Posterior Laminoplastic Laminotomy Combined with a Paraspinal Transmuscular Approach for Removing a Lumbar Dumbbell-shaped Schwannoma: A Technical Note

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Abstract

The surgical strategies and methods used to treat dumbbell-shaped tumors located in the lumbar-foraminal region are controversial. Although a total facetectomy and combined intra- and extraspinal canal approach provide a wide operative field, facet fusion is required, which can be rather invasive. Here, we report a successful removal of a lumbar dumbbell-shaped schwannoma using a combined laminoplastic laminotomy with Wiltse's paraspinal surgical approach. This was performed under an operating microscope without a complete facetectomy, fusion, and posterior fixation. Briefly, we treated two patients with lumbar foraminal tumors, both dumbbell-shaped schwannomas located in the intra- and extradural portion. After a laminoplastic laminotomy, the intradural tumor was removed. The tumor located at the extracanalicular site was removed after drilling the pars interarticularis of the lamina, which was performed to enlarge the intervertebral foramen via Wiltse's paraspinal surgical approach. During surgery, facetectomy with posterior fixation was not needed to remove the intraforaminal component. There was no lumbar instability or complication after surgery. Our results suggest that a combined posterior laminoplastic laminotomy and Wiltse's paraspinal surgical approach is useful and less invasive for treating patients with lumbar foraminal tumors.

Key words: dumbbell-shaped schwannoma, intraforaminal tumor, laminoplastic laminotomy, lumbar foraminal tumors, Wiltse's paraspinal surgical approach

Introduction

Total removal of neurinomas is a generally achievable goal that yields adequate results. However, dumbbell-shaped neurinomas often present challenges for complete resection. Various approaches have been described for treating these tumors.1–6) For most patients with lumbar dumbbell-shaped schwannomas, total removal of an intraforaminal tumor can be performed after removing the facet joints and pars interarticularis. This is followed by the posterior internal fixation.6) In 1968, Wiltse described a surgical approach for the degenerative pathology in the foraminal region using the cleavage plane of the multifidus and longissimus muscles as an entry point.7) This procedure is less invasive, preserves anatomy, and does not need posterior instrumentation. We utilized this approach for degenerative pathologies, such as neuropathy, due to foraminal stenosis and far-laterally located disc herniation. Although this approach is a technically demanding operation, the direct approach to the foraminal region between the two muscles helps reduce bleeding, tissue violation, and muscle retraction. Thus, this has become a popular surgical approach for laterally seated lesions.

We report our experience with an alternative approach, laminoplastic laminotomy combined with Wiltse’s paraspinal surgical procedure for one-stage removal of a lumbar dumbbell-shaped schwannoma8) and discuss the efficacy and technical advantage of this approach.

Materials and Methods

The subjects were two patients with lumbar Eden type II dumbbell-shaped schwannomas, who
underwent total tumor removal between June 2013 and November 2014 (Table 1). These patients presented with severe sciatica and motor weakness in the lower extremity. The patients were treated with the surgical techniques described below.

**Surgical technique**

Under general anesthesia, the patient was placed in the prone position. In Wiltse’s paraspinal surgical approach, the surgical route is between the multifidus and longissimus muscles. In this approach, it is easy to be disoriented, because of the small number of the important landmarks. It is very important to keep the patient in an appropriate horizontal position. The knees were positioned appropriately to allow the hips to flex and widen the laminar interspaces to improve access to the lumbar spinal canal. The distance from the midline to the cleavage plane of the multifidus and longissimus muscles was measured during preoperative magnetic resonance (MR) imaging or a computed tomography (CT) scan for an entry point. In most cases, the distance is 3–5 cm from the midline. Thus, an S-shaped incision was made in the skin (Fig. 1A). The midline linear portion of the skin incision was used for removing the intracanalicular portion of the tumor, and the sigmoid-shaped portion of the skin incision was for removing the intra- and extraforaminal portion of the tumor.

First, the subcutaneous fat was harvested for placement in the tumor removal cavity to prevent postoperative cerebrospinal fluid (CSF) leakage. After harvesting the subcutaneous fat, the nuchal ligament was sharply cut in the midline. The spinous process was cut in a linear fashion using a diamond-tipped drill or an oscillating saw. Paraspinal muscles were dissected to expose the affected laminae and facet joints. Care was taken to preserve the capsule of the facet joints. Laminoplastic laminotomy was carried out using an ultrasonic bone curette for postoperative reconstruction of the laminae. After the durotomy, the tumor was observed intradurally. Dissection was performed from the surrounding nerve roots after internal decompression. The rostral origin of the tumor was confirmed, followed by cutting and tumor removal with no response on the electromyography. Second, Wiltse’s paraspinal surgical approach was used to remove the extracanalicular tumor (Fig. 1B, C). After dissection between the multifidus and longissimus muscles, we determined that the corresponding facet joint was a good landmark. Here, the transverse process, isthmus, and facet joint are exposed. Partial drilling of the transverse process and isthmus was completed to widen the intervertebral foramen for removal of the extraforaminal tumor (small arrows). Care is always paid not to excessively drill the isthmus to prevent iatrogenic isthmic fracture. The asterisk shows the extracanalicular tumor. C: After resecting the lamina and drilling the pars articularis, the tumor located in the intra-(big arrow) and extra-(small arrow) dural region is confirmed. D: After removing the tumor, resected laminae are fixed with miniplates for laminoplasty.

