THE HIP IN THE MIDLUMBAR MYELOMENINGOCELE PATIENT

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As part of the requirements for the
Part III M Med (Orthopaedics)

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INTRODUCTION

The spectrum of spinal dysraphism can be devastating to both the patients and parents of affected individuals. In addition, apart from its many complexities, orthopaedic principles cannot always be applied directly from other related areas of orthopaedics. There are also the associated problems in other systems that need to be addressed concurrently. As a result these patients and their families are best managed with a team approach at a Spinal Defects Clinic where this type of expertise can be concentrated and developed.

Due to the many variables affecting the neurological pattern in the lower limbs of these patients and the effect of various general and regional factors on specific areas of analysis in the myelomeningocele patient, interpretation of the available literature is both difficult and confusing. This is particularly so in trying to define guidelines for the management of the hip in the myelomeningocele patient.

Areas of particular concern are:

(1) The definition of the neurological level

(2) Factors which influence ambulation

(3) More specifically whether hip stability is a factor

(4) The influence of hip deformity

(5) The natural history of the untreated hip

(6) The role of surgery

To elaborate on these factors in a little more detail and highlight the controversies:

(1) The definition of the neurological level

There are two main classifications of the neurological level in the lower limb of the myelomeningocele patient. The most widely accepted is that of Sharrard which has also been utilised by Menelaus (Sharrard 1964). Lindseth and more recently Asher have proposed a variation, based on an analysis of their patients, which essentially differs in the muscle supply of the L4 and L5 nerve roots (Lindseth 1976, Asher and Olsen 1983). Hoffer has proposed another variation in that he groups the L1, L2 and L3 levels of Sharrard into upper lumbar level and the L4 and L5 levels into lower lumbar (Hoffer et al 1973). The exact definition of the

neurological level is further complicated by the difficulties in assessing muscle power in a very young child and at best should be of muscle groups rather than individual muscles. Sensory assessment in defining the level is of limited practical use. There is individual variation within a specific level as has been shown by Sharrard (1964) and by DeSouza and Carrol (1976). Contractures in the lower limbs and spasticity further complicate the assessment and finally there is variation in the type of neurological lesion as has been shown by Stark and Baker (1967) in that approximately only 30% of patients have a Type 1 lesion (total loss of cord function below a specific level).

(2) Factors which influence ambulation.

A wide spectrum of factors have been reported to influence ambulation in these patients. More recently the neurological level has been emphasised as the most important determinant (Hoffer et al 1973, DeSouza and Carroll 1976, Feiwell, Sakai and Blatt 1978, Huff and Ramsy 1978, Stillwell and Menelaus 1983, Asher and Olson 1983,Samuelsson and Skoog 1988).

The role of fixed deformity around the hip is more controversial. Flexion deformity (>10°) may play a role

particularly if combined with other deformities according to Stillwell and Menelaus (1983) while Lee and Carroll (1985) definitely considered it an adverse factor.

Pelvic obliquity (>10^0) has been reported as significant by Feiwell, Sakai and Blatt (1978) while Samuelsson and Skoog (1988) disregard it, again Stillwell and Menelaus (1983) report it may be a factor if combined with other deformities.

Both Lee and Carroll (1985) and Samuelsson and Skoog (1988) reported scoliosis to influence ambulation.

Various other general factors also influence ambulatory potential such as I.Q., spasticity, body weight, motivation, renal function and rehabilitation facilities. It becomes extremely complex to analyse such a wide spectrum of factors although Asher and Olsen have done this recently and while they are all important, the neurological level remains the most significant determinant.

Most authors apply the criteria of Hoffer et al (1973) in defining ambulation and group community and household walkers together as functional walkers. Stillwell and Menelaus (1983) feel that the only true walkers are community walkers and therefore group household walkers as non walkers. Furthermore it has been shown that a small percentage of community walkers may in

fact deteriorate to non walkers with time. DeSouza and Carroll (1976) noted deterioration up to the age of 17 years while Stillwell and Menelaus (1983) reported 2 patients aged 18 and 20 years respectively who deteriorated to non walkers.This emphasises the need for long term studies in assessing ambulation.

(3) The role of hip stability.

Probably the most controversial factor is hip stability. Again as in other aspects of this condition authors differ in their definition of hip stability. This needs to be defined so that results can be compared.
In 1964 Sharrard described the posterolateral transfer of the iliopsoas to balance the muscle forces around the hip. The initial results were encouraging but a later report by Carroll and Sharrard (1972) noted that a significant percentage of patients had complications and that only 58,6% had located hips. Recently indications to reduce the hip in the myelomeningocele patient have become more selective (Menelaus 1980 and Carroll 1987) and the major soft tissue and bony procedures are no longer advised for all myelomeningocele patients with unstable hips. Those patients with a thoracic, L1 or L2 level who have little likelyhood of being functional

walkers should have soft tissue releases for fixed deformities around the hip if present.If ambulant they will utilise a swing through gait with above knee calipers and surgery should aim to facilitate this and also prevent pelvic obliquity when sitting. In our experience the L5 and S1 level hip is seldom a problem. However it is in the midlumbar (L3 and L4 level) patient, who has a good expectation of functional walking, that the controversy still rages.

Barden, Meyer and Stelling (1971), Feiwell, Sakai and Blatt (1978), Bazih and Gross (1981) and Samuelsson and Skoog (1988) have reported that hip stability does not influence ambulation. Lindseth (1976), Huff and Ramsy (1978), Asher and Olson (1983) and Lee and Carroll (1985), have supported locating the hip, particularly in the L4 level patient. More recently Menelaus (1980) has reported that reduction of the hips will not be responsible for the onset of functional walking at any age. The emphasis seems to be towards controlling deformity with hip stability a secondary factor. Whether walking is more efficient in those patients with located as opposed to dislocated hips has not been studied. Finally the issue of a unilateral dislocation with the attendant problems of leg length inequality and pelvic obliquity needs to be addressed.

(4) The influence of hip deformity.

The effect of flexion deformity of the hip and deformity around the hip on ambulation has already been addressed in the previous section. However there are also secondary problems related to deformity (Menelaus 1980). Flexion deformity results in a secondary hyperlordosis of the lumbar spine with poor posture and the long term effect of mechanical backache. Adduction and abduction deformities result in pelvic obliquity with trophic ulceration of the ischium, difficulties with sitting balance and problems with toilet.

(5) The natural history of the untreated hip.

This is important to ascertain in planning a management strategy. The only reported series in the literature is that of Sharrard (1964) and subsequently a later followup by Carroll and Sharrard (1972). Sharrard reported in 1964 that of 87 patients with L3 and L4 levels, 72 (82,8%) dislocated by 1 year while a further 13 were subluxed and invariably lead to dislocation. In 1972 Carroll and Sharrard reported that in a similar group of 43 patients, 28 (65%) dislocated at birth and a total of 33 (76,6%) by 2 to 3 years. Breed and Healy

(1982) mentioned the high risk of dislocation in this group. No-one has looked at L3 and L4 patients separately to ascertain if the incidence of dislocation is the same within each level.

