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Spondylolysis and spondylolisthesis after five-level lumbosacral laminectomy for selective posterior rhizotomy in cerebral palsy

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Abstract. Of 163 children who have undergone five-level lumbosacral laminectomies for selective posterior rhizotomy, 20% of those re-X-rayed post-operatively (19/99) have developed incidental isthmic spondylolysis or grade I spondylolisthesis. The majority of patients were ambulatory, active, spastic diplegics. There were five children with isthmic defects at L3-4, three at L4-5 and 11 at L5-S1. Six of the 19 children had grade I spondylolisthesis, but none were symptomatic nor has there been any evidence of further slipping to date. It is postulated that the laminectomy, associated lordosis and increased mobility after rhizotomy may be factors in the causation.

Key words: Selective posterior rhizotomy – Laminectomy – Laminotomy – Laminoplasty – Cerebral palsy – Spondylolysis – Spondylolisthesis

Introduction

Since 1981 at the University of Cape Town's Neurosurgical Service 163 children and young adults have undergone five-level lumbosacral laminectomies for selective posterior rhizotomy for the relief of cerebral palsy spasticity.

As spinal abnormalities are common in cerebral palsy, our first 55 patients were specifically followed up in this regard. It was found that 16% had scoliosis, 5% kyphosis, 7% lordosis, 4% degenerative osteophytes and 9% spondylolysis and spondylolisthesis [11]. All these abnormalities, with the exception of spondylolysis and spondylolisthesis, were thought to be due to manifestations of cerebral palsy rather than the laminectomy.

As a consequence of these findings we felt that it was essential to maintain an ongoing follow-up on the spines of the post-rhizotomy patients – both to monitor the children identified with spondylolysis and spondylolisthesis and also to determine the true incidence of this condition in the whole post-laminectomised rhizotomy group and to see whether this incidence increased with time.

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Patients and methods

Of the 163 patients who have had five-level lumbosacral laminectomies for selective posterior rhizotomy, 99 have been X-rayed post-operatively, and with the exception of a few out-of-state patients all X-rays were checked by the authors (J.C.P. and E.B.H.). Those patients previously identified in our initial study as having spondylolysis or spondylolisthesis were re-X-rayed and examined clinically by the authors.

Results

Nineteen of the 99 patients (15 male, 4 female) were identified as having post-laminectomy spondylolysis or spondylolisthesis (Tables 1, 2). Sixteen were spastic diplegics, 3 spastic quadriplegics and 1 was dystonic/athetoid. Sixteen were ambulatory, with or without walking aids, and often active in sports for the disabled.

In the initial five patients reported in 1990, who have been followed for 3 years, there has been no evidence of further slipping, and apart from mild backache all are asymptomatic.

Discussion

Different types of spondylolysis and spondylolisthesis are recognised and have been categorised. Wiltse's classification [18] describes five varieties: (1) dysplastic, due to congenital abnormalities of the upper sacrum and the arch of L5; (2) isthmic, where there is a lesion in the pars interarticularis secondary to a fatigue fracture, acute fracture or due to an elongation but an intact pars; (3) degenerative, due to long-standing intersegmental instability; (4) traumatic, due to fracture in bone other than

Table 1. Age profile of patients with spondylolysis or spondylolisthesis

Age at laminectomy		Age at detection of spondylolysis and spondylolisthesis	
Years	*n*	Years	*n*
0–5	6	6–10	3
6–10	7	11–15	8
11–15	4	16–20	8
16–20	2		

Table 2. Site of pars interarticularis defect and associated lordosis

	Spondylolysis (*n*)	Spondylolisthesis grade 1 (*n*)	Lordosis (*n*)
L3-4	4	1	2
L4-5	1	2	1
L5-6	8	3	6

the pars; and (5) pathological, where there is generalised or localised bone disease.

Although there is often a degree of osteoporosis and sometimes some degenerative disease in cerebral palsy, it was felt that the condition in our patients conformed to the Wiltse type II, isthmic form of spondylolysis and spondylolisthesis.

The aetiology of isthmic spondylolysis and spondylolisthesis is multifactorial [16]. True congenital forms occurring in neonates have been reported, but are uncommon, the youngest case being in a child aged 3.5 months [4]. Most North American series suggest that the time that most defects occur in the pars interarticularis is between the ages of 5 and 6.5 years [17]. There is a very small, 0.8%–2% increase from this time to 20 years of age [7, 17]. Most Western reports suggest an incidence of 5%–7% as the national average [7]. Frederickson followed 400 6- to 7-year-old schoolchildren for 25 years and noted an increase in incidence from 4.4% to 6% into adulthood [6].

It would appear that our incidence of nearly 20% of isthmic spondylolysis and spondylolisthesis is higher than can be accounted for by the natural incidence in our community. Familial types and the prevalence in certain ethnic populations has been documented, with Eskimo tribes having the highest incidence (54%) and black women the lowest (1.1%) [7, 15]. Our patients were drawn from both the coloured (mixed white and African) and white groups.

