Retention of a well-fixed acetabular component in the setting of acetabular osteolysis

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Abstract

Purpose The treatment strategy for pelvic osteolysis with a well-fixed acetabular component after total hip arthroplasty (THA) involves replacing the acetabular cup liner and femoral head, débriding osteolytic lesions, and grafting.

Methods We investigated whether retention of a well-fixed acetabular component using the two-approach technique—the ilioinguinal approach combined with the posterolateral approach—was compatible with socket survival. We reviewed clinical and radiographic findings for 24 patients (24 hips) who had undergone acetabular revision arthroplasty of a well-fixed socket for progressive osteolysis. The surgical techniques used included osteolytic lesion débridement and bone grafting through the ilioinguinal approach, and replacement of the acetabular liner and femoral head through the posterolateral approach.

Results The mean duration of follow-up after revision was 2.3 (range 2.1–3.9) years. At follow-up evaluation, all acetabular components were well fixed and showed no evidence of loosening, osseous integration was apparent and there was no radiographic evidence that any lesions had progressed. No new osteolytic lesions were identified, and there were no clinical or radiographic complications.

Conclusions Curettage and bone grafting under direct vision, cup liner and femoral-head replacement because of progressive retroacetabular osteolysis and retention of well-fixed components using the two-approach technique results in good osseous integration of lysis. Larger studies with

longer follow-up periods are required to establish the long-term success of this technique.

Introduction

Periprosthetic osteolysis (OS) is a common complication of total hip arthroplasty (THA) and cause for revision surgery. Its incidence in patients with cementless acetabular cups has been reported to range from 1% to 46% within five to seven years of THA, and is related to the quality of polyethylene (PE) used in the acetabular liner and to cup design. Liners with thin PE, incongruent liner contact and poor liner fixation are problematic [1–3]. For cementless acetabular components, the socket may remain well fixed when there is extensive pelvic OS that progresses without clinical symptoms until fracture around the cup or inclination of the cup occurs [4]. This presents the surgeon with the difficult decision of whether to revise a well-fixed acetabular component. The solution to this dilemma is controversial: Some authors advocate acetabular component removal [1, 5], whereas others believe that a stable acetabular component should be left in place [6–10]. Good results have been reported for retention of a well-fixed cup plus bone grafting, including allograft bone and demineralised bone matrix (DBM), with intraoperative confirmation of cup stability [9, 11–17]. For a well-fixed acetabular component, the surgical strategy for prosthesis retention entails replacing the bearing surface to decrease debris production and, when possible, débridement of the lesion cavity with grafting [10, 12, 18, 19]. Débridement of osteolytic lesions and cancellous bone grafting are usually done through the dome holes of the acetabular component and/or through the fenestrations in the superolateral ilium. This technique, however, is inadequate for complete

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débridement of the osteolytic lesions and bone grafting when the component is left in place because access to the osteolytic lesion for débridement and grafting is difficult. It has been reported that 26–33% of osteolytic lesions go untreated and do not undergo grafting because cementless components are well fixed and because it is difficult to access the lesions [7, 9, 20].

Clearly, there is room for improvement and refinement of the surgical technique for retaining well-fixed acetabular components. Therefore, for our study population, we determined: (1) whether the osteolytic lesions were completely débrided and the cavity was well filled through a combination of the ilioinguinal and posterolateral approaches, and (2) whether well-fixed acetabular components should have been retained by replacing acetabular liners and femoral heads, débriding osteolytic lesions and filling defects with allografts.

Methods

We retrospectively reviewed data for 24 consecutive patients in whom pelvic OS occurred after THA and who had well-fixed cementless acetabular components. All 24 patients (24 hips) had undergone replacement of PE liners and femoral heads and débridement of periacetabular osteolytic lesions from a combined ilioinguinal and posterolateral approach, after which the osteolytic cavity was packed with morsellised allograft. All cementless cups were well fixed and retained. This retrospective study was approved by the West China Hospital Review Board. There were 13 men and 11 women in our study group, with a mean age at the time of revision surgery of 46.6 (range 39–54) years and mean weight of 62.4 (range 49–82) kg. The preoperative diagnosis for primary THA was osteonecrosis of the femoral head in eight hips, developmental dysplasia in nine, traumatic osteonecrosis in two, traumatic osteoarthritis of the hip secondary to acetabular fracture in four and osteoarthritis secondary to pyogenic arthritis and tuberculosis of the hip in three. The mean elapsed time from primary THA to surgical revision was 4.8 (range four to seven) years. During primary THA, all patients were fitted with cementless acetabular components.

