Eur J Trauma Emerg Surg (2012) 38:511–516
DOI 10.1007/s00068-012-0231-9

ORIGINAL ARTICLE

The management of complex acetabular fractures in the elderly with fracture fixation and primary total hip replacement

M. Rickman · J. Young · M. Bircher · R. Pearce · M. Hamilton

Received: 10 June 2012 / Accepted: 17 September 2012 / Published online: 1 November 2012

Abstract Osteoporosis and associated fragility fractures are an increasing problem across the developed world. The elderly osteoporotic acetabular fracture presents a difficult problem due to high failure rates and poor outcomes. Standard management may or may not include fracture fixation, but generally includes a period of protected weight bearing, even if total hip replacement has been performed. We present a series of 12 cases of complex osteoporotic acetabular fractures in elderly patients, managed successfully using primary fracture fixation and total hip replacement with trabecular metal technology. Immediate weight bearing was allowed in all cases, few complications have been seen, and no component migration has been identified in any case.

Keywords Acetabulum · Arthroplasty · Geriatric trauma · Hip · Pelvic trauma

Introduction

With the population living longer, and activity levels rising, osteoporotic fractures are becoming more frequent. In 1999, Mears [12] predicted that by 2010 geriatric patients would represent the largest group of acetabular fractures. St George's Hospital NHS Trust is a tertiary referral centre for pelvic and acetabular fractures. A significant change in referred fracture types has been seen, with osteoporotic acetabular fractures becoming increasingly common, although not yet to the level predicted by Mears. The elderly osteoporotic acetabular fracture presents a difficult problem due to high failure rates and poor outcomes. We present the results of a series of these patients who have been successfully managed with early fracture fixation and simultaneous total hip replacement, allowing immediate full weight bearing, and with no component migration seen.

M. Rickman · J. Young (✉) · M. Bircher · R. Pearce
Department of Trauma and Orthopaedics, St George's Hospital, London, UK
e-mail: jamesyoung@doctors.org.uk

M. Hamilton
Department of Anaesthetics, St George's Hospital, London, UK

Materials and methods

Since 2009, referred acetabular fracture cases at St George's Hospital were considered for primary total hip replacement if all of the following criteria were met:

1. Patient aged over 65, or over 60 with poor physiological status or significant comorbidities
2. Osteoporotic fracture, identified by a low-energy injury (e.g. simple trip or fall from standing height)
3. Significant marginal impaction, or significant femoral head damage
4. Patient considered medically fit enough to undergo surgery

Patients were assessed jointly by surgical and anaesthetic teams prior to consent being taken. For American Society of Anesthesiologists (ASA) grade III or IV patients, postoperative care was delivered in an intensive care or high-dependency unit, where possible, for the first 24–48 h. In addition, ASA grade I and II patients with significant blood loss and replacement were observed for 24 h in the high-dependency unit. All patients underwent balanced general anaesthesia, with

Table 1 Patient demographic data

Case	Age	Sex	Mechanism of injury	Fracture type	Fracture side	Preoperative mobility	ASA grade
1	64	M	Simple fall	T plus dome	R	Normal	2
2	90	F	Simple fall	ACPH	L	1 stick	2
3	79	M	Fall from push bike	T plus dome	R	Normal	3
4	75	M	Simple fall	AC/QP	R	1 stick	2
5	65	M	Simple fall	T plus dome	L	Normal	2
6	71	M	Simple fall	AC/QP	R	Normal	3
7	82	M	Simple fall	ABC	R	1 stick	2
8	74	F	Simple fall	T plus dome	L	Normal	3
9	87	F	Simple fall	Transverse/QP	R	Normal	4
10	73	M	Simple fall after fit	PCPW	L	Normal	3
11	70	M	Simple fall	T plus dome	L	Normal	3
12	73	M	Simple fall	PWPC	L	Normal	2

controlled ventilation via an endotracheal tube with local anaesthesia supplementation.

The demographic data for the 12 patients included is shown in Table 1. The mean patient age was 75, range 63–90, and only three patients were female. The average time from fall to surgery was 11 days.

