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Incidence of spinal deformity in children after multiple level laminectomy for selective posterior rhizotomy

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Abstract. Fifty-five children with cerebral palsy had multiple-level laminectomies for selective posterior rhizotomies for the relief of spasticity. They were followed up clinically and radiologically to assess their spinal stability and the possible development of post-laminectomy deformity of the spine. The majority of the deformities found were related to cerebral palsy and did not appear to be due to the laminectomy: 16% had scoliosis, 5% kyphosis, 7% lordosis, and 9% spondylolysis/spondylolisthesis. Spondylolysis is the only abnormality that appeared to be more common in this group than in children with cerebral palsy.

Key words: Cerebral palsy – Laminectomy – Posterior rhizotomy – Spasticity – Post-laminectomy deformity – Spondylolysis/spondylolisthesis

Increasing interest in the operation of selective posterior rhizotomy for spasticity has resulted in many more multiple level laminectomies being performed in children with cerebral palsy. At the University of Cape Town there is now a 7-year follow-up on a large number of children who have undergone this procedure. As there have been numerous reports attesting to the frequent occurrence of spinal deformity in children after laminectomy [3, 6, 19, 20], and as this did not seem to be the case in our patients, we decided to follow up our children, specifically looking at the stability of the spine and any possible post-laminectomy change.

Tachdjian and Matson [20] reported post-laminectomy structural scoliosis (31%) and kyphosis (26%) in children who had had spinal tumours removed. These occurred within an average period of 12 years. It was felt that the important causative factors were: (a) the early age of surgery; (b) the cervical and thoracic site of the laminectomy; (c) post-operative radiation damage to the growing spine; (d) muscular paralysis.

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Lonstein and others have stressed the role that destruction of the lateral facet joints played in the development of post-laminectomy scoliosis and kyphosis. When a lateral joint is completely removed, gross instability may result with maximum angulation at this level [9, 10].

A more recent study by Yasuoka et al. [25] from the Mayo Clinic analysed post-laminectomy deformity in children and in adults. They excluded bone disorders that could possibly lead to deformity and in all cases the facet joints were spared. Although their study clearly shows that the growing spine is more susceptible to deformity after laminectomy and that this is more common in the rostral spinal column, the lumbosacral spine seemed to be spared in the development of post-laminectomy deformity.

Patients and methods

Multiple level laminectomies of the lumbosacral and cervical spine have been performed for selective posterior rhizotomy for the relief of spasticity in children at the Red Cross War Memorial Children's Hospital in Cape Town since 1981.

Fifty-five children were included in this study. These patients came from the greater Cape Town area and had been operated on up to 7 years previously. They were assessed both clinically and radiologically: 39 had spastic diplegia, 14 had total body involvement (spastic quadriplegia), and 2 had severe dystonia. Lumbosacral laminectomies from L2–S1 had been performed in 50 of the patients and 5 had had cervical laminectomies from C3–7. The spinous processes and laminae were removed subperiosteally, leaving periosteum behind to promote regrowth after surgery. Care was taken not to involve the lateral facet joints. In 2 cases, during cervical laminectomy, the spinous processes and laminae had been removed and replaced en bloc as described by Raimondi et al. [15]. All other cases had involved a piecemeal removal of bone, which was not replaced. The average age at operation was 6.5 years with a range from 2 to 16 years. The length of follow-up was 1–7 years with an average of 4½ years.

Spinal radiographs were performed on all patients in a standard erect or sitting erect position. Anteroposterior, lateral, and oblique views were taken. Children with any abnormality of the spine were examined clinically by the authors (J.C.P and E.B.H). The severity of the abnormalities was measured using Cobb's angles [4] and the normal ranges for children, published by Probst-Proctor and Bleck [14], were used.

Table 1. Spinal abnormalities in 23 patients

	No. of cases	Percentage of total group
Scoliosis	9	16
Kyphosis	3	5
Lordosis	4	7
Degenerative osteophytic change	2	4
Spondylolysis/spondylolisthesis	5	9

Table 2. Association of lordosis and spondylolysis/spondylolisthesis

Level of pars defect	Lordosis	Ambulatory	Age	Sex	Slip	Cerebral palsy type
L3–4	20°	+	13	F	–	Diplegia
L4–5	53°	–	16	M	Grade 1	Total body
L5–S1	66°	+	17	F	–	Diplegia
L5–S1	46°	+	6	M	Grade 1	Diplegia
L5 S1	52°	+	9	M	–	Diplegia

Results

Spinal abnormalities were found in 23 patients (Table 1). Scoliosis was the commonest spinal abnormality encountered in our group of post-laminectomy children. In most cases it was mild, but variations of the primary curves from 10°–60° were encountered. The curves were usually long, mobile, and of the kind associated with total body cerebral palsy. In our series, six out of nine children had total-body cerebral palsy.

