What's New in Geriatric Acetabular Fractures

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Abstract

The incidence of acetabular fractures in the geriatric population is growing, yet the optimal treatment algorithm remains a controversial topic among orthopaedic surgeons. This review highlights key studies published over the past 5 years on the outcomes of various treatment options for geriatric acetabular fractures. Topics include surgical timing, mortality and risk factors, nonoperative treatment, open reduction internal fixation, and acute total hip arthroplasty.

Keywords

Acetabular fractures; Geriatric; Mortality; Nonoperative treatment; Open reduction internal fixation; Total hip arthroplasty

Acronyms and Abbreviations

CRPP = closed reduction percutaneous pinning
ORIF = open reduction internal fixation
QLP = quadrilateral surface
THA = total hip arthroplasty

Introduction

Over the past 30 years, the incidence of acetabular fractures in the geriatric population has more than doubled.[1] Despite this growing trend, the treatment of this now common injury remains anything but routine. Based on the work of Letournel and Judet, age greater than 60 years and poor bone quality have long been viewed as primary indications for the non-operative treatment of acetabular fractures.[2] Mata, et al, showed that geriatric acetabular fractures with secondary congruence could predictably be treated non-operatively with good functional outcomes.[3,4] Reported outcomes following non-operative treatment, however, have not been uniformly positive. Surgical conversion rates to total hip arthroplasty (THA) of 15% and mortality rates of 24% at 1 year have been reported.[5] On the other hand, early fixation has not demonstrated any improvement in outcomes with conversion arthroplasty and 1 year mortality rates of 25% and 28%, respectively.[6] More recently, primary THA has gained importance for select individuals.[7,8] This includes those with articular impaction, femoral head chondral injury, and posterior wall involvement.[7-10] However, large population studies and long-term data are lacking.

Currently, there are no clinical practice guidelines for the treatment of acetabular fractures in the elderly. Not surprisingly, there is significant variation in how this injury is treated across the nation,[5,11] with no consensus on what is optimal. The multitude of studies published in recent years reflects our need and desire to better understand this difficult to treat injury. The purpose of this review is to highlight the recent literature over the past 5 years surrounding the evaluation and treatment of acetabular fractures in the geriatric population.

Mechanism of Injury and Fracture Pattern

A systematic review was performed by Goyal, et al, to determine the injury profile of geriatric acetabular fracture patients.[12] Forty-eight studies, representing 7,876 patients, met inclusion criteria. Mean patient age was 72 years. The most common mechanism of injury included a fall from low height (47%), followed by motor vehicle accident (29%). Based on the Letournel and Judet fracture classification system, the most common pattern was the associated both-column fracture seen in 19% of patients. This was followed closely by anterior column posterior hemitransverse (17%), anterior column (17%), and posterior wall fractures (13%). These results are consistent with the predominance of low-energy trauma and anterior column involvement that have been previously reported, but also suggest that high-energy fractures can be frequent.[1,12]

Surgical Timing

The importance of surgical timing has been compared between geriatric acetabular and hip fracture patients in two level III studies. Glogovac, et al,[13] retrospectively reviewed 183 acetabular fractures (mean age 76 years) treated with internal fixation and found that surgical fixation within 48 to 72 hours resulted in no significant decrease in mortality at 30 days, 6 months, or 1 year. In a second retrospective review, Harrison, et al,[14] analyzed 53 acetabular fractures (mean age 76 years) treated with internal fixation or combined fixation plus arthroplasty and found that surgical delay greater than 72 hours resulted in longer hospital stay, but no increased risk for mortality at 30 days, 90 days or 1 year. These results suggest surgical timing may be less critical for geriatric acetabular fractures. This is in contrast to geriatric hip fractures, in which there is a clear decrease in mortality associated with early surgery (ie, within 48 hours).[15] One explanation is that acetabular fracture fixation may not improve postoperative mobilization to the same extent since full weight bearing is typically not allowed.