**Table 1 Features of the patients**

| Case | Age/gender | Level | Side | Operation time (hours) | Amount of hemorrhage (g) |
|------|------------|-------|------|------------------------|--------------------------|
| 1    | 56/Male    | L1    | Left | 5.5                    | 450                      |
| 2    | 78/Female  | L1    | Right| 4.0                    | 200                      |
prevent iatrogenic isthmic fracture. An absorbable polyglycolic acid mesh, harvested fat, and fibrin glue were placed in the dural defect and extracanalicular tumor removal cavity to prevent postoperative CSF leakage. The dura was sutured with non-penetrating titanium clips (vascular clip system [VCS®] clip; LeMaitre Vascular Inc., Burlington, Massachusetts, USA) and covered with an absorbable polyglycolic acid mesh and fibrin glue. Resected laminae were fixed with mini-titanium plates (Fig. 1D). The wound was well-irrigated and closed in layers.

Results

Tumors were completely removed via the combined, aforementioned approach without total facetectomy and fusion. Surgery-related complications were not observed. There was no spinal instability after surgery. Preoperative symptoms improved in all cases as noted by postoperative examinations.

Illustrative case (Table 1, Figs. 2–3)

A 56-year-old man presented with a 3-year history of lower back pain without motor weakness. He visited a local clinic where T₁-weighted MR images with gadolinium enhancement showed a right L₁ dumbbell-shaped neurinoma, which was classified as an Eden type II. He was referred to our hospital for further examination and surgical intervention. On admission, a neurological examination showed no motor weakness. He complained of severe pain in his right lower back. Neuroimages showed a well-enhanced mass, which severely compressed onto the spinal cord. The tumor was removed via a combined approach without total facetectomy and posterior fixation. After surgery, severe pain was relieved.

Fig. 2 A, B: Preoperative axial and coronal T₂-weighted magnetic resonance images showing the tumor compressing the cauda equina to the left and extent of the extraforaminal portion along the L₁ nerve root (big arrows). C: Preoperative computed tomography scan showing thinning of the pedicle compressed by the tumor (small arrows).

Fig. 3 A, B: Postoperative axial and coronal T₂-weighted magnetic resonance images showing total removal of the tumor (big arrows). The high intensity area shows adipose fat tissue filled with the tumor removal cavity. C: Postoperative three-dimensional computed tomography (CT) showing the reconstructed lamina of the Th₁₂ (small arrows) and removed portion of the isthmus of the L₁ lamina (big arrow). D: Postoperative axial CT taken 12 months after surgery showing the fused lamina of the Th₁₂ (small arrow).
Postoperative MR images showed the complete removal of the tumor (Figs. 3A, B). Procedure-related complications, such as instability and CSF leakage, were not observed. Postoperative three-dimensional CT showed the reconstructed lamina of the Th12 and the removed portion of the isthmus of the L1 lamina (Fig. 3C). Axial CT performed 12 months after surgery demonstrated the fused lamina (Fig. 3D).

Discussion

Preoperative selection of surgical procedures is critical, especially for dumbbell-shaped tumors. 

For dumbbell-shaped tumors located in the lumbar region, several authors have described an approach for reconstruction of the spinal column. This includes a posterior spinal fixation using spinal instruments after tumor removal. 

Some reasons for using this approach are improvements with spinal implants and difficulties regarding orientation among surgical fields using the Wiltse's paraspinal surgical approach. Disadvantages of Wiltse's approach include surgeons' lack of expertise and the technical demands of this operation. The technical demands derive from no clear available landmarks, deep surgical fields, and laterally seated pathologies in certain cases.

We applied the combination of a conventional posterior and Wiltse's paraspinal surgical approaches in order to remove intracanalicular and foraminal portions of lumbar dumbbell-shaped neurinomas. There are some important landmarks in the midportion of the lamina, including the spinous process and medial border of the facet joint. Moreover, the surgical fields are comparatively shallow, and complex manipulations are easily available. The combined approach denotes that the surgical fields are extended continuously to the lateral border of the facet joint, which helps resolve one of the disadvantages of the Wiltse's approach. Important landmarks are available for the exact location of the transverse process and isthmus of the vertebral body with Wiltse's approach. Orientation of the lateral side of the vertebral body becomes easier to understand when using this combined approach.

At surgery, the vertebral lamina is removed during the posterior approach for the intracanalicular portion of the tumor. The isthmus is also removed for enlarging the intervertebral foramen during removal of the extracanalicular portion of the tumor. This leads to a thinning of the pars interarticularis, and stability of the spinal column is decreased biomechanically. Destruction of the unilateral isthmus and vertebral lamina are supposed to facilitate stability loss in the spinal column. However, detailed information regarding the range of the drilling isthmus for preserving spinal stability remains unclear. It is very important to reconstruct the posterior element of the vertebral lamina through a laminoplasty laminotomy for the present cases. At 6 months after surgery, the resected lamina will be fused and will restore the preoperative stability of the posterior element.

