Safety and efficacy of the extended iliofemoral approach in the treatment of complex fractures of the acetabulum

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There remains uncertainty about the most effective surgical approach in the treatment of complex fractures of the acetabulum. We have reviewed the experience of a single surgeon using the extended iliofemoral approach, as described by Letournel.

A review of the database of such fractures identified 106 patients operated on using this approach with a minimum follow-up of two years. All data were collected prospectively. The fractures involved both columns in 64 (60%). Operation was undertaken in less than 21 days after injury in 71 patients (67%) and in 35 (33%) the procedure was carried out later than this. The reduction of the fracture was measured on plain radiographs taken after operation and defined as anatomical (0 to 1 mm of displacement); imperfect (2 to 3 mm) or poor (> 3 mm). The functional outcome was measured by the modified Merle d’Aubigné and Postel score. The mean follow-up was for 6.3 years (2 to 17).

All patients achieved union of the fractures. The reduction was graded as anatomical in 76 (72%) of the patients, imperfect in 23 (22%), and poor in six (6%). The mean Merle d’Aubigné and Postel score was 15 (5 to 18) with 68 patients (64%) showing good or excellent and 38 (36%) fair or poor results. Function correlated significantly with the accuracy of the reduction (p < 0.009). Significant heterotopic ossification developed in 32 patients (30%) and was associated with a worse mean Merle d’Aubigné and Postel score of 13.7.

The extended iliofemoral approach can be performed safely in selected complex acetabular fractures with an acceptable clinical outcome and rate of complications. Effective prophylaxis against heterotopic ossification should be strongly considered.

The choice of surgical approach in the management of complex fractures of the acetabulum remains an area of debate. The functional outcome after operative fixation of these fractures is directly related to the accuracy of the reduction. The approach chosen must allow an exposure which is adequate to obtain an anatomical reduction of the articular surface. Certain patterns of fracture require simultaneous exposure of both columns of the acetabulum. Letournel et al. recognised this and by 1974 had developed the extended iliofemoral approach which proved effective in their experience.

Since its inception, there has been little information available as to the value of this approach. There has been a trend away from the extended iliofemoral approach and other extended lateral approaches because of concerns over increased morbidity, particularly of infection, stiffness, weakness of the abductors and heterotopic ossification. It has been suggested that the extended iliofemoral approach carries an unacceptably high rate of complications including necrosis or avulsion of the abductor muscles and functional impairment secondary to heterotopic ossification and that later reconstructive procedures, particularly total hip arthroplasty, may be compromised.

This study presents the experience of one surgeon in the treatment of complex and malunited acetabular fractures through the extended iliofemoral approach in order to document the expected outcome and complications and to evaluate whether later reconstructive procedures could be performed effectively.

Patients and Methods
A retrospective review of the senior surgeon’s (JMM) database of 640 acetabular fractures from 1980 to 1997 identified 126 patients in whom the extended iliofemoral approach had been used; 106 had a minimum follow-up of two years and were the basis of this study. Twenty patients were lost to follow-up at a
mean of eight months (2 to 17). All the information was collected prospectively using an established protocol.1 No other approaches were used for bicolumnar fractures during this period. No prior approval of the Institutional Review Board was obtained.

All patients had a pre-operative evaluation which included five radiological views of the pelvis and CT with three-dimensional reconstruction. On the basis of the classification and specific configuration of the fracture, a single operative approach was selected with the expectation that the entire reduction could be performed through this.1 The extended iliofemoral approach was chosen only when an anatomical reduction was judged likely to be impossible using either an ilioinguinal or Kocher-Langenbeck approach alone.3 The specific indications for the extended iliofemoral approach included transectal transverse or T-shaped fractures with or without involvement of the posterior wall especially in association with comminution of the roof of the acetabulum; T-shaped fractures with wide displacement of the vertical fracture line or with associated dislocation of the symphysis pubis; both-column fractures with extension into the sacroiliac joint, comminution of the posterior column or wide separation of the anterior and posterior columns at the rim of the acetabulum; and associated patterns of fracture presenting more than 21 days after injury.

