A dual anteroposterior approach to the Bernese periacetabular osteotomy

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When the Bernese periacetabular osteotomy is performed through an anterior approach, the ischial and retroacetabular osteotomies and manual fracture of the incompletely osteotomised ischium are conducted with an incomplete view resulting in increased risk and morbidity. We have assessed the dual anteroposterior approach which appears to address this deficiency.

We compared the results of the Bernese periacetabular osteotomy performed in 11 patients (13 osteotomies) through a single anterior approach with those in 12 patients (13 osteotomies) in whom the procedure was carried out through a dual anteroposterior approach. The estimated blood loss, the length of anaesthesia, duration of surgery and radiological parameters were measured.

The mean operative time and length of anaesthesia were not significantly different in the two groups (p = 0.781 and p = 0.698, respectively). The radiological parameters improved to a similar extent in both groups after the operation but there was significantly less blood loss in the dual osteotomy group (p = 0.034).

The dual anteroposterior approach provides a direct view of the retro-acetabular and ischial parts of the osteotomy, within a reasonable operating time and with minimal blood loss and gives a satisfactory outcome.

The Bernese periacetabular osteotomy is an effective and widely used procedure for the treatment of acetabular dysplasia in young adults in which the acetabulum is re-orientated to improve its cover of the femoral head.

The surgical technique involves an ilioinguinal, direct anterior, modified Smith-Peterson or combined anteroposterior (AP) approach. However, the ischial and the retroacetabular or posterior-limb approaches and manual fracture of the incompletely osteotomised ischium are performed with an incomplete view resulting in increased risk and morbidity. By contrast, with the dual approach all the osteotomies are in full view. We have compared therefore the results, the operating times, blood loss and complications of the Bernese periacetabular osteotomy performed either through a modified ilioinguinal or a dual AP approach.

Patients and Methods
We retrospectively assessed our experience using a single anterior approach and a dual AP approach by means of database inquiry and the evaluation of radiographs. We excluded the first ten patients (11 procedures) since we believed that they reflected the learning experience of the senior author (HTK) for this difficult osteotomy. The remaining 23 patients had undergone the procedure between 2001 and 2008. A single anterior approach had been used in 11 patients (13 procedures, two of which were staged bilateral) referred to as group 1, between July 2001 and November 2006. The dual approach had been used in 12 patients (13 procedures, one of which was staged bilateral) referred to as group 2, between December 2004 and February 2008. All the operations had been performed by the senior author.

There were two male and nine female patients in group 1 with a mean age at the time of surgery of 21.6 years (15.0 to 30.0). In group 2 there were two male and ten female patients with a mean age at the time of surgery of 17.3 years (11.3 to 38.0). The mean age for both groups was 19.3 years (11.3 to 38.0). Between December 2004 and November 2006 when we were using both techniques there was no specific indication for the single or the dual approach. This was decided by consensus among the surgeon, residents and fellows. The only exception was in obese patients in whom...
the dual approach was preferred since it allowed direct visualisation of all the osteotomies. For patients undergoing the Bernese periacetabular osteotomy using two approaches, it had been explained in advance that they would have two scars. After the potential benefit of the dual approach had been explained no patient objected to the procedure on cosmetic grounds.

Clinical and radiological evaluation. The duration of the surgery and anaesthesia were recorded. The duration of surgery was measured from the start of the skin incision to the completion of skin closure. Perioperative blood loss was estimated on the basis of the volume of blood in the suction bottles and the weighing of the swabs. The pre- and post-operative AP pelvic radiographs were each assessed three times for the centre-edge angle of Wiberg,\textsuperscript{15} the acetabular angle of Sharp,\textsuperscript{16} and cover of the femoral head\textsuperscript{17} by an orthopaedic fellow (JSL), an associate professor (SJC) and a resident (SHW), and the mean value was calculated. In addition, the post-operative radiographs were examined for the presence of the cross-over sign\textsuperscript{18} which is indicative of acetabular retroversion.

Operative technique. In group 1, the osteotomy was performed through a modified ilioinguinal approach,\textsuperscript{13} with the patient in the supine position as described by Ganz et al.\textsuperscript{1}

In group 2 the patient was placed in the lateral position and supported by kidney rests before being draped with exposure of both the anterior and posterior aspects of the hip. It was important to have draping which allowed a change of position with free movement of the leg on the side undergoing surgery. After draping, the patient was then rotated into the supine position with the involved hip slightly elevated for the modified ilio-inguinal approach and was later moved to a lateral position for the Kocher-Langenbeck approach.\textsuperscript{19} Fluoroscopic evaluation was performed throughout the operation facilitated by the use of a radiolucent operating table.

