatment, and analyses their outcomes.

Patients and methods

After approval by the Institutional Review Board, we retrospectively reviewed all severely injured trauma patients with pelvic ring injuries admitted to the Hosp University Frankfurt/Main from January 2007 to January 2012.
**Primary Survey according to ATLS®**

Anteroposterior X-Ray of chest and pelvis, FAST, Blood gas analysis
Intubation, large-bore i.v. access, decompression of chest/pericard
Fluid resuscitation (crystalloids, PRBC), mechanical pelvic stabilization (pelvic binder)

- "non-responder"
  - Emergency operation

- "transient-responder"
  - Re-Evaluation
    - Multislice CT with contrast media
      - No contrast blush
        - ICU or required surgical procedures (osteosynthesis / pelvic packing)
      - Contrast blush
        - Angio-Embolization

- "responder"
  - Re-Evaluation

Pelvic Fracture-Related Hemorrhage

Controlling Pelvic Fracture-Related Hemorrhage

Pelvic stabilization should be the first maneuver for controlling pelvic fracture-related hemorrhage.

There are multiple options for controlling pelvic-fracture related hemorrhage.

1. Pelvic immobilization (pelvic binder, a C-clamp, or external fixation) decreases the pelvic volume, permits tamponade to occur, and allows clot to stabilize, which decreases the bleeding from fractured bony surfaces.

Preperitoneal pelvic packing has been popular in Europe for years and is now gaining support in American trauma centers.

2. Along with angioembolization, these techniques have overlapping and complementary, but sometimes competing roles in controlling pelvic fracture-related hemorrhage.

In adults, pelvic stabilization controlled hemorrhage in 85% of patients, and angioembolization controlled hemorrhage in all the remaining patients.
Primary Survey according to ATLS®

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ICU or required surgical procedures (osteosynthesis / pelvic packing)
Contrast blush on CT scan is 82% sensitive and 95% specific in diagnosing pelvic fracture-related hemorrhage that requires intervention.

Contrast **blush on CT** scan is **82% sensitive** and **95% specific** in diagnosing pelvic **fracture-related hemorrhage** that requires intervention.


La serenità della **Venere di Botticelli** diventa sublime atarassia accanto all’urlo di dolore della **Medusa di Caravaggio**, ancora grondante di sangue e dallo sguardo pieno di orrore.
Contrast blush on CT scan is 82\% sensitive and 95\% specific in diagnosing pelvic fracture-related hemorrhage that requires intervention. 

Especially in the setting of hemodynamic instability, contrast blush on CT scan is highly predictive of arterial extravasation on angiography.

Nonetheless, some hemodynamically unstable patients will present with a pelvic fracture without associated hematoma or contrast blush on CT scan, yet still demonstrate extravasation on angiography and can frequently benefit from angioembolization.

Sacroiliac joint disruption and duration of hypotension were each found to be independent predictors of contrast extravasation on angiogram.

Furthermore, even patients with stable pelvic fracture patterns (AP type I, LC type I/II) may have arterial injuries on angiography, especially those with signs of ongoing hemorrhage.
Much of the pelvic vasculature is intimately associated with bone, and pelvic fractures can lead to vascular injuries.

Simply opening the retroperitoneum to search for an injured vessel can result in a loss of tamponade and uncontrolled hemorrhage, which can worsen shock, and can lead to the lethal triad of hypothermia, acidosis and coagulopathy, or secondary brain injury. Worst of all, this bloody exploration may still not allow for definitive control of hemorrhage.

The location of contrast blush and large pelvic hematomas on CT can be used to predict the injured artery and guide selective embolization.

<table>
<thead>
<tr>
<th>Fracture</th>
<th>Artery</th>
</tr>
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<tbody>
<tr>
<td>Sacroiliac joint</td>
<td>Iliolumbar artery</td>
</tr>
<tr>
<td>Sacrum</td>
<td>Lateral sacral artery</td>
</tr>
<tr>
<td>Iliac bone</td>
<td>Superior gluteal artery</td>
</tr>
<tr>
<td></td>
<td>Inferior gluteal artery</td>
</tr>
<tr>
<td>Acetabulum</td>
<td>Obturator artery</td>
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<tr>
<td></td>
<td>Superior gluteal artery</td>
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<tr>
<td></td>
<td>Inferior gluteal artery</td>
</tr>
<tr>
<td>Pubic rami</td>
<td>Internal pudendal artery</td>
</tr>
<tr>
<td></td>
<td>Obturator artery</td>
</tr>
</tbody>
</table>

