THE NATURAL HISTORY OF HIP DEFORMITY IN MYELOMENINGOCELE

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We studied 1061 children with myelomeningocele, reviewing 3184 pelvic radiographs from 802 patients. Hip dislocation had occurred by the age of 11 years in 28% of children with a thoracic neurosegmental level, 30% of those with an L1/2 level, 36% of L3, 22% of L4, 7% of L5 and only 1% of those with sacral levels. Hip dislocation was not inevitable even when there was maximal muscle imbalance about the hip. The average hip flexion contracture in children aged 9 to 11 years was significantly greater in those with thoracic (22°) and L1/2 (33°) levels than in those with L4 (9°), L5 (5°) or sacral (4°) levels.

Our findings indicate that muscle imbalance is not a significant factor in the production of flexion deformity or dislocation of the hip; both are commonly seen in the absence of imbalance. The restoration of muscle balance should no longer be considered to be the principal aim of the management of the hip in children with myelomeningocele.

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Children with myelomeningocele commonly develop contractures of the hip; some may suffer dislocation, and the natural history of these deformities is important in management. Sharrard (1964) reported the deformities present at the age of one year in 183 children with myelomeningocele. He found no hip dislocations or flexion deformities in limbs with no innervation below T12 and therefore no active muscles around the hip. In hips with innervation to L1 and L2, hip adduction and

flexion contractures had developed, and most were subluxed. He considered that these hips would inevitably dislocate by the age of five years. Most of the hips innervated to L3 and L4 had dislocated by one year and he stated that the others would do so within another year. Of 27 hips innervated to L5, seven were dislocated and 12 were subluxed; Sharrard stated that the subluxed hips would inevitably dislocate by the age of seven years. His view was that muscle imbalance caused contractures and dislocations, and he suggested that the restoration of muscle balance around the hip would prevent these and improve walking ability.

We report a much larger study of the development of hip deformity in children with myelomeningocele, using data collected prospectively and before any operation, over 17 years in two centres. A previous paper from the same centres has discussed the progression of hip flexion contracture (Shurtleff et al 1986).

PATIENTS AND METHODS

Of the total study group of 1061 children with myelomeningocele, details of 764 have been collected by DBS from Seattle, WA since 1971, and 297 from Melbourne, Australia by MBM since 1976.

At the first attendance, at any age, a specially trained physiotherapist recorded the range of movement in each direction at each lower limb joint, muscle strength on the standard international scale for all muscles of the lower limbs (Daniels and Worthingham 1986), ambulatory ability and any orthopaedic operations on the lower limbs. Interobserver differences in these measurements have been found to be small (Bartlett et al 1985).

The neurosegmental level in each case was assessed by a modification of Sharrard's classification (Table I), and three children with gross asymmetry of level were excluded. An overall neurosegmental level for each child was determined from all available assessments in the knowledge that muscle strength becomes more consistent after the age of five years (McDonald, Jaffe and Shurtleff 1986). The distribution of levels is shown in Table II.

A total of 3184 radiographs of 802 patients were assessed and hips were categorised as dislocated when there was no area of congruity between the femoral and acetabular surfaces. All observations relating to the

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natural history of deformities were made before any hip operation.

Data were stored using the Patient Data Management System (IBM PC compatible software standardised by the International Myelodysplasia Study Group) and R-BASE. Statistical analysis was by SPSS-X on a mainframe computer of the University of Melbourne and SPSS/PC. Methods included one-way analysis of variance and multiple comparisons by the Tukey-HSD test, difference of means by Student's *t*-test and survival curves and comparisons using Lee-Desu Statistic.

RESULTS

Hip dislocation. The proportion of hips remaining undislocated was related to age for each neurosegmental level and is reported in the form of survival curves to indicate the ages at which dislocation occurred. Pelvic radiographs were available for most children at about two-yearly intervals, some as part of urological investigations. Because of the intervals, the diagnosis of some dislocations was delayed and the curves may be displaced to the right.

