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Acute total hip arthroplasty versus open reduction internal fixation for posterior wall acetabular fractures in middle-aged patients

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Abstract

Introduction: Open reduction internal fixation (ORIF) is the standard of care for displaced acetabular fractures, but the inability to achieve anatomic reduction, involvement of the posterior wall, articular impaction, and femoral head cartilaginous injury are known to lead to poorer outcomes. Acute total hip arthroplasty (THA) is a reasonable treatment option for older patients with an acetabular fracture and risk factors for a poor outcome, but it is only described in case series. The purpose of this study is to compare outcomes of ORIF and acute THA in middle-aged patients with an acetabular fracture from a single center.

Methods: Retrospective case-controlled study of patients aged 45 to 65 years old with acetabular fractures involving the posterior wall treated with acute THA or ORIF at a level 1 trauma center between 1996 and 2011. Patients were matched by fracture pattern and age at a 2 (ORIF):1 (acute THA) ratio. Functional outcome, complications, and reoperation rates of acute THA and ORIF were compared.

Results: Sixteen acute THA patients (average age 56.4 years) and 32 ORIF patients (average age 54.3 years) were evaluated at an average follow-up of 6.2 years (range 1–15.2). The average Oxford Hip Score in the acute THA group was 44 compared to 40 in the ORIF group (P = .075). Complication rates were similar between both the groups. Twelve hips (37%) in the ORIF group had undergone THA or been referred for THA, and 2 revisions (13%) had occurred in the acute THA group. A Kaplan–Meier survival analysis showed that those undergoing acute THA had significantly better survival of their index procedure ($P = .031$).

Conclusions: Both ORIF and acute THA for high-energy acetabular fractures involving the posterior wall in middle-aged patients can provide excellent results, with acute THA patients achieving improved survival of the index procedure and improved functional scores.

Abbreviations: CT = computed tomography, EBL = estimated blood loss, ISS = injury severity score, OHS = Oxford Hip Score, ORIF = open reduction internal fixation, THA = total hip arthroplasty.

Keywords: acetabular fracture, acute total hip arthroplasty, posterior wall fracture

Introduction

ORIF for displaced acetabular fractures can achieve an excellent functional outcome and long-term survival.[1,2] However, a subset of patients with an acetabular fracture treated with ORIF have a poor result. Multiple factors are known to predict poor outcomes and the development of post-traumatic arthritis in acetabular fractures treated with ORIF. These include the inability to achieve an anatomic reduction, involvement of the posterior acetabular wall, acetabular impaction, and full-thickness femoral head cartilage damage.[2–5] Aside from the quality of reduction, all of these are injury-specific factors that the surgeon cannot control and can be used to predict the patients that will have a poor outcome.

A poor functional outcome typically results in revision to THA, and rates of THA within 2 years after ORIF of acetabular fractures involving the posterior wall have been reported to range from 8% to 24%.[2–4,6]

In patients that develop post-traumatic hip arthritis following ORIF, THA provides good functional outcomes for patients.[7,8] However, THA for post-traumatic arthritis has higher rates of revision compared to THA for osteoarthritis.[9,10] Rates of acetabular loosening and failure have been found to be 4 times higher following THA for post-traumatic arthritis compared to routine THA for osteoarthritis in the first 10 years following surgery.[10,11] In the last decade, there has been interest in treating selected acetabular fractures with acute THA.

Acute THA is defined as concomitant fixation of an acetabular fracture and THA under 1 anesthesia around the time of the injury. There is growing evidence that acute THA in patients with risk factors for a poor outcome after acetabular fracture ORIF is

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a reasonable treatment option. However, the current literature is comprised of case series involving older patients.[12–18] There have been no studies directly comparing outcomes of ORIF to acute THA in patients with acetabular fractures. In addition, there is little information on acute THA for acetabular fractures in patients less than 65 years old. Prior to widespread adoption of this new concept, a critical step in the systematic investigation of a contemporary surgical technique is comparison to the standard of care. The primary objective of this study is to gather evidence regarding the functional outcomes, complications, and re-operation rates of acute THA compared to ORIF for acetabular fractures, with the expectation of equivalent complication rates and functional scores but improved longevity of the index procedure after acute THA.

