Clinical Article

The Triple Entrapment Syndrome of the 5th Lumbar Spinal Nerve

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Objective : The 5th lumbar spinal nerve can be entrapped in the intraspinal zone, foraminal zone, and the extraforaminal zone simultaneously. The failure to recognize that the nerve root can be compressed in such manners may be the reason of a number of failures of surgical decompression. Here we describe a microsurgical method for the decompression of the triple entrapment of the L5 spinal nerve in 21 patients.
Methods : Clinical manifestations and surgical results of twenty-one patients treated surgically under the diagnosis of the triple entrapment of the L5 spinal nerve were reviewed retrospectively. All patients were treated by the posterior midline approach for the intraspinal entrapment and by the paraspinal approach for the foraminal and the extraforaminal entrapment.
Results : Pain relief was obtained in all patients immediately after surgery. The mean follow-up period after the surgery was 13 months, ranged from 6 to 24 months. The mean Numeric Rating Scale (pain score) improved from 8.9 before the surgery to 1.4 ($P< 0.0001$). The mean ODI scores improved from 76.2 before the surgery to 13.1 ($P< 0.0001$). Nineteen patients were satisfied with their result at the last follow-up examination. Neither complications related to the surgery, nor the spinal instability was detected.
Conclusion : The triple entrapment of the 5th lumbar spinal nerve is an important pathologic entity to identify for the treatment of L5 radiculopathy. Combined medial and lateral approaches are safe, minimally invasive and it provide the complete decompression of triple entrapment of the L5 spinal nerve without causing secondary instability like after complete facetectomy.

KEY WORDS : Triple entrapment syndrome · L5 spinal nerve · Surgical decompression.

Introduction

The 5th lumbar spinal nerve can be compressed simultaneously in the intraspinal, foraminal, and extraforaminal zones. When the L5 radiculopathy is due to the triple entrapment, the entrapment in the foraminal or extraforaminal zones are frequently overlooked[1,3,12]. Because of the unique anatomical feature of the ala, the iliolumbar ligamentum and the broad L5 pedicle, the L5 root is compressed frequently in the extraforaminal zone[17,18,20]. Diagnosis of the L5 radiculopathy should included the consideration of the potential source of neural compression. The full decompression of the L5 nerve as it passes intraspinal zone, foraminal zone, and extraforaminal zone will prevent the failed back surgery syndrome[3].

The conventional treatment of the triple entrapment is unilateral facectectomy or the hemilaminectomy for the release of the root followed by fusion at the affected segment[1,6,11,12].

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However, if the nerve root could be decompressed without such extensive bony resection, the lumbosacral spine is able to avoid the concomitant segmental fusion and to maintain the mobility[7,14-16]. Therefore, the affected nerve root was decompressed completely by the interlaminar and paraspinal approaches using a micro-surgical technique.

The authors have encountered twenty-one cases of triple entrapment of the L5 spinal nerve. Here, we investigated the clinical features, diagnosis, surgical treatment, and outcome of the surgery of the triple L5 spinal nerve entrapment.

Materials and Methods

Twenty-one patients with the triple L5 root entrapment treated with the surgery in our hospital between 2002 and 2003 were enrolled in this study. They are 8 men and 13 women. Their average age was 62 years ranged from 51 to 73 years. All patients were symptomatic. The mean duration of symptoms was 10 months, ranged from 2 month to 2 years. Patients with the symptomatic spondylolysis and the isthmic or the degenerative spondylolisthesis involving the L 5 nerve root compression, were excluded. Patients with the multiple neural compressions except the L5 nerve, were also excluded.

Table 1. Clinical characteristics obtained in 21 patients with triple entrapment syndrome of L5 nerve root

Case No.	Sex/ age	Symptom duration(M)	Pathology			NRS (pre/post)	ODI scores (pre/post)	PSI scores
			Intraspinal	Foraminal	Extraforaminal			
1	F/66	1	S	S+HD	HD+O	9/0	64/10	5
2	F/51	12	S	S	AB+O	9/4	64/22	3
3	M/54	15	S	S	AB+O	10/2	76/12	4
4	F/72	12	S+AB	S	AB+O	10/1	78/14	5
5	F/69	24	S+AB	S	AB+O	9/0	66/8	5
6	M/60	6	S+HD	S	AB	8/0	52/8	5
7	F/62	24	S+AB	S+AB	AB+O	10/2	72/14	4
8	F/58	12	S+AB	S+AB	AB+O	9/3	82/20	4
9	M/71	12	S	S+HD	HD+O	10/1	86/10	5
10	F/65	8	S+HD	S	AB+O	9/0	92/10	5
11	M/56	10	S	S	AB+O	8/3	88/18	3
12	M/56	2	S	S	HD+O	10/1	90/8	5
13	F/60	8	S+HD	S	AB+O	10/3	72/16	4
14	M/70	4	S	S	AB+O	8/2	68/12	4
15	F/58	10	S	S	AB+O	8/0	62/8	5
16	F/51	3	S	S	AB+O	10/0	76/12	5
17	F/73	12	S+AB	S	AB+O	8/1	92/10	5
18	F/68	6	S+AB	S+AB	AB	7/1	78/16	4
19	M/61	3	S	S+HD	HD+O	10/1	92/14	5
20	F/62	12	S	S	AB+O	8/1	76/18	5
21	M/60	10	S	S	AB+O	8/3	78/16	4

