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ORIGINAL STUDY

Acetabular reconstruction using morcellised bone with ring support – Medium term results at three to nine years

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Marked acetabular bone loss in revision hip arthroplasty is challenging. Reconstruction or reinforcement rings may be used in moderate or severe cases with morcellised bone graft to restore bone stock. We report a single surgeon series of 45 hips over a 5-year period. There were 6 complex primary and 39 revision hip arthroplasties with a mean follow-up of 85 months (range : 42-106). Mean age at surgery was 75.6 years (range : 31-95). Contour© (Smith & Nephew) titanium acetabular rings were used in all cases. At time of assessment 12 patients had died ; of the 30 alive patients (33 hips), 23 patients (26 hips) were available for clinical evaluation. Forty of 45 grafts healed uneventfully with good graft incorporation, 2 were radiologically loose and both were infected. No loosening occurred in the absence of infection. Based on this experience, we recommend this as a safe and effective technique with low complication rates.

Keywords : acetabular revision ; allograft ; reinforcement rings ; reconstruction rings.

INTRODUCTION

Management of moderate to significant bone deficiency in acetabular reconstruction surgery can be encountered in both complex primary and revision hip arthroplasty. Aseptic loosening continues to be the leading cause for revision hip arthroplasty (*4,37*). Other reasons for revision arthroplasty include infection, instability and component malpositioning (*16,22,45*). Developmental dysplasia of the hip joint, severe protrusio and secondary osteoarthritis from previous acetabular trauma are some examples where primary acetabular reconstruction could prove difficult (*16,25,40*). Various options including simple cemented acetabular revision (*23,28*), bipolar reconstruction (*5,29,48*), cementless sockets (*6,12,13, 46*), jumbo cups (*8,9,32,47*), high hip centre (*24,39*), bilobed acetabular component (*3,7,10*), trabecular metal augments and sockets (*30,41,51*) and bulk structural allograft (*11,21,26,31*) have been tried to address these often difficult situations.

Reconstruction or reinforcement rings may be used in moderate or severe acetabular bone loss in combination with morcellised bone graft to restore

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bone stock in primary and revision total hip arthroplasty (*2,15,16,18,35,36*). The ring provides a stable environment to protect the graft and allows successful reconstitution of bone for future revisions. It also acts to provide a stable base for fixation of cement and prevents early migration of the socket. Surgical technique is relatively straightforward and avoids the use of meshes.

The acetabulum is restored to the correct level, and version of the cemented cup can be orientated independent of the metal ring.

Some series have reported a high early complication rate associated with these devices, in particular dislocation. In others mechanical failure of the ring has occurred (*17,33,49,50*).

MATERIAL AND METHODS

Patients who underwent acetabular reconstruction using morcellised bone graft and ring support between January 2000 and December 2005 were included in this study. This is a single surgeon series performed by the senior author (PFP) over a 5 year period. Indications included complex primary and revision hip arthroplasty.

In all cases, Contour® (Smith & Nephew) acetabular rings were used. They are titanium grit blasted, and relatively easily contoured in comparison to stainless steel rings. A reinforcement ('roof') ring was selected when adequate column support existed and defects were superior or medial. For more extensive bony defects such as large cavitary defects or segmental defects involving anterior or posterior columns, a reconstruction ring was chosen (Fig. 1). When using a reconstruction ring, the tip of the ischial blade was firmly slotted into the ischium rather than fixing it externally (*33*).

Pre-operative assessment

All patients underwent routine pre-operative blood investigations (FBC, ESR and CRP). Plain radiographs of the pelvis and hip were supplemented by CT scan as required. If infection was suspected clinically, hip aspiration was performed as a separate procedure prior to the definitive surgery. Hip aspiration was performed in the operating room under local anaesthesia. A stab incision was made on the skin prior to introducing the needle into the hip joint to avoid any potential contaminants. The aspirated fluid was analysed for a minimum period of 7 days. If positive, 2-stage revision arthroplasty was instigated.

Surgical technique

A direct lateral (Hardinge) approach was used in 40 patients. The remaining 5 patients had a "Ganz" type greater trochanter sliding osteotomy and the greater trochanter was reattached using a trochanteric plate (DB-4 plate) and cable. The loose acetabular component explanted and any remaining cement were removed. The acetabulum was cleaned of osteolytic debris and membrane. The state of the roof, floor, columns and walls was recorded. The intra-operative findings were correlated with the pre-operative radiographs. Acetabular defects were then classified according to Paprosky's classification (*31*). The acetabulum was gently reamed inferiorly down to bleeding bone. Between 1 and 3 fresh frozen femoral heads from the national bone bank were used. The femoral heads were morcellised (using a bone mill) on table and carefully impacted into the acetabular defect followed by reverse reaming to create a 'neo-acetabulum'. An appropriate size ring was chosen and secured with a minimum of 5 screws. The majority of the screws were placed in the ilium with some in the ischium and pubis as dictated by the existing bony defects. A cup was then cemented in the correct orientation independent of the ring. Femoral revision was then carried out as required.