Surgical information

All operations were carried out in a single sitting by the senior author (MR). Where anterior reduction and fixation was necessary, the patient was placed supine and underwent anterior fixation first, using a modified Stoppa approach [3, 14] through a transverse skin incision (Fig. 1). If the anterior column fracture exited above the anterior superior iliac spine then, in addition, the outer window of the ilioinguinal approach was utilised (Fig. 2), but no cases required the middle window (i.e a full ilioinguinal approach).

All cases then underwent a Kocher–Langenbeck approach for total hip replacement, and simultaneous posterior fixation where necessary.

Although some attempt was made to achieve fracture reduction, an anatomic reduction was not sought for either column. Good bone contact was, however, ensured in all cases. Posterior column fractures were stabilised with a single plate, and if needed a second plate was added for a posterior wall fracture. Lag screws were used as required. In two cases significant superior/medial defects that remained after reaming were bone-grafted using cancellous bone from the femoral head. The specific operative details are given in Table 2.

A cemented Exeter stem (Stryker Corp.) and a trabecular metal revision modular shell (Zimmer Inc.) were used in all cases. The shell was impacted in whatever position achieved

Fig. 1 Example of simple anterior fixation performed through a Stoppa approach

Fig. 2 More complex case where the outer window of the ilioinguinal approach has been used

Table 2 Surgical information

Case	Anterior approach	Anterior fixation	Posterior fixation	Op. time (min)	Blood loss (ml)	Blood transfused (units)	Stem size	Shell size (outer/inner)
1	Stoppa	10 hole	10 hole	140	650	Nil	44 no 4	62/36
2	Stoppa	10 hole	8 hole	200	1,300	5	37.5 no 0	44/28
3	Stoppa	12 hole	10 hole	180	600	Nil	44 no 1	58/36
4	Stoppa	10 hole	Nil	200	1,500	2	44 no 3	58/36
5	Stoppa	14 hole	Nil	240	500	Nil	37.5 no 2	56/32
6	Stoppa plus outer window	2 plates	Nil	180	1,200	2	37.5 no 0	58/36
7	Stoppa plus outer window	2 plates	10 hole	280	2,000	2	44 no 4	58/40
8	Stoppa	12 hole	8 hole	240	1,500	2	37.5 no 2	52/32
9	Stoppa	12 hole	8 hole	210	600	3	44 no 1	54/32
10	Nil	Nil	2 plates	155	700	Nil	44 no 1	56/36
11	Stoppa	14 hole	2 plates	180	1,750	2	44 no 2	60/36
12	Nil	Nil	2 plates	180	2,500	2	44 no 1	52/28

maximal stability of the implant, wherever maximum bone coverage was possible. The polyethylene liner was then cemented into the acetabular shell, in the traditional position for total hip replacements. Where possible, a 36 mm internal diameter was used. In some cases, the inner diameter of the shell was not large enough to allow a 36 mm liner, and in one case a 40 mm liner was used. Metal heads were employed throughout. A minimum of two screws were used in every shell, and in most cases up to four. In one case there was an uncontained defect at the superomedial aspect, adjacent to the sciatic notch, and a trabecular metal augment was used to bridge this defect (Fig. 3).

Following surgery, patients were transferred to a high-dependency unit overnight, or until it was safe for them to be transferred back to the orthopaedic ward. Postoperative management included allowing full weight bearing as soon as possible for all patients. All patients were medicated with warfarin for 3 months as thromboprophylaxis, and follow-up after discharge was in a specialist pelvic and acetabular clinic. X-rays were taken immediately post surgery, then at 6 and 12 weeks, and 6 and 12 months.

Fig. 3 Postoperative radiograph showing a superomedial augment used to aid stability of the acetabular component

Results

The mean total operating time was just under 200 min (range 130–280), including the changeover time between approaches, and the mean intraoperative blood loss was 1,233 mls (range 500–2,500). The only intraoperative complication was a minor greater trochanteric fracture in one patient, which was wired and went on to heal uneventfully.

All patients mobilised rapidly, sitting out by day 2 and mobilising fully weight bearing by day 7 post surgery. The mean length of stay in our unit was 19 days, range 10–36.

