Should Total Hip Arthroplasty be Performed Acutely in the Treatment of Acetabular Fractures in Elderly or Used as a Salvage Procedure Only?

Abstract
Background: Total hip arthroplasty (THA) is now an increasingly common procedure for people sustaining acetabular fractures. The incidence of acetabular fractures among the elderly population is increasing, and contemporary treatment aims to avoid the risks of prolonged incumbency associated with poor bone stock for fixation or inability to comply with limited weightbearing in this patient group. The concept of acute hip arthroplasty as a treatment for acetabular fracture is, therefore, becoming more topical and relevant. Our systematic review investigates whether THAs for acetabular fractures should be performed acutely, with a short delay, or as a late procedure for posttraumatic osteoarthritis (PTOA) if it develops. Materials and Methods: Preferred Reporting Items for Systematic Reviews and Meta-analyses guidelines were followed when undertaking this systematic review. Detailed searches were performed on three different databases, using keywords, such as “acetabular fracture,” “acetabular trauma,” “total hip arthroplasty,” “hip arthroplasty,” and “hip prosthesis.” Studies from 1975 to September 2016 were included in the study. All studies included in the review were independently critically appraised by two of the authors. Results: Forty three studies were included in this review. Only two of them actually compared acute and delayed THAs for acetabular fractures with the rest focusing on one or the other. Results were comparable between acute and late THAs in terms of aseptic loosening, operative time, blood loss, Harris Hip Score, and ability to mobilize postoperatively without aid. Complication rates, however, were much higher in the acute group. Conclusion: Evidence based on this topic is scarce and therefore we have to be cautious about drawing a definitive conclusion. The findings of this systematic review do suggest, however, that acute THAs should be considered in elderly patients, where fixation is not possible, or when their health and ability to rehabilitate are poor. It should also be considered in patients where PTOA is very likely, or where there is already some preexisting degenerative osteoarthritis.

Keywords: Acetabular fracture, elderly, posttraumatic osteoarthritis, total hip arthroplasty
MeSH terms: Fracture fixation, osteoarthritis, hip, arthroplasty, replacement, acetabulum

Introduction
The incidence of acetabular fractures among the elderly is increasing with a 2.4-fold rise from 1997 to 2007.1 Frailty fractures resulting from a fall from standing height account for 60.6% in this age group.2 As the average age of those sustaining acetabular fractures is increasing, so is the potential role of total hip arthroplasty (THA) as a treatment method. Undisplaced fractures are commonly treated conservatively and equally, open reduction and internal fixation (ORIF) remains the gold standard for the young active population [Table 1]. However, for the older population, in a bid to avoid the risks of prolonged incumbency and inability to comply with limited weightbearing, should we follow in the footsteps of fracture neck of femur surgery and plan for one definitive procedure allowing the patient to be mobilized immediately postoperatively with confidence?

Late THA is the accepted salvage procedure for posttraumatic osteoarthritis (PTOA), avascular necrosis of the femoral head, or fixation failure.8,18 There is a bimodal distribution for this indication with 67% being performed between 6 and 24 months post-ORIF, with a second peak after a delay of many years.11,15,19 The incidence of PTOA following acetabular injury ranges from 12 to 57%.6,8,20,21 Laird and Keating1 report a significant decline in the decade up to 2003, with incidence falling from 31% to 14%. Rates of conversion to salvage THA following initial conservative management or fixation range from 6% to

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Predictive factors for the development of PTOA, conversion to THA and poor performance following THA, are shown in Table 2.3,5,8,11,19

Acute THA is being more frequently performed, particularly in older patients with fractures at high risk of developing PTOA, or in whom fixation would be insufficient to allow early mobilization. The advantages of acute THA include early mobility to avoid the high risks associated with the prolonged incumbency, smaller approaches, as the acetabulum is exposed by removing the femoral head, and nonanatomic reduction being more acceptable. It also precludes secondary surgery for PTOA.17,24 However, some have reported high complication and revision rates with THA as an acute treatment.

