POSTERIOR PSOAS TRANSFER AND HIP INSTABILITY IN LUMBAR MYELOMENINGOCELE

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Seventy-two posterior psoas transfer operations performed in forty-four children with lumbar myelomeningocele were reviewed one to eight years after operation in an attempt to assess its value. Muscle charting, an objective recording of the child's walking ability, and radiographic examination of the hips were done. Hip stability was improved: 49 per cent were stable at the time of psoas transfer and 94 per cent at review. Functional results depended mainly on the level of neurological activity present: 57 per cent of the children had an acceptable functional result. Usually, posterior psoas transfer should be done as soon after the age of nine months as the child's condition will allow. Over the age of two years it should be restricted to children with activity in the third and fourth segments of the lumbar cord.

Children with lumbar myelomeningoceles often have a neurological deficit which results in unbalanced muscle action about the hip. This situation often leads to the development of instability and fixed deformity of the hip. In 1959 Sharrard described posterior transfer of the iliopsoas muscle, and subsequently this procedure has been used for the treatment of hip instability in children with myelomeningocele and with neurological activity at or below the first and second lumbar segments of the cord.

In this paper we report the clinical and radiological results of seventy-two posterior psoas transfers done in forty-four children between 1964 and 1971. From this information the indications for, and limitations of, the operation are discussed, and a scheme for the management of instability and fixed deformity of the hip joint in children with lumbar myelomeningoceles is defined.

CLINICAL MATERIAL

During the eight years between 1964 and 1971, 100 posterior psoas transfers (Sharrard 1964a) were done in sixty-one children with lumbar myelomeningoceles attending the Spina Bifida Unit at Queen Mary's Hospital for Children, Carshalton. Forty-four of these children were available for review and we are able to report on a total of seventy-two operations one to eight years after operation (average follow-up three years ten months).

Age—The youngest child was aged ten months and the eldest ten years at the time of psoas transfer (Fig. 1). The average age at operation was two years and seven months.

Neurological level—The presence of voluntary activity in the hip flexor and adductor muscles before operation was considered to indicate normal cord function in the first

and second lumbar segments (twenty-four children: forty hips). Similar activity in the quadriceps muscle was considered to indicate innervation in the third and fourth lumbar segments (eighteen children: twenty-eight hips), and activity in the hip abductors implied normal cord function down to and including the fifth lumbar segment (two children: four hips).

Indications for operation—Posterior psoas transfer was

FIG. 1

Age at operation.

restricted to those children with myelomeningocele who had significant muscle imbalance resulting from a neurological deficit in the lumbar segments of the spinal cord. There is no justification for performing this operation in children with deficits above the level of the lumbar cord.

The indications for transfer in our patients were dislocation or subluxation of the hip (thirty-seven operations), dysplasia or fixed deformity suggesting future instability (twenty-two operations), and prophylactically when there was severe muscle imbalance although the hips were radiologically normal (thirteen operations).

METHOD

An adequate range of hip abduction before operation is essential, and if full abduction had not been maintained or produced by regular stretching then an open adductor tenotomy was done (Table I): this was needed in forty-one of the seventy-two hips.

The technique of psoas transfer described by Sharrard in 1964(a) was followed with only minor modifications. A portion of the lesser trochanter was detached

TABLE I
ASSOCIATED OPERATIONS IN SEVENTY-TWO POSTERIOR
PSOAS TRANSFERS

Open adductor tenotomy	41
Open reduction	19
Femoral osteotomy	4
Re-explored for technical failure	3
Subsequent soft-tissue releases	3

with the conjoined insertion of the iliopsoas muscle in order to retain as much length as possible, and to facilitate attachment to the greater trochanter under the correct tension. A large hole was made in the wing of the ilium to allow the transferred muscle unrestricted action. As the iliacus muscle is devitalised by mobilisation it was sacrificed and not attached to the outer aspect of the ilium as originally suggested by Sharrard. Thus the procedure is a posterior psoas transfer and not an iliopsoas transfer.

The use of a wire marker stitch (Fig. 2) in the distal end of the transferred tendon has been salutary in revealing that some of the transferred tendons have come adrift.

FIG. 2

After bilateral psoas transfers there has been complete detachment of the transferred tendon on the left as shown by the wire marker stitch. Nevertheless the child has mobile hips and no fixed deformity, and walks well in below-knee calipers.

