

Blush on Computed Tomography and Transcatheter Arterial Embolization in Pelvic Fracture

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Purpose: Bleeding is the primary cause of death after severe pelvic fracture. Transcatheter arterial embolization (TAE) is the mainstay of treatment for arterial bleeding. This study aimed to determine the frequency of bleeding by angiography of blush-positive pelvic fractures on computed tomography (CT) images. The bleeding arteries that were involved were investigated by pelvic angiography.

Methods: This retrospective cohort study evaluated 83 pelvic fracture patients who were treated in the intensive care unit of the author's trauma center between January 01, 2013 and April 30, 2015.

Results: Overall mortality was 9 of 83 patients (10.8%). Blush was observed in 37 patients; blush-positive patients had significantly higher mortality (24.3%) than blush-negative patients (0%). Twenty-four of the 83 patients (28.9%) underwent pelvic angiography. Bleeding was showed in 22 of 24 patients in pelvic angiography. TAE was successfully performed in 21 (95.5%) of the bleeding 22 patients. Angiography was performed in 23 of 37 blush-positive patients, and arterial bleeding was identified in 21 (91.3%). A total 33 bleeding arteries were identified in 22 angiography-positive patients. The most frequent origin of bleeding was internal iliac artery (69.7%) followed by the external iliac artery (18.2%) and lumbar arteries (12.1%).

Conclusion: The vascular blush observed in CT scans indicates sites of ongoing bleeding in pelvic angiography. TAE is an excellent therapeutic option for arterial bleeding and has a high success rate with few complications. [J Trauma Inj 2016; 29: 161-166]

Key Words: Pelvic bones, Fractures, Bone, Hemorrhage, Embolization, Therapeutic

I. Introduction

Despite recent advances in trauma surgery, successful treatment of severe pelvic fractures remains challenging. The overall mortality of pelvic fractures is 5% to 10%, but increases to 60% in patients with hemodynamic instability.(1-3) Recently, several novel treatments have been proposed, including pelvic binders, external fixation, pelvic C-clamps, pelvic

angiography/embolization, pelvic packing, and internal iliac artery ligation as an extreme method.(4) The optimal treatment of hemodynamically unstable pelvic fractures is controversial.

Bleeding is the major cause of death after severe pelvic fracture, and the origin of the bleeding can be arterial, venous or bone-related.(4) Arterial bleeding produces in the most severe hemorrhage and frequently results in hypotension.(5) Transcatheter arte-

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rial embolization (TAE) is the mainstay of the treatment for arterial bleeding, other than internal iliac artery ligation. It is effective and is associated with improved outcome.⁽⁶⁾ A randomized, controlled trial would be the best way to determine the true effect of TAE on mortality of severe pelvic fractures, but cannot be performed because of the severe risk and urgency of treatment. An indirect study is a realistic way to evaluate the role of the TAE in pelvic fracture. The authors investigated arterial bleeding and extravasation rate by comparing CT and conventional angiography via the femoral artery. The distribution of bleeding arteries within the pelvic vasculature was investigated by pelvic angiography.

II. Materials and Methods

This retrospective cohort study evaluated the pelvic fracture patients admitted to the intensive care unit of the authors trauma center between 1 January 2013 to 30 April 2015. Each protocol was reviewed and approved by the institutional review board of Authors medical center. Patients who had been admitted to the general ward, were not evaluated with contrast-enhanced CT, were transferred patients, or refused treatment were excluded. A total of 83 pelvic fracture patients were enrolled in this study and were divided into an angiography group and a non-angiography group for comparison.

The patient variables that were compared were sex, age, in-hospital mortality, initial respiratory rate, initial pulse rate, initial hypotension (systolic blood pressure < 80 mmHg), injury severity score (ISS), initial serum hemoglobin, the number units of packed red blood cells (RBC) transfused in the first 24 hours, evidence of extravasation on pelvic CT (i.e., blush), and the type of posterior pelvic instability. The presence of blush on the pelvic CT was confirmed by a trauma surgeon and radiologist. Posterior pelvic

instability was determined by a trauma surgeon and orthopedic surgeon on the trauma center staff as intact posterior arch, incomplete disruption of the posterior arch, and complete disruption of posterior arch. The bleeding arteries identified by conventional angiography were also investigated.

Continuous data were presented as means \pm standard deviation, unless otherwise noted. Fishers exact test was used to compare differences in nominal and categorical variables, and the Mann-Whitney U test was used to compare differences of continuous variables. A two-tailed p -value < 0.050 was considered statistically significant. All statistical analyses were performed with SPSS 19.0 for Windows (IBM SPSS Inc., Chicago, IL, USA).

