Congenital dislocation of the hip
A RE-APPRAISAL OF THE UPPER AGE LIMIT FOR TREATMENT

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Difficulties posed in managing developmental dysplasia of the hip diagnosed late include a high-placed femoral head, contracted soft tissues and a dysplastic acetabulum. A combination of open reduction with femoral shortening of untreated congenital dislocations is a well-established practice. Femoral shortening prevents excessive pressure on the located femoral head which can cause avascular necrosis. Instability due to a coexisting dysplastic shallow acetabulum is common, and so a pelvic osteotomy is performed to achieve a stable and concentric hip reduction. We retrospectively reviewed 15 patients (18 hips) presenting with developmental dysplasia of the hip aged four years and above who were treated by a one-stage combined procedure performed by the senior author. The mean age at operation was five years and nine months (4 years to 11 years). The mean follow-up was six years ten months (2 years and 8 months to 8 years and 8 months). All patients were followed clinically and radiologically in accordance with McKay’s criteria and the modified Severin classification. According to the McKay criteria, 12 hips were rated excellent and six were good. All but one had a full range of movement. Eight had a limb-length discrepancy of about 1 cm. All were Trendelenburg negative. The modified Severin classification demonstrated four hips of grade IA, six of grade IB, and eight of grade II. One patient had avascular necrosis and one an early subluxation requiring revision.

One-stage correction of congenital dislocation of the hip in an older child is a safe and effective treatment with good results in the short to medium term.

In countries outside Germany-speaking Europe, where ultrasound is a statutory requirement in the newborn, the prompt detection and treatment of developmental dysplasia of the hip (DDH) remains an unsolved problem. Clinical examination has been shown to be insufficiently reliable, and many children continue to present at a later age with dislocation, often noticed when they start to walk. The principal problems in the management of dislocations that are diagnosed late are a high femoral head, contracted soft tissues and a dysplastic acetabulum. A combination of open reduction with femoral shortening is now a well-established practice in previously untreated congenital dislocations and avoids the need for prolonged pre-operative traction. Femoral shortening helps prevent excessive pressure on the femoral head when it is relocated in the acetabulum, which may predispose to avascular necrosis. The relocated hip is often very unstable owing to a dysplastic shallow acetabulum, and a pelvic operation is required to achieve stable and concentric reduction of the hip. The theoretical advantages of a one-stage operation for DDH include a short hospital stay with no need for long or repeated immobilisation, and decreased joint stiffness. The challenge for the surgeon lies in achieving and maintaining a stable concentric relocation to give painless function and a durable hip in the older child and adult.

This paper describes the results of a single-stage combined procedure for DDH presenting late in children aged four years and over at the time of surgery.

Materials and Methods
We retrospectively reviewed 15 consecutive patients (18 hips) aged four years and above presenting with DDH between 1996 and 2003 who were treated by a single-stage combined procedure by the senior author (JNO). Children who had cerebral palsy and rarer associated syndromes were excluded.

All the children had CT or MRI with anteroposterior views of the femora. Careful attention was paid to the angle of anteverision of the outermost edge of the acetabulum to avoid the possibility of producing retroversion of the edge of the acetabulum after operation.
The procedure consisted of an arthrotomy, excision of the excess capsule with secure repair, femoral shortening with normalisation of anteversion (rarely was any varus used), and a Tonnis acetabuloplasty. Preliminary traction was not used. Two separate skin incisions were made.

**Femoral shortening.** After the induction of anaesthesia the hip was examined under image intensification to establish the gap in Shenton's line under the most gentle traction necessary to bring the leg into extension with no abduction. The femur was then shortened by this measured distance and the anteversion adjusted to 20°, as judged from the pre-operative CT scans. The upper two or three holes of the plate were fixed immediately below the attachment of the vastus lateralis. The plate was elevated and the bone divided below the most inferior drilled screw-hole, which was always below the lesser trochanter. The distal cut was started but left incomplete until the oblique cut had been made at about 45° to produce two wedges for acetabuloplasty. The cross-sectional orientation of the usually oval femur was carefully verified before undertaking the oblique cut, so as not to produce unduly long or short wedges. In two older children (three hips) the cylinder was resected as one piece and pre-drilled over the narrow diameter with two 4.5 mm holes. It was then turned through 90° and inserted into the site of the acetabuloplasty so as to provide accurate, intra-operative adjustment of acetabular correction and leg length. In the two cases where there was some valgus, simple placement of a straight plate on to the outwardly flared upper femur provided excellent correction. The osteotomy was fixed with a four- or five-hole...
plate and, after the first five cases, the lateral wound was closed.

**Surgery to the joint.** The hip was exposed through a Salter approach with release of the psoas, medial capsule, transverse ligament and ligamentum teres. The labrum never proved to be an obstruction to concentric relocation and was ignored. The whole capsule was carefully mobilised away from the abductors, the side of the pelvis and the false acetabulum using a Cobb periosteal elevator. With the head placed in the socket, the amount of capsule to be removed was estimated. An ellipse of about 3 cm x 2 cm was usually excised. Four or five No. 2 Vicryl sutures on a J-shaped needle were then inserted to repair the capsule, with careful attention paid to the complete closure of any posterior gap. The sutures were temporarily pulled tight with the hip in extension but no abduction, to check the apposition, but not tied until the acetabuloplasty was completed.

