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Review

Nonoperative management of acetabular fracture in elderly people: a viable option? Systematic review of the literature

Giorgio Cacciola[1], *Alessandro Aprato*[1], *Luigi Branca Vergano*[2], *Adel Sallam*[1], *Alessandro Massè*[1]
[1] University of Turin, Department of Orthopaedic Surgery, C.T.O., Turin, Italy; [2]Santa Chiara Hospital, Trento, Italy

Abstract. There is no consensus about the best treatment for acetabular fracture in older patients. The purpose of this study was to review the current literature looking for indication, perioperative information and outcome of nonoperative management for acetabular fractures in elderly.A systematic review of literature was performed on different research database by using various combination of the keywords "acetabular fracture", "elderly patients", "60 years", "nonoperative", "nonsurgical" and "conservative treatment".Six articles met our inclusion criteria, 315 patients aged 60 or more treated nonoperatively for acetabular fracture were included in the analysis. The average age was 78.1 years, the average follow-up length was 48.7 months. The main criteria for indication of nonoperative management for acetabular fractures were, old age (75 years or more), two or more important medical comorbidities, and minimally or undisplaced fracture. The most frequent fracture pattern was anterior column in 25.3% of cases. Fall from standard height was the most frequent causative mechanism in 80% of patients. A conversion total hip arthroplasty was performed after 8.3% of cases. A 1-year mortality of 18% was reported, an overall mortality of 33.1% at last follow-up was reported.The management of acetabular fractur in elderly is a challenging problem and there is no consensus about the best treatment. Currently, multiple treatment options have been suggested, depending on fracture pattern and patients' general conditions. Although operatively treatment allow for an early recovery, there is not an high level of evidence about the superiority in terms or complications and mortality rate compared to nonoperative treatment.

Keywords: acetabular fracture; elderly patients; nonoperative management; conservative management

Introduction

Nowadays, the global median age is increasing, and elderly people tend to have a more active lifestyle. For this reasons, acetabular fractures in the elderly (AFE) are getting more and more frequent; despite this changing situation, there is not a strong consensus about the optimal treatment of acetabular fractures in the elderly (1). The typical traumatic mechanism of AFE is a low-energy trauma, consisting in fall on the hip with direct impaction on the trochanteric region.

AFE are characterized by different features when compared with similar fractures in younger patients:

- involvement of the anterior column is very common in elderly patients, while involvement of posterior wall or column is more frequent in younger people (1);
- because of the high incidence of osteoporosis, AFE are characterized by comminution, dome impaction, quadrilateral plate involvement and femoral head osteochondral lesions. Because of these characteristics, anatomical reduction of the fracture, restoration of a congruent articular surface and obtaining a stable fixation are very difficult to reach (4, 5).

Many surgical treatments are available for AFE: open reduction and internal fixation (ORIF), percutaneous fixation, total hip arthroplasty (THA) alone or combined with ORIF (1). Surgical treatment for acetabular fracture reduces pain, allows early mobilization, reduces the hospital stay and reduces medical complications. On the other hand, surgical treatment

has known risks: infection, blood loss, wound complications, sciatic nerve injury, abductor weakness and heterotopic ossification (5).

Nonoperative management can be considered when treating acetabular fractures in people of every age: generally speaking, it can seem safer than surgical treatment (5, 6). Undisplaced or minimally displaced (< 2 mm) fractures could be treated nonoperatively, especially in elderly people. Absolute indications for surgical treatment even in elderly patients are displaced fractures with medialization of the femoral head and comminuted fractures of the posterior wall with consequent posterior instability and recurrent hip dislocation (9, 10).

The aim of this review is to analyze the current literature about AFE (aged 60 years old and over), considering mechanism of trauma, fracture classification, indications for nonoperative treatment, post-operative scores and postoperative level of function, total hip arthroplasty conversion rate and mortality.