(6) The role of surgery.

A wide range of surgical procedures have been advocated in the management of the hip of the myelomeningocele patient. Although each procedure has its proponents, a number of problems need to be addressed before considering surgery. The indications for surgery have already been touched on in the discussion on factors influencing ambulatory potential, role of hip stability and the role of deformity around the hip. In addition there are the complications of surgery such as failure to achieve or maintain a concentric reduction, which varies from 31% to 66% (Rueda and Carroll 1972, Drummond, Moreau and Cruess 1980) in reported series and may also reflect incorrect indications or failing to correct all components of the deformity, avascular necrosis, stiffness of the hip and pathological fractures. To expand on the options in a little more detail:

A) Adductor and psoas release

Various authors have advocated this, particularly in the younger patient although Sharrard (1964) reported that even if combined with anterior obturator nerve neurectomy and splintage it was insufficient to controll deformity in the myelomeningocele patient. Breed and Healy (1982) reported on an iliopsoas recession and adductor tenotomy (plus VDRO in 6 hips that were still subluxed after the initial procedure) and noted no recurrent flexion deformity and hip stability in 16 out of 19 hips (average follow-up 45 months) which they thought might be attributable to stronger hip extension by the medial hamstrings once the flexion deformity was eliminated. They did not find splintage an effective treatment modality. In contradistinction Carroll (1987) has recently advocated adductor release and splintage in the child under the age of 18 months. McKibbin's (1973) work is often quoted in reference to splintage of the myelomeningocele hip.In a series of 11 patients he applied splintage from birth, sometimes with an adductor tenotomy, and noted that 5 out of 6 patients with some muscle activity in the lower limbs stabilised their hips after an average of 20 months splintage and remained stable 9 months later. The 5 with flail lower limbs showed no improvement with splintage. Raycroft (1987) has

recently confirmed these results. A group of midlumbar patients who were splinted for a period of 2 years were compared to a similar group who did not have splintage. The former group underwent significantly less iliopsoas transfers and pelvic or femoral osteotomies. The same indications for surgery were applied to both groups. Sharrard (1964) first cautioned about splinting the hip in abduction as it may result in an abduction contracture in this group of patients. McKibbin (1968) demonstrated the action of iliopsoas to be a flexor and external rotator of the hip of the newborn. In addition that iliacus can contribute to abduction when the limb is abducted. Hence the potential risk for an abduction contracture but also the need to avoid what was later described as the " human position " by Salter as this will perpetuate the flexion deformity of the hip. The recommended position for splintage of the hip in these patients is abduction, extension and slight internal rotation.

(B) Iliopsoas transfer

The Mustard transfer, described in 1952, is not widely accepted as it does not restore extension to the hip and may aggravate the flexion deformity. Hence Sharrard (1964) described the posterolateral transfer of

the iliopsoas to remove the deforming force and gain hip abduction and extension. Initial results reported by Sharrard (1964) were excellent, 35 out of a total of 40 hips (87,8%) were stable at a minimum of 2 years followup, few complications occurred and all were ambulant with a slight Trendelenberg lurch, whereas only 5 of the 21 patients reported had walked prior to surgery. The results reported by Carrol and Sharrard in 1972 were poor with stability achieved in only 58,6% of hips, a 25% avascular necrosis rate, 3,4% sepsis rate, joint stiffness and a high incidence of pathological fractures. Additional procedures were performed in the majority of hips and the poor results were attributed to not achieving a concentric reduction with these procedures. Jackson, Padgett and Donovan (1979) reported only 29,6% of hips to be stabilised by an iliopsoas transfer alone and that age greater than 5 years or acetabular dysplasia were poor prognostic factors. In addition other authors felt that flexor power of the hip would be considerably reduced. Stillwell and Menelaus (1984) in a long-term follow-up of 47 patients who had an iliopsoas transfer more than 10 years previously have shown that although hip flexor power is reduced, walking ability is not compromised. They have also reported excellent results following iliopsoas transfer. Of these

47 patients 31 hips were unstable pre-operatively, 27 were stable at long-term review. Hip stiffness was not noted to be a problem. Menelaus (1976) has altered the surgical technique in that he initially detaches the lesser trochanter and psoas insertion through a vertical incision over adductor longus. A second incision is made parallel and below the iliac crest. The psoas is delivered retrograde into the proximal wound. The rest of the operation is as described by Sharrard. Menelaus reports less morbidity and blood loss with this modification of the technique. The transfer probably doesn't function actively, as very few patients can actively abduct or extend the hip against gravity, but rather as a tenodesis. Buisson and Hamblen (1972) studied 16 iliopsoas transfers in 13 patients, very few of whom had active abduction and none had active extension of the hip. They noted marked EMG activity in the iliopsoas during active hip flexion but not passive flexion suggesting the activity wasn't secondary to a stretch reflex. Stillwell and Menelaus (1984) postulated that the transfer may therefore have a role in improving foot placement during ambulation.

(C) Varus derotation femoral osteotomy (Figure 1)

Dias and Hill (1980) have reported excellent results in those patients with subluxation of the hip and a valgus femoral neck. In a series of 27 hips, 23(85%) were stable at an average follow-up of 4,3 years. Unsatisfactory results were associated with suprapelvic obliquity or an acetabular index >25° (in which case they recommended a Chiari osteotomy should be added). They stressed adequate varus of the osteotomy (100°-110°) in the patient less than 4 years old and the need to achieve 45^{0} abduction of the hip with an adductor myotomy, at the same time as the varus osteotomy, if not present preoperatively.

Weisl, Fairclough and Jones (1988) have shown that the results of varus derotation osteotomy are comparable to the Sharrard transfer.

