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Acute Complications of Patients With Pelvic Fractures After Pelvic Angiographic Embolization

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Abstract

Background Hemodynamically unstable patients with a pelvic fracture and arterial pelvic bleeding frequently are treated with pelvic angiographic embolization (PAE). PAE is reported to be a safe and effective method of controlling hemorrhage. However, the loss of blood supply and subsequent ischemia from embolization may lead to adverse consequences.

Objectives/purposes We sought to determine (1) the frequency and types of complications observed after PAE;

(2) the mortality after PAE; and (3) the clinical factors associated with complications and mortality after PAE.

Methods We conducted a retrospective case series descriptive study at a Level I trauma center. Using our institution's trauma registry, we isolated patients with pelvic fractures treated with PAE admitted between June 1999 and December 2007. Complications attributed to PAE occurring in the initial hospital stay were recorded. We identified 98 patients with pelvic fractures treated by PAE with an average hospital stay of 25.3 days.

Results The complication rate was 11% and included six patients with gluteal muscle necrosis (6%), five with surgical wound breakdown (5%), four deep infections (4%), one superficial infection, two patients with of impotence (2%), and one with bladder necrosis. The mortality rate in the PAE group reached 20%. Bilateral embolization was performed in 100% of the patients with complications. Nonselective embolization was performed in 81% of patients with complications. All of the patients with gluteal necrosis had bilateral nonselective embolization.

Conclusions Bilateral or nonselective PAE is associated with significant complications during the initial hospital stay. The value of PAE should be weighed against its possible adverse consequences. Selective unilateral arterial embolization should be considered whenever possible.

Level of Evidence Level IV, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

Each author certifies that he or she, or a member of his or her immediate family, has no funding or commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

All ICMJE Conflict of Interest Forms for authors and *Clinical Orthopaedics and Related Research* editors and board members are on file with the publication and can be viewed on request. Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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Introduction

Hemodynamically unstable polytrauma patients with pelvic fractures frequently are treated with angiography

and pelvic arterial embolization (PAE) for diagnostic and therapeutic purposes, respectively [2, 11, 17, 18]. Embolization occludes the arterial lumen and may effectively control retroperitoneal bleeding, but does not affect venous bleeding, which can be controlled with pelvic packing or acute pelvic stabilization. Although PAE is considered by many to be a safe procedure with minimal short-term complications [10, 16, 17], the loss of blood supply to the end organ can result in significant consequences. Complications such as gluteal [13, 14, 19], bladder [12], femoral head [9], and skin necrosis [6] all have been reported in association with PAE. Moreover, paresis [4], impotence [7], and surgical wound complications [15] have also been described after embolization in the pelvic region. However, few studies have documented complications after PAE in a large patient cohort.

We therefore sought to determine (1) the frequency and types of complications observed after PAE; (2) the mortality after PAE; and (3) the clinical factors associated with complications and mortality after PAE at a Level I trauma center.

Patients and Methods

We retrospectively reviewed a Level I trauma center’s hospital trauma registry records for patients diagnosed with a pelvic fracture and treated with PAE admitted between June 1999 and December 2007. Patients aged 18 years or older with pelvic fractures caused by blunt trauma and treated with PAE for suspected arterial pelvic bleeding were included in this study. We excluded patients with previous injuries to the pelvis, chronic skin and muscle disorders, prior significant

skin injuries, compromised immunologic status, neurological disorders, and those who died during the first 24 hours of the hospital stay. The study was approved by the University of California, San Francisco Committee on Human Research.

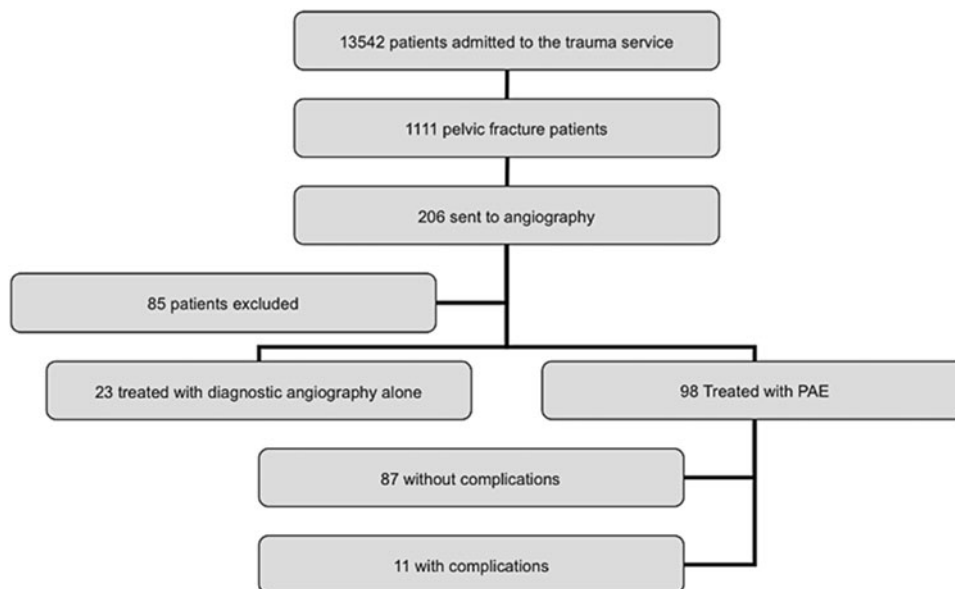
Of 13,542 patients admitted during the study period, there were 1,111 patients with pelvic fractures, of whom 206 were sent to angiography. Of the 206 patients sent to angiography, 121 met the inclusion criteria for this study. Of the 121 patients sent to angiography, 98 were treated with PAE and 23 underwent angiography without PAE (Fig. 1). The average overall hospital stay for the 121 patients included in the study was 25 days. The average age of all of the patients in the study was 46.5 years.