Materials and Methods

Search criteria

This research was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (11, 12). The US National Library of Medicine (PubMed/MEDLINE), Embase, and the Cochrane Database of Systematic Reviews were queried for publications without time limitation, utilizing various combinations of search terms: "acetabular fracture", "elderly patients", "60 years", "nonoperative", "nonsurgical" and "conservative treatment". Only abstracts of papers that evaluated the clinical outcomes of acetabular fractures in elderly patients (age > 60 years) were reviewed (Figure 1).

Inclusion and exclusion criteria

Abstracts describing clinical outcomes after AFE aged 60 years or over were reviewed. Inclusion criteria were: any original study in which all patients aged 60 years or over were managed nonoperatively. Exclusion criteria were: studies with patients younger than 60 years, case reports, reviews, surgical techniques reports, biomechanical reports, instructional course lectures, book chapters and abstracts from scientific meetings.

Data Extraction

Two independent reviewers (GC and AA) separately conducted the described search of articles by title and abstract. The two authors compile a list of papers after application of inclusion and exclusion criteria. If the title and abstract of the study contained the inclusion criteria, the full manuscript was reviewed. In addition, a cross-reference search of the selected articles was also performed to obtain other relevant studies. If there was disagreement between the two authors, a third author (A.M.) was consulted to reach a consensus. During the initial review of the study, the following information were collected for each paper: title, first author, year of publication, study design, fracture classification, mechanism of trauma, indications for nonoperative management, rehabilitation protocol, medical complications, hip's related complications, mortality rate and clinical score.

Level of Evidence and Studies Quality

Assessment of quality of the studies was conducted using the Methodological Index for Non-Randomized Studies (MINORS) criteria (13,14). MINORS score ranges from 0 to 25, with a higher score meaning higher quality.

Results

Demographic information and studies quality

After application of inclusion and exclusion criteria, six studies (5-6,15-18) were included in the final analysis (Table 1). A total of 315 patients aged 60 years old or over suffering for acetabular fractures were included in the study. The mean age was 78.1 years (range 60-101). The mean follow-up was 48.7 months (range 12-70) (Table 1).

The quality of the included studies was variable, with average MINORS score of 10.2 points

Table 1. Demographic data of patients treated nonoperatively for acetabular fracture.

First Authot (YoP)	Study Design	N° of patients	Age (years)	Female (%)	Inclusion Criteria	Follow-Up (m)
Spencer (1989)	Retrospective Non Comparative	25	74 (65 to 85)	16 (64%)	patients aged between 65 and 95 years	9 to 52
Firooobazaki (2016)	Retrospective Comparative	99	78.6 +/- 7.4	27 (27%)	Aged 65 or older	nr
Walley (2017)	Retrospective Comparative	49	81 (65 94)	nr	Aged 75 years or older, or 65 with 2 or more comorbidities	14 (1 60)
Ryan (2017)	Retrospective Non Comparative	27	76 (70 to 94)	nr	Aged 60 with fracture pattern that met operative criteria	26 (12 78
Boudissa (2019)	Retrospective Comparative	44	73.8 (60 101)	12 (27.3%)	60 years, with Parker score > 6 and displaced acetabular fracture	minimum 2 years
Wollmer-stadt(2020)	Retrospective Comparative	67	80 +- 10	38 (56.7%)	60 years old with low energy trauma	70 +/- 31

YoP = Year of Publication

(range 8-15), revealing that the quality of the studies was quite low. A meta-analysis was not done because of this low score.

