

Cervical Roots as Origin of Pain in the Neck or Scapular Regions

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Study Design. A prospective observational study.

Objectives. To determine whether the pain in the neck or scapular regions in patients with cervical radiculopathy originates from the compressed root and whether the site of pain is useful for diagnosing the level.

Summary of Background Data. The pain has been thought to be caused not by root compression but by instability caused by disc degeneration or zygapophysial joint osteoarthritis because it usually precedes radicular symptoms in the arm/fingers.

Methods. The subjects were 50 consecutive patients with pain as well as arm/finger symptoms, who underwent single-root decompression alone. The involved roots were C5 in 9 patients, C6 in 14, C7 in 14, and C8 in 13.

Results. The pain preceded the arm/fingers symptoms in 35 patients (70%). Although the pain had lasted for more than 7 months on average before surgery, it was relieved early after surgery in 46 patients (92%). When the painful site was suprascapular, C5 or C6 radiculopathy was frequent ($P < 0.01$). When it was interscapular, C7 or C8 radiculopathy was frequent ($P < 0.001$). When it was scapular, C8 radiculopathy was frequent ($P < 0.01$).

Conclusions. Pain in the suprascapular, interscapular, or scapular regions can originate directly in the compressed root. The site of the pain is valuable for determining localization of the involved root.

Key words: cervical radiculopathy, neck pain, scapular pain, cervical nerve root, diagnosis, surgery. **Spine 2006; 31:E568–E573**

Pain in the neck or scapular region is one of the most frequent symptoms in cervical radiculopathy, which is commonly caused by a degenerative process in the spine.¹ However, to our knowledge, the origin of this pain has not been clarified yet. The pain usually precedes other radicular symptoms such as pain, numbness, and motor weakness in the arm and/or fingers.^{2–4} The interval between the onset of the neck and scapular pain and the radicular symptoms has led to the belief that the pain is not caused by nerve root compression but by other mechanisms such as mechanical instability caused by degeneration of the intervertebral disc or osteoarthritic changes of the zygapophysial joint.^{2,3,5,6}

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When the pain originates from an intervertebral disc or joint, it will not be relieved with surgery that simply decompresses the root without fusion. On the other hand, when the pain originates from a compressed nerve root, it may be perceived at a site referable to the root. This study was prospectively conducted to determine whether the neck and scapular pain in patients with radiculopathy originates from the nerve root and whether the perceived site of the pain is useful for diagnosing the level of the involved nerve root.

Materials and Methods

Patients. The subjects of this study were 50 consecutive patients (42 males and 8 females) with radiculopathy who complained of neck or scapular pain as well as symptoms in an arm or fingers, and underwent single-nerve root decompression through posterior open foraminotomy⁷ between January 1998 and December 2002. Surgeries were indicated after ineffective conservative treatment for at least 4 months, except for the patients with the inability to elevate the shoulder or extend the fingers, in which cases surgery was indicated earlier. Informed consent was obtained from all the patients before surgery. The age of the patients at surgery ranged from 30 to 80 years (average 52). The duration of symptoms in the arm or fingers before surgery ranged from 2 months to 3 years (average 7 months). The involved nerve roots were C5 in 9 patients, C6 in 14, C7 in 14, and C8 in 13.

The involved nerve roots were identified based on the symptoms and signs in the arm or fingers, which were described by Yoss⁸ and Murphey *et al*³ as being valuable for identification (Table 1), and on imaging diagnosis. In all 50 patients, plain radiography, computerized tomography, magnetic resonance imaging, myelography, and computerized tomography after myelography were performed before surgery. In 5 patients, diagnostic root injections were performed into the C6 and C7 roots to verify the involved roots. Of these patients, the involved roots were C6 in 2 patients and C7 in 3. The pathologies compressing the roots were a laterally herniated disc in 20 patients and a spondylotic spur at the Luschka or facet joint, or both in 30. During posterior open foraminotomy, regardless of the pathology, 3 laminae on the symptomatic side were exposed and, with preservation of more than half of the facet joint capsule, an area 4 mm in width of the facet joint was resected medially. The surgeon (Y.T.) who was the most experienced at posterior foraminotomy in our institute performed every operation. The neck was immobilized after surgery with a collar for 2 weeks.

