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ORIGINAL ARTICLE

Hemi-semi Laminectomy Approach for the Microsurgical Treatment of Spinal Schwannomas

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Objective To evaluate the safety and efficiency of hemi-semi laminectomy approach for the microsurgical treatment of spinal schwannomas.

Methods A total of 22 patients underwent hemi-semi laminectomy for the microsurgical removal of spinal schwannomas during a period of 2009 and 2011 in Affiliated Hospital of Nantong University. We retrospectively analyzed the clinical outcomes of these patients.

Results Of them, 5 cases were diagnosed with cervical schwannomas, 9 with thoracic schwannomas, and 8 with lumbar schwannomas. All the tumors including two dumbbell schwannomas were totally removed without major complications. Postoperatively, all patients were followed up from 6 to 36 months. The symptoms and signs were obviously improved, and no tumor recurrence or spinal deformity occurred.

Conclusion Hemi-semi laminectomy is a safe and effective method for resection of spinal schwannomas.

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SCHWANNOMAS are relatively common in neurosurgical practice, accounting for approximately 25% of all primary spinal tumors.¹ Because conventional laminectomy may be related to postoperative spinal instability and deformity,^{2, 3} hemi-laminectomy approach to access intradural pathology were developed in part to reduce the risk of post-laminectomy complications since 1980s.^{4, 5} To minimize iatrogenic trauma and postoperative instability, hemi-laminectomy for the resection of spinal tumors or vascular malformations has been shown to have some merits.⁶⁻⁸

Now that our goal is minimally invasive surgery, hemi-semi laminectomy can further spare the mechanically relevant bone structures and we used hemi-semi laminectomy fenestration as an approach to the removal of spinal schwannomas. We described our experiences in the use of this technique, discussed its advantages and drawbacks, and detailed the technical aspects and perioperative complications of this approach to spinal tumors.

PATIENTS AND METHODS

Between April 2009 and August 2011, 22 spinal schwannomas patients who underwent hemi-semi laminectomy in Affiliated Hospital of Nantong University were included in this retrospective study. The patients ranged

from 16 to 69 years of age (median 44 years). The study consisted of 14 female and 8 male patients. We analyzed the clinical presentations, imaging examination, surgical technique, and outcomes of these patients.

RESULTS

Clinical presentations

All patients suffered from local or radicular pain and sensory or motor disturbance of the extremities. Preoperative neurological examination showed weakness of the extremities in 12 cases, sensory disturbances in 14 cases, and sphincter dysfunction in 4 cases. Detailed clinical manifestations are summarized in Table 1. The course of the disease ranged from 2 to 72 months, with the mean

being 18 months.

Results of imaging examination

Every patient was diagnosed as having spinal schwannomas by plain and enhanced magnetic resonance imaging (MRI). T1-weighted MRI showed the lesions were isointense in 14 patients and hypointense in 8 patients, whereas T2-weighted MRI demonstrated the lesions were hyperintense in 16 patients and isointense in 6 patients. The tumors were observed in the following regions: cervical in 5 cases, thoracic in 9, and lumbar in 8. Postoperative CT-scan and MRI were obtained to evaluate the spinal stability and whether there was any remnant tumor or recurrence respectively.

Table 1. Clinical summary of 22 spinal schwannomas patients

Patient's no.	Age (yr)	Sex	Symptoms and signs	Level	Result	Diagnosis	Complications	Follow-up (mon)
1	35	M	Bilateral upper extremity numbness and weakness	C ₃	Total resection	Schwannoma	None	10
2	47	F	Neck pain and left arm numbness	C ₄	Total resection	Schwannoma	None	25
3	42	M	Left lower extremity hypoesthesia	C ₄	Total resection	Schwannoma	None	6
4	22	F	Left upper extremity weakness and sensory deficit	C ₅₋₆	Total resection	Dumbbell schwannoma	Wound infection	18
5	65	M	Neck pain	C ₇	Total resection	Schwannoma	None	9
6	56	F	Right arm pain and sensory deficit	T ₁	Total resection	Schwannoma	None	12
7	51	F	Bilateral lower extremity weakness and sensory deficit	T ₃	Total resection	Schwannoma	None	20
8	19	M	Thoracic back pain and bilateral lower extremity weakness	T ₆	Total resection	Schwannoma	None	14
9	37	F	Left thigh ventral hypoesthesia	T ₆	Total resection	Schwannoma	None	36
10	62	M	Brown-Sequard syndrome	T ₈₋₉	Total resection	Schwannoma	Wound infection	24
11	48	F	Thoracic back pain and bilateral lower extremity weakness and numbness	T ₁₀	Total resection	Schwannoma	None	10
12	33	F	Left lower extremity hypoesthesia	T ₁₁	Total resection	Schwannoma	None	32
13	55	M	Brown-Sequard syndrome	T ₁₁	Total resection	Schwannoma	None	NA
14	16	F	Bilateral lower extremity weakness and low back pain	T ₁₁₋₁₂	Total resection	Dumbbell schwannoma	None	9
15	46	F	Low back pain and bilateral lower extremity numbness	L ₁	Total resection	Schwannoma	None	16
16	50	M	Bilateral lower extremity numbness and weakness	L ₁	Total resection	Schwannoma	None	28
17	53	F	Low back pain	L ₁	Total resection	Schwannoma	None	12
18	39	F	Bilateral lower extremity weakness and bladder dysfunction	L ₁₋₂	Total resection	Schwannoma	Urinary infection	13
19	46	M	Low back pain, right lower extremity weakness, and sphincter dysfunction	L ₂₋₃	Total resection	Schwannoma	None	18
20	59	F	Sphincter dysfunction	L ₂₋₃	Total resection	Schwannoma	None	30
21	69	F	Bilateral lower extremity numbness	L ₃	Total resection	Schwannoma	None	15
22	22	F	Sphincter dysfunction and bilateral lower extremity weakness	L ₃₋₄	Total resection	Schwannoma	None	18