Methods

Following institutional review board approval, we retrospectively reviewed consecutive patients under the age of 65 with acetabular fractures involving the posterior wall (62A1, 62A2 + posterior wall, 62B1 + posterior wall) who were treated at an urban Level I trauma center from 1996 to 2011. The following exclusion criteria were applied: patients with cognitive dysfunction (either due to a traumatic brain injury or pre-existing disease), patients age 65 and older, acetabular fractures not involving the posterior wall, and patients with <1 year follow-up. All surgeries were done by 2 experienced surgeons: 1 surgeon with 20 years of experience in a practice devoted to the care of pelvic trauma performed all ORIF cases (DT), and 1 surgeon with similar experience in both general trauma and total joint arthroplasty performed all acute THA cases in conjunction with the other surgeon (AS and DT). All patients had initial imaging consisting of pelvis radiographs (anteroposterior and Judet views) and computed tomography (CT) of the pelvis.

Patient selection

The indications to proceed with acute THA in this patient population were based on preoperative imaging and included the following: marginal impaction of the acetabulum, significant comminution (>3 fragments) of the articular surface of the acetabulum, or the presence of osteoarthritis represented by the presence of joint space narrowing, subchondral cysts, and osteophyte formation. Patients with these risk factors were counseled on the risks and benefits of ORIF and acute THA, and the final decision on the type of surgical intervention was based on a shared decision-making model between the surgeon and patient. All acute THA patients meeting inclusion criteria identified in our retrospective review were included in the study. ORIF patients identified in our retrospective review were selected as a random, age- and fracture pattern-matched control group. Patients who underwent ORIF were grouped by fracture pattern and age in 5 year blocks (based on year of surgery) with those who underwent acute THA. Controls were then randomly selected at a 2:1 ratio from within these groups.

Surgical technique

All patients were treated using a Kocher–Langenbeck approach. In both the groups, the posterior wall was stabilized with one or two 3.5 mm reconstruction plates with or without supplemental lag screws.

During acute THA, the femoral head was dislocated and resected. The resected femoral head was used as bone graft to fill any remaining bony defects in the posterior column or acetabular roof. A cup equal to or 1 mm larger than the outside diameter of the last reamer was selected and implanted, with additional screw fixation as needed for cup stability. An uncemented acetabular cup was used for all patients (Reflection Cup System, Smith & Nephew, Andover, MA). An uncemented proximally porous-coated femoral stem (Synergy Hip System, Smith & Nephew, Andover, MA) was implanted using standard canal preparation techniques in all femurs. All patients received a metal on polyethylene-bearing surface. In patients undergoing ORIF, the femoral head was left intact. Cancellous allograft was utilized for bone grafting if needed.

Postoperative instructions were similar between both groups, with the exception of weight-bearing recommendations. Male patients with a history of posterior hip dislocation were given 1 low dose (600–700 Gray) of radiation therapy on the day of surgery or postoperative day one. No other patients received prophylactic radiation. Patients were instructed to avoid hip flexion beyond 90° and to sleep with a pillow between their legs for 6 weeks. Patients with a posterior wall or transverse fracture type treated with acute THA were allowed to weight bear as tolerated immediately following surgery. Those with posterior column involvement treated with acute THA were kept toe-touch weight bearing for 6 weeks and then advanced to weight bearing as tolerated. Patients treated with ORIF were kept toe-touch weight bearing for 12 weeks. All patients received enoxaparin for 6 weeks following surgery for venous thromboembolism prophylaxis.

Patient evaluation

Patient demographics and relevant fracture characteristics were defined and collected via retrospective chart review. Injury severity score (ISS), length of surgery, and estimated blood loss (EBL) were recorded. Marginal impaction, acetabular comminution, and involvement of the weight-bearing dome were determined radiographically. Femoral head cartilage injury was determined by intraoperative findings described in the operative report. Delay from injury to surgery was calculated based on the initial admission history and physical note and subsequent brief operative note. In the ORIF group, fracture reduction was evaluated on postoperative radiographs as described by Matta.[3] Radiographic evaluation of fracture reduction was performed by a senior orthopaedic surgery resident (LM) that was not involved in the surgeries of the patients included in our cohort.