The mean age of the patients was 34 years (11 to 79). There were 67 males and 39 females. The left hip was involved in 64 fractures and the right in 42. The fractures were classified according to the system of Letournel8,13 and included 64 both-column (BC), 15 transverse plus posterior-wall (TR+PW), 12 T-shaped (T), seven T-shaped plus posterior-wall (T+PW), four transverse (TR), three anterior-column plus posterior hemi-transverse (ACH) and one anterior-column (AC).

Operation was undertaken less than 21 days after injury in 71 patients (67%) and later than this in 35 (33%). This latter group of patients included those with a malunion and others undergoing late open reduction and internal fixation. They were combined for this analysis. Six patients had undergone a previous operation, but were considered to have an inadequate reduction.

Operative technique. The patient was placed in the lateral decubitus position on the Judet-Tasseritt table. All received prophylactic antibiotics. The incision started at the posterior superior iliac spine, proceeded around the iliac crest to the anterior superior iliac spine and then continued anterolaterally down the thigh. The periosteum was incised along the crest, and the gluteal muscles and tensor fascia lata were dissected from the external aspect of the iliac wing as far as the greater sciatic notch. The fascia lata was incised over the anterolateral thigh exposing tensor fascia lata which was retracted posteriorly. The fascial layers separating tensor from the rectus femoris and that separating rectus from vastus lateralis were then carefully incised longitudinally. The anterior femoral circumflex vessels were identified and ligated. The dissection was then carried further posteriorly by elevating gluteus minimus off the hip capsule and releasing its tendinous insertion from the anterior aspect of the greater trochanter. At this point, the tendon of gluteus medius was identified and transected in its midsubstance. Alternatively, the greater trochanter was osteotomised, taking care to exit posteriorly superficial to the piriformis fossa. The trochanter was osteotomised in 13 patients. All achieved union.

The tendons of piriformis and obturator internus and of the gemelli were identified, tagged, divided and retracted posteriorly. Retractors were then placed in the greater and lesser sciatic notches. At this point, if necessary, the capsule of the hip could be incised circumferentially to allow access to the joint. In addition, the internal iliac fossa could be exposed by releasing the abdominal muscles from the iliac crest. Further access to the anterior column could be obtained by releasing sartorius and the inguinal ligament from the anterior superior iliac spine and the direct head of rectus from the anterior inferior iliac spine.

Techniques of reduction have evolved over the course of the study as new forceps and instruments were developed by the senior surgeon and others involved in the AO Pelvic Technical Commission.14 The use of the Judet table and the lateral traction post aided reduction. Malleable 3.5 mm reconstruction plates with 3.5 or 4.5 mm screws were used for stabilisation, with the exact position determined by the pattern of the fracture. The accuracy of the reduction and the position of the implants was assessed using intra-operative fluoroscopy. The origin of the abductors was carefully sutured back to the lumbo-femoral and abdominal aponeurosis, with the hip supported in abduction to reduce tension on the suture line. Interrupted sutures were used and after placement of all sutures in the origin of the abductors they were sequentially tied. The repair was protected with an abduction pillow during transfer of the patient from the operating table to the hospital bed. Post-operatively, patients were mobilised with weight-bearing of 30 pounds on the involved limb. They were instructed not to undertake active abduction exercises for four to six weeks. Formal physiotherapy with muscle strengthening was started eight weeks after operation or when the fracture was radiologically united. This programme was followed irrespective of the operative approach and thus did not delay rehabilitation when compared with patients operated on using either the ilioinguinal or Kocher-Langenbeck approach.