Evaluation of Neck and Scapular Pain

Pain Preceding Arm or Finger Symptoms. Neck or scapular pain, and pain, numbness, or motor weakness in the arm or fingers were recorded. When the initial symptom was neck or scapular pain alone and subsequent symptoms appeared the

Table 1. Diagnostic Indices for the Determination of Involved Nerve Root

Level	Paraesthesia/Sensory Change in Fingers	Muscle Weakness	Diminished Tendon Reflex
C5	None	Deltoid	Biceps
C6	Thumb	Biceps	Biceps
C7	Index/middle	Triceps	Triceps
C8	Little	Hand intrinsic muscles	Triceps

next day or thereafter, the interval between them was recorded as less than 1 week, 1 month, 3 months, or more than 3 months.

Site. The neck and scapular regions were divided into 5 subregions: nuchal, suprascapular, interscapular, and scapular region, and the region of the superior scapular angle (Figure 1). The neck or scapular pain was localized and evaluated immediately before, and 1 month and 1 year after surgery. At every examination, a single examiner (Y.T.) circumscribed each subregion with his finger directly on the skin of the patient and asked the patient in which subregion he/she had pain. When the pain was in ≥ 2 subregions, only the most painful site judged by the patient was recorded. When the most painful site could not be judged, all painful sites were recorded.

Severity. The severity of the neck and scapular pain was graded⁷: 3 points (no pain), 2 points (occasional pain), 1 point (continuous pain/occasional but severe pain), and 0 points (continuous severe pain).

Evaluation of Symptoms in the Arms and Fingers. To confirm effective decompression of the involved root, the severity of the symptoms and objective findings in the arms and/or fingers were evaluated before and 1 month after surgery, with reference to the following 4 items⁷:

- Arm symptom: 3 points, no pain; 2 points, occasional pain; 1 point, continuous pain/occasional but severe pain; and 0 points, continuous severe pain.

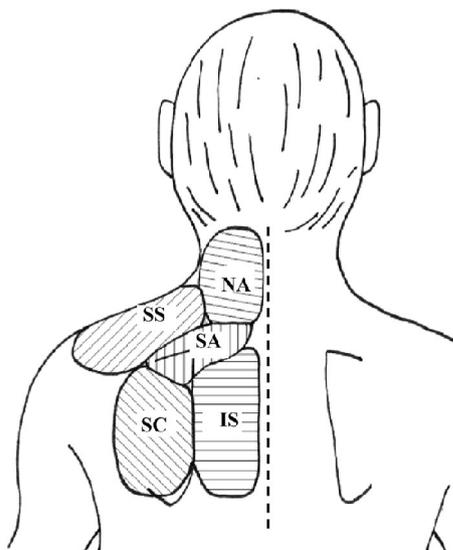


Figure 1. The nape (NA), superior angle of scapula (SA), suprascapular (SS), interscapular (IS), and scapular (SC) regions.

- Finger symptom: 3 points, no pain; 2 points, occasional pain; 1 point, continuous pain/occasional but severe pain; and 0 points, continuous severe pain.
- Sensory function: 2 points, normal; 1 point, minimal sensory loss; and 0 points, sensory loss $\leq 50\%$ than normal.
- Motor function: 2 points, normal; 1 point, weakness of grade 4 on manual muscle testing; and 0 points, weakness of grade ≤ 3 on manual muscle testing.

A normal score was 10 in total.

Statistical Analysis. The Pearson χ^2 test was used to assess the frequency of the neck and scapular pain preceding the arm or finger symptoms. The paired *t* test was performed to evaluate differences in the severity of the pain, and in the severity of the symptoms and objective findings in the arms and/or fingers before and after surgery. The Pearson χ^2 test was used to assess the relationships between the sites of the pain and involved roots. A *P* value < 0.05 was considered significant.