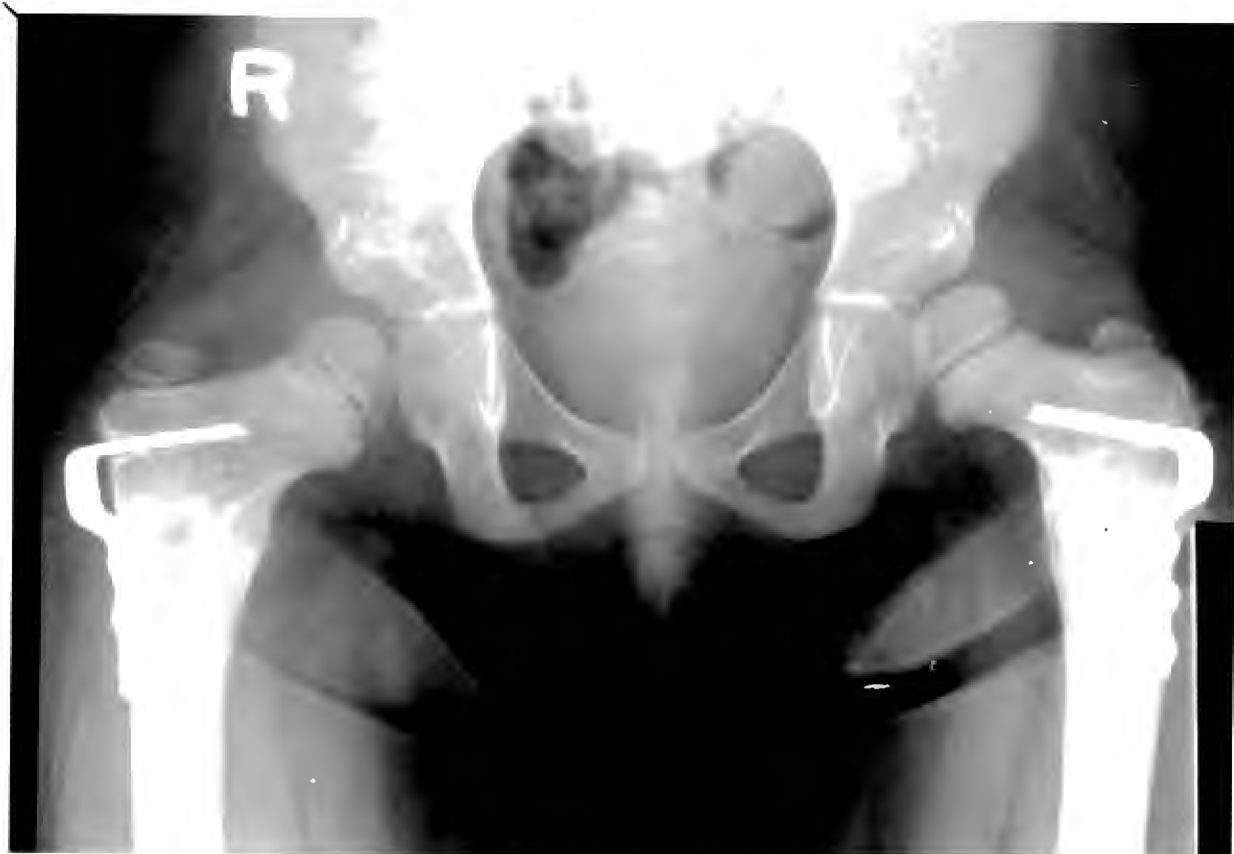


Figure 1

Patient aged 5 years, L3 level walker, bilateral VDRO's at age 4 years.

(D) Chiari pelvic osteotomy

Canale et al (1975) reported 19 out of 21 hips with deficient acetabula to be stabilised after a Chiari osteotomy and recommend this procedure for myelomeningocele patients over the age of 4 years if they have subluxing or dislocated hips with associated deficient acetabula. They caution against doing a Salter osteotomy as this will not give adequate posterior cover.

(E) Combined procedures

Lee and Carroll (1985) have recommended that potential walkers in this group of patients should have an adductor release, open reduction, capsulorrhaphy, iliopsoas transfer and acetabuloplasty (if the acetabulum is very small and deficient, a Chiari rather than acetabuloplasty is recommended). 83% of hips were stabilised with this protocol and hip mobility was not compromised.

MATERIALS AND METHODS

I undertook a retrospective study at the Spinal Defects clinic, Red Cross Childrens' Hospital together with Dr E.B.Hoffman to review our experience with the hip in the midlumbar myelomeningocele patient and formulate guidelines for future management. During the period 1970 to 1989, 67 patients (30% of the total patients seen at the clinic) presented with a midlumbar neurological level (L3 and L4 according to Lindseth). Patients less than 4 years old were excluded as their ambulatory status could often not be adequately assessed. Four were deceased at time of follow-up, leaving 51 patients of whom 38 or 74,5% were followed up and examined by us. The average follow-up period was 10,2 years with a range from 4 to 19 years.

The neurological level was assessed according to the criteria of Lindseth (1976) where L3 corresponds to grade 3 or more quadriceps power (using the Medical Research Council grading system), no hip extension with the legs straight and medial hamstrings less than grade 3. L4 is medial hamstrings of grade 3 or more, and hip extension with the legs straight of grade 3 or more. The role of gracilis as mentioned by Asher and Olson (1983) is confusing. They emphasise that patients should be prone

when assessing knee flexion. Then if the patient is able to flex his knee without his buttock rising from the bed, he has grade 3 medial hamstring power. If his buttock rises then he is using gracilis to flex the knee which is simultaneously flexing the hip (gracilis being innervated by L2,3) In our experience this was difficult to assess as patients had associated fixed flexion deformities of the hips or a tight rectus femoris which complicated the assessment. It was more accurate to asssess medial hamstrings as extensors of the hip with the legs straight as demonstrated by Breed and Healy (1982). The patient is positioned prone with hips flexed to 90° over the end of the examination couch. The hamstrings, when functioning, are able to extend the hip 30° to 60° from the starting position. In patients with asymmetrical levels the more distal level was used to define the neurological level. No patient had either active tibialis anterior or abductor function. Twenty four patients were L3 and fourteen L4.

Fixed deformity around the hip was defined as a flexion deformity greater than 10° or an adduction or abduction deformity. The presence of spinal deformity was recorded as was the presence of any spasticity in the lower limbs. I.Q. was determined by a paediatrician who specialises in developemental assessment using the

following scale. Severly retarded if I.Q. less than 30, moderately retarded if between 30 and 50, mildly retarded (trainable) if between 50 and 70 and normal (educable) if greater than 70 (Hoffer et al 1973).

Ambulation was defined using the criteria of Hoffer et al (1973) and for the purposes of this study only community ambulators were assessed as functional walkers (Stillwell and Menelaus 1983).

Standing AP radiographs of the pelvis were used to assess the stability of the hips and sitting or standing radiographs of the spine to assess spinal deformity.

An unstable hip was either dislocated or subluxed. Subluxation was present when the femoral head was not concentric within the acetabulum but there was still contact between the femoral head and acetabulum (Figure 2). Dislocation of the hip implied that the femoral head was not within the true acetabulum (Figure 3)

The age on initiating walking was recorded, the use of orthoses, the natural history of the hip both clinically and radiologically in those patients that had adequate records from birth and the various surgical procedures performed.