Delayed THA can be necessary in polytrauma patients, where other injuries take precedence, or in patients with comorbidities that require optimization. Some advocate an initial period of bed rest, followed by a THA, in the hope that this may provide more stability and cause fewer complications.

Our review sets out to investigate if THA should be performed as a treatment for acetabular fracture; acutely – within 3 weeks of injury, delayed – more than 3 weeks but before union or late – for PTOA.

### Materials and Methods

**Population, Intervention, Comparison, Outcomes**

Our systematic review followed Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines,25 with the review question designed according to the Population, Intervention, Comparison, Outcomes (PICO) method. Our review focused on patients with acetabular fractures (population), who underwent an acute THA (intervention), as compared to a late THA (comparison). Our outcomes included revision rates, functional outcomes (e.g., Harris Hip Score [HHS]), operation time, blood loss, and complications (including mortality).

**Literature searches**

Literature searches were performed on three databases: Medline, EMBASE, and Cochrane Library. An extensive search strategy was used for each database. Search keywords included “acetabular fracture,” “acetabular trauma,” “cemented total hip arthroplasty,” “uncemented total hip arthroplasty,” “hip prosthesis,” and “hip arthroplasty.”

Truncation symbols were used where appropriate. The search period extended from January 1975 to September 2016. Searches were independently performed by authors KH and GL, who also independently selected articles to be included in the systematic review. Any differences in opinion were resolved through discussion with the senior editor.
Inclusion and exclusion criteria

Papers in English, published between 1975 and 2016, that fit our PICO criteria, were included in the study. Both retrospective and prospective studies were included in the study.

Papers other than in English language were excluded from the study. Studies that focused primarily on ORIF of the acetabulum were also excluded from the study. Papers that we could not access online, by hand-searching journals or via libraries, were excluded from the study.

Data extraction

Data extraction from selected studies was performed by KH using a uniform template, which included details on the population, intervention, comparisons, and outcomes. This was then used to generate a cumulative table with details of findings to ensure systematic reporting of the results.

Risk of bias assessment

As most studies were predicted to be nonrandomized, the Quality Assessment Tool for Observational Cohort and Cross-sectional Studies by National Heart, Lung, and Blood Institute was used. This quality assessment tool contains 14 questions that facilitate the risk of bias assessment for any nonrandomized study. Each paper included in the review was quality assessed by KH and GL, to give an overall ranking of “good,” “fair,” or “poor.”

Results

Study selection

Our search strategy yielded 209 papers on Medline, 131 on EMBASE, and none on Cochrane Library. Seventeen were duplicated and had to be excluded in the initial stages. Titles were then scanned to identify relevant articles for abstract review and subsequently, for full-text review. Forty seven papers were reviewed in full by GL and KH. Four of these had to be excluded: one paper had to be excluded because it was a reply letter, two – because they were both review articles, and another paper was found to be irrelevant after the full-text review. A total of 43 studies were then included in our systematic review. The PRISMA flow diagram can be seen in Figure 1.

Risk of bias assessment

All 43 studies included in the review were independently quality assessed by GL and KH, as described in the methods section. Table 3 summarizes the outcome of the risk of bias assessment, with positive and negative
comments where appropriate. In general, most studies were of good quality, with fairly low risk of bias, considering they were not randomized studies. Some had poorer quality, usually due to the fact that methods were not sufficiently explained to award them a low risk of bias rating. The original detailed quality assessment (rather than the overall quality rating) can be made available for each of the studies upon request.

### Acute versus late total hip arthroplasty

Sermon et al.\(^{55}\) and Chémaly et al.\(^{34}\) are the only authors to directly compare acute and late THA. Their findings are summarized below.

### Age

Sermon et al.\(^{55}\) reported the only significant difference they found was the age of the patients, with the THA for...
PTOA group being younger individuals, with a mean age of 53 years compared to 78 years.

