Comparison of periacetabular osteotomy and total hip replacement in the same patient

A TWO-TO TEN-YEAR FOLLOW-UP STUDY

We evaluated 31 patients with bilateral dysplastic hips who had undergone periacetabular osteotomy for early (Tönnis grade 0 or 1) or moderate (Tönnis grade 2) osteoarthritis in one hip and total hip replacement for advanced (Tönnis grade 3) osteoarthritis in the other. At a mean follow-up of 5.5 years (2 to 9) after periacetabular osteotomy and 6.7 years (3 to 10) after total hip replacement, there was no difference in the functional outcome in hips undergoing osteotomy for early or moderate osteoarthritis and those with a total hip replacement, as determined by the Merle d'Aubigné and Postel score and the Western Ontario and McMaster Universities osteoarthritis index. More patients preferred the spherical periacetabular osteotomy to total hip replacement (53% vs 23%; p = 0.029).

Osteoarthritis secondary to hip dysplasia is often progressive. Given the results, timely correction of dysplasia by periacetabular osteotomy should be considered whenever possible in young patients since this could produce a favourable outcome which is comparable with that of total hip replacement.

Developmental dysplasia is a common cause of osteoarthritis (OA) of the hip.1-3 Although good long-term results have been recorded following total hip replacement (THR) in patients below the age of 50 years4,5 disappointing long-term results have been described in patients under 40 years of age.6,7

Periacetabular osteotomy was developed to reduce the consequences of hip dysplasia by surgical re-orientation of the acetabulum. Growing evidence suggests that timely correction of the deformity may prevent progressive destruction of the hip.8-12 However, periacetabular osteotomy is technically demanding and patients require a long period of rehabilitation.13-15 As yet it remains unclear as to how the clinical results compare with those obtained for THR, and the patients’ preference for either technique has not been determined. The lack of any direct comparison makes recommendation of the most appropriate procedure difficult in young adults with mild or moderate OA.16,17

We have therefore sought to determine if early correction of symptomatic hip dysplasia by periacetabular osteotomy would achieve a clinical outcome comparable with that of THR undertaken for the late stages of OA. In order to do this we compared the outcome in a group of patients who had been treated by periacetabular osteotomy for early or moderate OA in one hip with that of THR performed for advanced OA in the other.

Patients and Methods
Between July 1997 and November 2005, 155 consecutive patients (186 hips) with hip dysplasia were treated by periacetabular osteotomy at our institution. Retrospective review showed that 38 had also undergone THR for OA secondary to dysplasia in the contralateral hip. We excluded four patients whose THR had been performed elsewhere, one who was lost to follow-up before two years after operation, and two other patients who had undergone previous hip surgery before either the periacetabular osteotomy or THR, leaving 31 patients in the study. There were 26 women and five men with a mean age of 37.8 years (26 to 49) at the time of periacetabular osteotomy and 36.2 years (29 to 52) at the time of THR. Total hip replacement was performed before periacetabular osteotomy in 22 patients and a periacetabular osteotomy was performed first in the remainder.

All the operations were carried out by the senior surgeon (P-HH). The indication for surgery was progressive hip pain. The severity of the OA was assessed radiologically by the Tönnis classification system.18 All the hips selected for periacetabular osteotomy had been classified as having early (grade 0 or grade 1, 20) or
moderate OA (grade 2, 11). Those selected for THR had advanced OA (grade 3). Hips with a false acetabulum or those with a severe deformity which precluded a congruent correction were considered to be a contraindication for periacetabular osteotomy.

Operative techniques. The periacetabular osteotomy procedure is undertaken through a transtrochanteric approach and has been described in detail previously.11 In brief, the patient is placed in the lateral decubitus position under general anaesthesia, and the osteotomy is completed through a single longitudinal incision. The approach allows for bony cuts to be performed from outside the pelvis, and simultaneous arthroscopy of the hip enabling direct access to the intra-articular pathology to be made. The mobilised acetabular fragment is spherical in shape, which allows easy repositioning with minimal gap formation. The acetabular fragment is secured by three or four screws and the greater trochanter is stabilised by two 6.5 mm cancellous screws (Fig. 1).

