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ORIGINAL STUDY

Total hip arthroplasty after surgical treatment of acetabular fractures : a 5-year minimum follow-up study

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Total Hip Arthroplasty (THA) after acetabular fracture is a technically demanding procedure due to previous incisions, hardware presence, acetabular bone loss, residual pelvic deformity, post-traumatic osteonecrosis and high risk of infection. The objective of this study is to evaluate results of THA after post-traumatic osteoarthritis (OA) and/or hip joint avascular necrosis (AVN) secondary to acetabular fracture, with a minimum of 5 years follow up.

49 THA were performed after acetabular fractures open reduction internal fixation (ORIF) on 30 male and 19 female patients. Average age was 47.3 years (range, 25 to 73 years) at the time of THA. Time between initial acetabulum ORIF and definitive THA was on average 11 months (range 9 to 18 months). The mean follow-up period was 5.3 years (range 5 to 7 years). Harris hip score (HHS) was obtained pre and postoperatively.

Removal of previous hardware was complete in 7 patients (14.2%), partial in 19 patients (38.7%). A cemented cup was implanted in 13 patients (26.5%) and an uncemented cup in 36 patients (73.5%). The mean preoperatively HHS score was 42 (range 25 to 58) and 91 after arthroplasty (range 82 to 96). Revision surgery due to aseptic loosening of the acetabular component was required in 3 cases (6.1%).

Outcomes of THA after acetabular fractures previously treated with open reduction and internal fixation are acceptable at medium long-term follow-up. Selection of a cementless acetabular component seems to be a more predictable choice.

Keywords : total hip arthroplasty ; total hip replacement ; acetabular fracture ; hip osteoarthritis ; post-traumatic osteoarthritis ; osteonecrosis.

INTRODUCTION

Acetabular fractures have, in general, poor long-term-outcomes, despite initial conservative or surgical treatment *(1)*. This is strictly related to the development of secondary osteoarthritis (OA) *(2-5)* and avascular necrosis (AVN) of the hip joint. The main indication for total hip arthroplasty (THA) after an acetabular fracture is severe hip pain non-responding to conservative treatment with compatible radiological signs, such as articular space narrowing, joint incongruity and femoral head and

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subchondral acetabular sclerosis. Therefore THA is the first surgical option *(6-8)* in order to relieve pain and restore function.

THA after open reduction internal fixation (ORIF) of an acetabular fracture has been recognized as a challenging and difficult procedure. Several features must be taken into account, including undetected infection, longer procedure with greater blood loss, deficient acetabular bone stock, residual pelvic deformity, non-united fractures, presence of osteosynthesis hardware, sciatic nerve injuries, heterotopic ossifications (HO), AVN of the acetabulum *(9)* and long-term acetabular fixation *(6-8,10-13)*.

The objective of this study is to review the mid-term results of THA in a cohort of patients that developed secondary OA and/or AVN of the hip joint after an acetabulum fracture previously treated with ORIF.

MATERIALS AND METHODS

Between January 2011 and May 2013, data were prospectively collected and retrospectively reviewed for 49 patients who underwent THA after failed ORIF of an acetabular fracture. Acetabulum fracture patterns were classified according to Letournel and Judet classification *(2)* and are summarised in Table I. All 49 patients had previously had acute acetabulum ORIF, with no fractures treated conservatively. Of the total number of patients, 30 were males (61.2%) and 19 were females (38.8%). Mean age at the moment of THA was 47.3 years (range 25-73 years). Time from index procedure (acetabulum fracture ORIF) to secondary THA was 11 months on average (range 9-18 months).

Table I. — Initial acetabulum fracture patterns according to Letournel classification

Acetabulum Fracture Pattern	n	%
Posterior Wall	8	16
Posterior Column	7	15
Transverse + Posterior Wall	7	15
Anterior Column	5	10
Both Column	5	10
Transverse	4	8
Posterior Column and Wall	4	8
Anterior Column, Posterior Hemitransverse	4	8
T-shaped	3	6
Anterior Wall	2	4

