Acetabular Fractures in an Advanced Age – Current Knowledge and Treatment Options

Zlomeniny acetabula v pokročilém věku – současný stav poznání a možnosti léčení

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SUMMARY

The demographic change in industrial countries leads to an increasing population that sustains an acetabular fracture in an advanced age. Some authors predicted elderly individuals to be the most rapidly growing subgroup of patients currently sustaining acetabular fractures. Gold standard of treatment of acetabular fractures remains the open reduction and internal fixation. Relevant factors impeding surgical treatment include the significantly decreased bone stock and the incapability of the patients to partially weight bear following surgery. Therefore, special considerations should be performed when dealing with this patient group as surgical treatment is associated with several risks and often accompanied by poor outcomes. This review aims to summarize the current body of knowledge and to give a recommendation concerning a surgical treatment cascade.

INTRODUCTION

Due to the demographic change in industrial countries with an aging but still active population, the incidence of osteoporotic fractures associated with low energy traumata continues to increase (28, 46). The group of An *et al.* estimated the incidence of these fracture to approximately double within the next 20 years (1). National registers of acetabular fractures both in Europe and the United States demonstrated a shift of the mean age towards the geriatric patient population (9, 37). Ochs *et al.* documented a shift of the age distribution peak from 21-30 years in the first time period (1991–1993) to 61–70 years in the latest one (2005–2006) in the register of the German Pelvic Group (37). Some authors predicted elderly individuals to be the most rapidly growing subgroup of patients currently sustaining acetabular fractures (24, 32). Whereas the risk to develop perioperative complications is elevated due to the patient's higher age anyway, it is potentiated by comorbidities and medication (25, 35). Additional factors impeding surgical treatment include the significantly decreased bone stock and the incapability of the patients to partially weight bear following surgery. Many authors emphasized, that the advanced age patient cohort often presents with special fracture patterns that differ significantly from those of younger patients (9, 11, 27, 43). While younger patients often suffer from high energy traumata that often involve both columns, low energy fractures as mainly seen in geriatric patients, lead to pathologies that may also involve both columns fractures. However, fractures of the anterior column with a high percentage of impaction of the supraacetabular dome, posterior wall fractures and medial dislocation the quadrilateral surface are the typical fracture patterns for the elderly patient (9, 27, 43). The typical fracture patterns can be explained by the medial dislocation of the femoral head which follows the dislocation of the quadrilateral surface. This mechanism leads to further damage to the articular surface of the hip joint (22, 38) and to a superomedial roof impaction that is represented by the so-called gull sign commonly seen on plain pelvic radiographs (Figure 1a) (5). A complicating factor is the constantly seen comminution of the fracture zone in this age group (32).

Gary et al. postulated in their study, that many patients who meet operative criteria can be mobilized without surgery and may achieve similar results compared to surgical treatments (11). However, anatomic reduction resulting in articular displacement of less than 2 mm prevents the early onset of posttraumatic osteoarthritis (OA) of the hip and is the main predictor for a good clinical outcome, known from the pioneering work of Matta and Judet (17, 30, 31). Thus, gold standard is the open reduction followed by a stable fixation in younger patients in an attempt to minimize a secondary need for arthroplasty (11). Up to now, there is no sufficient evidence that elderly patients should be treated under the same criteria than the above mentioned. A 60-year-old active male merits different treatment considerations than a 90-year-old male with a comparable injury (11). As mentioned, decision making process in the treatment of acetabular fractures is fairly more complex for geriatric patients and must be adapted to individual circumstances.

Therefore, this review aimed to summarize the current knowledge in the management of acetabular fractures of geriatric patients regarding the conservative or specific surgical treatment options and their clinical outcome.

Diagnostic Workup and Classification

The basic radiographic evaluation is the anteroposterior pelvic film. However, some authors still recommend the obturator and iliac oblique Judet view (5). In our centre,