The THR was performed through an anterolateral exposure with the patient under general or spinal anaesthesia. A cementless, metal-on-polyethylene prosthesis with a modular femoral head of 28 mm in diameter was used in all hips using either a Perfecta Hip System (Wright Medical Technology, Arlington, Tennessee, 28 hips) or a Versys Hip Prosthesis (Zimmer, Warsaw, Indiana, 3 hips).

Clinical and radiological analysis. Clinical and radiological assessment was undertaken at one, three and six months, at one year and then annually thereafter. Function was assessed pre-operatively and at the time of the most recent follow-up using the hip score of Merle d’Aubigné and Postel.19 The patients completed the Western Ontario and McMaster University (WOMAC) OA index questionnaires20 and indicated which procedure they preferred (Table I). This information was gathered by a nurse who was not involved in the care of the patients. The scores for the three domains of the WOMAC OA index (pain, stiffness, and function) were normalised so that the most positive state of health was represented by 100 and the most negative state of health by 0.

Four radiological indices were used to evaluate the correction after periacetabular osteotomy: the lateral centre-edge angle of Wiberg21 (normal, > 25°), the acetabular angle of Sharp22 (normal, < 42°),1 the percentage cover of the femoral head (normal, > 75%),1 and the anterior centre-edge angle of Lequesne and de Seze23 (normal, > 20°).

Table I. Details of the patient preference survey after bilateral hip surgery

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Please complete the following questions and return this form in the enclosed envelope.
1. Do you prefer the results of one of your hip surgery more than the other?
   ____ Yes  ____ No

2. If yes, which hip do you prefer?
   ____ Right  ____ Left

3. If you prefer one hip, why do you prefer that hip?
   ____ More physiological loading is allowed
   ____ Recovery after surgery was easier
   ____ Other reasons (Please explain) ____________________

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Anteroposterior radiographs of the pelvis of a 42-year-old woman with bilateral dysplastic hips showing a) a pre-operative view of advanced osteoarthritis (OA) (Tönnis grade 3) in the left hip and moderate OA (Tönnis grade 2) with a large acetabular cyst in the right hip and b) a post-operative view five years after total hip replacement and four years after periacetabular osteotomy, with a well-fixed prosthesis in the left hip and solid bony union with good joint congruity in the right hip (Tönnis grade 1).
The acetabular component of the THR was evaluated radiologically for loosening by assessment of a change in the component angle of > 3°, migration of > 5 mm or a complete radiolucency of > 1 mm in the three zones of DeLee and Charnley. The stability of the femoral component was evaluated according to the system developed by Engh, Massin and Suthers. Osteolysis was defined as any discrete area of endosteal scalloping adjacent to either the acetabular or femoral component visible on serial radiographs, but not on immediate post-operative films. Linear polyethylene wear was assessed by a computer-aided digitiser as described previously. Excessive wear was defined as wear of more than 0.2 mm per annum.

**Statistical analysis.** For comparisons between the two procedures, a two-tailed Student t-test or a non-parametric Mann-Whitney U test was used for numerical data and Fisher’s exact test for categorical data. Analysis of variance with a Bonferroni all pair-wise multiple comparison test was used to compare the functional outcome in hips undergoing periacetabular osteotomy for early or moderate OA, and those undergoing THR, according to the Merle d’Aubigné and Postel score and the three domains of the WOMAC osteoarthritis index. Statistical significance was set at p ≤ 0.05.

**Results**

Periacetabular osteotomy was associated with a longer operating time, an increased volume of blood transfusion, a longer hospital stay, and a longer time before discontinuing walking aids (Table II).

**Functional outcome.** Table III gives the functional outcome in hips undergoing periacetabular osteotomy for early or moderate OA and those undergoing THR. The pre-operative hip scores were highest in hips with early OA treated by periacetabular osteotomy, and lowest in those with advanced OA treated by THR (p = 0.002). After a mean follow-up of 5.5 years (2 to 9) for periacetabular osteotomy and of 6.7 years (3 to 10) for THR each group achieved major improvements over the pre-operative values (p < 0.001), but the post-operative hip scores at final follow-up and the three domains of the WOMAC osteoarthritis index did not significantly differ in the groups (Table III).

