MINI-SYMPOSIUM: CHILDREN—OSTEOTOMIES AROUND THE HIP

(iv) The Chiari medial displacement osteotomy

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Summary
Management of acetabular dysplasia in young adults remains a challenge. A systematic approach is required to assess the nature and degree of the dysplasia in order to plan treatment. This article describes the rationale used to choose surgery appropriate for the dysplasia type and thereby to ensure a satisfactory result. In particular, the indications, surgical technique and the results for the Chiari medial displacement osteotomy and variants are described.

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Introduction

Acetabular dysplasia may be idiopathic or a sequel to developmental dysplasia of the hip (DDH), cerebral palsy or Perthes’ disease. Patients frequently complain of increasing pain and disability in adolescence or young adulthood. Whilst it is necessary to exclude other causes of pain such as femoroacetabular impingement, dysplasia is a potent cause of hip pain in this age group as tears or degeneration in the labrum are usually secondary to the mechanical instability. Untreated hip dysplasia inevitably progresses to premature arthritis, sometimes as early as the second or third decade of life. Advanced arthritis can realistically only be managed by a total joint replacement but the acetabular dysplasia, which caused the premature failure of the native hip also conspires to produce early failure of the replacement because of poor bone stock, the greater demands of a young person and the fact that even a successful hip replacement will not last 40–60 years. In view of this, techniques which normalise or prolong the life of the dysplastic joint are indicated until the patient is of an age when a total joint replacement has a reasonable chance of long-term survival become attractive. If the procedure also improves bone stock there is the added bonus that the eventual joint replacement has a better chance of long-term survival.

Anatomy

There are varying configurations of acetabular dysplasia. To some extent the morphology of the dysplasia decides the technique available to stabilise the hip. Possible types of dysplasia include:

1. a normal acetabular morphology but with the femoral head larger than the socket with lateral uncovering (Fig. 1),
2. a spherical acetabulum but with reduced lateral cover such that there is no downward tilt to give lateral stability (Fig. 2),
3. a biconcave acetabulum (Fig. 3), and
4. a saucer-shaped acetabulum (Fig. 4).

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Types 1 and 2 are congruent hips and can usually be managed by a realignment pelvic osteotomy, such as a Ganz procedure or a Wagner spherical acetabular osteotomy. These techniques provide the necessary lateral acetabular cover to the femoral head with normal articular cartilage; thereby improving hip anatomy and biomechanics. If performed before the development of obvious arthritic change a realignment pelvic osteotomy might offer a normal life expectancy for the hip. The outcome is less successful once degenerative changes are present.

Types 3 and 4, however, are incongruent hips which do badly with a realignment pelvic osteotomy because of the considerable discrepancy between the size and shape of the femoral head and acetabulum. These hips are better managed by a salvage acetabular augmentation procedure, which provides extra lateral cover thus preventing subluxation without trying to restore congruency. Such augmentation procedures include the various shelf operations or a Chiari medial displacement osteotomy. Shelf procedures augment the anterolateral aspect of the deficient dysplastic acetabulum with corticocancellous graft, thereby buttressing the femoral head and increasing joint stability.

The Chiari medial displacement iliac osteotomy involves division of the iliac bone from just above the acetabular lip to the inferior part of the sciatic notch with displacement of the distal fragment medially until the femoral head is covered. A variation of the Chiari is the Kawamura dome osteotomy which results in more congruent lateral support for the femoral head than the classical Chiari. The Chiari may be combined with a shelf procedure for severe dysplasia. Neither the Chiari nor the shelf procedure place hyaline articular cartilage over the femoral head. Instead...
they rely upon metaplastic transformation of the hip joint capsule to fibrocartilage.

**Diagnosis**

**History and physical examination**

The diagnosis of acetabular dysplasia is primarily radiological. The features of dysplasia are present on X-ray many years before symptoms develop. The pain of acetabular dysplasia is usually induced initially by overuse, though with time the pain occurs with everyday walking and standing. At first, the pain is commonly due to abductor fatigue and is felt over the buttock, greater trochanter and lateral thigh. Initially, the symptoms are infrequent and short lived, but the high load on the acetabular rim produces progressive degenerative change with more frequent and severe symptoms (acetabular rim syndrome) felt in the groin and medial thigh. A description of pops or clicks, shooting pains or catching suggests possible labral pathology. The differential diagnosis includes femoroacetabular impingement where the hip pain is usually felt in the medial groin area, and is aggravated by sitting or squatting.

