SURGICAL PROPHYLAXIS OF SUBLUXATION AND DISLOCATION OF THE HIP IN CEREBRAL PALSY

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The clinical and radiological state of the hips of a group of children with cerebral palsy treated without operation is compared with that in a group treated by operation to correct adduction and flexion deformity and to obtain balanced action in the hip muscles. In the first group, 11 per cent of hips were dislocated, 28 per cent subluxated, 46 per cent dysplastic and 15 per cent normal. In the second group no hip was dislocated, 13 per cent were subluxated, 35 per cent dysplastic and 52 per cent normal. Surgical intervention is indicated clinically for a range of abduction diminishing to less than 45 degrees and—on radiological criteria—for early dysplastic changes, especially a break in Shenton's line, irrespective of the patient's age, severity of involvement or neurological maturity. Prevention of subluxation or dislocation improves function and diminishes the liability to develop a painful hip in adolescence or early adult life.

Subluxation or dislocation is an important aspect of hip derangement in cerebral palsy. Considerable differences in incidence are reported in the literature, ranging from 2·6 per cent found by Mathews, Jones and Sperling (1953) in 1,243 patients to 28 per cent by Samilson, Tsou, Aamoth and Green (1972) in 1,013 severely affected and neurologically immature patients in institutional care.

Some of the effects of subluxation or dislocation depend on the severity of the cerebral lesion. In a less handicapped patient capable of independent walking, subluxation affects gait and walking ability, and dislocation may make walking impossible. In a patient with marked neurological immaturity, unable to stand or walk, flexion and adduction deformity associated with dislocation makes nursing care very difficult. In all patients, whatever their locomotor defect, pain is an important feature of subluxation or dislocation in cerebral palsy, especially in adolescence and early adult life.

For these reasons, measures that may prevent subluxation or dislocation of the hip should be considered. Tachdjian and Minear (1956) were among the first to point out that, with early detection and appropriate management, dislocation in cerebral palsy is a preventable condition. The purpose of this paper is to report the results of an investigation into the value of operation in the prophylaxis of subluxation and dislocation of the hip in cerebral palsy.

THE HIP AT RISK

A study of the mechanism of production of dislocation of the hip in cerebral palsy (Pollock and Sharrard 1958) showed that progressive limitation of abduction, often in association with flexion deformity, was an indicator of early instability of the hip. No hip that showed radiological evidence of subluxation or dislocation had a range of abduction of more than 45 degrees, and no hip that had a range of abduction of more than 45 degrees showed radiological evidence of subluxation or dislocation. In approximately 10 per cent of hips, however, limited abduction was not accompanied by radiological evidence of hip instability. These findings suggested that limited abduction should form the basis for identification of hips at risk in this study.

MATERIAL

Two groups of patients suffering from spastic cerebral palsy were compared. The patients in one series (Group 1) had been treated between 1949 and 1957 solely by conservative methods; those in the other (Group 2) had been treated between 1958 and 1973 by operation combined with similar conservative management. The average age and neurological distribution of limb involvement in the groups were alike.

Group 1—There were seventy-two hips in thirty-six children in this group. They were taken from a consecutive series of eighty-seven children referred for orthopaedic care and were examined clinically and radiologically in 1957. All had been treated by conservative measures that included passive joint movements, active exercises, control of abnormal reflex activity by posture, and education in locomotor activities. In some, adductor spasticity and progressive limitation of abduction had been treated by splinting in abduction. None had received

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any surgical treatment for the hip. The primary criterion for inclusion in the group was the presence of an abduction range of less than 45 degrees in one or both hips, though many also had flexion or rotational deformities.

The average age of the children was 7·5 years (range four to sixteen years). None was hemiplegic, ten were classified as spastic diplegic and twenty-six as spastic or mixed spastic and athetoid tetraplegic. Twenty-two were male and fourteen female.

Group 2—There were 134 hips in sixty-nine children in this group. They were taken from a series examined in 1973 in which all of the hips had been subject to at least one surgical procedure: the primary indication for operation had been a range of abduction of 45 degrees or less. Only one operation had been needed for 101 hips (75 per cent), two operations for twenty-eight hips (21 per cent) and three or more operations for five hips (4 per cent). Before and after operation, conservative treatment as used in Group 1 was given, except that splinting was used only in the period immediately after operation.

The average age of the children at review was eight and a half years (range 3·5 to 18 years). The average age at the time of the first operation was four and a half years (range 1·2 to 12·7 years). Two were hemiplegic, sixteen were classified as spastic diplegic and fifty-one as spastic or mixed spastic and athetoid tetraplegic. Forty-six were male and twenty-three female.