■ Results

Precedence of Neck and Scapular Pain

The neck or scapular pain, and the arm or finger symptoms occurred on the same day in 15 of the 50 patients (30%). The pain preceded the arm or finger symptoms in the remaining 35 patients (70%), and this finding was statistically significant ($P < 0.05$). Of the 35 patients, 33 described the interval between their neck or scapular pain and subsequent symptoms, which was 1 week or longer in 18 patients (55%) and 1 month or longer in 7 patients (21%) (Figure 2).

Symptom Scores in the Arms and Fingers

The scores of the symptoms and objective findings in the arms and/or fingers ranged from 0 to 8 (mean \pm standard deviation SD 3.4 ± 2.2) before surgery and 3 to 10 (mean \pm SD 7.6 ± 2.0) 1 month after surgery. The score increased in all 50 patients, indicating that the involved roots had been effectively decompressed. The ranges, means, and SDs of the scores of patients in which C5, C6,

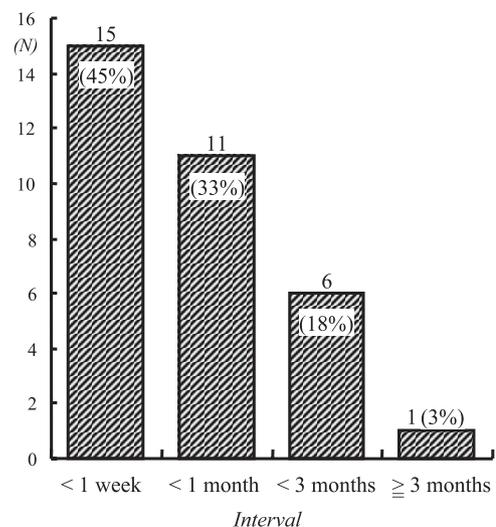


Figure 2. Time between the initial symptom of neck or scapular pain and subsequent symptom of arm or fingers in 33 patients. The number of patients is shown.

Table 2. Symptom Scores in the Arms and Fingers Before and 1 Month After Surgery

Levels	No. Patients	Preoperative Score			Postoperative Score		
		Range	Mean	SD	Range	Mean	SD
C5	9	4–8	5.2	1.3	6–10	8.0	1.3
C6	14	0–7	3.5	2.1	4–10	8.1	1.9
C7	14	0–6	2.8	2.0	3–10	8.2	1.8
C8	13	0–7	2.8	2.5	3–10	6.2	2.0
Total	50	0–8	3.4	2.2	3–10	7.6	2.0

C7, or C8 roots were decompressed are shown in Table 2. The increase of the scores at 1 month after surgery in each of the decompressed root levels was statistically significant ($P < 0.001$).

Subregions of Neck and Scapular Pain

There were 61 painful sites in total before surgery: 1 in 39 patients and 2 in 11 (Figure 3). A total of 27 patients had no complaint of pain 1 month after surgery. The remaining 23 patients had pain in 24 subregions in total (Figure 4). Seven (29%) of the sites were the same sites as those before surgery, and 17 (71%) were newly developed ones. All but 1 new site were nuchal and suprascapular subregions, despite root decompression at various levels (C5, 1; C6, 5; C7, 6; and C8, 5). The prevalence of new pain occurring in these particular subregions was statistically significant ($P < 0.01$, Pearson χ^2 test). A total of 45 patients had no complaint of pain 1 year after surgery. The remaining 5 patients had pain in 6 subregions in total. Of the sites, 3 (2 suprascapular and 1 interscapular) were the same sites as those before surgery, and 3 (2 suprascapular and 1 superior scapular angle) were newly developed ones.

