Outcome of surgically treated acetabular fractures: risk factors for postoperative complications and for early conversion to total hip arthroplasty

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Abstract

Introduction The gold standard of Acetabular fractures treatment is open reduction and internal fixation (ORIF). Our purpose is to assess the short- to medium-term outcomes and complications of surgically treated acetabular fractures. We analysed factors influencing clinical outcomes, incidence of complications and predictors of conversion in total hip arthroplasty (THA).

Materials and methods We retrospectively analysed 102 patients with acetabular fracture surgically treated between December 2017 and September 2020. We evaluated the quality of reduction with x-ray measuring residual displacement, classified into 3 groups (Matta Radiological Score). At the final follow-up, radiographs were graded according to Matta’s Radiological Outcome Grading, and the clinical outcomes were graded using Oxford Hip Score (OHS).

Results 62 patients were enrolled. OHS was influenced by quality of reduction ($p=0.031$), injury severity score (ISS) ($p=0.003$) and BMI $>30$ ($p<0.0001$). The late sequelae were heterotopic ossification (HO) in 13 patients, osteoarthritis (OA) in 22 and avascular necrosis (AVN) in 4. HO was significantly affected by posterior approach and ISS $>15$. The analysis showed a correlation between AVN and posterior hip dislocation. OA had a correlation with postoperative quality of reduction ($p=0.014$). Eight patients required THA with a significant correlation between THA and posterior dislocation, isolated posterior wall fracture and ISS $>15$.

Conclusion A high rate of patients with acetabular fractures still develop complications and require THA. Identification of predictors for poor outcome may help to inform surgical decision-making regarding options of plate osteosynthesis or ‘Fix and Replace’, to avoid poor outcomes and early revision surgery.

Keywords Acetabular fracture · ORIF · Hip arthroplasty · Polytrauma · Postoperative complications

Introduction

Acetabular fractures are relatively rare injuries (3/100.000 per year), with increasing incidence particularly in less developed countries [1]. They usually present a bimodal distribution in younger patients after high-energy traumas and in older patients after a low-energy fall [2]. For displaced acetabular fractures, surgical treatment with open reduction and internal fixation (ORIF) is considered the gold standard. Operative treatments of acetabular fractures

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remain challenging interventions and carry substantial risks [3]. Complications following ORIF are common and include posttraumatic osteoarthritis (OA), chondrolysis, avascular osteonecrosis (AVN) of the femoral head, heterotopic ossification (HO) and iatrogenic nerve palsies [4, 5]. When posttraumatic joint disease develops, total hip arthroplasty (THA) may be the only option available [6]. The aim of the present study is to further delineate the associated risk factors and predictors for adverse clinical outcome in the short to mid-term following acetabular fracture surgery, with an aim to improve surgical decision-making. The secondary objective is the assessment of the mid-term patient reported outcome of surgically treated acetabular fractures as well as occurrence of subsequent interventions.

