The three-pin modified ‘Harrington’ procedure for advanced metastatic destruction of the acetabulum


From the Royal Orthopaedic Hospital, Birmingham, England

Pathological fractures due to metastasis with destruction of the acetabulum and central dislocation of the hip present a difficult surgical challenge. We describe a series using a single technique in which a stable and long-lasting reconstruction was obtained using standard primary hip replacement implants augmented by strong, fully-threaded steel rods with cement and steel mesh, where required.

Between 1997 and 2006, 19 patients with a mean age of 66 years (48 to 83) were treated using a modified Harrington technique. Acetabular destruction was graded as Harrington class II in six cases and class III in 13. Reconstruction was achieved using three 6.5 mm rods inserted through a separate incision in the iliac crest followed by augmentation with cement and a conventional cemented Charnley or Exeter primary hip replacement. There were no peri-operative deaths. At the final follow-up (mean 25 months (5 to 110)) one rod had fractured and one construct required revision. Of the 18 patients who did not require revision, 13 had died. The mean time to death was 16 months (5 to 55). The mean follow-up of the five survivors was 31 months (18 to 47). There were no cases of dislocation, deep infection or injury to a nerve, the blood vessels or the bladder.

The modern management of pathological fractures is well established and has been summarised in guidelines issued by the British Orthopaedic Association. Numerous studies have shown that stable fixation decreases the morbidity of metastatic bone disease, gives relief of pain, maintenance of mobility and independence, and improvement in the quality of life. Metastatic involvement of the hip is a common cause of pain and disability in malignant disease. Surgical treatment of proximal femoral lesions is frequently successful and relatively uncomplicated. Peri-acetabular lesions however, present a greater reconstructive challenge, and in many cases have been treated non-operatively with consequent poor mobility.

Surgical reconstruction of peri-acetabular pelvic lesions is complex and many previous reports have described procedures involving long operating times, extensive exposures and considerable blood loss. Various techniques have been suggested, including total hip replacement (THR) with pelvic reinforcement with pins, acetabular reinforcement rings or allograft. In 1981 Harrington described a technique for reconstruction of the ilium, using threaded pins inserted retrograde through the acetabular roof and into the iliac wing. The pins were cemented together with an acetabular support ring into which a polyethylene socket was then cemented. Harrington concluded that this was the best method of creating a long-lasting durable reconstruction which permitted immediate weight-bearing. Since then, a number of authors have presented their results using similar techniques. They describe a variety of different methods, including a combination of smooth rods/pins or partially-threaded screws, inserted either antegrade from the iliac wing, or retrograde through the acetabular defect, which are then reinforced with an acetabular augment such as a flanged acetabular shell, a protrusio acetabular component or an anti-protrusio ring. This paper presents a single technique managed exclusively with threaded rods inserted from the iliac wing without the need for an acetabular augmentation device.

Patients and Methods

We present the results in 19 patients managed by a modification of Harrington’s procedure, which involves the insertion of a series of three fully-threaded 6.5 mm rods/pins from the iliac...
crest through a separate transverse iliac incision. The pins are directed distally to pass in front, behind and medial to the acetabulum (or what remains of it), thereby forming a secure scaffold onto which a mix of quick-setting cement can be applied, with or without reinforcement by steel mesh. This first mix will fill any major defects and create a firm socket, usually approximately 50 mm in diameter, with small ‘key-holes’ created before cement curing. A conventional cemented acetabular component, usually 40 mm × 28 mm, can then be implanted using a second mix of cement. It is well recognised that a cement-cement bond is very strong. Using this technique, it has not been necessary to insert a reinforcement ring in any of these cases.

Between 1997 and 2006, 19 patients with peri-acetabular metastatic deposits underwent surgery for relief of pain or to allow them to bear weight. Each operation was carried out by the senior author (RMT) at a single institution. All patients were assessed pre-operatively at the oncological multi-disciplinary conference. An oncological diagnosis was established and the patient was judged fit for surgery. Patients were considered for surgery if they had been rendered unable to bear weight as a result of impending or established pathological fracture, and had an expected survival of more than three months. They were excluded if further metastases were present in either lower limb or in the affected limb distal to the femoral neck. Co-morbidities which rendered a patient unfit for a complex THR revision also constituted a relative contraindication to surgery. Guidelines for the selection of patients for operative intervention have previously been well described by Capanna and Campanacci. Only one-third of patients referred for consideration of acetabular reconstruction were thought to be suitable. The mean age of the patients was 66 years (48 to 83). There were six men and 13 women. The left acetabulum was affected in 11 cases and the right in eight. The extent of peri-acetabular metastatic destruction was classified using Harrington’s method (Table I). There were six class II lesions and 13 class III. The primary tumour was known in all cases (Table II). The most common diagnoses were carcinoma of the breast and myeloma.

Radiological assessment was carried out using plain radiographs of the pelvis and full-length views of the femur, a CT scan of the pelvis and a whole body radio-isotope bone scan. The five patients with renal carcinoma also underwent pre-operative embolisation of the metastatic deposit within five days of their definitive surgery. Most patients had pre-operative radiotherapy but it was not clear whether radiotherapy had been given in every case.

