Total hip arthroplasty with a sliding iliac graft for acetabular dysplasia

We describe a new technique of reconstruction of the deficient acetabulum in cementless total hip arthroplasty. The outer iliac table just above the deficient acetabulum is osteotomised and slid downwards. We have termed this an iliac sliding graft. Between October 1997 and November 2001, cementless total hip arthroplasty with an iliac sliding graft was performed on 19 patients (19 hips) with acetabular dysplasia. The mean follow-up was 3.4 years (2 to 6).

The mean pre-operative Harris hip score was 45.1 which improved significantly to 85.3 at the time of the final follow-up. No patient had post-operative abductor dysfunction. Incorporation of the graft was seen after two to three months in all patients. Resorption of the graft and radiolucencies were infrequent. This technique is a useful alternative to femoral head autografting when the patient’s own femoral head cannot be used.

Total hip arthroplasty (THA) in patients with acetabular dysplasia presents technical difficulties as the dysplasia complicates the insertion of an acetabular component. Therefore, various techniques for achieving adequate bone cover and stability of the acetabular component have been devised, such as a small cup placed in a superior position,1,2 fracture or perforation of the medial wall3-5 (the protrusio technique) and lateral bulk bone grafting.6-13 The last has the advantage of restoring the normal anatomy, leg length and bone stock for future revision surgery.

Femoral head autografts have been widely used for reconstruction of the deficient acetabulum in THA.6-13 However, the patient’s own femoral head sometimes cannot be used because of inadequate strength or size. Although femoral head allografts have also been used in THA, many authors have reported their inferiority compared with autografts.13-15 The long-term results of femoral head autografting in THA have varied.6-13 The risk of failure of the fixation of an acetabular component is affected by how well it is covered by graft.11-13 Large structural grafts incorporate slowly and incompletely.16,17 They cannot, therefore, remodel and repair themselves in response to the fatigue of movement under a cyclical load, which ultimately results in the failure of a THA.

We have developed a new autografting technique without using the femoral head for the deficient acetabulum to achieve rapid and complete incorporation of the graft, which we have termed an iliac sliding graft. We now describe this technique and the early clinical results in primary cementless THA.

Patients and Methods
Between October 1997 and November 2001, we performed 19 primary cementless THAs on 19 patients using an iliac sliding graft. In all patients the diagnosis was osteoarthritis of the hip secondary to acetabular dysplasia. No patient had undergone any previous surgery on the hip. There were two men and 17 women with a mean age at the time of operation of 58 years (44 to 74). The mean duration of follow-up was 3.4 years (2 to 6); and no patient was lost to follow-up.

Operative technique. All operations were performed by or under the supervision of the senior author (TK). The direct lateral approach was used in all patients18 without a trochanteric osteotomy. The need for an iliac sliding graft is noted on the pre-operative radiographs, but the final decision is made at the time of operation. If more than 10 mm of the superolateral portion of the acetabular component cannot be contained by bone after the acetabulum has been reamed down to subchondral bone, the decision to use this technique is made. Figure 1 shows details of the technique. A small area of the outer iliac surface just above the deficient acetabulum is
exposed subperiosteally. Leaving the anterior border of the ilium intact, a rectangular osteotomy is made with an oscillating saw and an osteotome. Great care is taken not to cut the medial cortex of the ilium. After the outlined outer table of the ilium is separated from the medial cortex, it is slid down to the level of the superolateral acetabular rim. The graft is fixed with two AO cancellous screws (Robert Mathys, Bern, Switzerland). The size of the graft is about 30 mm to 40 mm long, 30 mm to 40 mm wide and 12 mm to 14 mm thick. An acetabular reamer is used to shape the graft until it is congruent with the acetabular rim. In all patients, a cementless, hydroxyapatite-coated hemispherical acetabular component (AMS; Kyocera, Kyoto, Japan) was secured with two to four screws. With increasing experience we have made the technique of the iliac sliding graft less invasive, leaving the soft tissues, including gluteus minimus, attached to the outer iliac surface (Fig. 2). Gluteus minimus, covering the iliac surface, is carefully elevated without detachment. After placing Kirchner wires at two proximal corners of the outline of the rectangular osteotomy, a transverse osteotomy is completed by multiple drilling between these two wires through the deep layer of gluteus minimus. A longitudinal osteotomy is performed by splitting the deep layer of gluteus minimus in the direction of its fibres. Great care is taken not to retract or incise the superficial layer of the muscle too proximally in order to avoid damage to the superior gluteal nerve. We performed this latter procedure in six hips.

