

Unwinding the Spine: Advanced Diagnostic and Surgical Strategies for Lumbar Dumbbell Schwannoma

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Abstract

We present a rare case of a lumbar dumbbell-shaped schwannoma in a 36-year-old male with persistent lumbar pain and paresthesia. MRI revealed a contrast-enhancing mass at L3–L4 compressing the right L3 nerve root. A combined posterior and retroperitoneal approach enabled complete resection. Histopathology confirmed schwannoma with Antoni A/B areas and S-100 positivity. Postoperatively, the patient had full symptom resolution and no recurrence at three months. This case highlights the importance of timely diagnosis, imaging, and surgical resection for symptom relief and definitive diagnosis in managing lumbar dumbbell schwannomas, with adjunct therapies considered for incomplete or inoperable cases. (**International Journal of Biomedicine. 2025;15(3):594-597.**)

Keywords: lumbar dumbbell schwannoma • spinal tumor • MRI • surgical resection • postoperative management

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Introduction

Schwannomas are nerve sheath tumors,¹ accounting for 25–30% of all primary spinal tumors,² with a predilection for the cervical and thoracic regions. Lumbar schwannomas are relatively rare, especially those presented in a “dumbbell” shape, extending through intervertebral foramen, with both intraspinal and paraspinal components.³ Depending on the etiology, schwannomas can be either sporadic or congenital, as a manifestation of neurofibromatosis.⁴

Due to their anatomical location and neurologic symptoms, lumbar dumbbell schwannomas pose significant diagnostic and therapeutic challenges.⁵ Lumbar dumbbell schwannomas may compress adjacent neural structures, causing radiculopathy, motor impairment, and low back pain,

depending on the level of the lesion.⁶ Back pain, numbness in the lower extremities, weakness, tingling, clumsiness, difficulty walking, or even urinary incontinence are the main symptoms of lumbar dumbbell schwannoma.⁷ Advances in imaging have greatly improved diagnostic accuracy. Surgical resection remains the cornerstone of treatment for schwannomas.⁸ However, this surgery is highly challenging due to the tumor’s proximity to critical neural and vascular structures, requiring laminectomy to access the tumor and spinal fusion to maintain spinal stability.⁹

We present a rare case of a lumbar dumbbell schwannoma, its diagnostic approach, surgical management, and clinical outcomes, underscoring the importance of multidisciplinary collaboration in the proper management of lumbar spinal tumors. Clinical manifestations were assessed by a comprehensive neurological examination. Particular attention was paid to identifying signs indicating compression of nerve roots or spinal cord damage. Preoperative magnetic resonance imaging (MRI)

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with detailed visualization and definition of the boundaries of the intradural and extraforaminal components was performed to assess the size, location, and extent of the schwannoma. Computed tomography was used to assess bone involvement and the relationship of the tumor to adjacent structures.

Surgical resection was performed using a microsurgical approach, including posterior laminectomy for intradural access and extraforaminal decompression for the paraspinal component. Intraoperative monitoring ensured the safety of both neural and vascular functions. In the postoperative period, the patient was closely monitored for neurological changes and underwent a course of pain relief and rehabilitation. Control MRI was performed after 3, 6, and 12 months to assess relapses or complications. Clinical outcomes were evaluated through neurological exams, and patient pain, mobility, and quality of life were measured using the Visual Analog Scale (VAS) and Japanese Orthopedic Association (JOA) score for neurological function.

Case Presentation

A 36-year-old male, weighing 84 kg with a height of 176 cm (BMI=27.1 kg/m²), presented with a six-month moderate right lumbar pain. The patient reported an increase in pain intensity over the past month, reaching a severity of 8/10 on the visual analog scale (VAS). The pain was persistent and resistant to non-steroidal anti-inflammatory therapy. The patient presented with right lumbar paresthesia, which significantly affected his daily activities and quality of life. There was no medical history of surgical interventions. No other significant comorbidities or family history of similar diseases were identified. However, the patient was a heavy smoker, smoking more than 20 cigarettes per day for more than 15 years.

Initial clinical examination, including a detailed neurological examination, revealed decreased sensation in the right lumbar region without motor impairment, while reflexes were preserved bilaterally. To further clarify the source of pain, an abdominal ultrasound was performed. The ultrasound revealed a hypoechoic lesion in the area of the right kidney, which raised concerns about a possible retroperitoneal lesion. Subsequently, a contrast-enhanced MRI of the lumbar spine was performed to more accurately characterize the lesion and its anatomical location. Subsequently, a contrast-enhanced lumbar MRI was performed to characterize the lesion and its anatomical localization.