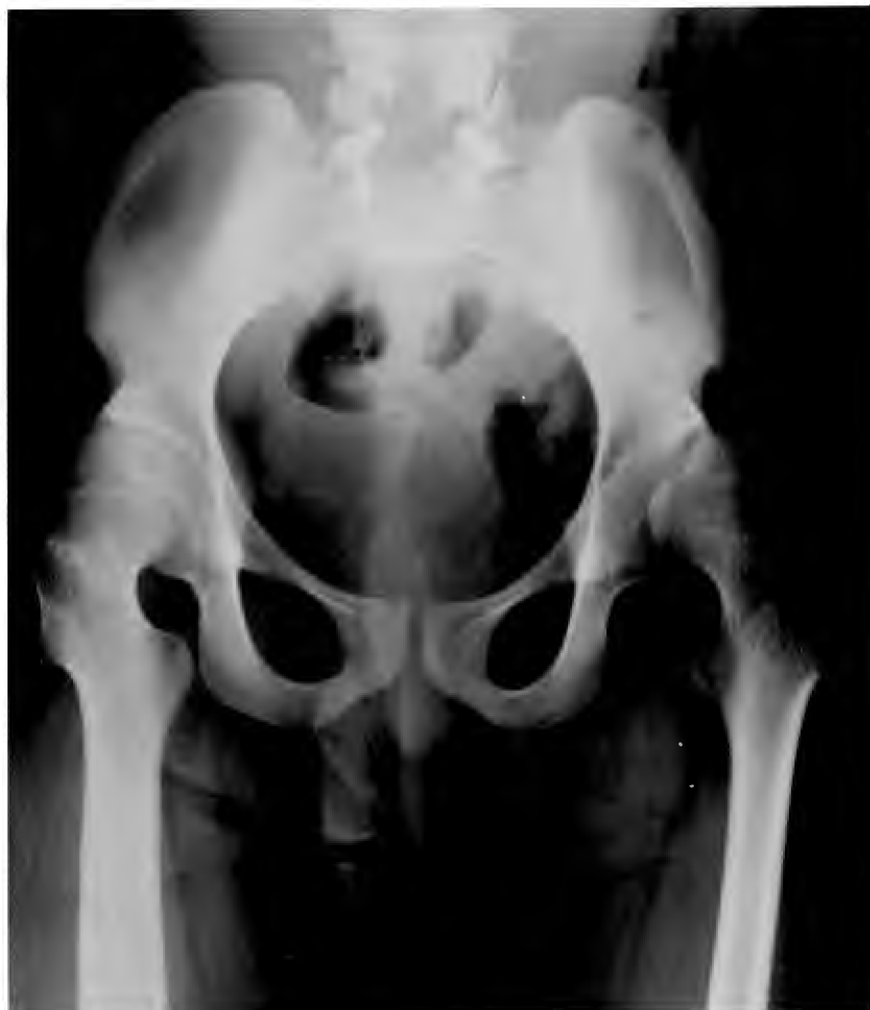


Figure 2

Patient aged 19 years, L3 level walker, with bilateral subluxing hips

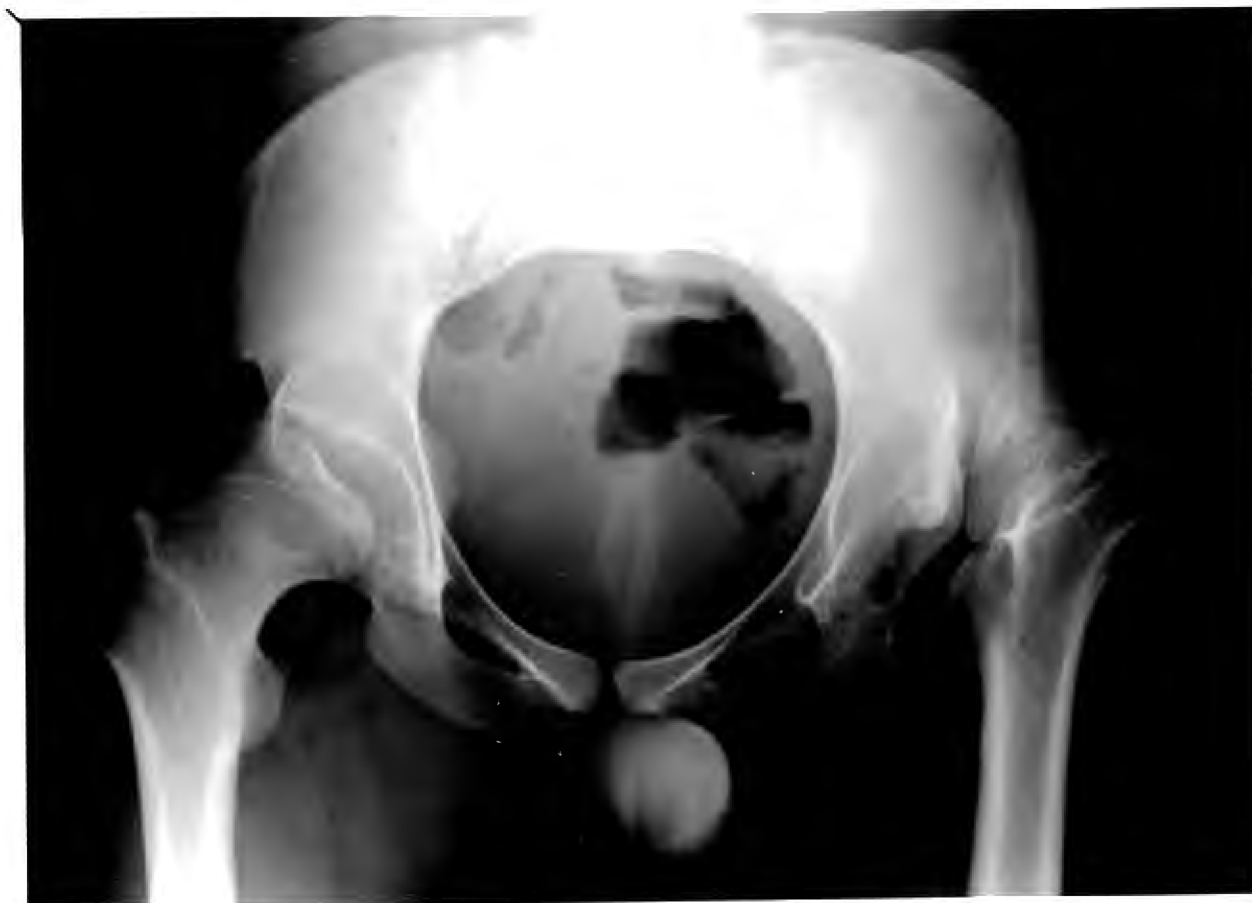


Figure 3

Patient aged 19 years, L3 level walker, right subluxed hip and left dislocated hip

RESULTS

Ambulatory potential (Table I)

100% of L4 patients walked compared to 33% of L3 patients. Hip stability does not appear to influence ambulatory potential. 71% of L3 walkers had unstable hips while 48% of L3 non-walkers had unstable hips. In addition 38,5% of L4 patients (who were all ambulant) had unstable hips. Concerning the ambulatory patients, it was not our clinical impression that the energy cost of ambulation was less with stable as opposed to unstable hips although this is probably an area for future more detailed analysis with calculation of the energy expenditure index for the two respective groups (Rose et al 1991).