Drains were left in place until output decreased to < 30 ml per 8 hours. Prophylaxis against deep-vein thrombosis was by the use of compression stockings before and after operation until the drains were removed. The patient was then placed on an adjusted dose of coumadin (INR 1.5 to 2.0) for six weeks.15 No uniform protocol for the prophylaxis of heterotopic ossification was used, but a number of patients received indomethacin post-operatively as part of a separate study.16

Radiological evaluation. The reduction of the fracture was evaluated by measuring the residual displacement at the
level of the joint on the three views of the pelvis on plain films taken before discharge from hospital. The highest value of displacement seen at any of the normal radiographic lines of the acetabulum or the innominate bone was recorded in millimetres, and the largest of the three values was used to grade the reduction into one of three categories: anatomical with displacement of 0 to 1 mm, imperfect (2 to 3 mm), and poor (> 3 mm). Clinical and radiological follow-up was carried out by the senior surgeon at six months, one year, and then annually if symptomatic or every two years if asymptomatic. Anteroposterior (AP) radiographs of the pelvis were evaluated at each visit for reduction, healing, heterotopic ossification and signs of post-traumatic arthritis and/or avascular necrosis of the femoral head. A diagnosis of post-traumatic arthritis was based on the appearance of narrowing of the joint space on the final follow-up radiograph and/or the presence of osteophytes around the head-neck junction. Osteonecrosis was diagnosed only when the radiological findings allowed it to be clearly differentiated from wear of the femoral head and confirmed by MRI.

**Clinical evaluation.** Physical examination included evaluation of the gait, muscle strength and range of movement for each hip. The clinical result was graded based on a modification of the score of Merle d’Aubigné and Postel. This is a validated clinical grading system in which pain, gait and range of movement are assigned a maximum individual score of six points. The three individual scores are summed to derive the final clinical score, according to which the clinical result is classified as excellent (18 points), good (15, 16, or 17), fair (13 or 14), or poor (< 13). It is less sensitive in the good to excellent range. Patients who even-
tually required total hip arthroplasty or arthrodesis were considered to have a poor result.

**Statistical analysis.** The results were analysed comparing the occurrence of various characteristics with clinical outcome using the Spearman non-parametric rank correlation test. The independent variables tested were the accuracy of the reduction, the time to surgery, the pattern of the fracture and damage to the femoral head. One-way analysis of variance was used to assess the relationship between the clinical scores and complications, including heterotopic ossification and further surgery. All the statistical tests were performed with clinical significance defined at a p value of less than 0.05.

**Results**

The mean follow-up was 6.3 years (2 to 17). All the patients achieved radiological evidence of union of the fracture. The 20 patients lost to follow-up had all obtained union and none had wound complications or formation of heterotopic bone. The reduction was graded as anatomical in 76 hips (72%), imperfect in 23 (22%), and poor (>3 mm) in seven (6%). The estimated mean blood loss was 1700 ml (250 to 5000) and the mean operating time 4.75 hours (2 to 10).

The mean post-operative functional score at the latest follow-up as graded by the Merle d’Aubigné and Postel score was 13 (5 to 18). There were 24 excellent (23%), 44 good (41%), 20 fair (19%), and 18 poor results (17%). The accuracy of the reduction and the clinical results correlated significantly (p < 0.009) but the type of fracture (p = 0.60), time to surgery (p = 0.30) and damage to the femoral head (p = 0.10) did not. At the latest follow-up 29 hips (31%) showed post-traumatic arthritis and three (3%) evidence of avascular necrosis. Subsequent reconstructive surgery included total hip arthroplasty in 10 (9%), arthrodesis of the hip in 3 (3%) and excision of heterotopic bone in nine (8%). One total hip arthroplasty required revision after two years for recurrent instability.

**Complications.** Post-operative complications were seen in 20 patients (19%). Ten hips (9%) developed wound complications including infection in seven, haematoma in two and wound edge necrosis in one. Three of the seven infections were superficial and resolved after debridement and the administration of intravenous antibiotics. The remaining four were deep and despite irrigation and debridement resulted in destruction of the joint with a poor result. The two haematomas were drained surgically and the skin edge necrosis healed after undergoing debridement and closure.

