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Early Physiotherapy in Selective Posterior Rhizotomy

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SUMMARY

The general principles of the early treatment of post-rhizotomy patients are described and explained. The precautions to be taken and their rationale are given. Case histories are presented which illustrate the improvement of 4 patients.

OPSOMMING

Die algemene beginsels van die vroeë stadium van die behandeling na rhizotomie word beskryf en verduidelik. Die voorsorgmaatreëls wat getref moet word en hul rationale word gegee. Daar word gevalbeskrywings voorgelê wat die verbetering van 4 pasiënte vertoon.

INTRODUCTION

Selective posterior rhizotomies have been performed at the Red Cross War Memorial Children's Hospital, Cape Town, since 1981. The operative technique and the interim results with the first 15 patients are discussed in detail in the previous article.[1]

The operation reduces spasticity by interrupting the afferent input to the anterior horn cell via the posterior root. Only rootlets which produce an abnormal muscular response to electrical stimulation are divided. Since there are invariably some rootlets in each root which do not produce an abnormal reaction, and since there is considerable segmental overlap as regards the sensory supply, the eventual disturbance of sensation is minimal.[2,3,4]

All the rhizotomies performed at the Red Cross Hospital have been on spastic cerebral palsied children in whom the spasticity was significantly limiting function despite regular physiotherapy on neurodevelopmental lines. Criteria for the selection of patients for rhizotomy are the subject of a separate study and cannot be discussed in detail here, but as a general rule spasticity must be the main factor limiting function and the patient must have reasonably good underlying voluntary

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power. Since the primary effect of the operation is to reduce spasticity, to do so in a child who is utilizing spasticity in order to stand and walk would be detrimental. The exception to this is the grossly handicapped child where reduction in spasticity, despite the absence of voluntary control, will render positioning and caretaking much easier.[1,3]

The Red Cross Hospital is, so far, the only centre in this country where rhizotomies are being performed on cerebral palsied children. As a result children are being referred to this centre from throughout the Republic of South Africa. Since the period of hospitalization seldom exceeds 10 days these children are being returned to their home centres within the early post-operative period and requests have been received from physiotherapists for guidance regarding treatment procedures and precautions. The approach described here gives a general perspective only, since each child must be individually assessed and treated accordingly. The pre-operative assessment, also, will give guidance as to possible post-operative problems.

GENERAL POST-OPERATIVE PRECAUTIONS

Access to the posterior roots is gained via a limited laminectomy procedure, removing the vertebral arch from the second to the fifth lumbar vertebrae but keeping well medial to the posterior joints.[1] The bony stability of the vertebral column is thus not compromised. However, the dura is opened over an extensive area and in order to prevent a dural leak and possible subsequent infection certain movements should be restricted for four weeks post-operatively.

It is not possible or necessary to prevent spontaneous movement on the part of the child, but the following movements should be prevented in therapy and the child should be encouraged in activities which avoid these movements:

1. Rotation of the lumbar spine — The torsion produced during rotation carries the greatest threat of causing a dural leak. Because of this some activities commonly used to inhibit tone and facilitate movement will have to be omitted during the first 4 weeks. In the early stages, when the child sleeps in side-lying the upper leg must be supported in flexion in order to prevent rotation of the lumbar spine. Either both legs can be flexed, with a pillow between them, or (preferably) the upper leg can be flexed forwards on a somewhat thicker pillow. For the first ten days the child is nursed in alternate side-lying and is "log-rolled" by means of the drawsheet when being turned to the opposite side.
2. Sustained or excessive flexion of the lumbar spine — Prolonged sitting should be avoided and, when sitting, the hips should not be flexed to more than 70°. Since many of these children return home by air on the 10th post-operative day the mother or caretaker must be shown how to position a small pillow or towelling roll so that it maintains a slight lumbar lordosis.

EARLY TREATMENT

In the immediate post-operative period the tone is quite drastically reduced, some children becoming completely flaccid.[4] Since the tone invariably returns, although at a lower level, over a period of days to weeks, Fasano *et al.*[3] ascribe this initial loss of tone and voluntary power to the operative medulloradicular shock. Undoubtedly, however, the older children in particular have underlying motor weakness and need active strengthening in order to re-establish voluntary control.