The primary outcome of our study is patient-reported functional outcome as defined by the Oxford Hip Score (OHS). The OHS is a reliable, validated 12-item questionnaire that assesses functional ability and pain from the patient's perspective and has been found to correlate well with the Harris Hip Score for the long-term assessment of hip function and the SF-36 for pain and physical function.[19–23] The OHS has an estimated standard deviation of 9 and minimum clinically important difference of 5 to 7 points. Since its inception, interpretation of the score has been modified and has a currently suggested range of 0–48: > 41 = excellent, 34–41 = good, 27–33 = fair, < 27 = poor.[24] Secondary outcomes included rates of re-operation and complications. Complications were classified as medical or surgical, and surgical complications were further divided into early (≤ 90 days) and late (> 90 days). Follow-up consisted of either an in-person or telephone evaluation.

Statistical analysis

Continuous variables are described as mean and standard deviation. Dichotomous variables are described as percentages of

Table 1

Matched patient and injury characteristics

Patient and injury characteristics	ORIF (n = 32)	Acute THA (n = 16)	*P* value
Age, years	54.3 (46–62)	56.4 (47–64)	.16
Gender			
Male	22/32 (69)	11/16 (69)	1.00
Female	10/32 (31)	5/16 (31)	
Fracture classification			
Posterior wall	16/32 (50)	8/16 (50)	1.00
Posterior wall+ posterior column	4/32 (12)	2/16 (12)	
Transverse	12/32 (37)	6/16 (37)	

Data are mean (range) or n/N (%).

the total. Bivariate analyses were performed using a chi-squared or Fisher's exact test. A P value $< .05$ was considered significant. Kaplan–Meier survival curves were generated and a log-rank survival test used to compare the 2 groups. All analyses was performed using Microsoft Excel 2010 (Redmond, Washington) and the open-source Rcmdr package.[25]

Results

From 1996 to 2011, 22 patients under the age of 65 with acetabular fractures involving the posterior wall were treated with acute THA and 199 with ORIF. Of the 22 acute THA patients, 6 were lost to follow-up which resulted in 16 included in this study. After addition of our control group, the final cohort included 16 acute THA patients and 32 ORIF patients. The matching of our control group was adequate, which is demonstrated by the similarities in age, sex, and fracture patterns between the 2 groups (Table 1). Additional characteristics, including ISS, length of surgery, EBL, and patient follow-up were similar between the 2 groups. There were higher rates of marginal impaction, acetabular comminution, involvement of the weight bearing dome, and femoral head cartilage damage in patients who underwent acute THA. Patients undergoing acute THA also had a longer delay between time of injury and surgery (Table 2).

Seven patients in the ORIF group had postoperative medical complications resulting in a prolonged hospital stay: 2 pulmonary emboli, 2 deep venous thromboses in the lower extremity, ileus, delirium, and a fungal urinary tract infection with fungemia. The acute THA group had 2 postoperative medical complications: pneumonia and urosepsis. There was no statistically significant difference in the total number of medical complications ($P = .697$).

Table 2

Additional patient and injury characteristics

Patient and injury characteristics	ORIF (n = 32)	Acute THA (n = 16)	*P* value
ISS	13.5	11.7	.545
Length of surgery (minutes)	188	170	.603
EBL (millilitres)	813	995	.637
Fracture characteristics			
Marginal impaction	13 (41)	15 (94)	<.001
Comminution	16 (50)	13 (81)	.06
Weight-bearing dome involved	4 (13)	7 (44)	.027
Femoral head cartilage damage	6 (19)	11 (69)	.001
Time from Injury to surgery (days)	4.8	8.3	
Follow-up (years)	6.3 [1–15.2]	6.8 [1.3–14.3]	.648

Data are mean (range).

Table 3

ORIF group outcomes based on accuracy of reduction

Accuracy of reduction[3]	Number of patients	Conversion to THA	Average time to THA
Anatomic	25	9	29 months
Imperfect	2	0	—
Poor	4	3	7 months
Surgical secondary congruence	0	—	—

One patient did not have postoperative imaging available due to the transition from paper chart to an electronic medical record following the time of the patient's surgery.