Three patients (all with L3 neurological level) aged 4 years, 4 years 4 months and 5 years respectively were excluded. All these patients had recently initiated standing in above knee calipers and we felt that their final ambulatory status could not be assessed at this stage. In those patients who were ambulant the average age at initiating ambulation was 3 years 8 months (range 2 years 6 months - 5 years 6months). L4 patients walked on average 6 months earlier than L3 patients (3years 6

months as opposed to 4 years 1 month). No patient has subsequently deteriorated from being a walker to a non-walker.

Table I Ambulatory status and hip stability.

Neurological level	Ambulatory status	Hip stability	
L 3	walker 7(33%)	unstable	10(71%)
		stable	4(29%)
	non-walker 14(67%)	unstable	13(48%)
		stable	14(52%)
L 4	walker 14(100%)	unstable	10(38,5%)
		stable	16(61,5%)
TOTAL	35 PATIENTS		67 HIPS

Three patients had asymmetrical levels L4/3, L4/3 and L3/2 respectively. Ambulatory function was assessed in relation to the more distal neurological level in each patient. In assessing hip stability in these 3 patients the upper level (2 hips with L3 neurological level, both dislocated, and 1 L2 level) was excluded as we felt they might bias ambulatory ability. Therefore Table I reflects 35 patients and 67 hips.

Influence of fixed deformity (Table II)

Fixed flexion deformity of the hip was an average of 25° (range 10° to 60°) in 28 hips. There were no hips with fixed adduction or abduction deformities. 71% of the L3 walkers had a fixed deformity while only 52% of L3 non- walkers had a fixed deformity. Of the L4 patients 12% had a fixed deformity. 40 hips (59,7%) had no fixed flexion deformity.

Table II Influence of fixed flexion deformity of the hip on ambulation.

Neurological level	Ambulatory status	Fixed flexion deformity present	absent
L 3	walker	10(71%)	4(29%)
	non-walker	14(52%)	13(48%)
L 4	walker	3(12%)	23(88%)
	TOTAL	27(40,3%)	40(59,7%)

We noted a very low incidence of associated spinal deformities in the mid lumbar myelomeningocele patients. Only 3 (8,6%) of the 35 patients had an associated scoliosis (Figure 4).

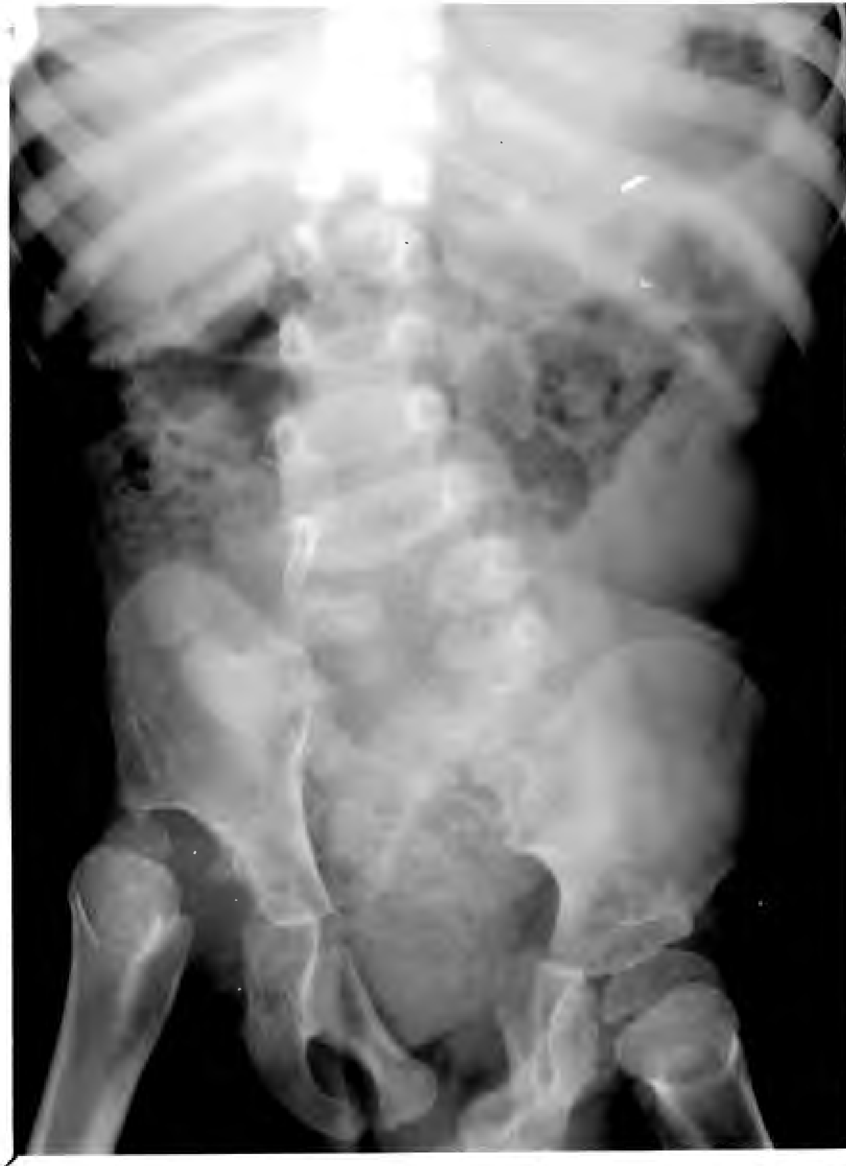


Figure 4

Patient aged 7 years, L3 level on the right and L4 on the left. Walker with associated congenital scoliosis.

Natural History (Table III)

The clinical records and radiographs of 24 patients were adequate to asses the natural history of the hip from birth. 69% of hips were unstable at 1 year. 86% of L3 hips were unstable at 1 year compared to 42% of L4 hips. Concerning the hips that were stable at 1 year, only 1 subsequently dislocated at 10 years due to increasing pelvic obliquity secondary to scoliosis.

Table III Natural history of mid-lumbar hips (24 patients, 1 patient with asymmetrical L3/L4 level).

Neurological level	stable at 1 year	unstable at 1 year
L 3	4 (14%)	25 (86%)
L 4	11 (58%)	8 (42%)
TOTAL	15 (31%)	33 (69%)

Surgical Procedures (Table IV)

A wide variety of surgical proceedures were performed by various surgeons. Analysing those hips in which surgery was performed only 14 out of 43 or 32,6% had a stable hip at review. There was no meaningful difference in comparing results of L3 with L4 patients.