Mortality

Early mortality rates have also been compared between geriatric acetabular and hip fractures. Khoshbin, et al, demonstrated that acetabular fractures in those ≥60 years are at significantly greater risk of early mortality compared to those with hip fractures.[16] In

their retrospective, matched cohort study, the 30-day mortality rate following acetabular fracture fixation was significantly higher when compared to hip fractures that underwent internal fixation or hemiarthroplasty (Odds ratio 1.9, 95% Confidence Interval [CI] 1.1-3.3). Stetzelberger, et al,[17] found no difference in 30-day mortality between a matched cohort of acetabular and hip fractures patients >60 years. This was despite a significantly higher perioperative complication rate in the acetabular fracture group (68% versus 48%, $P < .001$). At 1 year, however, mortality was significantly lower in the acetabular fracture group (18% versus 36%; $P = .005$). Mortality at 1 year in the acetabular fracture group was associated with intraoperative blood loss >1L and postoperative wheelchair mobilization.

There is poor consensus regarding the mortality benefit associated with operative compared to non-operative treatment. Firoozabadi, et al, demonstrated that open reduction internal fixation (ORIF) resulted in a lower risk for early mortality compared to non-operative treatment.[18] In their retrospective review of 156 acetabular fractures (mean age 78 years) presenting to Harborview Medical Center (Seattle, WA), the 1-year mortality rate for those in the ORIF group was 12% compared to 44% in the non-operative group. Of the 51 patients who died in the first year, 42 (84%) were treated non-operatively. Furthermore, the 1-year mortality rate for those treated with 4 to 6weeks of skeletal traction alone was79%. In contrast, other studies demonstrated no difference in 1-year mortality between operative and non-operative treatment.[19-21] In a multi-center retrospective review of 454 acetabular fractures (mean age 73 years), Gary, et al,[21] found the unadjusted 1-year mortality rate of non-operative treatment to be significantly higher than operative treatment (21% vs 13%, $P<.01$). However, when adjusted for patient age, gender, energy of mechanism, and Charlson comorbidity index, no significant increase in hazard of death for non-operative treatment was detected ($P=.6$). The authors concluded that when confounding factors are taken into account, operative treatment does not increase or decrease early mortality.

Sarcopenia, or age-related decreased muscle mass, has been utilized as an objective measure of frailty in the elderly. Recently, sarcopenia has also been used to predict early mortality among geriatric acetabular fracture patients. A retrospective study from the *Journal of Bone and Joint Surgery* found a 42% incidence of sarcopenia in a cohort of 99 acetabular fracture patients older than 60 years old.[22] Sarcopenia was determined using the skeletal muscle cross-sectional area at the third lumbar vertebral body on an abdominal and pelvic axial CT scan. Males with a skeletal muscle index <55.4 cm^2/m^2, and females <38.5 cm^2/m^2 were diagnosed with sarcopenia. The 1-year mortality of sarcopenic patients was significantly higher compared to non-sarcopenic patients (29% vs 12%, $P = .04$). Mitchell, et al,[23] measured sarcopenia utilizing a ratio comparing the average cross-sectional area of the psoas muscle and fourth lumbar vertebral body on axial CT scan. In their retrospective review of a combined group of 146 operatively and non-operatively treated acetabular fractures (mean age 70 years), sarcopenia was found to be an independent predictor of 1-year mortality when controlling for multiple patient factors.[23] The 1-year mortality rate in sarcopenic patients was 32% compared to 14% or less among others. Sarcopenia was found to be more likely in older patients and females ($P<.001$).

Mortality rates beyond 1 year have also been reported. Ryan, et al,[5] reported a mortality rate of 24% at 2 years in a series of displaced acetabular fractures treated non-operatively. Survival rates at 2 -5 years have ranged between 75-86% following ORIF and 30-68% following THA.[24,25] Navarre, et al,[26] found that the function and general health of those who do survive beyond 1 year from surgery may return to that of the general population by 2 years.

