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ORIGINAL ARTICLE • HIP - ARTHROPLASTY

Total hip arthroplasty for the treatment of osteoarthritis secondary to acetabular fractures treated by open reduction and internal fixation

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Abstract

Background Acetabular fractures are associated with damage to the femoral head, acetabular cartilage and labrum and possible disruption of the femoral head blood supply. Treatment aims to provide the best opportunity for restoration of joint function and to prevent long-term complications. Surgical intervention, in the form of open reduction and internal fixation (ORIF), is often required. Where post-traumatic osteoarthritis develops after ORIF, total hip arthroplasty (THA) is often required. Our aim here has been to identify and highlight our experience with the key technical points associated with successful outcomes for THA in this setting.

Methods A single-centre retrospective review of patients with acetabular fractures treated with ORIF and subsequent THA over a 4-year period was undertaken. Demographics, mechanism of injury, complications, interval time between surgeries, intra-operative outcomes and post-operative outcomes were recorded. Particular emphasis is made to describe standard pre-operative and intra-operative protocols.

Results Twenty-five patients were identified, with a mean age of 51.1 years at time of first ORIF. 60% presented following RTA. 80% of fractures involved the posterior wall or column. Meantime to eventual THA was 2.3 years. Mean THA duration was 1.52 h, with mean intra-operative blood loss and length of stay of 585 ml and 5 days, respectively. 24% required intra-operative removal of metal, with only one patient suffering a complication post-THA.

Conclusion Acceptable post-operative outcomes were demonstrated throughout the case series. In describing the pre-operative work up, intra-operative findings and intra-operative and post-operative complications encountered, common important technical points associated with a successful surgical strategy are described. Furthermore, potential pitfalls that may be encountered can be anticipated.

Keywords Arthroplasty · Hip · Revision · Acetabular fracture

Introduction

Acetabular fractures and their associated injuries to acetabular and femoral cartilage and femoral head blood supply will frequently lead to post-traumatic arthritis. For displaced fractures, surgical intervention with open reduction and internal fixation (ORIF) has been demonstrated to optimise joint function [1–6] and ultimately reduce the risk of developing post-traumatic arthritis. ORIF does not eliminate this risk however. Variable rates are reported for the development of post-traumatic arthritis following ORIF of acetabular fractures, ranging from 12 to 57% [7, 8].

Where acetabular fractures go on to develop post-traumatic arthritis, whether managed operatively or non-operatively, total hip arthroplasty (THA) is a well-established treatment option with good outcomes [8–10]. Where THA has been performed for post-traumatic arthritis, the outcomes are typically less successful than THA for primary hip arthritis, however, in terms of complications, function and implant survivorship [7, 8, 11]. Modern acetabular replacement, however, particularly utilising un-cemented components, has demonstrated increasingly satisfactory outcomes [8, 12–14].

Where an acetabular fracture has been treated with ORIF, subsequent THA will present significant technical challenges for the surgeon as compared to THA for primary arthritis.

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Associated problems arise due to fracture mal-union and non-union, metal fixation in situ, in situ metal wear and fatigue, bone defects, abnormal muscle function, heterotopic ossification and infection [8, 9, 11, 15, 16]. It is of critical importance that all of these factors are considered and planned for prior to proceeding to THA. The overall aim in reporting this case series is to identify and highlight up-to-date key technical points associated with successful outcomes for this procedure, to describe the stepwise approach in performing the procedure and to identify the associated challenges.

Patients and methods

From January 2013 to October 2017, a consecutive series of 25 patients, all with symptomatic post-traumatic osteoarthritis secondary to acetabular fractures previously treated with ORIF, were treated with THA by the senior author who is specialised in both pelvis and acetabular trauma and hip arthroplasty. Figures 1 and 2 demonstrate the onset of hip osteoarthritis post-open reduction and internal fixation for acetabular fracture with later treatment with total hip arthroplasty. All patients had initially been referred and treated for traumatic acetabular fractures at this institution, which is the national centre for pelvic and acetabular trauma. Patients were identified through a search of electronic theatre records. Data were collected through a comprehensive review of patient notes, intra-operative records and the electronic picture archiving and communication system (PACS).

The decision to proceed to THA is made on the basis of confirmed radiographic changes in keeping with end-stage osteoarthritis in the presence of symptoms causing significant limitation in function. Patients are screened for deep infection through careful history and examination and by using erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) blood tests. Where these blood tests are abnormal, a hip joint aspiration is carried out and progression to THA will only proceed where microbiological analysis of aspirate is negative for signs of infection. Where there is a concern for deep infection pre-operatively, a staged procedure with irrigation, debridement and removal of all fixation would be considered in the first instance and THA performed at a later second stage.