Clinical examination reveals good hip motion though some complain of pain with full abduction. Often there is more internal than external rotation due to excessive anteversion of the femoral neck. This is unlike the situation for hip impingement where internal rotation is limited and painful (positive impingement test), particularly with the hip in 90° of flexion. If the internal rotation is decreased and painful this might indicate a labral tear or the onset of early arthritis. Furthermore, patients with hip dysplasia may show anterior instability. This is demonstrated in the supine patient by extending and externally rotating the hip, which produces discomfort and instability when positive (positive apprehension test).

**Imaging**

An anteroposterior radiograph of the pelvis and both hips remains the most useful view for diagnosis and treatment planning. This view gives a good idea of the type and degree of acetabular dysplasia. The degree of dysplasia can be assessed from measurement of the centre-edge angle and Tonnis angle. Acetabular retroversion can be inferred from cross-over of the margins of the anterior and posterior walls of the acetabulum, which is not seen in the normal anteverted acetabulum. (The “false profile” view of Lequesne, Fig. 5), taken with the film at 65° to the pelvis in a patient standing with their foot parallel to the film, allows assessment of anterior acetabular cover and of the femoral head–neck offset where impingement is suspected.

An MR arthrogram may be helpful in detecting labral tears or degeneration and can also demonstrate abnormal femoral head–neck offset. Three-dimensional CT reconstructions are good for demonstrating the orientation and degree of acetabular and femoral version. However, these studies are not necessary routinely.

**Choice of procedure**

As noted previously, different types of acetabular dysplasia require different approaches. If the hip is essentially congruent and containable, with the degree of acetabular rotation needed to achieve adequate cover being 30° or less, a pelvic realignment osteotomy has the best chance of achieving long-lasting hip survival. A stiff hip is a contraindication whilst the presence of osteoarthritic change produces poorer results and is a relative contraindication.

Where the hip is not congruent or containable or the amount of pelvic tilt required to achieve cover is excessive, acetabular augmentation is the preferred option. Both the shelf procedure and the Chiari osteotomy have been shown to provide useful long-term survival for dysplastic hips though, as for the realignment pelvic osteotomies, the outcome is poorer when degenerative changes are present. A stiff hip is an absolute contraindication. A relative contraindication is a totally uncovered hip with proximal migration preventing the appropriate slope of the osteotomy and inadequate iliac bone cover. Irrespective of the choice of acetabular osteotomy concomitant femoral deformities such as excessive anteversion, varus or valgus may need correction.

The Chiari pelvic osteotomy was first described in 1953 as a salvage procedure. It appears to work by increasing the area of contact between the femoral head and the acetabulum and by medialisation of the hip, both of which reduce the load per unit area on the hip. Kawamura published his variation in Japanese in 1958 but it was not widely known about till 1982 when he described the dome osteotomy in Tachdjian’s textbook of paediatric orthopaedics. Both osteotomies are best delayed until the triradiate physis has closed to avoid iatrogenic dysplasia resulting from damage to this growth plate.
Technique

Chiari pelvic osteotomy

With the patient supine on a radiolucent table the hip is displayed via the Smith-Peterson approach. Both the inner and outer subspaces of the ilium are exposed back to the greater sciatic notch. Lateral stripping is minimised to decrease injury to the hip abductor muscles. The curved insertion of the reflected head of rectus femoris provides the marker for the level of the osteotomy. This is established by radiographically using a stout pin to demonstrate both the acetabular lip and the 10–15° angle of osteotomy in the antero-posterior plane. After protecting the sciatic nerve with retractors the ilium is divided with curved osteotomes around the acetabulum (Fig. 6a). A Gigli saw can be used for the most posterior portion of the osteotomy to avoid the risk of injury to the sciatic nerve by the osteotome or by bone splinters or spikes. Abduction of the hip with medial pressure displaces the acetabulum under the ilium (Fig. 7). Displacement of 1–1.5 cm is usually adequate to provide 80–100% lateral coverage of the femoral head. The osteotomy is inherently stable but can be fixed if desired with a screw or threaded pin. Evaluation of femoral head coverage should be performed to identify any remaining anterior or lateral deficiency. If present, further acetabular augmentation should be performed by a shelf procedure. Assessment of the range of motion in the hip is necessary to exclude any anterior block to flexion. Trimming the anterior ilium avoids such femoral neck impingement in flexion and aids wound closure.