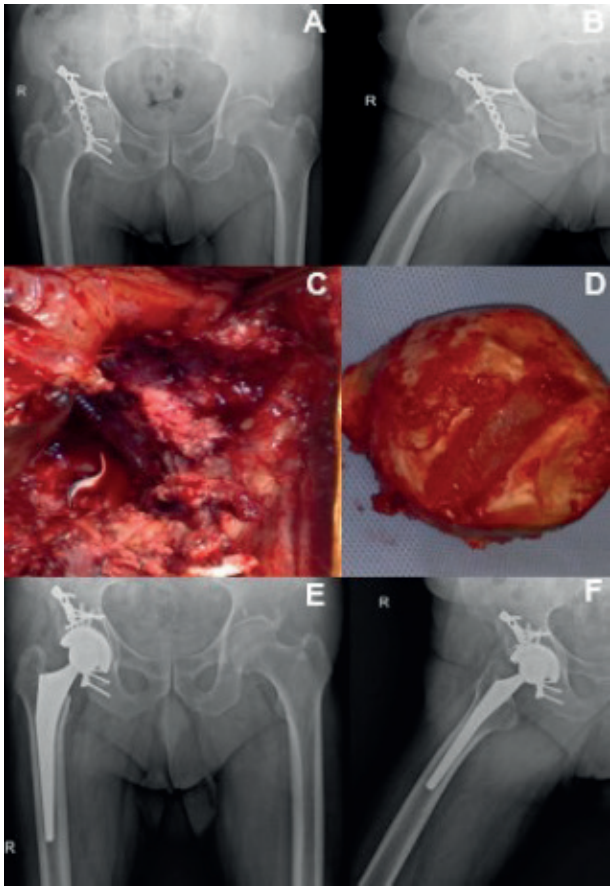

Figure 1. — AP **(A)** and Lateral **(B)** preoperative radiographs of a 56-year-old patient who underwent ORIF for a posterior wall acetabulum fracture, with ongoing hip pain, decreased range of motion and scraping sensation 10 months after initial surgery **(C)**. Intraoperative picture of the femoral head where the erosion caused by one distal screw can be seen **(D)**. AP **(E)** and Lateral **(F)** postoperative radiographs after 5 years follow-up.

The indication of THA was made according to clinical findings (function-limiting hip pain, decreased range of motion) along with compatible hip OA and AVN radiological signs.

Two senior authors of the same team performed the 49 surgeries. A posterolateral approach was used in all cases. Hemogram, erythrosedimentation rate (ESR) and C reactive protein (CRP) were obtained

preoperatively to rule out undetected infection. Intraoperatively, 3 samples of periacetabular fibrous tissue were collected for microbiologic cultures and frozen sections.

Hardware removal was only performed when it interfered with the acetabular reaming. It was done either by direct vision through the posterolateral approach, percutaneous incisions using fluoroscopy, or by cutting the body of a single screw crossing through the acetabular dome or quadrilateral plate with a diamond burr (Figure 1). Minimum acetabular defects or cavities were fulfilled with morselised bone graft from the femoral head but when large acetabular defects were encountered, structural bone graft and revision Burch-Schneider rings (Zimmer, IN, USA) were used.

Cemented (n = 9 ; 18.3%), hybrid (n = 4 ; 8.1%) and cementless (n = 36 ; 73.5%) THA's were used (Figures 2 and 3). Cemented components were a Lubinus cup (Waldemar LINK, Germany) and a polished Evolve Helios stem (Signature Orthopaedics, Australia). Cementless THA system combined a Crown Cup acetabular component (Exactech, Gainesville, FL, USA) with supplementary screw fixation and a LCU femoral stem (Waldemar LINK, Germany) or Element stem (Exactech, Gainesville, FL). A cemented cup was inserted in 13 patients (26.5%) while 36 patients