* M= month ; S=stenosis ; AB=annular bulging ; HD=herniated disc ; O=Osteophyte ; NRS=numeric rating scale ; ODI= Oswestry Disability Index ; PSI=Patient Satisfaction Index

Sixteen out of 21 patients had the radiculopathy in the buttock, the thigh, and the leg without back pain. Five patients had the low back pain associated with the leg pain. The diagnosis was established by the combination of the plain and computed tomography radiological tests, the selective nerve root block, magnetic resonance imaging(MRI), and myelograms. The selective nerve block relieving the symptoms is the most reliable diagnostic modality. The surgery was indicated for the patients with the disabling leg pain or the failure of previous medical therapy that had been administered for 2 months or longer. All patients had the radiculopathy of the L5 nerve root. MRI and CT scan showed the L5 entrapment in the intraspinal, foraminal and extraforaminal zones. All patients were treated with the interlaminal partial laminotomy followed by the lateral fenestration using the Wiltse approach[21]. Pain was measured by the numerical rating scale(NRS) ranged from 0 to 10 grade[10]. Grade 0 indicates no pain. The grade 10 indicates the worst pain that one could imagine. Before and after the surgery, the function was assessed using the Oswestry Disability Index (ODI) score[5]. The patient's satisfaction was assessed using the Patient Satisfaction Index(PSI) that asked, "Would you like to have the same treatment for the same ailment?"[4] The response was graded from 1 to 5. (1: definitely not, 2: probably not, 3: not sure, 4: probably yes, and 5: definitely yes) Grades 4 and 5 were regarded as the satisfactory outcome. Statistical analysis was performed using paired t tests. The *P* value less than 0.05 was considered statistically significant. The intraspinal compression was due to the spinal stenosis with the annulus bulging in 18 patients, and the disc protrusion in 3 patients. The foraminal compresson was due to the foraminal stenosis with disc in 4 patients, and the foraminal stenosis in 17 patients. The extraforaminal compression was due to the disc protrusion in 2 patients, and the stenosis (annular bulging and osteophytes) in 19 patients (Table 1).

Surgical approach

Separated two skin incisions are used for the nerve decompression : the midline skin incision for the spinal canal decompression, and the paraspinal skin incision for the foraminal and extraforaminal decompression.

The midline skin incision is used for the decompression of the intraspinal entrapment such as the herniated disc or the subarticular impingement. The medial fenestration was performed in the standard fashion under the microscope as described (Fig. 1). A 4 centimeters longitudinal skin incision was made approximately 3centimeters lateral to the midline above the dorsal curvature of the ilium centered at the L5-S1 (needle, lateral x-ray) for the decompression of the foraminal and the extraforaminal stenosis. The space between the multifundus and longissimus muscles were dissected using fingertips and a pair of scissors. The fingertip was used to identify the base of the transverse process and the lateral aspect of the facet joint. The medial boundary was the lateral edge of the

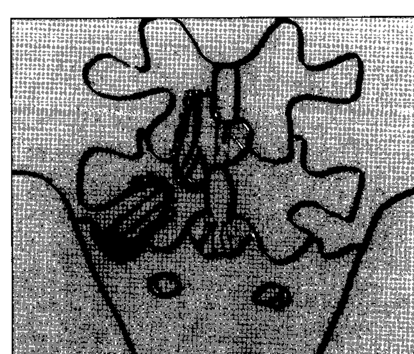

Fig. 1. Schematic drawing showing the location of decompression of triple entrapment of the 5th lumbar spinal nerve via the combined medial and lateral approaches.