Table IV Surgical procedures (43 hips)

adductor/psoas release	41
open reduction/capsulorraphy	14
Mustard	2
Sharrard	3
VDRO	26
Pemberton	1
Salter	1
Chiari	3
miscellaneous	6

Unilateral dislocations

12 patients had unilateral dislocations. There was no significant difference in the results in this particular subgroup of patients.

I.Q. (Table V)

All patients had either an I.Q. of 50 -70 (mildly retarded or trainable) or above 70 (normal or educable). In the educable group of patients 62% were non walkers and in the trainable group 75% were non-walkers.

Table V Intelligence quotient (I.Q.) and ambulatory status.

neurological level	I.Q.	ambulatory status non-walker	walker
L3	50-70 (8)	6(75%)	2(25%)
	>70 (13)	8(62%)	5(38%)
L4	50-70 (2)		2(100%)
	>70 (12)		12(100%)
TOTAL	35 patients		

Spasticity

Spasticity was present in the lower limbs of 5 of the 35 patients. All were L3 neurological level and nonwalkers.

Orthoses

All ambulant patients used bilateral elbow crutches and below knee orthoses.

DISCUSSION

(1) The definition of the neurological level

This is of cardinal importance as it has a direct bearing on management decisions. The difficulties in clinical assessment have already been mentioned. Due to the fact that the neurological level determines function, it is more important to think in terms of the level first and then the deformity rather than the other way round.

Hoffer's classification is too broad as it includes L1, L2 and L3 as upper lumbar. It would appear from our results that there is justification in categorising those patients with active knee flexion as separate from those that don't in that 100% of these patients walked as opposed to 33%. The reason for this better prognosis is not clear. It may be due to the stronger quadriceps power associated with more distal innervation (Asher and Olson 1983) or to the ability to extend the hip with the hamstrings, which account for almost one third of total hip extensor strength, as has been shown by Waters et al (1974). Lindseth (1976) noted in his series of 350 patients that 62 (17,7%) had strong quadriceps, medial hamstrings and no distal foot innervation hence justifying his classification. Samuelsson and Skoog (1988) reported a higher mean flexion deformity of the

knee in L4 patients as opposed to L3 patients (using the Lindseth classification) as further support for separation of the levels on this basis. However one can't ignore the extensive work that Sharrard (1964) has done in anatomical dissections and electrical stimulation of nerve roots of myelomeningocele patients intraoperatively. It is clear from his writings that there is considerable overlap in segmental innervation of different muscle groups and he noted 50% of patients who were L4 had medial hamstrings. In fact the 5 level classification used in his 1964 and 1972 articles would include these two levels of Lindseth, as Sharrard groups L3 and L4 together. The only significant difference that Lindseth proposes is that tibialis anterior be classified as L5 (in other words he defines a subgroup of Sharrard's L4 who have medial hamstrings and no tibialis anterior function). Hoffer et al (1973) have shown that there is considerable variation of muscle group power within a single neurological level. The importance of the medial hamstrings has received little attention in the literature with reference to the myelomeningocele hip or ambulatory potential and probably warrants specific comment on its power whether Sharrard's or Lindseth's classification is used.

(2) Factors influencing ambulation

The results of this study again confirm that the neurological level of the patient is the most important determinant of ambulation. 100% of L4 patients walked as opposed to only 33% of L3 patients. This agrees with the work of Feiwell, Sakai and Blatt (1978) who reported 26% of high lumbar level patients and 76% of low lumbar patients were ambulant, as well as the work of Stillwell and Menelaus (1983) who reported 30% of high lumbar level patients and 95% of low lumbar patients were ambulant. Lindseth (1976) differs in that 57% of L3 patients walked and 67% of L4 patients.

As mentioned in the results no patients have deteriorated from walkers to non-walkers although the average follow-up period is relatively short at 10,2 years compared to the work of DeSouza and Carroll (1976) or Stillwell and Menelaus (1983).

I.Q. did not appear to have any relation to ambulation although all patients had an I.Q. above 50.

DeSouza and Carroll (1976) reported spasticity in 11% of 68 patients and that it didn't adversely influence ambulation. Samuelsson and Skoog (1988) noted that spasticity secondary to syringohydromyelia or an Arnold

Chiari malformation was more prevalent in nonwalkers. All 5 patients in this series who had spasticity were non-walkers. It was difficult to determine if this was secondary to the spasticity per se or the neurological level.

(3) The role of hip stability

The results in this study show that hip stability does not influence ambulatory potential. In the L3 group of patients 71% of walkers and 48% of nonwalkers had unstable hips, while 38% of L4 patients had unstable hips. It was not clear from our results whether ambulation was more efficient with located as opposed to dislocated hips as this wasn't specifically assessed. Stillwell and Menelaus (1983) feel that foot placement is improved after iliopsoas transfer as opposed to merely doing an adductor and psoas release to correct the deformity. This they say is an impression which is supported by the work of Buisson and Hamblen (1972). In contradistinction Feiwell, Sakai and Blatt (1978) reported that in their series of patients neither reduction of the hip nor muscle transfer operations improved the lurching gait

caused by abductor weakness nor changed the type of brace required.

Two illustrative radiographs are presented (Figures 5 and 6).