Figures 2 and 3 show acetabular reconstructions with a reinforcement ring (Fig. 2) and a reconstruction ring (Fig. 3) respectively.

Post-operative care

Patients were routinely admitted to the High Dependency Unit for 24 hours prior to transfer back to the ward. Full weight bearing was permitted immediately in most patients, with more complex cases restricted for up to 3 months. Regular out patient follow-up for the first year with radiographs of their pelvis and the corresponding hip was arranged, followed by annual check up.

Radiographic analysis included assessment of the following :

1. Migration – A horizontal line was marked along the inferior border of the two tear drops on an AP pelvis radiograph, a vertical line bisecting the ipsilateral tear drop was then marked and the point of intersection was noted. The vertical and horizontal distance from this intersection point and the most inferior point of the ring gave us the position of the ring in relation to the teardrop. Any difference in the position of the implant between the immediate post operative and the most recent radiographs was recorded.

Table I. — Breakdown of the complex primary group

COMPLEX PRIMARY GROUP	
Acetabular fracture	2
Avascular necrosis *	2
Plasmacytoma	1
Protrusio	1

* Avascular necrosis of femoral head resulting in acetabular erosion and superior bony deficiency.

2. Radiolucent lines – The presence of any progressive or non-progressive radiolucent lines around the ring or acetabular cup were recorded.
3. Bony incorporation – Continuation of the trabecular lines from the host bone into the graft.
4. Implant fracture – Screws, ring or both.

Fig. 1. — Contour© (Smith & Nephew) titanium acetabular rings (reinforcement and reconstruction).

RESULTS

Between January 2000 and December 2005, 42 patients (45 hips) underwent acetabular reconstruction using morcellised bone graft and ring support. There were 6 complex primary and 39 revision hip arthroplasties with a mean follow-up 85 months (range : 42-106). Mean age at surgery was 75.6 years (range : 31-95). Eighteen patients had just their acetabulum revised and the remaining 27 patients had both their acetabulum and femur revised. In the revision group, all but 3 underwent surgery for aseptic loosening. The complex primary group was diverse. The details of the complex primary group are shown in table I.

The acetabular defect was quantified according to Paprosky's Classification taking into account the intra operative findings and pre operative imaging. There were three 2b, eleven 2c, sixteen 3a and fifteen 3b defects in our study. As expected all patients with 3b defect received a reconstruction ring and those with a 2b defect received a reinforcement ring. The break up of the defect and the ring used is highlighted in table II.

There were 12 deaths, one patient developed postoperative pneumonia leading to death at day 8 and the others died due to unrelated causes. Of the 30 alive patients (33 hips), 23 patients (26 hips) were available for clinical evaluation. There were 8 men and 15 women in this group with a mean age of 73.8 years (range : 31-95). Average follow-up was 85 months (range 42-106). Harris hip score of these 23 patients (26 hips) showed 16 excellent or good results, 6 fair and 4 poor. Two of the 4 patients with poor results had radiological evidence of loosening. The remaining 7 patients who were not available for clinical evaluation were recorded as doing well in the last follow-up.

Radiological assessment was carried out in all 45 hips. Good graft incorporation was found in 40 of 45 hips. Five hips showed some evidence of graft resorption, of which 2 hips were radiologically loose as evident by superior migration of the ring and circumferential radiolucent lines. All 8 patients

Table II. — Paprosky's classification and breakdown of the reinforcement and reconstruction rings

Paprosky's classification	Total number	Reinforcement ring	Reconstruction ring
2b	3	3	0
2c	11	7	4
3a	16	13	3
3b	15	0	15