The Tonnis acetabuloplasty\(^8\) was chosen to stabilise the hip and provide proper femoral head cover, as it did not alter acetabular anteversion, which was found to be within the normal range in these older-presenting hips. The acetabuloplasty cut was started in the outer table, 8 mm to 10 mm above the sourcil with an oscillating saw (Compact Air Drive, Synthes, Welwyn Garden City, United Kingdom) set the narrowest cutting width under image intensifier control. Once the correct plane was established with the saw, the extension to the quadrilateral plate and the triradiate cartilage was carried out with a 2 cm wide osteotome. The aim was for the roof of the acetabulum to hinge on the posterior two-thirds of the triradiate cartilage in the anteroposterior axis on the quadrilateral plate. Particular attention was paid to the completeness of the posterior corner at the sciatic notch. Final mobilisation of the bone and stretching of the soft tissues were performed with a broad flat osteotome, either 3 cm or 4 cm wide, inserted the whole way down to the triradiate cartilage. The gap was opened and held with a laminar spreader. The bone wedges were overdrilled with a 3.5 mm or 4.5 mm drill and introduced, longer side downwards, into the gap mounted on a (Synthes) drill guide incorporating a reducing sleeve and a blunt shoulder. This facilitated accurate introduction and impaction. The final position of impaction was determined by the correction seen on the image intensifier. The aim was to make the sourcil horizontal, allowing for a little subsidence of the bone wedges proximally into the ilium post-operatively. Usually the wedges proved stable. Occasionally a guide wire from the inside of the iliac crest was necessary to transfix them temporarily while they were definitively fixed with the 3.5 mm or 4.5 mm screws. In one bilateral case (aged ten) both sides were treated at the same time. In the others the second side was treated two weeks after the first operation, thereby minimising the period of immobilisation. Initially all patients were immobilised in broomstick plasters for a period of six weeks. With accumulated confidence, the four children over eight years old were not immobilised but treated in the manner of unstable hip replacements, with an abduction wedge and protected weight-bearing with crutches for six weeks. All were readmitted as a day case at six weeks for plaster removal and stability check. The four patients treated with an abduction wedge were also admitted for a stability check. The internal fixation was removed after bony union had been achieved (Figs 1 and 2).

All the patients were followed up clinically and radiologically in accordance with the modified McKay criteria\(^8\) (Table I) and modified Severin classification\(^10\) (Table II), respectively. Attention was paid to any limb-length discrepancy that might have resulted from over-shortening of the femur. The radiographs were evaluated for evidence of avascular necrosis, the severity of which was graded according to Kalamchi and MacEwen\(^11\) (Table III).
One child who developed avascular necrosis, had restriction of internal rotation but the remainder had no significant limitation of movement. None had a Trendelenburg limp. In the bilateral cases the leg lengths were all within 1 cm of each other. However, a discrepancy of up to 1.5 cm (mean < 1 cm) was noted in eight unilateral cases, despite verification of leg lengths at operation using an image intensifier. This was noticed by patients or parents in only two cases.

Complications. Resubluxation occurred on the left side after six weeks in one of the bilateral cases (Fig. 3). The operations were carried out at six years of age and were staged two weeks apart. There were problems with parental co-operation and with the patient’s obesity. An interlocking triple pelvic osteotomy was undertaken promptly. The hips remain stable and are free of symptoms. The left is of marginally better radiological appearance than the right at the age of 13 years. Another hip required an internal rotation osteotomy six years after the initial operation, as anteversion had not been correctly adjusted at the initial operation. There were no problems with fixation, loss of position, bony union or failure of the internal fixation. Two fractures of the distal femur occurred at ten weeks and seven months post-operatively following falls. These were virtually undisplaced and were treated conservatively with an uneventual recovery.

Avascular necrosis. One hip developed avascular necrosis (AVN) of the head of femur, grade IV severity as classified by Kalamchi and MacEwen.11 After eight years the child remains asymptomatic with good function, despite the development of coxa magna and coxa vara (Fig. 4). The leg lengths remain equal. It is presumed that the femur was not shortened enough and that excessive pressure was put on the proximal physis.

Discussion
The aim of treatment of DDH is to achieve a stable and concentrically-located joint and satisfactory development of the hip. In general, it is held that the ease of treatment and the outcome are inversely related to the age at presentation. Dislocations presenting later than four years of age

### Table I. Modified McKay criteria

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<th>Level</th>
<th>Description</th>
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<tr>
<td>Excellent</td>
<td>Stable, painless hip, no limp, negative Trendelenburg sign, and a full range of movement</td>
</tr>
<tr>
<td>Good</td>
<td>Stable, painless hip, slight limp, negative Trendelenburg sign, and a slight decrease in range of movement</td>
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<tr>
<td>Fair</td>
<td>Stable, painless hip, limp, positive Trendelenburg sign, and limitation of movement</td>
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<tr>
<td>Poor</td>
<td>Unstable or painful hip, or both; positive Trendelenburg sign</td>
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* CE, centre-edge