Hallinan JT, Tan CH, Pua U. Clin Radiol 2014;69:529–537
Cerva Jr DS et al. AJR Am J Roentgenol 1996;166:131–135
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"non-responder"*

Emergency operation

"transient-responder"

Multislice CT with contrast media

"responder"

Contrast blush

Angio-Embolization

ICU or required surgical procedure (osteosynthesis / pelvic packing)

* If the patient’s systolic blood pressure remains less than 90 mmHg despite PRBC transfusion.
Management of hemodynamically unstable pelvic trauma: results of the first Italian consensus conference (cooperative guidelines of the Italian Society of Surgery, the Italian Association of Hospital Surgeons, the Multi-specialist Italian Society of Young Surgeons, the Italian Society of Emergency Surgery and Trauma, the Italian Society of Anesthesia, Analgesia, Resuscitation and Intensive Care, the Italian Society of Orthopaedics and Traumatology, the Italian Society of Emergency Medicine, the Italian Society of Medical Radiology -Section of Vascular and Interventional Radiology- and the World Society of Emergency Surgery)

Stefano Magnone1, Federico Coccolini2, Roberto Manfredi1, Dario Piazzalunga1, Roberto Agazzi2, Claudio Arci3, Marco Barozzi1, Giovanni Bellanova1, Alberto Belluzzi2, Giorgio Berti2, Walter Biffi1, Stefania Camagni5, Luca Campanati5, Claudio Carlo Castello8, Fausto Catena5, Osvaldo Chiara10, Nicola Colaianni1, Salvatore De Masì11, Salomone Di Saverio12, Giuseppe Dodi13, Andrea Fabbrini14, Giovanni Faustinelli5, Giorgio Gambale15, Michela Giuli Capponi1, Marco Lotti1, GianMarino Marchesi16, Alessandro Massé17, Tiziana Mastropietro1, Giuseppe Nardi18, Raffaella Niola19, Gabriela Elisa Nita1, Michele Pisano1, Elia Polarsin1, Eugenio Polettì1, Antonio Rampoldi18, Sergio Ribaldi17, Gennaro Ripoli12, Luigi Rizzo10, V alter Sonzogni19, Gregorio Tugnoli20 and Luca Antelmi1

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Management of hemodynamically unstable pelvic trauma: results of the first Italian consensus conference (cooperative guidelines of the Italian Society of Surgery, the Italian Association of Hospital Surgeons, the Multi-specialist Italian Society of Young Surgeons, the Italian Society of Emergency Surgery and Trauma, the Italian Society of Anesthesia, Analgesia, Resuscitation and Intensive Care, the Italian Society of Orthopaedics and Traumatology, the Italian Society of Emergency Medicine, the Italian Society of Medical Radiology - Section of Vascular and Interventional Radiology and the World Society of Emergency Surgery)

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t, Gregorio Tugnolo
t, and Luca Ansaldi
t.

11 Societies... SIRM (SVIR)

41 Authors... 3 Interventional Radiologist

Hemodynamically UNSTABLE PELVIC TRAUMA ALGORITHM

Legend
- FAST: focused assessment sonography for trauma
- PPP: preperitoneal pelvic packing
- OR: operating room
- Ex Fix: external fixation
- ER: emergency room

PELVIC BINDER and FAST

FAST +
↓
OR
Ex Fix (if possible) + PPP + Laparotomy

Ex Fix (if possible) + PPP + Laparotomy

UNSTABLE

ANGIO

FAST -
↓
Ex Fix (if possible) + PPP
OR or ER

UNSTABLE

STABLE
CT Scan

UNSTABLE

ANGIO

NO BLUSH
BLUSH
OR for EX Fix if not done

ICU

TC + → Angio ?
TC + → Angio ?
TC + → Angio?
È NEGATIVA?
ANDIAMO A CASA?
TC + → Angio ?
TC + \rightarrow \text{Angio}?
TC + → Angio ?
TC + \rightarrow \text{Angio} +
TC $\rightarrow$ Angio $+$

GLUE
TC + \rightarrow \text{Angio +}
TC + \rightarrow \text{Angio} -
TC + → Angio -
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COSA AVRESTE FATTO?
TC + \rightarrow Angio -
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Ex Fix (if possible) + PPP

FAST -
\downarrow
Ex Fix (if possible) + PPP

OR or ER

FAST still -

CT Scan

STABLE

UNSTABLE

ANGIO

NO BLUSH

BLUSH

ANGIO

+ -

But if ongoing bleeding?