**Surgical technique.** An anterolateral (Hardinge) approach to the hip is used with the patient in a lateral position. The hip is dislocated very carefully in view of the risk of fracture of the neck or shaft of the femur. The acetabulum is fully exposed and its bony architecture and integrity assessed. The metastasis is curetted out, leaving the underlying bony defect. Once it has been established that reconstruction is both appropriate and feasible, a separate transverse incision is made over the iliac crest. The iliac crest is well recognised that a cement-cement bond is very strong. Using this technique, it has not been necessary to insert a reinforcement ring in any of these cases.

Between 1997 and 2006, 19 patients with peri-acetabular metastatic deposits underwent surgery for relief of pain or to allow them to bear weight. Each operation was carried out by the senior author (RMT) at a single institution. All patients were assessed pre-operatively at the oncological multi-disciplinary conference. An oncological diagnosis was established and the patient was judged fit for surgery. Patients were considered for surgery if they had been rendered unable to bear weight as a result of impending or established pathological fracture, and had an expected survival of more than three months. They were excluded if further metastases were present in either lower limb or in the affected limb distal to the femoral neck. Co-morbidities which rendered a patient unfit for a complex THR revision also constituted a relative contraindication to surgery. Guidelines for the selection of patients for operative intervention have previously been well described by Capanna and Campanacci. Only one-third of patients referred for consideration of acetabular reconstruction were thought to be suitable. The mean age of the patients was 66 years (48 to 83). There were six men and 13 women. The left acetabulum was affected in 11 cases and the right in eight. The extent of peri-acetabular metastatic destruction was classified using Harrington’s method (Table I). There were six class II lesions and 13 class III. The primary tumour was known in all cases (Table II). The most common diagnoses were carcinoma of the breast and myeloma.

Radiological assessment was carried out using plain radiographs of the pelvis and full-length views of the femur, a CT scan of the pelvis and a whole body radio-isotope bone scan. The five patients with renal carcinoma also underwent pre-operative embolisation of the metastatic deposit within five days of their definitive surgery. Most patients had pre-operative radiotherapy but it was not clear whether radiotherapy had been given in every case.

**Surgical technique.** An anterolateral (Hardinge) approach to the hip is used with the patient in a lateral position. The hip is dislocated very carefully in view of the risk of fracture of the neck or shaft of the femur. The acetabulum is fully exposed and its bony architecture and integrity assessed. The metastasis is curetted out, leaving the underlying bony defect. Once it has been established that reconstruction is both appropriate and feasible, a separate transverse incision is made over the iliac crest. Three fully-threaded 6.5 mm Steinmann pins (Biomet Howmedica Stryker, Newbury, United Kingdom) are inserted from proximal to distal into the iliac crest and diverted in front, behind and medial to the floor of the acetabulum (Fig. 1). The pins are visible in the acetabular floor so that correct positioning can be confirmed and the cement can bond directly onto them. Great care is taken not to direct the pins medially into the pelvis so as to avoid damage to vital structures such as the iliac vessels and bladder. We have learnt from experience that unthreaded Steinmann pins have a tendency to migrate.

---

**Table I.** Classification of peri-acetabular metastatic destruction according to Harrington

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Sufficient bone to permit conventional arthroplasty</td>
</tr>
<tr>
<td>II</td>
<td>Medial wall defect</td>
</tr>
<tr>
<td>III</td>
<td>Acetabular dome defect</td>
</tr>
<tr>
<td>IV</td>
<td>Isolated lesion that could be resected in an attempted curative procedure</td>
</tr>
</tbody>
</table>

**Table II.** Oncological diagnosis of the cases treated

<table>
<thead>
<tr>
<th>Primary lesion</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast carcinoma</td>
<td>6</td>
</tr>
<tr>
<td>Myeloma</td>
<td>6</td>
</tr>
<tr>
<td>Renal carcinoma</td>
<td>5</td>
</tr>
<tr>
<td>Adrenal carcinoma</td>
<td>1</td>
</tr>
<tr>
<td>Thyroid carcinoma</td>
<td>1</td>
</tr>
</tbody>
</table>

---

**Fig. 1**

Diagram showing antegrade rod placement from the iliac crest, creating a construct into which the implant can be cemented.
Having established that the acetabulum is secure and that cement can be introduced and pressurised without extruding into the pelvic cavity, one or two mixes of CMW 1 (DePuy, Berkshire, United Kingdom) are used to fill any voids and create a cement-lined cavity. If the floor is soft, then a broad strip of wire mesh (DePuy) is passed medial to the threaded pins before cementation. The handle of a cup pressuriser is then used to help create the cement cavity and key holes are sited in this lining layer of cement. The handle of a cup pressuriser is then used to help create the cement cavity and key holes are sited in this lining layer of cement. Once the cement has set, the cavity is measured and in every case, a 40 mm × 28 mm acetabular component is cemented in place. The femoral component (Exeter (Stryker; 15 hips), Charnley (Depuy International, Leeds, United Kingdom; 4 hips)) is implanted in the standard manner (Fig. 2).

