There are few reports describing the technique of managing acetabular protrusio in primary total hip replacement. Most are small series with different methods of addressing the challenges of significant medial and proximal migration of the joint centre, deficient medial bone and reduced peripheral bony support to the acetabular component. We describe our technique and the clinical and radiological outcome of using impacted morsellised autograft with a porous-coated cementless cup in 30 primary THRs with mild (n = 8), moderate (n = 10) and severe (n = 12) grades of acetabular protrusio. The mean Harris hip score had improved from 52 pre-operatively to 85 at a mean follow-up of 4.2 years (2 to 10). At final follow-up, 27 hips (90%) had a good or excellent result, two (7%) had a fair result and one (3%) had a poor result. All bone grafts had united by the sixth post-operative month and none of the hips showed any radiological evidence of recurrence of protrusio, osteolysis or loosening. By using impacted morsellised autograft and cementless acetabular components it was possible to achieve restoration of hip mechanics, provide a biological solution to bone deficiency and ensure long-term fixation without recurrence in arthritic hips with protrusio undergoing THR.

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Idiopathic central displacement of the femoral head within the acetabulum (protrusio) is a relatively rare occurrence. However, it may be occasionally seen in arthritic hips secondary to rheumatoid arthritis, ankylosing spondylitis, previous trauma, osteomalacia and Paget’s disease. Primary total hip replacement (THR) in such situations may be technically demanding due to associated significant medial and proximal migration of the centre of the joint, deficient bone medially and reduced bony support to the acetabular component peripherally. Protrusio is often seen bilaterally and in younger patients, which requires the surgeon to provide an enduring solution.

Several techniques have been previously described in the surgical management of protrusio. These include using cemented acetabular components with cement alone or in association with morsellised bone to reconstruct the acetabulum. However, cement alone has a high incidence of migration and high rates of loosening have been reported in the medium term for bone graft used with cement. The use of cemented acetabular components in younger patients may result in early loosening and high revision rates during the first decade after implantation. Other methods for reconstruction of the acetabulum include the use of metal cages, reinforcement rings and block bone grafts. However, these methods significantly add to the complexity and cost of the procedure, and may not be available in all countries.

The purpose of this article is to describe our technique and results of using impacted morsellised autograft with a porous-coated cementless acetabular component to achieve restoration of hip mechanics, provide a biological solution to bone deficiency and to ensure long-term fixation without recurrence in arthritic hips with protrusio.

Surgical technique
Pre-operative templating is important. The presence and degree of protrusio is determined by drawing Kohler’s line on an anteroposterior (AP) radiograph of pelvis showing both hips, so as to determine the amount of reaming which may be performed without penetrating the medial wall during preparation of the acetabulum and to determine the true hip centre using the ‘teardrop’ as a reference. In our series surgery was performed with the patient in the lateral position, through an anterolateral approach in all cases. Dislocation of the hip, which could be challenging due to the excessive depth of the acetabulum and medial
Peripheral fixation of socket

Impacted morsellised autograft

Porous-coated cementless socket

Fig. 1

Diagrammatic representation of key surgical steps.

displacement of the femoral head, was facilitated by an extensive capsulotomy, along with simultaneous gentle and sustained traction and rotation. An adductor tenotomy in cases with excessive adductor tightness as determined on the table before the main incision, facilitated hip dislocation. Rarely, the femoral neck was resected in situ and the femoral head excised piecemeal. Normally before the neck osteotomy was performed the dislocated femoral head was cut into slices using a power saw. The bone slices were then morsellised into 8 mm to 10 mm-sized pieces using a bone cutter. After the neck osteotomy, the acetabular floor was prepared using a curette while avoiding penetration of the soft, deficient medial wall until a bleeding bony surface was obtained. The periphery of the acetabulum was reamed starting with larger sized reamers. The morsellised graft was then introduced into the prepared acetabulum and impacted against the floor using hemispherical impactors making sure that no graft was present at the rim to cause obstruction to the peripheral fit of the acetabular component. Vigorous impaction was avoided to prevent fracturing of the medial acetabular wall, as many of these patients, especially with inflammatory arthritis, were osteoporotic. An acetabular cup trial was then inserted to ensure good peripheral fit and more than 50% contact with the host bone (Fig. 1). The final acetabular component typically 1 mm to 2 mm larger in diameter than the last reamer used was then impacted into place. Fixation could be supplemented using one or two screws if required, based on the quality of bone and stability of the rim fixation. The femoral canal was then prepared in the standard fashion to receive either a cemented or cementless stem based on the internal geometry of the femur. A cemented stem was used in cases with a very wide femoral canal.