Indications for nonoperative management of acetabular fractures

Two studies did not specify the criteria used for nonoperative treatment of acetabular fractures and the only inclusion criteria mentioned was patients with an age > 65 years (15,16). One study (18) included patients, aged 60 years or over, who sustained an acetabular fracture after a low energy trauma. Fracture caused by this mechanism (for example, a fall from standing) was a criterion for nonoperative treatment. One study chose nonoperative treatment for patients aged > 75 years, or > 65 years with two or more medical comorbidities (6). Two studies (5, 18) included patients aged 60 years or over with a fracture pattern that met criteria for operative treatment; one of these two studies, as an adjunctive inclusion criterion, considered only patients with a Parker-Palmer score > 6 (This score is a "mobility score", used to assess the functional level of activity before the injury). Only two studies reported the specific criteria used for eligibility of the patients to nonoperative treatment. In the study by Ryan et al. (17) the most frequent reason that led to nonoperative management was old age (higher than 75 years) and medical comorbidities; other minor reasons were pre-existing arthritis, osteoporosis, poor bone quality and refusal of surgery. In the study by Boudissa et al. (5), the most frequent reason for nonoperative treatment was the presence of medical comorbidities, followed by old age (higher than 75 years), and refusal of surgery.

Fracture classification

Four studies used the Judet-Letournel classification criteria (5, 6, 15, 17), one study used the AO/OTA classification criteria (16) and one study did not report any fracture classification (18). Overall, 190 fractures were classified according to Judet-Letournel criteria. A simple pattern fracture occurred in 76.5% of the cases (145 patients), while a complex pattern occurred in 23.5% of the cases (45 patients). The most frequent simple fracture pattern was the involvement of the anterior column (25.3%, 48 patients), followed by transverse fracture (10.5%, 20 patients); among the complex fracture pattern, the most frequent was anterior column plus posterior hemitransverse fracture (9.5%, 18 patients), followed by both column fracture (8.9%, 17 patients). Fractures involving the posterior region of the acetabulum were rare; in these cases, the most frequent patterns were posterior wall fracture (8.4%, 16 patients), isolated posterior column fracture (3.2%,6 patients) and posterior wall plus column fracture (3.2%, 6 patients). Firoozabadi et al. (16) used the AO/OTA classification in 99 patients: the most frequent fracture pattern was 62 B3 (32.1%), followed by 62 C1 (20.1%) and 62C2 (13.5%) (Table 2).

Table 2: Classification according to Judet and Letournel criteria was reported in four studies. Simple fractures (76.3%) involving the anterior columns (25.3) were the most frequent.

	Simple Fracture					Complex Fracture						
First Author	**AW**	**AC**	**TF**	**PC**	**PW**	**BC**	**ACPHT**	**T-Shaped**	**T + PW**	**PW+PC**	**Simple**	**Complex**
Spencer	0	2	11	5	1	4	0	2	0	0	25	6
Walley	9	21	5	0	5	4	1	0	1	3	49	9
Ryan	1	5	4	0	1	4	9	0	0	3	27	16
Boudissa	0	20	0	1	9	5	8	0	1	0	44	14
Overall	10 (5.3%)	48 (25.3%)	20 (10.5%)	6 (3.2%)	16 (8.42)	17 (8.9%)	18 (9.5%)	2 (1.1%)	2 (1.1%)	6 (3.2%)	145 (76.3%)	45 (23.7%)

AW = anterior wall; AC = anterior column; TF = transverse; PC = posterior Column; PW = posterior wall; BC = both column; ACPHT = anterior column-posterior hemi transverse; T+PW = transverse and posterior wall; PW +PC = posterior wall and posterior column

Trauma Related Information

Mechanism of trauma

Five out of six studies (262 acetabular fractures) reported the mechanism of trauma. The most frequent cause was a fall from standing in 80% of the fractures (210 acetabular fractures), while a traffic accident (as motorbike or motor-vehicle accident) was the cause in 14% of cases (37 acetabular fractures); a fall from a height (> 2 meters) was the cause in 6% of cases (15 acetabular fractures).

Associated Injuries

Five out of six studies reported information about the presence of associated injuries. In three studies (15-17), it was reported the percentage of patients that suffered for at least an associated injury; in the other two studies (15, 17), it was reported the average Injury of Severity Score. Spencer et al. (15), reported an associated orthopedic injury in 44% of the cases (11 out of 25 patients); they concluded that, in presence of ipsilateral fractures of the femoral head, the outcome was generally poor. Firoozabadi et al. (16) reported that an associated injury was present in 33% of cases. Ryan et al. (17) reported an average Injury of Severity Score of 9.4 in their case series, while Boudissa et al. (5) reported an average Injury of Severity Score of 6.6. Ryan et al. (17) reported the presence of an associated single injury at the ipsilateral limb in 7.4% of the cases, multiple injuries at the same limb in 7.4% and associated chest injury in 3.7%.