Revision
Sermon et al.35 reported revision rates of 21% in their late group and 8% in the acute group; however, this was not statistically significant. Chémaly et al.34 did not have any patients in either group who required revision.

Functional scores
Sermon et al.35 reported HHS 76% good or excellent in the late group versus 58% in the acute group, which did not reach significance. Chémaly et al.34 only reported functional scores for those in the acute group, as it related to poor functional status with Brooker Grade 3 heterotopic ossification (HO). Only 43% had good or excellent scores compared to 88% of those with grade 0–2. They found HO occurred eight times more in the acute group; however, in Sermon et al.’s35 work, HO occurrence was 76% in the late group and 28% in the acute group and the two groups were not significantly different.

Complication rate
Chémaly et al.34 had a complication rate of 25% in the acute group and 15% in the late group, but this was not analyzed statistically. Sermon et al.35 reported a 25% overall complication rate but did not divide this between the two groups.

Blood loss and operating time
Chémaly et al.34 found more than double the blood loss (992 ml vs. 416 ml) and operating time (171 min vs. 76 min) in the acute group. Sermon et al.35 did not report on these outcomes.

Acute total hip arthroplasty
Acute THA does not have a large evidence base. Around 300 cases are reported by the papers in our review, and more than 70% of the papers we found had less than twenty patients and 5-year followup. The results for each study can be seen in Table 4.

Revision
Aseptic loosening of the acetabular component has classically been the concern with regard to performing an acute THA for acetabular fracture. Across the papers, we reviewed revision for aseptic loosening occurred at a rate of 2.3% (range 0%–10%) albeit with a mean followup of only 53.7 months (range 18–81.5 months).

Functional scores
Functional outcomes were varied. The average HHS was 87 (range 42–99), but the proportion of good and excellent results varied from 100% to just 60%. Postoperatively, 74% of patients were mobile without walking aids or had returned to their preinjury status.

Complication rate
The overall complication rate was 20.1% ranging from no complications to 59%. The complications for each paper are shown in Table 5. The mean mortality was 9%, with some authors reporting no deaths and the highest 58% at 3 years, with 26% in the first year.12

Blood loss and operating time
These cases are technically demanding with an average operative time of 174 min (range 45–510 min) and blood loss of 964 ml (range 200–5000 ml).

Cemented versus uncemented
The results comparing cemented with uncemented are shown in Table 6. The two groups are comparable, with the notable exception being complication rate, which is 40% in the cemented group and 16% in uncemented; and mortality, which is 11% in the cemented group and 2.4% in the uncemented.

