THE USE OF SPLITNAGE IN THE MANAGEMENT OF PARALYTIC DISLOCATION OF THE HIP IN SPINA BIFIDA CYSTICA

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Instability of the hip in spina bifida results primarily from muscle imbalance around the joint, the flexor and adductor groups predominating over the paralysed abductors and extensors (Sharrard 1964). It seems logical therefore that if such instability is to be controlled permanently this imbalance must be redressed. Sharrard showed that this could be done by removing the tendon of the iliopsoas, which is a powerful deforming force, and transferring it to the back of the greater trochanter where it could assist the paralysed abductor and extensor groups.

Further experience with this procedure has shown that, whereas it is very effective in cases of subluxation and recent dislocation, when the displacement is of longer standing secondary dysplastic changes may have developed, and in these circumstances muscle rebalancing on its own may not be sufficient to maintain stability (Sharrard and Carroll 1970). Such a finding is not unexpected and conforms to the time-honoured principle that in any paralytic deformity the elimination of that deformity is an essential preliminary to muscle rebalancing. Consequently, operation on the hip itself, or one of its components, may be necessary in addition to the muscle transfer.

In order to avoid this some surgeons, including the writer, have adopted a policy of operating as soon as possible after the instability is recognised, provided only that the child is big enough for the procedure to be technically feasible, which is usually at about four or five months of age (Sharrard 1971).

There is no doubt that such a policy simplifies the management of the hip, but unfortunately, as in any other form of prophylactic surgery, it inevitably happens that the operation is sometimes performed on patients who—for reasons originally unforeseen—ultimately derive no benefit from it. This is particularly liable to happen in children with meningomyelocele, in whom the prognosis in the first year of life is so very uncertain. Approximately 15 per cent will die in the ensuing twelve months, and obviously if this could have been predicted for an individual it would have been kinder to have spared him yet another operation. Others will eventually prove to be so handicapped for reasons unconnected with the stability of their hips that this becomes irrelevant to their overall well-being. Still others will suffer an increased paralysis (Brocklehurst, Gleave and Lewis 1967; Duckworth and Brown 1970), so that a muscle transfer which appears to be indicated at a few months of age may subsequently become invalidated.

Since, however, the penalty for delay in treating the hip is increased difficulty when stabilisation is eventually attempted, it would obviously be better if some way could be found of postponing operation until the child's future prospects were more clearly revealed, without at the same time allowing the joint to deteriorate. The use of splintage is an obvious solution, as in congenital dislocation, but this has not found favour in the past because of the special problems provided by the neurological deficit leading to skin ulceration, pathological fracture, and the development of fixed deformity (Sharrard 1969, Menelaus 1971). The problem of deformity is particularly serious, especially if the "frog" position is used, because in these circumstances the iliopsoas is able to shorten to its greatest extent (McKibbin 1968), and since there are no extensor muscles to oppose it when the splintage is released, the leg may remain fixed in this grotesque position (Fig. 1).

In order to meet these objections a splint was devised to conform with the following criteria: it must be removable, so that the condition of the skin can be readily inspected;
it must allow the hip to move; and the position of immobilisation chosen must be that in which the iliopectos is stretched to its greatest extent, which is extension and medial rotation. The results obtained by using such a device are described.

**CLINICAL MATERIAL**

Cases were selected for treatment from a series of children under the age of three attending a special spina bifida clinic. All those showing clinical or radiological evidence of hip instability were considered, providing a total of fourteen cases.

**Age**—At the beginning of treatment the average age was fifteen months. The youngest child was aged four months and the oldest three years.

**Degree of instability**—Five patients had a complete dislocation of one hip only, and two had both hips dislocated. Seven patients had moderate to severe degrees of unilateral subluxation.

![Fixed flexion and abduction deformity in a case of paralytic dislocation, after prolonged splintage in the “frog” position.](image)

**Extent of paralysis**—Muscle charting was carried out at the end of treatment and this was compared with similar observations made at birth or soon afterwards. At the time of review eight children showed total paralysis of the abductor and extensor muscles of the affected hips with preservation of power to at least grade 4 (Medical Research Council grading) in the flexor and adductor groups. Six out of the seven children with complete dislocations were in this group. The remaining six had almost complete paralysis of the affected limb with no more than M.R.C. grade 2 in the hip, flexor and adductor groups. Three of the children with flail limbs had been noted earlier to have preservation of the flexor and adductor groups which had subsequently deteriorated.