When operations had been performed it was impossible to determine whether the hips would have dislocated without surgery. Accordingly, we give two curves for each neurosegmental level: one is for the observed dislocation rate, the other includes dislocations and hips on which an operation has been performed (Fig. 1). The natural dislocation rate without the influence of

any operations must lie between these curves. They show clearly that patients with an L3 neurosegmental level tend to dislocate early, with no more dislocations after the age of three years, whereas patients with thoracic and L1/2 levels continued to suffer hip dislocations even after the age of ten years (Table III). The graphs also show that 42% of the hips with L3 neurosegmental level, 67% with L4 level and 80% with L5 level never dislocated or had operations performed on them.

Statistical analysis of the survival curves for dislocation or operation, using Lee-Desu Statistic on SPSS-X, showed no significant difference between the curves for thoracic, L1/2 and L3 levels, but all three groups had significantly higher dislocation rates than L4, L5 and sacral levels.

Hip flexion contracture. We calculated the average hip flexion contracture in unoperated patients for each neurosegmental level and for those with no loss for each of the age categories 0 to 3 months, 9 to 15 months, and 9 to 11 years. The results are shown in Tables IV, V and VI, which include only one reading per child within each age category, although one child may appear in one, two or all three age categories. This means that the single observations are not independent and cannot be compared in terms of neurosegmental levels between age categories, but only within each age category. We used one-way analysis of variance and Tukey-HSD multiple comparison methods.

Hip flexion contracture is common in normal neonates (Hoffer 1980); we found it in all neurosegmental

Fig. 1

Hip dislocation rates in children with myelomeningocele. Results are for different neurosegmental levels and expressed as percentages of hips not dislocated at the various ages (see text).

Table I. The assessment of neurosegmental level in children with myelomeningocele modified from Sharrard (1964)

Level	
Thoracic	No active movement at the hip
L1	Iliopsoas grade 2 or better
L2	Iliopsoas, sartorius and adductors all grade 3 or better
L3	Quadriceps grade 3 or better, also meet criteria for L2
L4	Medial hamstrings or tibialis anterior grade 3 or better; also meet criteria for L3
L5	Lateral hamstrings grade 3 or better; also meet criteria for L4 plus one of the following three: gluteus medius grade 2 or better, peroneus tertius grade 4 or better, tibialis posterior grade 3 or better
S1	Two of the following three: gastrocnemius/soleus grade 2 or better, gluteus medius grade 3 or better, gluteus maximus grade 2 or better; also meet criteria for L5
S2	Gastrocnemius/soleus grade 3 or better and gluteus medius and gluteus maximus grade 4 or better, also meet criteria for S1
No loss	All leg muscles have normal strength

Table III. Results of survival analysis of hip dislocation in children with myelomeningocele

Level	Number	Percentage dislocated	Percentage dislocated or operated on
At 36 to 59 months			
Thoracic	75	17	50
L1/2	22	12	55
L3	37	36	48
L4	155	16	23
L5	44	7	17
Sacral	77	1	2
At 108 to 131 months			
Thoracic	28	28	59
L1/2	13	30	75
L3	19	36	50
L4	55	22	33
L5	17	7	20
Sacral	30	1	2

Table V. Average hip flexion contracture in children with myelomeningocele from 9 to 15 months of age

Level	Number of hips	Hip flexion contracture (degrees)	
		Mean	SD
Thoracic	87	11.44	16.63
L1/2	36	9.64	14.63
L3	31	7.74	13.65
L4	184	4.92	9.88
L5	82	5.98	12.30
Sacral	118	1.15	7.36
No loss	38	0.0	6.97

Table II. Distribution of neurosegmental levels in 1061 children with myelomeningocele studied at two centres

Level	Seattle (n = 764)	Melbourne (n = 297)
Thoracic	139	71
L1	30	14
L2	25	7
L3	60	27
L4	186	86
L5	82	27
S1	90	49
S2	76	12
Asymmetrical	2	1
No loss	74	3

Table IV. Average hip flexion contracture in children with myelomeningocele from birth to age three months

Level	Number of hips	Hip flexion contracture (degrees)	
		Mean	SD
Thoracic	128	21.31	20.57
L1/2	54	26.43	17.14
L3	39	32.21	16.49
L4	205	28.51	15.66
L5	82	27.5	11.53
Sacral	118	18.25	13.17
No loss	28	6.0	16.6