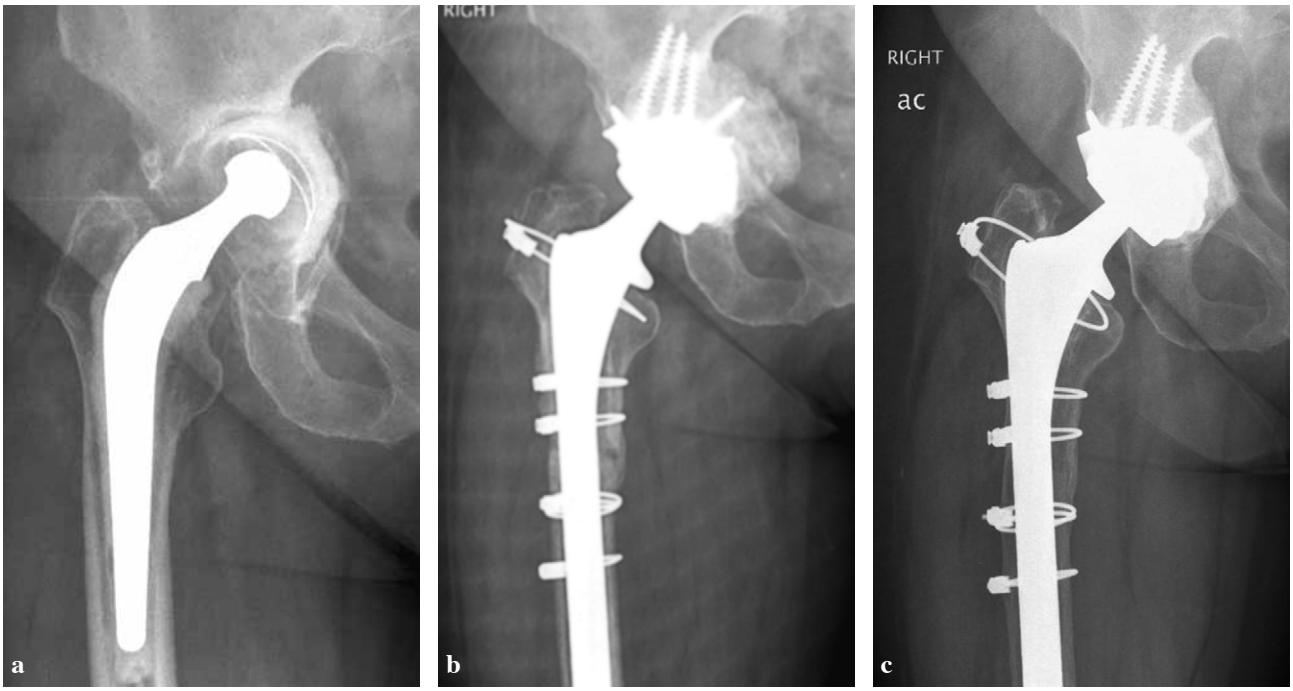

Fig. 2. — Case 1 (a) pre-operative AP view ; (b) immediate post-operative view with reinforcement ring ; (c) 3 years post-operative

with 2b defect had sound graft incorporation. One patient with 3a defect and two patients with 3b defect had evidence of minimal graft resorption but there were no other radiological features suggestive of construct loosening. The 2 patients with radiological loosening had 2c defects. These 2 cases were both infected. No loosening occurred in the absence of infection. No implant breakage was noted in our study.

There were no significant intraoperative complications in this series. Table III summarises the post-operative complications. Although there were 11 deaths, only one patient died of postoperative complication as highlighted before. Two of the 3 patients who developed deep infection underwent their reconstruction for septic loosening and the third patient contracted a postoperative infection.

Table III. — Breakdown of post-operative complications

POST-OPERATIVE COMPLICATIONS	
Death	1
Dislocation*	2
Superficial infection	1
Deep infection	3

* Dislocations – None recurrent.

DISCUSSION

Acetabular reconstruction rings can provide a rigid and stable construct where there is large bony deficiency in complex primary or revision hip arthroplasty. The supporting ring is secured with multiple screws in order to achieve satisfactory mechanical fixation to the pelvis. Where extensive bone grafting is necessary, the ring allows for containment of the graft. It protects it from overload and also prevents motion between the allograft and the acetabular component. Proper anatomical positioning of the socket can be achieved independent of the metal ring and early weight bearing can be achieved postoperatively.

