An improved acetabular cementing technique in total hip arthroplasty

We have evaluated the effect of vacuum aspiration of the iliac wing on the osseointegration of cement into the acetabulum. We entered a total of 40 patients undergoing primary total hip arthroplasty into two consecutive study groups. Group 1 underwent acetabular cement pressurisation for 60 seconds before insertion of the acetabular component. Group 2 had the same pressurisation with simultaneous vacuum suction of the ilium using an iliac-wing aspirator. Standard post-operative radiographs were reviewed blindly to assess the penetration of cement into the iliac wing. Penetration was significantly greater in the group with aspiration of the iliac wing.

Aseptic loosening of the acetabular component has been reported to be responsible for 79% of failures in cemented total hip arthroplasty (THA). The process of aseptic loosening is complex, involving biomechanical and biological factors. Migration of the prosthesis, the response of the host to particulate wear debris, joint fluid pressure, the design of the prosthesis and the operative technique all contribute to the pathogenesis. In spite of this, cement is still an effective way of securing an implant to bone. Survival rates of 89.9% at 25 years have been reported for cemented acetabular components. Modern cementing techniques have contributed to the longevity of cemented components in THA. While these have led to some increase in the survival of the acetabular component, the long-term results with cemented femoral components have been more impressive. Most mechanical failures of cemented acetabular fixation are attributable to failure to achieve good initial fixation at the cement-bone interface. Suction venting of the femoral shaft is a well-recognised practice but venting of the acetabulum during the cementing process is not an established procedure. The technique of venting of the iliac wing to achieve a dry cancellous bed was first reported in 2002. We are not aware of any publication which has evaluated the effectiveness of this method. Our aim was to determine prospectively the effect of aspiration of the iliac wing on the penetration of cement into the acetabulum. Our hypothesis was that vacuum aspiration would increase the osseointegration of cement into cancellous bone around the acetabulum to produce a more complete cement-bone interface.

Patients and Methods

We entered 40 consecutive patients undergoing unilateral primary THA into two study groups (20 hips per group). Group 1 consisted of ten men and ten women with a mean age of 65 years (SD 16; range 19 to 82). This group underwent acetabular cement pressurisation with an inflatable Exeter acetabular pressuriser (Benoist-Girard et Cie, Cedex, France) for one minute before insertion of the acetabular component. Group 2 consisted of eight men and 12 women with a mean age of 69 years (SD 8; range 52 to 80). This group had the same pressurisation but with simultaneous vacuum suction of the ilium using an Exeter iliac-wing aspirator (Benoist-Girard et Cie) (Fig. 1).

The indications for THA included osteoarthritis (35 hips), acetabular dysplasia (two), rheumatoid arthritis (one), Perthes’ disease (one) and conversion to a THA after insertion of a dynamic hip screw (one).

Operative technique. A consultant surgeon (OB) performed all of the procedures in a standard operating theatre with laminar flow. A posterior approach to the hip was used in all cases and the acetabular labrum was excised. A cancellous bed of bleeding bone was obtained using sequential hemispherical reamers of increasing diameter. Multiple drill holes (diameter 0.5 cm, depth 1 cm) were made in the acetabular bed. Pulsatile lavage was used to remove any debris and a hydrogen-peroxide-soaked swab followed by a dry swab was
inserted into the acetabulum before cementing the acetabular component. The inferior part of the acetabulum was occluded with autograft to prevent extrusion of cement and to aid pressurisation. In group 2, at this stage the iliac-wing aspirator was introduced with the aid of a trocar, approximately 2 cm into the cancellous bone of the ilium superior to the acetabulum. Cement was manually inserted in dough form and subsequently pressurised with the Exeter acetabular pressuriser. Suction was connected to the aspirator before the cement was inserted and was continued during cement pressurisation and placement of the acetabular component. The suction was maintained until the cement had hardened or until cement had been sucked into the aspiration device. A Charnley Ogee long posterior wall polyethylene component (Depuy, Leeds, UK) with an internal diameter of 26 mm was secured with Simplex polymethylmethacrylate cement (Stryker Howmedica, Limerick, Ireland). The external diameter of the cup varied between 43 mm and 53 mm, but there was no statistical difference in the size of the cup between the two groups (p = 0.69). Pre- and post-operative haemoglobin values were recorded for all patients.

Standard anteroposterior post-operative digital radiographs (100% magnification) were reviewed by two of the authors (NH, AA) in order to assess the penetration of cement into the adjacent bone. The authors were blinded to the patients’ group. A custom-made template facilitated measurement of the depth (mm) of penetration of cement in three areas corresponding to the acetabular zones of DeLee and Charnley.11

Statistical analysis. This was performed using Student’s t-test and a p value of < 0.05 was considered to be significant.