Heterotopic ossification was assessed on the plain AP radiograph of the pelvis and classified as grade 0 (none), grade 1 (minimal) or grade 2 (moderate to severe). The grade-2 category included classes II to IV of Brooker et al because the differences between these are small and do not necessarily indicate an increase in the severity of heterotopic ossification. This was seen in 63 patients (59%); in 31 (30%) it was graded as mild (grade 1), and 32 (30%) as moderate or severe (grade 2); in nine of these (8.5%) excision of the heterotopic bone was undertaken in order to improve movement (Fig. 1). The time to surgery, before or after 21 days, did not correlate with the formation of heterotopic ossification (p = 0.40), but male patients were more likely to develop this (p = 0.02). The mean Merle d’Aubigné and Postel score was significantly worse for patients with grade-2 ossification compared with those with grades 0 and 1, 13.7 vs 15.1 and 15.8, respectively (p = 0.031).

There were four cases of post-operative nerve palsy (3.7%), all involving the peroneal division of the sciatic nerve and thought to be the result of improper placement of retractors or excessive retraction. Other post-operative complications included one case of thrombosis of the femoral artery and one of a misplaced intra-articular screw. The former was managed successfully by thrombectomy, and the latter was revised at a further operation. There were no cases of necrosis or disruption of the abductor flap. Thus 34 patients (32%) required further surgery (Table I).

There was no significant difference in clinical outcome, as judged by the Merle d’Aubigné and Postel score, between patients who required an incision and debridement and those who did not, 14.6 vs 15.7 (p = 0.201) respectively, or between patients undergoing excision of heterotopic ossification and those who did not, 14.4 vs 14.9 (p = 0.664). Patients who had an arthrodesis fared significantly worse than those who needed an irrigation and debridement or underwent total hip arthroplasty, 7.2 vs 14.6 (p = 0.025) and 12.1 (p = 0.001), respectively.

**Discussion**

The choice of surgical approach in the management of complex fractures of the acetabulum will probably continue to evolve as instruments and imaging techniques improve, as well as with changes in surgical training. There have been several accounts of the use of extensile exposures in the treatment of these injuries but little has been written about the extended iliiofemoral approach. Although the overall clinical outcome was good to excellent in most of our patients, the risk of complications was high. A weakness of our study was the choice of follow-up in which the last available data were used. This made it difficult to compare our findings with those of other studies which used a defined follow-up period. Also, the high percentage of patients lost to follow-up (16%) made conclusions on the long-term function more difficult.

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**Table I. Details of further surgery in 34 patients**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Patients</th>
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<tbody>
<tr>
<td>Debridement and irrigation</td>
<td>10</td>
</tr>
<tr>
<td>Total hip arthroplasty</td>
<td>10</td>
</tr>
<tr>
<td>Excision of heterotopic ossification</td>
<td>9</td>
</tr>
<tr>
<td>Arthrodesis of the hip</td>
<td>3</td>
</tr>
<tr>
<td>Femoral artery thrombectomy</td>
<td>1</td>
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<tr>
<td>Revision of seven placement</td>
<td>1</td>
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While the selection of the appropriate approach is clear for most of the simple patterns of fracture in the Letournel classification, the choice of exposure in the complex patterns is a matter of the surgeon’s choice, based on his individual experience and training. This makes comparison of outcome based on the pattern of fracture difficult. An alternative to the extended iliofemoral approach as described by Reinert et al. is the Maryland approach in which a posterior approach can be extended by osteotomising the iliac crest and trochanter, providing improved soft-tissue repair of the abductor mechanism. Both Stockle et al. and Starr et al. have recently described their experience with this approach, achieving an anatomical or acceptable reduction in up to 92% of their patients with a rate of complications ranging from 0% to 14% for the wound and 5% to 13% for significant heterotopic ossification. Their data were limited to a specific time period and it is not clear if this represented their complete clinical experience. Alonso et al. found no difference between the extended iliofemoral approach and the triradiate approach with regard to the quality of reduction or the rate of complications. Rout and Swiontkowski described the use of combined anterior and posterior exposures in 24 patients with a complex pattern of fracture with a follow-up of four to 32 months. They achieved anatomical reduction in 88%, with no infections, neurological injury in 10% and a similar incidence of significant heterotopic ossification with no cases of avascular necrosis.

