Radiculopathy after laminectomy for cervical compression myelopathy

Liyang Dai, Bin Ni, Wen Yuan, Lianshun Jia

From Changzheng Hospital, Shanghai, China

Postoperative radiculopathy is a complication of posterior cervical decompression associated with tethering of the nerve root. We reviewed retrospectively 287 consecutive patients with cervical compression myelopathy who had been treated by multilevel cervical laminectomy and identified 37 (12.9%) with postoperative radiculopathy. There were 27 men and ten women with a mean age of 56 years at the time of operation. The diagnosis was either cervical spondylosis (25 patients) or ossification of the posterior longitudinal ligament (12 patients).

Radiculopathy was observed from four hours to six days after surgery. The most frequent pattern of paralysis was involvement of the C5 and C6 roots of the motor-dominant type. The mean time for recovery was 5.4 months (two weeks to three years). The results at follow-up showed that the rate of motor recovery was negatively related to the duration of complete recovery of postoperative radiculopathy ($\gamma = -0.832$, $p < 0.01$) and that patients with spondylotic myelopathy had a significantly better rate of clinical recovery than those with ossification of the posterior longitudinal ligament ($t = 2.960$, $p < 0.01$).

Postoperative radiculopathy may be prevented by carrying out an anterior decompression in conjunction with spinal fusion, which will achieve stabilisation and directly remove compression of the cord at multiple levels.

J Bone Joint Surg [Br] 1998;80-B:846-9.

Received 24 November 1997; Accepted 12 January 1998

Cervical laminectomy is commonly used to treat a variety of disorders of the cervical spine.¹⁻⁶ In contrast to the complexity and difficulty of anterior surgical approaches, it

is relatively simple and straightforward and has been clearly established as safe and efficacious. Various complications have been described including injury to the spinal cord during operation,^{7,8} dural tears,⁹ epidural haematoma,⁸ cerebellar haemorrhage,¹⁰ infection,¹¹ postlaminectomy kyphosis,^{8,12-17} postlaminectomy instability,^{12,14,18} adhesive arachnoiditis,¹⁴ residual compression of the neural elements,^{3,19,20} delayed central spinal cord syndrome²¹ and syringomyelia,²² but most of these are predictable and preventable.

The presence of radiculopathy after posterior decompression of the cervical cord has been well documented.^{8,15,23-25} It is characterised by neurological deterioration in the upper arms and has occurred even after successful posterior release of the cord and an initial phase of improvement. It has been suggested that neurological deterioration is caused by a tethering effect of traction on the intra- or extradural components of the nerve root due to the expansion and migration of the spinal cord after posterior decompression.^{8,23,24-26}

Patients and Methods

Between 1988 and 1995, we performed multilevel cervical laminectomy on 287 patients with cervical compression myelopathy at Changzheng Hospital in Shanghai. Postoperative radiculopathy which was not related to injury to neural tissue during surgery was seen in 37 (12.9%). We have reviewed retrospectively the clinical and radiological records of these patients.

We classified the radiculopathy according to the grading of Tsuzuki et al.²³ The motor-dominant type was defined as muscle weakness with little or no sensory loss and the sensory-dominant types as sensory loss and/or intractable pain with little or no motor impairment.

There were 27 men and ten women with a mean age at surgery of 56 years (37 to 74). The diagnosis was cervical spondylosis in 25 patients and ossification of the cervical posterior longitudinal ligament in 12.

The indication for laminectomy was progressive dysfunction of the cervical cord due to multilevel spondylotic narrowing of the spinal canal or ossification of the posterior longitudinal ligament. For cervical laminectomy the patient was positioned prone with the head in an adjustable head-

L. Y. Dai, MD, PhD, Associate Professor

B. Ni, MD, Associate Professor

W. Yuan, MD, Associate Professor

L. S. Jia, MD, Professor

Department of Orthopaedic Surgery, Changzheng Hospital, 415 Fengyang Road, Shanghai 200003, China.

Correspondence should be sent to Dr L. Y. Dai.

©1998 British Editorial Society of Bone and Joint Surgery
0301-620X/98/58580 \$2.00

rest. Under local anaesthesia posterior decompression was achieved by extensive laminectomy which was from C3 to C7 in 29 patients and from C3 to C6 in eight. We did not perform facetectomy and the dura was not opened.

Results

The mean time of the appearance of radiculopathy was 15 hours after surgery (4 hours to 6 days). All the patients had unilateral involvement, most frequently in the C5 root (29 patients), but also in the C5 and C6 roots combined (4) and in the C7 (3) and C8 roots (1).

There were 26 patients with the motor-dominant and seven with the sensory-dominant type. Of the former, nine were graded as mild, ten as moderate, and seven as severe according to the manual muscle-testing score. Radiculopathy with both motor and sensory loss to a consistent degree was identified in four patients, two with moderate and two with severe changes.