**METHOD OF TREATMENT**

The object was to produce concentric reduction of the hip and to maintain it until a decision about operation had been made.

Treatment was begun in thirteen out of the fourteen children as soon as possible after the instability was recognised. The remaining child was three years old with high bilateral dislocations and severe acetabular dysplasia, so that it was decided not to attempt treatment. **Reduction of the dislocation**—In all the cases of subluxation reduction was easily achieved by abducting and slightly medially rotating the lower limb. When there was complete dislocation a preliminary open adductor tenotomy was needed, followed by immobilisation in knee plasters in abduction for three weeks, after which the limbs were transferred to splints.
Splintage—A specially designed splint was used to hold the limbs in abduction, extension and medial rotation. Essentially this was a polythene version of the knee plasters described by Batchelor (1959) for the treatment of congenital dislocation of the hip (Fig. 2). The knee cylinders, secured by Velcro fastenings, were connected by an adjustable abduction bar attached by a ball-and-socket joint adapted from a type of Denis Browne splint so that the amount of abduction and medial rotation could be individually adjusted. The splints were first applied in abduction and neutral rotation and an antero-posterior radiograph of the hips was obtained. If the hips were found to be concentrically reduced the joints on the splint were tightened with a spanner. In some instances it was necessary to add a little medial rotation to complete the reduction but this was seldom more than a few degrees. Initially the device was worn as a night splint only, but when the child became more accustomed to it, it was usually worn for additional periods during the day. The children were seen at monthly intervals to ensure that no fixed deformities had developed, and radiographs were obtained at three-monthly intervals. The splints were worn at least until the child was two years of age, and longer if there was radiological evidence of continuing improvement in the appearance of the hip. Movement of the hip was encouraged as far as possible while the splint was worn; the child was allowed to sit up with it on, and also lay prone for a time each day to minimise the development of fixed flexion contractures. Those children who showed a desire to stand and walk were permitted to have their splints off to do so and calipers were fitted in the usual way as dictated by their level of innervation.

RESULTS

The splints were well tolerated by all the children except one who proved so emotionally labile that treatment had to be abandoned after a few days. Only minor difficulties were encountered with skin soreness, and splintage never had to be discontinued for this reason. There was no instance of an increase in fixed deformity and there were no pathological fractures. In two cases of complete dislocation the hip was found not to be fully reduced on the splint. In one of these the child’s general condition was so poor that open reduction was considered unjustifiable and treatment was abandoned. In the other, splintage was continued for a time but the head showed no sign of sinking in and treatment was therefore discontinued as the child was completely paraplegic.

Eleven children remained. Six of these had strong hip flexors and adductors: there were four complete dislocations and two severe subluxations. In the remaining five the lower limbs...
Case 1—Lumbo-sacral meningomyelocele closed within twenty-four hours of birth. Figure 3—At birth. There was a preponderance of flexor and adductor activity in the right hip, which was clinically dislocated. Figure 4—At the age of 6 months. The right hip is still dislocated. Figure 5—After six months of splintage the right hip has become stable but considerable dysplasia is still present. Figure 6—At the age of 30 months, six months after the discontinuation of splintage. Only minimal subluxation of the right hip is now present.
were effectively flail: each had one subluxated hip. After treatment all six children in the first group showed considerable improvement both in the appearance of the acetabulum and in the stability of the hip. The amount of improvement was such that in five patients splintage was abandoned after an average time of twenty months. These children have now been followed for an average time of nine months since splintage was discontinued, and there has been no further deterioration. The remaining patient in this group did show some recurrent subluxation requiring an iliopsoas tenotomy for its control (Case 4).

In none of the five in the second group was there any significant improvement in the radiological appearance of the hip. In one patient whose hip had been splinted for two years without improvement there was rapid deterioration in the hip when splintage was discontinued.

**CASE REPORTS**

**Case 1**—A lumbo-sacral myelomeningocele in a girl was closed within twenty-four hours of birth. The right hip was thought clinically to be dislocated at the time (Fig. 3), and this was confirmed later (Fig. 4). When the child was six months old an open adductor tenotomy was performed and after three weeks of knee plasters splintage was begun. The child had then intact innervation down to the fifth lumbar root on the affected side. Rapid improvement of the hip resulted (Fig. 5), the joint became stable and the acetabulum improved so that after twenty months splintage was discontinued. Six months later the hip is still in joint although there has been a slight increase in subluxation (Fig. 6).