Severity of Neck and Scapular Pain

The scores on the neck and scapular pain ranged from 0 to 2 points (mean \pm SD 1.4 ± 0.7) before surgery and 1 to 3 points (mean \pm SD 2.5 ± 0.6) 1 month after surgery. The increase of the scores (*i.e.*, the decrease in pain) was statistically significant ($P < 0.001$). Of the 23 patients who had neck or scapular pain 1 month after surgery, 9 had an increased score, 1 a decreased score, and 13 the

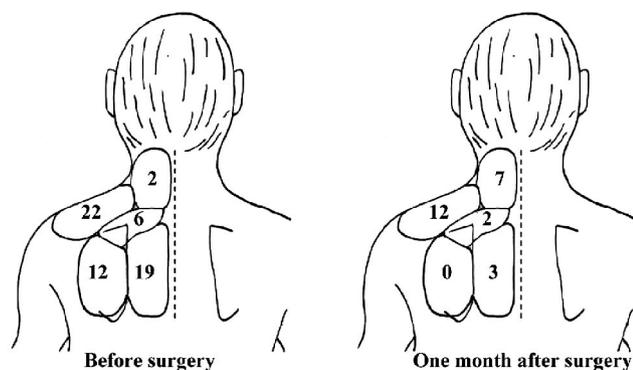


Figure 3. Sites of neck or scapular pain before surgery and at 1 month after surgery in 50 patients. The number of patients is indicated.

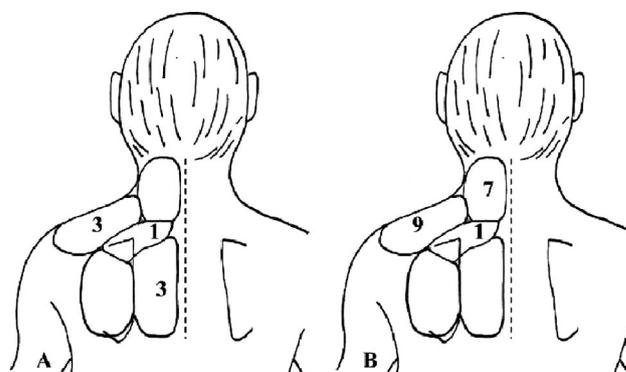


Figure 4. Sites of neck or scapular pain at 1 month after surgery in 23 patients. Of 24 sites, 7 were the same sites as before surgery (A), and 17 were newly developed sites (B). The number of patients is shown.

same score (Table 3). Of the 13 patients who had the same score, the painful subregions were the same as the preoperative ones in 3 patients and newly developed ones in 10. Accordingly, in 46 (92%) of the 50 patients, the preoperative neck or scapular pain was eliminated or diminished within 1 month after surgery. Of the 5 patients who had neck or scapular pain 1 year after surgery, 4 had an increased score, and 1 had the same score, compared to the score before surgery. In the patient who had the same score, the painful subregion was a newly developed one.

Subregions of Neck and Scapular Pain Versus Involved Root Levels

In C5 radiculopathy, the painful sites were located in either the nuchal, superior scapular angle, or suprascapular subregions, and none were in the interscapular or scapular subregions. The suprascapular pain was significantly frequent ($P < 0.01$) (Table 4). In C6 radiculopathy, the suprascapular pain was significantly frequent ($P < 0.001$). In C7 radiculopathy, the interscapular pain was significantly frequent ($P < 0.01$). In C8 radiculopathy, the interscapular or scapular pain was significantly frequent ($P < 0.001$). On the other hand, when the painful site was the suprascapular subregion, C5 or C6 radiculopathy was significantly frequent ($P < 0.01$), and none of the cases was C8 radiculopathy (Figure 5). When it was the interscapular subregion, C7 or C8 radiculopathy was significantly frequent ($P < 0.001$), and all the cases were either C7 or C8 radiculopa-

Table 3. Scores of the Neck and Scapular Pain, and Number of Cases Among the 50 Patients Before and 1 Month After Surgery

