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Single-Stage Open Reduction or Reconstruction With Total Hip Arthroplasty for Displaced Acetabular Fractures

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Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

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Case series

Patients: Female, 67-year-old • Male, 25-year-old • Male, 70-year-old • Male, 70-year-old

Final Diagnosis: Acetabular fracture

Symptoms: Altered joint movement • hematoma • pain

Clinical Procedure: —

Specialty: Orthopedics and Traumatology

Objective: Challenging differential diagnosis

Background: Despite advances in surgical techniques and increased clinical experience, displaced acetabular fractures present a significant challenge for the orthopedist. The current gold standard for treatment is an open reduction and internal fixation. However, significant complications such as post-traumatic osteoarthritis and avascular necrosis of the femoral head persist. In such cases the effective solution is total hip arthroplasty. Four cases were treated with a single-stage open reduction with a total hip arthroplasty, and the available literature on this topic was analyzed.

Case Reports: Four cases with acetabular fractures were managed. They were classified using the Letournel classification. Postoperative assessment was done via a clinical evaluation, and a Harris Hip Score instrument. Case reports are presented for 4 patients: 1 aged 25 years, 1 aged 67 years, and 2 aged 70 years. The mean body mass index was 29.4 kg/m². A Kocher-Langenbeck approach was mainly utilized in all the patients. The follow-up period was 27, 49, 22, and 122 months, respectively. The Harris Hip scores at the final follow-up were 87, 92, 80, and 85 points, respectively.

Conclusions: Open reduction and internal fixation alone remains the gold standard for displaced acetabular fractures. However, in selected older patients or those with fracture patterns carrying a high risk of avascular necrosis or post-traumatic osteoarthritis, single-stage open reduction or reconstruction with total hip arthroplasty appears feasible and may avoid the need for secondary arthroplasty. Larger comparative studies are needed to define optimal patient selection.

Keywords: Acetabulum • Fracture Fixation • Hip Prosthesis • Osteonecrosis

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Introduction

The management of displaced acetabular fractures remains a subject of ongoing debate, particularly in young patients who typically sustain these injuries from high-energy trauma. The current gold standard for treatment is surgical intervention, specifically open reduction and internal fixation (ORIF) with plates and screws. However, despite advances in surgical techniques and increasing clinical experience, significant complications such as post-traumatic osteoarthritis and avascular necrosis of the femoral head persist. In cases in which these complications arise, total hip arthroplasty (THA) is often the only effective solution.

Acetabular fractures are relatively rare, with an incidence of about 3 per 100 000 cases annually, and predominantly affect young individuals after a high-energy trauma [1]. However, the epidemiology of acetabular fractures has significantly changed over the decades. Since the 1990s, there has been a marked increase in cases in older adults [2]. This shift is supposedly due to aging populations and improved survival. By 2017, the median age of patients who sustained an acetabular fracture had risen to 77 years, compared with 49 years in 2004, based on data from the German Pelvic Registry [3]. Notably, acetabular fractures display a bimodal distribution: younger individuals are injured in high-energy events, while older adults sustain fractures from low-energy mechanisms [4,5]. The complexity of acetabular fractures varies, potentially involving the anterior or posterior wall, anterior or posterior column, or the acetabular roof or floor. The Letournel classification system is widely used to categorize acetabular fractures [6]. It has been highlighted that 2-column fractures are the most prevalent, particularly in patients over 55 years old, in which they account for 23% to 26% of cases [7]. Fractures of the anterior column occur in up to 11.4% of cases, while posterior column fractures are much less common, observed in only 1.7%. Transverse and T-type complex fractures represent approximately 10% [8].

Stable, non-displaced fractures are often managed conservatively. The literature supports non-operative treatment for fractures with an intra-articular gap of less than 2 mm in the weight-bearing zone or a column separation of less than 5 mm [6]. However, in cases in which these criteria are not met,

ORIF remains the preferred treatment. The primary objective of ORIF is to achieve an anatomical reduction and stable fixation, thereby reducing the risk of post-traumatic osteoarthritis. Displaced fracture patterns present a significant clinical challenge [1].