During the first week physiotherapy consists of routine post-operative chest treatment (as necessary) and gentle inhibitory stretching of the hamstrings, adductors and plantar-flexors. Care must be taken not to flex the hip more than 30° when stretching the hamstrings. When the upper limbs are involved the arms must also be taken through a full reflex-inhibiting pattern, taking care to avoid lumbar rotation or side-flexion. Since the posterior roots also have ascending collaterals which give off branches at higher segmental levels there is frequently a concomitant although lesser reduction in the tone in the upper limbs after a lumbar rhizotomy.

If the child is able to co-operate, and once the initial discomfort is less, bridging with straight legs (hips in extension, abduction and lateral rotation) can be started, as well as small, controlled reciprocal knee and hip movements in a selective pattern. A few children complain bitterly of hypersensitivity of the soles of the feet; in this case firm pressure should be maintained on the soles during handling, and friction from bedclothes must be avoided.

A vague feeling of numbness or "different" sensation is common, but usually disappears within the first 10 days. Proprioception is rarely affected.[3]

The child is allowed up after a week and sitting, as previously discussed, is also allowed at this stage. The stitches are removed on the 10th post-operative day and at that stage most children are discharged from hospital. The parents must be taught the precautions outlined above and the need for intensive physiotherapy over the next 3 months must be stressed.

From 10 days to 4 weeks

During this period flexion and rotation must still be restricted. Frequently underlying motor weakness is evident, particularly of postural extension. The muscle groups most affected are the extensors and abductors of the hips and the extensors of the knees but, with the reduction of spasticity, weakness may also be present in the adductors. Although extension needs to be emphasized, the poor abdominal control of the cerebral palsied child is very evident post-operatively. Since trunk flexion is contra-indicated, the abdominal muscles must be worked iso-metrically in a neutral position.

Because of the restrictions on rotation, exercises in straight planes are used. Suggestions are:

1. *Prone*

Until reasonable control has been achieved, a plinth, the floor or a large ball should be used, as the child

may flex excessively over a roller or smaller ball. Back extension and hip extension must be emphasized. Hip extension should be combined with abduction and lateral rotation, but these latter two components must not be excessive. When bringing the child down towards standing from the large ball the abduction and lateral rotation must be reduced in order to allow efficient weight-bearing through the hips. In this position of "semi-standing" weight shift and lateral head and trunk-righting can be facilitated. Selective movements which can be elicited in prone, using proprioceptive stimulation (tapping) techniques, include isolated knee flexion with the hip in extension, inner range knee extension with the foot inhibited in dorsiflexion, and isolated foot movements with the knee in varying degrees of flexion. Mass movement patterns, which tend to persist despite the reduction in tone, must be inhibited.

Weight-shifting in the puppy position is useful if scapular stability is poor and has the added advantage of encouraging spinal extension.

2. *Supine*

Bridging with extended knees can be progressed to include lateral weight-shift with forwards rotation of the pelvis on the weight-bearing side. This minute degree of rotation does not put any strain on the dura and is necessary to gain control over both abduction and extension of the hips. Bridging with various degrees of knee flexion can also be practised. Overactivity of the peronei is often a problem following rhizotomy and care must be taken to ensure as perfect alignment of the feet as possible in any weight-bearing positions. Active hip abduction in supine (preferably bilateral) is often difficult to achieve since the child tends to flex and laterally rotate the hips simultaneously; in this case tapping for active abduction-in-extension in the side-lying position may be more successful.

3. *Sitting*

Sitting astride a roller, on a ball or astride the therapist's knee reduces the angle of hip-flexion. In this position small-range anteroposterior and lateral equilibrium reactions can be facilitated, avoiding rotation. The therapist's knee is often one of the best treatment positions for a small child, and from this position the child can be brought to weight-bearing either symmetrically or on each leg alternately.

4. *Standing*

The child should be stood as soon as possible for increasing lengths of time, using aids if required. Depending upon the child's active control, a prone board, standing frame or gaiter splints can be used. The occasional problem of hypersensitivity of the feet has already been mentioned; these children need firm pressure through the feet and may also be more comfortable standing in shoes. Once again the feet must be in as perfect alignment as possible to avoid feeding into the already overactive peronei. UCBL supports or ankle-foot orthoses may be necessary to overcome this problem.

Occasionally flexor spasms are a problem until proper control over extension is established. Inclined standing on a prone board may be tolerated more easily, but if the spasms originate in the abdominal muscles rather than the hip flexors, pressure on the abdominal wall may trigger them. In this case a backwards-inclined stander might be of assistance in teaching the child to correct his head forwards without initiating total flexion. Upright kneeling is inclined to trigger flexor spasms as a result of tension on rectus femoris, and also often results in an excessive lordosis.