Postoperative regime

Once control of the limb is regained the patient mobilises, touch weightbearing with crutches for 6 weeks. This is progressed to full weight bearing by 12 weeks. Active flexion and abduction should be avoided in the initial postoperative phase.

Dome osteotomy

With the patient lying affected side up, a longitudinal incision is made from proximal to the greater trochanter to the iliac crest. Under image intensifier control (with the C-arm in the inverted U position to give an antero-posterior view) the greater trochanter is divided in a supero-medial direction. The hip abductors are reflected proximally to expose the outer table of the ilium. A stout wire is inserted and screened to show the level and direction of the osteotomy. A copper or aluminium malleable retractor is inserted from the anterior inferior iliac spine to the sciatic notch to push the sciatic nerve posteriorly and to protect the pelvic contents. The dome osteotomy is made using a narrow-bladed oscillating saw and osteotomes (Fig. 6b). The acetabulum is displaced by medial pressure with the hip abducted. Fixation with threaded pins or screws is usual (Fig. 8). The greater trochanter is reattached, with advancement as needed. Postoperative rehabilitation is similar to that following a Chiari osteotomy.

Complications

In addition to the general risks of wound infection and thrombo-embolic disease, damage to the sciatic nerve or lateral cutaneous nerve of thigh are specific risks. Most nerve palsies recover spontaneously. Other complications include iatrogenic arthritis if the cut enters the hip joint or idiopathic chondrolysis. Non-union secondary to complete medial displacement should be avoided by fixation though complete medial displacement with fixation is compatible with a good result (Fig. 9). Narrowing of the pelvic outlet, particularly with bilateral procedures, may require delivery by caesarean section during childbirth.

Outcomes

Both the Chiari and dome osteotomies rely on remodelling of the ilium and metaplasia of the previously unsupported
capsule and labrum to fibrocartilage. This process can take up to 2 years. Limping is common initially due to longstanding weakness of the hip abductors and the trauma of surgery, but in most patients the limp becomes less marked than pre-operatively due to the improved biomechanics.

Good pain relief is produced in 80–90% of patients with 50–60% still doing well 15–20 years from surgery. The results are poorer if there are obvious degenerative changes prior to surgery. Osteoarthritic change is certainly retarded but it is likely that in the long-term most patients will require a total hip replacement for degenerative arthritis of the joint. Neither osteotomy prevents conversion to a total hip replacement.

Total hip replacement after Chiari osteotomy

This procedure can be difficult due to presence of the scar and the change in local anatomy. It is important to recognise that the antero-posterior diameter of the acetabulum is smaller than the supero-inferior diameter. The anterior and posterior walls should hence be preserved during preparation of the acetabulum. In theory, the projecting shelf of bone anteriorly and laterally may result in dislocation of the hip due to impingement.

There is conflicting evidence regarding the results of total hip replacement after Chiari osteotomy. Hashemi-Nejad et al. reported results of total hip arthroplasties done in dysplastic hips with and without previous Chiari osteotomy at a mean follow-up of 5 years. Patients with a previous Chiari osteotomy required less bone grafting during the procedure, had better coverage of the cup by host-bone and near anatomic restoration of the centre of motion of the hip. This group also had fewer acetabular augmentation procedures and controlled medialisations, along with a lower mean blood loss and operative time. Minoda et al. compared 10 patients undergoing hip replacement after previous Chiari osteotomy with 20 patients undergoing hip replacement for dysplastic hips with no previous surgery. They concluded that the patients with a previous Chiari osteotomy had more blood loss, their surgical time was prolonged and joint forces were more vertical. These two studies reported no significant clinical differences after medium-term follow-up. The authors’ surgical experience of total hip arthroplasty in this subgroup agrees with the observations made by Hashemi-Nejad et al. The increased bone stock produced by these procedures assisted the total joint replacement procedure. However, the reconstructive surgeon should observe certain special precautions mentioned above during total hip replacement in this subgroup.

Figure 8 Dome osteotomy with supplementary shelf, fixed with 2 threaded pins.

Figure 9 Pre- and post-operation dome osteotomy with complete displacement.
References


Conclusion

Chiari osteotomy is generally a safe procedure, with good long-term clinical outcomes reported in the literature. It is indicated in patients with symptomatic hip dysplasia in whom redirectional osteotomy is contraindicated due to an incongruous joint. While a stiff hip joint is an absolute contraindication for this procedure, the presence of moderate to severe arthritis remains a relative contraindication. When indicated, patients with previous Chiari osteotomy can expect good short to medium term results after total joint replacement.