There is a paucity in the literature on studies that describe results on studies with displaced acetabular fractures that are treated with both open reduction or reconstruction and THA, single-stage. The purpose of this report was to present 4 cases treated with the mentioned technique, and to analyze the available literature on this controversial topic.

Case Reports

The CARE Guideline (checklist for reporting a case report or case series) was used. In accordance with the guidelines of the Bulgarian Health Research Authority, separate ethical approval and informed consent, including consent for the publication of clinical information and images, were legally waived for this study (institutional review board protocol No. 2339/ 20.01.2021).

Four cases which were treated in 2 institutions are described. The demographic characteristics of the patients are presented in **Table 1**.

Patients underwent a posterior Kocher-Langenbeck approach; in 1 case, an additional ilioinguinal approach was utilized for femoral head removal. During the initial procedure, fractures were openly reduced or reconstructed and stabilized either with plates and screws or using an autologous bone graft from the spongy part of the femoral head. Following fracture stabilization, a THA was performed.

Postoperative rehabilitation followed a protocol similar to that used in revision arthroplasty. Patients were mobilized on the day of surgery and were gradually allowed weight-bearing with the assistance of 2 devices over a period of 2 months. Individualized rehabilitation processes in these complicated cases are commonly used. The protocol should be customized based on the patient's age, comorbidities, and specifics

Table 1. Patients' key characteristics.

Clinical case	Age, sex	Body mass index	Injury description
Case 1	67, female	30.1	Fracture of posterior column of right acetabulum
Case 2	25, male	29.2	Fracture of left acetabulum and Pipkin type 4 fracture
Case 3	70, male	27	Fracture of left acetabulum with medial protrusion
Case 4	70, male	31.5	Transverse acetabular fracture with medial migration