OR for EX Fix if not yet done

ICU
TC - → Angio?

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+ -?
**Hemodynamically UNSTABLE PELVIC TRAUMA ALGORITHM**

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**UNSTABLE**
- FAST:
  - FAST +: PELVIC BINDER and FAST
  - FAST -:
    - Ex Fix (if possible) + PPP
    - OR or ER
- OR:
  - Ex Fix (if possible) + PPP + Laparotomy

**STABLE**
- CT Scan:
  - NO BLUSH:
    - ICU
  - BLUSH:
    - ANGIO
      - NO CT
      - ANGIO
  - But if ongoing bleeding?

**UNSTABLE**
- FAST still -:
  - OR or ER
  - Ex Fix if still not done

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Management of hemodynamically unstable pelvic trauma: results of the first Italian consensus conference (cooperative guidelines of the Italian Society of Surgery, the Italian Association of Hospital Surgeons, the Multi-specialist Italian Society of Young Surgeons, the Italian Society of Emergency Surgery and Trauma, the Italian Society of Anesthesia, Analgesia, Resuscitation and Intensive Care, the Italian Society of Orthopaedics and Traumatology, the Italian Society of Emergency Medicine, the Italian Society of Medical Radiology - Section of Vascular and Interventional Radiology - and the World Society of Emergency Surgery)

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Statements about Angiography

1. After non-pelvic sources of blood loss have been ruled out, patients with pelvic fractures and hemodynamic instability or signs of ongoing bleeding should be considered for pelvic AG/embolization. [GoR A, LoE III]

2. Patients with CT-scan demonstrating arterial intravenous contrast extravasation in the pelvis, may require pelvic AG and embolization regardless of hemodynamic status. [GoR A, LoE III]

3. After non pelvic sources of blood loss have been ruled out, patients with pelvic fractures who have undergone pelvic AG with or without embolization, with persisting signs of ongoing bleeding, should be considered for repeat pelvic AG/embolization [GoR B, LoE IV]
When patients have persistent hemorrhage after pelvic stabilization, preperitoneal pelvic packing seems to be more effective at controlling pelvic fracture-related hemorrhage than angioembolization, but this could be a result of the fact that angioembolization was performed an average of 85 min later than preperitoneal pelvic packing.

Delay in pelvic embolization has been shown to negatively affect patients because of ongoing blood loss.

Admission during the night is associated with a 90-min delay in angioembolization for pelvic fractures, and this delay is estimated to nearly double the mortality.

Stefano Magnone1*, Federica Dini1, Marco Barozzi2, Giovanni Bella, Luca Camporota3, Claudio Carli2, Salomone Di Savino4, Giuseppe Filz5, Michela Giulii Capponi1, Marco Gattuso6, Giuseppe Nardi8, Raffaella Nava, Antonio Rampoldi9, Sergio Rinaldo3, and Luca Ansaldi1.
In 2000, Velmahos described the **damage-control technique of nonselective bilateral internal iliac artery embolization using gelfoam**. This was used to provide temporary occlusion:

1. when the hemorrhage source was diffuse from multiple branches bilaterally;
2. when hemodynamic lability prevented selecting multiple branches for embolization;
3. when the patient required continued transfusion after apparently successful subselective embolization.

In this series, overall **success was 90%** and included repeat angioembolization in two thirds of patients in whom it initially failed.

*Nonselective bilateral internal iliac artery embolization should be the procedure of choice in hemodynamically unstable patients.*

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**Anterior–posterior compression fractures** place patients at increased risk for bilateral posterior arterial injuries, **even when only unilateral blush is seen on CT scan**.

These patients **should undergo bilateral internal iliac artery angiograms**.

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Klein EN, Kirton OC. *Curr Trauma Rep* 2015;1:26–34

The use of subselective embolization should be limited to hemodynamically stable patients.

Klein EN, Kirton OC. *Curr Trauma Rep* 2015;1:26–34
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- ER: emergency room

But if ongoing bleeding?

