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Research Paper

Total Hip Arthroplasty Outcomes for Osteoarthritis Secondary to Acetabular Fracture

Amir Aminian[1], **Mohammadreza Bahaedini**[1], **Mehdi Komijani**[1]*

1. Department of Orthopedics, Bone and Joint Reconstruction Research Center, School of Medicine, Iran University of Medical Sciences, Tehran, Iran.

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ABSTRACT

Background: Acetabular fractures are common traumatic injuries globally, posing challenges owing to their complex nature and difficulties in achieving precise anatomical reduction. Total hip arthroplasty (THA) is a valuable treatment for posttraumatic osteoarthritis secondary to these fractures; however, outcomes can vary based on initial fracture management, and optimal strategies remain debatable.

Objectives: This study evaluates THA outcomes in patients with previous acetabular fractures managed with open reduction and internal fixation (ORIF).

Methods: We conducted a retrospective review of patients who underwent THA for posttraumatic osteoarthritis following acetabular fractures managed with ORIF. The inclusion criteria comprised osteoarthritis graded ≥III according to the Kellgren-Lawrence classification and a minimum two-year follow-up. Clinical outcomes were assessed using the Harris hip score (HHS).

Results: Sixty-eight patients who underwent THA after ORIF for acetabular fractures were included (mean age 52.5±13.8 years). Preoperative HHS improved significantly from 41.4±9.9 to 83.1±10.4 at the final follow-up (P<0.001). Postoperative complications occurred in 54.4%, with 11.8% requiring revision THA.

Conclusion: THA for posttraumatic osteoarthritis following acetabular fractures, particularly in patients managed with ORIF, shows significant clinical improvement but has a high complication rate.

*** Corresponding Author:**
Mehdi Komijani, MD.
Address: *Department of Orthopedics, Bone and Joint Reconstruction Research Center, School of Medicine, Iran University of Medical Sciences, Tehran, Iran.*
E-mail: *dr.m_komijani@yahoo.com*

Introduction

Acetabular fractures are relatively common injuries resulting from high-energy trauma, affecting nearly 4 million individuals globally each year [1]. Various approaches have been proposed for managing acute acetabular fractures, including conservative methods, open reduction and internal fixation (ORIF), and total hip arthroplasty (THA). However, no universally accepted treatment strategy has been established [2]. The primary objectives of fracture fixation are to preserve blood supply, achieve stability, and restore anatomical alignment. Nonetheless, while many patients experience good-to-excellent outcomes after surgical treatment for acetabular fractures, the clinical results are influenced by various factors. These include the patient's pre-injury health status, specific injury-related factors, and the surgical approach and techniques used during treatment [3-5]. Furthermore, posttraumatic osteoarthritis can develop even after anatomical reconstruction, with reported incidence rates ranging from 12% to 57% [6-8]. Osteoarthritis and femoral head osteonecrosis are frequent long-term complications following the treatment of acetabular fractures. Between 13% to 44% of patients who undergo surgical intervention for acetabular fractures eventually experience hip-related issues necessitating further interventions, with approximately 8.5% of complications arising within two years of initial treatment [9, 10].

Conversion to THA remains the preferred approach for managing complications or failures following fixation, owing to notable improvements in pain relief and quality of life. However, orthopedic surgeons face technical challenges during conversion THA compared to primary THA, such as the need for bone grafts, acetabular reconstruction, and management of existing implants [11-13]. Consequently, conversion THA is believed to carry a higher risk of complications and potentially poorer functional outcomes. Comparisons between the outcomes of conversional and primary THA continue to be a subject of active research in the field of trauma orthopedics [14-16].

Available evidence suggests that the outcomes of conversion THA may be influenced by two primary factors: The initial treatment approach (ORIF or conservative) and the timing between initial fracture management and subsequent THA (acute or delayed). Some previous studies have reported no significant difference in hip survival rates between groups managed with early surgical intervention versus conservative treatment [17], while others have reached different conclusions [18]. Additionally, the timing of THA, whether performed acutely or after a delay, following acetabular fracture remains a fundamental topic of debate [19]. The results of THA in treating hip arthritis secondary to acetabular fractures have been described in a limited number of studies. Additionally, consensus is lacking regarding the influence of initial treatment on the outcomes of these patients [20, 21].

Objectives

This study was conducted to report the outcomes of THA for posttraumatic osteoarthritis in a series of patients with high-energy acetabular fractures who had previously undergone operative management.

Methods

Study design

We retrospectively reviewed the medical records of patients who underwent delayed THA at our institute between 2009 and 2020 for posttraumatic osteoarthritis following an acetabular fracture. The inclusion criteria included acetabular fracture, osteoarthritis graded ≥III according to the Kellgren-Lawrence classification [22], and a minimum follow-up period of two years. The exclusion criteria included patients who could not be evaluated in the final assessments.