Complications during the primary hospital stay (until discharge or transfer) were recorded in the chart. Complications previously associated with PAE, including gluteus muscle necrosis [13, 14, 19], bladder necrosis [12], skin necrosis [6], impotence [7], and surgical wound complications [15], were noted.

PAE is routinely performed at our institution after initial angiography to identify focal areas of extravasation or pseudoaneurysm formation involving the internal iliac artery. Arterial occlusion is achieved by coil embolization through a microcatheter with embolization to stasis using a Gelfoam® slurry (Upjohn, Pfizer, Kalamazoo, MI, USA) or a combination of the two. In the current study, nonselective embolization was defined as occlusion of arteries at the level of or proximal to the internal or external iliac arteries. Selective embolization was defined as occlusion of arteries distal to the internal or external iliac arteries.

We analyzed length of stay greater or less than 7 days because it was found as the median stay for patients with

Fig. 1 Selection of study patients with pelvic fractures treated with and without angiographic embolization. Of the 13,542 patients who were admitted in the study period, 121 patients were included for analysis in the study.



pelvis fractures in a previous study [1]. We also used an Injury Severity Score (ISS) of greater or less than 25 as a cutoff for severely traumatized patients because it was reported in a previous safety study as the average score in patients with pelvic fractures who were embolized [18]. Comparisons were made between embolized patients with ($n = 11$) and without complications ($n = 87$). For continuous variables, t-tests were used to compare means. Categorical variables were analyzed with bivariate analysis using chi square and Mantel-Haenszel tests to generate odds ratios (ORs), 95% confidence intervals (CIs), and p values. For the 2×2 tables with cells containing less than five, the Fisher's exact test was used. Two-sided p values < 0.05 were considered statistically significant. Descriptive statistics were produced to show the distribution and spread among the stratified variables. The statistical analysis for this study was performed using SAS (Version 9.2; SAS Institute Inc, Cary, NC, USA).

Results

There were 11 patients with complications out of the 98 treated with PAE (11.2%) (Table 1). However, there were 19 complications in those 11 patients. The complications identified were six patients with gluteal muscle necrosis (6%), five with surgical wound breakdown (5%), four deep infections (4%), one superficial infection, two patients with impotence (2%), and one with bladder necrosis. When patients with open fractures or Morrel-Lavalle lesions (closed shear injuries occurring between the fat and fascia) were excluded from the complications group, there were 86 patients treated with PAE and nine complications in seven patients (8%), including three cases of gluteal necrosis (4%), two cases of wound breakdown (2%), two cases of deep infections, one case of impotence, and one case of bladder necrosis. There were no complications in the group of patients who underwent angiography without embolization.

Table 1. Frequency distribution of demographic characteristics in the groups with and without complications

Variable	Embolized without complications, number (%) ($N = 87$)	Embolized with complications, number (%) ($N = 11$)
Age (years)		
< 65	65 (74.7)	11 (100)
≥ 65	22 (25.3)	0 (0)
Sex		
Male	46 (52.9)	9 (81.8)
Female	41 (47.1)	2 (18.2)

The mortality rate was 20% (42 of 206 patients) in patients sent to angiography (with or without PAE) and 12.3% (111 of 905 patients) in patients not sent to angiography ($p < 0.01$). In the severely injured group (ISS ≥ 25 , $n = 438$), the mortality rate was 26.5% (40 of 150 patients) in patients sent to angiography and 38.3% (110 of 290 patients) in the patients not sent to angiography ($p = 0.013$). After controlling for ISS, those patients who went to angiography had a decreased OR of mortality (OR, 0.63; 95% CI, 0.41–0.97). The overall mortality rate in our pelvic fracture population was 13.8% (153 of 1,111 patients), and in the severely injured group, it was 33% (12 of 36 patients).