The three cases of kyphosis (more than 40°) occurred in the thoracic area. All involve a gentle C-shaped curve, which was totally mobile and represented the natural curvature of an inadequately supported trunk in cerebral palsy. No cases were seen of kyphosis related to the laminectomy or of true swan-neck deformities commonly described in larger series of cervical laminectomy patients [3, 19].

We found 7% of our children had lordosis with angles of more than 50°, measured between the inferior end plate of L1 and the superior end plate of L5. Five children had spondylolysis, including two with grade 1 spondylolisthesis, neither of whom had backache or root involvement. Three of these also had lordosis (Table 2).

Two patients who had had cervical laminectomies showed osteophytic degenerative changes of the anterior disc spaces at two levels. There was no foraminal encroachment or symptoms relating to these changes.

Discussion

Our incidence of scoliosis is below that reported in some series of scoliosis associated with cerebral palsy. The incidence reported varies from 5% to 38%, with a higher incidence in total body cerebral palsy [2, 11, 16]. Only in one case of cervical laminectomy could we possibly relate the scoliosis to the laminectomy. This was a fixed 10° scoliosis occurring at C6–7, at the junction of the inferior end of the laminectomy with the relatively fixed upper thoracic spine.

The 9% incidence of spondylolysis in our post-laminectomy cerebral palsy patients is higher than the 4%–6% reported in the literature for normal children. Baker and McHollick, in an analysis of 400 children aged 6–7 years, found an incidence of 5% [1]. Fredrickson et al., in a study of the natural history of spondylolysis showed an incidence of 4.4% at 6 years, which increased to 6% in adulthood [7]. Roche and Rowe found the incidence in adults varied with ethnic group and sex, being greatest in the white male (6.4%) and least in the black female (1.1%) [17]. In our series the average age was 13 years (range 6–17 years) with a predicted incidence of spondylolysis, according to Fredrickson, of 5.6%. Our incidence of 9% is almost double what we could expect in a normal population, but for meaningful comparison there is no series reporting the incidence in cerebral palsy patients. Rosenberg et al. showed no case of spondylolysis in 143 non-ambulatory patients and in this group there were 59 patients with cerebral palsy [18]; 4 of our 5 cases were ambulatory. We are at present investigating the incidence of spondylolysis in cerebral palsied children who have not undergone laminectomy.

The aetiology of spondylolysis remains confusing, but contributory factors such as trauma, inheritance, and biomechanical factors have been implicated [7, 21, 22, 24]. Possibly increased lordosis and weakness of the posterior supporting column of the spine caused by the laminectomy are factors increasing the tendency to spondylolysis in our group. There were four cases of lordosis of more than 50° and three of these were associated with spondylolysis. Of our five cases of spondylolysis, three had a lordotic angle of between 50° and 60° and one in the upper limit of normal between 40° and 50°. The one patient with the normal lordotic angle had a defect at L3–4. Wiltse believes the defect in the pars is related to repetitive stress and that the defect represents a fatigue fracture [23]. Athletes and especially gymnasts have a higher incidence. Jackson et al. report an 11% incidence of spondylolysis in female gymnasts with an average age of 15 years [8]. In gymnasts and football linesmen, hyperextension seems to be the cause of the repeated trauma [5]. The increased lumbar lordosis adds to the hyperextension force on the pars. Neithard has shown an increase in spondylolysis in patients with increased lordosis, secondary to kyphosis in Scheuermann's disease [12].

The defect in the posterior supporting column of the lumbosacral spine created by the multiple laminectomy from L2 to S1 may also add to the stress on the pars. This posterior weakness may also explain why we had two cases above L5 (one L4 and one L3), which normally is very rare [13]. Also, in contradistinction to Rosenberg's findings, we had one patient with spondylolysis who was a non-ambulator.

Fredrickson et al. have shown that in idiopathic spondylolisthesis the chance of progressive slip is minimal and that progression to more than 30% does not occur [7]. These patients were able to lead a normal life

without restriction of activities and had minimal symptoms, and not one patient required surgery. Our patients will have to be followed longer to determine what the natural history of these cases is.