Radiographically, no component migration has been seen on plain X-rays in any case. All fractures were seen to be fully healed, with healing occurring between 3 and 6 months in all cases. The minimum follow-up at the time of writing is 12 months, with a mean time of 18 months, excluding case 8, who died whilst in hospital (detailed below).

Within the hospital setting, two postoperative complications were seen. One case had a slowly healing posterior wound, which was treated as a superficial infection. On day 14 the patient returned to theatre for a wound washout, and the wound subsequently healed uneventfully. Microbiology samples were all negative throughout, but it is assumed that this was a superficial wound infection. This was the only reoperation throughout the series.

There was one perioperative death. Case 8, a 74-year-old female patient, who was operated on 11 days after a simple fall at home. Surgery was performed via a modified

Stoppa approach and a Kocher–Langenbeck approach. On day 6 after surgery she became acutely unwell, with raised cardiac troponin, and two days later died of cardiac failure secondary to a myocardial infarct. No post-mortem examination was performed. In her past medical history, the patient had high blood pressure and high cholesterol, and had suffered a myocardial infarct 12 years previously; at that time the patient underwent an angioplasty and stent insertion, and had been relatively asymptomatic since.

No thrombo-embolic complications were identified, and no component migration on X-ray has been seen. There have been no dislocations, nerve palsies, or deep infections. At the 12-month review, the 11 surviving patients all remained mobile. Six patients had returned to their preoperative mobility level (three with no aids, three with a single stick), whilst five remained dependent on at least a single stick when they had not done so prior to the injury. No patients had to use a zimmer frame beyond six weeks after surgery. All patients had returned to their preinjury abode.

Discussion

Osteoporosis is an increasing problem across the world, and the annual associated cost in Europe is estimated at €30 billion [4]. With patients' life expectancies rising, and exercise/activity levels also increasing, the combined effect is a rise in the number of osteoporotic fractures. Amongst the most difficult of these are the osteoporotic acetabular fractures. Since the 1960s, surgical fixation has become common for displaced acetabular fractures, and results have steadily improved [2, 7, 8, 11]. A regular finding, however, has been poorer results from fixation of acetabular fractures in the elderly [8–10]. Explanations for this are largely based on poor bone quality. Even low-energy fractures cause crushing of osteoporotic bone and subcortical impaction, making anatomic reduction impossible; however, long-term outcome of acetabular fractures is directly related to accuracy of reduction [10]. There is little in the literature suggesting good outcomes with fixation in the elderly acetabular fractures. Although Helfet [5] reported good results with fracture fixation, the age group involved was over 60 with a mean age of 67, a decade younger than the group in this series.

Numerous papers looking at acute total hip replacement for acetabular fractures have been published. In some, the fractures are generally simple posterior fractures, often posterior wall only, and thus there is no inherent instability. Especially with modern implants, this situation is not significantly different to a routine arthroplasty procedure. In others, although more complex fractures are included, patients were not allowed to weight bear fully after surgery [1, 6, 13].

The fracture patterns seen in this study group appear to be varied (Table 1), but had a common theme. None of them were simple fracture patterns. The majority of cases had involvement of the anterior column and quadrilateral plate, and almost all cases had significant crushing of the subchondral bone (Fig. 4). Several of the "T" fractures had significant displacement of the anterior column, but much less of the posterior column. In several cases, although the fracture did not exit through the back of the acetabulum, significant marginal impaction was still seen at the back of the hip joint (also shown in Fig. 4). This posterior impaction is impossible to address from the front, and from the back would require an osteotomy; this is typical of fractures in this age group, and goes some way to explaining why simple fracture fixation generally fails.

By stabilising the anterior column first in all cases, the initial stability of the acetabular component after posterior fixation was generally excellent, especially following the addition of screws. The overall stability concept, however, was to create the equivalent of an "A" construct, using the trabecular shell as an internal plate. Thus, there was an anterior plate (if fractured, or intact bone if not), a posterior plate (or intact column) and a "horizontal" trabecular metal shell (Fig. 5a–c). The shell was not implanted in the traditional ideal position for arthroplasty, but more where it would get maximum bony contact between the two columns and the acetabular dome. Since it is seen as a third plate, screws were always placed, even if the stability felt excellent. The polyethylene liner was then cemented into the shell, in a more traditional position. Usually, the liner was slightly less open than the shell, as well as slightly more anteverted.