The complication group had more Morel-Lavalle injuries ($p = 0.004$) but not a higher ISS score ($p = 0.06$), number of open fractures ($p = 0.3$), or longer intensive care unit stay ($p = 0.11$) (Table 2). All patients with complications had bilateral PAE. Nine of 11 patients who had complications had nonselective embolization ($p = 0.007$) (Table 3). All six patients with gluteal necrosis had bilateral nonselective embolization. One of six patients receiving coil embolization alone (16.6%) developed complications, whereas nine of 78 (11.5%) who received Gelfoam and one of 14 (7.1%) who received a combination of Gelfoam® and coils had complications. It is also noteworthy that all patients with complications had surgery (seven had open reduction and internal fixation and four had percutaneous pinning of their pelvic fracture), and this was different from the patient group without complications ($p = 0.006$). With the numbers available, the mean age of the patients with complications was not different from that of those who did not have complications (39.0 ± 11.7 years versus 49.4 ± 18.49 years, $p = 0.065$). A fall from a height was the leading mechanism of injury in the complications group compared with motor vehicle accidents in the group without complications.

Discussion

Angiographic embolization in the hemodynamically unstable patient with a pelvis fracture has been used with great success. However, acute postembolization complications have not been extensively studied. The aim of this study was to investigate the associated complications in patients with pelvic fractures who also were treated with angiographic embolization. This study demonstrates that complications associated with bilateral, nonselective PAE are frequent and potentially clinically important.

This study has several limitations. As a result of a small sample size of 98, the precision of effect estimation was significantly reduced, causing large CIs and an increased probability of chance findings. A much larger sample would have increased the statistical power and improved our ability to interpret the results. There were too few control

Table 2. Estimated effects odds ratio (OR) and 95% confidence interval (CI) associated with selected factors on complications

Variable	Embolized without complications, number (%) (N = 87)	Embolized with complications, number (%) (N = 11)	OR (95% CI) p value
Injury mechanism			
Motor vehicle accident	45 (51.7)	4 (36.4)	0.53 (0.14–1.95)* 0.33
Motorcycle accident	3 (3.5)	0 (0)	
Pedestrian versus automobile	11 (12.6)	1 (9.1)	
Fall	23 (26.4)	4 (36.3)	1.6 (0.43–5.9) [†] 0.49
Other blunt injury	5 (5.8)	2 (18.2)	
Injury Severity Score			
≤ 25	34 (39.1)	2 (18.2)	2.9 (0.59–14) 0.32
> 25	53 (60.9)	9 (81.8)	
Days in intensive care unit			
≤ 7	54 (62.1)	4 (36.4)	2.9 (0.78–11) 0.11
> 7	33 (37.9)	7 (63.6)	
Open/closed fracture			
Closed	85 (97.7)	10 (9.9)	4.3 (0.35–51) 0.30
Open	2 (2.3)	1 (9.1)	
Morel-Lavalle			
No	86 (98.8)	8 (72.7)	32 (2.9–347) 0.004
Yes	1 (1.2)	3 (27.3)	
Surgical stabilization of the pelvis			
No	37 (42.5)	0 (0)	17 (0.97–299) 0.006
Yes	50 (57.5)	11 (100)	

* Motor vehicle accidents versus all other mechanisms of injury; [†]fall versus all other mechanisms of injury.

subjects (patients sent to diagnostic angiography only) available for study and appropriate comparisons to the PAE group. This study focused on short-term complications that were diagnosed before patients' discharge or transfer from the hospital (range of 6 weeks to 6 months). Therefore, some complications may have occurred outside of the study window. However, because Gelfoam[®] was used in 94% of the embolizations in our study, and Gelfoam[®] degrades after 7 to 21 days, we expected a comparatively smaller rate of additional long-term complications. Other sources of bias included potential underreporting of certain conditions such as impotence and missing information during chart review and followup. Presumably, there may be patients with unreported problems that occurred or were noticed by the patient subsequent to discharge. Therefore, the complications reported in this study may underestimate the actual

rate of complications. Finally, some of the complications we observed (such as impotence and wound infections) may have been related to the pelvic fractures themselves or to the surgical treatments used and not the result of PAE; our study design permits us only to report on association, and we are not able to draw any firm inferences regarding causation.