All patients except one completed the questionnaires. The unresponsive patient had satisfactory clinical and radiological results five years after THR and three years after periacetabular osteotomy. Of the 30 patients who completed the questionnaires on preference, 16 (53%) preferred periacetabular osteotomy, seven (23%) THR and seven (23%) had no preference (p = 0.029). All patients who preferred periacetabular osteotomy indicated that the procedure provided more physiological loading, but none preferred the early post-operative course after it. Two of the seven patients who preferred THR reported that it tolerated heavier loading than the osteotomy side, two stated that it allowed earlier recovery and three that it provided both advantages.

**Radiological outcome.** There was a significant post-operative improvement in all the radiological indices after periacetabular osteotomy (p < 0.001; Table IV). The Tönnis
grades of OA had improved in seven hips, remained unchanged in 23 and had deteriorated in one hip after periacetabular osteotomy (Table V).

In the THR group, a complete radiolucent line in one acetabular component necessitated revision for loosening four years after implantation. The femoral components showed bone ingrowth in 29 hips and stable fibrous fixation in two. No component had migrated into valgus or varus. The mean linear wear rate of the polyethylene insert was 0.12 mm/year (0.04 to 0.26). Excessive polyethylene wear was noted in seven hips (23%) and osteolysis in 12 (39%) (Fig. 2).

Complications. There were no cases of infection, neurovascular injury or deep-vein thrombosis (DVT). Two patients developed trochanteric bursitis after periacetabular osteotomy and required removal of the screws from the greater trochanter. Two had asymptomatic pubic nonunion requiring no additional surgery. No patient had symptoms of femoroacetabular impingement due to over-correction. Complications of THR included one patient with aseptic loosening of the acetabular component as described above. In one patient an intraoperative crack fracture of the calcar was treated by a cerclage wire. One patient had an early post-operative dislocation which was successfully treated by closed reduction without recurrence.

Discussion
The management of young active patients with symptomatic OA secondary to hip dysplasia is a major challenge. While periacetabular osteotomy is usually considered for early OA (Tönnis grade 0 to 2) to arrest or delay its progression,9–11 and THR is often required for advanced changes (Tönnis grade 3). The clinical results and patient preferences of an appropriately timed joint-preserving reconstruction, as opposed to prosthetic replacement, are not well understood. We found that at review at two to ten years post-operatively, periacetabular osteotomy led to similar functional results as those of THR. Both groups of patients showed marked improvement in the Merle d’Aubigné and Postel hip scores and most patients had high WOMAC scores in both hips. More patients preferred the outcome in the hips treated by periacetabular osteotomy to those treated by THR.

It is recognised that the indications for periacetabular osteotomy and THR are different, and hips undergoing periacetabular osteotomy usually have better pre-operative function than those requiring THR, making comparison between the two procedures difficult. Studies have shown that hip dysplasia, if left untreated, often progresses to the advanced stages of OA.1–3 Hasegawa et al,3 in an observational study of 86 untreated hips with dysplasia, noted that 66% of the hips with early OA developed advanced-stage OA within 7.8 years. We did not attempt to analyse the indications for both procedures. Our purpose was to determine if timely correction of symptomatic dysplastic hips by periacetabular osteotomy before OA progressed to advanced stages could achieve a clinical outcome comparable with that of THR.

Our findings contrast with the results of a recent study in which the outcome of 28 patients who were older than 40 years and who had undergone periacetabular osteotomy, were compared with 33 of the same age who had undergone THR.17 Although both procedures improved the quality-of-life in a high proportion of patients, patients who underwent THR had a significantly better outcome. These results are not surprising since complications were much more frequent in the osteotomy group; ten patients who had undergone periacetabular osteotomy had complications of varying severity, including nerve injury, nonunion, infection, disruption of the posterior column and DVT. Only one in the THR series had a superficial wound infection which resolved with antibiotics. Our series was carried out in a younger age group and there was a similar low incidence of minor complications in both groups and no major complications. In addition, all the patients underwent periacetabular osteotomy in one hip and THR in the other. We consider this method of comparison to be justifi-