### Table II. Modified Severin classification

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<tr>
<td>Excellent</td>
<td>IA CE angle &gt; 19˚, age 6 to 13 years; CE angle &gt; 25˚, age &gt; 14 years</td>
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<td>Good</td>
<td>IB CE angle 15˚ to 19˚, age 6 to 13 years; CE angle 20˚ to 25˚, age &gt; 14 years; II Moderate deformity of femoral head, femoral neck or acetabulum but otherwise same as grade I</td>
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<tr>
<td>Fair</td>
<td>III Dysplastic hip, no subluxation; CE angle &lt; 20˚, age &gt; 14 years</td>
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<tr>
<td>Poor</td>
<td>IV Subluxation; V Femoral head in false acetabulum; VI Redislocation</td>
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* CE, centre-edge

### Table III. Kalamchi and MacEwen’s classification of avascular necrosis of the hip

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<th>Group</th>
<th>Description</th>
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<td>Group I</td>
<td>Failure of appearance of the ossific nucleus during the first year after reduction; Broadening of the femoral neck during the year after reduction; Increased radiographic density followed by fragmentation; Residual deformity after re-ossification is complete; Present of persistent stiffness after cast removal even without radiological criteria may be the earliest sign of ischaemic necrosis</td>
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<td>Group II</td>
<td>Damage of the lateral aspect of the growth plate is the principal characteristic of this group; Radiographs show lateral physeal bridging, and a lateral metaphyseal notch or defect; Patients in this group develop subcapital coxa valga, with a tendency to have poor acetabular coverage</td>
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<tr>
<td>Group III</td>
<td>Damage of the physis with a large central defect; Commonly, patients develop a short femoral neck without varus or valgus; Relative ‘overgrowth’ of the greater trochanter and limb-length discrepancy are the principal problem</td>
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<tr>
<td>Group IV</td>
<td>Damage to the entire femoral head and physis are characteristic of this group; Irregular femoral head with varus, flattening, and coxa magna; ‘Overgrowth’ of the greater trochanter, limb-length inequality, and subsequent early arthritis are the principal complications</td>
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Figure 3a – Radiograph of a girl aged 6 years and 8 months with bilateral dysplasia of the hip. Figure 3b – MRI measuring the anteversion angles. Figure 3c – Radiograph two weeks after operation. Figure 3d – Radiograph six weeks after operation, showing subluxation of the left hip. Figure 3e – Radiograph after left triple pelvic osteotomy. Figure 3f – Radiograph at final follow-up in 2005, aged 13 years.
may present potentially insurmountable difficulties. Many surgeons are reluctant to consider any treatment in children of this age because of the risk of misadventure, the development of untreatable complications and the uncertainty as to whether a durable or radiologically normal hip will be obtained at maturity. Many bilateral dislocations are left untreated at this age, as they function well and may do so for up to three decades before needing hip replacement.

Pre-operative traction has been advocated in many studies in order to pull the head of the femur down gradually and to avoid excessive pressure on the head after operation, thereby reducing the risk of AVN. We have found that the single-stage approach without preliminary traction has led to a very low incidence of AVN, with excellent patient satisfaction and clinically acceptable results.

We have shown that, at least in the short to medium term, a very satisfactory functional and radiological outcome is readily achieved in this group of patients. Left untreated, DDH will produce limping, pain, stiffness, and finally progressive disability. There is also an incalculable social and psychological cost.

The most important aspect of the operation is to shorten the femur adequately: too much is often better than too little. After shortening, an image intensifier view should show that the head is almost reducible, except for the tight medial capsule and transverse ligament. Once these are released, the head should easily reduce into the socket. The remainder of the operation is devoted to stabilising the relocated head. In this age group the acetabulum does not have excessive anteversion. Salter and Pemberton operations are contraindicated. The acetabuloplasty described provides appropriate correction in the lateral plane only. We believe that it is particularly important to excise the redundant sac and repair the capsule, especially posteriorly.

None of our patients was regarded as anything less than good according to the modified McKay criteria. The CE angle averaged 38° at final follow-up. This improved the overall cover of the femoral head as determined by the final Severin classification grading, coupled with acetabular indices well within normal limits. The sphericity of the head and the congruity of the hip joint at skeletal maturity is a good predictor of long-term outcome. However, all the children in our series were skeletally immature at the final follow-up.

Our complication rate was low, but there were four cases of ipsilateral overgrowth. We expect these discrepancies to become less noticeable at maturity. We continue to observe our single child with AVN eight years after the primary procedure. He continues to function well, despite the development of coxa vara.

We believe that older children presenting with unilateral or bilateral dislocation of the hip should be treated, unless there is an underlying disorder that would contraindicate operation. The complications are only occasional and easily managed. The outcomes have been satisfactory.

Supplementary Material

A further opinion by Mr Andrew Wainwright is available with the electronic version of this paper on our website at www.jbjs.org.uk

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


Fig. 4

Radiograph of a boy aged 12 years showing grade IV avascular necrosis following single-stage correction of left developmental dysplasia of the hip at the age of 4 years and 3 months.