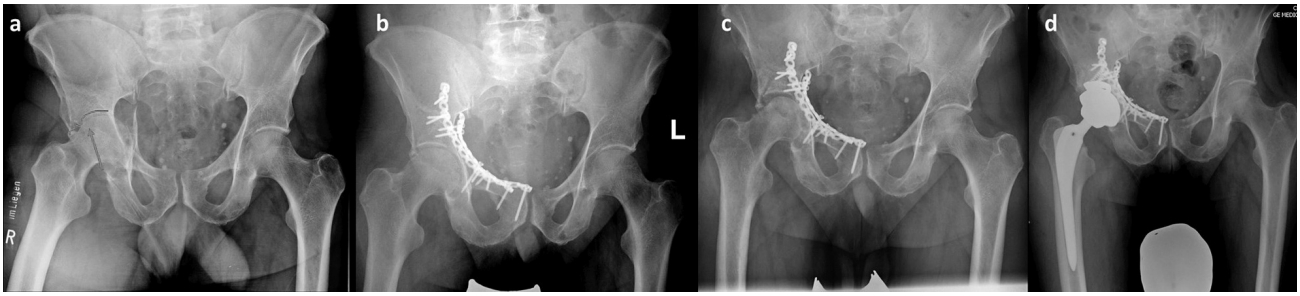

Fig. 1. 60-year-old male patient that sustained a low energy trauma. He presented with a anterior column posterior hemitransvers fracture of the right side and the gull sign present in the AP view of the pelvis (a). Although reconstruction was performed with a good reduction quality (b), implant failure was seen six months postoperative (c). One month later the patient was subject to arthroplasty (d).

we resign these views while all patients are subject for computed tomography (CT) scans. The possibility of two-dimensional as well as three-dimensional reconstructions that are freely movable in all plains in real time at the computer screen now provides an excellent overview of the fracture pattern and is most helpful for preoperative planning. Furthermore, the CT scan allows are more detailed interpretation of the fracture pattern and thereby a better preoperative classification that helps to direct the surgeon to the adequate treatment approach. The classification of Letournel and Judet is still the most widely used classification system for acetabular fractures that divides the fracture types into simple and associated fractures (21). The AO/ASIF (**A**ssociation for the **s**tudy of **i**nternal **f**ixation) developed a more detailed classification system that provides a variety of fracture types. In addition, further information about the status of the joint, that are gained during surgery, can be coded. These additional informations are useful for research purposes and should be documented whenever possible. Regarding the known current fracture distribution, a recent epidemiological study (focussed on patients aged 60 years and above) demonstrated that the most frequent fracture pattern in this age group is the both column fracture (26.4%), followed by pathologies that involve the anterior column (9). They also found, that the proportion of elderly patients that demonstrated with a fracture of the acetabulum increased during the 27 years' study period (2.4-fold more in the second half of the study). These findings are in concordance to other publications that emphasize the shift in fracture patterns of the elderly patient group (9).

Risk factors

To date, several risk factors, that are associated with poor outcome have been published. Generally, these factors can be divided into fracture morphology (radiographic signs), patient and surgery related factors. Regarding radiographic signs Anglen et al. described the so-called "gull sign" to be strongly correlated with fixation failure and poor outcome (Fig. 1a–d) (2). It represents an impaction of the subchondral bone of the anteromedial roof into the osteopenic supporting bone (2). In addition, other poor prognostic factors found in the radiographic evaluation have been described previously (Table 1) (2, 5, 9, 44). Regarding the patient related factors, to date, advanced aged and osteoporosis/osteopenia have been linked to poor outcome (2, 32). Risk factors related to the surgical treatment could also be identified: In concordance to the results in young patients, the quality of reduction seems to play a major role (34). Furthermore, the delay of surgery of more than 11 days has been identified to be accompanied by worse outcome (34).

Treatment options

Before considering the specific therapeutic strategy, the full history of the patient should be assessed. It should be focussed on the patients' associated injuries, comorbidities, ambulatory status, functional demands, housing situation and signs of osteoarthritis of the hip joint (5, 32). A complete physical examination should be performed with a focus on signs of osteoporosis (previous fragility fractures). As any other fragility fracture the diagnostic cascade (e. g. vitamin-D level and other factors) should be evaluated and a clinician comfortable in the evaluation and treatment of low bone density should be involved (5).

Nonoperative treatment

Prior to the pioneering work of Matta and Judet fractures of the acetabulum were treated nonoperatively. Matta and Judet could clearly demonstrate, that anatomic reconstruction of the articular surface with a resulting step/gap of less than 1–2 mm prevents the progression of posttraumatic hip osteoarthritis and is the main predictor for a good clinical outcome (15, 30, 31, 39). This induced a shift in the treatment strategy so that surgical treatment is now considered gold standard of treatment. Nevertheless, nonoperative treatment is indicated in fractures that exhibit so-called secondary congruence. This means that all fracture elements may settle around the femoral head and achieve a congruent reduction (45). Gänsslen et al. demonstrated, that the concept of secondary congruence works in selected cases (31 patients, 77% excellent functional results, 17% degenerative changes or pain with a mean follow up of 5 years) (10). However, in some cases

