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The place of valgus extension femoral osteotomy in the late management of children with Perthes' disease

Key words: *Perthes disease, older child with Perthes disease, surgical treatment*

SUMMARY

Despite considerable research into the aetiology and management of Perthes' Disease, patients still present late with symptoms related to serious femoral head deformity. The process of progressive deformity is discussed and the clinical signs which recognise it identified. The clinical signs of the established condition are shortening, loss of abduction proceeding to a flexion/adduction contracture with unstable movement and hinge abduction on the dynamic arthrogram. Treatment must result in stable movement as the child stand and walks. This is achieved by a valgus/extension upper femoral osteotomy. The advantage of this procedure is that it relieves pain, improves leg length, restores the normal abductor lever arm, and in consequence improves the limp, which is one of the patient's chief complaints. The results in the long term are discussed.

INTRODUCTION

The concept of a valgus osteotomy in the management of hip disorders is at the first sight illogical. This is because tradition has established, particularly with regard to Congenital Dislocation of the hip, Perthes' disease and early osteoarthritis, that a varus osteotomy often with derotation will centre the femoral head within the acetabulum and improve both stability and cover. Valgus osteotomy has been reserved in the past for congenital coxa vara and more recently by Bombelli for the intermediate stages of osteoarthritis of the hip.

To understand the indications for valgus extension femoral osteotomy in the management of Perthes' disease and other causes of avascular necrosis a knowledge of the way the femoral head becomes deformed is necessary.

THE PATHOLOGY OF FEMORAL HEAD DEFORMITY

Four processes may be recognised in the morphological changes in Perthes' disease. There is a growth disturbance in cartilage which effects both the articular cartilage and also the growth plate. There is evidence of an epiphyseal infarct, which involves a variable amount of the bony epiphysis. The infarct may have occurred on more than one occasion and is associated with a subchrondral fracture and crushing of the bony trabeculae in the weight bearing area of the femoral head. Thirdly, there is a process of repair. The fourth is the presence of abnormal movement.

The impact of these first three processes depends on the morphology of the femoral head at the time that the insult occurs. In the younger child there is a greater proportion of femoral head in cartilage and the changes observed will be largely overgrowth of cartilage with some bony deformity. In the older child, where there is a greater proportion of epiphyseal bone within the femoral head, the effect of the crushing and fracture of the bony trabeculae will be more important, as an early change in head shape will occur [1,2,3].

During the course of the disease, following the infarction of the bony epiphysis, the articular cartilage becomes thickened particularly on the medial and lateral aspects of the femoral head. This results in a Coxa Magna. In the growth plate there is inhibition of growth under the epiphyseal bone involved by the infarction. This growth disturbance tilts the femoral head on the long axis of the neck. In the epiphysis there is evidence of recurrent bone infarction, which may or may not involve the whole epiphysis. In the weight bearing part of the femoral head, fracture of the avascular trabeculae produces deformity and flattening of the femoral head. Particularly in the older child, this may be associated with an antero-lateral

subluxation of the femoral head from the acetabulum. The process of repair re-establishes the normal growth processes within the femoral head. This removes loose necrotic bone and allows union of the subchondral fracture. The subsequent reossification allows reconstitution of the subchondral bone plate and a resumption of the normal growth processes on the surface of the femoral head. Where the femoral head remains within the acetabulum it usually stays round but if subluxation occurs marked deformity may result.

On the clinical side these three processes are usually associated with a fourth abnormality, which is an alteration of movement. There is a global and progressive loss of movement particularly in the ranges of abduction and internal rotation. Because of this the femoral head begins to assume an adducted position with uncovering of the antero-lateral segment. Where there is overgrowth of the antero-lateral portion of the femoral head or a dysplastic anteverted acetabulum, this antero-lateral segment comes to lie outside the confines of the bony acetabulum. Its lateral edge now begins to deform the femoral head producing a dent in the soft load-bearing area of the femoral head. Attempted abduction in these circumstances changes from a movement of pure rotation of the femoral head within the acetabulum to one of hinging of the flattened outer aspect of the femoral head on the lateral lip of the socket. This phenomenon is called „Hinge Abduction" [4,5]. The act of hingeing inhibits the growth and ossification of the lateral aspect of the acetabular roof and induces a secondary acetabular dysplasia which further exacerbates the problem. The effect of this unstable movement is to induce a reactive synovitis in which spasm of the psoas and adductor muscles predominates exacerbating the adducted position of the femoral head, which now becomes a fixed subluxation. Continuing overgrowth laterally in the presence of this fixed subluxation results in an irregular flattened femoral head. The irregularity is the result of pressure by the lateral edge of the acetabulum on the outer aspect of the femoral head.