After removal of the suction drains two days after operation, wheelchair transfer was allowed with partial weight-bearing at two weeks after surgery and full weight-bearing two to three weeks later.

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Diagrams showing the lateral view of the iliac sliding graft. Figure 1a – Acetabular dysplasia and a superolateral bone defect. Figure 1b – Osteotomy of the iliac outer table above the deficient acetabulum. Figure 1c – The reconstructed acetabulum with the graft.

Diagrams showing the anteroposterior (AP) view of the sliding iliac graft without soft-tissue detachment. Figure 2a – A proximal transverse osteotomy is made by multiple drilling through the deep layer of gluteus minimus intact. Figures 2b and 2c – The iliac sliding osteotomy leaving the attachment of the deep layer of gluteus minimus intact. Figure 2d – The acetabular component is contained by the reconstructed acetabulum.
Methods of evaluation. Clinical and radiological assessments were performed pre-operatively and then at one, two, three and six months, and annually thereafter. For clinical evaluation, we assigned a Harris hip score\(^ {19} \) and measured abductor strength (0, zero; 1, trace; 2, poor; 3, fair; 4, good; 5, normal)\(^ {20} \) and checked for the Trendelenburg sign.

Pre-operative radiographs were reviewed to determine the severity of acetabular dysplasia. According to the classification of Crowe, Mani and Ranawat,\(^ {21} \) nine hips (47.4%) were in group I; five (26.3%) in group II; and five (26.3%) in group III. The mean acetabular head index\(^ {22} \) was 53.9% (38.6 to 76.3).

The immediate post-operative radiographs were assessed to determine any lengthening of the affected limb, the inclination angle of the acetabular component and the amount of cover of the acetabular component by the graft. This latter value was expressed as a percentage of the horizontal distance between the most medial point and the lateral edge of the acetabular component. On serial post-operative radiographs, the inclination angle of the acetabular component, the vertical and horizontal migration of the acetabular component,\(^ {23} \) the incorporation of the graft, resorption, and radiolucencies were assessed. Incorporation of the graft was inferred by the disappearance of the graft-host interface and, when visible, the appearance of bridging trabeculae across this interface.\(^ {14,24} \) Resorption of the graft was graded as minor (less than one-third of the graft), moderate (one-third to one-half), and major (more than one-half).\(^ {25} \) Radiolucencies were evaluated using the three zones of DeLee and Charnley.\(^ {26} \)
autografts used in cementless THA were incorporated at less THA with bone graft.

Results
There was one dislocation two weeks after operation which required closed reduction. No revision operations were carried out. No patient had deep infection, nerve palsy, symptomatic deep-vein thrombosis or pulmonary embolism. The mean pre-operative Harris hip score was 45.1 (30 to 71) which improved significantly to 85.3 (68 to 100) at the time of final follow-up.

Before surgery, 12 of the 19 hips had an abductor strength of 4/5 or greater. Six months after surgery, all patients had an abductor strength graded 4/5 or greater. The Trendelenburg sign was positive in 13 of the 19 hips before surgery, but negative in all hips by one year.

The mean limb lengthening was 20.3 ± 7.3 mm (8 to 32). The mean inclination angle of the acetabular component was 43.5 ± 7.2° (33 to 58) and the mean cover of the acetabular component by the graft was 28.7 ± 3.8% (22.0 to 34.9).