Table 1. Published risk factors associated with poor outcome or failure of fixation following operative stabilisation of acetabular fractures

Radiographic findings
Gull sign
Femoral head impaction fracture
Marginal impaction
Hip dislocation
Osteoarthritis
Femoral head or neck fracture
Comminution of the posterior wall

nonoperative treatment of even displaced fracture may be a necessity when comorbidities or the general status of the patient does not allow an anaesthesiologic intervention or if patients are functionally incapacitated. Anyhow the surgeon must be aware that nonoperative treatment of acetabular fractures historically yielded in poor results (31). In the past, attempts were undertaken with trochanteric and longitudinal traction and bed rest. Sen et al. managed thirty-two displaced fractures with closed techniques. A good reduction was achieved in 56% of the cases, however, 44% of the cases resulted in a poor clinical outcome (41). Other authors could demonstrate similar results (42). Specific indications for a nonoperative treatment of geriatric acetabular fractures do not exist. However, literature on acetabular fractures demonstrated that nonoperative treatment can be an option in fractures that simultaneously meet the following criteria as published earlier (5):

- < 2 mm displacement
- Roof arc angle 45°
- Posterior wall fracture < 20% of the posterior wall
- Stability of the hip joint and congruity
- Absence of poor prognostic factors (see Table 1).

The nonoperative treatment protocol consists of a period of bed rest for initial pain control which should be as short as possible followed by early mobilisation with partial weight bearing under physiotherapeutic supervision. In our department those patients are seen at 3, 6 and 12 weeks as well as 6 and 12 month for plain X-ray control to monitor for displacement and clinical result. A longer period of bed rest should be omitted in this patient group given the morbidity and mortality associated with prolonged bed rest (16).

Preoperative considerations

Patient preparation

Before planning the surgical procedure, the patient should be properly prepared. A brief risk analysis and elucidation of the patient is mandatory to achieve informed consent prior to a surgical intervention. This should include a realistic assessment of the goals that can be achieved regarding mobility and expected quality of life. Medical comorbidities should be evaluated and attempts to improve the general status of the patient should be made as studies demonstrated that comorbidities adversely influence outcome (34). However, the decision for an operative treatment should not be based on the concern for increased or decreased mortality as the group of Gary et al. could demonstrate that the risk for death does not significantly differ compared to conservative treatment when comorbidities are taken into account (13). When trying to translate results from periprosthetic fracture management in elderly patients concerning postoperative mortality, one could recommend to especially concentrate on preoperatively assessing and improving cardiac dysfunctions even if this results in delay of the surgery. Data of our group show that disturbed cardiac functions where mainly correlated with a higher rate of mortality whereas delay in timing of surgery did not show any influence. (Märdian S, Perka C, Schaser KD, Gruner J, Scheel F, Schwabe P. Cardiac disease and advanced age increase the mortality risk following surgery for periprosthetic femoral fractures. Bone Joint J. 2017;99-B:921–926.)

Surgical approach

Due to the complex anatomy and the three-dimensional geometry of the acetabulum, a multitude of anterior, posterior or combined and extended approaches have been described to address the diversity of fracture patterns (6, 39, 40). Irrespective of patient's age and individual patient characteristics, the choice of the appropriate surgical approach depends on the preoperative analysis and fully understanding of the fracture pattern. Ideally, all aspects of the fracture can be addressed via one specific approach. Although, the ilioinguinal approach according to Letournel (17, 20, 21) is regarded as gold standard for anterior pathologies (27), the intrapelvic approaches (modified Stoppa approach according to Cole (6), pararectus approach according to Keel (18)) gain more and more popularity and literature documents an ongoing effort to present outcomes of patients treated by either of the intrapelvic approaches. Our group tried to summarize the major benefits using the pararectus approach (27):

- Better visualisation and direct buttressing of the quadrilateral surface
- One incision approach (compared to the modified stoppa approach that might need an additional incision (first window of the ilioinguinal approach) depending on the fracture morphology)
- No touch of the ilioinguinal canal
- Facilitated wound closure.

A recent study of Elmadag et al. which focussed on the comparison of the ilioinguinal approach and the Stoppa approach did not show differences in blood loss, functional outcome and complication rates. However, considering that pathologies involving the quadrilateral surface are rising disproportionally, the possibility to directly access this region of the pelvis is again one of the major advantages of the intrapelvic approaches. Regarding fractures that involve the dorsal column/wall structures, the Kocher-Langenbeck approach remains to be gold standard (22).