**Material and methods**

This study is a retrospective review of 102 patients-treated surgically for closed pelvic trauma consisting of an isolated acetabular fracture by a single experienced surgeon between December 2017 and September 2020 in our Trauma centre. The inclusion criteria were adult patients with a pelvic injury consisting of isolated acetabular fracture surgically treated with ORIF and postoperative follow-up of at least 2 years. Exclusion criteria were patients with associated pelvic ring injury or open fracture, loss to follow-up, or a follow-up shorter than 2 years. Those undergoing primary THA (‘Fix and Replace’) were excluded (x = 42) (Fig. 1). All patients were admitted via our emergency department and a detailed clinical examination and radiological assessment were collected. In patients with posterior hip dislocation, closed reduction was carried out within 6 h. Demographic data for each patient were collected. Imaging studies included radiography (anteroposterior and Judet views) and computed tomography scans with surface-rendered 3-dimensional reconstructions. Fractures were classified as Judet-Letournel classification. Surgical technique consisted of open reduction and internal fixation via a modified Stoppa with lateral window, ilioinguinal, or Kocher-Langenbeck approach as determined most appropriate based on fracture pattern. Fixation was performed using a pelvic reconstruction plating system (Matta Pelvic System, Stryker, USA). Intraoperative fluoroscopy is routinely employed in our institution to evaluate the quality of the reduction achieved, determine the presence of intraarticular bodies and to confirm extraarticular placement of the screws. As part of our perioperative protocols, patients routinely receive antibiotic prophylaxis and surgery is performed under general anaesthesia. Post-operatively a tube drain with vacuum bottle is placed, remaining in situ for 24–72 h based on drain output. Anti-thromboembolic prophylaxis consisted of low-molecular weight heparin and was administered until the patient regained full weightbearing gait. No prophylaxis for HO was administered. The Matta Radiological Score was applied to postoperative radiographs: anatomical (0–1 mm of gap), congruent (2–3 mm) or incongruent (> 3 mm) [4]. We do not currently perform a CT scan as part the postoperative protocol in our institution. Rehabilitation is led by a team of experienced musculoskeletal physiotherapists and tailored to the patient and the fracture; in the majority of the cases, the patients began with quadriceps, hip and knee flexion exercises as early as possible. Toe-touch weightbearing was permitted unless contraindicated by concomitant injuries. Partial weightbearing was permitted for 6 weeks, progressing to weight bearing as tolerated from 8 to 12 weeks. Follow-up appointments with clinical and radiological assessment were performed at 1, 2, 3, 6, 12 and 24 months. Radiographs at 24-months follow-up or beyond were assessed using the Matta Radiological Outcome Grading system [7]. Functional outcome was evaluated using the Oxford Hip Score (OHS) [8]. Any presence of HO was classified according to Brooker et al. [9], and AVN as per Ficat and Arlet [10]. Complications or adverse outcomes such as postoperative anaemia, surgical site infection, neurological
deficit, deep vein thrombosis or pulmonary embolism were recorded at each follow-up episode.

**Statistical analysis**

Statistical analysis was performed using SPSS statistics software version 25.0 for MACINTOSH (IBM, Armonk, NY). The normal distribution was tested with Kolmogorov–Smirnov’s test. Descriptive statistics (mean, standard deviation etc.) were used to describe the patients’ variables and clinical, functional and radiological outcomes. Categorical variables were assessed using the Chi-square test or Fisher’s exact test for statistical significance. Continuous variables were compared using paired and unpaired t-test as appropriate. A nonparametric test used to measure the strength of association between the two variables, quality of fracture reduction (Matta Radiological Score) and Matta’s Radiological Outcome Grading, was Spearman’s rho coefficient. P-values < 0.05 were considered statistically significant.

**Results**

Sixty-two patients met the inclusion criteria, of which 15 females and 47 males. Mean age was 53.4 years. Patient characteristics are summarised in Table 1. Road traffic accidents (RTAs) were the most common cause of trauma (50% of cases). The mean injury severity score (ISS) was 12.9 ± 9.6, and 27 patients (43.5%) sustained other injuries. The trauma-related injuries and fracture types are summarised in Tables 2, 3. The surgical approach best suited to each fracture pattern was determined by the operating surgeon and consisted of the modified Stoppa with iliac window (n = 32), Kocher-Langenbeck (n = 26) and Ilioininguinal (n = 4) approaches. Post-operative assessment of fracture reduction as per the Matta radiological score [4] was “Anatomical” (n = 44), “Congruent” (n = 14) and “Incongruent” (n = 4).