Surgical procedure and postoperative protocol

All THAs were performed by a single senior arthroplasty surgeon at our trauma center. Patients were positioned in the lateral decubitus position under general anesthesia, and THA was performed using either a direct lateral or posterolateral approach to the hip [23]. A standardized postoperative protocol was applied to all patients, involving toe-touch weight bearing for the initial six weeks after surgery, followed by progressive weight bearing with crutch support. Radiological and clinical follow-up appointments were scheduled six weeks, three months, six months, and 12 months post-surgery and annually thereafter.

Assessments

We extracted baseline characteristics from the patient's medical records, including age, sex, type of acetabular fracture, Paprosky classification of acetabular bone loss [24], gross classification for acetabular bone loss [25], and surgical specifics.

Table 1. Baseline characteristics of the patients who underwent THA to treat posttraumatic osteoarthritis after ORIF of acetabular fracture

Variables		Mean±SD/No. (%)
Age (y)	THA*	42.9±12.5
	Acetabular fracture	39.6±13.5
	Final follow-up	52.5±13.8
Sex	Male	56(82.4)
	Female	12(17.6)
Location of acetabular fracture	Posterior wall	19(27.9)
	Posterior wall and column	16(23.5)
	Anterior column	5(7.4)
	Both column fracture	5(7.4)
	T-type fracture	4(5.9)
	Transverse and posterior wall	4(5.9)
	Transverse	3(4.4)
	Other	6(8.8)
	Missing	6(8.8)

*Follow-up after THA (y).

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THA: Total hip arthroplasty; ORIF: Open reduction and internal fixation.

Radiological assessments involved evaluating loosening and heterotopic ossification on the final radiograph of each patient. Loosening was evaluated by assessing radiolucency around the cup based on DeLee and Charnley zones [26] and radiolucency around the femoral stem using Gruen zones [27]. Acetabular loosening was defined as the presence of a radiolucency line of >2 mm or evidence of migration. Heterotopic ossification was graded using the Brooker classification [28].

The clinical outcomes of THA were evaluated using the Harris hip score (HHS), assessed preoperatively and at the last follow-up. Postoperative complications, such as THA failure and infection, were documented in patient records. Failure was defined as any complication necessitating THA revision.

Statistical analyses

Statistical analyses were performed using SPSS software, version 26 (SPSS Inc., Chicago, Ill., USA). Descriptive data were presented as Mean±SD for continuous variables or as numbers with percentages for categorical variables. A paired t-test was employed to compare the mean preoperative and postoperative HHS. Categorical data were analyzed using numbers and percentages, and Fisher's exact test was used to compare groups. A significance level of $P<0.05$ was considered statistically significant.

Results

Of ninety-four eligible patients, sixty-eight underwent THA for posttraumatic osteoarthritis following previous ORIF of an acetabular fracture and were included in the final analysis. The study population included 56 men (82.4%) and 12 women (17.6%), with a mean age of 52.5±13.8 years. The most common type of acetabular fractures among patients who underwent ORIF was posterior wall fractures alone or in combination with posterior column fractures. The mean age of patients at the time of the initial acetabular fracture was 39.6±13.5 years, while the mean age at the time of THA was 42.9±12.5 years. Patients were followed up for an average of 8.5±3 years after undergoing THA. Table 1 presents detailed baseline characteristics of the patients.

Table 2. Surgical features of patients who underwent a THA after ORIF of acetabular fracture

Variables		No. (%)/Median
THA type	One-stage	59(86.8)
	Two-stage	9(13.2)
Gross class	1	10(14.7)
	2	15(22.1)
	3	30(44.1)
	4	13(19.1)
Paprosky class	1	13(19.1)
	2a	16(23.5)
	2b	15(22.1)
	2c	8(11.8)
	3a	4(5.9)
	Missing	12(17.6)
Bone graft	Femoral head	14(2.06)
	Morcelized	8(11.8)
	Combined	1(1.5)
	None	45(66.2)
Cup type	Continuum	32(47)
	Trilogy	14(20.6)
	Pinnacle	5(7.4)
	Tantalum monoblock	5(7.4)
	Trident	3(4.4)
	Other	9(13.3)
Metal augment	Yes	10(14.7)
	No	59(85.3)
Cage implementation	Yes	1(1.5)
	No	67(98.5)
Cup size (mm)		54
Liner (mm)		36
Number of screws (mm)		2
Head size (mm)		36

THA: Total hip arthroplasty; ORIF: Open reduction and internal fixation.