Open reduction and internal fixation

The sequence of reduction is guided by the underlying fracture pattern and the preoperative planning that should consider the special fracture patterns that occur in the elderly patient cohort. It generally starts with the disimpaction of the medialised femoral head via lateral traction which is applied using a Schanz pin placed in the femoral neck (5). The reduction of the impacted roof segments is facilitated with the use of intrapelvic approaches (pararectus, modified Stoppa approach) while direct visualisation of the roof fragment is possible (4, 27). We recommend void filling with bone graft to support the roof segment. In our practise, the direct buttressing of the quadrilateral plate is either performed by a contoured infrapectineal pelvic reconstruction plate (Fig. 2a) or an infrapectineal plate of the Stryker Matta Pelvic System (Fig. 2b). However, it has to be mentioned, that the rigid fixation of the quadrilateral plate can be the most difficult part of the procedure (32). When the fixation of the quadrilateral surface is completed, the anterior column is stabilised by a contoured pelvic reconstruction plate which is placed along the pelvic brim (Fig. 2a and 2b). We prefer placing screws above the dome in different planes to additionally support the roof fragment. These screws may be solitary lag screws or they are placed through the infrapectineal and the anterior column plate. Laflamme et al. demonstrated good clinical results when an infrapectineal plate was applied in osteoporotic acetabular fractures. Secondary loss of reduction was seen only in 2 of 21 cases (19).

Closed reduction and internal fixation

Some authors advocated percutaneous fixation to minimize perioperative risks (12). In a series of 12 patients treated with percutaneous screw fixation of acetabular fractures, we demonstrated good to excellent results in all cases with no adverse events (39). Gary et al. demonstrated in their series of 43 patients that functional outcome and conversion to hip arthroplasty did not differ when compared to published series of open reduction and internal fixation (14). However, these procedures can only be performed in selected cases of non-displaced fractures or fractures where anatomic reduction can be achieved in a closed manner. In addition, the patient should be able to follow a distinct postoperative weight bearing regime, which generally is a problem for geriatric patients.

Arthroplasty

A standard indication for acute total hip arthroplasty (THA) in acetabular fractures of elderly patients does not exist. It remains to be an individual decision and authors often confine, that this method of treatment was performed for selected cases only. However, studies