The mean operating time was 120 minutes (95 to 170) and the mean blood transfusion 3.2 units (0 to 6). The number of threaded rods/pins inserted varied according to the anatomy of the defect and with refinement of the technique. In six early cases, for which only pins of a smaller diameter were available, a fourth pin was felt to be necessary to provide adequate support for the acetabular component.

Cephalosporin antibiotic prophylaxis was given at induction and for up to 24 hours post-operatively. Patients were mobilised fully weight-bearing, as for a conventional THR, if their pain allowed them to do so.

Results

There were no deaths and no intra-operative complications; in particular no vascular, nerve, or bladder injuries occurred. Post-operatively, there were no cases of dislocation, deep infection or problems with wound healing. One patient whose disease progressed had a fall which resulted in fracture of two of the four pins and migration of the acetabular component. The symptoms were not sufficiently severe to warrant revision and death occurred 4.5 years after the reconstruction. One patient with myeloma who had a reconstruction with small diameter pins required revision of the construct 8.9 years later with three 6.5 mm pins and an acetabular mesh. There have been no further complications in the 19 months since revision. Of the 18 patients who have not required revision, 13 have died. In the deceased group the mean time from surgery to death was 16 months (5 to 55). The mean follow-up for the five surviving patients was 31 months (18 to 47). The mean follow-up the non-revised patients was 20 months (5 to 55); including the revised case (the first in the series), it was 25 months (5 to 110).

Functional assessment was carried out six months after operation using the system described by Allan et al for patients undergoing complex acetabular reconstruction for metastatic disease. This scores patient’s mobility from 1 (bedridden) to 7 (no walking aids). Each patient improved by at least two points on this scale and was able to walk indoors independently (Allan grade 4). The need for analgesics was reduced after operation, but at the six-month follow-up four patients required opiate analgesia due to progression of their disease.

Discussion

We describe a relatively simple, safe and reproducible technique which we have used successfully to reconstruct major acetabular defects caused by metastatic disease. The key element has been the use of fully-threaded 6.5 mm pins, produced to order by Biomet UK, which are inserted through a separate incision over the iliac crest. Smooth or only partly-threaded pins have, in our experience, migrated and have not provided long-lasting fixation. We have had a low complication rate, but similar procedures described in the literature have highlighted the risk of significant complications. Surgeons must be very experienced in major hip and pelvic procedures before using this technique as it is essential that the pins are not misdirected into the pelvic cavity.

We have reviewed and analysed literature on Harrington reconstruction techniques. However, in the majority of these studies, Harrington reconstruction was only one technique used in a larger series. We recognise three distinct types of reconstruction. First, those
employing predominantly retrograde pins or screws (i.e., inserted from the acetabulum and directed proximally), secondly, those using only antegrade pins or screws (inserted from the iliac crest to the acetabulum) and finally, those combining antegrade and retrograde pins or screws.

In Harrington’s\(^5\) original series of 25 cases using retrograde pins there was one intra-operative haemorrhage, leading to death post-operatively and two further peri-operative deaths. There were no deep infections, no loss of fixation, and one complete femoral nerve palsy. The paper does not say whether the two peri-operative deaths were in the class III lesions managed with Harrington reconstruction or in the complete series of 58 cases encompassing all methods of treatment. In the series of Vena et al.\(^1\) of 21 cases there were three peri-operative deaths, two dislocations and two nerve palsies. The patients of Allan et al.\(^5\) were not subdivided by treatment and included 14 treated with a bulk allograft and a re-inforcement ring. The overall complications consisted of three pulmonary emboli (one fatal), two dislocations and three intra-operative bleeds of more than 1500 ml (maximum 8500 ml). In the series of Marco et al.\(^14\) (15 of a larger series of 55 cases using a number of different techniques) it was again not possible to differentiate the adverse events resulting from cases using other techniques.

Parikh and Kreder\(^15\) used multiple antegrade pins combined with an acetabular reconstruction ring which they supplemented with screws and on occasion with reconstruction plating of the posterior column. This series of ten cases produced one dislocation but no other major complications. Four patients have been described by Walker\(^10\) who used pins and an antiprotrusio ring. In Marco et al.’s\(^14\) series of 36 patients it was not possible to distinguish the results and complications occurring from other techniques which were used (n = 19).

A combined retrograde and antegrade placement of pins was used by Nilsson et al.\(^9\) in 33 hips. There were three cases of severe haemorrhage, two of which were fatal. There were two dislocations, one deep infection and two peri-prosthetic fractures distal to the femoral component. Kunisada and Choong\(^16\) managed 25 of 40 patients in this way with one intra-operative death and one dislocation.

The technique used in this series is cost-effective because no expensive implants are needed and by keeping these patients mobile, their need for personal care and support is much diminished.

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