CLINICAL RECOGNITION OF FEMORAL HEAD DEFORMITY

In the early stages of femoral head deformity there is a reduction in hip movement, particularly adduction and rotation. The adducted position of the leg results in apparent shortening of the leg. As the hip starts to flex from this adducted position it moves into the position of flexion and abduction because of the shape of the femoral head and the loss of rotation. This sign of „Flexion with Abduction" is present early during the process of femoral head deformity and is one of the „Head At Risk" signs (Table 1). Treatment by restoring the normal axis of movement in the early stages will reverse the progression of deformity, but persistence of the sign of flexion with abduction always implies progressive change. In the established condition patients present with pain, limp and shortening.

THE CHILD PRESENTING LATE WITH FEMORAL HEAD DEFORMITY

Children with Perthes' disease who have developed femoral head deformity will often present late with pain, persisting limp and shortening. Clinical examination will confirm the short leg limp and apparent shortening due to fixed flexion and fixed adduction as the child lies. As the hip is flexed, the sign of flexion with abduction will be noted all of which points to femoral head deformity. On other occasions the child will present with persisting limp but without serious discomfort, the clinical findings, however, will be the same.

The principles of treatment for all cases of Perthes' Disease are the restoration of movement, the reduction of forces through the hip joint, correction of subluxation and revascularisation of necrotic bone to allow union of the subchondral fracture and subsequent remodeling (Table 2). When these principles are applied to the early stages of treatment, centring the femoral head in abduction will produce stable move-

Tab. 1. Signs of the „Head at Risk"

Clinical Signs
1. Progress of loss of movement
2. The Sign of "Flexion with Abduction."
3. Adduction contracture
4. The heavy child
Radiological Signs
1. Gage's Sign
2. Calcification lateral to the epiphysis
3. Diffuse metaphyseal reaction.
4. Lateral subluxation
5. Horizontal growth plate

Tab. 2. Indications for definitive treatment by valgus extension femoral ostetomy

1.	Persisting fixed deformity
2.	Pain with Hinge Abduction.

Tab. 3. Principles of treatment

1.	Restoration and maintenance of movement.
2.	Reduction of forces through the hip joint.
3.	Correction of Subluxation
4.	Revascularisation of the necrotic bone with union of the subchondral fracture

ment and provides an indication for varus femoral or innominate osteotomy. In late disease, however, where there is femoral head deformity and an arthrogram shows hinge abduction, the stable position of the hip joint is in adduction and flexion and movement, therefore, must be restored following realignment of the position of fixed deformity to the neutral position. A valgus femoral osteotomy will, therefore, produce stable movement with the leg in the neutral position of weightbearing. It has the advantage of improving leg length, re-establishing the normal abductor lever arm and decompressing the lateral aspect of the femoral head and acetabulum so that normal growth and remodeling can be established. The indications for valgus upper femoral osteotomy is pain with hinge abduction on the Dynamic Arthrogram or persisting fixed deformity (Table 3)

The Dynamic Arthrogram

This investigation, which is best thought of as An examination under anaesthetic with dye in the joint, is a dynamic investigation undertaken by the surgeon or surgical team who are advising on treatment. It has the great advantage over other imaging techniques in that it allows observations to be made not only on the shape of the femoral head but also on the way the hip moves. This allows the presence of unstable movement to be recognised at an early stage. The first observation is to compare the range of movement with the pre-anaesthetised state. In the majority of cases no fixed deformity is present under aneathetic and there is an increased range of both abduction and flexion. This observation suggests that there is muscle spasm present which will not require soft tissue release. Radio-opaque dye is now injected into the joint and the hip movement carefully screened under the image intensifier to demonstrate the cartilaginous shape of the femoral head. As the hip is moved changes in congruity are noted and the position of best fit identified. This movement is best recorded using a video recorder and static radiographs then taken to identify the position of best fit. At the end of the procedure three types of movement can be identified. In the first the hip is „contained" with a stable axis of rotation. The second is „the containable hip" where the hip is uncovered at rest, but will centre in flexion and abduction. (Finally there is the „uncontainable hip" whose arthrographic sign is that of „Hinge Abduction" (Fig. 1).