SURGICAL MANAGEMENT

The surgical prophylaxis of subluxation and dislocation of the hip is based on the concept that the abnormality that causes subluxation is the action of strong adductor and flexor muscles in the presence of weak gluteal abductors and extensors, a finding first noted by Watson-Jones (1926) and confirmed by many subsequent investigators (Tachdjian and Minear 1956, Pollock and Sharrard 1958, Phelps 1959).

The aim of the first operation (Table I) was to correct the length of short adductor and flexor muscles by adductor tenotomy and myotomy and, if necessary, iliopsoas tendon elongation. An open surgical technique was used for all but one hip in which subcutaneous tenotomy of adductor longus only was needed. When there was imbalance of more than two grades of power (Medical Research Council 1942) between the adductor and abductor muscles, adductor power was diminished further by division of the anterior branch of the obturator nerve. In one patient, the first operation was division of the anterior branch of the obturator nerve without adductor release.

Recurrence of adduction or flexion deformity after initial adductor release was treated by a second operation to release adductor and flexor muscles, sometimes combined with partial obturator neurectomy. In some hips other procedures were needed (Table II). Multiple operations were especially needed for severe subluxation or dislocation arising in tetraplegics with marked neurological immaturity. Operation to correct deformity at other joints was also required for most patients, but only hip procedures are listed in Table II.

The indications for the first surgical procedure are shown in Table III. The predominant clinical indication was limited abduction. The radiological indications varied between dysplasia, often first represented by a break in Shenton's line, and complete dislocation. The dislocations and some of the subluxations were not necessarily present when the decision to operate was made. Some developed during the period, at times unfortunately long, between the time the child was put on the waiting list and the time of admission.

TABLE I
FIRST SURGICAL PROCEDURES IN GROUP 2 HIPS

Operation	Number of hips
Adductor release	131
Anterior branch obturator neurectomy	46
Iliopsoas tendon elongation	3
Subcutaneous adductor tenotomy	1

TABLE II
SECOND AND ADDITIONAL PROCEDURES IN GROUP 2 HIPS

Operation	Number of hips
Adductor release	32
Anterior branch obturator neurectomy	4
Iliopsoas tendon elongation	5
Flexor release (Soutter)	3
Femoral osteotomy	5
Capsulorrhaphy	1
Pelvic osteotomy	1
Abductor release	2
Iliopsoas transfer (Sharrard)	2
Removal of plate	1

TABLE III
INDICATIONS FOR FIRST SURGICAL PROCEDURES

Indication	Number of hips
Limited abduction	132
Break in Shenton's line	38
Subluxation	49
Dislocation	4
Fixed flexion	19
Scissor gait	2

Complications of operation were few. Haematoma formation or mild superficial infection was recorded on three occasions. One child developed two successive fractures after release from immobilisation; both fractures healed uneventfully. In general, fractures were avoided by limiting the period of plaster immobilisation after operation to a maximum of four weeks. Bilateral abduction contracture occurred in one child after adductor release and anterior branch obturator neurectomy, but this was subsequently corrected by an abductor release.

FIG. 1

Radiographs of the hips of a spastic diplegic child aged 7·9 years three years after adductor release and anterior branch obturator neurectomy for bilateral dysplastic hips. The left hip is normal; the right hip is still slightly dysplastic.

FIG. 2

Radiographs of the hips of a spastic tetraplegic child aged 3 years, treated conservatively. The left hip is subluxated; the right hip is dislocated.

ASSESSMENT

Clinical—The range of passive hip movements was assessed. The limitation imposed by true shortening of muscle and tendon rather than that produced by spasticity was measured. Abduction was estimated with the patient supine with the hips and knees extended, gracilis being an important factor in limiting abduction in many spastic hips. The presence or absence of fixed flexion, the range of rotation and the extent of straight-leg raising were recorded, though only limitation of abduction and fixed flexion proved to be relevant in the production of hip instability. When the child was old enough and able to cooperate with the examiner, the power of voluntary hip abduction and adduction was assessed. The overall state of motor development was noted.