Ex Fix (if possible) + PPP
OR or ER

FAST +

FAST -

NO CT

PELVIC BINDER
and FAST

FAST +

FAST -

OR

Ex Fix (if possible) + PPP + Laparotomy

UNSTABLE

ANGIO

CT Scan

CT Scan

STABLE

UNSTABLE

ANGIO

NO BLUSH

BLUSH

OR for Ex Fix if yet done

Yes

No

Yes

No

ICU

Coexistence of hemoperitoneum and a pelvic fracture in a hemodynamically unstable trauma patient creates a difficult decision for the surgeon.

Angioembolization is effective in controlling pelvic fracture-related hemorrhage and frequently intraperitoneal hemorrhage, but it may not be the quickest method for controlling intraperitoneal hemorrhage.

Even in hemodynamically unstable patients with multicompartiment hemorrhage, angioembolization might benefit patients more than surgery by avoiding further tissue damage and the resulting physiologic insult while effectively controlling hemorrhage.
When having to choose between the operating room for laparotomy or the angiography suite for pelvic embolization, an incorrect decision can have fatal consequences for the patient.

Specialized hybrid operating rooms are being designed to accommodate the multidisciplinary treatment strategies for trauma patients.
**Pelvic Fracture-Related Hemorrhage**

### Angioembolization Complications

**Catheter-related complications** can occur at the access point or from catheter manipulation. These vascular complications are not unique to angiography in trauma patients.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>van der Vlies CH et al. <em>J Trauma Acute Care Surg</em> 2012;73:1208–1212</td>
<td>Pelvic trauma is a known risk for <strong>sexual dysfunction</strong>, and angioembolization has not been shown to increase this complication.</td>
</tr>
<tr>
<td>Ramirez JI et al. <em>J Trauma: Inj Infect Crit Care</em> 2004;56:734–741</td>
<td>Gluteal necrosis has been reported after nonselective internal iliac artery embolization, but this complication does not seem to occur after selective embolization.</td>
</tr>
<tr>
<td>Travis T et al. <em>J Vasc Interv Radiol</em> 2008;19:840–847</td>
<td>Despite multiple reported complications after angioembolization, many could be attributed to the high burden of traumatic injury. When employed to control potentially life-threatening hemorrhage, the frequent benefit surely outweighs the rare risk.</td>
</tr>
<tr>
<td>Auerbach AD et al. <em>J Orthop Trauma</em> 2012;26:290–295</td>
<td><strong>Contrast nephropathy</strong> is a risk of angiography; concomitant hypotension and renal hypoperfusion can exacerbate this risk. Contrast nephropathy is more common in patients with renal injury than with other organ injuries, but it is still transient and resolves in just a few days.</td>
</tr>
<tr>
<td>Yuan KC et al. <em>J Trauma</em> 2009;66:267–270</td>
<td><strong>Coil migration</strong> has been reported as a complication that can contribute to rebleeding after successful embolization.</td>
</tr>
</tbody>
</table>
No randomized controlled trials exist addressing the use of angioembolization in trauma patients.

Despite the lack of guideline consensus and frequent protocol deviations in multiple published studies, no trauma surgeon can dispute the fact that angioembolization has revolutionized the care of trauma patients, especially those with pelvic fracture-related hemorrhage.

As techniques advanced and clinical experience progressed, surgeons and radiologists have attempted to define algorithms and protocols for the optimal applications of angioembolization in trauma patients.
Trading scalpels for sheaths: Catheter-based treatment of vascular injury can be effectively performed by acute care surgeons trained in endovascular techniques

Megan Brenner, MD, MS, Melanie Hoenh, MD, William Teeter, MD,
Deborah Stein, MD, MPH, and Thomas Scalea, MD, Baltimore, Maryland

BACKGROUND: The skill set of the acute care surgeon can be expanded by formal training. We report the first series of traumatic vascular injury (TVI) treated by acute care surgeons trained in endovascular techniques (ACSTEV).

METHODS: We retrospectively reviewed patients admitted to our trauma center with TVI over 5 months who survived for more than 24 hours and had catheter diagnosis and/or therapy by ACSTEV. Demographics, admission data, and outcomes were reviewed. Follow-up ranged from 0 day to 150 days.