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Table 3. Postoperative complication, management, and outcomes in patients who underwent a THA after ORIF of acetabular fracture

Type of Complication	Frequency	Management	Outcomes
Adduction contracture	1	Physiotherapy	Limb length discrepancy (3cm)
Aseptic loosening	1	Revision THA	Doing well
Wound discharge	1	DAIR	Accepting cup loosening requiring revision
Early infection	2	Antibiotics	One of them led to a stiff hip due to Heterotopic ossification.
Femoral artery intimal injury	1	Repair	Doing well
Hematoma	1	Washout	Doing well
Hip dislocation	3	Close reduction-abduction brace	Re-dislocation in two patients, leading to the cup loosening and revision in one patient
Heterotopic ossification	4 (one type IV, two types III, and one type II)	Type IV excised and received radiotherapy, One type III was excised, other two no treatment	Doing well
Late infection	4	DAIR	Two-stage revision for all three patients
Infection and deep vein thrombosis	1	Two-stage revision	Doing well
Periprosthetic fracture of the stem	1	Long stem revision	Doing well
Peroneal palsy	1	None	Partial nerve recovery
Persistent drainage and positive culture	1	DAIR	Doing well
Venous thromboembolism	2	Enoxaparin	Doing well

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Abbreviations: THA: Total hip arthroplasty; ORIF: Open reduction and internal fixation; DAIR: Debridement, antibiotics, and implant retention.

Of the 68 patients who underwent THA following ORIF of an acetabular fracture, nine underwent two-stage THA due to concurrent infection, while the remaining 59 patients underwent one-stage THA. Table 2 presents details of the surgical features of these patients.

The mean HHS of the patients improved significantly from 41.4±9.9 before the operation to 83.1±10.4 at the last follow-up (P<0.001). A total of 37 postoperative complications were recorded, of which eight (11.8%) required revision THA. Table 3 presents the types of complications along with their management approaches and outcomes.

Discussion

In our study, we examined the outcomes of THA in treating posttraumatic osteoarthritis following the management of ORIF acetabular fractures. After THA, significant improvements were observed in mean HHS. However, the incidence of postoperative complications was notable in both cohorts. Specifically, among patients initially managed with ORIF, 37(54.4%) experienced postoperative complications, and 8(11.8%) required revision THA. These results underscore the challenges and considerations associated with THA in individuals with posttraumatic osteoarthritis following acetabular fractures, highlighting the importance of careful patient selection and management strategies to optimize outcomes and minimize complications.

The outcomes of THA for posttraumatic osteoarthritis following acetabular fractures have been investigated in various studies. Kumar et al. reported THA outcomes in 18 patients with failed ORIF for acetabular fractures. They found that all patients had stable implants at a follow-up of 2.4 years, with a mean HHS of 89.72. No postoperative complications were recorded in their study, leading them to conclude that THA is a reliable option with satisfactory outcomes for patients with failed ORIF of acetabular fractures [29]. Similarly, in our study, we observed a significant improvement in the mean HHS

after THA for posttraumatic osteoarthritis following acetabular fracture. These results align with the positive outcomes reported by Kumar et al., further supporting THA as an effective treatment option in this patient population [29].

Certain acetabular fractures treated with ORIF carry a significant risk for reoperation, conversion to THA, and medical complications. Retrospective reviews of acute acetabular fractures treated with ORIF have reported reoperation rates as high as 30% [30, 31], with approximately 20% to 30% of cases ultimately requiring conversion to THA due to posttraumatic arthritis, osteonecrosis, or fixation failure [30-33]. Other reasons for reoperation include infection (12.2%) and excision of heterotopic ossification (3.3%) [31], highlighting the substantial morbidity associated with these injuries despite ORIF treatment. Nonfatal complications following ORIF have been reported in some series with rates as high as 64% and a mean complication rate of 40% in meta-analyses [32]. A recent multicenter retrospective study comparing outcomes of acetabular fractures treated with ORIF versus acute THA with ORIF in patients over 60 years of age found that the acute THA with ORIF group had shorter operative times, earlier weight-bearing, and improved HHS, with no statistically significant differences in complications. The most common complications observed were wound infection, heterotopic ossification, and deep vein thrombosis, each occurring at a rate of 14.3% [34]. Kelly et al. observed a revision rate of 18.2%, an overall surgical complication rate of 26.9%, and an overall medical complication rate of 13.2% following acute THA. These results provide crucial insights into the outcomes of acute THA following acetabular fracture, suggesting that THA may have a role in treating these complex injuries in select cases despite the associated risks and complications [35].