Radiological—Antero-posterior radiographs of the pelvis were taken with the hips, if possible, in neutral rotation. It was not thought justifiable to take lateral radiographs because of the hazard of excessive irradiation in young children. The hips were classified as normal or stable, dysplastic, subluxated or dislocated. The main consideration was the stability of the joint and the relationship of the femoral head to the acetabulum. A hip with mild valgus and anteversion was classified as normal or stable provided that the femoral head was completely covered by the acetabulum (Fig. 1). Dysplastic hips were those with more than two-thirds cover of the femoral head but a clear break in Shenton's line or abnormality of the acetabulum or femoral head. A hip was regarded as subluxated when contact with the acetabulum was maintained but there was less than two-thirds cover of the femoral head (Fig. 2). Complete loss of acetabular contact constituted a dislocation.

TABLE IV

RADIOLOGICAL STATE AND RANGE OF ABDUCTION IN GROUP 1 HIPS

Radiological state	Range of abduction: Fixed adduction	0 to 30 degrees	30 to 45 degrees	Total
Normal	—	—	11	11 (15 per cent)
Dysplastic	—	3	30	33 (46 per cent)
Subluxated	—	5	15	20 (28 per cent)
Dislocated	3	5	—	8 (11 per cent)
Total	3	13	56	72

TABLE V

RADIOLOGICAL STATE AND RANGE OF ABDUCTION IN GROUP 2 HIPS

Radiological state	Range of abduction: 45 degrees or more	30 to 45 degrees	0 to 30 degrees	Total
Normal	60	10	—	70 (52 per cent)
Dysplastic	36	11	—	47 (35 per cent)
Subluxated	11	4	2	17 (13 per cent)
Dislocated	—	—	—	—
Total	107	25	2	134

RESULTS

Group 1 (*conservative treatment*)—The range of abduction and its relationship to the radiological state of the hip are shown in Table IV. In general, the more unstable the hip, the greater was the limitation of abduction. Fixed flexion of more than 40 degrees was present in three of the dislocated hips and of 20 degrees or more in thirty-seven hips. All had some degree of adductor dominance relative to abductor power but a detailed analysis was not

FIG. 3

FIG. 4

Radiographs of the hip of a spastic diplegic child. Figure 3—At age 1·2 years, before operation. The right hip is subluxated; the left hip is dysplastic. Figure 4—At age 5·7 years, 4·5 years after bilateral adductor release and left anterior branch obturator neurectomy. The right hip has become normal; the left hip is still dysplastic.

FIG. 5

FIG. 6

Radiographs of the hips of a spastic diplegic child. Figure 5—At age 3 years, before operation. Both hips are subluxated. Figure 6—At age 8·4 years, five years after bilateral adductor release and three years after a further bilateral adductor release with anterior branch obturator neurectomy. Both hips are mildly dysplastic.

possible because abductor power could not be estimated satisfactorily in dislocated and severely subluxated hips.

At the time of review, 39 per cent of hips were subluxated or dislocated and only 15 per cent were normal. Further follow-up to discover whether more still might have become unstable under conservative management was not possible for ethical reasons. Estimates of neurological motor maturity were difficult to make in children with marked deformity. None with a dislocated hip was able to walk, though five of the dislocations were in hips in children with good sitting control who would probably have been able to walk had the deformity not been severe.

Group 2 (operative treatment)—The range of abduction and its relationship to the radiological state of the hip is shown in Table V. There was no correlation between the range of abduction and the state of the hip after operative treatment; some normal hips had a significant limitation of abduction and some persistently subluxated hips had a range of 45 degrees or more. No flexion deformity was found in ninety-six hips, 15 degrees of fixed flexion in thirty-one hips and between 15 and 30 degrees in seven hips, with no obvious relationship to the radiological state of the hip.

In sixty-two hips, abductor and adductor power could be measured. A balance of action had been achieved in forty-eight hips (77 per cent), one grade of adductor dominance was present in eight hips (13 per cent) and one or one and a half grades of abductor dominance in six hips (10 per cent).

Fifty-two per cent of hips were radiologically normal. No hip was dislocated and subluxation was present in 13 per cent.

Effects of operation on hip stability—Radiographs were available of 115 hips at the time of their first operation for comparison with the state at review (Table VI). Fifty-eight per cent were improved and 40 per cent remained the same (Figs. 3 to 6). Only two hips were worse: one showed coxa magna after adductor release, and one in a severely affected child was subluxated. Figure 7 illustrates in histographic form the comparative states before operation and at the time of review.

Neurological state—The state of neurological motor maturity is shown in Table VII. All those who had progressed beyond sitting control were able to walk with assistance or independently. The radiological state of the hips in relation to the pattern of limb involvement (Table VIII) shows that diplegics had a better result than tetraplegics.