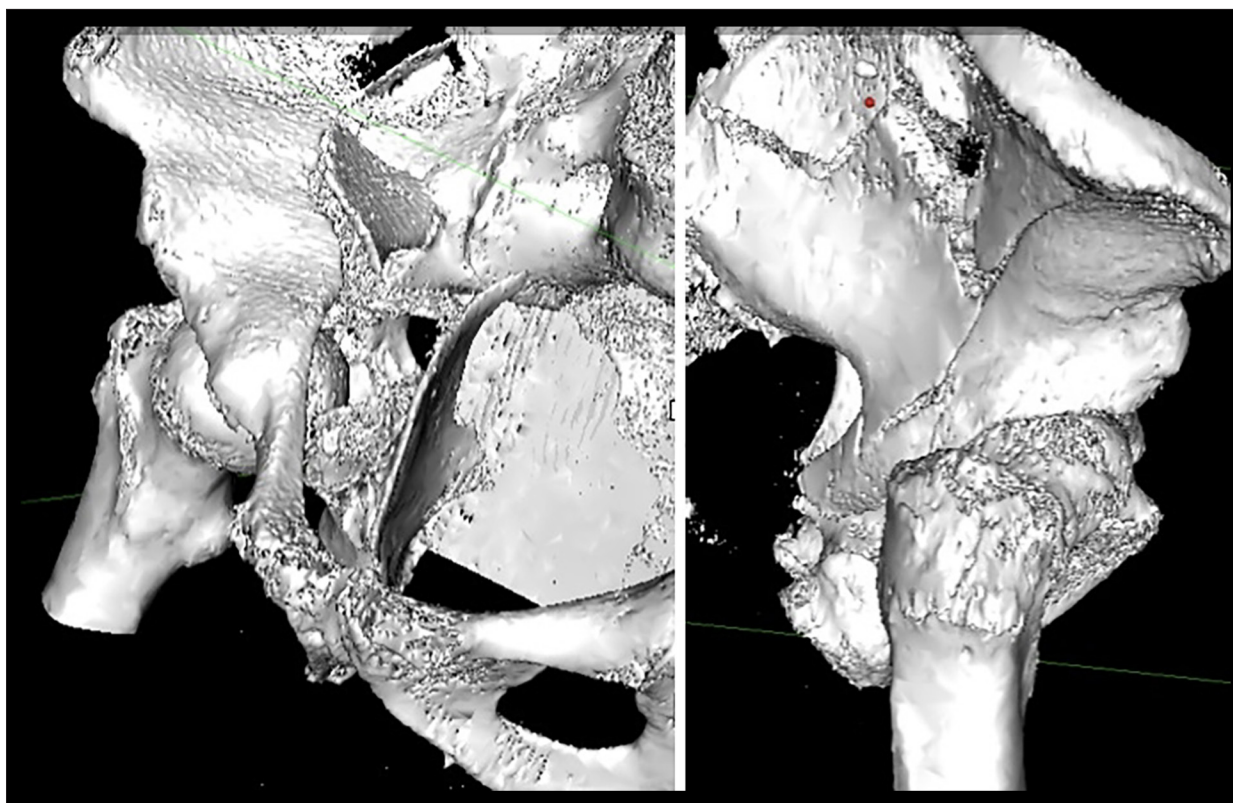


Figure 1. Three-dimensional reconstruction of the fracture pattern. A comminuted fracture line proximally at the wing of the iliac bone is seen on the anterior side (left), and the posteriorly (right).

of the surgical procedure. Engaging a multidisciplinary team, including orthopedic surgeons, physical therapists, and occupational therapists, contributes to a comprehensive recovery plan. Patient education on the importance of adherence to rehabilitation and safety precautions is also critical for achieving better outcomes.

Clinical Case 1

A 67-year-old woman presented with a fracture of the posterior column of the right acetabulum, sustained from a pedestrian road traffic accident. She was admitted to the emergency department with severe pain in the right hip region. The patient had a mitral-valve prosthesis as a comorbidity. Upon admission, there were no signs of leg shortening or external rotation, and no vascular or neurological deficits were noted. Larey and Eriksen tests were positive. The patient was hemodynamically stable and in overall good condition. Examination by the on-duty surgeon indicated no internal organ injuries or pelvic instability. Diagnostic X-rays confirmed the fracture of the posterior column of the right acetabulum, according to the Letournel classification. Following hospitalization, the patient underwent a 3-day preoperative preparation, which included the administration of low molecular weight heparin due to a mitral valve prosthesis. Further imaging with 3-dimensional

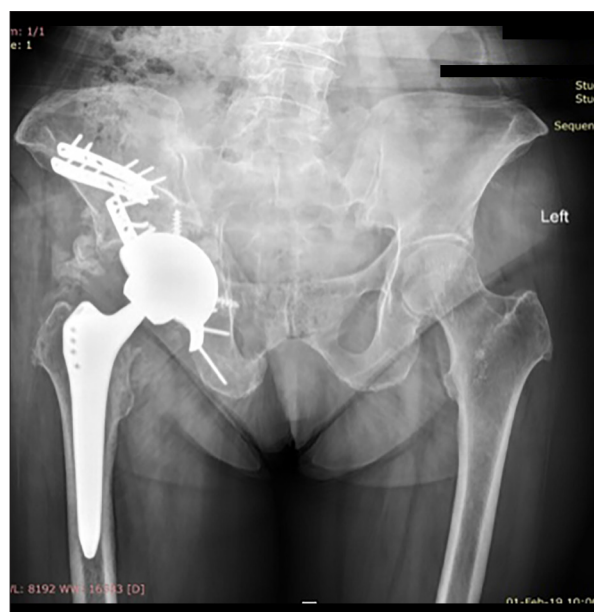


Figure 2. Postoperative radiograph after cementless total right hip arthroplasty with plate fixation of the concomitant acetabular fracture.

reconstruction from computed tomography revealed a comminuted fracture line proximally at the wing of the iliac bone (**Figure 1**). Due to the significant dislocation, the decision was made to perform operative treatment involving a THA alongside a plate osteosynthesis of the posterior column of the acetabulum. The time from injury to surgery was 3 days for this case. A posterior approach utilizing the Kocher-Langenbeck technique was employed to access the fracture site. This approach was extended proximally to reach the fracture line in the ala ossis ilii, which was then reduced and stabilized with plates and screws. Subsequently, a THA was conducted on the same joint using a cementless total hip prosthesis.

The postoperative course and rehabilitation were uneventful. The patient was discharged with instructions for a protective regimen for the operated limb. Following physiotherapy and adherence to the prescribed treatment plan, the patient resumed daily activities. At the 3-month follow-up, the Harris Hip Score was 87 points (**Figure 2**). At the final follow-up (27 months) the score remained at 87 points. Common complications such as heterotopic ossification, sciatic nerve injury, surgical site infection, prosthetic loosening, and lower extremity deep vein thrombosis were not recorded on the final follow-up in this patient.