Comorbidities

Four out of six studies reported the comorbidities of patients that sustained acetabular fracture. Firoozabadi et al. (16) reported that at least one medical comorbidity was present in 85.7% of cases, with an average of 2,2 medical comorbidities per patient. Walley et al. (6) reported that 24% of patients younger than 75 years have two or more medical comorbidities: the most frequent were coronary artery disease (45%), diabetes (25%) and chronic obstructive pulmonary disease. Ryan et al. (17) reported that patients had an average of two comorbidities; three patients (11.1%) presented four or more comorbidities. Boudissa et al. (5) reported that 22% of the patients reported at least one medical comorbidity.

Outcomes

Conversion to THA

Five out of six studies (289 patients) reported the conversion rate to THA due to secondary osteoarthritis. The overall conversion rate was 8.3% (24 cases), ranging from 2% in the paper by Walley (6) to 25% in Boudissa's series (5).

Mortality

Six studies (311 patients) (5-6,15-18) reported the overall mortality rate in nonoperatively treated acetabular fracture. The overall mortality was 33.1% (103 of 311 cases), ranging from 12% to 44%. Five out of six studies reported the data about 1-year mortality (6,15-18): the average 1-year mortality was 18%, ranging from 8% to 24% (Table 3).

Medical postoperative complications

Two studies reported the incidence of medical postoperative complications (5,18). Boudissa et al. (5) reported deep vein thrombosis in 11% of cases after nonoperative treatment, compared with 5% of cases in patients who underwent surgical treatment. Hearth failure was present in about 10% of cases in both group (operative and nonoperative). Wollmerstadt et al. (18) reported infectious complications (pneumonia or low urinary tract infection) as present in 22.9% of patients treated nonoperatively, while it was only 9% in patients treated operatively. In his series, patients treated operatively showed a higher incidence of thromboembolic event compared to nonoperatively managed patients, respectively 7.5% and 0.9%.

Level of function and scores

Postoperative outcomes expressed by clinical scores were reported in three studies. In two studies, Merle-D'Aubigne scores was used (5, 18), in one study WOMAC and HHS scores (17). In one study, three pre-injury scores (Parker-Palmer, Activity of daily living, instrumental activity of daily living) were used. Two studies didn't report pre-operative or post-operative scores (15,16). Boudissa et al. (5) reported A pre-injury Parker-Palmer score of 8.3, a pre-injury activity of daily living score of 5.5, a pre-injury instrumental activity of daily living of 6.4. Ryan et al. (17), reported a post-operative WOMAC score of 12.9. Wollmerstad et al. (18), reported a post-operative Merle D'Aubigne score of 14.

Discussion

In this systematic review, we analyzed fractures patterns, patient's data, outcomes and indications to nonoperative treatment of AFE. The weakest point of this review is the lack of high evidence studies with an appropriate number of patients on this topic. We point out and try to understand the argumentation at the base of nonoperative treatment of such fractures; as it is well known, this seems opposite to the optimal treatment for similar fractures in younger people (open reduction and stable internal fixation for acetabular fractures) (19, 23).

Indications for nonoperative management of acetabular fractures

Acetabular fractures are articular fractures that need an anatomic reduction in order to obtain a good functional outcome. Nonoperative management is feasible in case of congruence of the hip joint, articular stability and absence of displaced fractures on the weight-bearing acetabular dome. In this systematic review, we report as age, comorbidities and pre-injury activity level play an important role in decision making, when choosing between operative or nonoperative treatment.