In nineteen of the seventy-two operations transfer was combined with open reduction of the dislocated hip (Table I). In one child with a high dislocation the opera-

tion was done in two stages; preliminary soft-tissue release including mobilisation of the lesser trochanter was followed by a period of skeletal traction using a femoral pin. Open reduction of the hip with completion of the transfer was done when the femoral head had been brought down to the level of the acetabulum.

Immobilisation in a plaster hip spica was maintained for three to four weeks after the psoas transfer, but this was increased to six weeks after open reduction. When both sides had to be done there was an interval of at least three weeks between operations.

COMPLICATIONS

There was no death from the 100 operations. Fracture of the femur or tibia after removal of the plaster hip spica was frequent and sometimes led to knee stiffness.

FIG. 3

Massive new bone formation after posterior psoas transfer.

Infection was not a serious problem although there were two abscesses, both of which drained spontaneously without sequelae. In nine of the sixty-six operations in which a wire marker stitch was used there was radiological evidence of detachment of the transferred tendon. In one case the detached tendon was re-explored and re-attached. Peri-articular new bone formation led to ankylosis of one hip (Fig. 3). There was radiological evidence of avascular necrosis of the capital epiphysis in eight hips, of which four had had open reduction. These complications are summarised in Table II.

TABLE II
COMPLICATIONS AFTER SEVENTY-TWO OPERATIONS

Lower limb fractures	22
Sepsis	9
Marker stitch adrift	9
Ankylosis from new bone formation	1
Avascular necrosis	8

RESULTS

The children were examined clinically and radiologically. The range of hip movement and the presence of any fixed deformity were recorded. An objective assessment was made of the child's walking ability, and the muscle

no resultant handicap were classed as stiff (eight hips). Twenty hips had some fixed flexion but this was less than 20 degrees in sixteen hips (Table IV).

Walking ability and bracing—Walking ability was closely related to the amount of bracing that was necessary. The ability to sit down, stand up, and walk at least twenty-five

TABLE III
RADIOGRAPHIC ASSESSMENT OF HIPs

		Neonatal		Pre-operative		At review	
		Number	Per cent	Number	Per cent	Number	Per cent
Stable	Normal	33		13	49	32	94
	Dysplastic	8		22		36	
Unstable	Subluxated	9	34	14	51	2	
	Dislocated	12		23		2	
No record		10		—		—	

activity in the lower limbs was recorded by an experienced physiotherapist. From this information the following clinical and radiological factors were studied in detail.

Stability of hip—An antero-posterior radiograph of the hips was taken with the lower limbs in neutral position. This radiograph was compared with those taken before and after operation. In many of the children the hips were visible on a pyelogram done in the neonatal period. We have used the classification suggested by Carroll and Sharrard (1972) in the radiological grading of our hips (Table III). We regarded those hips graded as normal or dysplastic to be radiologically stable whereas those which were subluxated or dislocated were unstable.

The number of radiologically unstable hips rose from 34 per cent at birth to 51 per cent at the time of operation. Posterior psoas transfer was effective in achieving or maintaining hip stability, with an improvement in the proportion of stable hips from 49 per cent before operation to 94 per cent at review.

Hip mobility and fixed deformity—Good mobility was defined as at least 90 degrees of flexion, 50 degrees of abduction and no fixed deformity (forty-four hips). Hips with less mobility than this but no fixed deformity and

TABLE IV
HIP MOBILITY AND FIXED DEFORMITY

Hip mobility	Number of hips	Fixed flexion (degrees)	Number of hips
Good	44	0-20	16
Stiff	8	20-30	1
Fixed deformity	19	Over 30	3
Ankylosed	1		
Total	72	Total	20

metres independently was assessed. None of the children who needed trunk support was able to accomplish this slight amount of useful activity (Table V).