Nonoperative Treatment

No prior study has utilized a validated assessment tool to investigate the functional outcomes of geriatric acetabular fractures treated non-opertatively. Ryan, et al,[5] utilized the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)[27] and the short form 8 (SF-8)[28] health index scores to assess the functional outcomes of 27 displaced acetabular fractures (mean age 76 years) treated conservatigvely. Each fracture in this series met at least 1 operative indication: joint incongruity, femoral head medialization, articular impaction, and/or intra-articular fragments. Fractures with posterior wall instability were excluded. Age and medical comorbidities were the most common reason for non-operative treatment. Non-operative treatment consisted of early physical therapy. All patients were restricted to flat foot or non-weight bearing except for two patients who were allowed to weight bear as tolerated. At a mean follow-up of 2 years, WOMAC[27] and SF-8[28] health index scores were surprisingly good, and comparable to an operatively treated cohort. However, it is important to point out that 24% of patients were deceased by one year and the surgical conversion rate among those living was 15%.

Other studies, in particular those using self-reported measures, have not shown the same favorable functional outcomes following non-operative treatment. Baker, et al,[29] evaluated the outcomes of 49 patients (mean age 80 years) with "associated type" acetabular fractures. All patients were treated non-operatively due to physiologic frailty. The authors found a significant reduction in mobility and living independence at 1 year, with only 35% returning to their baseline ambulation status and 69% maintaining habitation in their own home. Walley, et al,[19] retrospectively reviewed 49 acetabular fractures (mean age 81 years) treated non-operatively and found that only 29% had returned to their pre-injury ambulation status at a mean of 16 months. Surprisingly, this was slightly better, although not statistically significant, than the operative cohort (24%).

Fracture Fixation

Acetabular fracture fixation in osteoporotic/osteopenic bone is technically challenging. Inadequate fixation of the frequently involved quadrilateral surface (QLS) can result in secondary medialization of the femoral head, persistent disability, and subsequent reoperation. A biomechanical study published in the *Journal of Bone and Joint Surgery* demonstrated the effectiveness of fragment-specific QLS buttress plating when compared to conventional plating methods.[30] Twenty-four pelvic SawBones® models with anterior column posterior hemitransverse fractures underwent fixation with one of four methods: (1) Suprapectineal QLS buttress plating; (2) Infrapectineal QLS buttress plating; (3) Suprapectineal reconstruction plating; or (4) Infrapectineal reconstruction plating. Each pelvic model underwent cyclic loading at partial and full weight-bearing conditions. Fracture displacement did not exceed 1.1 mm in any model. However, under both cyclic loading conditions, suprapectineal reconstruction plating demonstrated significantly greater stiffness compared to infrapectineal reconstruction plating ($P = .006$ and $P = .026$). No differences were found between suprapectineal reconstruction plating and either QLS buttress plating technique. The authors recommended fragment-specific QLS buttress plating as an acceptable alternative to suprapectineal reconstruction plating, especially when a less invasive anterior pelvic approach is desired. Additionally, the authors recommended against infrapectineal reconstruction plating of osteoporotic anterior column posterior hemitransverse fractures in order to preserve fixation strength.

Sanders, et al,[31] investigated factors that influence outcomes following ORIF of geriatric acetabular fractures in order to help guide treatment decisions. Seventy-eight fractures (mean age 70 years) treated with ORIF were retrospectively reviewed. A poor outcome was defined as THA conversion or radiographic osteoarthritis with an Oxford Hip Score[32] <34. At a mean follow-up of 4.3 years, sixteen (20%) patients required reoperation. Eleven of these patients underwent conversion total hip arthroplasty. The 7-year joint survivorship including those considered to have a poor outcome was 60%. The only significant predictor of outcome on multivariate regression analysis was reduction quality. Based on Matta grade,[3] an imperfect (2-3 mm) or poor (>3 mm) reduction was associated with a 3.3 times greater likelihood of a poor outcome ($P = .002$). Non-anatomic reduction rates were highest among associated both column fractures. In a sub analysis comparing low and high-energy mechanisms of injury, low-energy trauma was more likely to be associated with a poor outcome and a lower 7-year joint survivorship. The general treatment algorithm recommended by the authors included ORIF whenever an anatomic reduction is feasible. On the other hand, arthroplasty should be considered whenever a non-anatomic reduction is likely. In particular, this includes low-energy associated both column fractures as the ability to achieve and maintain an anatomic reduction is likely compromised.