The functional outcome after surgery for fractures of the acetabulum correlates with the accuracy of the reduction, which is dependent, to a significant degree, on the selection of the best surgical exposure based on the pattern of the fracture. As instrumentation and techniques have improved, more such fractures have been managed through either the ilioinguinal or Kocher-Langenbeck approach. However, some require visual access to both columns of the acetabulum for adequate reduction and fixation and the extended iliofemoral approach is an effective exposure for obtaining reduction in most of these cases. Only seven (6%) of the reductions in our series were graded as poor. However, if early operation can avoid the use of the extended iliofemoral approach the operative morbidity can be significantly minimised.

Previous studies on the operative treatment of these fractures by experienced surgeons have shown good or excellent results in 75% to 80% of patients. These series included both simple and associated patterns of fracture operated on predominantly through the ilioinguinal or Kocher-Langenbeck approaches. The percentage of good or excellent results in our study (64%) is lower than this, since the series included the most difficult injuries and malunions which have a higher incidence of poor results. The accuracy of reduction correlated with the functional result. Therefore the approach which affords the greatest likelihood of achieving an anatomical reduction should be used. The overall rate of complications in our series (24%) correlated closely with that of Letournel et al. (19%) and with that of other extensile exposures. Our rate of infection was higher, which may reflect the larger number of acute injuries in our series.

Reinert et al. found abductor necrosis, weakness and avulsion to be significant problems with use of the extended iliofemoral approach, but gave no data. They also described a modification of the extended iliofemoral approach with osteotomy of the iliac crest for more secure repair (Maryland approach). We did not experience problems related to the abductors and did not encounter necrosis of the abductor flap. Letournel et al. noted that no such cases had been encountered in over 400 operations carried out by different surgeons.

Heterotopic ossification is considered to be clinically significant when it results in loss of 20% or more of movement in the hip. While it is commonly seen after dissection of the abductor muscle mass from the external ilium, it is not usually clinically significant. We used no formal prophylaxis and had an incidence of 30.2% for moderate to severe ossification. Nine of the 63 hips with heterotopic ossification were treated by excision. Patients who develop moderate or severe heterotopic ossification have a significantly worse clinical outcome and subsequent excision did not appear to reverse this trend, although our numbers may be too small to detect an impact. Effective prophylactic measures may be helpful, and we currently use Letournel’s protocol combining indomethacin and single-dose radiation as described by Moed and Letournel.

Our series has shown that the extended iliofemoral approach is versatile and effective for the treatment of complex patterns of fracture and for the delayed reconstruction of fractures of the acetabulum. One of its limitations is in access to the anterior column past the iliopectineal eminence, which requires subcutaneous access to one of the windows of the ilioinguinal approach. Its use does not preclude a later, standard posterior approach to the hip for removal of implants, arthroplasty or arthrodesis.

The extended iliofemoral approach is the most challenging of the standard three approaches and we recommend use of the ilioinguinal or Kocher-Langenbeck exposures whenever possible. These may be modified to allow direct access to the joint. The main indications for the extended iliofemoral approach include fractures involving both columns with extension into the sacroiliac joint for which the other approaches will not provide adequate exposure, and old or malunited fractures. It may be considered for transectal transverse fractures with extended posterior-wall components, transectal T-shaped fractures with wide displacement of the vertical stem of the T or associated dislocation of the symphysis and both-column fractures with wide displacement of the fragments at the acetabular rim. Prophylaxis against heterotopic ossification is recommended. For the surgeon not familiar with this approach, the use of combined or sequential exposures may...
be more prudent. These are challenging injuries and are most effectively managed by surgeons who have subspecialty training in this aspect of orthopedic trauma.

Supplementary Material

A further opinion by Dr Michael Lennig is available with the electronic version of this article on our website at www.jbjs.org.uk

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References