Post-operatively, partial weight-bearing with the assistance of a walking frame was advised for the first six weeks. Thereafter, unrestricted weight-bearing with a walking stick was recommended for another six weeks, after which patients were allowed to walk without any aid. Post-operatively, an AP radiograph of the pelvis with both hips was obtained immediately after surgery, at six weeks, three and six months, and annually thereafter to determine the position of the hip centre, integration of bone graft and any signs of acetabular displacement and loosening.

Our experience

A total of 30 primary THRs were performed between 1995 to 2004 by the senior author (ABM) in patients with protrusio acetabuli using impaction bone grafting and a cementless porous-coated hemispheric acetabular component as described above. The results of this series (16 unilateral and 7 bilateral) in 23 patients (six males and 17 females) were previously reported and has been summarised here. A total of 18 hips were affected by rheumatoid arthritis, seven by ankylosing spondylitis, and five were of unknown aetiology. Eight hips had mild, ten had moderate and 12 had severe grade of protrusio. Duraloc porous-coated cups (DePuy Orthopedics Inc., Warsaw, Indiana) were used in 17 cases and Bicontact cups (Aesculap Co., Tuttlingen, Germany) were used in 13. A porous-coated stem was used in 21 cases: Bicontact (Aesculap Co.) in 13 and Summit (DePuy) in eight. Cemented Charnley stems (DePuy) were used in nine cases.

At a mean follow-up of 4.2 years (2 to 10) the mean acetabular inclination angle was 42° (38° to 50°). All bone grafts had united by the sixth month (Fig. 2) with no perceptible change in acetabular component position in any case. This is based on observations of any loosening, which was defined as vertical migration of the new hip centre from the inter-teardrop line > 2 mm and medial migration as a reduction in the horizontal distance of the hip centre from the teardrop by > 2 mm on successive radiographs. No radiolucency was seen at the periphery of the acetabular components; several small radiolucencies (< 2 mm) were seen around the screws in three cases.

The mean pre-operative Harris hip score (HHS) was 52, which improved to 85 at latest follow-up. A total of 14 hips (47%) had excellent results, 13 hips (43%) had good results, two hips had fair results, and one hip had a poor result. The fair and poor results were in three patients with rheumatoid arthritis. The HHS in the group of patients with good or excellent results remained unchanged after a mean follow-up of two years, and there was no dislocation. One patient developed a post-operative haematoma and required re-opening of the wound, evacuation irrigation, and closure and another patient required secondary suturing owing to necrosis of the superficial edges of the wound, both of whom recovered uneventfully at final follow-up.

Discussion

THR in the presence of protrusio acetabuli often requires bone grafting in order to restore bone stock, establish a medial buttress for the acetabular component and appropriately lateralise the cup to restore the hip centre. Although the use of impacted morsellised bone graft along with a...
cementless component is an option in the management of protrusio during THR, literature is relatively sparse on the use of this technique and as to its effectiveness (Table I).

Impaction bone grafting, along with a cemented cup for acetabular reconstruction in protrusio during THR was first proposed by Slooff et al.13 A recent 20- to 28-year review of their series of 42 cases (all performed in patients aged < 50 years) by Busch et al14 reported a survivorship of 73% at the end of 20 years. Similarly, Rosenberg et al15 reported 90% survival in 36 hips at a mean follow-up of 12 years in rheumatoid patients with protrusio acetabuli where acetabular reconstruction was performed using impacted morselised bone graft and cemented cups. Hence, although the medium-term results of using impaction bone grafting and cemented cups for protrusio acetabuli are encouraging, the long-term results of this procedure are not as gratifying, especially in patients aged < 50 years. In contrast, the results of cementless acetabular reconstruction in patients aged < 50 years have revealed significantly better survival rates compared with cemented acetabular reconstructions.16,17