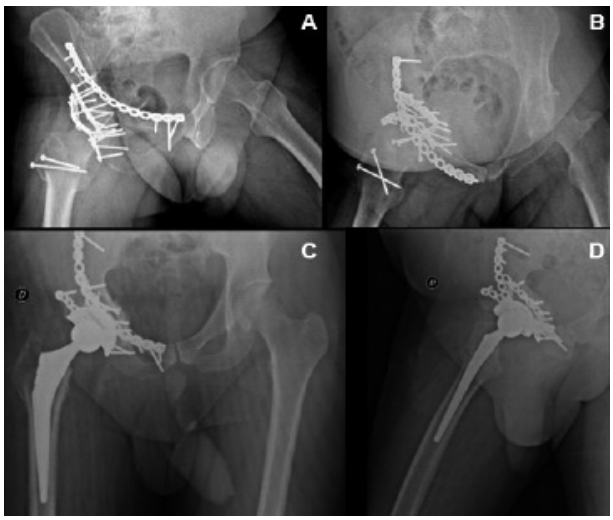

Figure 2. — Pelvic oblique views (**A** and **B**) of an associated both-column acetabulum fracture treated with ORIF in a 49-year-old patient with persistent hip pain. Postoperative AP (**C**) and lateral (**D**) radiographs showing selected hardware removal and THA.

(73.5%) had a cementless cup. For enhanced fixation, two supplementary screws were added to uncemented acetabular components, even in the presence of good primary press-fit. Metal heads were used and the implanted acetabular liners had a 10º elevated posterior wall. A cell-saver suction device was used in every case and blood loss was

Figure 3. — Failed ORIF of a left acetabulum fracture with medialisation of the femoral head at the level of the quadrilateral plate and femoral head damage (Top). Surgical treatment included partial hardware removal, morselised bone graft from the femoral head to fulfil the central acetabular defect and a hybrid THA (cemented cup, cementless femoral stem).

measured according to its final count. Transfusion requirements were obtained from the patients' medical records.

Three intravenous antibiotic prophylaxis doses were given to the patients and no drains were used postoperatively. All patients received the same scheme for deep venous thrombosis (DVT) prophylaxis : subcutaneous enoxaparin 40 mg during hospitalisation and rivaroxaban 10 mg orally for one month. No routine HO prophylaxis was given, although some patients at risk (specifically, obese males with a previous extensive posterior acetabular approaches) had postoperative radiation therapy (single-dose 700 Gy). Rehabilitation protocol included early mobilisation after surgery and full weight-bearing ambulation with a walker for 15 days. After that, we encouraged patients to progressively return to normal daily activities as tolerated with the use of a cane or crutch for at least one month, depending on their clinical evolution and findings on follow-up radiographs.

Clinical outcomes were assessed with the Harris Hip Score (HHS) *(14)*. All patients were scored before and after THA.

Anteroposterior and lateral radiographs of the hip were obtained immediately postoperatively, at 3 weeks, 2 months, 6 months, and annually thereafter. We compared the immediate postoperative radiographs with those made at the latest follow-up. A femoral or acetabular radiolucency was defined as any irregular line between the implant and the bony interface, and periprosthetic osteolysis was defined as progressive bone loss larger than 5mm using both Gruen and DeLee and Charnley *(15)* zones, respectively. The subsidence of the femoral stem was determined using the method described by Loudon and Charnley *(16)*, measuring the distance from a selected (but variable) point in the femoral prosthesis to a fixed point in the bone. Loosening was defined as subsidence of more than 5 mm or continuous demarcation around the stem. Stem fixation was assessed using the method of Engh et al. *(17)*. The Brooker classification was used to determine the extent of HO *(18)*.

We registered all complications according to Dindo-Clavien classification *(19)*. We considered a septic failure as any case requiring revision surgery due to a surgical site infection. We defined an aseptic implant failure whenever any revision surgery performed for non-infectious causes.

RESULTS

In our series, indication for THA after acetabulum ORIF was post-traumatic hip OA in 38 patients (77.6%) while AVN of the femoral head was

Table II. — Intraoperative technical details and surgical postoperative variables in THA after acetabulum ORIF

Intraoperative Technical Details and Surgical Postoperative Variables	
	n (%)
Hardware Removal	
Partial	19 (38%)
Complete	7 (14%)
Acetabular bone defect	
Minimum	
Morselised Bone Graft	15 (30%)
Large	
Structural Bone Graft + Burch-Schneider Ring	6 (12%)
Acetabular Component	
Uncemented + supplementary screw fixation	36 (73.5%)
Cemented	13 (26.5%)
Femoral Components	
Uncemented	40 (82%)
Cemented	9 (18%)
Mean Surgical Time (minutes)	135 (range 100 to 242)
Mean Blood Loss (millilitres)	790 (range 600 to 1050)
Mean Blood Transfusion (units)	0.65 (range 0 to 3.5)