RESULTS: Most patients were male (63%) and sustained blunt mechanism (91%). Mean (SD) age was 48.2 (21.9) years, and mean (SD) Injury Severity Score was 32.1 (11.8). Mean (SD) admission systolic blood pressure, heart rate, Glasgow Coma Scale (GCS) score were 126.13 (30.4) mm Hg, 101.21 (28.2) beats per minute, and 10.8 (4.73), respectively. Forty-six patients underwent 48 endovascular procedures for TVI: 32 angiograms and 16 venograms were obtained. Two pelvic angiograms and one aortic arch angiogram were negative and required no treatment. One superficial femoral artery arteriogram showed minor luminal defects requiring angioplasty only. Pseudoaneurysms were found in 17 vessels, vessel transection in 4, active extravasation in 5, stenosis in 1, and dissection with thrombus in 2. Four patients had resuscitative endovascular balloon occlusion of the aorta performed before catheter intervention for pelvic hemorrhage. Procedures included aortic repair (4), pelvic embolization (13), splenic embolization (5), lumbar artery embolization (1), branchial artery embolization (1), profunda artery embolization (1), common carotid artery stent (1), cervical artery stent (1), inferior vena cava filter placement (1) and retrieval (2), and pharmacomechanical thrombolysis (1). Treatment material included coils (12), Gelfoam (4), and nitinol plugs (5). No procedural or device-related complications occurred. Morbidity was 15.7% unrelated to any endovascular procedure. One patient had repeat coil embolization of a pelvic pseudoaneurysm on postoperative Day 7.

CONCLUSION: ACSTEV can safely treat TVI with good success. We performed nearly 10 procedures per month underlining the role of the ACSTEV for managing and care of TVI in a high-volume trauma center. J Trauma Acute Care Surg. 2016;80:783-786. Copyright © 2016 Wolters Kluwer Health, Inc. All rights reserved.

LEVEL OF EVIDENCE: Therapeutic study, level 3.

KEY WORDS: Catheter-based therapy; hemorrhagic shock; pelvic fracture; embolization.

Treatment of vascular injury has evolved significantly during the past several decades. An analysis of the National Trauma Data Bank reported that 8.1% of acute arterial injuries in 2003 were treated with endovascular therapy, compared with only 2.1% in 1994. Nearly an equal number of blunt (55%) and penetrating (45%) injuries were treated with endovascular therapy. The more recent study, also using National Trauma Data Bank data, reported that 16% of traumatic vascular injuries (TVIs) were treated with endovascular therapy, including 20% who were hypotensive at the time of intervention. The authors report decreased mortality with the increased use of endovascular intervention. With advancements in both imaging and device technology, the use of endovascular techniques has become a part of the treatment algorithm for the injury. Historically in trauma, catheter-based therapies have been relegated to consultants, either interventional radiologists or vascular surgeons with formal training in these specialties. There is a role for the expansion of the skill set of the acute care surgeon (ACS) in the diagnosis and treatment of vascular injury by endovascular therapies. The expansion of this skill set by the ACS requires formal training in endovascular techniques. Options for such training include Accreditation Council for Graduate Medical Education (ACGME)-approved vascular surgery fellowships, which have the additional benefit of conferring open vascular skills, or nonaccredited endovascular fellowships at high-volume specialized centers. However, some procedures such as resuscitative endovascular balloon occlusion of the aorta (REBOA) can be performed by the ACS without formal, lengthy endovascular training. This report excludes REBOA and focuses on advanced endovascular skills.

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In most institutions, catheter techniques are performed by interventional radiologists. These individuals are usually quite skilled with catheters, wires, coils, and stents. However, they often have little understanding of the dynamic nature of a patient, particularly one who is actively bleeding. In addition, they are almost never instantly available even during regular business hours, as they have competing priorities as they are pulled to handle interventional tasks all over the medical center.
Introduction of Mobile Angiography into the Trauma Resuscitation Room

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Background: Digital subtraction angiography is frequently required in the initial evaluation of trauma patients. We hypothesized that mobile digital subtraction angiography technology directly into the trauma resuscitation area would save time in restoring metabolic derangements for patients with ongoing hemorrhage.

Material: This is a retrospective review of a cohort of trauma patients treated before and after the direct availability of mobile angiography in the trauma resuscitation room performed by the trauma surgeons. Data collected for comparison included demographics, hemodynamic variables, metabolic factors (pH and temperature), units of blood administered, and outcomes.