A systematic review of geriatric acetabular fracture management by McCormick, et al,[33] found ORIF to be associated with the highest non-fatal complication rate. The pooled outcomes of non-operative treatment, ORIF, closed reduction percutaneous pinning (CRPP), and acute THA with or without fixation were compared in 38 studies. This represented 3947 fractures with a mean age of 72 years. The non-fatal complication rate of patients treated with ORIF was 37.8%. This was significantly higher than all other treatment options ($P < .01$). Anatomic reduction (<2 mm displacement) following ORIF was achieved in just 55% of cases, which was significantly better than 23% following CRPP (95% CI 11.4-34.8%). Not surprisingly THA conversion rates were lower following ORIF (26%) compared to CRPP (15%) (OR 0.49, 95% CI 0.32-0.77). Both ORIF and CRPP had higher conversion THA rates compared to non-operative treatment. The authors suggest that internal fixation alone should be cautiously considered in geriatric acetabular fractures due to the substantial risk for non-fatal complications and THA conversion.

Total Hip Arthroplasty

Immediate weight bearing following primary THA can lead to acetabular cup instability if inadequate cup fixation is present. Marmor, et al,[34] provided insight into acetabular cup fixation strategies by utilizing 3-dimensional computer tomography (CT) to map out stable articular bone stock and available bone corridors for screw fixation. The 3-dimensional CT scans of 97 acetabular fractures (mean age 75 years) were retrospectively reviewed. The acetabular dome was found to be the most commonly available stable articular surface (77%), followed by posterior (40%) and anterior (22%) articular surfaces. All fractures (100%) had an available sciatic buttress corridor, while 78% had an available gluteal pillar corridor for screw fixation. Additionally, 65% of fractures had at least 3 bone corridors available for screw fixation. These results suggest stable cup fixation can be achieved in most geriatric acetabular fractures with the use of appropriately placed screws. Future studies are needed, however, to determine optimal acetabular cup fixation constructs.

In a separate study, Marmor, et al,[35] demonstrated that immediate assisted weight-bearing does not compromise acetabular cup fixation for fractures involving up to 50% of the posterior wall and 25% of the acetabular rim. In this biomechanical study, a representative fracture model was created using the CT scans of 18 posterior wall acetabular fractures (mean age 77 years). This "averaged" fracture pattern, consisting of 50% of the posterior wall and 25% of the acetabular rim, was recreated in 6 paired hemipelvis cadavers (mean age 81 years). A multi-holed acetabular shell was impacted into each specimen and secured with four column screws. A reconstruction plate was used to fix the posterior wall fracture prior to cup insertion in one-half of each hemipelvis, such that one hemipelvis was treated with THA alone and the other half with combined THA plus ORIF.

Cyclic loading up to 4 times body weight resulted in <150 μm of cup motion in all specimens. No significant difference in cup motion was found between specimens that did or did not receive direct fixation of the posterior wall fracture.

Morrison, et al, demonstrated that THA in the setting of a prior acetabular fracture may be associated with significantly lower 10-year implant survivorship and more major complications when compared to THA performed for primary osteoarthritis or avascular necrosis.[36] In this level III case-control study, the 10-year THA survivorship for those with a prior acetabular fracture was 70% as compared to 90% for those without (P<.001). Initial fracture management (non-operative or ORIF) did not influence 10-year survivorship in the acetabular fracture group. Regarding major complications, the acetabular fracture group had a higher likelihood of infection (7% vs 0%, P=.03), dislocation (11% vs 3%, P=.05), and severe heterotopic ossification (43% vs 16%, P<.001).

