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Acetabular fractures: Epidemiology and mortality based on 2,132 fractures from the Swedish Fracture Register

Aims

To describe the epidemiology of acetabular fractures including patient characteristics, injury mechanisms, fracture patterns, treatment, and mortality.

Methods

We retrieved information from the Swedish Fracture Register (SFR) on all patients with acetabular fractures, of the native hip joint in the adult skeleton, sustained between 2014 and 2020. Study variables included patient age, sex, injury date, injury mechanism, fracture classification, treatment, and mortality.

Results

In total, 2,132 patients with acetabular fractures from the SFR were included in the study. The majority of the patients were male (62%) and aged over 70 years old (62%). For patients aged > 70 years, the 30-day mortality was 8% and one-year mortality 24%. For patients aged \leq 70 years, the 30-day mortality was 0.2% and one-year mortality 2%. Low-energy injuries (63%) and anterior wall fractures (20%) were most common. Treatment was most often non-surgical (75%).

Conclusion

The majority of patients who sustain an acetabular fracture are elderly (> 70 years), of male sex, and the fracture most commonly occurs after a simple, low-energy fall. Non-surgical treatment is chosen in the majority of acetabular fracture patients. The one-year mortality for elderly patients with acetabular fracture is similar to the mortality after hip fracture, and a similar multidisciplinary approach to care for these patients should be considered.

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Introduction

Fractures of the acetabulum, especially in the elderly population, are an increasing orthopaedic concern.^{1.4} Larger epidemiological studies are scarce, and available studies have mainly focused on surgically treated patients who sustain acetabular fractures after high-energy trauma mechanisms.⁴⁻⁸ However, in recent years, some epidemiological studies have included non-surgically treated patients.^{1,3,9,10} In our experience, most acetabular fracture patients are elderly patients sustaining low-energy fractures that are treated non-surgically. The literature describing this large group of patients is still rather limited. However, the Swedish Fracture Register (SFR) enables us to conduct a nationwide study of all patients sustaining acetabular fractures regardless of fracture pattern and treatment.¹¹⁻¹³ The current study aimed to provide further information on patients who sustain an acetabular fracture, how the different fracture patterns are distributed, and what treatment the patients receive, and describe the mortality after an acetabular fracture.

Methods

Study design and setting. Information on all acetabular fractures (ICD-10 S32.4) reported to the SFR between 01 January 2014 and 23 October 2020 occurring in patients over

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Table I. Demographic characteristics of the study population (n = 2,132).

Variable	Value	
Sex, n (%)		
Male	1,327 (62)	
Female	805 (38)	
Age, n (%)		
≤ 70 yrs	813 (38)	
> 70 yrs	1,319 (62)	
Median age, yrs (IQR)		
All	76 (62 to 86)	
Male	73 (59 to 83)	
Female	82 (68.5 to 89.0)	
Side, n (%)		
Left	1,168 (55)	
Right	964 (45)	
Type of energy, n (%)		
High-energy	456 (21)	
Male	367 (80)	
Female	89 (20)	
Low-energy	1,347 (63)	
Male	770 (57)	
Female	577 (43)	
Unknown	289 (14)	
Not applicable	40 (2)	

IQR, interquartile range.

the age of 16 years, with closed growth plates and a preserved native hip joint, were collected from the register. Patients with bilateral injuries (n = 18) and patients sustaining a contralateral injury at a later occasion during the study period (n = 3) were excluded. The SFR includes all types of fractures in all patient groups. Registrations and fracture classifications are done by the treating orthopaedic surgeon. Data on mortality are transferred daily to the SFR from the Swedish Tax Agency. During the study period, the SFR went from 50% coverage in 2014 to 100% coverage in 2020, meaning that all orthopaedic departments treating acute fractures in Sweden are now affiliated with the SFR and register fractures on a daily basis.¹²

The following variables were retrieved from the SFR: age at time of injury, sex, injury date, injury mechanism including energy level, fracture classification, treatment, and mortality. Injury mechanisms were divided into six categories as defined by Bergdahl et al¹⁴ and Wennergren et al:¹⁵ simple fall, fall from height, unspecified fall, traffic-/transportation-related trauma, miscellaneous injuries, and non-traumatic injuries. Energy level is, in the SFR, defined by the treating orthopaedic surgeon as low or high. Acetabular fractures are classified according to the AO/OTA classification, which is based on the Judet and Letournel classification.^{5,16,17} Treatment is registered as non-surgical and surgical. Surgical treatment was further divided into osteosynthesis, primary arthroplasty, or a combination thereof.