The innervation has deteriorated in both lower limbs since the time of birth, and on the affected side there is now strong activity down only to the third lumbar root.

**Case 2**—A girl’s lumbo-sacral meningomyelocele was closed soon after birth. At this time the right hip was seen to be dislocated and Ortolani’s sign was clearly present. The child had complete paralysis below the fourth lumbar segment. At fourteen weeks the dislocation was confirmed clinically and radiologically (Fig. 7) and was reduced after an open adductor tenotomy. After four weeks of knee plasters splintage was applied. The stability of the hip rapidly improved (Fig. 8) and after fifteen months the hip was thought to be normal and the splint was discarded. Five months later the position appears to be essentially unchanged (Fig. 9). There has been no alteration in the level of innervation.

**Case 3**—A lumbo-sacral myelomeningocele was closed within a few hours of birth. On the left side the hip flexors and adductors were noted to be acting strongly and it was thought that there was slight activity in the abductor and extensor group. Progressive subluxation occurred until eighteen months when there was an almost complete dislocation (Fig. 10). Adductor tenotomy was performed and after a few weeks of plaster splintage was begun. Considerable improvement occurred both in appearance and in stability of the hip (Fig. 11), and splintage has recently been abandoned.

**Case 4**—A meningomyelocele in a girl was closed on the day of birth. All muscle groups were then working except the hip adductors on the right; a subluxation of the right hip was present. By eight months the hip was seen both clinically and radiologically to be dislocated completely (Fig. 12). An adductor tenotomy was carried out and splintage instituted after the usual three weeks in plaster. By eighteen months the hip appeared to be quite stable (Fig. 13) and splintage was abandoned. Innervation was by this time reduced to the first four lumbar roots on the right side. Five months later subluxation recur (Fig. 14) whereupon the iliopsoas tendon was divided but not transplanted and splintage was reinstituted. The hip again became stable and splintage was again abandoned after a further five months. One year later the hip still appears stable (Fig. 15).

**Case 5**—A meningomyelocele was closed on the first day of life. At that time the legs were thought to be completely paralysed, and apart from a slight flicker in the hip flexors on the right side no activity was ever detected subsequently. By the age of eight months both hips were thought to be slightly subluxated (Fig. 16) and splintage was begun in order to prevent deterioration. By twenty-two months the radiographs showed that the position was virtually unchanged (Fig. 17) and splintage was therefore abandoned. Four months later the left hip had become completely dislocated (Fig. 18).

**DISCUSSION**

By the use of the splint described it has proved possible to prevent deterioration in all of the hips so far treated, and in some instances to produce an actual improvement in stability without encountering any of the complications which have previously been associated with
this method. Skin ulceration was not a problem because the device could easily be removed and reapplied by the parents so that any pressure areas could be recognised before irretrievable damage had been done. It is important however that when the splint is first used it should

FIG. 10
Case 3—Lumbo-sacral meningomyelocele closed within a few hours of birth. Figure 10—Age 18 months. The right hip is severely subluxated. Figure 11—Age 42 months. After splintage for two years the right hip has become normal.

FIG. 11

be worn only for an hour or so on the first occasion, the duration being gradually increased when it is evident that the skin is unaffected and no adjustments are required. Pathological fractures did not occur, probably because the splintage was intermittent and because in most
instances periods of weight-bearing exercise were permitted. The most gratifying feature was the absence of fixed deformity. Fixed flexion was prevented by the weight of the splints while the secondary abductor action of the iliacus, which is responsible for much of the fixed deformity associated with the frog position (McKibbin 1968), was eliminated by keeping the limb in extension and medial rotation.

These findings suggest that nothing is lost by deferring operation. In those children who ultimately prove to need it the position may actually be improved by a decrease in the dysplasia, while those who die or prove unsuitable for surgery will have been spared an unnecessary operation. It is recommended therefore that when a child with a meningomyelocele presents with hip instability in the first eighteen months of life and the characteristic muscle imbalance is present no definite decision about a muscle transfer operation should be made at that time. Instead the joint should be reduced, with the assistance if necessary of an adductor tenotomy, and the legs splinted in accordance with the criteria which have been defined. This should be continued at least until the child is two years old and longer if there is radiological evidence of continuing improvement. Once it has become apparent that improvement has ceased the hip problem can be reconsidered against the background of the child’s general condition. If this is satisfactory and the iliopsoas is still acting strongly it can then be transferred with the expectation that with a well reduced hip and a good acetabulum permanent stability will result.