The MRI results revealed a well-defined, heterogeneously contrast-enhanced mass located at the L3-L4 level on the right. The lesion had a classic dumbbell shape, extending through the intervertebral foramen, with intraspinal and paraspinal components. The intraspinal portion of the tumor caused significant compression of the right L3 nerve root and displacement of adjacent neural structures. The paraspinal component was encapsulated and showed no evidence of infiltration into surrounding tissues. These imaging features were highly suggestive of a schwannoma (Figure 1).

We further performed a computed tomography scan to evaluate bone remodeling, erosion, or widening of the intervertebral foramen, particularly where the tumor exerts

pressure. Computed tomography findings are presented in Figure 2.

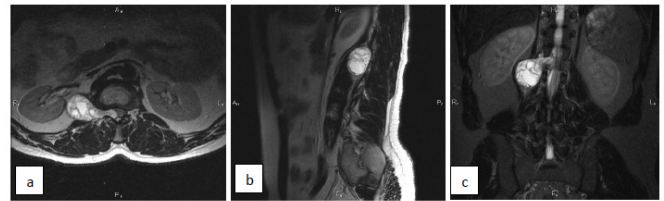


Fig. 1. On the T1 post-contrast axial (a), sagittal (b), and coronal (c) MRI sequences, we notice a well-demarcated intraspinal mass, with mixed hyperintense contrast enhancement and visible hypointense septations, close to the right neural root, measuring 64x40 mm, suggestive of a lumbar dumbbell schwannoma. The coronal view demonstrates its proximity to the spinal canal, highlighting its spatial relationship to surrounding structures.

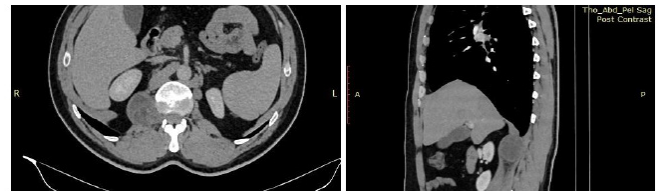


Fig. 2. A CT scan reveals an isodense circumscribed mass with smooth, well-defined margins that extends through the intervertebral foramen, with both intraspinal and extraforaminal components, displacing right nerve roots. There were no bone erosions or remodeling detected.

Surgical intervention was considered necessary to alleviate the patient's symptoms while relieving neural compression and achieving the definitive histological diagnosis. The patient was informed regarding the risks and benefits of surgery and agreed to a combined posterior and retroperitoneal surgical approach to ensure complete resection of both intraspinal and paraspinal components of the tumor. The postoperative course was successful. Histopathological examination of the excised area confirmed the diagnosis of schwannoma, characterized by the presence of Antoni A and Antoni B zones, as well as immunohistochemical positivity for S-100 protein. The neoplasm consisted of intertwined bundles of spindle-shaped cells with oval nuclei, eosinophilic cytoplasm, unclear cytoplasmic borders, and intranuclear vacuoles. In the postoperative period, the patient noted significant pain relief and complete disappearance of paresthesia within two weeks following surgery. A follow-up MRI performed three months postoperatively (Figure 3) showed no residual tumor, and the patient returned to work without any neurological deficits.



Fig. 3. The post-contrast T1-weighted MRI axial, sagittal, and coronal images demonstrate complete resection of a spinal schwannoma. There is no enhancement at the resection site indicating successful tumor removal, with no signs of recurrence. The surrounding tissues, including the nerve roots and spinal cord, appear intact, with no evidence of pathological enhancement.

This case highlights the importance of a multidisciplinary approach in diagnosing and managing lumbar dumbbell schwannomas. Early and accurate diagnosis of clinical and imaging features, combined with timely surgical intervention, can lead to favorable outcomes, even in complex cases like this one.

Discussion

Schwannomas are often asymptomatic and are discovered incidentally; in such cases, a conservative approach, including observation and regular monitoring, may be appropriate.¹⁰ This strategy includes serial imaging, especially MRI, to detect any progression in tumor size or the emergence of symptoms that would necessitate intervention. This approach is particularly suited for patients with minimal symptoms, or at high surgical risk.¹¹

Contrary, the most frequent treatment of lumbar dumbbell schwannomas is surgical resection, which remains the cornerstone for both symptomatic relief and definitive histological diagnosis.⁵ Surgical intervention is typically indicated when the tumor exerts significant compression on adjacent neural structures, leading to symptoms such as pain, paresthesia, or neurological deficits. The surgical approach involves posterior laminectomy to access the spinal canal, complemented by anterior decompression if the tumor extends through the intervertebral foramen.¹² In cases with extensive involvement, a combined anterior-posterior approach may be necessary to achieve complete tumor excision. Recently, minimally invasive procedures like microsurgical resection with laminectomy, endoscopic-assisted and robotic-assisted surgeries, offer significant advantages by minimizing muscle dissection, reducing blood loss, and lowering the risk of postoperative complications, due to smaller incisions, reduced tissue trauma, and faster recovery times. Yet, open resection, on the other hand, allows superior visualization and complete tumor removal. Therefore, the choice between a minimally invasive procedure and open surgery depends on the tumor's size, its complexity in relation to the surrounding tissues, and location.