Table II. 30-day and one-year mortality in patients aged \leq 70 and > 70 years in total and by sex of patients in each group (total n = 2,131). One patient was excluded because of obvious false data (negative survival value).

Age group, yrs	30 days, n (%)	One year, n (%)		
≤ 70 (n = 813)	2 (0.2)	17 (2)		
> 70 (n = 1,318)	100 (8)	317 (24)		
Male ≤ 70 (n = 596)	2 (0.3)	11 (2)		
Male > 70 (n = 730)	70 (10)	184 (25)		
Female ≤ 70 (n = 217)	0 (0)	6 (3)		
Female > 70 (n = 588)	30 (5)	133 (23)		

A total of 2,132 patients with acetabular fractures were included in the study. In the mortality analyses, one patient was excluded because of obvious false data (negative survival time value). A majority of the fractures occurred in males (n = 1,327; 62%). Basic demographic information for the study population are shown in Table I. The median age for the entire cohort was 76 years(interquartile range (IQR) 62 to 86), and for male and female patients 73 and 82 years, respectively. A majority of the patients (n = 1,319; 62%) were over 70 years of age. Age and sex distribution is shown in Figure 1.

Statistical analysis. Nominal variables are presented as numbers, proportions of all registered acetabular fractures in the SFR and median (range), excluding any missing values. Statistical analyses were conducted using SPSS Statistics v. 25 (IBM, USA).

Results

Mortality. The 30-day mortality was 8% in patients aged > 70 years and 0.2% in patients aged \leq 70 years. The one-year mortality was 24% and 2% for the respective groups. Male patients aged > 70 years had a 30-day mortality of 10% and female patients aged > 70 years had a 30-day mortality of 5% (Table II).

Injury mechanisms. The most common injury mechanisms were a simple fall (56%, n = 1,186), transport accidents (18%, n = 377), and fall from a height (12%, n = 251). Male patients were more frequently injured due to transport accidents or fall from a height compared to female patients (Table III). Simple and unspecified falls accounted for 74% (n = 592) of the injuries in females, compared to 55% (n = 735) in males.

Overall, 63% (n = 1,347) of the injuries were classified as low-energy and 21% (n = 456) as high-energy trauma (Table I). In patients \leq 70 years old, 47% (n = 381) of fractures were caused by high-energy trauma compared to 6% (n = 75) in patients > 70 years. High-energy trauma was more common among male patients and in the younger patient groups (Table I and Figure 1).

Fracture classification. The most common fracture type was the anterior wall fracture (20%, n = 437) followed by the posterior wall fracture (14%, n = 292). Anterior column, pure transverse, posterior column, associated



Distribution of age, sex, and injury mechanism in 2,132 patients.



Distribution of fracture classifications and injury mechanism in 2,132 patients.

both columns, and T-shaped fractures each occurred in 7% to 9% (n = 154 to 191) of the cases. Associated anterior and posterior hemitransverse, associated posterior column and posterior wall, and associated transverse and posterior wall fractures were less common, each accounting for 4% to 6% (n = 92 to 125) of the fractures. In 205 of the 2,132 fractures (10%), the registrant was unable to classify the fracture (Figure 2).

Among high-energy injuries, posterior wall fractures were most common (24%, n = 108) compared to anterior wall fractures in the low-energy injuries (23%, n = 309)(Figure 2).

Treatment. Of 1,995 fractures 75% (n = 1,505) were initially treated non-surgically. In less than 1% of these cases (n = 13), the treatment strategy changed early on to surgical treatment. In surgically treated patients (n = 503), open reduction and internal fixation (ORIF) was performed in 73% (n = 369) of the cases, and ORIF in combination with primary arthroplasty (combined hip procedure (CHP)) in 15% (n = 77) of the cases; 7% (n =

Mechanism of injury	Patients, n (%)	Male, n (%)	Female, n (%)	
Simple fall	1,186 (56)	665 (50)	521 (65)	
Fall from height	251 (12)	208 (16)	43 (5)	
Unspecified fall	141 (7)	70 (5)	71 (9)	
Transport accident	377 (18)	281 (21)	96 (12)	
Miscellaneous*	53 (3)	36 (3)	17 (2)	
Non-traumatic	40 (2)	17 (1)	23 (3)	
Unknown	84 (4)	50 (4)	34 (4)	

Table III. Injury mechanism in 2,132 patients.

*Includes self-inflicted injuries, abuse, and unspecified accidents.

Table IV. Distribution of fracture types, and the proportion of primary surgical treatment for each fracture type, for 1,995 fractures with registered treatment information.