Yuan et al. conducted a meta-analysis of 31 studies involving 1284 patients to assess THA outcomes for posttraumatic osteoarthritis due to acetabular fracture. They reported an 88% implant survival rate and a significant improvement in HHS. Complication rates included 22.53% for heterotopic ossification, 4.66% for implant dislocation, 3.44% for implant infection, and 10.07% for iatrogenic nerve injury, suggesting THA as a viable therapeutic option [21]. However, our study observed higher rates of postoperative complications, such as infection, dislocation, and THA failure. Stibolt et al. also reviewed ten studies involving 448 patients who underwent THA after failed acetabular fracture treatment. They found that HHS improved from 41.5 to 87.6, with common complications, including heterotopic ossification (up to 63%), implant loosening (up to 24%), and infection (up to 16%). Implant survival ranged from 70% to 100% at 5 years, with revision rates ranging from 2% to 32% [20]. Similarly, our study demonstrated a significant improvement, but with a high complication rate following THA for posttraumatic arthritis after acetabular fracture.

A study by O'Driscoll et al. [36] underscores significant improvement in patient-reported clinical outcomes following THA for posttraumatic arthritis secondary to acetabular fractures. Short-term to medium-term follow-ups across various studies consistently showed clinical enhancement post-THA. For instance, Garcia-Rey et al. reported improved HHS from 6 months to 2 years post-THA in both ORIF (83.0 to 89.6) and conservative (84.6 to 91.0) cohorts, with sustained scores in the long-term (89.5 and 91.3, respectively), suggesting positive correlations between early patient-reported outcomes and promising medium- to long-term clinical results after THA for posttraumatic arthritis following acetabular fractures [37]. Clarke-Jensson et al. highlighted the impact of surgical setting on outcomes, noting higher postoperative HHS scores (88±13) in THAs performed at specialist pelvic institutions compared to non-specialist settings (75±6) [38]. Previous studies on THA outcomes also linked surgical success and complications with surgeons and hospital volume [37-41]. Concerning infection risk, Aali Reziae et al. observed significantly elevated infection rates in their acetabular fracture THA cohort compared to controls, emphasizing the need for infection screening and management [14]. Ranawat et al. and Yuan et al. reported infection-related challenges despite rigorous preoperative protocols, emphasizing the importance of patient counseling and comprehensive preoperative infection screening for this at-risk patient group [42-44]. Garcia-Rey et al. reported that complications, including sciatic palsies and heterotopic ossification, were more frequent in the ORIF and THA [37]. Our study recognized that infection rates, a significant cause of revision, were higher following surgical treatment for acetabular fractures and revealed a considerable incidence of complications following THA for posttraumatic osteoarthritis after initial acetabular fracture treatment.

Planning THA post-acetabular fracture presents challenges, such as implant positioning in altered anatomy and addressing bone loss and soft-tissue scarring [4, 45, 46]. Computed tomography plays a crucial role in preoperative planning to quantify bone loss and identify nonunion, aiding in managing potential dislocations [36]. Dislocation rates post-THA for post-traumatic arthritis (PTA), following acetabular fractures are notable, prompting attention to implant choice and preoperative

planning [36, 43]. Uncemented implants are increasingly favored for conversion THA following acetabular fracture due to lower rates of aseptic loosening compared to cemented implants reported in earlier studies [13, 36, 45]. Novel implant designs, including multihole cups with screw augmentation and highly porous tantalum implants, show promise in achieving stability and osseointegration [36]. Iatrogenic sciatic nerve injury is a significant concern, particularly in the ORIF group, highlighting the importance of obtaining comprehensive surgical records when planning THA post-acetabular fracture to mitigate potential complications [36].

Conclusion

Although THA is a viable treatment option for acetabular fractures, it is crucial to note that it is associated with a relatively high rate of postoperative complications. Furthermore, patients initially managed with ORIF may experience a higher incidence of complications following THA. Given these considerations, it is essential for orthopedic surgeons to thoroughly address patients' expectations regarding THA outcomes before proceeding with surgery. Patients should be informed about the potential risks and complications associated with the procedure, especially in previous ORIF cases. This ensures that patients have realistic expectations and are well-prepared for postoperative recovery and the potential challenges that may arise. Effective preoperative counseling and education can improve patient satisfaction and outcomes after THA for acetabular fractures.

It is crucial to acknowledge the limitations of the study. The primary limitation is its retrospective design, which precludes the establishment of causality and lacks a matched control group undergoing THA for primary osteoarthritis. This constraint may impact the generalizability and interpretation of our results within the broader context of orthopedic practice.

Ethical Considerations

Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

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Authors' contributions

All authors contributed equally to the conception and design of the study, data collection and analysis, interception of the results and drafting of the manuscript. Each author approved the final version of the manuscript for submission.

Conflict of interest

The authors declared no conflict of interest.

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