Delayed
Delayed THA is performed more than 3 weeks from injury but before union. The published evidence is very limited – our search only found two abstracts from meeting
| Variable | Herscovici et al. 2010 | Sarkar et al. 2004 | Chakravarty et al. 2006 | Simko et al. 2006 | Lin et al. 2008 | Strauss et al. 2008 | Tidermark et al. 2003 | Mousine et al. 2013 | Malhotra et al. 2013 | Boraiah et al. 2010 | Rickman et al. 2012 | Beaul et al. 2014 | Mears and Velyvis et al. 2004 | Chana-Solomon et al. 2012 | Chana-Rodriguez et al. 2015 | Total All studies |
|----------|---------------------|------------------|------------------------|------------------|----------------|-------------------|-------------------|-------------------|------------------|-------------------|------------------|------------------|-------------------|-------------------|------------------|------------------|
| N        | 22                  | 35               | 19                     | 10               | 33             | 11                | 10                | 12                | 15               | 18                | 10               | 57               | 18                | 6                 | 11               | 20               |
| Age range| 60-95               | 41-91            | 57-90                  | 60-83            | 47-92          | 67-78             | 57-87             | 65-93             | 63-84            | 57-69             | 55-86            | 63-90            | 50-85             | 26-89             | 65-93            | 70-85            | 72-87            | NR               |
| FU (m)   | 29.4                | 72               | 22                     | 36               | 67             | NR                | 38                | 24                | 48               | 81.5              | 47               | 18               | 36                | 97                | 36               | 24              | 18               | 31.2             |
| RAC%     | 20                  | 42               | NR                     | 0                | 6              | 0                 | 0                 | 0                 | 0                | 5.5               | 0               | 0                | 1.8               | 0                 | 0                | 0               | 0.7              |
| AS       | 10                  | 5.7              | NR                     | 0                | 6              | 0                 | 0                 | 0                 | 0                | 5.5               | 0               | 0                | 0                 | 0                 | 0               | 0.3              |
| Op time (m) | 232              | 100              | 231                    | 100              | 200            | 300               | 159               | 120              | 180              | 135              | 110             | 100              | 85                | 135              | 100             | 171             | 174             |
| Blood L(mL) | 1163             | NR               | 700                    | 1000             | 852            | 3U                | 1100              | NR               | 665              | 835              | NR              | 1233            | 1060              | NR               | 92              | NR              | 992             |
| HHS      | 82.6                | NR               | NR                     | NR               | NR             | 100               | NR               | NR               | NR               | 85                | NR              | 85               | NR                | 91.1             | NR               | NR               | NR              | NR              |
| G/Ex (%) | NR                  | NR               | NR                     | NR               | NR             | 100               | NR               | 100              | NR               | 87                | NR              | 81               | NR                | 97               | NR               | 90              | NR              | NR              |
| CR (%)   | 59                  | 17               | 42                     | 0                | 15             | 9                 | NR               | NR               | NR               | 33                | 5.5             | 8               | 20                | 10.5             | 5.6             | 16.6            | 18              | 25              |
| LOS (d)  | 8.1                 | 16               | 13/40                  | NR               | NR             | NR                | NR               | 10               | NR               | NR                | 11              | 19               | NR                | 13                | NR               | 17              | 15.4            |
| Mobility (%) | NR               | NR               | NR                     | 100              | 12.5           | 80                | 91               | 53                | 66                | NR               | 100             | NR               | 83                | NR                | 100             | NR              | 94%             |
| Mortality (%) | 0              | 0                | 9                      | 58               | 0              | 18                | 27.2             | 0                 | 0                | 0                 | 0               | 8.3              | 0                | 5.6              | 0               | 9               | 7.3              |
| Stability | ORIF               | ORIF/roof        | Screws only            | Cage +          | Screws          | Screws            | Screws            | Screws            | Screws           | Screws           | Screws          | Screws          | Screws            | Screws           | Screws          | Screws          |
| HHS      | 1-2                 | NR               | 4(no class)            | 1-2             | 1-5            | 0                 | 1-2-4            | 1-3              | 1-1              | 1-0              | 1-0             | 1-0             | 1-2              | 1-6              | 1-0             | 1-2             | Overall 20%     |
| G/Ex (%) | 1-1                 | 2-1              | 2-1                    | 2-2             | 1-0            | 1-0              | 2-2              | 2-2              | 2-1              | 2-2             | 2-1             | 2-0             | 2-1              | 2-1              | 3-8             | 2-4.7%          |
| CR (%)   | 3-0                 | 3-3              | 3-3                    | 3-0             | 3-0            | 3-0              | 3-0              | 3-0              | 3-0              | 3-0             | 3-0             | 3-0             | 3-0              | 3-0              | 3-0             | 3-0             | 4-0.7%          |
| Mobility (%) | 4-1              | 4-0              | 4-0                    | 4-0             | 4-0            | 4-0              | 4-0              | 4-0              | 4-0              | 4-0             | 4-0             | 4-0             | 4-0              | 4-0              | 4-0             | 4-0             | 4-0             |

N=Number of participants, FU=Average follow up period in months, RAC=Revision any cause, AS=Revision for aseptic loosening, HHS=Harris Hip Score, CR=complication rate, LOS=Length of stay in days, G/Ex =% of patients achieving good or excellent functional outcomes, HO=Heterotopic Ossification by Brooker Grade, NR=Not reported, Av=Average, Op=Operation
presentations with this as their focus. Iotov et al.\(^\text{41}\) only included patients with significant displacement, whereas Halawa and Sadek\(^\text{37}\) also included patients who had had failed fixation – both of these factors may predispose to poorer results.

