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Trends in the management of pelvic fractures, 2008–2010

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ABSTRACT

Background: Bleeding from pelvic fractures can be lethal. Angioembolization (AE) and external fixation (EXFIX) are common treatments to control bleeding, but it is not known how frequently they are used. We hypothesized that AE would be increasingly more common compared with EXFIX over time.

Methods: The National Trauma Data Bank for the years from 2008–2010 were used. Patients were included in the study if they had an International Classification of Diseases, ninth edition, Clinical Modification codes for pelvic fractures and were aged ≥18 y. Patients were excluded if they had isolated acetabular fractures, were not admitted, or had minor injuries. Outcomes included receiving a procedure and in-hospital mortality.

Results: A total of 22,568 patients met study criteria. AE and EXFIX were performed in 746 (3.3%) and 663 (2.9%) patients, respectively. AE was performed more often as the study period progressed (2.5% in 2007 to 3.7% in 2010; $P < 0.001$). This remained significant in adjusted analysis (odds ratio per year 1.15; $P = 0.008$). Having a procedure was associated with higher mortality in unadjusted analyses compared with those with no procedure (11.0% for no procedure *versus* 20.5% and 13.4% for AE or EXFIX, respectively; $P < 0.001$). In adjusted analyses, only AE remained associated with higher mortality (odds ratio 1.63; $P < 0.001$).

Conclusions: AE in severely injured pelvic fracture patients is increasing. AE is associated with higher mortality, which may reflect the fact that it is used for patients at higher risk of death. The role of AE for bleeding should be examined in future studies.

Introduction

Pelvic fractures account for approximately 3% of skeletal injuries, with associated mortality rates ranging between 8% and 16% [1,2]. Hemorrhage from pelvic fractures contributes to this high mortality [3]. Treatment for bleeding pelvic fractures involves noninvasive means (pelvic binders) and invasive procedures such as angioembolization (AE), external fixation (EXFIX), or pelvic packing. Despite these available options, mortality remains high in hemodynamically unstable pelvic fractures [2,4].

Which strategy to use is often subject to great debate [5–8]. Most studies evaluate specific protocols rather than compare the efficacy of available modalities [8–13]. It is not clear which

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technique is more often used or whether outcomes differ. In addition to bleeding outcomes, the procedures also can differ with regards to possible complications. Although AE is often considered to be a generally safe procedure, muscle or pelvic organ necrosis, poor wound healing, and bladder necrosis can occur. EXFIX can be associated with risk for infection, lateral femoral cutaneous nerve irritation, and asymptomatic heterotopic ossification [14,15].

We sought to determine how frequently the two most commonly used techniques, AE and EXFIX, were used in severely injured patients admitted to US trauma centers with a diagnosis of a pelvic ring fracture in the United States. On the basis of the observed trends, we hypothesized that there would be an increase in the use of AE and a decrease in the use of EXFIX over time. We also hypothesized that there would be a difference in mortality based on procedure.

Methods

Data for this study were obtained using the National Trauma Data Bank (NTDB) from the Committee on Trauma, American College of Surgeons (NTDB Version 8.0, Chicago, IL, 2008). Years 2008–2010 were included. The NTDB is the largest registry of trauma patients and contains records for more than 5 million trauma patients voluntarily provided by more than 900 US trauma centers.

Patients were included in the study if they had an International Classification of Diseases, ninth edition, Clinical Modification (ICD-9-CM) codes [16] for pelvic fractures and were aged ≥18 y. Patients were excluded if they had an isolated acetabular fracture as their primary pelvic fracture as these are at a lower risk for bleeding. The ICD-9-CM diagnosis codes for pelvic ring fractures included 808.43 "multiple with disruption of pelvic circle, closed," 808.53 "multiple with disruption of pelvic circle, open," 808.41 "ilium closed," 808.51 "ilium open," 808.42 "ischium closed," 808.52 "ischium open," 808.2 "pubis closed," 808.3 "pubis open," 808.44 "multiple closed pelvic fractures without disruption of pelvic circle," and 808.54 "multiple open pelvic fractures without disruption of pelvic circle."