The Operation

In considering the technical aspects of the operation, internal fixation is always used and a plaster spica is not required. The patient lies flat on their back and the proximal femur is approached through a lateral incision and the bone exposed subperiosteally. To obtain the appropriate wedge, the leg is first placed in the position of best fit, (flexion and adduction), and the bone divided at right angles to the patient and the floor. The leg is now brought into the neutral position and a second osteotomy performed again at right angles to the patient and the floor with the patella pointing exactly forward. This removes an exact wedge to compensate for the fixed deformity or position of best fit. The first osteotomy allows correction of the flexion and varus element of the deformities and the second correction of rotationas the osteotomy is at right angles to the long axis of the bone. The osteotomy is ideally closed with some slight lateral displacement and stabilised using a Coventry plate and screws. The immediate postoperative care is with crutches partial weightbearing and this should be continued until the osteotomy is joined which will be between six and ten weeks depending on age. Full weightbearing should then be allowed and activities gradually recommenced.

RESULTS

The initial results of Valgus extension osteotomy were reported by Quain et al in 1986. [6]. In a 2 year

follow up it was demonstrated that pain was improved in 20 out 23 cases. The range of abduction and the shortening were also improved. The results, however, were preliminary as the follow-up was short. Banks undertook a maturity review of this procedure [7]. Clinical data were available for 47 patients (50 hips), at a mean follow up of 10 years (range 25 months to 20 years 9 months). The average time from onset of disease to operation was 3 years 6 months (range 6 months to 10 years 6 months) and the average age at surgery was 13 years (range 7 years 7 months to 17 years 11 months). Four hips had undergone a later total hip replacement and one an arthrodesis. Improvement in femoral head shape was found in 12 hips (26%), no change in 32 hips and deterioration in 2 hips. Favourable remodeling was associated with younger mean age at time of operation (11 years compared with 13 years 7 months), and surgery performed during the healing phase of the disease and with the tri-radiate cartilage open. Similar results have been reported by Pecasse et al. of operations performed in late adolescence [8].

Fig. 1ab. Radiographs of a child aged 8.5 years who had a two year history of increasing pain and limp involving the left leg. Perthes' disease was diagnosed at the age of 6.5 years and initial treatment was with a weight-relieving caliper. Despite this treatment, the symptoms have increased. a) The AP and Lateral radiographs showing gross flattening of the femoral head. There is lateral subluxation and uncovering of the femoral head. The superior joint space is wider medially than laterally suggesting unstable. b) The Dynamic Arthrogram The gross flattening and deformity of the femoral head is confirmed with typical hinge abduction. There is enlargement of the lateral aspect of the acetabulum in cartilage. The position of best fit is in adduction and flexion where the decompression of the lateral element is well shown