Two patients in the ORIF group had surgical complications requiring reoperation within 90 days of the index procedure, both of which were failures of fixation. One patient was treated with conversion to THA, and the other was treated with revision ORIF. There was 1 patient in the THA group with an early surgical complication that consisted of aseptic loosening of the acetabular component which was treated with an acetabular revision. The difference in the rate of early complications was not statistically significant ($P = 1.000$).

At the last follow-up, 12 hips in the ORIF group had undergone THA or been referred for THA, and 10 of these occurred within 2 years (Table 3). This was compared to 2 revisions in the THA group: 1 for aseptic loosening of the acetabular component at 2 months and 1 for hematogenous infection from an infected pacemaker at 14 years. On survival analysis, those who underwent acute THA had an improved survival of the index procedure ($P = .031$) (Fig. 1).

OHSs were available on 26 of 32 of the ORIF patients and 15 of 16 of the acute THA patients ($P = .398$). The other 7 patients were willing to discuss if they had undergone additional hip surgery but unwilling to go through the OHS questionnaire. The average OHS in patients with surviving hips (those who had not received a revision THA or had received or been referred for a THA) was 44 (95% CI, 41.4–46.6) in the THA group and 41 in the ORIF group (95% CI, 38.1–44.2), with no statistical significance between the 2 groups ($P = .19$). When comparing all patients, including those who had undergone revision arthroplasty or conversion to secondary THA, the average OHS for all patients in the acute THA group was 44 (95% CI, 41.4–46.6) compared to 40 (95% CI, 36.8–42.9) in the ORIF group ($P = .075$) (Fig. 2).

Discussion

The standard of care for displaced acetabular fractures in active, middle-aged patients is ORIF. However, a small subset of middle-aged patients with risk factors for a poor outcome likely benefit from acute THA.

Currently, the literature describing acute THA for acetabular fracture is comprised of case series. The largest series to date is that of Sermon et al,[26] in which acute THA was performed in 64 cases. Their indications for arthroplasty were advanced age, osteoporosis, concomitant femoral neck fracture, or pathologic fracture. The mean age was 78, and only 58% had good-excellent Harris Hip Scores at an average of 2.5 years. Mears and Velyvis included 57 patients (mean age of 69 years) treated with acute THA and screw and cable fixation. At an average follow-up of 8 years, the mean Harris Hip Score was 89 points, indicating good or excellent outcomes. They had no cases of late component loosening.[12] Most recently, Herscovici et al[14] reported the