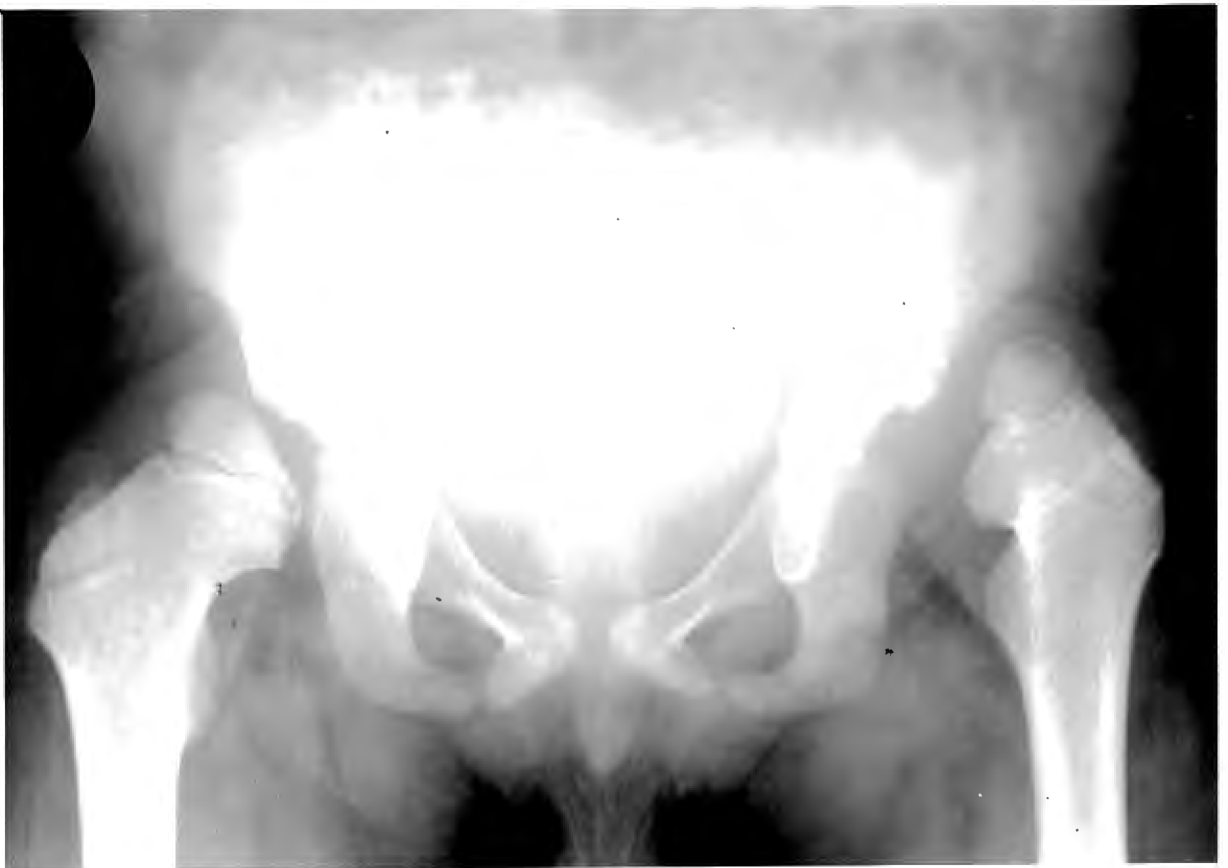


Figure 5 is a patient aged 6 years, neurological level L3, with bilateral unstable hips and yet a community walker

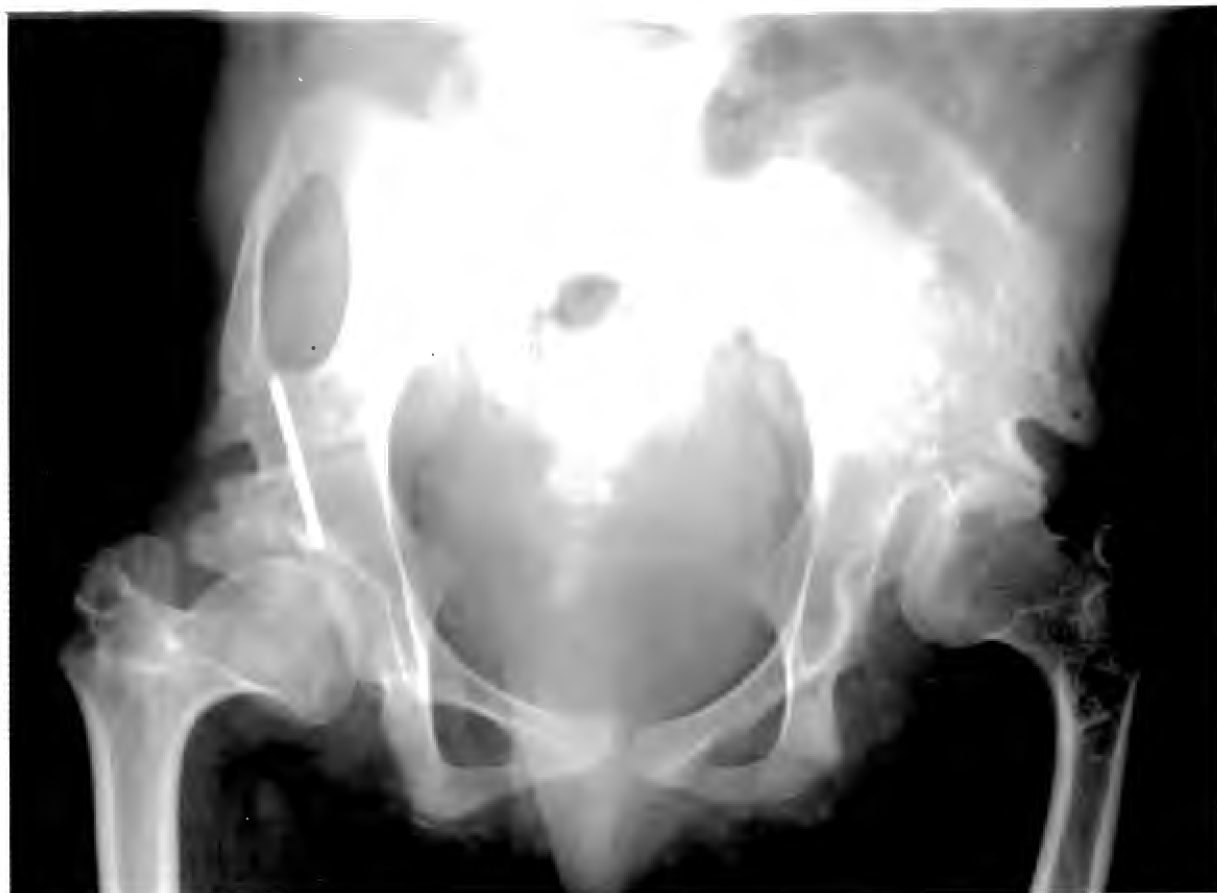


Figure 6 is a patient aged 11 years, L3 level with bilateral stable hips after Sharrard transfer, VDRO and Chiari on the right and VDRO and Chiari on the left. However a non-walker.

Unilateral dislocations did not have any significant difference in results compared to bilateral dislocations, as far as the factors analysed in this study was concerned, and therefore the recommendations would not differ. Pelvic obliquity of an infra-pelvic cause can be managed with soft tissue releases to correct deformity and leg length inequality is seldom a significant problem. Six of the 12 patients with unilaterally unstable hips were walkers. It was our subjective impression that the Trendelenberg gait was equal on both sides in these patients and therefore due to the weak abductors and not instability per se.

(4) The influence of hip deformity.

Fixed flexion deformity of the hip bore no relationship to ambulatory potential. The oldest patient in this series had bilateral fixed flexion deformities of 60° and 45° respectively and was able to compensate for this with hyperlordosis. No patients had a fixed adduction or abduction deformity of the hip at follow-up. As tabulated previously an adductor and psoas release had been performed in 41 hips. A further 5 hips had either a

Mustard or Sharrard iliopsoas transfer. Therefore in 46 (68,6%) hips the adductors and/or psoas were defunctioned. It was not possible to determine the natural history of fixed deformity of the hip from this review. However although fixed deformity of the hip did not influence ambulatory potential in this series of patients, I would advocate correction of flexion deformity of the hip when greater than 20 - 30° to facilitate a better posture in the ambulant patient and possibly decrease the incidence of mechanical backache in the future. This should be performed after the age of 3 years as recommended by Shurtleff et al (1986) to allow physiological flexion deformity of the hip to resolve. Adduction deformity leads to problems with toilet and infra-pelvic obliquity with ischial pressure sores (Menelaus 1980). Therefore I would recommend adductor release if an adduction contracture is present.