F: female; M: male; NA: not available.

Surgical technique

All patients were operated on in a prone position after general anesthesia and hemi-semi laminectomy was performed through a midline incision. C-armed roentgenogram was usually undertaken to precisely localize incision intraoperatively. We performed a longitudinal paramedian dural incision. Subperiosteal detachment of the paravertebral muscle was performed on the affected side, preserving the spinous processes and supra/ interspinous ligaments. High-speed grinding drill was used to unilateral partial laminae fenestration (Figs. 1 and 2) and partial vertebral arches bony structures were retained (Fig. 3). The dissection of the arachnoid compartments and the release of cerebrospinal fluid provided a larger space for surgical manipulation intraoperatively. One-piece removal was performed for small tumors under microscope (Fig. 1D), but patients with larger or tough lesions underwent internal debulking and piecemeal resection.

Outcomes

The mean surgical time was 2.2 hours (range, 1.5-3.0 hours) and the mean blood loss was 150 mL (range, 50 to 400 mL). All the patients were mobilized on second day postoperatively. Postoperative MRI within 72 hours for all patients revealed complete removal of the tumor (Fig.3B). In 2 cases of dumbbell schwannomas, we applied this approach to remove tumors completely. Conversion to conventional laminectomy was not required in any of the cases in our study.

All patients were followed up from 6 to 36 months. In all the treated cases, the pain and neurological deficit were improved compared to their preoperative neurological status. No incision cerebrospinal fluid leak was noted. There were 2 cases experiencing wound infection and 1 case with urinary infection, which were cured after antibiotic therapy (Table 1). At follow-up evaluation none of the patients showed signs of spinal instability or deformity (Fig. 3F).

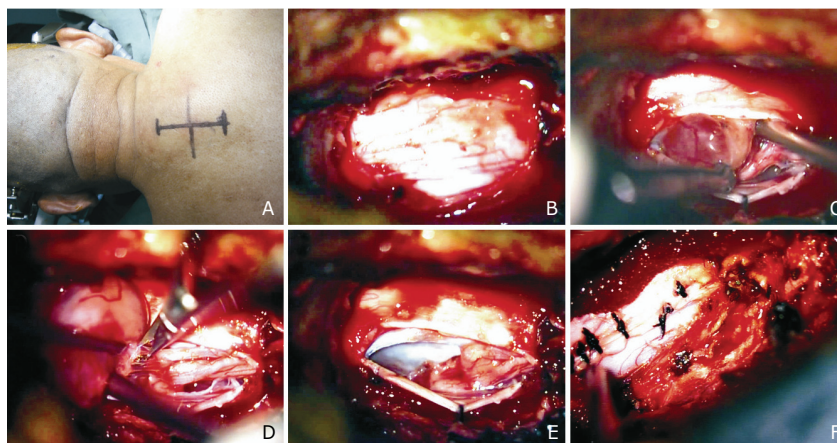


Figure 1. Intraoperative photographs of resection of schwannoma at the C₅₋₆ by hemi-semi laminectomy (Case 4).

- A. Body position and skin incision.
- B. Photograph shows right C₅₋₆ hemi-semi laminectomy using high-speed grinding drill under microscope.
- C and D. Expose and dissect tumor under excellent visualization and sufficient working space.
- E and F demonstrate complete removal of the schwannoma and suture dural closely.

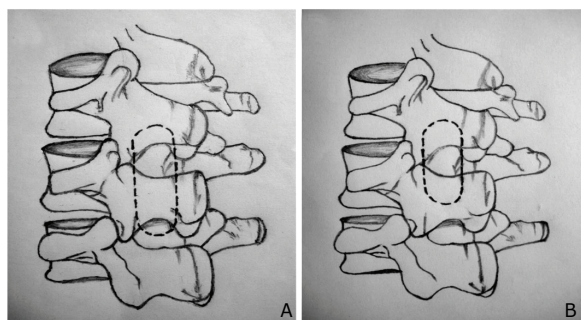


Figure 2. Artist's illustrations show the extent of bone removal by traditional hemilaminectomy (A) and hemi-semi laminectomy (B), respectively.