detected in 11 cases (22.4%). 8 cases (16.3%) had an acetabular non-union evidenced at the time of implantation. No patients had previous sciatic nerve injuries or symptomatic HO after ORIF. No infections were detected with the laboratory tests (CRP and ESR), microbiologic cultures and/or frozen sections taken at the day of THA. Table II summarises intraoperative technical details and surgical variables obtained after surgery. Complete hardware removal was needed in 7 patients (14%) and partial removal in 19 patients (38%). Morselised bone graft was used to fill small acetabular defects in 15 patients (30%) but an acetabular revision cage (Burch-Schneider ring) and structural bone graft were required in 6 patients (12%). Mean surgical time was 135 minutes (range 100 to 242 minutes). Blood loss was in average 790 ml with a range of 600-1050 ml. Transfusion requirements were from 0 to 3.5 units with an average of 0.65 units per patient.

There was a significant improvement in the HHS score when comparing preoperative and postoperative values from 42 (range 25 to 58) to 91 (range 82 to 96).

No radiolucent lines were evidenced around the femoral components. 7 acetabular cups (14%) presented radiolucent lines without further progression and remained asymptomatic at the latest follow-up. No symptomatic HO was pre or postoperatively identified.

8 patients presented complications in the series (16%) (Table III). Revision surgery due to aseptic loosening of the acetabular component was required in 3 patients (6.1%), of which 2 were cemented and 1 was cementless. All 3 cases had progressive radiolucent lines and migration of the cup in sequential radiographs, along with worsening hip pain and impeded function. No deep infections were found at the time of revision surgery, where the same protocol was applied (laboratory tests and 3 intraoperative specimens for microbiology and histology). Other complications included two superficial wound infections (4%) surgically treated with debridement, antibiotics and implant retention, two posterior dislocations (4%) treated with closed reduction under general anaesthesia, and one deep venous thrombosis (2%) medically treated.

Table III. — Complications of THA after acetabulum ORIF

	n	%
Aseptic Loosening Acetabular Component	3	6
Cemented	2	
Uncemented	1	
Surgical Site Infection	2	4
Dislocation	2	4
DVT	1	2
Overall Complications	8	16

At a mean time of 5.3 years of follow-up, taking revision surgery for any reason as the endpoint, the survivorship rate was 94%.

DISCUSSION

THA after acetabular fracture may be performed in two scenarios : acutely or when the patient has developed uncontrolled non-responding pain to conservative treatment in the late setting, which remains to be the main indication for THA. In our study all cases had an acetabular fracture that was treated acutely with ORIF, developed secondary OA or femoral head AVN that lead to pain and activity limitation, and therefore THA was indicated. Hip OA is estimated to occur in approximately 20% of patients sustaining an acetabular fracture, but, as reported by Giannoudis et al *(13)* only 8% would need a further operation, especially those aged more than 60 years old with marginal impaction or injury to the femoral head *(20)*.

There is no consensus if a secondary THA is easier if initial ORIF *(3,21)* of the acetabulum fracture is performed. Although initial ORIF is accompanied by some degree of scar tissue, muscle damage, potential HO formation and infection risk, most authors *(2,7,13,21,22)* agree that THA after acetabular fracture is greatly facilitated by initial surgical treatment. Failed non-surgical treatment in complex fractures requires advanced acetabular reconstruction. On the other hand, there is no evidence to confirm that previous ORIF predispose the hip to more instability but less bone deficiency *(10)*.

THA after acetabular fracture has always been recognized as a difficult procedure[6-8] with numerous technical challenges, such as previous incisions, presence of previous osteosynthesis hardware,