Results: Mean age, Shock Index, and Injury Severity Score were similar. The interval from the decision to perform transcatheter arterial embolization (TAE) to starting TAE were significantly different (59 minutes ± 45 minutes vs. 31 minutes ± 11 minutes, p = 0.001). The other resuscitation intervals were similar. The mean Δbody temperature from emergency department arrival through completion of TAE between the two groups were significantly different (−1.18 ± 1.69 vs. −0.08 ± 1.42, p = 0.026). The mean ΔpH from emergency department arrival through completion of TAE were also significantly different (−0.118 ± 0.083 vs. 0.028 ± 0.127, p = 0.001).

Conclusion: There were no significant correlations between Δbody temperature and resuscitation interval, and between ΔpH and resuscitation interval.

Key Words: Trauma, Mobile, Emergency department, Interventional radiology, Transcatheter arterial embolization.

Crowley and others were among the first to describe the “golden hour” as being critical to the outcome of seriously injured patients. The golden hour encompasses the time of initial evaluation, resuscitation, and procedures to control hemorrhage. Although the mainstay of treatment has historically required surgical techniques, interventional angiography is increasingly being utilized as an alternative treatment method, especially when arterial bleeding is located in difficult to control areas such as the liver or pelvis. The recent remodeling of the trauma resuscitation room at Tokyo Medical University Hospital afforded the opportunity to incorporate digital subtraction angiography (DSA) equipment directly into the trauma room.

The objective of this study was to evaluate our working hypothesis that the availability of DSA technology in the trauma resuscitation room would shorten the time to definitive control of hemorrhage in trauma patients. We further hypothesized that this time savings would translate into more rapid reversal of acidosis and hypothermia.

PATIENTS AND METHODS

We obtained the institutional review board approval and written informed consent from each patient or from a guardian before the initiation of any study procedure. We retrospectively reviewed the hospital charts and radiographs of the patients to identify blunt trauma patients who underwent transcatheter arterial embolization (TAE) between January 2001 and December 2006. Until July 2002, the conventional angiography suite (Multistar; Siemens, Tokyo, Japan) was located on the third floor and intensive care unit (ICU) was located on the fifth floor. From August 2002, we rearranged the emergency department (ED) and trauma intensive care unit (TICU) location on the ground floor in our hospital, and arranged the ED which was side by side with TICU as an area designed for radiologic and surgical procedures and installed a mobile DSA device (OEC Series 9800, GE Medical Systems, Tokyo, Japan) into the trauma resuscitation room (Fig. 1). The OEC 9800 is a mobile imaging technology that combines real-time 1k × 1k imaging resolution with a rotating anode X-ray tube and the 15 kW generator. It has operator control panels on both sides of the C-arm chassis conveniently located for operator use. Our ED has two resuscitation tables and one angiography table which is 22 in. wide and 80 in. long that are always ready in the room.

Patients

Patients with a systolic blood pressure less than 90 mm Hg and Shock Index (SI), which is the ratio of heart rate to systolic blood pressure, of more than 1.5 were considered to be in shock. The shock was classified as hypovolemic, distributive, cardiogenic, or unexplained. The data were analyzed using commercial statistical software.

The introduction of mobile angiography into the trauma resuscitation room and the immediate availability of trained trauma surgeons to perform angiographic procedures allowed for a shorter time required to restore normal physiology.

Pelvic Hemorrhage

- TRAUMATIC
- NON TRAUMATIC
Pelvic Hemorrhage

• TRAUMATIC

• NON TRAUMATIC
Non Traumatic Pelvic Hemorrhage

Angioembolization is a safe method for hemostasis of surgical bleeding, even in selected hemodynamically unstable patients.

It is most often used to decrease blood loss and improve success when attempting nonoperative management of hemorrhage, but it can also be used as an adjuvant therapy before, during, or after surgery.

Non Traumatic Pelvic Hemorrhage
Non Traumatic Pelvic Hemorrhage
Non Traumatic Pelvic Hemorrhage
Non Traumatic Pelvic Hemorrhage

Sometimes, we are lucky to find only a **single potential source of hemorrhage**, and implementation of an effective method for hemostasis can save the patient’s life.

In other patients, we find **multiple potential sources** and face the **dilemma** of determining the most significant cavity that must be tackled first.

Klein EN, Kirton OC. *Curr Trauma Rep* 2015;1:26–34
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