**Clinical and radiological outcome**

The OHS was classified as ‘Excellent’ in 30 hips, ‘Good’ in 15, ‘Fair’ in 4 and ‘Poor’ in 13 [7]. The mean score was 35.4 points (range 7–48). The OHS was significantly influenced by the quality of reduction (Fig. 2), ISS and age of the patients. Patients with OHS classed as ‘Excellent’ or ‘Good’ were younger than patients returning an OHS classed as ‘Fair’ or ‘Poor’ (51.7 ± 13.3 years vs 58.7 ± 16.2 years (p = 0.046)). The sex of the patient, type of fracture and presence of posterior hip dislocation at emergency department admission did not significantly correlate with clinical outcome (Table 4). A significant correlation was identified between the patient BMI and OHS at final follow-up. Patients with a ‘Fair’ or ‘Poor’ classed OHS outcome score had a higher BMI (30.69 ± 5.36) than patients with ‘Good’ outcome (25.89 ± 3.64). Furthermore, obesity (BMI > 30) significantly affected the postoperative outcomes of surgically treated acetabular fractures (p < 0.0001). At final radiographic follow-up, the Matta Radiological Outcome Grading was determined as ‘Excellent’ (n = 20), ‘Good’ (n = 23),

| Table 1 Demographics |  |
|---|---|
| Variable |  |
| Age | 53.4 ± 14.26 (24–81) |
| Male | 47 |
| Female | 15 |
| Weight (BMI Kg/m²) | 27.89 ± 5.12 |
| Laterality | 27 Right: 35 left |
| Follow-up (months) | 39.9 ± 16.5 (24–57) |
| Injury severity score (mean) | 12.9 ± 9.6 (4–57) |
| Posterior dislocation (n) | 16 |
| Delay in surgery (days) | 8.26 ± 4.74 (1–30) |
| Intensive care post-operative (n) | 23 |
| Hospitalization (days) | 24.58 ± 12.36 (7–66) |

| Table 2 | Associated injuries |  |
|---|---|
| Trauma | n = |
| Head | 20 |
| Chest | 23 |
| Intra-abdominal | 14 |
| Upper extremity fractures | 21 |
| Lower extremity fractures | 15 |
| Vertebral fractures | 9 |
| Major vascular | 5 |
| Neurological deficit | 7 |

| Table 3 | Fracture pattern distribution according to Judet Letournel |  |
|---|---|
| Type | n = |
| Simple | 25 (40.3%) |
| Posterior wall | 19 |
| Posterior column | 0 |
| Anterior wall | 1 |
| Anterior column | 5 |
| Transverse | 0 |
| Complex | 37 (59.7%) |
| Posterior column + posterior wall | 1 |
| Transverse + posterior Wall | 5 |
| T-shaped | 1 |
| Anterior column + hemi-transverse posterior | 7 |
| Both columns | 23 |
‘Fair’ \( (n=11) \) and ‘Poor’ \( (n=8) \). Analysis of the correlation between the initial postoperative Matta Radiological Score and the final follow-up Matta Radiological Outcome Grading score was performed using the Spearman Rho test, demonstrating a coefficient of 0.411 \( (p=0.001) \) indicating a significant correlation of moderate strength.

### Failures and complications

Complications related to both trauma and surgical treatment are summarised in Table 5. The 7 sciatic nerve deficits, all present before the surgery, were in patients with posterior wall, posterior column + posterior wall and transverse + posterior wall fractures. We recorded 1 case of sciatic palsy without functional recovery, and two cases of superficial peroneal nerve deficit, both of whom had partial recovery of function. One patient with deep infection was treated surgically with debridement and partial removal of hardware combined with prolonged antibiotic therapy. One fracture non-union required a second revision fixation surgery based on an ilioinguinal approach. At final radiographic follow-up HO was recorded in 13 patients, post-traumatic OA in 22 and AVN of the femoral head in 4. HO was significantly associated with the use of the Kocher-Langenbeck approach \( (p=0.031) \) and by an ISS value > 15 \( (p=0<0.001) \). Fracture pattern \( (p=0.880) \) and posterior dislocation \( (p=0.590) \) were not significantly associated with HO formation. All