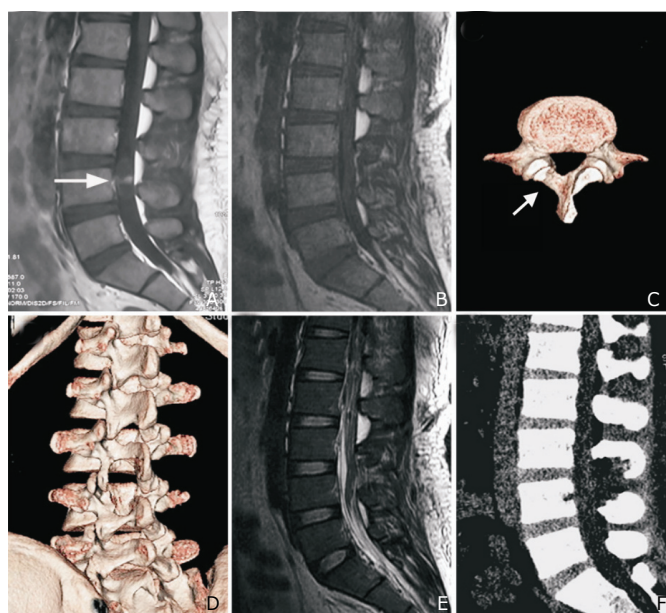


Figure 3. Pre- and postoperative imaging results of Case 22.

- A. Preoperative sagittal T1-weighted MRI shows spinal schwannoma at the L₃₋₄ level (arrow).
- B. Postoperative sagittal T1-weighted MRI obtained 2 days later confirms complete removal of the tumor.
- C. Postoperative axial CT scan shows partial resection of L₄ lamina and partial vertebral arches bony structures are maintained (arrow).
- D. The three-dimensional reconstructed postoperative CT scan clearly indicates bone removal and angle of view.
- E. Postoperative sagittal T2-weighted MRI obtained 6 months later reveals no tumor recurrence.
- F. No spinal deformity is visible on CT film obtained 18 months after surgery.

DISCUSSION

In 1983, Denis firstly described the concept of the three-column theory. Numerous studies confirmed that the intact middle and posterior column structures were very critical to spinal stability.^{9, 10} Taking into account the functional importance of posterior column structures, it is possible that surgical approaches to the vertebral column that resect bone structures or ligaments increase the risk of early or late spinal instability.^{11, 12}

Conventional laminectomy continues to be commonly used for removal of spinal tumors, but it may be associated with a number of postoperative complications. Both clinical data and biomechanical studies have demonstrated that bilateral damage to paravertebral muscles and ligaments, together with removal of the spinous process, might entail postoperative instability and/or deformity.^{13, 14} With the development of minimally invasive technique, numerous investigators have reported their experience using hemilaminectomy to resect spinal tumors.^{5, 15} However, we perceived that hemi-semi laminectomy can achieve a further reduction in iatrogenic trauma because except for the contralateral laminae and supra/interspinal ligaments, the partial vertebral arches bony structures are preserved

as much as possible and the original form of the spine can be better preserved compared with hemilaminectomy.

The modified hemilaminectomy approach has been used in the surgical treatment of degenerative spinal stenosis, in patients with tumors and hematomas.¹⁶⁻¹⁸ In our series, hemi-semi laminectomy can acquire excellent visualization and sufficient working space for the removal of spinal schwannomas. Most importantly, the tumors were able to be completely resected without adverse neurological complications.^{18, 19} The necessary considerations preoperatively in using this technique for spinal schwannomas are the accurate location and size of the lesion. In addition, arachnoidal openings and the release of cerebrospinal fluid and combination with surgical bed tilted angles intraoperatively help to obtain larger operative field. We believed that hemi-semi laminectomy was suit for the resection of one or two level spinal schwannomas. If the tumor is larger than 2.5 cm, especially in the cervical or thoracic levels, we recommend piecemeal removal, and aggressive removal should be avoided.^{20, 21} In this paper, hemi-semi laminectomy was selected for resection of tumors located at dorsal spinal cord. We should note that this approach also has its limitations and drawbacks. Because of the relatively limited exposure, we suggested that the tumors located in ventral spinal cord or adhered to spinal

cord tightly intraoperatively were removed by laminectomy.¹⁵ Maybe the lesions being resected in this study were relatively small, we did not find a need to expand to hemilaminectomy or converted into a conventional laminectomy approach intraoperatively.

Although this is a small series of consecutive patients with a short period of follow-up, we have demonstrated that it is feasible to completely resect most spinal schwannomas safely with the advantages of less operative invasion and postoperative complications. However, it should be noted that this approach should be reproduced by practitioners familiar with minimally invasive techniques.

In conclusion, we believe that the hemi-semi laminectomy can achieve less invasion than hemilaminectomy and is a safe and effective approach for the microsurgical treatment of spinal schwannomas.

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