

Correlation between Pelvic Bone Fracture Site and Arterial Embolization in Severe Trauma Patients: A Retrospective Study in a Single Korean Institute

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Abstract

Background: Immediate identification of vascular injury requiring embolization in patients with pelvic bone fracture is not an easy task. There have been many trials of indicators of embolization in patients with pelvic bone fracture. Although the Young and Burgess classification is useful in making decisions about treatment, it is reported to have little value as an indicator of embolization in major trauma patients.

Objectives: The aim of this study is to find fracture patterns for predicting vessel injury by analyzing pelvic radiographs taken from major trauma patients with pelvic bone fracture.

Patients and Methods: Among major trauma patients with injury severity scores (ISS) higher than 15 who visited our emergency room from January 2011 to June 2014, 170 patients were found with pelvic bone fracture and thus pelvic computed tomography (CT) angiography was performed. Setting aside patients who met the exclusion criteria, 126 patients were enrolled in this study for analysis of the length of anterior pelvic ring displacement, fracture involving the greater sciatic notch, iliac bone fracture involving the sacroiliac joint and sacral fracture.

Results: Anterior pelvic ring displacement in group I was shorter (3.8 mm) than that of Group II (18.0 mm), but without statistical significance ($P > 0.05$). Although fracture involving the SI joint did not prove to be of statistical significance ($P > 0.05$), fracture involving the sciatic notch or sacrum was statistically significant ($P < 0.05$).

Conclusions: Analyzing fracture sites involving the sciatic notch and sacrum may help predict the need for embolization of arterial injury concomitant with pelvic fracture.

Keywords: Pelvic Fracture, Arterial Injury, Embolization, Young And Burgess Classification

1. Background

Pelvic bone fracture from extensive force is complex.

Fragmented cases complicating treatment, may occur concomitantly with vessel injuries, resulting in high mortality rates (1, 2). Recently, advances in endovascular techniques for treatment of vascular injuries have enabled less invasive but effective hemostasis (3, 4). However, immediate identification of vascular injury requiring embolization in patients with pelvic bone fracture is not an easy task (2, 5, 6). Upon arriving at the emergency room, major trauma patients often require urgent resuscitation such as airway management (intubation and ventilator) and present unstable vital signs and immobility, preventing immediate computed tomography (CT) angiography. Moreover, blood lab results and hemodynamic status can-

not accurately indicate embolization. Thus, a pelvic radiograph, one of the initial trauma series, is the main tool used to decide whether embolization is necessary, leading to trials of various indicators (2, 7, 8).

The young and Burgess classification is a common method of classifying pelvic bone fracture and is useful in making decisions regarding treatment as it reflects injury mechanism and severity. Nevertheless, it is reported to have little value as an indicator of embolization in major trauma patients (9-11).

2. Objectives

Thus, the aim of this study was to find fracture patterns that may predict vessel injury by analyzing pelvic radio-

graphs taken from major trauma patients with pelvic bone fracture.

3. Patients and Methods

3.1. Study Group

Among major trauma patients with injury severity scores (ISS) higher than 15 who visited our emergency room from January 2011 to June 2014, trauma series showed 170 patients with pelvic bone fracture and pelvic CT angiography was performed for 126 patients. The exclusion criteria included patients with emergency laparotomy with pelvic packing, pelvic radiograph taken but who expired before being checked for vascular injury, and patients with acetabular anterior or posterior wall fracture or small avulsion without intra-pelvic cavity fracture.

The 126 patients were divided into two groups; Group I included 107 patients who did not need embolization during hospitalization, while Group II included 19 patients whose CT scan showed dye extravasation and thus underwent arterial embolization. We compared the two groups' sex, age, ISS, Young and Burgess classification, length of anterior pelvic ring displacement (sum of pubic superior ramus displacement and symphysis pubis displacement), fracture involving the greater sciatic notch, iliac bone fracture involving the sacroiliac (SI) joint, and sacral fracture.

3.2. Radiological Evaluation

Fracture involving the sciatic notch was defined as discontinuation of the bony cortex of the sciatic notch border on the pelvis AP radiograph. Sacral fracture was defined as discontinuation of the bony cortex on the pelvis AP radiograph regardless of location or direction. Fracture involving the SI joint was defined when the iliac bone fracture involved the SI joint, (regardless of disruption) (Figure 1).