There is high variability in terms of inclusion criteria among the studies analyzed in this review.
Some studies considered "elderly" only the patients aged 60 years old or over, while two other studies considered patients over 65 years old (15, 16). One paper (18) included only patients over 60 years that sustained an acetabular fracture after a low energy trauma; these were the only two criteria utilized for submitting a patient to nonoperative treatment. One study chose nonoperative treatment for patients aged 75 years or over, or 65 years or over but with two or more medical comorbidities (6). Two studies (5, 18) included patients aged 60 years or over with a fracture pattern that met criteria for surgical treatment; in addition one of these two studies (18) included only patients with a Parker-

Palmer score > 6.

Only two studies reported the specific criteria for nonoperative treatment. In the study by Ryan et al. (17) the most frequent reason that led to nonoperative management was old age and the presence of medical comorbidities; other causes of exclusion from surgical treatment were secondly considered (pre-existing arthritis, osteoporosis and refused surgical treatment). In the study by Boudissa et al. (5), the most frequent reason for nonoperative treatment was presence of comorbities, followed by old age and refusal of surgical indication by the patient.

The role of age in decision making

In the last years, as other fragility fractures, acetabular fractures have become more frequent in elderly population (4,19-21). Feguson et al. (4) reviewed a prospective database of 1309 acetabular fracture gathered between 1980 and 2007, comparing the incidence over time between patients younger and older than 60 years. They reported a 2.4-fold increase in acetabular fractures of the older patients between the first and the second half of the study period. The incidence of AFE was 10% between 1980 and 1994 and 24% between 1995 and 2007 (4). Rinne et al. (24) reported an overall increase in incidence of acetabular fracture in the Finnish population: from 6.4/100.000 fractures per year in 1997 to 7.2/100.000 fractures per year in 2014; the incidence of these fractures in younger population remained constant in this period, while a considerable increase in incidence was reported in patients older than 60 years.

In this review, the average age for patients treated nonoperatively is 78.1 years (range 60 to 101 years). This is slightly higher than the average age of patients operated for acetabular fractures in the paper by Capone et al (25), whom average age was 71.6 years (range 55 to 96 years). Similarly, Goyal et al. (26) reviewed 48 studies about AFE (7878 geriatric patients), reporting an average age of 72.4 years (treated both surgically or non surgically)

Mechanism of injury

In elderly patients the incidence of different fracture patterns is different from younger people. A fall from standing, with direct hit on the greater trochanter, pushes the head from posterior to anterior and from lateral to medial. This force is transmitted through the anterior wall or column and involves the quadrilateral plate as well. Indeed, as reported in the German Trauma Registry, anterior column fracture is the most common simple fracture, and anterior column plus posterior hemi-transverse in the most common complex fracture (27).

Another point to discuss is the energy of injury. The prevalent mechanism of injury for AFE is a fall from standing: in the present study we report this mechanism in 80% of cases. Other reviews, that included patients treated operatively, reported fall from standing as the most frequent mechanism of trauma as well, but with a significantly lower incidence (4, 26). Capone et al (24) reported 54% of fractures caused by a fall; Goyal et al reported fall from standing in 47,1% of cases (26).

AFE caused by low energy trauma occurs very often in osteoporotic bone; nonoperative treatment of such cases can be advisable also for the risk of inability to get a good reduction (for the comminution) and a stable fixation (for bad bone quality). When nonoperative treatment is chosen, the partial articular congruence, as consequence of an unreduced fracture, is counterbalanced by avoidance of the risks correlated with anesthesia and with surgical treatment. This argumentation could explain the high rate of low energy fractures in studies where conservative treatment was chosen, in contrast to relatively low rate (of low energy fractures) in studies analyzing operative treatment.

Comorbidities

Medical comorbidities play an important role in decision making. Medically unfit patients with several medical comorbidities are often treated nonoperatively (28, 29). In the present review, four out of six studies reported information about comorbidities. Firoozabadi et al. (16) reported 85,7% of patients with one or more comorbidities; Walley et al. (6) reported that 24% of patients younger than 75 years had two or more comorbidities. Coronary artery disease and diabetes were the most frequent comorbidities (5, 6).