In the present case, postoperative CSF leakage did not occur. It was important to seal the dural defect caused by tumor piercing with the surrounding adipose tissue. When the dura mater is closed, it must be meticulously sutured to avoid CSF leakage. However, primary closure is challenging when the dura mater is fragile, and the operating field is too narrow and deep to allow proper stitching. The mesh-and-glue technique might be effective in this situation. This method uses an absorbable polylactic acid mesh that is soaked in fibrin glue. We used a dural defect covered with this mesh-and-glue construction, and the tumor removal cavity was filled with the fatty tissue.

Limitations on this approach should be noted. We removed a tumor located dorsal to the iliopsoas muscle using a combined approach. However, it is impossible to remove a tumor extended anteriorly and inside the iliopsoas muscle by this approach. For these tumors, an anterior retroperitoneal transmuscular approach would be more appropriate.

Based on our limited cases, a combined posterior and Wiltse's paraspinal surgical approach was useful for removing the intraforaminal component of a lumbar dumbbell-shaped schwannoma. The posterior approach could complement the Wiltse's paraspinal surgical approach. This combined approach does not require posterior fixation and may be less invasive for treating patients with lumbar foraminal and extraforaminal tumors.

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Conflicts of Interest Disclosure

The authors have made declaration of conflict of interest every year to the Japan Neurosurgical Society. They have no personal, financial, or institutional relationships with other people or organizations that could inappropriately influence this work. Drs. Ngerageza and Ito contributed equally to this work.
References

1) Ozawa H, Kokubun S, Aizawa T, Hoshikawa T, Kawahara C: Spinal dumbbell tumors: an analysis of a series of 118 cases. *J Neurosurg Spine* 7: 587–593, 2007

2) Seppälä MT, Haltia MJ, Sankila RJ, Jääskeläinen JE, Heiskanen O: Long-term outcome after removal of spinal schwannoma: a clinicopathological study of 187 cases. *J Neurosurg* 83: 621–626, 1995

3) Ito K, Aoyama T, Kuroiwa M, Horiuchi T, Hongo K: Surgical strategy and results of treatment for dumbbell-shaped spinal neurinoma with a posterior approach. *Br J Neurosurg* 28: 324–329, 2014

4) Jiang L, Lv Y, Liu XG, Ma QJ, Wei F, Dang GT, Liu ZJ: Results of surgical treatment of cervical dumbbell tumors: surgical approach and development of an anatomic classification system. *Spine (Phila Pa 1976)* 34: 1307–1314, 2009

5) Conti P, Pansini G, Mouchaty H, Capuano C, Conti R: Spinal neurinomas: retrospective analysis and long-term outcome of 179 consecutively operated cases and review of the literature. *Surg Neurol* 61: 34–43; discussion 44, 2004

6) Asazuma T, Toyama Y, Maruiwa H, Fujimura Y, Hirabayashi K: Surgical strategy for cervical dumbbell tumors based on a three-dimensional classification. *Spine (Phila Pa 1976)* 29: E10–E14, 2004

7) Kwon I. Posterior and posterolateral approaches to the lumbar spine, in Kim DH, Cho D, Dickman CA, Vaccaro AR, Lee S, Kim I (eds): *Surgical Anatomy and Techniques to the Spine, ed 2*. Saunders, Elsevier, 2013, pp 382–388

8) Eden K: The dumb-bell tumours of the spine. *Br J Surg* 28: 549–570, 1941

9) Ito K, Ishizaka S, Sasaki T, Miyahara T, Horiuchi T, Sakai K, Shigeta H, Hongo K: Safe and minimally invasive laminoplastic laminotomy using an ultrasonic bone curette for spinal surgery: technical note. *Surg Neurol 72*: 470–475; discussion 475, 2009

10) Viswanathan R, Swamy NK, Tobler WD, Greiner AL, Keller JT, Dunsker SB: Extraforaminal lumbar disc herniations: microsurgical anatomy and surgical approach. *J Neurosurg* 96(2 Suppl): 206–211, 2002

11) Kim K, Isu T, Sugawara A, Yusa J: [Paraspinal approach to lumbar foraminal tumor]. *No Shinkei Geka* 36: 147–152, 2008

12) Nagata K, Kawamoto S, Sashida J, Abe T, Mukasa A, Imaizumi Y: Mesh-and-glue technique to prevent leakage of cerebrospinal fluid after implantation of expanded polytetrafluoroethylene dura substitute—technical note. *Neurol Med Chir (Tokyo)* 39: 316–318; discussion 318–319, 1999

13) Lane JD, Moore ES: Transperitoneal approach to the intervertebral disc in the lumbar area. *Ann Surg* 127: 537–551, 1948

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