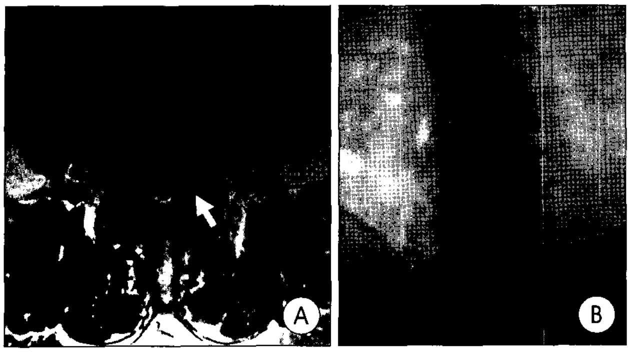

Fig. 2. Axial magnetic resonance image (A) and myelogram (B) of the lumbar spine showing the marked stenosis (superior facet hypertrophy) of the left L 4–5. Arrow indicates the left L 5 superior facet hypertrophy.

L5-S1 facet joint. The caudal boundary is formed by the upper rim of the sacrum with the costral process. The cranial boundary was the lower edge of the L 5 transverse process. Because the surgical field became very deep, the use of a surgical microscope was essential to obtain good surgical vision. A high-speed drill is used to remove the lateral edge of the facet joint and the costal process of the ala to enter the extraforaminal space. The iliolumbar ligament maybe found overlying the nerve. Such ligaments may participate in the lateral entrapment of the ganglion or the nerve. The iliolumbar ligaments were removed with the punch. The ligament was removed carefully not to injure the neurovascular bundle and the fat tissue surrounding the L5 root is exposed. The osteophytes from vertebral body was removed with the down-biting curette, tamp and mallet. Bone fragment were delivered to the disc space, and subsequently removed. The foraminal stenosis was decompressed by removing the tip of superior facet (Fig 1).

Illustrative Case

Case 9

A 71-year-old man presented with one year history of severe pain in the left buttock, lateral calf, and medial foot as well as intermittent claudication. He rated the pain as"10" on the 0 to 10 scale. The pain occurred while standing and walking but it was relieved by sitting and bending forward. He was not able to lie on the back straight due to the leg pain. On physical examination, decrease of the pin prick sensation at the L5 dermatome and mild weakness of the right extensor hallucis longus were detected. Deep tendon reflexes were normal. Extension of his back worsened the leg pain. The straight leg raising was limited. Electromyography suggested the right L-5 radiculophy. The axial MRI of the lumbar spine and myelogram revealed marked stenosis of spinal canal at the L 4-5 interspace especially on the left side (Fig. 2). The sagittal MRI revealed the loss of the fat signal around the exiting L-5 root in the left foraminal zone (Fig. 3). The axial MRI and CT scans revealed the marked extraforaminal stenosis of the left L5-S1 (Fig. 4). Based on the observations, the interlaminal partial laminotomy followed by the lateral fenestration by the approach of Wiltse[20] were performed. The L5 root that was compressed at the triple zones was completely decompressed. The patient was mobilized on the following day.

Fig. 3. Sagittal magnetic resonance image revealing loss of fat signal around exiting L5 root in the left foraminal zone.

Results

The mean follow-up period was 13 months, ranged from 6 to 24 months. The reduction of pain was found after the surgery (Table 1). The pain improved in all patients. The mean Numeric Rating Scale improved from 8.9 before the surgery to 1.4. The difference is statistically significant ($P< 0.0001$). The mean ODI scores improved from 76.2 before the surgery to 13.1 ($P< 0.0001$). Nineteen patients were satisfied with their result at the last follow-up examination. Nineteen out of 21 patients stated that they would undergo the same surgery for the same ailment (PSI of 4 or 5) at the last follow-up. All patients had the plain lateral radiographs in flexion and extension posture during the follow-up period. No complications or the spinal instability related to the surgery was detected.

Fig. 4. Axial magnetic resonance image (A) and computed tomography (B) showing marked extraforaminal stenosis due to disc protrusion and osteophytes of the left L5–S1.

Discussion

The L5 nerve root canal is considerably longer than others because of the broad L5 pedicle. Consequently, the entire length of the L5 nerve root is exposed to a variety of compressive disorders. The L5 nerve root entrapment occurs at three positions : the intraspinal zone, the foraminal zone, and the extraforaminal zone[12].

The intraspinal entrapment is usually due to the herniated disc or the hypertrophy of the medial edge of the superior facet and the ligamentum flavum. The osteophytes along the superior articular process of L5 may entrap the L5 root against the L5 body or L4-5 disc. The osteophyte ridging or bulging annulus may contribute to the stenosis in this zone. The compression may be increased due to the subluxed inferior articular process of L4 that compresses the L5 nerve root against the posterior aspect of the L5 vertebral body.