Displacement of the pubic superior ramus fracture was defined as the length between the centers of the opposite fracture surfaces where bony cortex of the superior pubic ramus on the pelvis AP radiograph is fractured. Multiple fractures of the ramus were assessed, as were cases of overlapped fracture fragments from lateral compression injury (Figures 2 and 3).

Disruption of the symphysis pubis was defined as the longest distance between centers of fracture surfaces of the symphysis pubis on the pelvis AP radiograph (Figure 4).

Decision regarding arterial embolization was made by the trauma surgeon and interventional radiologist based on patient status and extravasation of dye in the arterial phase on the CT angiograph, which was rechecked during intervention. The radiologist recorded the injured artery.

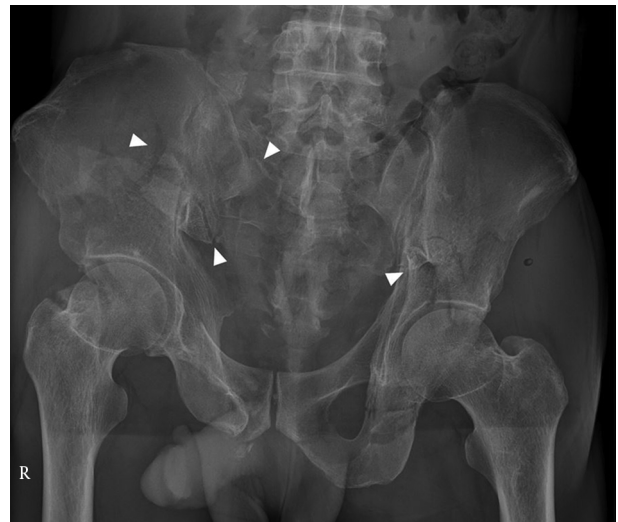


Figure 1. Pelvis AP X-ray of a 44-year-old male. White arrows indicate fractures involving the sacrum, sacroiliac joint and sciatic notch.



Figure 2. Pelvis AP X-ray of 66-year-old female. White arrow indicates sacral fracture. White line shows length of superior ramus displacement.

To reduce measurement errors, measurements were taken twice by each author, and the average values were calculated. Intra-observer reliability was recorded using the criteria of Winer (degree of bias and mean squared error) (25). Reliability was classified, according to the intraclass correlation coefficient, as absent to poor (0 - 0.24), low (0.25 - 0.49), fair to moderate (0.50 - 0.69), good (0.70 - 0.89), or excellent (0.90 - 1.0).

3.3. Statistical Analysis

Data was statistically analyzed using an independent t-test performed using SPSS for Windows (version 20.0, SPSS

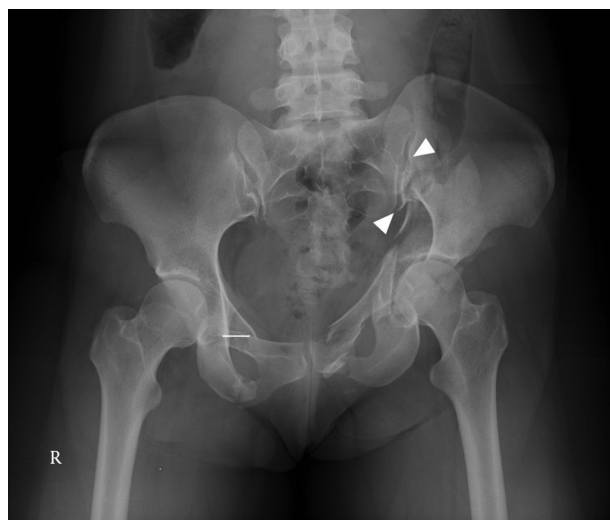


Figure 3. Pelvis AP X-ray of 30-year-old female. White arrows indicate fractures involving the sacroiliac joint and sciatic notch. White line shows length of superior ramus displacement from lateral compression injury.



Figure 4. Pelvis AP X-ray of 9-year-old male. White line shows length of symphysis pubis disruption.