TABLE V
AMOUNT OF BRACING NEEDED TO WALK

	Children
No caliper	7
Below-knee calipers	6
Full-leg calipers	13
Trunk bracing	12
Wheel-chair	1
Too young to assess	5
Total	44

TABLE VI
MOTOR POWER (SIXTY-SIX HIPs)

	Before operation	After operation	Change
Flexion	3.7	2.1	-1.6
Adduction	3.2	2.8	-0.4
Abduction	1.0	1.6	+0.6
Extension	1.0	1.4	+0.4
Medical Research Council Grades 0-5 averaged			

Motor power—The muscle power about sixty-six hips at the time of review was compared with that recorded before operation. Of the Medical Research Council Gratings (1942) an average was taken to give an overall

impression (Table VI). The psoas transfer did result in a small redistribution of muscle power around the hip joint, with the power of flexion effectively reduced and the power in the abductors and extensors marginally improved.

Twelve hips had abduction and extension of power 3 after operation. In all of these the gluteal muscles had a power of grade 1 or 2 before transfer and this had been increased by the posterior psoas transfer.

The relatively low average of the figure of flexor power before operation is not only because of the high proportion of children with first and second lumbar segment deficits in this series, but also to the underestimation of power that results from inefficient muscle action in the presence of hip dislocation. Thus the reduction in flexor power after transfer may in fact be greater than is suggested by the average of the figures.

The other hip—The natural history of the hips not treated by psoas transfer in those sixteen children in whom unilateral transfers were done was investigated. All

children in this group were over the age of eighteen months at the time of transfer and were observed for an average period of four and a half years.

Thirteen of the hips had the same muscle imbalance as on the operated side. Nine hips remained stable, but one has now had muscle transfer prophylactically to reduce severe muscle imbalance. Four untreated hips became unstable radiologically, two of which have now had transfers; the remaining two hips have not been treated for reasons unrelated to the hip joint.

These findings suggest that after the age of eighteen months it is less common for muscle imbalance to cause dislocation (Figs. 4 and 5).

GENERAL ASSESSMENT

We considered a good result to imply that the child had achieved the full aims of the operation—that is, the hip was stable and mobile with no fixed deformity, and the child could sit, stand and walk at least twenty-five metres without the need for bracing above hip joint level. Twenty of the forty-four children fulfilled all these criteria. Five children were graded satisfactory. They also met the criteria of a good result but slight fixed hip flexion (up to 20 degrees) persisted. Nineteen children did not meet these criteria and are classed as poor results.

FACTORS AFFECTING RESULTS

We were able to relate these results to the following factors: 1) neurological level; 2) age at time of posterior psoas transfer; and 3) radiological hip stability at the time of transfer. Of these, the neurological level was the most important. Other factors such as intelligence, ambition, upper limb ataxia and environmental factors are also important but were not assessed.

Neurological level—Children with normal neurological function preserved in the third and fourth lumbar segments usually did well, whereas the results in those with higher deficits were less predictable (Table VII).

TABLE VII
RESULTS RELATED TO NEUROLOGICAL LEVEL

Neurological level	Good or satisfactory		Poor result	
	Number	Per cent	Number	Per cent
L.1/2	9	37	15	63
L.3/4	15	83	3	17
L.5	1	50	1	50

Age at time of transfer—There was no definite relationship between the overall result and the age at the time of psoas transfer. There was, however, almost a year's difference in age at the time of transfer between those hips finally graded as radiologically normal (average

FIG. 4

Paralytic dislocation of the left hip and dysplasia of right hip at the age of two and a half years.

FIG. 5

The same child shown in Figure 4 at the age of 8 years. Both hips are normally contained, there is no fixed deformity, and the child walks well without calipers. On the left, adductor tenotomy, open reduction of the hip joint, and posterior psoas transfer have been performed. On the right only adductor tenotomy was necessary because full abduction had not been maintained by stretching.

twenty-five months) compared with those graded as dysplastic (average thirty-six months).

Radiological stability of hip at time of transfer—There was a relationship between the amount of radiological hip dysplasia at the time of operation and the overall result. If the hip was radiologically stable 69 per cent of the children achieved a good or satisfactory result. If the hip was unstable 47 per cent of the children achieved a good or satisfactory result.

DISCUSSION

The aims of hip surgery in children with lumbar myelomeningocele are to help the child to walk, to achieve or maintain stability of the hip joint and to correct or prevent fixed deformity. Posterior transfer of the insertion of the psoas muscle permanently reduces the power of the deforming and dislocating flexor force but it is doubtful if complete correction of the muscle imbalance is ever achieved. The transferred muscle probably serves as a tenodesis; occasionally it will supplement any gluteal power that is present to produce active abduction or extension of the hip joint.