The pre-operative planning stage involves carrying out clinical examination, pre-operative anaesthetic assessment and making a comprehensive review of operative records and up-to-date plain film X-rays. During clinical examination, baseline hip abductor muscle function, sciatic nerve function and the presence of any limb length discrepancy are assessed and recorded. In reviewing operative records and X-rays, particular attention is made to identify hardware

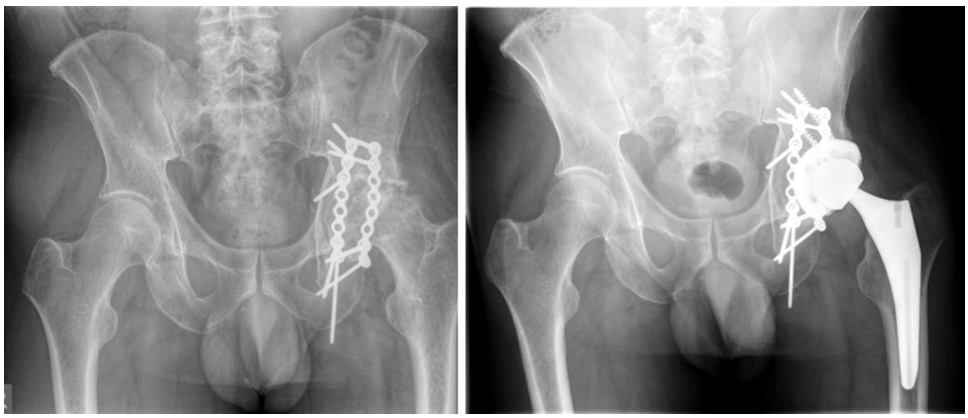

Fig. 1 Case 1 demonstrating the onset of hip osteoarthritis post-open reduction and internal fixation for acetabular fracture with later treatment with total hip arthroplasty

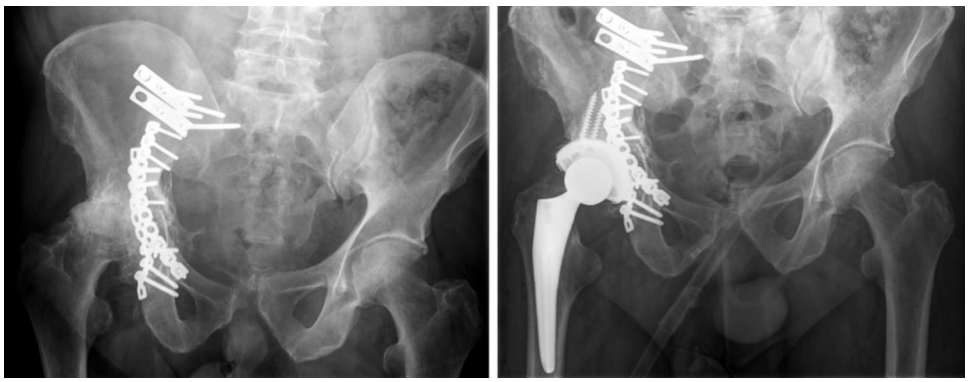

Fig. 2 Case 2 demonstrating the onset of hip osteoarthritis post-open reduction and internal fixation for acetabular fracture with later treatment with total hip arthroplasty

in situ in order to anticipate the potential need for removal of metal and to make available necessary removal sets. Plain film X-rays may furthermore allow for the detection of any major bone defects present, fracture non-unions and heterotopic ossification. Where bone defects are suspected on X-ray, further assessment is carried out with CT scan.

Intra-operative set-up involves placing the patient in the lateral position, whether the approach is anterolateral or posterior. The surgical approach was determined according to the requirement for removal of metal and the specific utility provided by either posterior or anterolateral approach. In younger patients, in particular, this may be required in order to facilitate the use of un-cemented acetabular components.

Where bone defects are identified pre-operatively, femoral head allo-grafts are ordered and kept on standby. Bone defects identified intra-operatively are treated with bone auto-graft as required. In particular, quadrilateral plate deficiencies and medialisation of the hip centre are treated with wafer technique grafting utilising the native femoral head [17, 18].

Where no acetabular deficiencies are present, the acetabulum is sequentially reamed to the true floor. Additional screw fixation is used as required to achieve implant stability. Intra-articular soft tissue and free fluid are routinely sent for culture and sensitivity.