Children with cerebral palsy are subject to spinal deformities more frequently than the normal population [2, 3, 9, 13]. Unlike the other common abnormalities encountered in our spinal deformity study, such as scoliosis and kyphosis, we could find nothing published on the natural incidence of spondylolysis and spondylolisthesis in cerebral palsy per se. As a result we instigated our own study on 100 children of similar sex and race with cerebral palsy – the majority of whom were ambulatory spastic diplegics over the age of 12. We were only able to demonstrate one example of incidental isthmic spondylolysis, which was unexpectedly below the reported western national average. It would appear that once a five-level laminectomy for selective posterior rhizotomy has been performed in cerebral palsied patients, fatigue fractures may develop in the pars interarticularis at any level in the operation area. What the reason for this is, is speculative. Undoubtedly the reduction of spasticity after rhizotomy is striking. In a recently completed 10-year follow-up of our selective posterior rhizotomy patients, 95% out of a total of 110 children gained considerably in terms of movement and flexibility [10]. Probably the combined effects of this newly obtained mobility on the laminectomised spine provide the added stress necessary to cause the fracture of the pars. Lordosis and hyperextension stresses of the spine have also been implicated in spondylolysis. A similar high incidence (14%) in female gymnasts, football linesmen and back-packers have all been reported [5, 7, 8]. It is significant that lordosis was more common in our group who developed spondylolysis, and of note was that many of our children were keen participants in sports for the cerebral palsied, including events such as javelin, discus throwing and horse-riding.

The rarity of spondylolysis in non-ambulatory patients has been noted [14]. One of our non-ambulatory patients who developed spondylolisthesis post-operatively was one of our early patients who had a rhizotomy performed for severe dystonia [1]. Although it is now well established that athetosis/dystonia is a contra-indication to rhizotomy, it could well be that the continual writhing movement was a factor in the production of this patient's spondylolisthesis despite the fact that he was bedridden.

At the present time we perform a very narrow laminectomy removing spine and lamina medial to the lateral joints. A more limited laminectomy is possible if the operation is done just at the conus, but we believe the main advantage of using the five-level lumbosacral laminectomy approach is that damage to the lower sacral nerve roots supplying the bladder sphincter is prevented because of the very clear exposure of the nerve roots as they exit from their respective foramina. The incidence of incontinence using this method of rhizotomy is very low: we have performed 168 lumbosacral rhizotomies with this method since 1981 and have had only one case of urinary incontinence in the early part of this series. We think that the considerable advantage gained by this approach far outweighs the mechanical considerations of spondylolysis and spondylolisthesis.

The technique of laminotomy or laminoplasty was reported by Raimondi et al. [12] and subsequently by other authors as a way of preserving the bony arch as well as more accurate alignment of the mechanical pull of the paravertebral muscles after surgery. We will be changing to laminotomy in an attempt to overcome the risk of spondylolysis after laminectomy, but the ability of laminotomy to prevent spondylolysis or spondylolisthesis will still have to be assessed with further follow-up. Spondylolysis and spondylolisthesis is usually an incidental finding, and indeed we doubt whether any of our cases would have been demonstrated without actual

mandatory follow-up X-rays. Apart from mild backache, which is present in most active cerebral palsied patients, all our children remained asymptomatic. After 3 years none of our initial group have had further slippage on repeat X-rays.

The studies of Frederickson and many others show that spondylolysis in children is usually a static condition and virtually never progresses with time. A need for fusion with this condition is unusual [6].

Conclusion

The incidence of spondylolysis and spondylolisthesis is increased after five-level lumbosacral laminectomies for selective posterior rhizotomy. To date these patients remain asymptomatic and there has been no evidence of further slipping on follow-up.

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Editorial comment

Laminectomy is a destructive procedure; however, its role in determining postoperative spine deformity is still a subject of continuous discussion. Children are more involved than adults, showing a high incidence of postlaminectomy spinal deformity and instability due to wedging change in the cartilaginous portion of the vertebral body and the major viscoelasticity of their ligaments [3]. Spinal deformity, for example, developed in 46% of the patients under 15 years of age who underwent multilevel laminectomy, versus 6% of the subjects aged 15–24 years, in a series described by Yasuoka and co-workers in 1982 [4]. Osteoplastic laminar resection and reconstruction have been suggested for use instead of laminectomy in children in order to decrease the incidence of postoperative spine deformity [2].

Theoretically, the potential of laminectomy to lead to further spinal deformity is increased when multiple level procedures are carried out or when congenital spine malformations as well as spinal muscle imbalance are present. In this regard, this interesting paper by Dr. Peter and colleagues offers a unique opportunity to evaluate the role of some important preconditions for the occurrence of postlaminectomy vertebral instability, such as an extended laminectomy (five levels) and the presence of paraspinal muscle weakness and tone abnormality. The extended laminectomy was utilized by the authors in order to achieve better access to the spinal canal, so avoiding the risk of damaging the lower sacral nerve roots supplying the bladder sphincter.

In this paper, the most frequent postoperative spinal abnormalities detected were incidental isthmic spondylolysis or grade I spondylolisthesis; no mention is made of complications such as kyphosis or accentuated lordosis. Spondylolysis and spondylolisthesis are multifactorial in origin, so the role of the surgical procedure still remains disputable. Lordosis has been implicated and this type of anomaly was, in fact, present in a high proportion of the children who developed spondylolysis or spondylolisthesis after surgery. Correctly, the authors also point out the possible role of the increased mobility of the laminectomized spine resulting from rhizotomy. Actually, a high incidence of fatigue-fractures in the pars interarticularis of the vertebra have been observed in young athletes; conversely, spondylolysis is rare in nonambulatory patients.

As the authors plan to adopt the technique of osteoplastic laminotomy, it is probable that they will be able to clarify the specific role of laminectomy in the genesis of spondylolysis and/or spondylolisthesis in children with cerebral palsy undergoing selective posterior rhizotomy.

The effectiveness of the procedure of laminotomy in inducing proper reossification and alignment of the replaced bony segment has been confirmed in children undergoing five-level laminotomy for selective dorsal rhizotomy in a recent paper by Abbott and co-workers [1]. In no case was pseudarthrosis or canal stenosis observed, either at 1- or at 3-year postoperative radiographic follow-up, neither did these authors observe any case of