TABLE VI

RADIOLOGICAL STATE OF 115 HIPS IN GROUP 2 AT THE FIRST OPERATION AND AT REVIEW

Radiological state	Number of hips	
	At first operation	At review
Normal .	28 (24 per cent)	59 (51 per cent)
Dysplastic .	26 (23 per cent)	39 (34 per cent)
Subluxated .	57 (50 per cent)	17 (15 per cent)
Dislocated .	4 (3 per cent)	—

TABLE VII

NEUROLOGICAL MOTOR MATURITY AND FUNCTION IN CHILDREN IN GROUP 2

No head control	2 (3 per cent)
Head control only	10 (14 per cent)
Sitting control	11 (16 per cent)
Walking with aids and some assistance . .	13 (19 per cent)
Walking independently with or without aids .	33 (48 per cent)

TABLE VIII

RADIOLOGICAL STATE AND PATTERN OF NEUROLOGICAL INVOLVEMENT IN CHILDREN IN GROUP 2

Radiological state	Diplegic children (*hips*)	Tetraplegic children (*hips*)
Normal . .	23 (72 per cent)	47 (46 per cent)
Dysplastic .	9 (28 per cent)	38 (37 per cent)
Subluxated .	—	17 (17 per cent)
Total . .	32 hips	102 hips

End-result—In neither group was any significant change found in the stability of the hip after the twelfth year of life; any alteration in late adolescence or early adult life was associated with the development of painful degenerative arthropathy. Thirteen children in Group 2 had reached or passed the age of twelve years. In them, twenty-five hips had received operative treatment, the average time from the last operation being five years. All except one hip, which was subluxated, showed a normal or mildly dysplastic appearance and were stable. At all of these hips, a satisfactory balance of adductor and abductor action had been obtained and the children were able to walk independently or with aids, with or without assistance.

Comparison of groups—Figure 8 summarises the comparative radiological state of the hips. The group treated by operation shows a significant superiority. In that group, function was determined mainly by the state of neurological maturity; in the group treated conservatively, function was often less than the neurological state indicated might be attainable. Absence of pain was a feature of those treated by operation. In the conservatively treated hips, subluxation and dislocation were often painful, especially in older children.

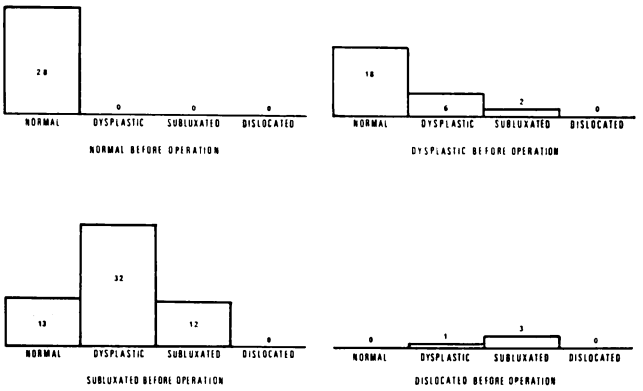

FIG. 7

Histographs to show the comparative radiological state of the hips in Group 2 before and after operation. The figures indicate the number of hips.

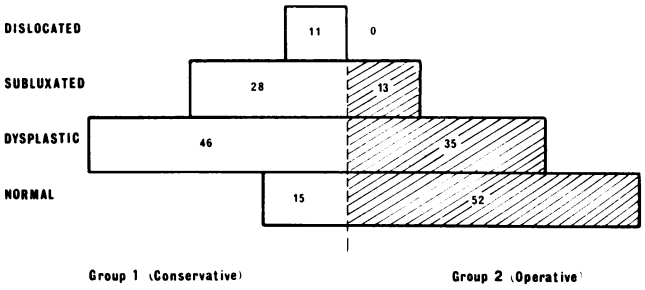

FIG. 8

Histograph to show the comparative radiological state of hips treated conservatively and operatively. The figures are in percentages.

DISCUSSION

Comparability of groups—The groups were as nearly comparable as it is possible to obtain in a disease with such great variation in its presentation. The age, sex and limb involvement were acceptably alike. In Group 2 the primary indication for operation was that, at some time, the range of abduction had become 45 degrees or less; in the conservative group, the same limitation was the criterion for inclusion. In this way, hips not at risk were excluded in both groups.

A comparison of the findings in Tables IV and VI suggests that Group 2 contained a greater proportion of more severely affected hips. Group 1 showed 39 per cent of subluxated or dislocated hips at an average age of 7·5 years; Group 2 had 53 per cent of subluxated or dislocated hips at an average age of 4·5 years immediately preceding their first operation.