Preoperative Score	Postoperative Score				Total
	0	1	2	3	
Point					
0			2	4	6
1		2	7	11	20
2		1	11	12	24
Total		3	20	27	50

Table 4. Relationship Between the Level of the Involved Nerve Root and Site of the Neck and Scapular Pain

	Levels				Total
	C5	C6	C7	C8	
No. cases	9	14	14	13	50
Single	7	13	10	9	39
Double	2	1	4	4	11
Painful Sites					
Nape	2	0	0	0	2
Superior scapular angle	2	3	1	0	6
Suprascapular	7	11	4	0	22
Interscapular	0	0	10	9	19
Scapular	0	1	3	8	12
Total	11	15	18	17	61

thy. When it was the scapular subregion, C8 radiculopathy was significantly frequent ($P < 0.01$), and none of the cases was C5 radiculopathy.

■ Discussion

In clinical studies on neck and scapular pain, unavoidable difficulties are encountered in determining the site of the pain. Patients do not always describe clearly the site because they seldom know its anatomic name. When asked to point with a finger, the finger may not reach the site, especially the interscapular or scapular region. Even when it can reach the site, physicians in turn may not be able to describe the site correctly because the pain is generally indistinct at its border. To overcome these difficulties, we took a new approach in which patients are asked not to describe or point out the sites of pain but to choose them from among 5 subregions in the neck and scapular regions. Through this approach in the present study, the painful sites were identified in all patients, and further, by comparing the preoperative and postoperative sites of pain, new pain that developed after surgery was detected. This new approach is useful not only for detecting the site of the pain but also for investigating the source, or assessing the effect of treatment on the pain.

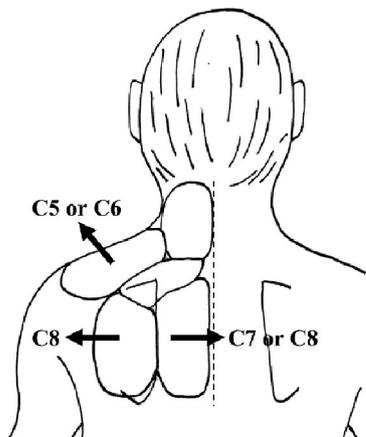


Figure 5. Site of the neck or scapular pain and the indicated level of the involved nerve root.

Our attempt to divide the neck and scapular regions into 5 subregions must be the first such method to study the neck and scapular pain in patients with cervical radiculopathy. In fact, in representative studies about the symptomatology of radiculopathy, Yoss *et al*⁸ divided the regions into 3 subregions (nuchal, interscapular, and scapular), and Murphey *et al*³ divided them into 2 (neck and scapular). The numbers of their subregions seem to be too small because 1 of 4 cervical roots (C5–C8) is generally affected. Even if each root level has a characteristic painful site, its identification in merely 2 or 3 subregions would probably be difficult. We added the suprascapular subregion and subregion of the superior scapular angle simply because pain in these subregions was not infrequently encountered in our clinical practice and because we had already known that such pain could be distinguished from that of other subregions through a previous study concerning the sites of neck and scapular pain of zygapophysial joint origin.⁹

Posterior foraminotomy for cervical radiculopathy decompresses the nerve root alone. Therefore, the root would prove to be the origin of the neck and scapular pain if the pain is relieved together with the radicular symptoms in the arm and fingers. There have been a few reports describing that such pain was relieved after foraminotomy.^{3,10} However, evaluations of the pain in those studies were performed 1–28 years³ or 4–42 months¹⁰ after surgery. Early postoperative assessment is essential, provided that the pain from the surgical wound does not prevent evaluation, for verifying that the relief of the pain was actually brought about by surgery. Otherwise, it is difficult to determine if the relief resulted from the root decompression or a natural remission of pain originating from sites other than a nerve root. In the 50 patients in the present study, although the preoperative pain had persisted for more than 7 months on average, the pain was eliminated or diminished within 1 month after surgery in 92%. We conclude that the improvement in the pain was certainly brought about by surgery and the pain originated directly from the root compression.