III. Results

A total of 24 of the 83 pelvic fracture patients (28.9%) underwent pelvic angiography. Bleeding was showed in 22 of 24 patients in pelvic angiography. TAE was successfully performed in 21 (95.5%) of the bleeding 22 patients. Embolization was tried but could not be conducted in one patient because of a cardiac arrest during the procedure. There was no TAE-related complication. The overall mortality rate was 10.8% (9 of 83 patients). One patient was died of

Table 1. The relationship between the mortality and blush on CT scan and posterior pelvic instability

	Mortality rate	<i>p</i> value
Blush		< 0.01
Positive	9/37 (24.3)	
Negative	0/46 (0)	
Posterior pelvic instability		0.08
Intact arch	1/21 (4.8)	
Incomplete disruption	6/56 (10.7)	
Complete disruption	2/6 (33.3)	

Table 2. The relationship between the posterior pelvic instability and blush in CT scan

	Intact (N=21)	Incomplete (N=56)	Complete (N=6)	<i>p</i> value
Blush				< 0.01
Positive	4 (19)	27 (48.2)	6 (100)	
Negative	17 (81)	29 (51.8)	0 (0)	

hypoxic brain damage after traumatic asphyxia. Two patients had severe abdominal contamination due to intestinal injury, they died of septic shock. Others died of hypovolemic shock. Four preperitoneal pelvic packings were performed during the study period,

but two of the patients were excluded because of absence of a CT scan. The other two were included, underwent TAE and survived. Blush was identified in 37 patients who had significantly higher mortality rate (24,3%) than the blush-negative patients (0%) (Table 1). The mortality rate also increased along with the degree of the posterior pelvic instability but there was no significance (Table 1). Blush-positive patients had significantly more severe posterior pelvic instability than blush-negative patients (Table 2), and significantly more blush-positive than blush-negative patients were hypotensive (Table 3). There were no significant differences between the angiography group and non-angiography groups in sex

Table 3. The relationship between hypotension and blush in CT scan

	Hypotension (N=22)	<i>p</i> value
Blush		< 0.01
Positive	18/22 (81.8)	
Negative	4/22 (18.2)	

Table 4. The comparison between angiography group and non-angiography group

	angiography group (N=24)	non-angiography group (N=59)	<i>p</i> value
Gender (Male, %)	13 (54.2)	34 (57.6)	0.81
Age (year)	49.2 ± 20.7	54.0 ± 19.0	0.31
Posterior pelvic instability			0.01
Intact arch	4 (16.7)	17 (28.8)	
Incomplete disruption	15 (62.5)	41 (69.5)	
Complete disruption	5 (20.8)	1 (1)	
Mortality	7 (29.2)	2 (3.4)	< 0.01
Hypotension	12 (52.2)	8 (13.8)	< 0.01
Injury severity score	27.3 ± 11.9	22.1 ± 8.9	0.03
RBC transfusion (pack)	10.5	1.0	< 0.01
Respiratory rate (number/min)	23.6 ± 6.2	20.5 ± 4.3	0.03
Pulse rate (number/min)	99.2 ± 21.1	94.8 ± 23.1	0.47
Hemoglobin	11.1 ± 2.26	12.1 ± 2.1	0.08

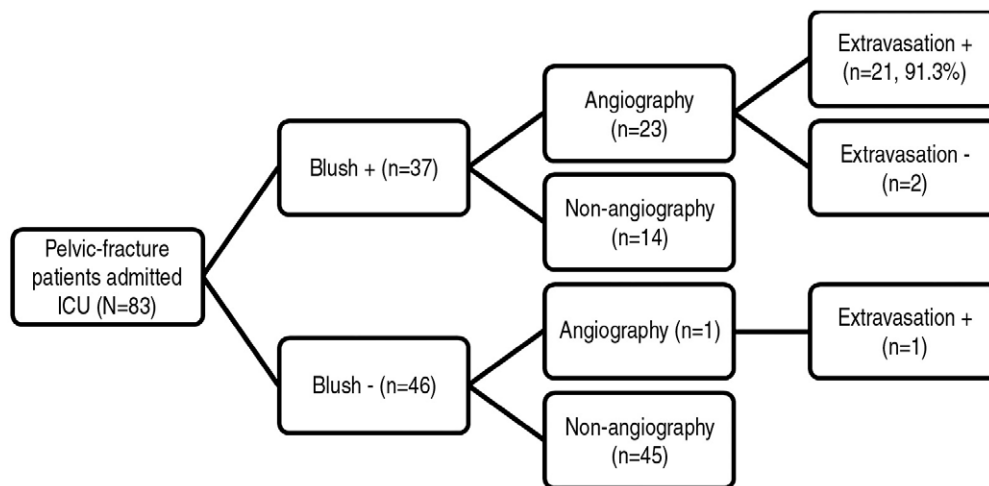


Fig. 1. Angiography was performed for 23 patients of 37 blush-positive patients, and arterial bleeding was identified in 21 patients (91.3%) in the angiography.