Once a hip starts to become unstable, spontaneous improvement seldom, if ever, occurs. Had the hips that were treated operatively been allowed to continue with conservative management, it is likely that, at the age of seven or eight years, even more than 53 per cent would have become unstable or more unstable still. In spite of this weighting against Group 2, the end-result was considerably in favour of those treated by early prophylactic surgery.

Maintenance of stability by operation—In 75 per cent of hips, one operative procedure, usually a simple adductor release, succeeded in obtaining and maintaining hip stability. If hip stability and a balance of muscle action had not been achieved at the first operation, recurrence, shown by radiological deterioration or recurrent limitation of abduction, became apparent within two years and indicated the need for a further procedure. The behaviour of the twenty-five hips followed to adolescence suggested that, if an adequate range of hip movement and a balance of muscle action had been achieved, the stability of the hip up to the end of growth was assured.

The finding that the range of abduction after operative treatment does not necessarily correlate with the radiological state of the hip (Table V) shows that a full range of abduction is probably not the important factor in the production of hip stability. Of greater significance is the finding that a balance of abductor and adductor action and of flexor and extensor action, corresponds with the maintenance of hip stability.

Neurological maturity—Success in preventing hip instability was closely related to the severity of involvement and the neurological maturity of the child. Diplegic and tetraplegic children with a good level of neurological maturity had the best results. The most difficult were the severely affected, neurologically immature tetraplegic children, in whom the most that can be expected is a dysplastic or mildly subluxated hip that still falls into flexion and adduction even when all overactive adductor and flexor forces have been eliminated or balanced. Even this is a considerable improvement on the dislocated, painful hip in a grossly deformed child that is the almost invariable result of purely conservative management.

Subluxation or dislocation developing during the first two years of life is a bad prognostic sign, but surgical treatment can succeed if it is begun sufficiently early, before secondary changes have developed in the femoral head and acetabulum. Even if it is thought that such a child will never walk, and experience has shown that firm prophecies are unwise in young children, relief of pain, diminution in overall spasticity and increased ease of nursing are important considerations in an individual already severely handicapped.

Improvement in function—The improved function found in almost all children in the operative group, whatever their intellectual or motor development, was striking. Some children, about whom clear predictions had been made in earlier years that they would be unable to walk, did achieve a useful measure of walking ability when their neurological maturity improved with age and time.

The immediate after-effects of operation were varied and unpredictable. Many spastic children show a temporary increase in spasticity after removal of plaster splints, and parents and physiotherapists need to be warned that this may occur; only occasionally did emotional regression and withdrawal persist for several months, the degree of affect being related to the magnitude of the procedure and the immaturity of the child (Reynell 1965). Once this phase was over, there was often a remarkable reduction in spasticity generally and an unexpected improvement in functional ability, even extending to better use of the upper limbs.

In only one case did operation make function worse for a short time by producing an abduction deformity that needed an abductor release to correct it. This instance underlines the need for adequate assessment before operation and the importance of matching the extent of the procedure to the requirements indicated by the state of the hip musculature and the radiological findings. If there is doubt, especially in a younger child, in whom muscle assessment is less reliable, it is better to do too little and to repeat and extend the surgical measures if deformity recurs.

Radiological improvement—Although 52 per cent of normal hips in a population at risk is a considerable improvement compared with the results of those treated conservatively, Figure 7 indicates that intervention before subluxation had developed might have resulted in an even greater proportion of normal hips. Prophylactic operation could often return a progressively dysplastic hip to normal, but a subluxated hip usually continued to show some dysplastic changes.

CONCLUSIONS

1. A planned regime of early, prophylactic surgical intervention can improve function, relieve or prevent pain and spasticity, and control the development of subluxation and dislocation of the hip in cerebral palsy. Regular orthopaedic assessment should be started as soon as the diagnosis of cerebral palsy has been made.
2. Initial surgical intervention should be considered whenever the range of abduction becomes less than 45 degrees and is indicated with certainty if radiological dysplastic changes, such as a break in Shenton's line, are present. Early subluxation is an indication for urgent surgical treatment. In 75 per cent of hips, one procedure,

usually an open adductor release, sometimes combined with anterior branch obturator neurectomy, suffices. Recurrence of deformity is an indication for a further procedure.

3. Restoration of muscle and tendon length and the production of balanced muscle action at the hip can prevent the development of progressive instability in a stable hip or restore stability to an unstable hip.

4. The need for operation is independent of age, severity of involvement or neurological maturity of the child.

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