It can be questioned whether it is really necessary to fix the anterior column, especially as the anterior column can be missing in revision hip replacement surgery and is generally not addressed. However, in general for the cases in this series, the quadrilateral plate was fractured, and

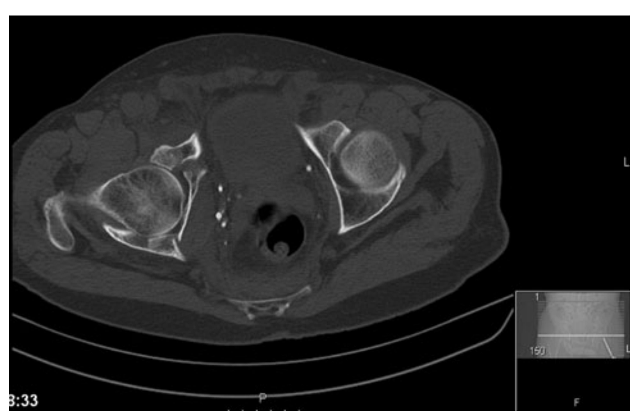

Fig. 4 Preoperative CT showing a typical fracture with displacement of the quadrilateral plate, and marked posterior marginal impaction

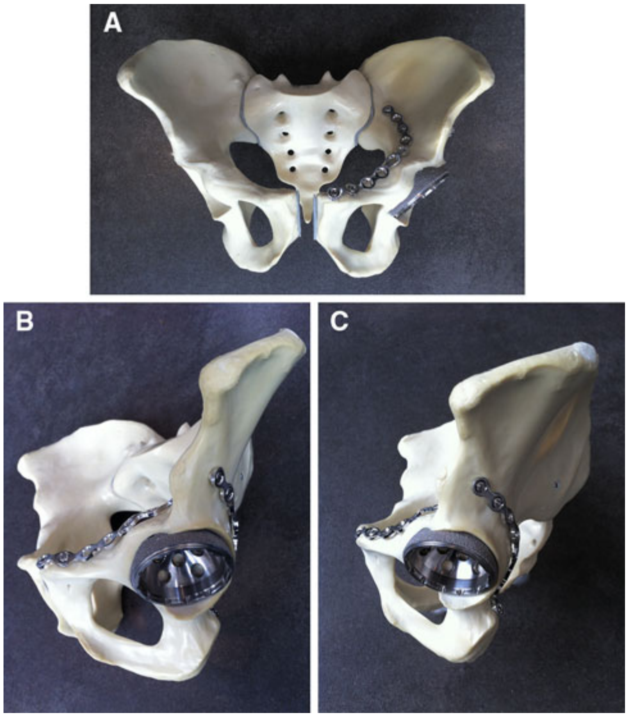

Fig. 5a–c Sawbone model of "A" construct (**a** anteroposterior, **b** obturator oblique and **c** lateral views), with plate fixation of both columns and a trabecular shell in the middle, acting as a third plate

often the dome was impacted; thus, if the anterior column was not stable, the only bone available for fixation is the posterior column. In osteoporotic bone, with such minimal implant–bone contact, stability would not be sufficient to allow immediate full weight bearing.

Despite the extent of emergency surgery performed on this elderly group of patients, we have seen very few complications. There was one perioperative death, but careful preoperative cardiac screening is not possible in this group due to the emergency nature of the surgery and lack of opportunity to test functional status. By using large heads wherever possible, as well as cementing the polyethylene in the ideal position regardless of bone cover, joint stability appears to be achievable. Our infection rate was low, and possibly zero. The injuries are predominantly low energy, and the soft tissues on the whole are therefore good, with no stripping or skin abrasions, and even the deeper tissues showed little evidence of marked bruising or damage. Healing is therefore less problematic than it might be in the younger, high-energy injuries.