The mean time to complete recovery was 5.4 months (2 weeks to 3 years). Those with the sensory-dominant type improved more quickly than those with the motor-dominant or mixed patterns and the duration of complete recovery

Table I. Duration of complete recovery (months) of postoperative radiculopathy in 37 patients

Type	Duration of complete recovery				
	<1	1 to 3	3 to 6	6 to 12	>12
Motor-dominant					
Mild	3	4	2	0	0
Moderate	0	3	5	2	0
Severe	0	2	2	1	2
Sensory-dominant	2	4	1	0	0
Motor-and-sensory	0	1	0	1	2

was related to the degree of motor impairment (Table I).

The mean follow-up was for 48 months (18 to 104). The results of operation were evaluated according to the scoring system for cervical myelopathy proposed by the Japanese Orthopaedic Association (JOA).²⁷ The mean rate of recovery according to Hirabayashi et al²⁸ was 53.8% (3.2% to 80%) and was statistically negatively related to the duration of complete recovery ($\gamma = -0.832$, $p < 0.01$) (Fig. 1). It was significantly higher ($t = 2.960$, $p < 0.01$) in the patients with spondylotic myelopathy than in those with ossification of the posterior longitudinal ligament (Fig. 2).

Fig. 1

Correlation of rate of recovery of cervical myelopathy with the duration of complete recovery of postoperative radiculopathy.

Fig. 2

Rate of recovery of cervical myelopathy in patients after laminectomy (1, spondylotic myelopathy, 2, ossification of the posterior longitudinal ligament).

Discussion

Cervical compression in myelopathy is predominantly due to pressure on the anterior spinal cord with ischaemia and to deformation of the cord by anterior herniated discs, spondylitic spurs or an ossified posterior longitudinal ligament. Posterior decompression, laminectomy or laminoplasty increases the amount of space available for the cord and allows it to move away from the anterior structures. Using MRI, Levi et al²⁹ showed that dorsal migration of the cord occurred after extensive laminectomy in patients with injuries to the central cord and severe stenosis of the spinal canal. Matsuyama, Kawakami and Mimatsu³⁰ used CT and intraoperative spinal sonography to assess the relationship between the morphological changes in the cord and the clinical improvement after posterior decompression in patients with cervical myelopathy. They divided expansion of the cord after posterior decompression into immediate or gradual, and found that good clinical recovery was significantly correlated with gradual expansion. However, posteromedial shift of the dura-root junction combined with the expansion of the spinal cord after laminectomy exerts a traction force on the extradural components of the anterior and posterior roots causing postoperative paralysis of the arm.^{23,25} The radiological findings in patients with postoperative radiculopathy also suggest an increase in tension on the roots outside the dural sac.²⁴ Sasai et al¹⁵ retrospectively analysed the preoperative risk factors in cervical radiculopathy in a radiological and electrophysiological study. No relationship was found between postoperative radiculopathy and the preoperative radiological findings such as cervical lordosis, the position of the spinal cord in the canal and of the superior articular process to the vertebral body. In our study, postganglionic type-C5 radiculopathy was suggested as an important risk factor which can be identified preoperatively by electrophysiological studies.

Our study has shown that postoperative radiculopathy developed after an initial phase of improvement. The most frequent pattern of paralysis was involvement of the C5 and C6 roots of the motor-dominant type. We agree with Tsuzuki et al²³⁻²⁵ that postoperative radiculopathy is caused by a tethering effect of expansion and migration of the spinal cord on the nerve root rather than a technical problem. There is a wide variation in the presentation of postoperative radiculopathy. Full recovery took more time than expected in some although most patients achieved improvement by one year. The rate of recovery of myelopathy was negatively related to the duration of complete reduction of overall radiculopathy, indicating that posterior migration and expansion of the spinal cord after posterior decompression not only cause radiculopathy but also have an unfavourable effect on the cord. Patients with spondylitic myelopathy and postoperative radiculopathy had a significantly better rate of clinical recovery than those with ossification of the posterior longitudinal ligament, probably

because of the insidious progression of the ossification and the slow onset of the myelopathy. Consequently, by the time decompression is undertaken the cord may be severely deformed and flattened. Immediately after decompression the cord expands and shifts, thereby exerting more severe traction on the root.

Procedures for the prevention of postoperative radiculopathy have been proposed. The effects of longitudinal durotomy were investigated in a controlled study involving 118 patients who had a laminoplasty.²⁴ The results showed that in 78 patients who had laminoplasty without durotomy there were eight with C5 lesions whereas none was seen in the 40 who had laminoplasty with durotomy. Application of longitudinal durotomy in laminoplasty also resulted in the disappearance of postoperative radiculopathy in one patient. Decompression through an anterior procedure in conjunction with a spinal fusion may achieve stabilisation and directly remove all compression of the anterior spinal cord at multiple levels. Complete or a partial vertebrectomy is usually indicated in patients with severe multilevel myelopathy.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References