The anterior skin incision began 5 cm to 6 cm above the anterior superior iliac spine and 1 cm below the iliac crest, and continued distally along the crest to the lateral aspect of the neurovascular bundle in the supine position. The fascia was incised through the ilio-inguinal approach,\textsuperscript{9,10} and the lateral femoral cutaneous nerve was isolated and carefully retracted. In order to allow transverse retraction of the soft tissues, the hip was maintained in a semiflexed position. Iliacus and iliopsoas were detached and rotated medially to expose the anterior aspect of the hip.

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An iliac osteotomy above the acetabulum was performed with the hip again kept in slight flexion and adduction. This osteotomy, consisting of two parts, was begun by scoring the inner table of the ilium with an osteotome before completion with an oscillating saw and/or osteotome, beginning just below the anterior superior iliac spine and proceeding to the rim of the pelvic inlet at a point 1 cm anterior from the margin of the posterior column, as seen from the medial aspect of the ilium. This corresponded to a point 1 cm above the greater sciatic notch as seen from the lateral aspect of the ilium through the posterior approach. The bone is at its widest at the level of the pelvic inlet. Care was taken not to damage the abductor muscles.

After the superior acetabular osteotomy the patient was changed from the supine to a lateral position to make a partial length Kocher-Langenbeck incision (Fig. 1). The
incision began 5 cm to 6 cm inferior to the posterior superior iliac spine and continued distally along the fibres of gluteus maximus but extended only to the level of the hip and did not reach the greater trochanter. The fascia was incised and the fibres of gluteus maximus split by blunt dissection and retracted, exposing the posterolateral aspect of the hip, which was still covered by the short external rotator muscles. Piriformis was preserved to mark the location of the posterior aspect of the acetabulum, with the hip internally rotated. The anastomosis between the inferior gluteal and the deep branches of the medial circumflex artery could be identified just superficial and distal to the tendon of piriformis. When tenotomy of the external rotators was necessary, the deep branch of the medial circumflex artery, running along the inferior border of the tendon of obturator externus was protected to reduce the risk of avascular necrosis of the femoral head. The sciatic nerve was protected by a retractor placed at the greater or lesser sciatic notch. Sufficient exposure of the posterior column could be obtained with less extensive division of the external rotators. The extent of division depended on the tightness of the soft tissue. The gemelli and obturator internus were exposed and partially divided and, if desired, the tendon of piriformis was divided at its insertion on the femur. Using interrupted sutures we reattached these structures to the greater trochanter or to the adjacent soft tissue when the attachment of muscles to the greater trochanter was insufficient. This posterior access afforded direct vision of the posterior column of the acetabulum and the ischium after periosteal dissection.

The third step (Fig 2) was a retroacetabular osteotomy without the aid of image intensification, which was performed with an oscillating saw and/or osteotome on the outer cortex beginning 1 cm above the ischial spine and continuing at a trajectory of 45° to the ground (with the patient in a true lateral position) above the greater sciatic notch. Throughout, the osteotomy was maintained 1 cm away from the margin of the posterior column as seen from both the anterior and posterior approaches. The accuracy of the 45° retroacetabular osteotomy was ensured by observation of the posterior aspect of the acetabulum and by frequent manual palpation of the line of the osteotomy on the anterior aspect of the posterior column, either through the anterior or the posterior approach. When the retroacetabular osteotomy was completed, it connected with the superior acetabular osteotomy at a point 1 cm above the greater sciatic notch. The end of the superior acetabular osteotomy could be seen directly, or palpated through the posterior approach. When the posterior skin incision was too inferior, more subperiosteal dissection on the outer cortex of the ilium and forceful upward traction of the gluteal muscles were required.

The fourth step (Fig 3) was a complete ischial osteotomy starting from the inferior margin of the retroacetabular osteotomy along the infracotyloid groove, from its postero-superior to its anteroinferior aspect, maintaining an angle of 120° with the retroacetabular osteotomy. The anteromedial outlet of the osteotomy was directed slightly inferiorly to the posterolateral inlet to avoid the osteotomy penetrating the joint. A retractor was placed in the medial aspect of the acetabulum to prevent soft-tissue damage during the ischial osteotomy. As with the retroacetabular osteotomy, it was safer to use the oscillating saw for the near cortex and then the osteotome to complete the osteotomy of the far cortex of the ischium.