Additionally, radiation therapy plays an adjunctive role, especially in cases where complete surgical resection is not feasible or residual tumor remains postoperatively. Schwannomas are generally radiosensitive, and modalities such as stereotactic radiosurgery offer targeted treatment with minimal impact on surrounding tissues. Radiation therapy is also employed as a primary treatment for inoperable cases or when surgery poses significant risks due to comorbidities.¹³

Lumbar dumbbell schwannomas generally have a favorable prognosis, particularly following complete surgical excision. Recurrence rates are low when resection is complete, underscoring the importance of meticulous surgical planning and execution.¹⁴ The recurrence risk of spinal dumbbell schwannomas is generally low following complete resection, but factors such as incomplete excision, tumor size, and location can influence this risk. Incomplete resection, often due to the tumor's proximity to critical neural or vascular structures, significantly increases the likelihood of recurrence.

Larger tumors, particularly those in difficult-to-access areas, also have a higher recurrence rate. To monitor for recurrence, long-term MRI surveillance is essential, with follow-up imaging typically starting at three months' post-surgery, and continuing at six, 12, and 24 months. Annual MRI may be performed thereafter if no recurrence is found. Magnetic resonance imaging (MRI) is preferred for its sensitivity in detecting soft tissue changes. Regular imaging during the first two years is crucial, as this is when the risk of recurrence is highest. Early detection through imaging ensures timely intervention if necessary.

When diagnosing a retroperitoneal mass located in close proximity to the spinal cord, it is essential to carefully consider the differential diagnosis with dumbbell schwannoma of the lumbar spine. The differential diagnoses for a lumbar dumbbell schwannoma include a range of neoplastic, infectious, and inflammatory conditions that can mimic its presentation in clinical and imaging findings, including neurofibromas, meningiomas, metastatic lesions, ependymomas, paragangliomas, abscess or infectious lesions, lipoma or hemangiomas.¹⁵ Schwannomas, neurofibromas, and metastatic tumors can be distinguished based on their MRI characteristics. Schwannomas typically present as well-defined, oval or round masses, often with a "dumbbell" shape due to extension through the intervertebral foramen. They are usually hypo- to isointense on T1 and hyperintense on T2, with homogeneous or heterogeneous contrast enhancement. Schwannomas are generally encapsulated and cause minimal peritumoral edema. In contrast, neurofibromas are more ill-defined and infiltrative, often following the course of the nerve from which they originate, with heterogeneous signal intensity on both T1- and T2-weighted images. On post-contrast images, neurofibromas exhibit less uniform enhancement and may show an infiltrative pattern along the nerve roots. While metastatic tumors are typically irregular, heterogeneous, and infiltrative, often involving bone, soft tissue, and epidural space, with central necrosis in larger masses. Thus, while schwannomas tend to be more localized and well-defined, neurofibromas and metastatic tumors present with more aggressive, infiltrative patterns and greater variability in signal intensity and enhancement.

Therefore, accurate lumbar schwannomas' diagnosis relies on correlating clinical presentation with imaging features, supplemented by histopathological confirmation in surgical cases. Recognizing these differential diagnoses is crucial for guiding appropriate management and optimizing patient outcomes.

The management of these tumors benefits from a multidisciplinary approach, involving neurosurgeons, radiologists, and oncologists to tailor treatment strategies to individual patient needs. Advances in minimally invasive surgical techniques and precision radiotherapy have significantly enhanced the therapeutic landscape, reducing morbidity and improving quality of life.¹⁶

In conclusion, the successful management of lumbar dumbbell schwannomas relies on timely diagnosis, individualized surgical treatment planning, and a comprehensive follow-up strategy. Surgical resection remains

the definitive treatment, augmented by radiation therapy in select cases. A collaborative, patient-centered approach ensures optimal results by combining therapeutic efficacy with preservation of neurological function and overall quality of life.

Competing Interests

The authors declare that they have no competing interests.

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