Seven of the 24 patients had minimal symptoms after the primary procedure. Two patients presented with moderate symptoms, the main ones being groin or buttock pain. The pain was worse with activity and decreased with rest. Four patients presented with increasing discomfort and swelling in the groin. On physical examination, these four were found to have an obvious and tender soft-tissue mass in the iliac fossa. All masses were confirmed by ultrasound (US) examination and were identified as hypoechoic masses

along the psoas muscle. Computed tomography (CT) scans of the abdomen and pelvis revealed retroperitoneal masses in the iliac fossa along the iliopsoas muscle adjacent to the anterior aspect of the acetabulum (Fig 1). The other 11 patients were asymptomatic; their periacetabular OS was found during a scheduled follow-up radiographic examination. During short-term follow-up (three to six months), all 11 asymptomatic patients exhibited progressive local OS. Hip radiographs demonstrated eccentric wear of PE liners, with no evidence of cup loosening. Each patient had a CT scan before revision surgery and another at the final follow-up. A single revision surgeon (JY) analysed CT data and identified number, extent and location of periacetabular osteolytic lesions.

PE liner wear was measured by the Livermore et al. method [21]. The approximate size of each lesion was determined by measuring its longest diameter and then measuring the second diameter perpendicular to the first diameter on the CT image (Fig 2).

The senior surgeon (FP) performed all surgical procedures. Indications for surgery were impending wear-through of the PE liner, rapidly progressive OS or symptoms of PE wear such as hip subluxation, groin pain or presence of a pseudotumour in the groin. In every case, the surgical approaches were the same: The patient was placed in the lateral decubitus position under general anaesthesia, and the entire abdomen, lower limb, back and perineum were draped; the lower limb was draped free so that its position could be adjusted during the procedure. The lesion in the ilium was accessed through the ilioinguinal approach, as described elsewhere [22], but without lateral extension along the iliac crest. Medial and lateral mobilisation of the iliopsoas muscle, combined with medial retraction of the external iliac vessels, provided access to create a cortical

Fig. 1 Computed tomography pelvic scan demonstrating a space-occupying mass in the right iliac fossa along the iliopsoas muscle and adjacent to the anterior aspect of the acetabulum

Fig. 2 Computed tomography scan of an osteolytic lesion in the ilium. Lesion size was determined by measuring its longest diameter and then measuring a second diameter perpendicular to the first diameter ($a \times b$)

window in the inner ilium at the dome of the acetabular component. Through the window, the osteolytic lesion was débrided completely using a specialised instrument, such as a curved curette, under direct vision. After débridement, the osteolytic cavity was irrigated with saline. Then the morsellised allograft was packed into the osteolytic cavity. In the four patients with a pseudotumour mass in the groin region, the pseudotumours communicated with the osteolytic lesion through a small hole in the inner ilium wall and were completely resected before débridement. Before resection, the pseudotumours

were aspirated; two yielded thick yellow fluid—245 ml and 285 ml, respectively. Another two pseudotumours contained yellowish grey caseous necrotic tissue. Microscopic evaluation showed $>175.00/\text{mm}^3$ nucleated cells and macrophages with inclusions. Cytopathological examination revealed Oil Red O staining in macrophages, consistent with PE-wear debris (Fig 3). Routine and fungal cultures showed no growth. After bone grafting was complete, the incision was closed with drainage. Then, via the posterolateral approach, a complete capsulectomy was performed and the hip dislocated. Hypertrophied synovial tissue was débrided, and the acetabular liner was removed. Integrity of the locking mechanism was checked. Stability of the metal shell was confirmed using a clamp and manual pressure. If the metal shell was stable, some of the morsellised allograft was packed into the osteolytic cavity again through the hole in the acetabular component. A new PE liner was inserted, and the femoral head was replaced. Eleven patients received a ceramic femoral head, and 13 received a metal head. The new acetabular liner was locked in 22 hips and in two hips with a deficient locking mechanism, it was cemented into the socket.