Clinical Case 2

A 25-year-old man sustained injuries to the pelvis and left hip joint in a motorcycle accident. Initial first aid, including direct skeletal traction, was administered at an external medical facility. Five days later, he was transferred to the institution. The patient had no comorbidities. Upon admission, he was in stable general condition, with no internal organ injuries or vascular-neurological deficits in the affected limb. Diagnostic X-rays revealed a fracture of the left acetabulum and a Pipkin type 4 fracture of the left femoral head, with dislocation of the femoral head into the pelvis. Posterior wall acetabular fracture was concomitant, according to the Letournel classification. The time from injury to surgery was 6 days for this clinical case. Surgical treatment was performed, consisting of single-stage open reduction and a THA (**Figure 3**). In the initial surgical stage, an ilioinguinal approach was used along with an osteotomy of the iliac wing to access the obturator foramen. The femoral head was subsequently exposed and removed, and the osteotomy was stabilized with a single screw (**Figure 4**). The posterior-wall acetabular fracture was reduced. After that, the joint was reached through a Kocher-Langenbeck approach and a cementless total hip prosthesis was implanted (**Figure 5**). The decision to perform a THA on this young patient was dictated by the severity of the initial trauma, the status of the soft tissues and the femoral head blood circulation. Since there would be a very high risk of avascular necrosis of the femoral head in this patient, and considering



Figure 3. Preoperative radiograph evaluating an acetabular fracture with a left femoral head fracture (Pipkin type 4).

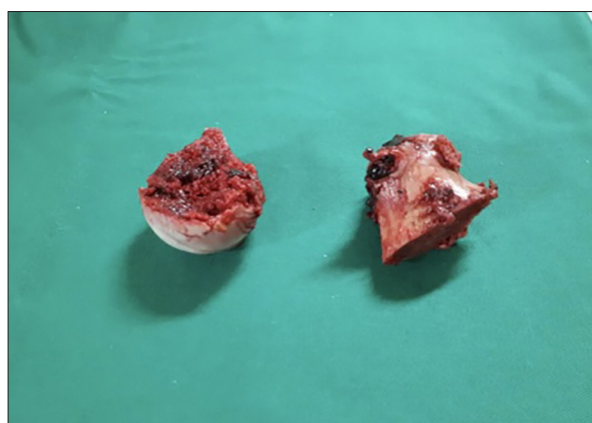


Figure 4. Native photos of the head and neck of the femur in a patient with Pipkin type 4 fracture.

the poor status of the bone of the femoral head fracture, a decision to perform a THA was deemed more appropriate. No complications were recorded until the end of hospital treatment. The patient was discharged with recommendations for physiotherapy. The Harris Hip Score on the third postoperative month was 94 points. No additional complications were registered at the 4-year follow-up period (49 months), which included a 92-point Harris Hip Score.

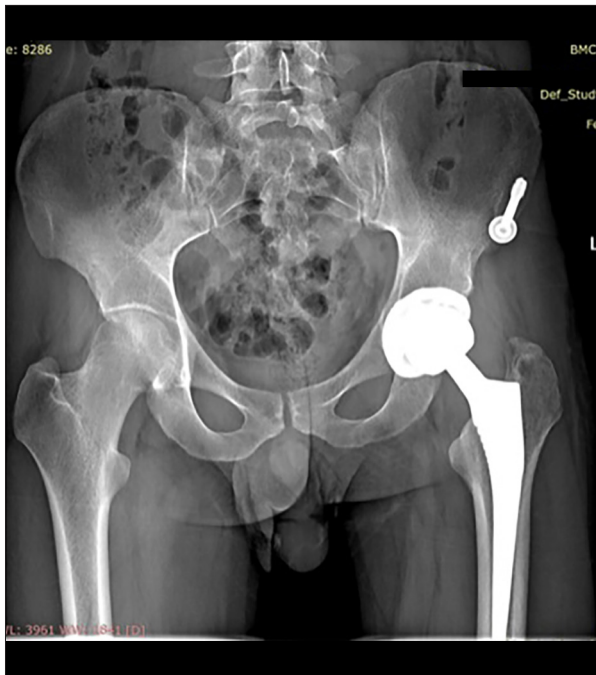


Figure 5. Postoperative radiograph of a left cementless total hip arthroplasty, along with screw fixation of the spina osteotomy. The concomitant acetabular fracture was openly reduced without additional fixation.