In this series 57 per cent of the children achieved an acceptable result following posterior psoas transfer. If those children with high deficits (innervation down to and including the second lumbar segment) are excluded, 83 per cent of those with third and fourth lumbar segment innervation had an acceptable result at the time of review.

Hip instability—The effectiveness of posterior psoas transfer in maintaining hip stability in this series supports the experience of Sharrard (1964a); Menelaus (1969, 1971) and Freehafer, Vessely and Mack (1973). Most of the operations in this series were done before the children had reached their third birthday. Rueda and Carroll (1972) found only six of fifteen hips treated by posterior psoas transfer at an average age of three and a half years stable at review and said that delay in operating might be a cause of failure.

Femoral osteotomy to correct excessive valgus or anteversion of the femoral neck has been well described in the treatment of paralytic hip instability (Blundell Jones 1954; Somerville 1959; Parsc hand Schulitz 1972). Carroll and Sharrard (1972) found it necessary to do forty-one femoral osteotomies on fifty-eight hips treated by posterior psoas transfer. However, we agree with Menelaus (1969) that femoral osteotomy is seldom necessary if the psoas is transferred posteriorly before the age of eighteen months. Only four femoral osteotomies were done in this series.

In the children who underwent unilateral transfers in this series only four of thirteen hips not operated upon with a similar severe muscle imbalance subsequently became unstable. This suggests that muscle balance gives place to structural changes in the hip joint as the main factor on which stability is dependent after the age of about eighteen months. This is in agreement with the experience of McKibbin (1973), who found that only one

of eleven hips subluxated after periods of splintage in abduction and medial rotation maintained until at least the age of two years. Paralytic subluxation due to poliomyelitis is rare if the onset of paralysis is after the age of eighteen months (Parsons and Seddon 1968). We have found that with the paralysis that results from a lumbar myelomeningocele dislocation can occur at any age (nine years was the latest observed in this series), but it is less likely after the age of eighteen months.

Walking ability—Hoffer, Feiwell, Perry and Bonnett (1973) found that less than 50 per cent of patients with lumbar myelomeningocele achieved a useful level of walking ability, but they did not correlate this with the level of innervation that was preserved. The least level of activity that we have considered useful is the ability to sit down, stand up and walk twenty-five metres without help. In our series, after posterior psoas transfer 83 per cent of children with innervation preserving the third or fourth lumbar segments achieved this capacity, compared with 37 per cent in which innervation was only preserved in the first or second lumbar segments. No child who required trunk bracing had a useful level of walking ability and there is little doubt that many of these will eventually have to accept a wheel-chair existence. The level of neurological activity that is present is therefore an important factor in the prognosis.

The management of hip instability

The aims of hip surgery in these children sometimes appear to conflict. It is important to help those children who are likely to obtain an increase in function by operation but to avoid operation in those who will not.

In patients with radiologically unstable hips with muscle imbalance it is best to operate as soon as this is feasible. By the age of eight months a general assessment of the child will usually allow a decision to be made about the advisability of orthopaedic procedures. Posterior psoas transfer, and when necessary open reduction and open adductor tenotomy, should be done before secondary radiological joint changes become irreversible.

After the age of two years transfer should be restricted to children with evidence of neurological activity in the third or fourth lumbar segments—that is, when there is voluntary activity in the quadriceps (Sharrard 1964b). Children with higher deficits are unlikely to gain any functional benefit from this operation and it may be questioned whether the hip instability needs to be treated at all. Nevertheless, reduction of the hip makes it easier to control fixed deformities and may be justified despite the fact that the child will require extensive bracing. Unilateral dislocations are usually best reduced, regardless of neurological level, in order to avoid the problems of leg length inequality.

In children with stable hips regular stretching, with adductor tenotomy if necessary, may control the development of fixed flexion and adduction deformities and allow a full range of movement to be maintained. Accurate

testing of muscle power in infancy helps in the assessment of the child's future walking potential, and a decision regarding treatment can be made if progressive radiological hip dysplasia develops. In children with high lumbar deficits dysplasia does not invariably progress to

dislocation, and a wait-and-see policy can avoid unnecessary operation.

These points are important in providing a rational approach to the surgical management of hip instability in lumbar myelomeningocele.

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