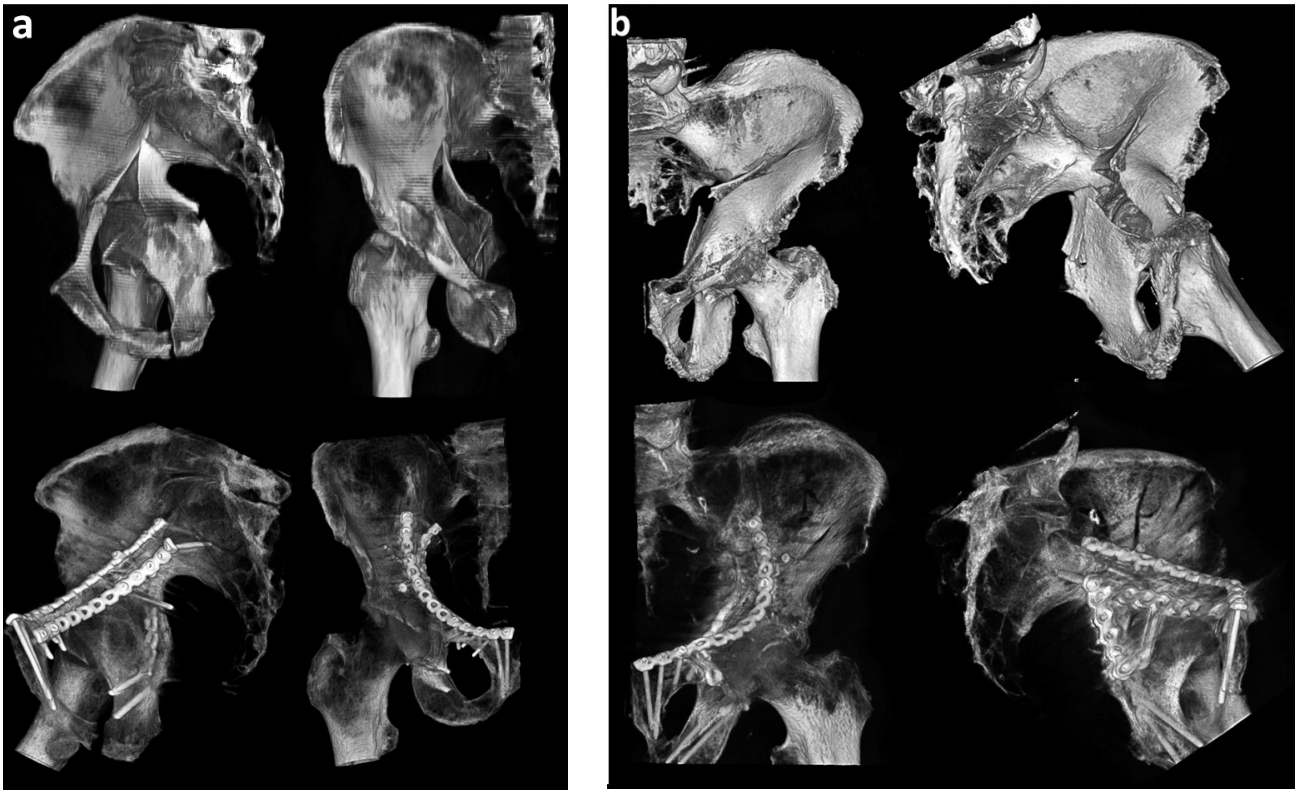

Fig. 2a. 73-year-old male with a two column fracture of the right acetabulum. Reduction was performed in a two stage procedure (starting with the dorsal column via Kocher-Langenbeck approach and secondly the anterior pathology via pararectus approach). The pararectus approach offers the opportunity to directly buttress the quadrilateral surface with a plate.

Fig. 2b. 83-year-old male suffering from a low energy trauma that lead to a anterior column posterior hemitransvers fracture of the left acetabulum (high variant). Reduction was performed via pararectus approach and the infrapectineal plate of the Stryker Matta Pelvic System was used to buttress the quadrilateral surface.

focussing on acute hip arthroplasty in acetabular fractures proposed several indications for this type of treatment (33):

- Severe non-reconstructable comminution related to poor bone stock
- Cases in which the impacted zone of the fracture accounts for more than 40% of the dome
- Accompanying femoral head and/or neck fractures
- Pre-existing severe osteoarthritis.

Nevertheless, acute THA often requires additional plating to fix at least one column, mainly the posterior one, for a sufficient anchorage of the acetabular component. In a retrospective study of 33 patients with acetabular fractures, only 4 (12%) did not need an additional plate osteosynthesis when treated with acute THA (23). Results of acute THA in elderly patients seem to be promising. Mears et al. published the results of 57 patients (mean age 69 years) treated with acute THA with a mean Harris Hip Score of 89 (33). In this cohort 79% had a good or excellent outcome. Another series of 15 patients with a mean age of 76 years resulted in an mean Harris Hip Score of 88 (8).

However, a recently published study of 162 surgically treated acetabular fractures only 20 (12%) received acute THA while most patients (n = 142) were treated with open reduction and internal fixation (88%) (26). In this series, the indication for acute THA was significantly associated with the above-mentioned risk factors. A systematic review that analysed eight studies on acetabular fractures in patients aged beyond 55 years demonstrated similar failure rates (defined as conversion to THA) (7). In this analysis 86% of the cases showed an acceptable reduction with an anatomical reduction (according to the criteria published by Matta et al. (29)) achieved in 45.3% of the cases. Despite these data, that provide a high reduction quality, there is a significant rate of secondary osteoarthritis. O Toole et al. published a series of 147 patients with acetabular fractures. Of 46 that were treated by plating, 28% were in need for a secondary arthroplasty due to secondary osteoarthritis (36). Another group that reviewed 26 patients aged 70 or above found 5 patients (19%) that received a secondary total hip arthroplasty (3).

CONCLUSIONS

Published data concerning the outcome of acetabular fractures of elderly patients do not draw a clear picture. Different outcome measurement tools, inhomogeneous patient cohorts and different methods of treatment make a direct comparison difficult. Open reduction and internal fixation remains to be gold standard in the treatment of displaced acetabular fractures to prevent from posttraumatic arthritis and the need for further surgery. The growing patient cohort of elderly sustaining an acetabular fracture with its special fracture patterns represents a challenging issue for orthopaedic surgeons regarding the decision-making process with special regard to the differential indication of conservative or type of surgical treatment. Innovative implant designs as well as advances in surgical approaches and postoperative intensive care may help to improve the clinical outcomes and diminish postoperative complications and mortality.

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