In their series of 29 primary THRs (mean age at surgery, 66 years) for arthritis with protrusio acetabuli using morselised autograft and dual-geometry acetabular component, Krushell, Fingeroth and Gelling18 reported good to excellent clinical results in 76% of hips, with no incidence of radiographic aseptic loosening or recurrence at a mean follow-up of two years. In their series of 23 primary THRs (mean age at surgery 62 years) for arthritic hips with cavitory acetabular bone defects using morselised autograft and cementless cup, Pereira et al19 reported good to excellent clinical results in 91% of hips, and 100% survival with revision and radiographic loosening as endpoints at a mean follow-up of 7.8 years. Similarly, in our series of 30 primary THRs (mean age at surgery, 46 years) with protrusio, acetabular reconstruction was performed using a cementless cup supplemented with impacted, morsellised autograft. At a mean follow-up of 4.2 years (2 to 10), 27 hips (90%) had good to excellent clinical results, with none of the hips showing any radiological signs of loosening, instability or recurrence of protrusio. The results of our series support the contention that a cementless acetabular reconstruction in conjunction with impaction bone grafting, restores bone stock, provides a more biological mode of fixation and a more enduring solution.

A standardised procedure for impaction bone grafting can facilitate successful bone graft consolidation. Paramount steps for this are ensuring a uniform size of the bone graft particles,20,21 preparing a vascular host bed for the graft, and optimal impaction of graft material.22 Contact of the bone graft with saline and lavage of the acetabular floor

**Table I.** Comparison of results of different techniques used to treat acetabular protrusio with primary total hip replacement in literature published since 2000

<table>
<thead>
<tr>
<th>Study</th>
<th>Hips (n)</th>
<th>Age at surgery (yrs)</th>
<th>Technique</th>
<th>Survival rate of acetabular components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rosenberg et al15</td>
<td>36</td>
<td>53</td>
<td>Impacted bone graft with cemented component</td>
<td>90% at 12 years</td>
</tr>
<tr>
<td>Garcia-Cimbrello et al2</td>
<td>148</td>
<td>54</td>
<td>Cemented polyethylene component</td>
<td>79% at 16 years</td>
</tr>
<tr>
<td>Welten et al16</td>
<td>69</td>
<td>56</td>
<td>Impacted bone graft with cemented component</td>
<td>94% at 12.3 years</td>
</tr>
<tr>
<td>Pereira et al19</td>
<td>23</td>
<td>62</td>
<td>Impacted, morselised bone graft with cementless component</td>
<td>100% at 7.8 years</td>
</tr>
<tr>
<td>Current series10</td>
<td>30</td>
<td>46</td>
<td>Impacted, morselised bone graft with cementless cup</td>
<td>100% at 4.2 years</td>
</tr>
<tr>
<td>Krushell et al18</td>
<td>29</td>
<td>66</td>
<td>Impacted, morselised bone graft with dual-geometry cementless component</td>
<td>100% at 2 years</td>
</tr>
<tr>
<td>Busch et al14</td>
<td>37</td>
<td>&lt; 50</td>
<td>Impacted bone graft with cemented polyethylene component</td>
<td>73% at 20 years</td>
</tr>
</tbody>
</table>
are to be avoided so as not to cause loss of osteogenic factors in the graft material.\textsuperscript{23} It is important to oversize the cementless cup in order to achieve a peripheral rim fit of the cup. Consolidation of the graft will establish a medial buttress for the acetabular socket, and enhance stability to resist the superomedially directed joint reaction force. Acetabular cages and rings may only be required if the bony rim of the acetabulum is not intact, or the defect is enormous. Radiographs did show several radiolucencies around some of the screws, however none of these exceeded 2 mm. There was no evidence of progression of protrusio or socket loosening in any of our cases. Also we have not seen osteolytic lesions up to the present time.

The shape of the femoral canal determined choice of stem. We have used both cemented and cementless stems, and have observed graft consolidation in all cases, irrespective of stem configuration and its mode of fixation.

In conclusion, the use of impacted morsellised autograft in conjunction with porous-coated cementless acetabular components is a technically straightforward solution, through which the hip mechanics are restored and sound fixation achieved, thereby preventing recurrence of protrusio.

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. 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. There was no evidence of progression of protrusio or socket loosening in any of our cases. Also we have not seen osteolytic lesions up to the present time.