Once the splintage has been discarded the timing of the subsequent operation requires
consideration. In theory, since the original muscle imbalance is still present, it might be expected that redislocation would soon follow and that therefore operation should not be long delayed. However, since the purpose of this investigation was to determine ways in which unnecessary operations could be avoided it was decided to await actual proof of this tendency before proceeding. On this basis it has in fact been necessary to operate on only one patient so far (Case 4) even though some of the others have been free of splintage for up to one year. This observation is of some practical importance in that it indicates the urgency of operation to be not so great as might have been expected, but it also raises certain theoretical considerations in relation to the mechanism by which these dislocations come about.

The mechanism of dislocation—In most forms of paralytic dislocation of the hip the muscle imbalance is present at the time of birth—as in spina bifida and cerebral palsy. When the paralysis is acquired the liability to dislocation is very much less and appears to be related to the maturity of the individual at the time of onset. Thus the condition is virtually unknown in the adult unless there is some additional destructive lesion—such as sepsis—within the joint. A particularly good example is provided by traumatic paraplegia in the adult which often produces a flexor adductor muscle imbalance from loss of the fifth lumbar and the sacral segments; yet after an immense experience of such cases Holdsworth (1969) stated that he had never seen such a dislocation unless it were accompanied by sepsis from a neighbouring bed-sore or other source. Similarly in the twenty-seven patients originally described by Watson
Jones (1926) twenty had some associated pathological condition within the joint while the remaining seven had been paralysed during childhood. Evidence from the study of poliomyelitis suggests that the vulnerability of the hip to muscle imbalance is in fact confined to the first few years of development, and that if the paralysis is acquired after that time subsequent dislocation is most unlikely (Blundell Jones 1954). In the series of fifty-six dislocations from this cause studied by Parsons and Seddon (1968) there was only one case in which the paralysis had occurred after the age of eighteen months and even that was probably a case of true congenital dislocation. The reason for this special vulnerability of the very young hip is unknown, although the rapid rate at which dysplasia develops after a neonatal dislocation compared with that which follows a later dislocation suggests that the tissues are particularly susceptible to their mechanical environment at this stage. There is also some evidence that the acetabulum is shallower at birth than at any time later (Le Damany 1903, Morville 1936, Ralis and McKibbin 1973), and this may be a contributory factor.

Whatever the reason, these observations do provide a possible explanation for the surprising delay in redislocation in the cases in this series. If splintage could enable an unstable hip to develop normally, then by the age of two or three it might have reached that degree of maturity which normally renders the joint immune from the effects of muscle imbalance and would no longer be liable to dislocation. In practice it is unlikely that such completely normal development would result from splintage alone and it is not suggested that in the presence of a strong muscle imbalance the instability can be completely controlled in this way. Nevertheless it is evident that the tendency to dislocate is very much less than formerly, and it may be that in a borderline case where the imbalance is not marked, permanent control could be achieved either by splintage alone or together with some simple procedure such as psoas tenotomy, as in Case 4.

The truth of this can only be resolved by time and more experience, but for the present there does not seem to be any reason to urge that operation be undertaken after a period of splintage until the liability to redislocate has become manifest.

There remains the problem of the unstable hip that is associated with total paralysis. The cause of the displacement here must be presumed to be a previously existing muscle imbalance which subsequently became eliminated by further paralysis and indeed this situation arose in some of the cases in the present series. It had been expected that these would be the cases in which splintage would be most effective because of the absence of muscle imbalance, whereas in fact the very opposite was found. The only explanation which can be offered is that the stimulus for the joint to resume normal development must be dependent not only on the fact that it has been reduced but also on the amount of movement taking place. Certainly such development was very much greater in those children with some preservation of muscle function. This conclusion is reinforced by previous experience with the use of a simple divaricating splint of the Forrester-Brown type in which the hip was held reduced but could not move. With this device, although deterioration appeared to be slowed, no instance of actual improvement was ever seen. Since splintage appears to exert only a temporary restraining effect on the flail dislocation there seems to be no reason to advocate its use.

SUMMARY

1. A specially designed splint is described with which it is possible to maintain the reduction of a paralytic dislocation in a child with spina bifida cystica. The results of its use in a series of thirteen cases are recorded.
2. It is suggested that all such children presenting in the first year of life, in whom the power of the flexor and adductor muscle groups is preserved, should be treated initially in this way until the prognosis for the individual can be accurately assessed.
3. The theoretical implications of the findings are discussed.
REFERENCES