To our knowledge, the cause of neck and scapular pain that occurs after laminoplasty for cervical myelopathy has not been clarified. We revealed in this study that the occurrence of neck and scapular pain after posterior foraminotomy was significantly more prevalent in the nuchal or suprascapular regions. These regions are almost the same as the regions where the pain occurs after laminoplasty.^{11,12} The pain that occurs after these 2 different surgeries is considered to be related to the dissection and retraction of the nuchal muscles, which are procedures common to both surgeries.

Why does neck or scapular pain usually precede arm or finger symptoms in cervical root compression? It would appear obvious that the pain is not derived from the compression of the sensory nerve fibers traversing the root. Otherwise, the pain would tend to co-occur with the arm or finger symptoms. There is a report describing that free nerve endings were histopathologically identi-

fied in the dural sheath of the cervical roots from post-mortem subjects.¹³ The fiber diameters of the free nerve endings corresponded to those of either A delta fibers or C fibers,¹³ both of which are responsible for the mediation of pain.¹⁴ Furthermore, it is not infrequent, in our experience, that during diagnostic root injections to detect the involved level the patients perceive first only neck or scapular pain and afterwards arm or finger pain as the needle is inserted deep into the root. Accordingly, neck or scapular pain is probably the initial symptom of cervical radiculopathy when the compression is confined to the dural sheath.

In clinical practice, it is common to see patients who have neck or scapular pain unaccompanied by radicular symptoms in the arm or fingers. Most physicians doubt that the pain originates from a nerve root. However, as we confirmed in this study, the pain is usually the initial symptom in radiculopathy²⁻⁴ and can last alone as long as a few weeks or more before the arm or finger symptoms develop.² In short, neck and scapular pain without symptoms in the arm or finger can originate in the root.

Clarifying the origin of neck and scapular pain occurring in the degenerative process of the cervical spine has long been a challenge to physicians. Any of the structures that receive a nerve supply can be an origin of the pain.¹⁵ Of the structures, the zygapophysial joint has been much studied, both experimentally in normal volunteers and clinically in patients.^{16,17} Dwyer *et al*¹⁶ described characteristic regions of pain from zygapophysial joints at segments C2–C3 to C6–C7. Although a strict comparison between their findings and ours is not possible because of the different methodologies, the pain regions of zygapophysial joint origin except for the C6–C7 joints seem to locate mainly or partly in the nuchal region, which we found in this study to be quite rare for pain of cervical root origin. To our knowledge, no clinical sign has been clarified as pathognomonic of zygapophysial joint pain or pain of other structures. On the other hand, it is well known that the Spurling neck compression test usually reproduces neck and scapular pain in patients with cervical radiculopathy.⁴ The unilateral pain of a scapular but not nuchal location, which is reproducible by the test, may originate in the root.

There is a study that attempted to determine the reliability of subjective symptoms for the localization of the involved nerve root in cervical radiculopathy.⁸ As for neck or scapular pain, the description of the site of the pain by the patient was of little value for the localization. However, in that study, as we mentioned earlier, the neck and scapular regions were divided into only 3 subregions, and pain of the suprascapular region was not distinguished from the pain of the interscapular or scapular region. We conclude from the present study that the site of the scapular pain is significantly reliable for localization of the involved nerve root in patients with cervical radiculopathy. Pain in the suprascapular region indicates C5 or C6 radiculopathy. The same

applies to the relationships between the pain in the interscapular region and C7 or C8 radiculopathy, and between pain in the scapular region and C8 radiculopathy.

This was a prospective study incorporated into the usual management for cervical radiculopathy. Surgeries for the patients were indicated strictly based on our routine criteria. The most experienced surgeon performed the operations, and the same surgeon did the preoperative and postoperative examinations. Therefore, the results of this study might not be reproducible by different or among multiple observers. However, this study has the advantage that the surgical techniques and examination methods were consistent for every patient. Furthermore, we believe that because this is a clinically relevant study about a very common lesion, the validity of this study will be easily and promptly confirmed in daily clinical practice at wherever such patients are examined.