Weaver, et al, retrospectively evaluated revision surgery rates in geriatric acetabular fracture patients treated with ORIF or primary THA and found a high rate of conversion arthroplasty within 2 years following ORIF.[25] However, the overall reoperation rate did not reach statistical significance when ORIF was compared to the primary THA group (30% vs. 14%, P=.12). The authors did note that this was likely due to a type II error. Revision surgery following THA was most commonly due to infection, followed by instability, and symptomatic heterotopic ossification. In this same study, patients tended to have better hip function following THA compared to ORIF based on Harris Hip Scores[37] (82 vs 63, P=.06) and short form 36[38] pain scores (48.4 vs 35.4, P=0.04).

Two studies compared THA plus ORIF (ie, combined approach) with ORIF alone and found that a combined approach is associated with a lower risk for revision surgery. Borg, et al, prospectively followed 27 acetabular fractures (mean age 72 years) treated with a combined approach or ORIF alone.[39] At 3 years, no patient in the combined group required further surgery (100% hip joint survival), while the hip joint survival in the ORIF group was just 29% (see Figure 1). Lont, et al, retrospectively reviewed 55 acetabular fractures (mean age 77 years) treated with ORIF alone or primary THA combined with posterior column plating and use of a cup cage construct.[24] Implant survival was higher in the combined group at both 1 (100% vs 74%) and 2-year follow-up (91% vs 52%). Dome impaction was noted to be associated with poor prognosis when treatment included ORIF alone.

Jauregui, et al,[40] published the first meta-analysis on the complications of acute THA for elderly patients with acetabular fractures. Their final analysis included 21 studies, representing 430 acetabular fractures. This included the previously mentioned studies by Weaver, et al,[25] Borg, et al,[39] and Lont, et al.[24] All arthroplasty procedures were performed in combination with some type of fixation. Mean patient age was 72 years. The overall complication rate was 20%, resulting in a revision rate of 4.3% at a mean follow-up of 44 months. The most common complication was heterotopic ossification (HO) at 19.5%. However, only 6.8% were considered clinically significant (Brooker grade III and IV).[41] This indicates that most cases of HO are not clinically relevant. The next most common complication was postoperative hip instability (6.1%). The direction of dislocation or surgical approach used was not mentioned. Additionally, deep infection occurred at a rate of 3.8%. Both

Figure 1. Plain radiographs show a pelvic view of a 66-year-old male patient who sustained an acetabular fracture through a same-level fall treated with a combined hip procedure. The left photo is a preoperative radiograph and the right photo is a postoperative radiograph.[25]

the dislocation and deep infection rates reported in this study were higher than known rates associated with primary THA for osteoarthritis. The authors attributed this to the traumatized soft tissue envelope of the hip and longer surgery times (mean 176 min), respectively. Despite the less than ideal results reported in this study, in select individuals acute THA may still represent the optimal form of treatment. Therefore, surgeons should be aware of the complications associated with acute THA in order to educate their patients on potential complications and the risk for revision surgery.

Conclusion

The highlighted studies in this review shed light on the multitude of challenges associated with acetabular fractures in the geriatric population. Most notably, there is a high rate of morbidity and mortality regardless of treatment choice. Unlike in modern hip fracture management, conservative management of geriatric acetabular fractures continues to play an important role in the treatment of stable fracture patterns and those medically unfit for surgery. ORIF provides acceptable functional outcomes when anatomic reduction can be achieved. However, internal fixation alone should be cautiously considered due to the high THA conversion and non-fatal complication rates. When surgical treatment is preferred, THA alone or concurrent with ORIF should be pursued whenever possible. As the incidence of geriatric acetabular fractures is predicted to increase, future prospective studies are needed to refine decision aids surrounding optimal management in this heterogenous population.

Conflict of Interest

None of the authors identify a conflict of interest.

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