Metabolic and cardiovascular diseases, obesity and severe osteoporosis are common in these patients. In case of one or more comorbities, the prognosis of formal open surgical procedure is worse and other options can be considered: prosthetic replacement, minimally invasive surgery or nonoperative treatment (5,6-16). The current data support the theory that medical comorbidities should be strongly considered in the process of decision making when treating acetabular fractures in elderly people.

Outcomes

This review shows a low incidence of THA conversion in patients treated nonoperatively (8.3%, range 2% to 25%) (6, 16), that is lower when compared with patients treated with ORIF (nearly 30%) (30-31%).

Similar to hip fracture in elderly population, AFE are associated with an increased risk of mortality in the perioperative period . In our review, we reported a mortality rate of 18% at one-year follow-up, and an overall mortality of 33.1%, with an average follow-up of 48.7 months. Gary et al. (32) reported the mortality rate in a multicenter study including 454 patients: considering both surgical and conservative treatment, one-year mortality rate was 18%. Patients treated nonoperatively showed higher mortality rate than those treated with ORIF. When results were adjusted for confounder factors, as age, gender, mechanism of trauma, and Charlson Comorbidity Index, no significant difference in hazard of death were documented. They observed that factors as age > 60 (Hazard Ratio 1.5), age > 70 years (Hazard Ratio of 1.08 per year) , and complex fractures (Hazard Ratio 1.51) were associated with an increased risk of mortality (32,34). This study reveals that age and comorbidities are the main factors affecting mortality rate, more than the treatment itself. Firoozabadi et al. (16) reported one of the higher overall mortality rates (32.7% at one year), with 78.4% of these patients died within 75 days from the injury. In their study, 44% of patients treated nonoperatively was died at one-year follow-up. Khosbin et al. (35) compared mortality rate and perioperative complication of elderly patients affected by acetabular and hip fractures. They reported the mortality rate at 30-days: 6.6% for acetabular fracture and 4.6% for hip fractures ($p = 0.14$). No differences were noted for perioperative complications, such as deep vein thrombosis, deep and superficial wound infection, pneumonia and stroke (35,38). The only statistically significant difference was for pulmonary embolism, that was more frequently associated with acetabular fracture.

Limitations

We had some limitations in this study.

First, we were limited by the low quality of the analyzed studies. The variability in the inclusion criteria was one of the main concerns in this review. Another important difference is that some studies included patients with fractures pattern amenable to nonsurgical treatment, while other studies included patients treated nonoperatively for general contraindications. Moreover, methods used for outcomes report were different among different studies.

Second, our methodology did not allow for identification of unpublished literature and is limited by potential publication bias. Larger multicenter studies that use similar outcome assessment measures would be helpful to better compare results of nonoperative and operative treatment of AFE.

Finally, there was high variability in rehabilitation protocols following nonoperative treatment.

Conclusion

The management of AFE is a challenging problem and there is no consensus about the best treatment. Currently, multiple treatment options have been suggested, depending on fracture pattern and patients' general conditions. Acute THA have become a commonly used treatment for acetabular fractures in elderly patients, while ORIF is preferred in younger patients. Although operatively treatment allow for an early recovery, there is not an high level of evidence about the superiority in terms or complications and mortality rate compared to nonoperative treatment in AFE.

In conclusion, we can assume that nonoperative management is a viable option in presence of undisplaced or minimally displaced AFE (27). Moreover, patients with a displaced fractures that are medical unfit to sustain a surgical procedure are also candidates

for nonoperative treatment, considering that they have a low incidence of secondary osteoarthritis, and mortality rate and postoperative outcomes similar to operated patients.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article

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Correspondence:
Alessandro Aprato, MD
University of Turin, Department of Orthopaedic Surgery, C.T.O., Turin, Italy.
Via Gianfranco Zuretti n°29
Turin, 10126, Italy
Phone: 3386880640
E-mail: Ale_aprato@gmail.com