ratio, age, pulse rate, or hemoglobin level (Table 4). Complete or incomplete pelvic instability was significantly more frequent in angiography group (83,3%) than in the non-angiography group (70,5%). The mortality rate, hypotension rate, ISS, the number of RBC transfusions, and the respiratory rate were significantly higher in the angiography group than in the non-angiography group (Table 4).

Angiography was performed in 23 of the 37 blush-positive patients, and arterial bleeding was identified during angiography in 21 of the patients (91,3%) (Fig. 1). A total 33 bleeding arteries were identified in 22 angiography-positive patients (Fig. 2). In a blush-negative patient, pelvic angiography was performed because of a large hematoma in front of the left iliac ala fracture. An active arterial bleeding

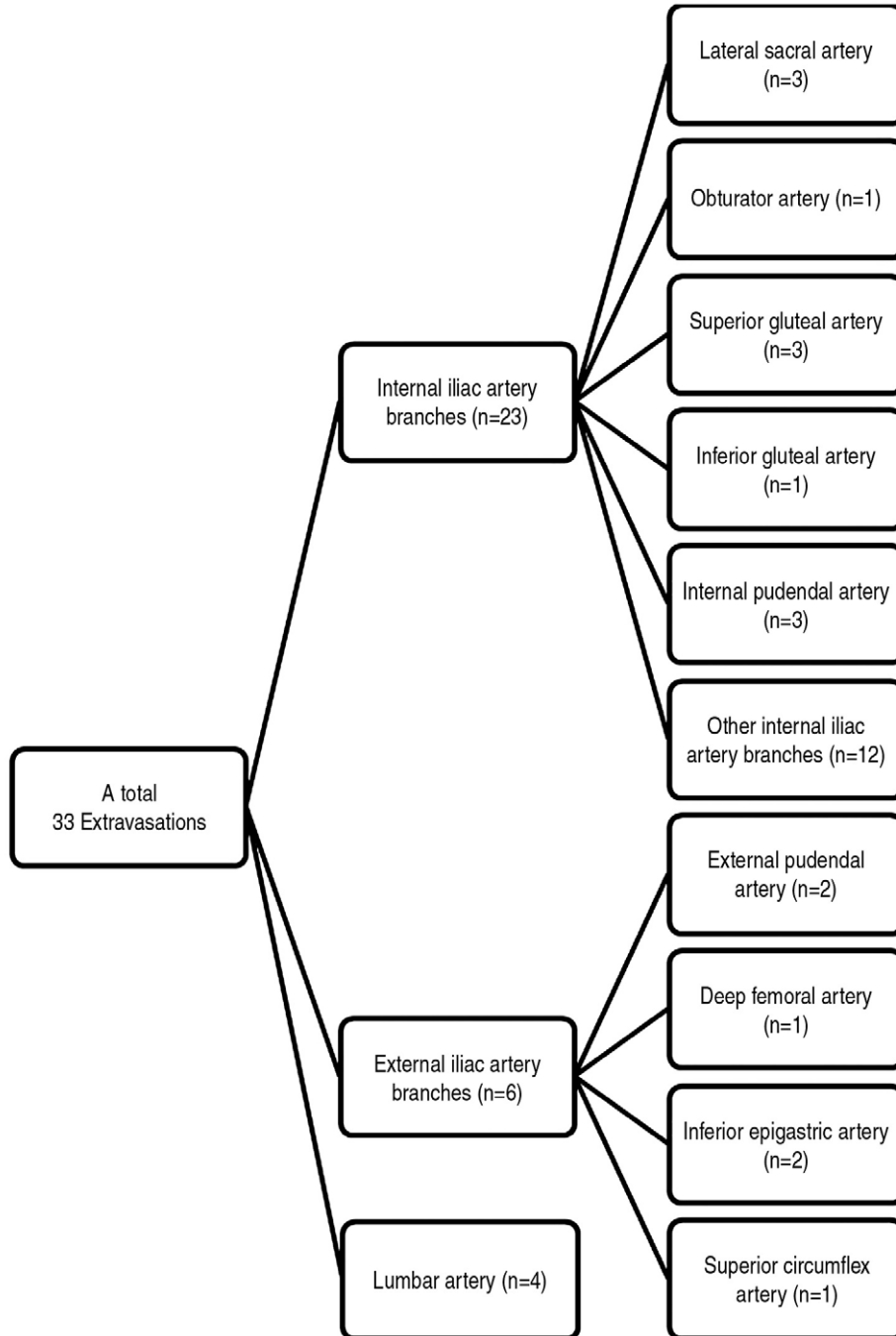


Fig. 2. The distribution of bleeding arteries in pelvic angiography.

from the lateral sacral artery was identified in the pelvic angiography. The patients bleeding artery was embolized successfully.