From 4 weeks onwards

Weight transference activities in sitting and standing can now be progressed to incorporate rotation, and changes of position involving flexion and rotation can be introduced gradually. Since mass movement patterns do tend to persist despite the reduction in tone, pelvic rotation provides the key to the ability to dissociate movement between the two legs and to develop more selective movements. Treatment to this end continues along neurodevelopmental principles. Persistent underlying muscle weakness will require further strengthening measures such as the use of body-weight, but abnormal movement patterns must be strongly inhibited.

The case histories cited here are chosen to depict the wide range of children who have undergone rhizotomy, from a very functional walker who has achieved a near-normal walking pattern to a severely handicapped child whose care has been made easier.

CASE HISTORIES

1. D.K. — age at operation 5,2 years — spastic diplegia with no involvement of arms.
   Previous surgery: bilateral open division of adductor longus and gracilis plus elongation of iliopsoas at age $3^4/_{12}$.

Pre-rhizotomy status	*Post-rhizotomy + 3 months therapy*
Functional abilities	
Sidesitting: can only maintain briefly without arm support, particularly to the right	Can maintain easily to either side, with arms free to play in this position
Longsitting: very sacral and with knees flexed	Still very sacral, but can extend knees.
Kneelstanding: hip flexion, and lordosis and retraction of right hip. Relies continually on protective extension and arm support	Maintains position well with very good, full equilibrium reactions, without arm-support
Standing: some hip flexion, slight knee flexion (right more than left) more weight on left leg, retraction and trunk side flexion on left	Very slight hip flexion, trunk symmetrical, slightly more weight on left leg

Walking: toe-heel gait with some knee flexion — tending to walk on toes as speeds up. Slight internal rotation, more obvious on right	Heel-toe gait with only very minor abnormalities — slight internal rotation on the right
Cannot heel walk	Can heel walk, but right foot not as dorsiflexed as left
Running: pattern deteriorates with more hip flexion and internal rotation, knee flexion and plantar flexion	Good pattern with minor abnormalities only noticed by careful observation
Range of movement	
Apparent fixed flexion deformity both hips ±20°	Flexion deformity 5 - 10°
Knee extension — right (-5°), left (-10°)	Knee extension full
Dorsiflexion — to just 90°	Dorsiflexion above 90°, right > left
Abduction — slightly limited on right	Abduction full
Hamstrings tight	Hamstrings as tight
Tone	
Not high on passive movements, but builds up steadily on activity	No increased tone
Muscle power	
Weak abdominals, also hip and knee extensors	No appreciable weakness in legs. Lower abdominals slightly under par but still improving.

Following the original orthopaedic surgery and therapy, moderate spasticity had been reduced to minor spasticity, but Grabe procedures or gastrocnemius slides and later hamstring releases were being considered. As no therapy was available in the home town and admission to a cerebral palsy school was not considered, a decision was made for rhizotomy, rather than resorting to further orthopaedic surgery and prolonged therapy for this now rather mild diplegic.

The aims of the rhizotomy procedure and therapy have been realised. D. K. is now no different from his class mates at his local school. He takes part in athletics — races, jumps, cycles and is on a par with his peers, coming second in the school athletics. His new teacher (Sub B) was unaware that he had or has a problem until permission was requested to miss school for a follow-up assessment.

2. D.L. 7½ years. Spastic diplegia. Arms involved.

Pre-operative assessment	*10 weeks post-operative assessment*
Posture—principally flexed. Trunk low toned with marked abdominal weakness. No dissociation of legs. Poor head control.	More upright. Strong abdominals (able to change from lying to sitting and reverse without using arm support). Fair dissociation of legs. Fair head control.
Supine — evidence of tightness of hip flexors and hamstrings.	No evidence of hip flexor tightness. Straight leg raising to 70°.
Prone — on elbows—slight weight shift. No sustained reach.	Able to transfer weight and sustain a reach position.
Sitting — in buggy — very flexed. On floor — M-sitting. Side-sitting very poor with arm support.	Sitting straight in chair. Can sustain side-sitting to both sides without arm support.
Rolling — No trunk rotation. Supine to prone with flexed hips and trunk. Prone to supine or sitting — uses arms.	Rotation of trunk starting. Uses arms less and introducing extension.
Crawling—No weight shift. Usually bunny hops.	Reciprocal crawl.
Walking — with elbow crutches. No weight shift. Hips and trunk very flexed. Reciprocal pattern.	Stable and upright on crutches. Trendelenberg on weight shift. Reciprocal pattern.
Balance — no equilibrium reactions in sitting or standing. Good protective extension. Arm support to change position or pulls herself up.	Equilibrium reactions developing in sitting and standing. Gets up through half-kneeling, pushing on arms.
Drools. Eyes shoot upwards especially under stress.	Drooling only under stress. Eye position more stable.