### Table 4

| Factors                    | Oxford score | \( p = \) |
|----------------------------|--------------|----------|
|                            | Poor + moder- | Good + excellent | Total |   |
| Sex                       |              |          |         |   |
| Male                      | 12           | 35       | 47      | 1.000 |
| Female                    | 4            | 11       | 15      |   |
| Body mass index (Kg/m\(^2\)) |              |          |         |   |
| < 30                      | 5            | 40       | 45      | <0.0001 |
| \geq 30                   | 11           | 6        | 17      |   |
| Posterior dislocation     |              |          |         |   |
| Present                   | 6            | 10       | 16      | 0.214 |
| Absent                    | 10           | 36       | 46      |   |
| Quality of reduction      |              |          |         |   |
| < 2 mm                    | 8            | 36       | 44      | 0.031 |
| \geq 2 mm                 | 8            | 10       | 18      |   |
| Injury severity score     |              |          |         |   |
| \geq 15                   | 9            | 8        | 17      | 0.003 |
| < 15                      | 7            | 38       | 45      |   |
| Type of fracture          |              |          |         |   |
| Simple                    | 7            | 18       | 24      | 0.745 |
| Complex                   | 9            | 28       | 38      |   |

Table 5 Complications recorded

| Complication            | \( n = \) |
|-------------------------|----------|
| Post-operative anemia   | 15       |
| Deep vein thrombosis    | 7        |
| Wound infection         | 1        |
| Hardware failure        | 1        |
| Nerves lesion           | 7        |
| Systemic infection      | 3        |
| Heterotopic ossification| 13       |
| Post-traumatic arthrosis| 22       |
| AVN                     | 4        |
4 patients with femoral head AVN were identified to have a documented posterior hip dislocation on arrival in the emergency department. A significant correlation between femoral head AVN and posterior hip dislocation was determined \((p=0.004)\). Post-traumatic OA had significant correlation \((p=0.014)\) with the quality of the reduction achieved as determined on initial post-operative radiograph. Patients with Matta Radiological Score rated as ‘Congruent’ and ‘Incongruent’ developed OA more frequently than patients with an ‘Anatomical’ reduction.

**Total hip arthroplasty**

Eight patients with poor radiological and clinical outcomes subsequently underwent hip arthroplasty. The mean OHS in this subgroup was 12.9±1.46, and the mean Matta Radiological Outcome Grade was 2.5. Amongst these patients, four presented with femoral head AVN, 3 with severe HO (Brooker grade III/IV) and four with advanced OA. Compared with patients who did not require arthroplasty, we noted a significant correlation between requiring arthroplasty and initial posterior hip dislocation \((p=0.022)\), isolated posterior wall fracture \((p=0.039)\) (Fig. 3) and an ISS score value greater than 15 points \((p=0.029)\). The quality of the reduction was not associated with subsequent arthroplasty \((p=0.680)\). In patients who underwent arthroplasty, we observed a significant improvement in mean OHS from 12.9±1.46 to 38.2±13.67 \((p<0.001)\).

**Discussion**

Acetabular fractures still represent a challenge for orthopaedic trauma surgeons, with moderate clinical outcomes and high rates of complications reported [11]. In the present study, 27.4% of patients was limited to a final follow-up OHS category of ‘Fair’ or ‘Poor’. This is comparable to results from the metanalysis by Giannoudis et al. [1] in which 16 studies assessed functional results using the Merle d’Aubigné score and five studies employed the Harris hip score. Of those using the Merle d’Aubigné score, 20.6% of the population \((n=1610)\) was scored as ‘Fair’ or ‘Poor’. With the Harris hip score, 26.8% of patients \((n=600)\) had ‘Fair’ and ‘Poor’ results [1]. Additional studies using the Harris Hip Score have produced similar results; Mears [12] and Matta [7] respectively, reporting 28% and 24% of outcomes as ‘Fair’ or ‘Poor’.