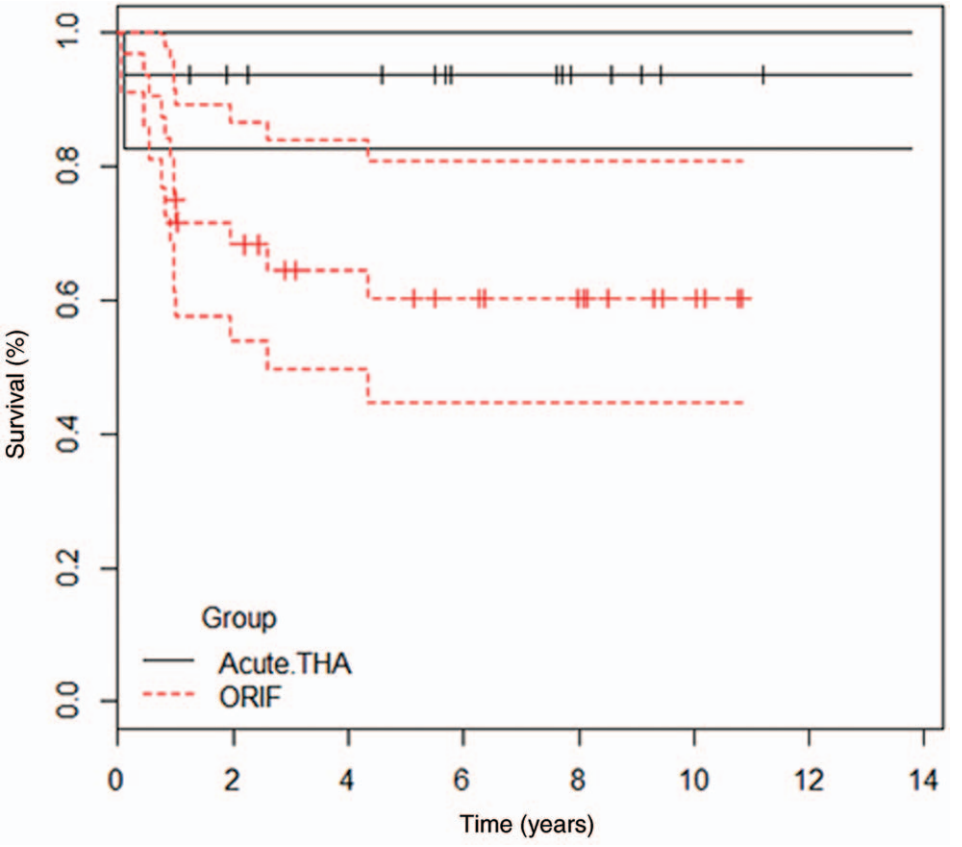

Figure 1. Kaplan–Meier survival analysis of index procedure: ORIF versus acute THA.

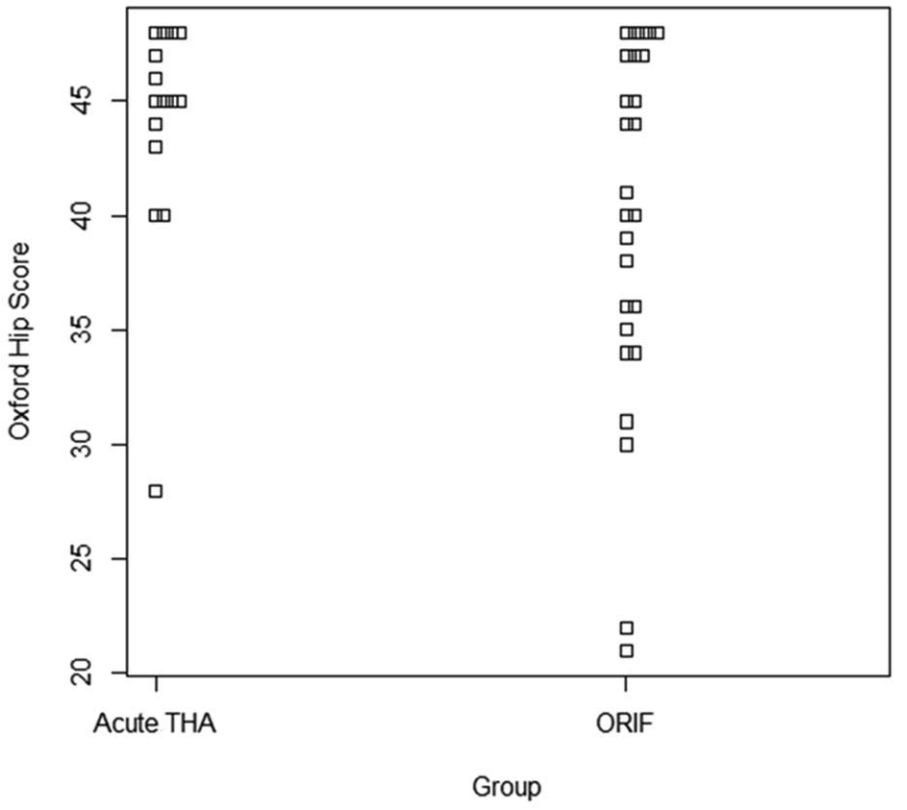

Figure 2. Plot of Oxford Hip Scores in patients at last follow-up. Suggested range 0–48: > 41 = excellent; 34–41 = good; 27–33 = fair; < 27 = poor.

results of combined ORIF and THA on 22 patients over 60 years old and had 4 revisions at an average follow-up of 2.5 years. Their average Harris Hip Score was 69.