We performed myelography to confirm the intraspinal L5 compression in 15 out of 21 patients. Myelography was not helpful to diagnose the foraminal and the extaraforaminal entrapment.

The second entrapment is in the foramen due to the superior migration of the superior facet of the S1 or the herniated disc from L5-S1. As the root emerges through the foramen, it lies close to the tip of the superior facet of the vertebra below. The significant correlation was observed between the compression of the nerve root and the posterior disc height at the foraminal zone[8]. As the intervertebral disc space narrows, the posterior joint overrides, and the root may be compressed by the superior articular facet[8]. Hypertrophy of the superior articular process of the S1 and the attached ligamentum flavum may encroach upon the L5 nerve root. Spur formation may occur at the disc margin and compress the nerve root against the pedicle. The foraminal stenosis was confirmed by the parasagittal T-1 weighted MRI magnetic with the circumferential loss of the perineural fat signal at the L5-S1 level.

The third entrapment is in the extraforamen due to the bulged annulus fibrosus, the lateral L5- S1 disc protrusion, or the osteophytes of the vertebral body as the L5 nerve root exists its nerve root canal so called the far-lateral zone as described by Wiltse[21]. The L5 nerve root runs inferolaterally against the superior border of the ala of the sacrum and then descends into the pelvic cavity anterior to the ala. Nearly all extraforaminal stenosis occur at the L5-S1, the most likely location lying between the inferior margin of the low-lying pedicle of the L5 and the superior rim of the sacral ala. The posterolateral osteophytes due to the vertebral endplates protruded into the extraforamen along with the laterally bulging annulus fibrosus or the hearniated disc, compress the nerve root against the superior pedicle.

Several studies reported the extraforaminal entrapment in the lumbosacral spine. The osteophytes on the lower border of the body of the L5 and the upper border of the sacrum may contribute to the formation of the inferior portion of the tunnel encasing the nerve[13,15]. The diffused bulging annulus fibrosus at this point may press the nerve against the sacral ala and the L5 pedicle[2]. The annulus bulging narrows the extraforaminal tunnel.

The lumbosacral ligament extends from the L5 to the sacrum and forms the osteofibrotic tunnel through that the L5 traverses. The iliolumbar and the lumbosacral ligaments can participate in the extraforaminal entrapment. Based on the cadavaric studies, many authors reported that lumbosacral ligament (LSLs) could compress L5 spinal nerve and give rise to clinical manifestation[17,18,20].

The buckling and the overgrowth of iliolumbar and lumbosacral ligaments may result in narrowing of the extraforaminal tunnel[9]. The loss of the intervertebral disc height secondary to the desiccation and the degeneration of the disc allow the superior articular process of the inferior vertebra to subluxate anteriorly and superiorly, resulting in diminishing the area of the foramen and the extraforamen at the lumbosacral spine[9]. The combination of the disc space narrowing, the overgrowth of the iliolumbar ligament, the bulging disc and the bony spur may diminish the volume of the foramen and the extraforamen to a great extent. The most causative factor of the extraforaminal entrapment of L5 nerve was the annulus bulging with the ostaophytes in this study. The diagnosis of the extraforaminal stenosis is the narrowing of the distance between the disc margin and the ala at the axial view on MRI. However, the MRI finding is not always corresponded to clinical findings, which must always be taken into consideration before diagnosing of the extraforaminal stenosis.

The affected nerve root was decompressed completely by the midline approach for the intraspinal lesion followed by the paraspinal approach for the foraminal and the extraforaminal lesions using a microscopic technique.

The Wiltse's posterior procedure allows relatively easy access to the extraforaminal zone at the L5-S1 intervertebral level[21]. Because of the large anteroposterior diameter of the sacral ala through which the L5 spinal nerve transverses, the partial resection of the sacral ala along the L5 spinal nerve not only in the cephalocaudal direction but also in the anteriorposterior direction should be performed[16,19]. Because the surgical field becomes very deep, use of a surgical microscope is essential to obtain the good surgical vision. The combined lateral and medial approach could accomplish the complete decompression of the L5 nerve without resection the facet joint and fusion.

Conclusion

The triple entrapment of the 5th lumbar spinal nerve is an important pathologic entity for patients with L5 radicular symptoms. The failure to recognize that the nerves can be compressed in such manners may be associated with the failure of the back surgery. The combined medial and lateral approach is not only safe and minimally invasive, but also it provides complete decompression of the L5 spinal nerve without causing secondary instability like after complete facetectomy.

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