Clinical Case 3

A 70-year-old man presented with a history of chronic left hip pain that suddenly intensified. The patient had no known comorbidities. He had undergone right hip joint arthroplasty 3 months prior to this presentation. Diagnostic X-rays revealed a fracture of the left acetabulum, accompanied by medial protrusion of the femoral head (**Figure 6**). There was a fracture of the posterior wall, according to the Letournel classification. The time from injury to surgery was 77 days, as later on the patient admitted to being part of a car vehicle incident. Surgical intervention was planned, involving open reduction of the posterior wall of the fractured acetabulum, along with a left hip arthroplasty. The posterior-wall acetabular fracture was reduced. The acetabular defect was addressed by filling it with an autologous bone graft harvested from the spongy part of the femoral head. The procedure followed standard protocols, with a cementless total hip prosthesis being implanted (**Figure 7**). No complications were registered during follow-up. The Harris Hip Score was 82 points at month 3 and 80 points at the final follow-up, at 22 months.

Clinical Case 4

A 70-year-old man was admitted to the emergency department after falling approximately 3 m from a ladder. His only comorbidity was well-controlled stage 1 hypertension.

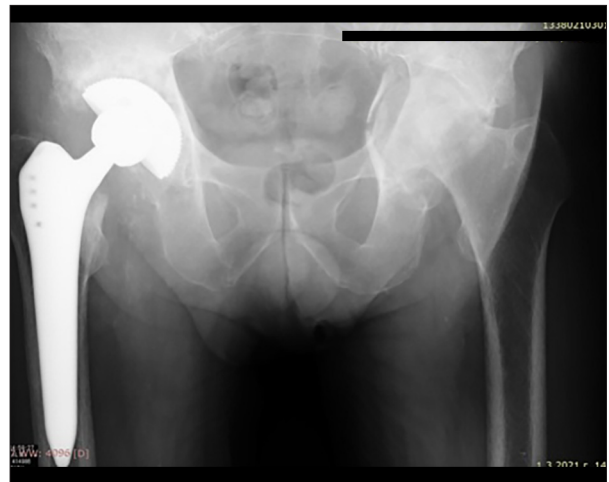


Figure 6. Preoperative radiographs of a left acetabular fracture and protrusion of the femoral head.



Figure 7. Postoperative radiograph from the same patient treated with a cementless total hip arthroplasty. The acetabular fracture was reduced, and the acetabular defect filled with autologous bone graft.

On physical examination, the patient was lying in a forced supine position. The right lower limb was shortened and externally rotated. Anteroposterior and lateral radiographs demonstrated a transverse acetabular fracture with medial migration of the femoral head (**Figure 8**). According to the Letournel classification, the fracture was classified as an associated T-shaped acetabular fracture. After evaluation, the patient underwent a 1-stage procedure consisting of ORIF, implantation of an antiprotusion cage, and THA with a cementless total hip prosthesis. Surgery was performed 3 days after the injury.

The postoperative course was uneventful, and the patient was discharged on postoperative day 8 after completing the standard rehabilitation protocol. At the 3-month follow-up, the Harris Hip Score was 85 points (**Figure 9**). Four months later,



Figure 8. Preoperative radiograph in a patient showcasing a right acetabular fracture with femoral head protrusion.