1. Batzdorf U, Batzdorff A. Analysis of cervical spine curvature in patients with cervical spondylosis. *Neurosurgery* 1988;22:827-36.
2. Benzel EC, Lancon J, Kesterson L, Hadden T. Cervical laminectomy and dentate ligament section for cervical spondylotic myelopathy. *J Spinal Disord* 1991;4:286-95.
3. Carol MP, Ducker TB. Cervical spondylitic myelopathies: surgical treatment. *J Spinal Disord* 1988;1:59-65.
4. Crandall PH, Batzdorf U. Cervical spondylotic myelopathy. *J Neurosurg* 1966;25:57-66.
5. Fager CA. Results of adequate posterior decompression in the relief of spondylotic cervical myelopathy. *J Neurosurg* 1973;38:684-92.
6. Magnaes B, Hauge T. Surgery for myelopathy in cervical spondylosis: safety measures and preoperative factors related to outcome. *Spine* 1980;5:211-4.
7. Yonenobu K, Okada K, Fuji T, et al. Causes of neurologic deterioration following surgical treatment of cervical myelopathy. *Spine* 1986;11:818-23.
8. Yonenobu K, Hosono N, Iwasaki M, Asano M, Ono K. Neurologic complications of surgery for cervical compression myelopathy. *Spine* 1991;16:1277-82.
9. Eismont FJ, Weisel SW, Rothman RH. Treatment of dural tears associated with surgery. *J Bone Joint Surg [Am]* 1981;63-A:1132-6.
10. Chadduck WM. Cerebellar hemorrhage complicating cervical laminectomy. *Neurosurgery* 1981;9:185-9.
11. Haines SJ. Systemic antibiotic prophylaxis in neurological surgery. *Neurosurgery* 1980;6:355-61.
12. Cattell HS, Clark GL Jr. Cervical kyphosis and instability following multiple laminectomies in children. *J Bone Joint Surg [Am]* 1967;49-A:713-20.
13. Lonstein JE. Post-laminectomy kyphosis. *Clin Orthop* 1977;128:93-100.
14. Mikawa Y, Shikata J, Yamamuro T. Spinal deformity and instability after multilevel cervical laminectomy. *Spine* 1987;12:6-11.
15. Sasai K, Saito T, Akagi S, Watanabe H. Clinical study of cervical radiculopathy after laminoplasty for cervical myelopathy. *J Jpn Orthop Assoc* 1995;69:1237-47 (in Japanese).
16. Yasuoka S, Peterson HA, Laws ER Jr, MacCarty CS. Pathogenesis and prophylaxis of postlaminectomy deformity of the spine after multiple level laminectomy: difference between children and adults. *Neurosurgery* 1981;9:145-52.

17. **Yasuoka S, Peterson HA, MacCarty CS.** Incidence of spinal column deformity after multilevel laminectomy in children and adults. *J Neurosurg* 1982;57:441-5.
18. **Callahan RA, Johnson RM, Margolis RN, et al.** Cervical facet fusion for control of instability following laminectomy. *J Bone Joint Surg [Am]* 1977;59-A:991-1002.
19. **Epstein N, Epstein JA, Benjamin V, Ransohoff J.** Traumatic myelopathy in patients with cervical spinal stenosis without fracture or dislocation: methods of diagnosis, management, and prognosis. *Spine* 1980;5:489-96.
20. **Guidetti B, Fortuna A.** Long-term results of surgical treatment of myelopathy due to cervical spondylosis. *J Neurosurg* 1969;30:714-21.
21. **Levy WJ, Dohn DF, Hardy RW.** Central cord syndrome as a delayed postoperative complication of decompressive laminectomy. *Neurosurgery* 1982;11:491-5.
22. **Middleton TH, Al Mefty O, Harkey LH, Parent AD, Fox JL.** Syringomyelia after decompressive laminectomy for cervical spondylosis. *Surg Neurol* 1987;28:458-62.
23. **Tsuzuki N, Abe R, Saiki K, Okai K.** Paralysis of the arm after decompression of the cervical spinal cord. II. Analysis of clinical findings. *Eur Spine J* 1993;2:197-202.
24. **Tsuzuki N, Abe R, Saiki K, Zhongshi L.** Extradural tethering effect as one mechanism of radiculopathy complicating posterior decompression of the cervical spinal cord. *Spine* 1996;21:203-11.
25. **Tsuzuki N, Zhongshi L, Abe R, Saiki K.** Paralysis of the arm after posterior decompression of the cervical spinal cord. I. Anatomical investigation of the mechanism of paralysis. *Eur Spine J* 1993;2:191-6.
26. **Stoops WL, King RB.** Neural complications of cervical spondylosis: their response to laminectomy and foramenotomy. *J Neurosurg* 1962;16:986-99.
27. **Japanese Orthopaedic Association.** Scoring system for cervical myelopathy. *J Jpn Orthop Assoc* 1994;68:490-503.
28. **Hirabayashi K, Miyakawa J, Satomi K, Maruyama T, Wakano K.** Operative results and postoperative progression of ossification among patients with ossification of cervical posterior longitudinal ligament. *Spine* 1981;6:354-64.
29. **Levi L, Wolf A, Mirvis S, et al.** The significance of dorsal migration of the cord after extensive cervical laminectomy for patients with traumatic central cord syndrome. *J Spinal Disord* 1995;8:289-95.
30. **Matsuyama Y, Kawakami N, Mimatsu K.** Spinal cord expansion after decompression in cervical myelopathy: investigation by computed tomography, myelography and ultrasonography. *Spine* 1995;20:1657-63.