Inc., Chicago, IL, USA), and the significance was determined based on the validated P value of 0.05.

4. Results

The average age of patients in Group I was 50.5 years and in Group II was 57 years, with no statistically significant differences ($P > 0.05$) (Table 1). ISS of Group I (26.7)

was lower than that of Group II (36.4), with statistical significance ($P < 0.05$)

Table 1. Demographic Data and ISS of the Two Groups

Value	Group I	Group II	P Value
Mean Age	50.5 ± 19.9	57.0 ± 18.7	0.609
Sex (male: female)	59:48	11:8	0.098
Mean ISS ^a	26.7 ± 8.46	36.4 ± 12.41	0.021

^aInjury severity score.

The Young and Burgess classifications of the two groups are listed in Table 2. Lateral compression injury was the most common injury in both groups. There was no statistically significant difference between the classification of the two groups ($P = 0.397$), implying that pelvic fracture stage based on the Young classification cannot predict the need for embolization.

Table 2. Young and Burgess Classifications for Groups I AND II

Value	Group I	Group II
APC ^a I	15	2
APC II	4	
APC III	1	
LC ^b I	29	4
LC II	33	9
LC III	6	1
VS ^c	7	1
Combined injury	12	2

^aAnteroposterior compression injury.

^bLateral compression injury.

^cVertical shear injury.

Displacement of the anterior pelvic ring was shorter for Group I (13.8 mm) than for Group II (18.0 mm), but without statistical significance ($P > 0.05$). Fractures involving the sciatic notch, SI joint, and sacrum are listed in Table 3. Eight patients had more than one pelvic fracture site. Both fractures involving the sciatic notch and sacrum fractures demonstrated statistically significant difference ($P < 0.05$), while fracture involving the SI joint did not ($P > 0.05$).

The obturator artery was the most common injured artery and six patients had more than one bleeding site (Table 3). Arterial embolization was performed on all patients in Group II (Figures 5 and 6).

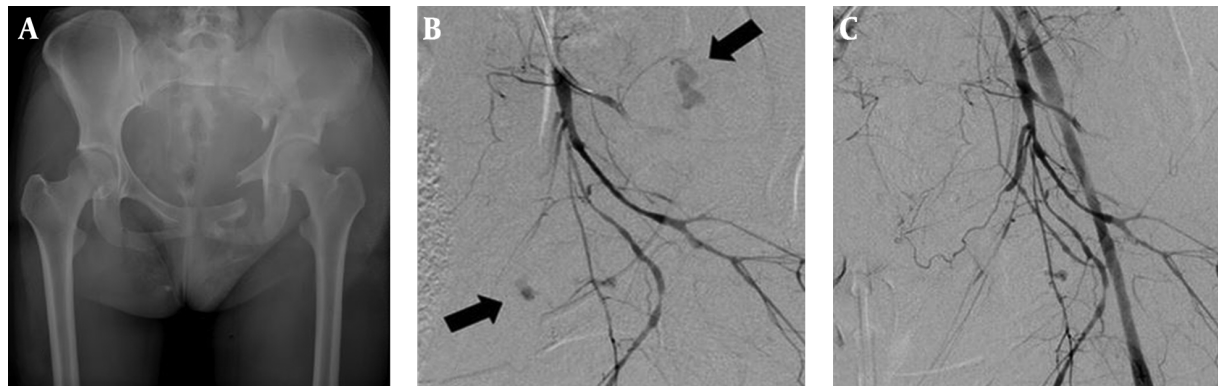


Figure 5. (A) Pelvis AP X-ray of a 20-year-old woman injured by falling. In the radiograph, a left inferior ramus fracture, right superior and inferior ramus fracture, and right sciatic notch fracture are observed. (B) Bleeding of the left superior gluteal artery and obturator artery was observed (black arrow). (C) The bleeding stopped upon arterial embolization.



Figure 6. (A) Pelvis AP X-ray of a 63-year-old woman injured by falling. In the radiograph, a left superior and inferior ramus fracture are observed. (B) Bleeding of the left superior gluteal artery was observed (black arrow). (C) The bleeding stopped upon arterial embolization.