It should be pointed out that whilst these cases were treated as described, there were other patients of a similar age range within the same timeframe who were managed by conventional fixation. For a simple fracture pattern with no marginal impaction in a previously mobile patient who can tolerate a period of mobility using crutches, routine reduction and fixation should be considered. We are not advocating fixation and replacement for all acetabular fractures in this age group—only for those in whom routine fixation is very unlikely to work and primary fixation and replacement is feasible. Similarly, in the very unfit patient there is sometimes no option but to consider nonoperative management.

Conclusions

Osteoporotic acetabular fractures in the elderly are a difficult group of injuries, and there is never going to be a single way to treat all cases. Surgical fracture fixation alone has poor results, and nonoperative management is not ideal either. Using a combination of acetabular fracture techniques and modern hip arthroplasty technology, including trabecular metal, it is possible to manage these patients in such a way as to allow immediate full weight bearing with very few complications. However, careful patient selection is required, as well as thorough preoperative planning. A selection of surgical skills covering both acetabular fracture surgery and complex hip arthroplasty techniques is required. We would strongly recommend a combined preoperative workup with an intensive care physician/anaesthetist, perioperative HDU care, and close physiotherapy monitoring for several days postoperatively. Given these factors, good results can be achieved in this difficult group of patients, and component migration does not appear to be a problem.

Conflict of interest None.

References

1. Beaule PE, Griffin D, Matta J. The levine anterior approach for total hip replacement as the treatment for an acute acetabular fracture. J Orthop Trauma. 2004;18:623–9.
2. Briffa N, Pearce R, Hill AM, Bircher M. Outcomes of acetabular fracture fixation with ten years' follow-up. J Bone Joint Surg. 2011;93:229–36.
3. Cole J, Dean MD, Bolhofner BR. Acetabular fracture fixation via a modified stoppa limited intrapelvic approach description of operative technique and preliminary treatment results. Clin Orthop Rel Res. 1994;305:112–23.
4. Cooper C, Cole ZA, Holroyd CR, Earl SC, Harvey NC, Dennison EM, Melton LJ, Cummings SR, Kanis JA, IOF CSA Working Group on Fracture Epidemiology. Secular trends in the incidence of hip and other osteoporotic fractures. Osteoporosis Int. 2011;22(5):1277–88.
5. Helfet DL, Borelli J, DiPasquale T, Sanders R. Stabilisation of acetabular fractures in elderly patients. J Bone Joint Surg. 1992;74:753–65.
6. Joly JM, Mears DC. The role of total hip arthroplasty in acetabular fracture management. Oper Tech Orthop. 1993;3:80–102.
7. Letournel E. The treatment of acetabular fractures through the ilioinguinal approach. Clin Orthop Rel Res. 1993;292:62–76.

8. Letournel E, Judet R. Fractures of the acetabulum. 2nd edn. Berlin: Springer; 1993.
9. Liebergall M, Mosheiff R, Low J, Goldvirt M, Matan Y, Segal D. Acetabular fractures: clinical outcome of surgical treatment. Clin Orthop Rel Res. 1999;336:205–16.
10. Matta JM. Fractures of the acetabulum : accuracy of reduction and clinical results in patients managed operatively within three weeks after the injury. J Bone Joint Surg. 1996;78:1632–45.
11. Mayo KA. Open reduction and internal fixation of fractures of the acetabulum. Results of 163 fractures. Clin Orthop Relat Res. 1994;305:31–7.
12. Mears DC. Surgical treatment of acetabular fractures in elderly patients with osteoporotic bone. J Am Acad Orthop Surg. 1999;7(2):128–41.
13. Mears DC, Velyvis JH. Acute total hip arthroplasty for selected displaced acetabular fractures: two to twelve-year results. J Bone Joint Surg Am. 2002;84-A(1):1–9.
14. Stoppa RE, Rives JL, Warlaumont CR, Verhaeghe PJ, Delattre JF. The use of Dacron in the repair of hernias of the groin. Surg Clin North Am. 1984;64(2):269–85.