Fracture type	Total fractures, n (%)	Early surgically treated fractures, n	Primary surgical treatment, %
Posterior wall	271 (14)	96	35
Posterior column	166 (8)	14	8
Associated posterior column and posterior wall	111 (6)	37	33
Anterior wall	418 (21)	31	7
Anterior column	181 (9)	60	33
Pure transverse	170 (9)	23	14
Associated transverse and posterior wall	89 (4)	37	42
T-shaped	138 (7)	45	33
Associated anterior and posterior hemitransverse	117 (6)	70	60
Associated both column	148 (7)	78	53
Unclassifiable	186 (9)	12	6

36) of the patients received a primary hip arthroplasty without supplemental fixation (Figure 3).

The rate of primary surgical treatment was higher in patients aged \leq 70 years (316/755; 42%) than in patients aged > 70 years (187/1,240; 15%).

The distribution of surgical and non-surgical treatment also differed between the fracture types. Associated anterior and posterior hemitransverse and associated both column fractures were most commonly treated surgically (60% and 53%, respectively). Anterior wall and posterior column fractures were most commonly treated non-surgically (7% and 8%, respectively) (Table IV).

Discussion

One key finding of the current study was that the mortality after an acetabular fracture in the elderly population was comparable to the mortality after hip fracture. The present study also found that acetabular fractures in Sweden are more common among males and most often due to low-energy injury mechanisms. The distribution of fracture type differed between high- and low-energy injures. There are clear differences in primary treatment modality between different fracture types.

Consistent with previous studies, the current study shows a male predominance (62%) among patients sustaining acetabular fractures. The German Pelvic Registry reports that patients with acetabular fractures

were male in 69% of the cases.9 Similar male/female ratios have also been shown by others.^{1,3,4,18} The reason for this is unclear. A decrease in proximal femur fractures due to enhanced osteoporotic treatment may instead have resulted in an increased load to the pelvis.¹⁰ However, such reasoning should result in an increased number of acetabular or pelvic fractures, mainly among the female population, as was the case in the study performed by Boufous et al.¹⁹ Part of the explanation for why acetabular fractures mainly occur in the male population may be due to the anatomical differences of the pelvis between the sexes. Wang et al²⁰ described that the more stable hip joint during anteroposterior loading among females is less likely to fracture or dislocate. The reported differences in anteversion and inclination of the acetabulum may also influence the likelihood to fracture under force.²¹ Another explanation could be that injury mechanisms differs between the sexes, as shown in the current study: male patients are more often the subjects of high-energy trauma mechanisms resulting in an acetabular fracture.

The previously shown increasing incidence of acetabular fractures among the elderly population is also in accordance with our results where more than 60% were aged > 70 years.^{1-3,7,9}

The injury mechanism is classified as high- or lowenergy trauma by the individual orthopaedic surgeon in the SFR. It is up to the surgeon to decide what type



Flowchart of primary treatment in 1,995 fractures with registered treatment. ORIF, open reduction and internal fixation.

of trauma the patient was exposed to, as there is no general definition of high- versus low-energy trauma in orthopaedics.

Despite a similar pre-injury function level, geriatric patients (\geq 60 years) with acetabular fractures have been reported to have a higher 30-day mortality risk compared to hip fracture patients in the same age group;²² Bergh et al^{23,24} reported similar mortality rates for both femoral and acetabular fractures among the elderly (> 80 years) in Sweden. The 30-day and one-year mortality in the elderly population in the current study is comparable to hip fracture patients.²²⁻²⁴

Many hospitals have developed a standardized and multidisciplinary way to improve care for hip fracture patients.²⁵⁻²⁸ Given the similar mortality rates, a similar multidisciplinary approach in geriatric patients who sustain acetabular fractures should be considered.

The current study also indicates that male patients aged > 70 years have a higher 30-day mortality than female patients. Male sex, adjusted for differences in comorbidities, has been associated with higher mortality, especially in the first weeks, following proximal femur fractures.²⁹ This was found despite males being younger at the time of injury. The reasons for the high mortality among males with either a hip fracture or acetabular fracture are still to be explained, but the causality can probably be expected to be similar in these two patient groups.