Several variables may affect the outcome of acetabular fractures and contribute to poor results. The accuracy of reduction correlates strongly with the outcome, and return to preinjury functional activity is not common [12]. In the present study, 45 out of 62 hips (72.6%) had ‘Excellent’ or ‘Good’ medium-term OHS, which is comparable to the results reported by other groups [11, 13]. According to the literature, Excellent’ or ‘Good’ functional outcomes can be obtained in the majority of patients if anatomical reduction is achieved [14, 15]. Of the 62 hips in the present study 44 (70.96%) were determined to have ‘Anatomical’ reduction on assessment using the Matta Radiological Score. Eighty percent of our patients with an anatomical Matta radiological score had ‘Excellent’ or ‘Good’ outcomes. Furthermore, the OHS was significantly affected by ISS \((p=0.003)\), BMI \((p<0.0001)\) and age \((p=0.046)\). Patients with an ISS < 15 exhibited a better functional outcome at the final follow-up. Moed et al. did not analyse ISS, but highlighted the detrimental effects of associated musculoskeletal injuries on clinical scores in their patient cohort [16]. In our cohort the BMI > 30 significantly affected the postoperative outcomes \((p<0.0001)\). Karunakar et al. [17] and Morris et al. [18] reported that obesity is associated
with increasing complications following operative fixation of pelvic and acetabular fractures. In our group analysis, patients with OHS classed as ‘Excellent’ or ‘Good’ were younger than patients returning an OHS classed as ‘Fair’ or ‘Poor’ (51.7 ± 13.3 years versus 58.7 ± 16.2 years). The older group was significantly more likely to score poorly in the final OHS (p = 0.046) according to previous findings by Wollmerstädt [19]. The quality of postoperative acetabular fracture reduction is the most important predictor not only of clinical function, but also of radiological grade and development of OA [7]. We report that a postoperative displacement greater than 2 mm has a significant effect on both the functional score (p = 0.031) and Matta’s Radiological Outcome Grading (Spearman Rho coefficient of 0.411 (p < 0.001)).

Complications of acetabular fractures and ensuing surgeries are frequently documented in the literature [1, 20]. Incidence of infection reported is in the order of 2–5% [17–19]. We report one case (1.6%) of deep infection of the surgical site associated with fistula. We recorded 7 cases (11.2%) of deep vein thrombosis (DVT) with no cases of pulmonary embolism. In the literature, the perioperative incidence of DVT is variable. Wang et al. [20] described an incidence of DVT of 29.1% in patients with acetabular fractures. Other studies have reported acetabular fractures associated incidences of DVT between 2 and 33.7% [20, 21]. We identified 7 cases (11.2%) of sciatic nerve palsy present at ED admission. No cases of iatrogenic nerve palsy were recorded. Comparable rates are reported by Briffa et al. [22] and Meena et al. [3], 12.4% and 12% sciatic nerve palsy respectively, with 3 cases of nerve palsy in Briffa et al. [22] population. The literature indicates that the incidence of patients with neurological deficits, including iatrogenic injuries after acetabulum fracture, is 5–33% [13, 23, 24].

In the present study, we identified a 60% rate of late complications; 13 cases of HO, 22 of OA and 4 of AVN. Despite the urgent closed reduction within 6 h, 6% of our cohort of patients suffered from femoral head AVN comparable to incidences reported in the literature (3–11%) [1, 14, 25]. Femoral head AVN development was significantly associated with presence of posterior hip dislocation (p = 0.004), according to previous authors that described femoral head AVN as predominantly a complication following traumatic posterior hip dislocation [26, 27], highlighting the importance of expeditious hip reduction, with increased risks if a 12-h window following injury is exceeded [26, 27]. HO represents a common problem in acetabular fractures, with the aetiology still the subject of debate [28]. The incidence of HO in our study population was 20.1%. This rate is incomparable with the literature [1, 29]. We currently do not administer HO prophylaxis, as the efficacy remains controversial [29, 30]. The analysis of our cohort detected a significant association between HO formation and use of a posterior surgical approach (p = 0.031) or an ISS value > 15 (p < 0.001). The most frequently observed late complication in the present study was development of post-traumatic OA which concords with previous literature [4] where incidences of 20–50% are reported [1, 11, 14, 31]. We report an incidence of 34.5%. Analysis of potential predictor variables of OA revealed a significant association between post-traumatic OA and poorer quality of articular surface reduction (p = 0.014) according to Giannoudis et al. [1]. Furtermore, Ziran et al. [14] reported that when the reduction was anatomical (< 2 mm), the incidence was 13.2%, however, if it was not satisfactory (> 2 mm), the incidence of OA increased to 43.5% [14].