As shown in Fig. 2, the most common origin of the bleeding was the internal iliac artery (23 of 33 bleeding arteries, 69.7%) followed by external iliac artery (6 of 33 bleeding arteries, 18.2%), and lumbar arteries (4 of 33 bleeding arteries, 12.1%).

IV. Discussion

In this study angiography was performed to determine the actual rate of bleeding in pelvic fracture patients who were blush-positive on CT scan and to identify the source of arterial bleeding. The adverse clinical effects of blush and posterior instability were also investigated. Blush and posterior pelvic instability were closely associated and were also associated with mortality and hypotension.

TAE is indicated for patients who remain hemodynamically unstable after the adequate resuscitation. (7) Patient with blush on CT scans may also be candidates for TAE.(8–10) However, routine TAE for blush-positive patients were controversial.(11,12) In this patient series, most CT blushes were found on angiography to indicate actual sites of bleeding. The success rate of TAE was high and was performed without procedure-related complications. These favorable outcomes are consistent with previous studies. (4,6,8,10) The incidence of blush-positive patients in the current is higher than that of other studies.(13,14) This difference could be caused by subject selection. Other studies were performed for the all pelvic fracture patients.(13,14) However, this study only includes the pelvic fracture patients admitted to the intensive care unit of the authors trauma center during the study period. Therefore, the pelvic fractures in this study could be more severe than that of other studies.

Some authors have reported that not all instances of blush are lethal and can be successfully treated without TAE.(11,12) Others favor TAE to treat fracture-related blush because currently there are no certain indicator, which blush is the potentially risky until now.

TAE has several downsides. The outcome is dependent on the interventionist, and performance of TAE

requires a team, which make it time consuming and inconsistent.(4,12) Delay in availability may become significant on weekends or at night.(4,15) Consequently, outcome and availability vary widely among institutions. A delay in embolization is associated with poor prognosis.(6,16) Therefore, if the intervention team can be accessed promptly, immediate TAE may be desirable. On the other hand, if a delay is anticipated, preperitoneal pelvic packing can be used as bridge to TAE.(3) Various treatments including TAE and preperitoneal pelvic packing have been developed for bleeding pelvic fractures. But controversy remains over the optimal timing, order, and combination of the available modalities. Because each was developed to manage different origins of bleeding that can occur with pelvic fracture, hemodynamically unstable patients may require a combination of therapies.

There have been attempts to use the fracture pattern of the pelvis as a severity indicator clinically. (17,18) However, the fracture classifications used in previous studies were complex, which makes their use in emergent patients difficult. The classification can also be interpreted differently by different clinicians, especially non-orthopedic doctors. In addition, use of fracture patterns as a clinical indicator may not be feasible.(17,18) Posterior pelvic instability of the pelvic ring indicates disruption of the sacroiliac joint. It is generally the result of high-energy trauma and is easy to recognize.(19) In this patient series, posterior pelvic instability was associated with high rate of blush and high mortality. Therefore, it is suitable for use an index of clinical decision and prognosis.

The internal iliac artery was the source of bleeding in 69.7% (22 of 33 bleeding arteries) of pelvic fractures. An extreme method, bilateral internal iliac artery ligation/embolization(20) can be effective, but it has a limitation of not stopping possible bleeding from the external iliac or lumbar artery. Therefore, a patient with persisting hemodynamic instability after the bilateral internal iliac artery ligation should undergo pelvic angiography.

The current study has limitations. The first is its retrospective study design. The study period of this study includes the transition point of our trauma center. The establishment of the authors trauma center

was officially approved in July, 2014 by national health-care authority, even though the center had functioned as a trauma center before then. Therefore, the policy deciding TAE has lack of consistency in the current study. The second is that the application of pelvic binders could not be evaluated because of missing information in the medical records. However, pelvic binders are essential for the management of severe pelvic fractures at our center and seemed to have been applied in treating most patients enrolled in this study.

V. Conclusion

Vascular blush on CT indicated ongoing bleeding in the pelvic angiography. TAE was an excellent therapeutic option for the arterial bleeding with a high success rate and a low complication rate.

VI. Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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