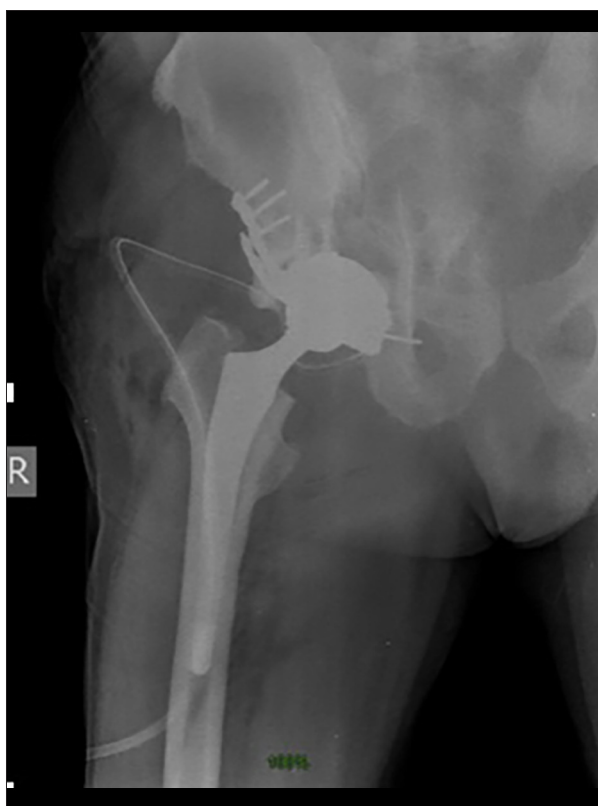


Figure 9. Postoperative radiograph in the same patient (Figure 8). A cementless total hip arthroplasty was performed along with open reduction and internal fixation of the acetabular fracture. An anti-protrusion cage was utilized.



Figure 10. Post-revision radiograph. Open reduction was performed utilizing a trochanteric osteotomy. The last was fixed with K-wires and wiring in a standard fashion.

the patient was readmitted because of a dislocation of the operated hip. Open reduction with greater trochanteric osteotomy was performed. At the 3-year follow-up after this procedure, the patient reported no further complications (**Figure 10**). At the final follow-up, conducted 122 months after the index surgery, the Harris Hip Score remained 85 points. No heterotopic ossification, sciatic nerve injury, prosthetic loosening, or lower-extremity deep vein thrombosis was observed.

Discussion

Combined single-stage open reduction or reconstruction and THA presented a good alternative in 4 patients with acetabular fractures.

The treatment strategy for acetabular fractures is critical in determining patient outcomes, particularly in predicting the survival of the hip joint and minimizing the risk of postoperative osteoarthritis. In a study encompassing 810 patients with a 20-year follow-up, Tannast et al identified several factors that increase the probability of future joint replacement, even when surgical techniques are executed optimally. These factors included an age exceeding 40 years, anterior dislocation,

involvement of the posterior wall, impact fractures, fractures with cartilage damage to the femoral head, displacement greater than 20 mm, and non-anatomical reduction postoperatively. In this series, the 20-year survival rate for surgically treated acetabular fractures was 79% [9].

ORIF remains the gold standard for treating displaced acetabular fractures in young patients. Success relies on achieving an anatomical reduction and stable fixation. A comprehensive meta-analysis by Giannoudis et al found that postoperative osteoarthritis developed in approximately 26% of surgically treated patients 5 years postoperatively. The study also highlighted that the rate of osteoarthritis was 13% in cases in which the reduction was deemed satisfactory (with an intra-articular gap of less than 2 mm). In contrast, complications were significantly higher, at 43%, in cases with unsatisfactory reduction (intra-articular gap greater than 2 mm) [10].

Avascular necrosis of the femoral head is a notable complication of acetabular fractures, occurring in approximately 5% of cases. The incidence is higher (9%) in cases involving posterior dislocation. These statistics underscore the significant risk of complications, even with optimal reduction and fixation. This risk is further elevated in adult patients due to generally poorer bone quality, which may necessitate secondary arthroplasty [10].

Preston et al reported an 85% survival rate for ORIF-treated patients with acetabular fractures. Of the remaining 15% of patients, arthroplasty was performed on average 14 months after the initial surgery [11]. Secondary arthroplasty is the preferred intervention when post-traumatic osteoarthritis and failed osteosynthesis or conservative treatment with unsatisfactory outcomes are present [12]. The implantation site for the prosthesis is significantly altered, and according to some researchers, these procedures can be categorized as revision arthroplasty. The magnitude of the intervention, previous surgical procedures, bone condition, presence of soft tissue adhesions, and ectopic ossification not only result in intraoperative challenges but also lead to a complex rehabilitation process. Furthermore, an elevated risk of infections warrants consideration.