| Table IV. Radiological results (mean, range) of periacetabular osteotomy |
|-----------------------------|-----------------------------|
| Lateral centre-edge angle (°) | Pre-operative 6 (-12 to +11) 31 (20 to 42) |
| Acetabular angle of Sharp (°) | 59 (50 to 68) 37 (32 to 43) |
| Femoral head coverage (%)     | 55 (38 to 62) 89 (80 to 100) |
| Anterior centre-edge angle (°) | 5 (-20 to +5) 28 (18 to 50) |

| Table V. Grades of osteoarthritis before and after periacetabular osteotomy at a mean follow-up of 5.5 years (2 to 9) according to the classification system of Tönnis,18 by number and percentage |
|-------------|----------|----------|----------|
| Grade       | 0        | 1        | 2        | 3        |
| Pre-operative | 5 (16.1) | 15 (48.4) | 11 (35.5) | 0        |
| At final follow-up | 8 (25.8) | 16 (51.6) | 6 (19.4)  | 1 (3.2)  |
able since factors such as gender, body-weight, level of activity, and emotional response were better controlled.

The findings of our study support the results of another recent report. Sharifi et al\textsuperscript{16} compared the health-related quality of life of patients undergoing periacetabular osteotomy and THR and found that periacetabular osteotomy was effective and preferable to THR in young patients with Tönnis grade-1 and grade-2 OA.

There are limitations which may have biased our results. First, the evaluation of the patients was retrospective which restricted the analysis to the small number of available patients. This may have had insufficient power to detect a minor difference between the two procedures. Further, the patients were not blinded to the procedures and they may have held preconceptions that the preserved natural hip would perform better than a THR. Therefore they may have pursued more aggressive rehabilitation and been prepared to tolerate heavier loads on the natural hip. Finally, the patient preference survey was carried out at a minimum of two years after the second hip operation, so that detailed comparison of early post-operative preference was not possible. Reduced preference would be expected for periacetabular osteotomy in the early post-operative period because of the long recovery time. Accordingly, we believe that the long-term patient satisfaction with the surgery is more important than the early perception.

Another limitation was the use of the Tönnis classification system to assess the severity of OA. This is no longer considered to be the most sensitive indicator of the extent of OA. A recent technique, the delayed gadolinium-enhanced magnetic imaging of cartilage, is more sensitive and analyses changes in glycosaminoglycan in the articular cartilage which may precede radiological changes.\textsuperscript{30}

The attractiveness of periacetabular osteotomy is the preservation of the natural joint with fewer limitations on physical activity. However, surgeons performing this procedure are concerned about the incidence of complications and the learning curve.\textsuperscript{6,13-15} This is an operation which should only be performed by suitably trained surgeons.

While THR is the standard treatment of end-stage OA with reliable relief from pain, the long-term outcome has been disappointing in young active patients.\textsuperscript{4} In our study at a mean follow-up of 6.7 years after THR, excessive wear was seen in seven hips and osteolysis in 12. Failure of the component due to wear of the polyethylene and osteolysis may become a major concern in the longer-term follow-up. Good long-term results have been reported following THR with acetabular graft augmentation in patients with OA secondary to dysplasia.\textsuperscript{31}

In regard to the bearing surface in THR other options include the use of highly cross-linked polyethylene liners,\textsuperscript{32} ceramic-on-ceramic bearings\textsuperscript{33} and metal-on-metal couples.\textsuperscript{34-36} These surfaces result in less wear debris, but long-term observation is still needed to determine the clinical benefits.\textsuperscript{37}

In summary, we found that joint-preserving periacetabular osteotomy could provide a favourable clinical outcome comparable with that of THR in matched-pair analysis in young active patients. Despite its increased surgical difficulty and longer recovery time, more patients preferred the outcome of periacetabular osteotomy to that of THR at two to ten years after surgery. These findings may provide some assistance in clinical decision-making in the treatment of young adults with symptomatic developmental dysplasia of the hip.
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.

References