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Initial Implant Stability Predicts Migration But Not Failure in Cementless Acetabular Revision with Bone Grafting

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ABSTRACT

Host bone contact of less than 50% is perceived but not proven to cause migration and loosening after actetabular revision. A prospective analysis of cementless acetabular revision cases with impaction grafting was performed to determine if this was an independent risk factor for these events. Sixty-two hips in 54 patients were assessed at a mean follow-up of 84.5 months (range 61–112) yielding a probability of 94.6% of retaining the acetabular component using revision for aseptic loosening as the end point. No single factor was independently causative for loosening, although Type III fixation was associated with migration ($p = 0.0159$); subanalysis suggested that achieving host–bone contact in at least part of the dome and posterior column is important.

The use of bone graft for acetabular reconstruction was first described over 30 years ago in primary THA for protrusio acetabuli [1]. Autograft from the femoral head and neck was pressed against a vitallium mesh to increase the medial support. The indications for bone graft were then expanded to revision surgery where it was used to overcome deficient bone stock [2]. Slooff et al.'s [3] technique of impaction grafting offered increased conformity of the socket and long-term data from that author's group demonstrate its success in revision cases [4].

Other studies note much higher failure rates for impaction grafting of between 56% and 72% at 9–15 years [5,6]. They have identified underlying disease processes such as rheumatoid arthritis, surface finish of the acetabular components, and polyethylene wear as reasons for failure. In addition, there is a long-standing perception that host–bone contact less than 50% [7,8] is a cause of loosening or migration although this has been disputed [9,10].

The primary aim of this study is to identify if host–bone contact or any other patient- or surgical-related factor is an independent risk factor for re-revision or migration. The secondary aim is to report the clinical and radiological outcomes in patients revised with hemispherical porous acetabular components implanted with supplementary screw fixation on impacted allograft at a minimum 5-year follow-up.

Methods

Patients

A prospective analysis of all cementless acetabular revision cases with impaction grafting by a single surgeon between 2000 and 2005 was undertaken. The acetabulae of 69 hips in 61 patients with AAOS Type II [11] defects were revised using the Trilogy (Zimmer; Warsaw, IN) or Reflection (Smith and Nephew; Memphis, TN) acetabular systems. The choice of implant was determined by availability at the practicing institution; the former implant was used between 2000 and 2003 and the latter between 2003 and 2005. There were four patients (four hips) who died and three patients (three hips) who were lost to follow-up; the causes of death were unrelated to the acetabular reconstruction. Thus 62 hips in 54 patients were available for assessment at a minimum 5-year follow-up.

The cohort comprised 21 males and 41 females with a mean age of 68.2 years (range 38–92) at the time of revision. The mean height was 167.0 cm (range 149–193) and the mean weight was 76.0 kg (range 44–136) giving a mean BMI of 27.1 kg/m^2 (range 18.8–37.0) at the time of revision surgery. The indications included aseptic loosening (31 cases), single-stage revision for infection (7 cases), and second stage of two-stage revision for infection (24 cases).

Isolated acetabular revision was performed in 19 cases, with the remaining 43 cases undergoing revision of both acetabular and femoral components. Forty-six of the revised acetabular components were previously cemented and 16 were uncemented. The mean time to previous surgery (excluding the first stage of two-stage revision) was 8.9 years (range 1.8–22.1).

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The cumulative number of arthroplasties prior to the index acetabular revision was one in 49 hips, two in 11 hips, and three in 2 hips.

Implants

Both implants have a titanium porous surface on the outer hemisphere and a polished inner-metal backing with stable locking mechanism. The Reflection shell also has a peripheral build-up designed to ensure rim stability. Screw holes were present in both implants and were used to accommodate 6.5-mm cancellous screws with the Trilogy shell and 6-mm cancellous screws with the Reflection shell. The outer diameter of cup used ranged from 52 to 68 mm (median 58).

Surgical Technique

All operations were performed using a posterior approach. Loose components were removed and debridement of pseudomembrane and previous cement undertaken to provide acetabular exposure. The acetabulum was then reamed down to bleeding bone to provide a suitable host.

All grafts used were fresh-frozen (within 24 h of harvest), non-irradiated, allogenous femoral heads that were tested free of microbial growth and stored at −40 °C. Just prior to surgery, each head was sawed in half with one half passed through a bone mill and the other prepared by hand with a bone nibbler. The graft retrieved from the bone mill was a mixture of slurry and particles that ranged from 1 to 5 mm. Particles ranging from 5 to 10 mm were produced from the bone nibbler-prepared graft.