■ Key Points

- A prospective study was conducted to determine whether the pain in the neck or scapular regions in patients with cervical radiculopathy originates from the compressed root and whether the site of the pain is useful for diagnosing the level.
- It was confirmed through this study that scapular region pain is generally the initial symptom in radiculopathy and can persist alone before the arm or finger symptoms develop.
- Although the pain had persisted for more than 7 months on average before surgery, it was relieved early after surgery for single-root decompression in 46 (92%) of 50 patients.
- Pain in the scapular region can originate directly in the compressed root, and the site of the pain is valuable for determining the localization of the involved root.

References

1. Radhakrishnan K, Litchy WJ, O'Fallon WM, et al. Epidemiology of cervical radiculopathy. A population-based study from Rochester, MN, 1976 through 1990. *Brain* 1994;117:325–35.
2. Macnab I, McCulloch JA, eds. Cervical disc disease: Clinical assessment. In: *Neck Ache and Shoulder Pain*. Baltimore, MD: Williams & Wilkins; 1994: 54–78.
3. Murphey F, Simmons JCH, Brunson B. Surgical treatment of laterally ruptured cervical disc. Review of 648 cases, 1939 to 1972. *J Neurosurg* 1973; 38:679–83.
4. Spurling RG, Scoville WB. Lateral rupture of the cervical intervertebral discs. A common cause of shoulder and arm pain. *Surg Gynecol Obstet* 1944;78:350–8.
5. Epstein JA, Lavine LS, Aronson HA, et al. Cervical spondylotic radiculopathy. The syndrome of foraminal constriction treated by foraminotomy and the removal of osteophytes. *Clin Orthop Relat Res* 1965;40: 113–22.
6. Williams RW. Microcervical foraminotomy. A surgical alternative for intractable radicular pain. *Spine* 1983;8:708–16.
7. Tanaka Y, Kokubun S, Sato T. Cervical radiculopathy and its unsolved problems. *Curr Orthop* 1998;12:1–6.
8. Yoss RE, Corbin KB, MacCarty CS, et al. Significance of symptoms and signs in localization of involved root in cervical disk protrusion. *Neurology* 1957;7:673–83.

9. Tanaka Y, Sato T, Miyagishima J, et al. Cervical zygapophyseal joint blocks for posterior neck pain [in Japanese]. *Toboku Arch Orthop Surg Traumat* 1986;30:1-6.
10. Aldrich F. Posterolateral microdiscectomy for cervical monoradiculopathy caused by posterolateral soft cervical disc sequestration. *J Neurosurg* 1990;72:370-7.
11. Hosono N, Yonenobu K, Ono K. Neck and shoulder pain after laminoplasty. A noticeable complication. *Spine* 1996;21:1969-73.
12. Kawaguchi Y, Matsui H, Ishihara H, et al. Axial symptoms after en bloc cervical laminoplasty. *J Spinal Disord* 1999;12:392-5.
13. Li Z. The distribution of nerve endings in the sheath of human cervical nerve roots, with a focus on free nerve endings. *J Saitama Med School* 1996;23:33-45.
14. Prichard JW. Nerve. In: Albright JA, Brand RA, eds. *The Scientific Basis of Orthopaedics*. 2nd ed. Norwalk, CT: Appleton & Lange; 1987:423-44.
15. Bogduk N, Aprill C. On the nature of neck pain, discography and cervical zygapophysial joint blocks. *Pain* 1993;54:213-7.
16. Dwyer A, Aprill C, Bogduk N. Cervical zygapophyseal joint pain patterns 1. A study in normal volunteers. *Spine* 1990;15:453-7.
17. Aprill C, Dwyer A, Bogduk N. Cervical zygapophyseal joint pain patterns 2. A clinical evaluation. *Spine* 1990;15:458-61.