It is notable that previous series focused primarily on patients with severe osteoporosis in which attempts at ORIF could be at-risk for early failure or in elderly patients in whom early mobilization and weight bearing is a priority. However, as indicated by Mears' and Velvys' series, acute THA has been performed in younger patients with multiple risk factors for early post-traumatic arthritis.[12] There is little data on outcomes in these nonosteoporotic patients who are the victims of high-energy trauma. Additionally, the literature on outcomes following acute THA are limited by significant differences in age and heterogeneity of fracture patterns.[12–18] We selected a subgroup of fractures that are known to be associated with a higher risk of conversion to THA,[2–4] and our study is the first to perform an age and fracture-pattern matched comparison between these 2 treatment options. The case-control design reduces the risk of confounding from variable age groups and fracture patterns which are known risk factors for post-traumatic arthritis. We found that patients who underwent early THA had equivalent outcome scores when compared to those who underwent ORIF. Furthermore, we found a significant benefit in the survival of the index surgery in those who underwent acute THA.

Our rate of THA after ORIF (37% overall, 28% at 2 years) was considerably higher than what some studies have reported in the literature. The large discrepancy is likely attributable to different patient populations. We purposefully included patients that had known risk factors for poor outcomes as we felt that these are the patients for whom the decision to fix or replace is the most difficult. Moed et al reported an 8.5% revision rate in 94 adult patients who underwent ORIF for posterior wall fractures. The study identified age >40 years and femoral head impaction as significant risk factors for poor outcomes which corresponds to our cohort, which had a mean age of 55. Their cohort was younger (mean age 38) and had a lower incidence of associated femoral head impaction.[5] Additionally, several studies have found similarly high rates (16%–26%) of conversion to THA after ORIF with 2 year follow-up.[2,4]

Though our patients were closely matched by demographics and fracture pattern, the retrospective nature of our study limits the ability to truly match severity of injuries. As one would expect, more severe injuries that were at higher risk for a poor outcome were treated with acute THA. Factors such as articular comminution, full-thickness articular damage to the femoral head, marginal impaction, and involvement of the weight-bearing dome were all significantly more common in the acute THA group. The predominance of these factors suggests that our criteria to proceed with acute THA are similar to those used in previous case series.[12–18] We do recognize that not all marginal impaction, comminution, or femoral head damage is the same, and our indications for ORIF versus acute THA require additional refinement.

A significant portion of patients who underwent ORIF still went on to develop end stage post-traumatic arthrosis despite an anatomic reduction. Although a standardized system for grading the quality of reduction of the acetabulum based on radiographs has been described and frequently used for clinical and research purposes,[3] there have been concerns that this system is inaccurate.[5] It is possible that a number of our patients with an anatomic reduction may have millimeters of displacement undetectable on radiographs that could have been better delineated on CT, and this may have contributed to our high rate of revision in patients with an anatomic reduction.

A number of additional limitations involving the outcomes of our study must also be considered. Most importantly, our series does not have complete radiographic follow-up. However, the purpose of our paper was to assess clinical outcomes from the patient's perspective, as well as reoperation rates, both of which are of primary concern to patients. For this reason, we do not feel that the lack of follow-up imaging negatively impacts our findings. Furthermore, minimum 1 year follow-up is suitable to define early complication rates and need for revision in both patient cohorts but is inadequate for understanding long term outcomes. In addition, although the OHS is a validated questionnaire to assess hip function, scores may have been affected by other injuries sustained by patients. Lastly, the results of 2 high-volume, experienced surgeons may not be generalizable to the trauma and arthroplasty communities.

The rate of early revision in the acute THA group was 6%, which we consider to be dramatically less than expected rates of up to 20% to 30% for conversion to THA for those patients managed with ORIF alone. Furthermore, functional scores in acute THA patients in this group were slightly higher than those reported in patients who undergo delayed THA after either initial non operative or operative management of acetabular fractures.[7] Based on these results, we conclude that acute THA for selected acetabular fractures in middle-aged victims of high-energy trauma is a safe, viable treatment option with good to excellent functional outcomes in properly selected patients. However, additional comparative studies with larger numbers of patients are needed to fully delineate the long-term outcomes and indications for this procedure.

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