An anterior wall fracture was the most common fracture type in the current study, especially in low-energy injuries. In patients with high-energy trauma, a posterior

wall fracture was more common. Compared to the cases reported by Letournel⁵ and Matta,⁶ this indicates a change in fracture pattern. However, the cohort described by both authors mainly reported on surgically treated, younger patients, while the SFR includes patients of all ages regardless of treatment. Among high-energy injuries, the posterior wall fracture was most common (24%) in the SFR, which is comparable to the results from Letournel (24%). Yet, the fracture distribution in the current study differs from more recent studies where a lower proportion of anterior wall fractures are reported than in the current study.4,7,18,30,31 However, the frequency of posterior wall fractures is similar. Gary et al³⁰ and Ferguson et al⁴ reported a higher degree of both column fractures than we found. Ferguson et al⁴ studied displaced acetabular fractures over a 27-year period, noting an increase in elderly patients and describing a difference in fracture class distribution between younger and older patients. The differences in fracture class distribution are probably, at least in part, related to a selection of surgically treated patients in these studies.

Ochs et al⁷ reported data where the distribution of fracture types was more similar to our study except for anterior wall fractures. However, the number of anterior wall fractures in the SFR needs to be interpreted with some caution. When validating the classification in the SFR, only one out of 11 fractures classified as an anterior wall fracture in the SFR was an actual anterior wall fracture according to the established gold standard in that study.¹³ According to Letournel et al's³² description

of the fracture classes, a combination of anterior wall and anterior column fractures should be classified as an anterior wall fracture. This may not be known to the inexperienced registrant. Therefore, perhaps the accurate number of anterior wall fractures ought to be higher than previously described. It can also be theorized that lateral fractures of the superior ramus with an insignificant fracture line through the anterior wall are registered as anterior wall fractures. Another part of the explanation might be that, in contrast to most previous studies, the current study includes both surgically and non-surgically treated fractures. Non-surgically treated fractures in the SFR account for 75% of acetabular fractures, and anterior wall fractures were shown to be the fracture type least operated on. Thus, anterior wall fractures may have been under-reported previously.

In the current study, 10% (n = 205) of the fractures are labelled as unclassifiable. The Letournel classification is difficult to fully understand, and it takes experience to classify these fractures correctly. Despite this, it has stood the test of time and its reproducibility has previously been studied.^{13,33} As the classification is complex, it is surprising to find that only 10% of the acetabular fractures in the SFR are deemed unclassifiable, and that the Kappa value describing the accuracy of classification in the SFR is still acceptable.13

Age, comorbidities, fracture pattern, and the level of energy causing the fracture are considered in the treatment decision and may favour non-surgical treatment to a greater extent in the elderly than in a younger population. This may explain the large proportion of nonsurgical treatment in the > 70 years group in the current study. The Letournel classification does not consider the level of displacement in a fracture, and therefore it is a blunt instrument when it comes to indications for surgery.

As expected, associated anterior and posterior hemitransverse fractures, and the both-column fractures, most frequently underwent primary surgical treatment. More surprisingly, the posterior wall fractures were only operated on in 35% of the cases. In other studies, three out of four patients with a posterior wall fracture were treated surgically.^{7,30} This difference may be due to patient recruitment from level one trauma centres in these studies, in contrast to the current study where all Swedish hospitals, regardless of level, were included.

Most surgically treated fractures were treated with ORIF, which is the first choice of treatment for most displaced acetabular fractures.^{6,32} One in five surgically treated patients received an arthroplasty alone, or in combination with fixation. This technique is now the preferred option for many acetabular fractures in the elderly patients with osteopenic bone, marginal impaction, and a displaced quadrilateral plate where joint reconstruction is deemed impossible.34-39 Early reports

have shown favourable results regarding joint survival compared to ORIF alone.⁴⁰ The population in highincome countries is ageing, and consequently this group of patients with osteopenic fractures around the hip joint, where reconstruction is precarious, is increasing.¹⁻⁴

The major strengths of this study are the large number of patients, of all ages and all treatments, and the national coverage of the SFR. The SFR coverage increased during the study period from 50% in 2014 to 100% in 2020.12 The inclusion of patients from all orthopaedic units provides information on the full spectrum of injuries, and not only those selected for surgery or collected only from larger trauma centres.

One limitation is the completeness of the SFR. Although the aim is to register all fractures in the SFR, it can be speculated that the ones missing are more often non-surgically treated fractures, seen only once at the emergency department and not subject to surgery or follow-up.

In summary, acetabular fractures in Sweden are most common in patients aged > 70 years, the majority of whom are male. The fracture pattern is dependent on energy level, anterior wall fractures being most common in low-energy injuries and posterior wall fractures in highenergy injuries. Three out of four patients with acetabular fractures are treated non-surgically. The one-year mortality for patients aged > 70 is similar to the mortality after a hip fracture.



Take home message

- Elderly patients who sustain an acetabular fracture have similar one-year mortality as hip fracture patients - The majority of acetabular fracture patients are male and aged over 70 years.

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