Table 3. Fracture Sites and Degree of Fracture Displacement for Groups I and II.

Value	Group I	Group II	P Value
Mean displacement of anterior pelvic ring ^a , mm	13.8 ± 7.07	18.0 ± 7.97	0.65
Presence of sciatic notch fracture (cases)	16	8	0.001
Presence of involvement of SIJ ^b (cases)	33	9	0.081
Presence of sacral fracture (cases)	47	14	0.001

^aSummed length of displacement of superior ramus fracture and displacement of symphysis pubis disruption.

^bSacroiliac joint.

Table 4. Injured Arteries of Group II

Artery	Case
Obturator artery	8
Internal pudendal artery	3
Lateral sacral artery	6
Iliolumbar artery	4
Superior gluteal artery	2
Median sacral artery	1
Inferior gluteal artery	3

5. Discussion

Past studies of the Young and Burgess classification have been limited to simply analyzing predictive factors of mortality and transfusion and have been unable to

suggest a model for the need for embolization (2, 9, 10). There are conflicting reports of whether the classification can predict mortality or prognosis (2, 12-14). These studies included studies with large numbers of patients and prospective studies. Nevertheless, there seems to be sev-

eral reasons for the discrepancy of opinions and the inability to predict the need for embolization. The Young and Burgess classification reflects the degree of ligament and bony disruption but not the area of vascular injury. According to Ruatti, the most common injured arteries requiring embolization for pelvic ring fracture patients are the lateral and median sacral artery, the pudendal artery, and the superior gluteal artery (2). This study emphasized fractures of the sciatic notch or sacrum, which the Young and Burgess classification cannot reflect. This study also showed a statistical difference in the fractures in this site between groups I and II. Second, the vasculature of the pelvic cavity is complex. The vessels are intertwined and flow in various directions (15, 16). The net-like structure of the vessels may allow them to withstand AP and lateral compression classified by Young and Burgess. Third, artery elasticity is better than that of ligaments or bony structure. Injury of AP compression 3 may not damage arteries. Fourth, arteries are probably injured directly by fracture fragments rather than by displacement of bony structures, as there were differences of fracture of the sciatic notch or sacrum between Groups I and II.

We analyzed fractures involving sites where the aforementioned vascular injuries are likely, such as the sciatic notch, the iliac bone, and the sacrum. The measuring displacement of the sciatic notch and sacrum fracture is difficult due to irregular fracture lines in various directions; thus, we simply assessed whether there was a fracture or not. Nevertheless, there was a statistically significant difference between the two groups, probably because the net-like vasculature can be injured by sharp edges of fragmented bones regardless of the fracture direction. On the other hand, there were no statistically significant differences of fractures involving the SI joint and displacement of the anterior pelvic ring between the two groups. The sacroiliac joint is covered with thick anterior and posterior SI ligaments, preventing severe displacement and injury by sharp edges of fractured segments. Moreover, displacement of the anterior pelvic ring is measured by AP X-ray, and thus cannot accurately reflect the three-dimensional length of displacement. Further studies on this matter are needed.

There are several limitations to this study. First, venous injury was not considered. Venous injury is as important as arterial injury in mortality, yet direct visualization of vein site and injury was not done. Second, the number of patients who received embolization was small. There was only one case of arterial injury near the superior pubic ramus, and thus anterior pelvic ring injury could not accurately reflect arterial injury around the pubic ramus. Third, there were differences in ISS between the two groups. Group II had higher ISS, and thus could have more

injuries; increasing the chance that embolization would be required. However, ISS is higher when there is arterial injury, so we cannot conclude that higher ISS is directly proportional to more injury. Fourth, we lack other clinical data such as vital signs and the results of blood tests.

We think the results of this study can be of use in predicting the need for embolization when checking the fracture site on simple pelvis AP radiographs taken in the emergency room, thereby helping physicians make treatment decisions for patients with pelvic bone fractures. Further studies with a larger number of patients are warranted for confirmation of these findings.

5.1. Conclusions

Analysis of fractures involving the sciatic notch and sacrum can help predict the need for embolization of arterial injuries in patients with pelvic bone fracture.

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