Results

Patients who had iliac-wing aspiration (group 2) had greater penetration of cement in all three zones of DeLee and Charnley than those in group 1. However, the difference between the groups was only statistically significant in zones I and II. The difference in the depth of penetration was most noticeable in zone I (mean 21.1 mm (SD 6.4) with venting vs 12.8 mm (SD 2.8) without venting; p < 0.001). That in zone II (7.0 mm (SD 2.4) vs 5.5 mm (SD 2.0); p = 0.03) and in zone III (5.3 mm (SD 2.4) vs 4.2 mm (SD 1.4); p = 0.087) was less dramatic. Venting also enhanced the interdigitation of cement within the cancellous bone, resulting in elimination of a visible interface of the cement-bone mantle on the post-operative radiographs (Fig. 2). The mean fall in the haemoglobin level was greater in the venting group compared with the control group but this difference was not statistically significant (3.2 g/dl with venting vs 2.6 g/dl without venting, p = 0.1).

Discussion

Long-term studies have shown that failure of the acetabular component in THA increases exponentially ten years after surgery and occurs most commonly at the cement-bone interface. Since cement has no adhesive properties, the strength of the interface depends upon the physical properties of the opposing surfaces, the contact area of the interface and the extent of penetration of cement into the bony trabeculae.12-15 Cement pressurisation is recommended to achieve a minimum cement-bone mantle thickness of 3 to 5 mm which is that required for stable three-dimensional fixation.15,16 Inadequate cementation has been shown to be the most significant feature associated with clinical evidence of loosening of cemented Charnley femoral components.17 A discontinuous or thin cement mantle around an acetabular component is associated with increased wear of polyethylene, fracture of cement and increased frequency of migration.18 An incomplete mantle has also been shown to cause backside wear on the outer non-articulating surface of the polyethylene cup.19 Histopathological analysis of aseptic loosening has demonstrated the presence of cement and polyethylene particles at the cement-bone interface with progressive resorption of bone.20-22 Fragmentation of cement causes wear of polyethylene which in turn promotes the formation of granulomas and further disintegration of the bone cement.22 Subsequent instability leads to the formation of a fibrous pseudomembrane which encourages additional bone resorption.2 The presence and progression of radiolucent lines around prostheses have been extensively reviewed and it has been shown that a clear demarcation of the cement-bone interface on the initial post-operative radiograph increases the risk of migration of the component and subsequent loosening.23 To overcome this, cementing techniques have evolved over time. Mechanical tests have shown that greater stability is achieved when the acetabular component has been completely covered, when all the articular cartilage has been removed, when the acetabulum has been reamed and when anchoring holes for
cement have been used. Components secured with acrylic bone cement have been shown to have greater initial stability than uncemented prostheses. Acetabular components with bone-cement spacers have also been used to improve the quality of the cement mantle.

We have shown that aspiration of the iliac wing increases the depth of penetration of cement into cancellous bone during insertion of the acetabular component. This leads to an improved cement-bone mantle with elimination of the visible cement-bone interface. Comparisons of acetabular osteolysis have been made between cemented and cementless fixation and, while no significant difference in prevalence was noted, the pattern of osteolysis differed. Progressive osteolysis occurred predominantly in zone I in the cemented group. In our study, venting had the greatest effect in zone I resulting in the best penetration of cement and complete obliteration of radiolucent lines at the mantle interface. This effect in zone I is most likely to occur because of the anatomical placement of a single aspirator and the greater volume of trabecular bone in zones I and II compared with zone III. Although lateral radiographs were not systematically measured, their review showed enhanced penetration of cement anterosuperiorly compared with that in the unvented group. These lateral radiographs, in conjunction with the anteroposterior views imply three-dimensional penetration of the cement into the trabecular bone of the ilium. Cadaver studies have previously shown improved three-dimensional incorporation of cement when comparing the Exeter acetabular pressuriser with another commercial pressuriser. However, such studies have yet to be performed in conjunction with aspiration of the iliac wing.

The factors which influence the outcome of acetabular replacement include the design materials, the means of fixation, the operative technique and patient-related variables such as age, the aetiology of osteoarthritis and levels of activity. The aetiology of aseptic loosening is also multifactorial and includes excessive deepening and widening of the acetabulum, rudimentary techniques of pressurisation of cement, the presence of an incomplete cement-bone mantle, fragmentation of the cement, wear of polyethylene and osteolysis. The technique of aspiration of the iliac wing has been shown to increase the interdigitation of cement within the bony trabeculae of the pelvis. It also eliminates the presence of radiolucent lines at the interface of the cement mantle and bone on the post-operative radiograph. We believe that this technique may reduce the rate of aseptic loosening by improving the fixation of the acetabular component. Furthermore, while the technique is unlikely to affect the usual production of polyethylene wear particles, we hope that the enhanced cement-bone mantle may effectively seal off the cancellous bone in zone I, preventing penetration of polyethylene debris and therefore delaying the process of osteolysis. It is hoped that this operative technique will result in longer survival of the cemented acetabular component, but this will only become apparent after long-term clinical and radiological follow-up.

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References