The completion of all the osteotomies was confirmed by ensuring that the acetabulum could be moved with the osteotome placed in the osteotomy gap with the patient in the lateral position. The patient was then tilted back into the supine position again for mobilisation of the
acetabulum using a 5 mm Schanz screw (Synthes-Mathys, Bettlach, Switzerland) placed into the superior aspect of the osteotomised acetabulum as a lever. A Kirschner (K)-wire was inserted at the anterior superior iliac spine, parallel to the Schanz screw before any manipulation to act as a reference point for the amount of correction required. It was confirmed that the pelvis was horizontal by observing that the obturator foramina had the same shape when viewed with the image intensifier. The acetabular fragment was then rotated using a combination of bone-holding forceps, a bone hook, laminar spread and the inserted Schanz screw. After preliminary fixation of the fragment with K-wires, the range of movement of the hip, especially flexion and rotation, was tested, and if necessary improved by correcting the position of the acetabular fragment. The correct re-orientation was then confirmed fluoroscopically. When the acetabulum was not retroverted, the contour of the anterior and the posterior acetabular margins met proximally exactly at the most lateral point of the acetabular roof and the line of the anterior rim was medial to the posterior rim. Additionally, we aimed for the sourcil of the acetabulum to be horizontal after re-orientation.

Final fixation of the fragment to the ilium was achieved using two or three 4.5 mm cortical screws placed in the superior acetabular area (Fig. 4). Any unnecessarily protruding bony portion of the rotated acetabulum, usually the rotated part of the bone near the anterior superior iliac spine, was trimmed and used for bone graft, either at the superior pubic ramus when the gap was large or in the superior acetabular osteotomy area. A 3.5 mm cortical screw was used to reattach the osteotomy of the anterior superior iliac spine. In a few cases, the obliquely placed long cortical screws used for fixation of the re-orientated acetabulum prevented the use of the 3.5 mm cortical screw, in which case wire was used in place of the latter.

**Statistical analysis.** We used an independent samples t-test to compare the surgical parameters between the groups. A p-value ≤ 0.05 was considered to be statistically significant.

**Results**

The blood loss, length of anaesthesia and operating time for both groups are given in Table I. The length of anaesthesia and the operating time were similar, but there was a significant difference in the estimated blood loss which was much lower in group 2 (p = 0.034).

**Radiological evaluation.** Both the pre-operative values of the three radiological parameters measured and the
corrections achieved were similar for both groups (Table II). For both techniques there was a significant improvement in all parameters \( p < 0.05 \). Table II also shows the numbers of patients in both groups with positive and negative cross-over signs, both pre- and post-operatively. All patients with positive signs before surgery were also positive post-operatively, while a few pre-operatively negative hips were also positive after surgery.

**Discussion**

The Bernese periacetabular osteotomy is a technically demanding procedure in which misplaced partially obscured osteotomies can lead to failure of the operation. Nevertheless it is well accepted in the treatment of dysplastic hips.\(^1,7,10-12,14,21\) Generally, a single anterior approach such as the ilioinguinal,\(^9,10\) the modified Smith-Peterson\(^8,10-12\) or the direct anterior approach\(^10-13\) is followed, but there is the risk of complications such as intra-articular extension of the osteotomy or posterior-column fracture.\(^1,4\)

In our early experience of this osteotomy using a single anterior approach, we experienced great difficulty in making the blind or semiblind cuts, and encountered some posterior-column fractures and intra-articular extensions. In order to overcome this, we began to use a dual AP approach, requiring an additional 1.5 hours of operating time. Some authors have found that a dual approach required an additional 1.5 hours of operating time.\(^10\)

In our study we found that the mean length of anaesthesia and operating time were not significantly different in the two groups, which we attributed to the direct view of deep pelvic structures through the posterior approach, allowing easier and quicker retroacetabular and ischial osteotomies. The time taken to change the position of the patient using the dual approach was compensated for by the faster and more accurate osteotomies which it allowed. The time required for the surgery depended mostly on the surgeon’s experience. Our mean operating time was around 4.5 hours for both groups, but as we gained more experience, this has decreased and is now about three hours.

Despite our efforts to the contrary, acetabular retroversion, indicated by a positive cross-over sign,\(^18\) was found in both groups. This is not directly related to the surgical approach but is associated with the positioning of the osteotomised acetabulum and to fluoroscopic problems after completion of the osteotomies. Great care needs to be paid to the acetabular repositioning.

We cannot over-emphasise that regardless of the approach, there is a learning curve for the Bernese periacetabular osteotomy which requires considerable experience before proficiency is attained.\(^1,22-24\) We recognise the limitations in our study with its retrospective nature and some differences in the mean age of the groups. In addition, when the dual AP approach was adopted, the senior author had already performed 22 Bernese periacetabular osteotomies using the single-incision approach.

It is recognised that detachment of the external rotators at their insertion on the femur can disrupt the deep branch of the medial circumflex artery which may compromise the vascularity of the femoral head.\(^20\) In order to avoid this we identified the trochanteric branch of the medial circumflex artery before incising the muscles 1.5 cm to 2 cm from the trochanteric crest, where the deep branch runs at the inferior border of the tendon of obturator externus.

Our results suggest that the dual AP approach, by providing a direct view for each part of the periacetabular osteotomy allows safe accurate osteotomies in a reasonable operative time, with minimal blood loss and a satisfactory outcome.

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**