There has been a marked functional improvement so far. The child moves with greater ease. Isolated movements are now possible, dissociation of legs is present and she is much more independent.
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3. V.N. 2½ years. Spastic quadriplegia. Legs more involved than arms, left more than right.

Pre-operative assessment	*22 weeks post-operative assessment*
Active function — moved from lying to W-sitting to bunny hopping. Movement slow and laboured.	Movement from lying to W-sitting to four-point kneeling to crawling. Does not bunny hop. Movement quick and easy.
Supine — scissoring of legs with internal rotation of hips and plantar-flexion.	No scissoring. Less internal rotation, but left more than right.
Range of movement — tight hamstrings and hip flexors. Dorsiflexion to 90° with difficulty.	Full range stretch of hamstrings and hip flexors. Easy dorsiflexion to 90°.
Long-sitting — marked sacral sitting with knees flexed.	No sacral sitting. Knees straight.

Kneeling — Poorly executed and not sustained. Hips flexed.	Easy movement sustained for a few minutes. Hips extended.
Assisted standing — extreme plantar-flexion, scissoring and internal rotation.	Heels almost down, valgus-feet, hyperextension of knees, less internal rotation.
Arm function — slow, stiff movements with internal rotation and total grasp. Left arm abducted with elbow flexion.	Quicker easier movements with less internal rotation. Total grasp. Left arm down now.

The quality of movement has improved markedly and the child now moves easily. The tendo achilles may need to be lengthened later. The rhizotomy is never performed lower than S_1 level for fear of affecting bladder control. As a result the plantarflexors may remain a little tight.

An elongation of the tendo achilles should not be done prior to a rhizotomy for fear of causing calcaneus feet.

4. M.K. is an 8 year old girl who suffered a bullet wound through her head causing extensive brain damage and resulting in severe spastic quadriplegia. Following 6 months intensive physiotherapy from 6-12 months after the incident there was little improvement.

Pre-operative assessment	*4 weeks post-operative assessment*
Muscle tone — very high. Arms in total flexion pattern. Legs in total extension. Marked clonus present, also ATNR. Tone affected by tonic labyrinthine reflex.	Same patterns of increased tone, but easier to inhibit. No clonus present. ATNR less marked, also the tonic labyrinthine reflex.
Head control — Fair, but unable to sustain extension in prone.	Sustained head control and active side flexion possible.
Active arm movements — not functional. Some voluntary internal rotation of shoulders and protraction of (R) scapula.	Slight shoulder elevation and abduction, protraction of both scapulae, some wrist and finger extension possible.
Active leg movements — in mass patterns only, with associated reactions.	Some isolated movements possible.
Standing — in a standing frame. No active head or trunk extension. Marked truncal ataxia.	Almost upright on a prone board. Some active head and trunk control, maintaining an upright position. No truncal ataxia.

Strong abdominal flexor spasms still interfere with movement, but are occurring less often. As a result of the rhizotomy handling has been made easier but how much voluntary movement will return remains to be seen.

CONCLUSIONS

The authors have not had the opportunity of studying a large number of post-rhizotomy patients over a prolonged length of time. Children are discharged from the Red Cross Hospital after ten days and are followed up at different centres throughout the land; no one physiotherapist has, at present, handled more than a few patients. A collaborative study seems indicated and it would be interesting to correlate reports on the long-term progress of children who were operated on 3 or 4 years ago.

In suitable cases of cerebral palsy, selective posterior rhizotomy seems to produce an appreciable reduction in spasticity accompanied by a considerable increase in function. Less inhibition is required during post-operative treatment, and it is easier to facilitate normal movement patterns. Fasano *et al.*[3] point out, however, that few patients who were unable to stand and walk unsupported before the operation were able to achieve this post-operatively.

Selective posterior rhizotomy has almost no side-effects[1,3] and very little recurrence of spasticity has been noted. Fasano *et al.*[3] noted only 3 cases of partial recurrence in a series of 109 cerebral palsied patients; all 3 cases were of a mixed type with multiple motor problems.

Further studies by physiotherapists on the post-operative re-education of normal motor patterns and the long-term gain in function will be welcomed.

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