All patients commenced partial weight bearing with the aid of one crutch or a walker for four to eight weeks after revision surgery. All were monitored clinically and radio-

Fig. 3 Anteroposterior pelvic (a) and lateral hip (b) radiographs in a 43-year-old woman 67 months after total hip arthroplasty demonstrate diffuse expansile periacetabular osteolysis (white arrows) with associated eccentricity of the femoral head, indicative of polyethylene wear (arrows). Revision surgery was done with lytic lesion débridement, use of morsellised allograft and acetabular liner and femoral head replacement using the ilioinguinal and posterolateral approach (c). Radiograph obtained immediately (d) and 2.6 years (e) after revision surgery showing incorporation of bone graft with almost complete resolution of the osteolytic defect

graphically. Postoperative Harris hip scores (HHS) were determined on the basis of clinical evaluation performed by the operating surgeon. Each follow-up radiograph was evaluated for evidence of osseous integration [11, 23], including trabecular formation, as demonstrated by increased lesion density, a hazy border between lesion and surrounding trabecular bone, reduced lesion size and persistent defect filling after graft resorption.

Each institution approved the protocol for this investigation, which was conducted in conformity with ethical principles of research. Informed consent for participation in the study was obtained from all participants.

Results

Average liner wear and volumetric wear rates were 0.18 ± 0.13 mm/year (range 0.13–0.28 mm/year) and $534.92 \text{ mm}^3/\text{year}$ (range 228.64–756.38 mm³/year), respectively. All osteolytic lesions were located in DeLee and Charnley zone II on anteroposterior pelvic radiographs adjacent to an acetabular component dome hole. The average osteolytic lesion was 465.84 cm^2 (range 147.36–634.69 cm²). Femoral-head eccentricity was measured before revision; all but six of 24 femoral heads appeared eccentric within the metal shell, with head displacement ranging from two to seven (mean 3.2) mm. Three patients were lost to follow-up (attempts to contact them were unsuccessful), leaving 21 patients (21 hips) available for review. Mean duration of follow-up after revision was 2.3 (range 2.1–3.9) years. Average HHS improved from 84 before revision to 93.8 at the final follow-up evaluation. Patients who had no or only slight pain before revision surgery had no pain at the most recent follow-up evaluation. Two patients who had had groin pain before surgery (scores of 5 and 6 on a visual analogue pain scale, where 0 represents no pain and 10 unbearable pain) had less pain afterwards (scores of 2 and 3 on the pain scale). None of these patients had any postoperative complications. At a mean of 2.3 years of follow-up, all patients were asymptomatic or had mild symptoms and had returned to their previous level of function. None of these patients required another operation to date. There was no radiographic evidence of progression of osteolytic lesions at the latest follow-up examination. Also, all acetabular components appeared to be well fixed and showed no evidence of loosening. Bone grafts appeared radiographically to have consolidated and incorporated to varying degrees (Fig 4). There was complete lesion resolution in 11 hips and good osseous integration in another 12. One hip had poor integration. Despite the lack of complete graft consolidation, there was no radiographic evidence of OS lesion progression during our study.

Fig. 4 Histophotomicrograph of cyst tissue demonstrating blood cells, haemosiderin, giant cells and fibrous tissue, consistent with foreign-body reaction to particulate polyethylene (haematoxylin and eosin stain; magnification $\times 40$)

Discussion

The two-approach technique to débride osteolytic lesions, perform bone-grafting and replace PE liners and femoral heads produced favourable outcomes in our study; it is a technique that can be used effectively in young patients. The treatment of retroacetabular OS was successful with cup retention, curettage and allograft in our patients. The question of cup retention versus cup revision in OS progression around a stable component is controversial [1–3, 24, 25]. The majority of osteolytic lesions occur and progress in the absence of clinical symptoms; therefore, progression may go undetected until considerable bone loss has occurred. However, in the setting of a well-positioned and osseointegrated cup, the optimal approach has not been conclusively established. Some authors recommend preserving cups and grafting defects if the cups are modular and well fixed, have an intact-locking mechanism and are in an acceptable position and if an appropriate PE liner is available [6–10, 26]. Other authors recommend removing even well-fixed cups at revision, noting that this will enhance identification of the extent of OS and facilitate grafting of defects [1, 5, 27, 28]. Cup revision allows full access to the lytic lesion with adequate débridement of granuloma. However, removing a stable cup can result in significant bone loss or pelvic dissociation and subsequent bone ingrowth requirement in the revised cup. Fixation of any revision acetabular component will initially be worse than that of a stably ingrown component, even in the presence of retroacetabular OS [29]. If cup stability is confirmed, cup retention and liner replacement preclude the bone loss associated with cup revision, although its disadvantages are incomplete exposure of the osteolytic lesion, dislocation and limited use of newly developed bearing surfaces. The purpose of our study was to determine the usefulness of cup retention in revision THA