OA and femoral head AVN are both predictors for conversion to THA. In our study, 8 patients (12.9%) ultimately required conversion to a THA. Four of them had developed femoral head AVN, 3 profound HO (Brooker IV) and 4 post-traumatic OA. Several studies showed similar rates of THA, between 18 and 24%, though the follow-up intervals varied from the present study [15, 29]. Analysis within the present study did identify significant correlation between THA and potential the predictive risk factors of posterior hip dislocation (p = 0.022), isolated posterior wall fractures (p = 0.039) and ISS scores > 15 points (p = 0.029). Within the literature, cited predictors for THA include patient age, ‘less-than-anatomical’ reduction, particularly incongruence of the acetabular roof [12], femoral head cartilage lesion, acetabular cartilage impaction, delayed reconstruction, and relocation of a posterior hip dislocation later than 12 h [32, 33]. Tannast et al. [34] identified additional risk factors, including hip fracture-dislocations, and involvement of the posterior acetabular wall to be associated with a subsequent need for THA. Posterior hip dislocation and posterior acetabular fractures are typically hallmarks of a high energy trauma, often accompanied by comminution and impaction of the posterior wall, chondral damage and interruption of the femoral head vascular supply. These fracture features are thought to represent risk factors for subsequent poor outcome and therefore further treatment with THA [35].

The retrospective, single-centre, nature of present study subjects it to some limitations. A relatively small sample of patients could be achieved (n = 62). Our follow-up period of a minimum of 12-months and a mean of 27.7 months may not capture the full extent of long-term conversion to THA. Despite these drawbacks, this study presents a view of recent medium-term outcomes of contemporary techniques, with patients being recruited in a recruitment window lasting just 3 years. A further strength lies in the homogenous, single-surgeon series using homogeneous rehabilitation principles. This allows a more direct and controlled comparison of the potential risk factors and outcomes assessment using a validated patient reported outcome tool (OHS) [8]. By providing this recent original work to the literature we aim to inform future systematic reviews considering the topic and
demonstrate that outcomes have not substantially improved in the past 20 years [1, 15, 34]. A high rate of patients with acetabular fractures still develop complications and need THR [15, 16, 35].

Conclusions

Data from the case series study confirm that a good surgical reduction of acetabular fractures can provide a good to excellent result over a midterm follow-up. A significant association of poor outcomes with obesity, ISS > 15, incongruent fracture reduction, fracture of the posterior wall or column, or posterior hip dislocation may require further investigation. These predictors of poor outcome may help to inform surgical decision-making regarding the options of plate osteosynthesis or ‘Fix and Replace’, in the goal to avoid poor outcomes and early revision surgery. AVN cannot be reliably predicted, so the authors do not suggest primary prostheses in younger patients with posterior hip dislocation associated with posterior column or posterior wall fracture.

Author contributions LZ, LC and PDB contributed to the study conception and design. Material preparation, data collection and analysis were performed by LZ, SG, LC and DB. The first draft of the manuscript was written by LZ and LC, and all authors commented on previous versions of the manuscript. DTB edited the manuscript. All authors read and approved the final manuscript.

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Data availability All data are available in the main text and tables. Additional information can be provided if solicited.

Declarations

Conflict of interest All authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Therefore, no benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

Ethical approval All authors have participated in the research, the article has not been submitted elsewhere and there is no financial interest to report. All patients accepted the proposed treatment and follow-up after an adequate information and written informed consent. The study and follow-up, respecting the criteria of the Declaration of Helsinki, have been approved by Institutional Review Board (IRB) of Azienda Ospedaliera Universitaria Careggi (AOUC) Department of Surgery and Translational Medicine.

Consent for publication Obtained.

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