A number of different alternatives exist. These include simple cemented acetabular revision (*23,28*), bipolar reconstruction (*5,29,48*), cementless sockets (*6,12,13,46*), jumbo cups (*8,9,32,47*), high hip

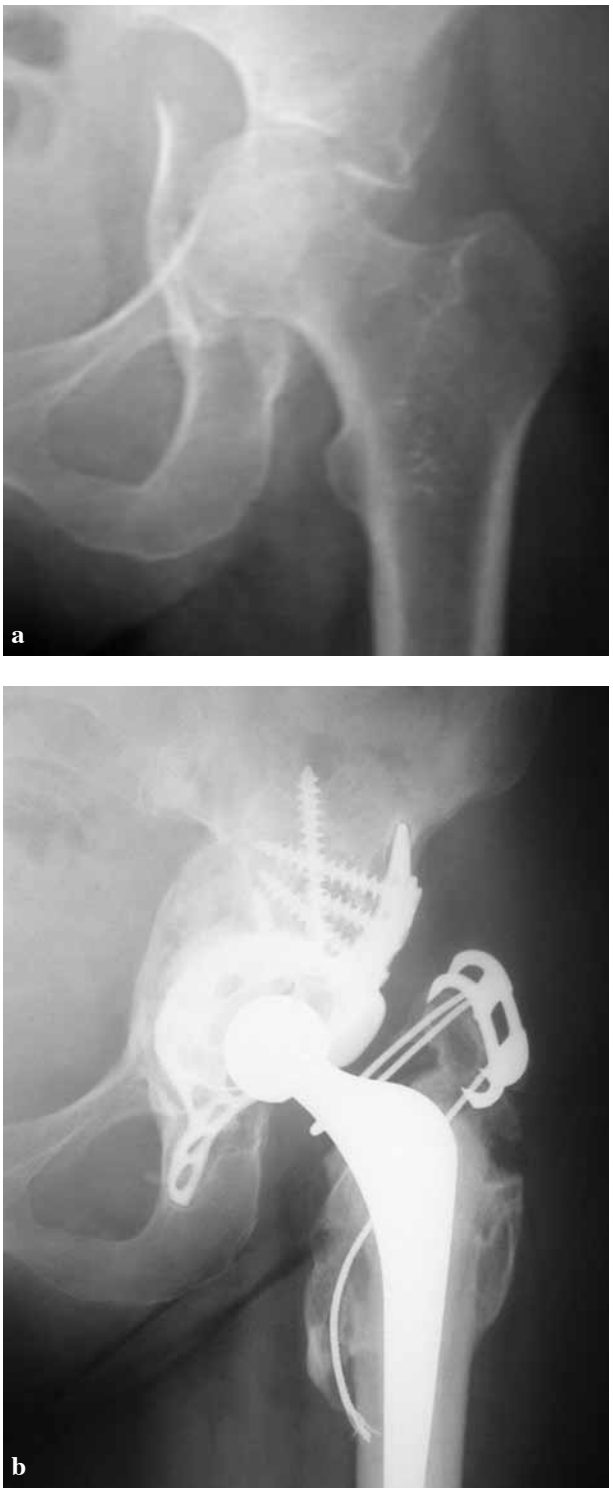

Fig. 3. — Case 2, (a) pre-operative AP view ; (b) 6 years post-operative with reconstruction ring.

Fig. 4. — Radiological loosening due to infection

centre (*24,39*), bilobed acetabular component (*3,7,10*) and bulk structural allograft (*11,21,26,31*). Results from these techniques in the context of large bony deficiency have not been encouraging. Trabecular metal augments and cups are recently gaining popularity ; only early results are available (*30,41,51*). The use of cemented arthroplasty on a background of mesh and morcellised bone graft is possible where defects can be contained (*38,42-44*).

Where bony deficiency is severe, the acetabular support ring provides initial stability and containment of the graft (*2,18,19,35*). Good short and midterm results have been reported (*1,14,19,20,34*). Most studies, however, include results from a number of different surgeons using different techniques and implants. A number of authors have identified a

moderately high rate of failure and risk of complication (*17,49,50*). Dislocation, graft resorption and implant failure seem particularly common. The implant failure was attributed to poor bony ingrowth or ongrowth on to the ring. The Contour® ring seems durable, and not subject to fracture as seen with other implants. The implant, screws and cement effectively form a locking plate once inserted, with divergent screws giving excellent initial stability, and ability to weight bear early. The grit blasted titanium ring and the titanium screws provide opportunity for osseointegration. Perhaps this had a role to play in the success of the reconstruction. At the time of re-revision in cases of infection the titanium screws were often well osseointegrated, and had to be cut from the acetabular bone. As the titanium rings are less stiff than their stainless steel counterparts, the phenomenon of stress shielding behind the ring does not seem to be a problem, with high rates of bone incorporation identified in our series.

Our series presents the results of a single surgeon over a 5 year period. Using a relatively simple uniform technique and implant, good medium term results have been achieved.

Based on this experience, the use of the support ring appears as a safe and effective means of acetabular reconstruction in difficult cases. It allows for early weight bearing and successful reconstitution of bone stock in the majority for future revisions. In our experience, the complication rate is lower than in other series.

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