Tranexamic acid and IV antibiotics are administered at induction. IV antibiotics are continued for 24 h post-operatively. For thromboprophylaxis, low molecular weight heparin is commenced post-operatively for 3 days after which aspirin 150 mg once per day is commenced and maintained for 4 weeks. Compression stockings are worn for 6 weeks.

Results

In total, 25 patients were identified for this study, 8 women and 17 men. The mean age at the time of injury was 51.5 years, and the mean age at the time of THR was 53.8 years. The average time interval between injury and ultimate THR was 2.3 years.

60% of patients presented following road traffic accidents, and in a further 32% of cases, the cause of injury was a fall from height. Fractures were classified according to the Letournel system [19] and the itemisation, and the relevant categorisation is described in Table 1. In 24% of patients, there was an associated hip dislocation, and in 12% of patients, there was an associated femoral fracture. For the initial fixation, the Kocher–Langenbeck approach [20] was used in 76% of cases and the ilioinguinal approach [21] in 16% of cases. A combined ilioinguinal and Kocher–Langenbeck approach was used in 8% of cases.

For THA, no patients tested positive in pre-operative ESR and CRP screening for infection. In 12 patients, the approach was by an anterolateral approach and in 13 by a posterior approach. The mean THA operative time was 1.52 h. The mean intra-operative blood loss and length of stay were 585 ml and 5 days, respectively. 28% of patients required intra-operative removal of metal from the original fixation. The standard acetabular implant choice at our centre for this procedure is to use an un-cemented cup with screw augmentation as required. In instances where metal fixation in situ is preventing increasing sequential reaming of the acetabulum, and where removal of this metal is not practical, a cemented cup is used. In this patient cohort in 24% of cases, a cemented cup was used for this reason. The average inpatient hospital stay was 6.8 days.

Table 1 Classification of fractures identified in the study [1]

Letournel classification	Number	Percentage
Posterior wall	4	16
Anterior wall	0	0
Posterior column	3	12
Anterior column	2	8
Transverse	0	0
T type	3	12
Posterior wall and posterior column	3	12
Transverse and posterior wall	4	16
Anterior column hemitransverse	0	0
Associated both columns	6	24

Nine patients underwent auto-graft to acetabular defects using the native femoral head. In three of these patients, the graft was augmented with synthetic granules.

Mean follow-up time was 22 months from the time of THA. At the time of the last follow-up examination, all patients had a stable prosthesis with consolidation of the femoral head auto-grafts. There was no evidence of radiographic loosening, subsidence or migration of implants. There was no radiographic evidence of heterotopic ossification.

In total, six patients (24%) developed complications post-THA as described in Table 2. In five cases, intra-operative complications were noted. As described in the management protocol, free fluid and soft tissue samples are sent routinely for culture and sensitivity before implanting the prosthesis. In Case 1, free fluid retrieved returned a positive culture for Staphylococcus epidermidis. The patient has since been kept under regular observation with regular CRP and ESR screening with careful assessment for component loosening, and at 32-month follow-up, there is no evidence suggestive for deep infection.

In Case 2, free fluid in the joint was determined to be frank pus at the time of operation and the decision was made to carry out the hip replacement as a two-stage procedure. Copious pulsed lavage and aggressive debridement with

Table 2 Complications identified post-THA

Case	Stage	Description	Outcome
1	Intra-operative	Free fluid collected intra-operatively grew Staph epidermidis on culture	Uncomplicated post-operative course. No evidence for deep infection at 32 months follow-up
2	Intra-operative	Pus identified intra-operatively. Converted to two-stage procedure and cement spacer introduced	Second stage performed at 2 months. No further complications at 6 months follow-up
3	Intra-operative	Femoral head dislocation not possible due to medialisation of the femoral head in the acetabulum	Femoral neck cut performed in situ
4	Intra-operative	Posterior approach abandoned due to difficult dissection secondary to fibrous scar tissue	Converted to anterolateral approach. No further complications at 14 months follow-up
5	Intra-operative	Non-union identified in posterior column. Treated with femoral head bone graft	Boney union apparent on X-ray at 18 months follow-up
6	Early post-operative	Superficial wound infection	Successfully treated with intra-venous antibiotics

removal of all metal fixation were carried out. An antibiotic-impregnated cement spacer was left in situ for 3 months until the second-stage procedure. At 6 months after the second stage, there is no evidence suggestive for deep infection. Intra-operative fluid samples sent at the time of the first-stage procedure did not return any positive growth on culture and sensitivity testing.

For Case 3, it was determined intra-operatively that dislocating the femoral head was not possible due to medialisation of the femoral head secondary to the index fracture mal-union. An in situ neck cut was made, and the femoral head removed with corkscrew.