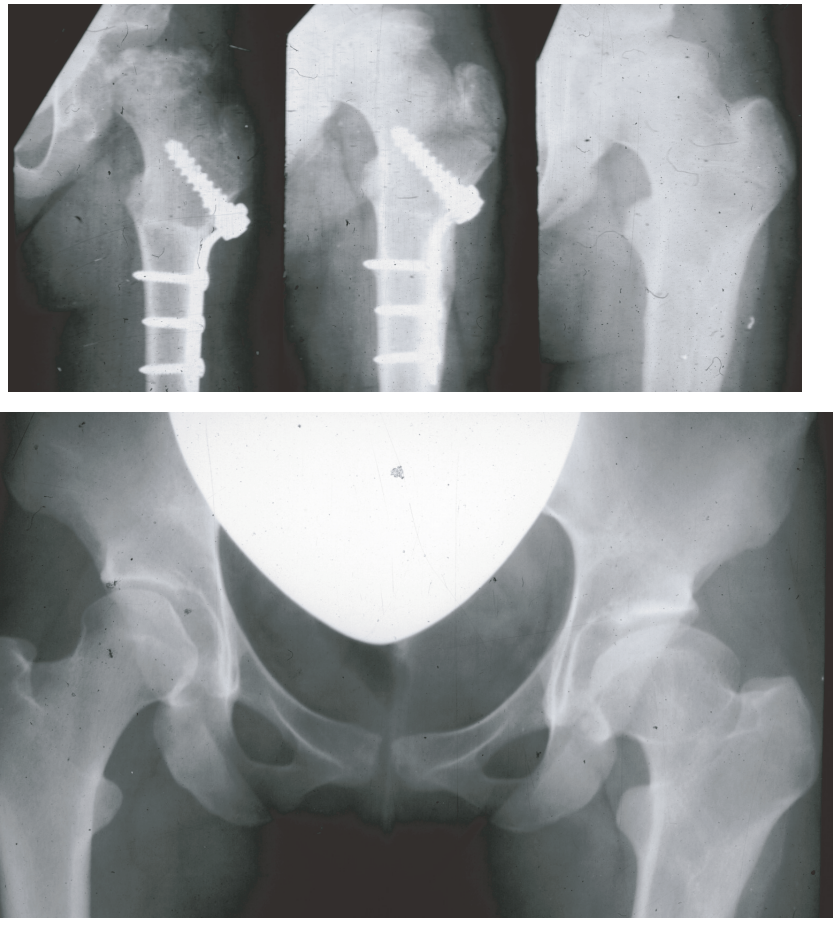

Fig. 1cd. Radiographs of a child aged 8.5 years who had a two year history of increasing pain and limp involving the left leg. Perthes' disease was diagnosed at the age of 6.5 years and initial treatment was with a weight-relieving caliper. Despite this treatment, the symptoms have increased. c) The appearances one and three years following valgus extension osteotomy. There has been increased uncovering of the femoral head but considerable remodelling is already apparent. This remodelling involves not only the femoral head but the whole architecture of the proximal femur. d) The sequential results seven years later showing excellent remodelling of the femoral head

DISCUSSION

Hinge Abduction in Perthes' disease results from lateral overgrowth of the femoral head outside the acetabulum. The large uncovered anterolateral segment impinges on the lateral lip of the acetabulum, shifting the axis of hip rotation outside the bony acetabulum and produces pain, fixed deformity, and unstable movement. There is an inhibition of lateral acetabular growth due to the abnormal loading. By definition Hinge Abduction can only occur in uncontainable hips and therefore any treatment for this aspect of Perthes disease must be regarded as a salvage procedure. Reinker has reported elimination of hinge abduction using only plain radiographic criteria in 11 of 19 cases of early Perthes' disease using bed rest, progressive abduction traction, and Petrie casts [9]. Kruse, Guille and Bowen have treated Hinge Abduction with lateral shelf acetabuloplasty, having repositioned the weight bearing part of the femoral head within the acetabulum using several weeks of longitudinal traction and progressive abduction [10]. Gradual abduction over the course of weeks, which is a feature of both these methods, may be able to force a small soft lateral segment into the acetabulum. However, such treatment is time consuming, applicable only to certain cases of active disease, and has an unpredictable outcome. The author's experience of cheilectomy is unfavourable although its very limited role in older children in the late stages of the disease has been described. It has the disadvantage of being an intracapsular procedure with no beneficial effects on leg lengths or abductor weakness. Valgus extension osteotomy abolishes Hinge Abduction by restoring movement with the femoral head congruous in the neutral position of weight bearing. This provides a better functional range of movement by correcting the fixed deformities, and has a beneficial effect on

leg length. It also results a better abductor lever arm. In addition, unloading of the lateral parts of the acetabulum produces favourable remodeling of the hip joint, particularly when the tri-radiate cartilage remains open.. The functional result at maturity are also satisfactory with the majority enjoying good function and pain relief. Whilst some improvement in femoral head shape is part of the natural history of the disease, the abolition of Hinge Abduction by realignment increases the incidence and degree of this remodeling. Careful follow-up is particularly important for older children with Perthes' disease to identify a reducing range range of abduction which together with the sign of „Flexion with abduction" suggests femoral head deformity with lateral overgrowth of the femoral head. If containment is impossible and Hinge Abduction supervenes, valgus extension osteotomy is an effective salvage procedure which can also induce favourable remodeling of the hip when the tri-radiate cartilage is open.

CONCLUSION

Valgus extension femoral osteotomy remains a useful procedure for the management of children, who present late with femoral head deformity. The object of the operation is to provide stable movement of the hip joint as the child walks. It provides the best opportunity for remodeling in the long term. Valgus extension femoral osteotomy remains a useful procedure for the management of children, who present late with femoral head deformity. The object of the operation is to provide stable movement of the hip joint as the child walks. It provides the best opportunity for remodeling in the long term.

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