for the treatment of pelvic OS when cementless cups are well fixed, especially in relatively young patients, using the two-approach surgical technique.

As mentioned earlier, good results have been reported for retention of a well-fixed cup plus bone grafting [2, 24], with intraoperative confirmation of cup stability. Curettage and grafting of the osteolytic lesion while retaining the component constitutes a good surgical option [7]. In this procedure, the granuloma of the osteolytic lesion is débrided, morsellised bone is inserted into the osteolytic defect and the PE liner and femoral head are replaced. If the cementless cup is modular and well fixed, has an intact locking mechanism, is in an acceptable position and if an appropriate PE liner is available, the cup should be preserved [6, 8, 14, 26, 30]. In our experience, the key to successful surgery that will retain a well-fixed cup is careful preoperative planning, which includes a detailed medical history and conducting a thorough physical examination to determine the previous surgical approach employed and the components inserted and to rule out infection. Before surgery, it is imperative to ensure that the appropriate liners and femoral heads are available, ordering custom components if it means avoiding revision of the acetabular cup on some occasions. If the locking mechanism is unstable, the liner can be cemented into the shell. Yoon et al. [31] reported good results with liner cementation into a stable acetabular shell using a metal-inlay PE liner. In our study, we used liner cementation in two hips where locking mechanisms were destroyed.

The principles for treating OS with a well-fixed cup are identifying and replacing potential particle generators, eliminating granulation or periprosthetic tissue and filling defects with bone or bone substitute. At present, there are several approaches for débriding osteolytic lesions and performing bone grafting. Osteolytic granuloma may be débrided through the screw holes, with graft insertion via this route, through a superior acetabular window [1, 2, 24] or a rectangular trapdoor created in the ilium [32] to allow access to the defect. However, when the acetabular cup is retained, it is not possible to visualise the osteolytic lesion while débriding it. If granulomatous tissue remains or residual fluid becomes trapped during grafting, it would be impossible to fill the defect completely. Engh et al. [7] reported that in working through screw holes, an average of only 49% of lesion volume was débrided and filled and concluded that it is difficult to gain access through screw holes. Their results are similar to those of Maloney et al. [9] and Schmalzried et al. [11]. In our study, we adapted the two-approach technique, combining the ilioinguinal approach with the posterolateral approach. Through the ilioinguinal approach, we resected the pseudotumour in the iliac fossa and débrided the osteolytic lesion completely under direct vision via the inner ilium cortical window. We

then fully packed the morsellised allograft into the defect. Through the posterolateral approach, we débrided the granuloma around the joint and replaced the PE liner and femoral head. In some cases, some morsellised bone was packed into the osteolytic defect again through the dome hole of the acetabular cup. At a mean of 2.3 years of follow-up, all lesions treated with the two-approach technique and bone grafting showed evidence of healing. There was no osteolytic lesion progress or acetabular component loosening.

In conclusion, our results show that well-fixed acetabular cups can be successfully retained using osteolytic lesion débridement, morsellised allografting and PE-liner and femoral-head replacement via the two-approach technique. The prerequisite for using this technique is a stable, well-fixed cup in a reasonable position that can accept a new liner via its existing locking mechanism or through cementation of a new liner. The pseudotumour in the iliac fossa and the periacetabular OS can be resected and completely débrided under direct vision, and the osteolytic defect can be filled completely with morsellised allograft. Early results of the technique show bone stock restoration and neither lytic lesion progression nor cup loosening. Larger studies with longer follow-up periods are required to establish the long-term success of this technique.

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