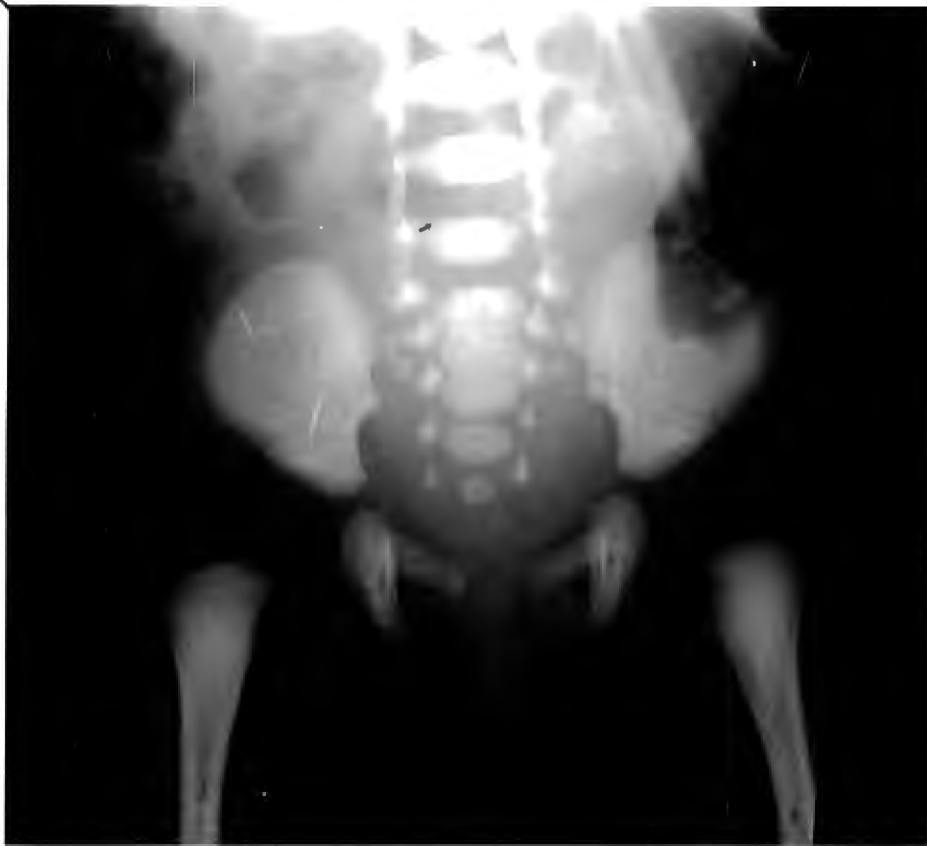
Spinal deformity

There appears to be a very low incidence of associated spinal deformity in our midlumbar patients. These patients may have a variety of spinal deformities ranging from scoliosis which may be idiopathic, congenital, neuromuscular or secondary to a tethered cord to kyphosis which may be congenital or neuromuscular or

increased lordosis. A similar low incidence (12,5%) has been reported by Jackson, Padgett and Donovan (1979). By comparison Samuelsson and Skoog (1988) reported an incidence of 90% in L3 patients and 85% in L4 patients. Similarly Lindseth (1990) reported an incidence of 85% in L3 patients and 75% in L4 patients. The reason for the low incidence in our series is not clear.

(5) The natural history of the untreated hip. (Figure 7)

Carroll and Sharrard (1972) are the only authors to address the natural history of the hip in the myelomeningocele patient. Many papers refer to the high incidence of dislocation in these patients, particularly in the mid-lumbar group, but don't give the proportion of hips that remain stable.



<u>Figure 7</u>

Patient aged 7 months, L3 with bilateral dislocated hips.

In this study 86% of hips with an L3 level were unstable at 1 year compared with 42% of those with an L4 level. The five level classification of Sharrard groups L3 and L4 together (Group 3). They noted a 65% incidence of instability at birth and 76,6% at 2-3 years. It is important to distinguish between L3 and L4 due to the significant difference in natural history. This may also be relevant in analysing surgical results. Carroll and Sharrard (1972), in their long term review of iliopsoas transfers, had 15 hips (out of a total of 58 hips) in which a successful isolated iliopsoas transfer was performed (this is a subgroup of patients mentioned in the paper who had an isolated iliopsoas transfer and on review had a stable hip). Eight of these were stable pre-operatively and surgery was performed on the basis of the pattern of muscle paralysis to prevent late instability. In the light of our findings these hips may have been associated with an L4 level and remained stable,without surgery Similarly Jackson, Padgett and Donovan (1979)reported a 50% success rate with iliopsoas transfer but when hips with pre-existing stability were excluded this dropped to 29,6%.

(6) The role of surgery

A wide variety of surgical procedures were performed. In spite of multiple procedures, up to 5 per hip, only 32,6% of the hips which had surgical procedures performed on them were stable at follow-up. In analysing the results of surgery it was difficult to draw any definite conclusions, as being a retrospective study, the indications for and adequacy of the various procedures varied considerably. However, in the light of the findings in this study, various recommendations can be made about the future role of surgery in the mid lumbar myelomeningocele patient.

As it has been shown in this study that hip stability per se doesn't influence the ambulatory potential of the patient there appears to be no role for surgical procedures to locate the hip whether this be for unilateral or bilateral hip instability. As stated previously it was our clinical impression that the energy cost of ambulation was the same whether the hip was located or not, as a result of the hip abductor and extensor weakness in this group of patients. However this remains an area of future investigation. Recently the energy expenditure index has been described which has a good correlation with the energy expenditure of walking

in normal and cerebral palsy patients (Rose et al 1991). This may not be able to be applied in a meaningful way to myelomeningocele patients due to the large number of additional variables which influence ambulation in these patients.

Surgery does have a role for established deformity, not to facilitate ambulation, as we have also shown that deformity per se doesn't influence ambulatory potential but as stated previously to improve posture and decrease the risk of mechanical backache from hyperlordosis secondary to a flexion deformity. Secondly to improve perineal toilet and sitting balance, thus avoiding trophic ulceration of the ischium, adduction and abduction contractures should be released.

Conclusions

The main conclusions from this study are:

(1) It is confirmed that the neurological level of the patient is the main determinant of ambulatory potential.

(2) Neither hip stability nor fixed flexion deformity influences ambulatory potential.

(3) The natural history of the midlumbar hip is reported and the importance of destinguishing L3 neurological

level from L4 is emphasised as the natural history differs.

(4) Surgery has a role to correct fixed deformity of the hip to prevent secondary problems but has no role in facilitating ambulation.

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