**Revision**

Halawa and Sadek\(^\text{37}\) had three patients (7.9\%) requiring revision due to uncoupling of metal–backed, cemented acetabular components, whereas Iotov et al.\(^\text{41}\) report all-cause revision at 21.4\% and for aseptic loosening – 14.3\%.

*Functional scores*

The average HHS in Iotov et al.\(^\text{41}\)’s patients was 78, improving from 54, whereas Halawa and Sadek\(^\text{37}\) used the Merle d’Aubigne score, which improved in all the cases, from a range of 4/5 to 15/18.

| Study                        | Dis | Nerve | VTE | Vessel | Superficial infection | Deep infection | Fracture |
|------------------------------|-----|-------|-----|--------|-----------------------|---------------|----------|
| Beaulé et al.\(^\text{27}\)  | 1   | -     | -   | -      | -                     | -             | -        |
| Bellabarba et al.\(^\text{28}\) | 0   | -     | -   | -      | -                     | 0             | -        |
| Berry and Halasy\(^\text{29}\) | 1   | -     | -   | 1      | -                     | 3 (femoral)   | -        |
| Boardman and Charnley\(^\text{7}\) | -   | -     | 6   | -      | 1                     | -             | -        |
| Boraiah et al.\(^\text{30}\)  | 1   | -     | -   | 1      | -                     | -             | -        |
| Bronsema et al.\(^\text{31}\)  | -   | -     | -   | -      | -                     | -             | -        |
| Chakravarty et al.\(^\text{32}\) | 1   | 1     | 2   | -      | 1                     | -             | -        |
| Chana-Rodríguez et al.\(^\text{33}\) | 1   | -     | -   | -      | -                     | -             | -        |
| Chémaly et al.\(^\text{34}\)  | 1   | -     | -   | -      | 0                     | 0             | -        |
| Enoecon and Blomfeldt\(^\text{15}\) | 0   | 1     | 1   | -      | 0                     | 0             | 0        |
| Flóris et al.\(^\text{36}\)  | 3   | 1     | 1   | -      | -                     | 2             | -        |
| Halawa and Sadek\(^\text{37}\) | -   | -     | -   | -      | -                     | -             | -        |
| Herscovici et al.\(^\text{38}\) | 3   | 0     | -   | -      | 0                     | 0             | -        |
| Huang et al.\(^\text{39}\)   | -   | 1     | -   | -      | -                     | 2             | -        |
| Huo et al.\(^\text{40}\)     | 1   | 1     | -   | -      | -                     | -             | 1 (calcar) |
| Iotov et al.\(^\text{41}\)   | -   | -     | -   | -      | -                     | -             | -        |
| Kamath et al.\(^\text{42}\)  | -   | -     | -   | -      | -                     | -             | -        |
| Lai et al.\(^\text{43}\)     | 2   | 1     | 1   | -      | -                     | -             | -        |
| Lin et al.\(^\text{44}\)     | 1   | 0     | 0   | -      | 1                     | 1             | -        |
| Liu et al.\(^\text{45}\)     | 1   | 1     | 1   | -      | -                     | -             | -        |
| Lizaúr-Utrilla et al.\(^\text{46}\) | 6   | -     | -   | -      | -                     | 1             | -        |
| Malhotra et al.\(^\text{47}\) | 1   | 1     | -   | -      | 2                     | -             | -        |
| Mears and Velyvis\(^\text{13}\) | 2   | 0     | 3   | -      | -                     | 0             | -        |
| Morison et al.\(^\text{48}\) | 8   | 1     | -   | -      | -                     | 5             | -        |
| Mouhsine et al.\(^\text{49}\) | 1   | 0     | -   | 0      | 0                     | 0             | 0        |
| Mouhsine et al.\(^\text{50}\) | 0   | 0     | 0   | 0      | 0                     | 0             | 0        |
| Pritchett and Bortel\(^\text{51}\) | 0   | 1     | -   | -      | 0                     | 0             | -        |
| Ranawat et al.\(^\text{52}\) | -   | -     | -   | -      | 3                     | 3             | -        |
| Rickman et al.\(^\text{53}\) | 0   | 0     | 0   | -      | 1                     | 0             | 1 (GT)   |
| Romness and Lewallen\(^\text{54}\) | -   | -     | -   | -      | -                     | -             | -        |
| Sarkar et al.\(^\text{55}\)  | 4   | -     | -   | -      | -                     | -             | -        |
| Sarkar et al.\(^\text{56}\)  | 2   | -     | -   | -      | 1                     | 2             | -        |
| Schnaser et al.\(^\text{57}\) | 2   | -     | 3   | -      | 1                     | -             | -        |
| Schreurs et al.\(^\text{58}\) | 0   | -     | -   | -      | -                     | -             | -        |
| Sermon et al.\(^\text{59}\)  | 4   | 6     | -   | 1      | 11                    | 8             | -        |
| Simko et al.\(^\text{60}\)   | -   | -     | -   | -      | -                     | -             | -        |
| Solomon et al.\(^\text{61}\) | 0   | -     | 2   | -      | 0                     | 0             | -        |
| Strauss\(^\text{57}\)         | -   | -     | -   | -      | -                     | 1             | -        |
| Tidermark et al.\(^\text{58}\) | 1   | -     | 1   | -      | -                     | -             | -        |
| von Roth et al.\(^\text{59}\) | 0   | -     | -   | -      | -                     | 0             | -        |
| Weber and Berry\(^\text{60}\) | 3   | 1     | 1   | -      | -                     | 0             | -        |
| Yuan et al.\(^\text{61}\)    | -   | 0     | -   | -      | 0                     | 0             | 1 (GT)   |
| Zhang et al.\(^\text{62}\)   | 1   | 3     | -   | -      | -                     | 0             | -        |