Patients were also excluded if they were not admitted to the hospital or had evidence of minor injuries, defined by having an injury severity score (ISS) <15. We excluded these groups because it would be unlikely the patient was sufficiently injured as to require acute management of a pelvic fracture injury. Furthermore, because we included all trauma center levels, it is possible that level III/IV centers might not have capability to perform both procedures. As a result, we only included hospitals that performed both procedures.

The primary outcomes were AE or EXFIX. Whether a patient had a procedure was determined using ICD-9-CM procedure codes. ICD-9-CM codes for AE included the following: 88.4 "arteriography using contrast material, unspecified site," 88.47 "arteriography using contrast material, intra-abdominal vessels," and 39.79 "other endovascular repair (of aneurysm) on other vessels." EXFIX cases were identified using ICD-9 procedure codes: 84.71 "application of external fixator device, monoplanar system," 84.72 "application of external fixator device, ring system," 84.73 "application of external fixator device, hybrid," 78.10 "application of external fixator device, unspecified site," and 78.19 "application of external fixator device, other (pelvic bones, phalanges, and vertebra)." Because these procedures may have been performed nonacutely for other conditions, we only considered AE or EXFIX to be likely to be associated with pelvic fracture hemorrhage if it was performed within 24 h of arrival. The secondary outcome was in-hospital mortality.

Unadjusted and adjusted analyses were performed. For adjusted analyses, we performed mixed effects logistic regression to control center effect. Variables included in the analysis were selected based on several criteria: (1) variables that have been recommended as necessary for trauma analyses [17], (2) *a priori* determined variables hypothesized to be relevant to receiving a procedure, and (3) variables found to be significant in univariate analysis. The most parsimonious model with optimal model performance was then created. Variables included in the final model included demographics (age and gender), injury severity, emergency room physiology (including hypotension, tachycardia, and Glasgow coma score), diagnosis of traumatic shock, hospital characteristics (hospital region, trauma center status, hospital bed size, and university hospital), and year of admission. Statistical significance in trends over time was determined using Poisson regression. A P value of <0.05 was considered significant. The study was waived by the Stanford Institutional Review Board as only de-identified data were used.

Results

A total of 22,568 met inclusion and exclusion criteria and were included in the analysis (Table 1). Patients were predominantly male (59.6%), white (70.3%), and aged between 18 and 44 y (50.7%). Overall, procedures were infrequent in the pelvic fracture population (710 patients, 6.2%). The number of patients who underwent AE was 746 (3.3%), and the number who underwent EXFIX was 663 (2.9%). The number of patients who underwent both AE and EXFIX procedures was 74 (0.3%).

Patients who received AE *versus* EXFIX were different across most measures in unadjusted analyses. Patients who had an AE were on average older compared with those who underwent EXFIX (age ≥65 for 24% *versus* 8.3%, respectively; $P < 0.001$) and less often of white race (59.6% *versus* 73.6%; $P = 0.03$). Patients who underwent AE were also more severely injured (ISS ≥26 in 59.0% *versus* 48.7%; $P < 0.001$) and more often had a diagnosis of traumatic shock (7.1% *versus* 4.8%; $P < 0.001$). There were also differences in where these procedures were performed. Most procedures (either AE or EXFIX) were performed in the university setting. However, more AE procedures were performed in community hospitals compared with EXFIX (30.4% *versus* 21.7%; $P < 0.001$).

In-hospital mortality rates were high for the entire pelvic fracture cohort (2561; 11.3%), but these rates were higher for those who underwent a procedure. The mortality rate for patients who had an AE procedure was 20.5%, and mortality rate for patients who underwent an EXFIX procedure was 13.4% ($P < 0.001$).

Next, we determined which variables were associated with receiving a procedure when controlling for known