Conclusion

Provisional follow-up of posterior rhizotomy laminectomies of the lumbosacral spine confirm that deformity in this area is extremely rare. Most of the deformities are attributable to cerebral palsy rather than to the laminectomy. There is, however, a trend towards the development of asymptomatic spondylolysis and spondylolisthesis. Even though this is possibly attributable to the consequences of laminectomy and cerebral palsy, it is felt that it is unlikely to progress or to become a problem in the future.

References

1. Baker DR, McHollick W (1956) Spondyloschisis and spondylolisthesis in children. J Bone Joint Surg [Am] 38:933
2. Balmer GA, MacEwen GD (1970) The incidence and treatment of scoliosis in cerebral palsy. J Bone Joint Surg [Br] 52:134–137
3. Cattell HS, Clark GL (1967) Cervical kyphosis and instability following multiple laminectomies in children. J Bone Joint Surg [Am] 49:713–720
4. Cobb JR (1948) Outline for the study of scoliosis. (Publications of the American Academy or Orthopaedic Surgeons, vol 57) Edward, Ann Abor, Mich
5. Ferguson RJ (1974) Low-back pain in college football lineman (abstract). J Bone Joint Surg [Am] 56:1300
6. Fraser RD, Paterson DC, Simpson DA (1977) Orthopaedic aspects of spinal tumours in children. J Bone Joint Surg [Br] 59:143–151
7. Fredrickson BE, McHollick WJ, Yuan HA, Lubicky JP (1984) The natural history of spondylolysis and spondylolisthesis. J Bone Joint Surg [Am] 66:699–707
8. Jackson DW, Wiltse LL, Carincione RJ (1976) Spondylolysis in the female gymnast. Clin Orthop 117:68–73
9. Lonstein JE (1977) Post-laminectomy kyphosis. Clin Orthop 128:93–100
10. Lonstein JE, Winter RB, Moe JH, Bradford DS, Bianco AJ (1976) Post-laminectomy spine deformity. J Bone Joint Surg [Am] 58:727
11. Madigan RR, Wallace SL (1981) Scoliosis in the institutionalised cerebral palsy population. Spine 6:583–590
12. Neithard FB (1983) Scheuermann's disease and spondylolysis. Orthop Trans 7:103
13. Pierce ME (1987) Spondylolysis. What does this mean? A review. Autralas Radiol 31:391–394
14. Propst-Proctor SL, Bleck EE (1983) Radiographic determination of lordosis and kyphosis in normal and scoliotic children. J Pediatr Orthop 3:344–346
15. Raimondi AJ, Gutierrez FA, Di Rocco C (1976) Laminotomy and total reconstruction of the posterior spinal arch for spinal canal surgery in childhood. J Neurosurg 45:555–560
16. Robson P (1968) The prevalence of scoliosis in adolescents and young adults with cerebral palsy. Dev Med Child Neurol 10:447–452
17. Roche MB, Rowe GG (1952) The incidence of separate neural arch and coincident bone variations. J Bone Joint Surg [Am] 34:491–494
18. Rosenberg NJ, Bargar WL, Friedman B (1981) The incidence of spondylolysis and spondylolisthesis in non-ambulatory patients. Spine 6:35–37
19. Sim FH, Svien HJ, Bickel WH, Janes JM (1974) Swan neck deformity following extensive cervical laminectomy. J Bone Joint Surg [Am] 56:564–580
20. Tachdjan MO, Matson DD (1965) Orthopaedic aspects of intra-spinal tumours in infants and children. J Bone Joint Surg [Am] 47:223–248
21. White AH, Wiltse LL (1976) Spondylolisthesis after extensive lumbar laminectomy. J Bone Joint Surg [Am] 58:727–728
22. Wiltse LL, Jackson DW (1976) The treatment of spondylolisthesis and spondylolysis in children. Clin Orthop 117:92–100
23. Wiltse LL, Widell EH Jr, Jackson DW (1975) Fatigue fracture: the basic lesion in isthmic spondylolisthesis J Bone Joint Surg [Am] 57:17–22
24. Wiltse LL, Newman PH, MacNab I (1976) Classification of spondylolisis and spondylolisthesis. Clin Orthop 117:23–29
25. Yasukoka S, Peterson HA, MacCarty CS (1982) Incidence of spinal column deformity after multilevel laminectomy in children and adults. J Neurosurg 57:441–445