Isolated cavitary defects were initially packed with the prepared allograft. Those areas in the remainder of the socket which were distorted, compromised or missing were then densely packed to provide suitable coverage. Impaction was performed with the socket trial prosthesis and coupled with reverse reaming. Slots in the trial shell allowed host–bone contact to be assessed and this was recorded. One femoral head or equivalent was used in 36 cases, two or equivalent in 23 cases and three or equivalent in 3 cases. A depth gauge or needle was used in all cases with a thin or deficient medial wall to ensure that the minimum thickness of the bone graft bed forming the new wall exceeded 10 mm.

The size of acetabular component chosen was 1 mm larger than the last trial socket prosthesis and inserted to achieve a press-fit where possible. UHMWPE was used as the liner material in 47 cases while highly cross-linked polyethylene was used in the remaining 15 cases; this was dictated by the increased availability of the newer material at the study institution. The security of fixation at the time of implantation was classed as either Type I: subjectively secure without supplemental screw fixation; Type II: secure only after screw fixation (number of screws ≤ 3); and Type III: secure only after screw fixation (number of screws ≥ 4). There were 21, 30 and 11 cases respectively making each group. Supplementary screw fixation was employed in all cases with a minimum of two screws including those exhibiting Type I fixation. The number of screws used was then increased until secure fixation was achieved. Two screws were used in 11 cases, three in 40 cases, four in six cases, five in 4 cases and six in 1 case.

Femoral revisions were uncemented in 55 cases and cemented in 7 cases. Cobalt-chromium heads were used in 52 cases and oxidized zirconium heads in 10 cases. The size of head was 32 mm in all cases.

All patients received parenteral antibiotics; those undergoing revision for aseptic loosening or a second of two-stage revision received this at induction. Patients undergoing a single-stage revision for infection received antibiotics after removal of tissue samples and all existing components. Antibiotic protocols were extended in all infected cases and stopped after satisfactory return of blood inflammatory markers to normal limits. Venothrombotic prophylaxis included bilateral thromboembolic deterrent stockings for 1 to 6 weeks, and subcutaneous low-molecular-weight heparin. All patients were mobilized partial weight bearing on the first post-operative day and this continued for 6 weeks.

Follow-Up and Evaluation

Patients were assessed pre-operatively and at 6 weeks, 6 months, 1 year and annually thereafter to a mean of 84.5 months (range 61–112). Clinical assessment tools included the Harris hip score [12] and normalized WOMAC score [13]. Radiographic assessment was performed on antero-posterior and lateral radiograph taken at each clinic visit with inclination defined as the angle between the opening of the acetabular shell and a line intersecting the inferior margins of the ischial tuberosities and version defined as the angle between the face of the acetabulum and a line perpendicular to the horizontal plane [14]. Loose components were defined as those displaying progressive radiolucent lesions or evidence of migration. The location of radiolucencies was identified using the three zones described by DeLee and Charnley [15]. Migration was assessed using the technique described by Nunn et al. [16] and defined as having occurred if ≥ 5 mm in any direction was observed [17].

Statistical Analysis

Kaplan–Meier analysis was used to calculate survivorship, and stepwise logistic regression was used to identify which demographic and implant-related factors were risk factors for migration and failure. The factors included within the risk analysis model are listed in Table 1. Comparison between pre- and post-surgery clinical scores was carried out with the Mann–Whitney *U* test. All analyses were calculated using XLSTAT (Version 2009; Addinsoft, New York, NY) with statistical significance set at $p<0.05$.

Results

Survivorship, Failures and Migration

At a mean follow-up of 84.5 months, Kaplan–Meier survivorship analysis gave a probability of 92.9% (95% CI 86.2–99.7) of retaining the acetabular component using revision for any reason as the end point (Fig. 1). There were four hips revised in four patients during the study

Table 1
Variables Included in the Risk Analysis Model.

	Categorical (Ca)/Continuous (Co)/Discrete (Di)
Demographic variables	
Sex	Ca
Height	Co
Weight	Co
Body mass index	Co
Surgical variables	
Indication for revision	Ca
Number of prior arthroplasties	Di
Previously cemented cup	Ca
Components revised	Ca
Number of femoral heads used	Di
Host contact area	Ca
Type of fixation	Ca
Acetabular component size	Di
Number of screws	Di
Acetabular component manufacturer	Ca
Liner material	Ca
Femoral head material	Ca
Acetabular inclination	Ca
Acetabular version	Ca