Stibolt et al discovered in a systematic review that secondary osteoarthritis was present in patients with ORIF-treated acetabular fracture at a mean of 37 months postoperatively. Subsequently, the patients underwent arthroplasty, resulting in an increase in the average Harris Hip Score from 41.5 preoperatively to 87.6 postoperatively. According to the same study, the incidence of complications, such as ectopic ossification, infection, and aseptic loosening, is higher in comparison to primary arthroplasty [13]. The extent of the intervention, previous surgeries, bone condition, presence of soft tissue adhesions, and ectopic ossification not only lead to intraoperative difficulties but also to a complicated rehabilitation process.

Some articles in the literature report that single-stage total hip replacement leads to good outcomes. In a study with a mean follow-up of 8.1 years of 57 patients who underwent THA due to acetabular fracture, Mears and Velyvis reported very good results (mean Harris Hip Score of 89) [14]; their series did not observe early aseptic loosening during the follow-up period, with all components having cementless fixation. In another study of 33 patients, Lin et al reported that 61% of operated patients had excellent results at a follow-up between 1 and 14 years, and 93% had good or excellent results [15].

One-stage THA may offer important advantages in selected patients with Pipkin IV fractures, particularly when irreparable femoral head damage, severe chondral injury, or complex acetabular involvement make durable joint preservation unlikely. Giannoudis et al identified femoral head injury, fracture complexity, and suboptimal reduction as important predictors of poor outcomes following reconstructive surgery, including the development of post-traumatic osteoarthritis. In such cases, primary THA may provide reliable pain relief, early functional recovery, and avoidance of technically demanding secondary conversion arthroplasty [10].

Lin et al reported favorable long-term functional outcomes following acute THA for complex acetabular fractures. In patients with substantial acetabular bone loss or comminution, adjunctive reconstructive techniques, including bone grafting and acetabular reinforcement devices, were used to obtain stable cup fixation. These findings support the use of bone grafting and reinforcement cages, particularly in older adult patients with poor bone quality and complex acetabular defects undergoing primary THA [15].

Compared with a 2-stage strategy, 1-stage THA is technically more demanding because fracture reconstruction and arthroplasty are performed during the same operation, which may increase operative time and intraoperative risk. However, it avoids a second procedure and the difficulties associated with delayed conversion arthroplasty. Morison et al [16] demonstrated that THA performed after previous acetabular fracture treatment is associated with lower implant survivorship and higher complication rates than primary THA. Taken together with the findings of Giannoudis et al and the favorable long-term results reported by Lin et al, these data support 1-stage THA as a reasonable option in carefully selected patients with unreconstructable Pipkin IV fractures, with the potential to reduce subsequent procedures and improve long-term functional outcomes [10,14-16].

Despite the advantages of single-stage arthroplasty, the literature also mentions several drawbacks. In a study by Morison et al comparing patients with endoprosthesis after acetabular fracture and those after osteoarthritis, the 10-year

survival rate of arthroplasties in the first group was lower than in the second group [16].

It should be noted that the commonly used posterior approach carries a risk of complications, particularly when dealing with complex fracture lines requiring proximal or distal extension of the exposure. Nerve injury, particularly affecting the sciatic nerve, is highly probable and should always be considered during fixation of the posterior column [17].

Limitations

The authors would like to acknowledge the small sample size (n = 4), and the absence of a control group as limitations. Additionally, variability existed in the follow-up of some of the clinical cases.

Conclusions

ORIF alone remains the gold standard for displaced acetabular fractures. However, in selected older patients or in those with fracture patterns carrying a high risk of avascular necrosis or

post-traumatic osteoarthritis, single-stage open reduction or reconstruction with THA appears feasible and may avoid the need for secondary arthroplasty. Larger comparative studies are needed to define optimal patient selection.

Institution Where Work Was Done

Medical University – Sofia, Sofia, Bulgaria.

Patient Consent/Permission Declaration

In accordance with the guidelines of the Bulgarian Health Research Authority, separate ethical approval and informed consent, including consent for the publication of clinical information and images, were legally waived for this study (Institutional Review Board protocol No. 2339/ 20.01.2021).

Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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