Table VI. Average hip flexion contracture in children with myelomeningocele from 9 to 11 years of age

Level	Number of hips	Hip flexion contracture (degrees)	
		Mean	SD
Thoracic	61	22.16	21.44
L1/2	12	32.91	10.54
L3	13	11.23	15.59
L4	49	9.48	17.47
L5	39	5.38	10.22
Sacral	100	3.53	8.76
No loss	24	-1.25	7.10

levels of children with myelomeningocele (Table IV). The average hip flexion contractures between 9 and 15 months are shown in Table V. The thoracic group has a significantly higher average than the L4, L5, sacral and no loss groups. The L1/2 group has a significantly higher average than the sacral and no loss groups, but there are no significant differences between other groups.

Between 9 and 11 years the average hip flexion contractures show a significantly higher average for the thoracic group than for the L4, L5 and sacral groups (Table VI). The L1/2 group had a significantly higher average than the L3, L4, L5, sacral and no loss groups. The L4 group average was significantly higher than the no loss group, but there were no significant differences between the other groups.

We made a specific analysis to determine whether the lower average hip flexion contracture in each of the L4, L5 and sacral groups at 9 to 15 months was due to exclusion because of previous surgery, and found that this was not the case. The average hip flexion contracture in patients who had surgery at less than 15 months was 15° for those with L3 or more distal neurosegmental levels (n = 20) and 29° for those with thoracic or L1/2 neurosegmental levels (n = 12).

DISCUSSION

The data which we have used have been collected by carefully-trained personnel to minimise interobserver and intraobserver error (Bartlett et al 1985; Broughton et al 1989). Our results from the study of 1061 children over a period of 22 years in Seattle and 17 years in Melbourne differ from those of Sharrard (1964). He studied 183 children and his observations led him to postulate that muscle imbalance was the cause of dislocation and deformity of the hip.

For lesions at the thoracic level we found unexpectedly high rates of dislocation in the absence of muscle imbalance. We also found that flexion contracture of the hip was common in patients with high-level lesions: by the age of 11 years, in thoracic level patients, the average hip flexion contracture was 22° (n = 61). Children with adductor and flexor power associated with L1 or L2 levels at the same age did not have a significantly different average flexion deformity than did the thoracic level group with no muscle power at the hip. By the age of 11 years, only 30% of the L1/2 group of children had dislocated hips and 45% had been operated upon, usually for progressive flexion deformity. This means that 25% had neither dislocated nor been operated upon.

In the children with an L3 level, only 36% of hips had dislocated by the age of five years and this number did not increase in later life. In all, 42% of the hips of children with this level neither dislocated nor had operations.

In children with L4 neurosegmental level lesions, which should give the maximum muscle imbalance across

the hip, 67% of the hips neither dislocated nor required operation. The average hip flexion contracture in this group at the age of 11 years was significantly less than that in children with flail hips. In the group with an L5 neurosegmental level only 7% had dislocated by the age of five years, and at the age of 11 years, 80% had neither dislocated nor had operations.

We therefore agree with Beeker and Scheers (1986) that hip deformity and dislocation are not as common as was first assumed and that the development of these abnormalities cannot be predicted on the basis of the level of the lesion. The concept that muscle imbalance is responsible has been accepted and is repeated in most text books (Vander Brink 1980). It also provides the rationale for management which includes the correction of muscle imbalance. Our results indicate that these concepts are no longer valid.

The high incidence of hip dislocation and flexion contracture in high-level lesions leads us to hypothesise that completely paralysed hips dislocate simply because they are not kept in place by normal muscle tone. In addition, both prolonged sitting and spinal deformity may encourage the development of flexion contracture and dislocation. This means that hip deformity cannot be predicted from muscle imbalance about the hip, and that prophylactic surgery to correct muscle imbalance is illogical. Children with myelomeningocele require careful observation to detect the development of deformity or dislocation; it is not possible to predict the severity of any deformity or the occurrence of hip dislocation.

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