Dis=Dislocation, VTE=Venous thromboembolism, GT=Greater Trochanter fracture only
Complication rate

Neither report gave details regarding complications. However, Chémaly et al. did note in their report that the highest risk of heterotopic ossification occurred when THA was performed 2–8 weeks postinjury.

Blood loss and operating time

This is only reported by Iotov et al. with blood loss between 850 and 2200 ml and operating time of 3–7 h.

Late

Late, THAs for acetabular fractures have historically performed poorly compared to THA for degenerative osteoarthritis (DOA), but they are improving over time. The results for all the studies are collated in Table 7.

Age

Revisions for loosening occur at double the rate in patients under 60 (17.2%) as opposed to those over 60 (7.7%).

Revision

Across all papers, the average revision rate for any cause was 10.9% (range 0%–43%) and 6.9% (range 0%–25.3%) for aseptic loosening, with a mean followup of 6.3 years. The highest revision rates were in the earliest papers, and if studies published before 2000 are excluded the average is 5% for aseptic loosening, but similar for any-cause revision at 10.1%, with a mean followup of 6 years.

Functional scores

The average HHS was 86.7 (range 70–93), the proportion of good and excellent results varied from 54% to 94%. HHS correlated with age but not fracture pattern, previous treatment, or model of component. Overall, 77% of patients were mobile with no walking aids.

Complication rate

The complication rate was 13.8% overall, with the highest at 24%. The complications for each paper are shown in Table 5. The mean mortality was 9%, with some authors reporting no deaths and the highest 55.5% at 20 years.

Blood loss and operating time

The average operative time was 137.8 min (range 60–315 min) and blood loss was 768.9 ml (range 100–2900 ml).

Cemented versus uncemented

The results comparing cemented with uncemented are shown in Table 6. The two groups are comparable, with the notable exception of mortality, which is 15% in the cemented group and 3.2% in the uncemented group.