In Case 4, the approach was changed intra-operatively from a posterior approach to an anterolateral approach. The index fracture was classified as an associated both column types and had been fixed through a Kocher–Langenbeck approach. At THA, dissecting posteriorly revealed highly fibrous and vascular scar tissue in approaching the sciatic notch. It was decided at this time that further dissection posterior could not be done without compromising the safety of the sciatic nerve.

In Case 5, where the index injury was classified as an associated both column types, fracture non-union was noted in the posterior column, which was treated with femoral head auto-graft.

Post-operatively, one patient, Case 6, developed a superficial wound infection and this was successfully treated with antibiotics. There was no late-stage complication at 22 months mean follow-up.

Discussion

THA after ORIF of an acetabular fracture is a technically demanding procedure. Fracture mal-union and non-union, metal fixation in situ, in situ metal wear and fatigue, bone defects, abnormal muscle function, heterotopic ossification and infection all contribute to the complexity of acetabular reconstruction and achieving hip stability. The aim in reporting this case series has been to identify and highlight the experience at a national pelvis and acetabulum trauma centre with the key technical points associated with successful and reproducible outcomes for this procedure.

Acetabular defects are a particular concern in these patients and must be anticipated.

However, a number of defects are only recognised intra-operatively and so the full spectrum of revision kit should be available with a wide-ranging selection of cemented and un-cemented sizes. Bone defects are treated with reaming or bone graft in the first instance. Reconstruction of any defects with bone graft harvested from the native femoral head presents a good solution to restore bone stock [17, 18]. In particular, quadrilateral plate deficiencies and medialisation of the hip centre were treated with wafer technique grafting [17] utilising the native femoral head. Cup stability is augmented with screw fixation as required. 26% of patients in this study had acetabular defects requiring bone graft, with rates ranging from 30 to 49% reported in the literature [10, 12].

Leg length inequality is frequently encountered before THA and is frequently secondary to superior migration of the femoral head relative to the true centre of rotation, with the acetabulum healed in this position. Significant risk of a traction injury to the sciatic nerve arises when performing THA in this setting where leg length inequality is corrected operatively. This may be further exacerbated if the nerve has been tethered by fibrosis tissue in the aftermath of fracture healing. Rates of sciatic nerve injury in this setting are reported in the region of 6% [10]. Part of the reasoning in preference for using a posterior approach for this procedure is that allows for routine exploration and identification of the sciatic nerve. As standard, a record is made that the sciatic nerve is safe and tension free at the end of the procedure. No incident of sciatic nerve injury is reported in this series.

The standard approach in the setting of previous ORIF of the acetabulum is to utilise a posterior approach to the hip

joint in order to best facilitate any potential requirement for removal of metal. Where the approach used for ORIF was an ilioinguinal incision, the posterior approach is used as standard and if hardware is present and occupies a portion of the acetabulum that needs to be reamed, a cemented acetabular component is used. In patients greater than 70 years old, consideration is given to using cemented implants as standard and so consideration is also given to using an anterolateral approach in these cases.

Where there are concerns, either pre-operatively or intra-operatively, that the hardware is infected, the hardware should be removed in the initial stage and the THA performed at a later second stage. As demonstrated in Case 2 in this study, pre-operative screening protocols do not necessarily rule out a deep infection and intra-operative findings may necessitate deciding to proceed to a two-stage procedure there and then.

As this is a retrospective case series study, there are associated inherent limitations, most importantly the absence of control subjects with which to compare outcomes. However, this paper does describe a large number of patients in a niche specialism treated with comparable technique. A further limitation is that surgery was performed at a high-volume tertiary referral centre for pelvis and acetabular fractures. This could imply that some patients who originally underwent acetabular ORIF further went on to have THA at a local centre.

Only one post-operative complication is described, a superficial wound infection, and this compares well with rates and types for short-term complications reported in the literature [8]. Longer term follow-up will be required to determine how this case series fares in terms of the incidence of dislocation, heterotopic ossification and deep infection as well as in terms of 5-year and 10-year survivorship.

In summary, THA in the setting of previous ORIF for acetabular fractures presents with significant technical challenges. It should be approached with thorough pre-operative planning in a fashion similar to that taken with complex revision arthroplasty. We believe overall, that demonstrated here, with meticulous surgical planning and anticipation for the key technical challenges frequently encountered, the results of THA in this setting are good in the short-term to medium-term.

Conflict of interest Peter Dawson, Lisa Dunne, Hasnain Raza, Mark Quin and Michael Leonard declare that they have no conflict of interest.

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