acetabular bone loss, residual pelvic deformity, osteonecrosis of bone fragments, longer operative time and blood loss, neurologic injury and higher infection risk. Infection should be always ruled out. The first step should be obtaining preoperatively CRP and ESR, and if these values are elevated or if high clinical suspicion persists, aspiration of the hip joint is indicated. If the infection is confirmed, the reconstructive procedure should be staged *(23)*. Another technical issue is the positioning of the acetabular component, due to the loss of anatomical landmarks caused by malunion, non-union or acetabular bone deficiency. In these cases, the use of morselised or structural autografts fixed with screws and pelvic reconstruction hardware such as trabecular metal augments or Burch-Schneider cages are very useful and should be available in the operating room. In order to improve stability, larger heads are recommended, and the use of dual mobility components must be considered. Routine removal of the previous hardware is not recommended except in cases of infection (Figure 1). Extended approaches with excessive bone fragments resection would be necessary with a significant risk of sciatic nerve injury and HO formation. Both NSAIDS and radiation therapy have demonstrated to be effective in HO prophylaxis, being the decision to use one or another weighed accordingly to each individual and radiation therapy availability *(24,25)*. Despite all these potential complications, most series report that THA after acetabular fracture has excellent results in terms of pain relief and function restoration *(10,26-29)*. Boardman and Charnley *(30)* reported in 1978 the excellent short-term outcomes of a cemented low friction THA in 66 patients with a mean follow-up of 3.5 years. Pritchett et al. *(31)* reported a mean HHS of 84 points after secondary THA for failed treatment of acetabular fracture in 19 patients. Huo et al. *(32)* performed 21 cementless THA for previous acetabular fractures and had good to excellent clinical results in 19 patients. These studies correlate well with our data because our patients had a 49 points average improvement in HHS (range 82-96) after THA. However, these results are not as good as for primary osteoarthritis. Lizaur-Utrilla *(29)* found significant differences regarding operative time and postoperative HHS when comparing a cohort of 24 cementless THA after acetabular fracture matched with a control cohort of routine THA in a 8.4 years-period follow up.

Another historical controversy of THA after acetabular fracture has been early aseptic loosening of the acetabular components, especially with cemented cups, theoretically due to bone loss and the underlying sclerotic bone bed that prevents PMMA to interdigitate between it. An example is the study by Romness and Lewallen, who reported a cemented-fixation failure rate of 21% at 5 years and 50% at 10 years *(6)*.

Regarding literature about cementless acetabular fixation, Bellabarba et al (10) showed 1 revision of 30 acetabular components (3.3%) while Ranawat *(28)* reported 2 revisions in 32 acetabular components (6.2%) at 5 years follow-up. These results also correlate well with our study, because 2 of the 3 cases of aseptic cup loosening we report, were in cemented components. On the other hand, Scott and colleagues lately reported a ten-year survival rate of 92% with cemented implants, stating that concerns

Table IV. — Literature review concerning Acetabular Component Revision

Author	Year	THA (n)	Fixation	Revision (n) (%)	Follow-up (years)
Romness et al.	1990	55	Cemented	7 (13.7%)	7.5
Bellabarba et al.	2001	30	Cementless	1 (3.3%)	5.2
Berry et al.	2002	34	Cementless	9 (26%)	10
Ranawat et al.	2009	32	Cementless	2 (6.2 %)	4.7
Scott et al.	2017	49	Cemented	4 (8.6%)	10
This Study	2018	49	Cementless	1 (2%)	5.3
			Cemented	2 (4.1%)	

about early loosening of cemented acetabular components were unsupported (Table IV).

Either way it has to be remarked that loosening is related to age and activity level, and in our study mean age at the moment of THA was 47.3 years, which is a younger average age than other studies (48.7 years *(6)*, 51 years *(10)*, 52 years *(28)*, 65.5 years) and than patients who routinely undergo THA for OA.

Posterior dislocation occurred in 2 patients (4%) as a single event, not requiring early revision surgery. Ranawat *(28)* suggested that one factor that may be influencing this, is the use of a 20º elevated liners, although this type of liners had been associated with a significantly risk of cup revision in the long term due to aseptic loosening.

Retrospective design, absence of a control group and the use of many prostheses' models and types of fixation are the main limitations of our study.

To summarise, THA after acetabular fracture managed with initial surgical treatment show favourable clinical outcomes in the mid-term. A thorough preoperative evaluation and planning are mandatory for the identification of potential complications. Experienced surgeons trained in both acetabular and pelvic trauma and complex hip reconstruction should perform these procedures, because multiple complications may arise, such as undetected infection, acetabular bone loss, non-united fractures, presence of hardware interfering with the procedure, sciatic nerve injuries, HO and sclerotic acetabular bone that may difficult fixation. Selection of a cementless acetabular component seems to be a more predictable choice than cemented components, at least until more studies are performed.

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