Initial management

Comparing the results following THA by their initial management, it has been found that previous fixation resulted in a longer index procedure and greater blood loss. It was also noted that elevated acetabular liners were used more often, and the development of HO was twice as likely after previous fixation. Bone grafting was less common than in the conservative group in one study and more common in another. There was found no difference in HHS, radiographic stability, complication rates, acetabular nonunion, radioluency or anatomic hip center reconstruction, clinical outcomes, loosening, or nonunion between different treatments.

Post traumatic osteoarthritis versus degenerative osteoarthritis

Outcomes for THA performed for PTOA are worse than for DOA. The PTOA THAs had a longer operative time, higher blood loss, and complication rates. Functional outcomes were comparable in Bellabarba et al.’s series, but Schnaser found they were significantly worse. The presence of radiolucent lines was significantly higher in the PTOA group than the DOA group; however, this did not affect the 10-year survival, which was similar with 97% in the PTOA and 99% in the DOA.
| Variable | Mixed | Cemented | Uncemented | Total |
|----------|-------|----------|------------|-------|
| N        | 17    | 22       | 30         | 79    |
| Age range| 60-94 | 20-74    | 36-72      | 120   |
| FU (m)   | 77    | 72       | 51         | 190   |
| RAC%     | 6     | 22       | 0          | 28    |
| AS%      | 0     | 0        | 0          | 0     |
| RLS      | NR    | 0        | 0          | NR    |
| OT       | NR    | NR       | NR         | NR    |
| BL       | 668   | NR       | NR         | NR    |
| HHS      | 70    | NR       | 84         | 81    |
| CR%      | 24    | 8        | 20         | 52    |
| TTA(y)   | NR    | 31       | 20.2       | 51.2  |
| Mobility | NR    | 81       | 81         | NR    |
| G/Ex hhs | 35.1  | 59       | NR         | NR    |
| Cement   | MIX   | MIX      | MIX        | MIX   |
| Mortality| 7.6   | 2.7      | 6.7        | 4.5   |
| HO       | NR    | 1.0      | 3          | 4     |

N=Number of participants, FU=Average follow up period in months, RAC=Revision any cause, AS=Revision for aseptic loosening, RL=Clinical or radiological loosening, OT=Operating time in minutes, BL=Blood loss in ml, HHS=Harris Hip Score, CR=Complication rates, TTA(y)=Time to arthroplasty in years, G/Ex = % of patients achieving good or excellent functional outcomes, NR=Not reported, HO=Heterotopic Ossification by Brooker Grade, Av=Average
et al.,48 however, found higher rates of survival in the PTOA group (70% vs. 90%) and when only considering aseptic loosening – 77% versus 90%. Complication rates are higher in the PTOA group, equivalent to revision procedures,28 and Morison et al.38 had an infection rate of 7% in their PTOA group versus no infections in DOA group – they noted previous fixation was a risk for infection. Fracture type did not affect clinical outcomes, the stability of the acetabular component, operative time, or blood loss for late THA.40,43

Comparison

Results from acute and late THA studies [Table 8] show comparable findings for aseptic loosening, operative time, blood loss, HHS, and ability to mobilize postoperatively without aid. Complication rates are, however, much higher in the acute group, with deep infection being almost 50% more common.

Discussion

THA is well established as the treatment for PTOA. Its use as a primary definitive treatment in the acute setting is controversial but is gaining momentum in certain circumstances, where it may provide the best outcome. Using this review, we feel that acute THA should be considered:

1. In elderly patients in whom the acetabular fracture configuration, bone stock, or quality would not allow for fixation with immediate mobilization. As with arthroplasty as a treatment for neck of femur fractures, it may provide a suitable definitive treatment and avoid the relative risks of prolonged incumbency in this age group
2. In elderly patients in whom fixation is possible but that their health, life expectancy, or ability to rehabilitate would increase the risks or negate the benefits of fixation
3. When the damage to the articular surface is severe, and thus the development of PTOA is likely, and the patient is over 65
4. If there is preexisting DOA severe enough to warrant a THA, then it should be considered.