In our study, gluteal necrosis was seen in six of 98 (6.1%) patients treated with PAE. In a study performed by Takahira et al. [14], which examined the incidence of gluteal necrosis after PAE, five of 151 (3.3%) patients treated with PAE developed gluteal necrosis. Three of these patients (60%) died as a consequence of sepsis and disseminated intravascular coagulation. The higher incidence of gluteal necrosis in our study may be explained by concomitant injuries. When patients with Morell-Lavalle lesions were excluded from our

Table 3. Frequency distribution of the clinical methods used in the groups with and without complications

Variable	Embolized without complications, number (%) (N = 87)	Embolized with complications, number (%) (N = 11)	p value
Side embolized			
Bilateral	68 (78.2)	11 (100)	0.046
Unilateral	19 (21.8)	0 (0)	
Vessels embolized			
Selective*	51 (60.7)	2 (18.2)	0.008
Nonselective†	33 (39.3)	9 (81.8)	
Embolization material			
Gelfoam	69 (79.3)	9 (81.8)	> 0.05
Coil	5 (5.7)	1 (9.1)	> 0.05
Gelfoam + coil	13 (15.0)	1 (9.1)	> 0.05

* Selective embolization was distal to the internal or external iliac arteries; † nonselective embolization was at or proximal to the internal or external iliac arteries.

study population, the rate of gluteal necrosis was similar to that in the previously mentioned study (3.1%). In our study period, two patients were diagnosed with bladder necrosis after nonselective bilateral PAE. However, these patients were excluded from the study as a result of bladder injury from the initial trauma. Other complications included impotence and infection. Two males were diagnosed with impotence (49 and 56 years old). The rate of impotence after PAE in this study, however, may have been higher as a result of patient underreporting and this study's short-term followup. The findings from the current study are consistent with those from another study that showed an association between impotence and unilateral and bilateral occlusions of the hypogastric artery [8] as well as previous studies reporting complications after PAE [15]. We observed a 4.1% rate of deep surgical wound infection. After we excluded the patients with Morell-Lavalle lesions and open fractures, the rate was 2.1%. A higher deep wound infection rate after PAE was recently reported [8], demonstrating that this complication could be associated with PAE. In a recently published report by Travis et al. [15], pelvic or perineal infection rates were 24% (13 of 54 patients) after PAE compared with 10.7% (three of 28 patients) in patients undergoing angiography alone. However, this increased infection rate did not reach statistical significance.

Our pelvic fracture patient population had an overall mortality of 13.8%, similar to previously published mortality rates of 14.2% and 13.4%. [1, 3, 5]. The higher mortality rate observed in patients treated with an angiographic procedure is probably the result of increased injury severity seen in this population. When controlling for ISS, we found that the OR

for mortality decreased. Moreover, when analyzing the severely injured patient group (ISS > 25), a reduced mortality rate was also observed in patients treated with an angiographic procedure (26.5% versus 38.3%, $p = 0.013$). Therefore, there may be a protective effect of the angiographic procedure, which may be inherent in the procedure itself or the result of confounding factors (extrapelvic injuries) not controlled for in this study. In a recently published study evaluating internal iliac artery embolization in patients with pelvic trauma, no appreciable short- or long-term complications after performing Gelfoam® embolizations were found [15]. The only added long-term complications the authors discovered were buttock, thigh, and perineal paresthesias seen in 31% of embolized patients compared with 12.5% of nonembolized patients. Our study does not support this low complication rate. The results of this study are in agreement with a recent study examining PAE performed in the setting of acetabular fractures that illustrated there was a 50% deep infection rate in 14 patients treated with open reduction and internal fixation [8]. We did not observe any complications in the group of patients sent to angiography without undergoing PAE, although our numbers on this point were small.

Complications were almost invariably seen after bilateral, nonselective embolizations. This finding is in accordance with a recently published study in which all reported complications after PAE were associated with bilateral internal iliac artery embolization [15]. However, the complications found in that study were not severe, leading the authors to conclude that PAE was not associated with an increased rate of complications. The differences between that study and the current study may be explained by dissimilar patient populations. In this study, the patient population had an ISS > 25 in 63% of the patients versus 35% in the one by Travis et al. There were also differences in embolization technique (type of embolization materials and levels of embolization). Our findings are supported by previous studies that have shown complications associated with PAE [15, 19]. In the study performed by Travis et al., nonselective embolization was associated with a higher percentage of perineal infection (eight of 33 patients versus five of 21 in selective embolization), nerve damage (two of 28 patients versus zero of 20 in selective embolization), and skin sloughing or necrosis (four of 34 patients versus one of 20 in selective embolization). However, these increased complication rates did not reach statistical significance [15].

In conclusion, our findings suggest that nonselective bilateral PAE in patients with pelvic fractures may be associated with a higher complication rate than previously reported. The value of PAE should be weighed against its possible adverse consequences. When indicated, selective unilateral arterial embolization should be performed.

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