The most recent radiographs did not indicate any vertical or horizontal migration > 2 mm, or change in the inclination angle > 3°. In three hips, the host-graft interface was not visible on either the immediate post-operative or follow-up radiographs. In the remaining 16 hips, incorporation of the graft was seen two to three months after operation (Fig. 3). Resorption of the graft and radiolucencies were infrequent. Resorption was minor in one hip only. One hip had radioluencies less than 2 mm in zone 1 only. No resorption or radiolucency was seen in patients who underwent an osteotomy with the soft tissues attached to the iliac outer surface.

Discussion
While several long-term studies of the use of cemented THA with bone graft have been reported, there has to our knowledge, been only one long-term study into cementless THA with bone graft. The authors reported a high rate of failure, despite the small cover of the graft (mean 20.0%) with loosening of the cup in 18 of 36 hips (50%) and revision surgery in 7 of 36 hips (19.4%). Although the short- and mid-term results of cementless THA with a bone graft have been encouraging and similar to those of cemented THA with a bone graft, the long-term results may be worse than those for cemented THA with a bone graft. We believe that rapid and complete incorporation of the graft in cementless THA is more important than in cemented THA since there is no cement to provide early fixation. The acetabular component should be biologically fixed not only to the host bone but also to the graft in cementless THA.

Large structural grafts incorporate slowly and incompletely. Hasegawa et al reported that femoral head autografts used in cementless THA were incorporated at seven months and continued to remodel for more than 18 months after operation. Clarke et al reported that the mean time to incorporation of femoral head autografts was 12 months. Although radiological review of incorporation of the graft may be difficult and unreliable, our results showed that all grafts were incorporated rapidly (within three months). The principal determinants are stability of the construct and contact between the host bone and the graft. We believe that the reasons for the rapid incorporation in our study were intimate host-graft contact and rigid stability. Furthermore, since the graft was biologically active because of rapid incorporation, there was little resorption and few radioluencies.

There are a few reports of a pedicled bone graft for acetabular reconstruction in THA. Theoretically, formation of new bone by the graft and host can lead to more rapid incorporation of the graft and remodelling, since most of the osteocytes in the graft survive. However, this procedure is technically demanding and more invasive. Its use may be limited to primary THA for the severely dysplastic hip or revision THA. We think that our procedure maintains the blood flow of the graft because detachment of soft tissues is avoided. It will be necessary to study the blood flow of the grafts at a later date.

The superior gluteal nerve and its branches are at risk during this procedure. Injury to the nerve can result in post-operative abductor dysfunction. Although further examination including electromyographic and radiological studies will be necessary to quantify nerve injury, our clinical results showed that no patient had post-operative abductor dysfunction. With care, this technique can be performed safely without damage to the superior gluteal nerve.

The relative advantages of an iliac sliding graft include intimate host-graft contact and rigid stability of the graft compared with a femoral head autograft. Since the anterior, medial and posterior surfaces of the graft make contact with the host bone, it fits well. Cortical bone of the iliac outer table provides a better base for the fixation of screws. Furthermore, since this technique has no relation to the availability of the femoral head autograft, it may have greater significance in revision THA than in primary THA.

The disadvantage of the iliac sliding graft is its limited availability. The thickness of the graft is limited to 12 mm to 14 mm. On the other hand, a thin graft is expected to incorporate rapidly, which is an advantage. An additional method may be needed if sufficient bony cover of the acetabular component is not achieved. We now use the iliac sliding graft in combination with the medial protrusio technique in THA for severely dysplastic hips.

Our study has shown that acetabular reconstruction with iliac sliding grafts in cementless THA can reconstruct the deficient superolateral rim of the acetabulum and offer intimate host-graft contact and rigid stability which allow rapid incorporation of the graft. From this study alone, we cannot conclude that this procedure can take the place of femoral head autografting in primary THA. However,
when the patient’s own femoral head cannot be used because of revision THA or its inadequate strength or size even in primary THA, this technique is a useful alternative.

A longer term follow-up study is necessary to determine its ultimate outcome.

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References