Difficulty exists in providing the answer for the younger patients, with indications for a THA. Until robust evidence is provided to further clarify on this small subgroup of patients, the trend is to proceed with fixation in the majority of cases and deal with PTOA in the future if it occurs.

In clinical practice, a delayed THA is often used. This negates the need to gain initial stability or negotiate a previous surgical site. However, whether this prevents the higher rates of complications and infection seen in acute THA, is still not known. The evidence we do have suggests a higher risk of heterotopic ossification, blood loss, and longer operation time, particularly if the fracture is significantly displaced. It also needs to be considered that bed rest requires intensive nursing, has its own complications, and may delay recovery without improving outcomes.

Strengths and weaknesses

We believe that this is a useful systematic review on a topic that may be controversial and definitely requires more evidence base, which we are hoping this systematic review, at least in part, provides. A clear and succinct search strategy was used to make sure that all relevant articles were identified. A lengthy study period was used, and journals were also handsearched, in addition to including relevant papers from review articles. This was all performed by two authors, minimizing the risk of errors and bias. This ensured that this review is as systematic and as detailed as possible. Extensive summary tables of all study findings were designed; ensuring that data are reported consistently, and any differences between studies or the way results were reported would be obvious.

Weaknesses of our review include the fact that studies used numerous different implants and surgical techniques and reported outcomes using different methods and scales. There are not many studies that actually compare acute and delayed THAs, and there were no randomized controlled trials. This made it relatively difficult to summarize the findings of all the studies included in our review. There were not many studies overall focusing on this topic, making it difficult to draw definitive conclusions from our systematic review.

Table 8: Results from acute versus late total hip arthroplasty studies

| Variable                     | Acute     | Delayed    | Late       |
|------------------------------|-----------|------------|------------|
| AS (%)                       | 2.3       | 9.6        | 6.9        |
| Operation time (months)      | 174 (45-510) | 180-420    | 137.8 (60-315) |
| Blood loss (ml)              | 964 (200-5000) | 850-2200   | 768.9 (100-2900) |
| HHS Absolute                 | 87        | 78         | 86.7       |
| Proportion good/excellent (%)| 60-100    | NR         | 35.1-94    |
| Mobility without aid (%)     | 74        | NR         | 77         |
| Complication rate (%)        | 20.1      | NR         | 13.8       |
| Deep infection (%)           | 2.3       | 1.9        | 1.5        |

AS=Revision for aseptic loosening, HHS=Harris Hip Score, NR=Not reported
Further work

There is a paucity of high-level evidence in this area. Further work in the field is needed, especially more studies focusing on acute versus delayed THAs in acetabular fractures to help guide future clinical practice. However, acetabular fractures amenable to acute THA are relatively rare, and there are inherent difficulties in designing randomized trials for trauma. No joint registry specifically reports on the performance of THA following acetabular fracture and given the relatively low number of this procedure; it may be the only way to collect meaningful data. Universal assessment method for both functional and radiological outcomes would be useful, as this would allow potential future meta-analyses to be performed, therefore allowing more definitive conclusions to be drawn from the systematic review.

Conclusion

We feel that THA as an acute treatment option should be performed for elderly patients in whom the risks of poor quality fixation, inability to comply with limited weightbearing, and risks of prolonged incumbency outweigh the potentially increased risks of the procedure. Once the decision to perform an acute THA has been made, gaining bony stability is vital. The majority of modern papers combine arthroplasty with augment such as concomitant fixation or ring reinforcement, and the trend is moving from “fix or replace” toward “fix and replace.” It should be undertaken by a surgeon familiar with both pelvic fixation and revision hip arthroplasty, often requiring a specialist pelvic and acetabular trauma surgeon working with an arthroplasty specialist to be equipped to deal with the highly technical demands of the procedure.

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Conflicts of interest

There are no conflicts of interest.

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