

Microsurgical treatment of lumbar paravertebral tumors via lateral retroperitoneal approach

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Abstract

Objective

To investigate the surgical techniques and post-operative therapeutic effectiveness of microsurgical treatment of lumbar paravertebral tumors via lateral retroperitoneal approach.

Methods

The clinical data of 6 cases with lumbar paravertebral tumors that went through surgical treatment via lateral retroperitoneal approach in the Neurospine Center of Xuanwu Hospital, Capital Medical University were retrospectively analyzed. The average operation time, volume of blood loss, incision length, length of hospitalization, and the resection rate of paravertebral tumors were collected, score of The Ability to Perform Activities of Daily Living (ADL) and incidents of postoperative complications were recorded.

Results

The operation time ranged from 56 to 181 minutes, with an average of (94.8 ± 48.3) minutes. The volume of blood loss was between 5-100ml, with an average of (31.7 ± 37.5) ml. The length of the surgical incision was 6-7cm, with an average of (6.7 ± 0.5) cm. The hospitalization length was between 5–11 days, with an average of (8.7 ± 2.6) days. The resection rate of paravertebral tumors was 100%. Postoperative pathological diagnosis result revealed 4 cases of schwannoma, 1 case of ganglioneuroma, 1 case of malignant small round cell tumor. During the 3-month follow-up, there was no recurrence of tumors, no abdominal cavity infection and no incisional infection, no incisional hernia, no death cases, and there was no significant decrease of the ADL score compared with that score before the operation.

Conclusion

The surgical treatment of lumbar paravertebral tumors via the lateral retroperitoneal approach has the advantages of short operation time, minimally invasive procedures, quick postoperative recovery, and few complications.

Full Text

Lumbar paravertebral tumors in the retroperitoneal space are mainly neurogenic tumors, most of them are schwannomas, accounting for 0.7%-2.7% of retroperitoneal tumors,^{1,2} and most of them originate from the dorsal root of the spinal nerve. Because of the loose structure of the lumbar paravertebral tissue behind the peritoneum and the large space in abdominal cavity, the tumor generally grows to a large size without obvious symptoms. The medical treatment is mainly focused on surgical treatment.³⁻⁶

Conventional surgical methods include standard midline posterior approach, separation or transection of the paraspinal muscles are needed to obtain larger exposure space for surgeries, and even the removal of the lamina and articular processes and reconstruction of the stability of the spine are required to remove the tumor, another method is to remove the tumor through anterior approach.^{4,6,7} Wiltse et al. proposed an approach through the paraspinal intermuscular space, first, separate the space between the longissimus and the multifidus to approach the lateral side of the transverse process, then remove the intertransverse ligament, expose the paravertebral space, so that the tumor can be removed.⁸ Traditional surgical methods have disadvantages such as long operation time, large surgical trauma, heavy blood loss, and long hospitalization period. In recent years, removal of retroperitoneal tumors through laparoscopic surgery is a relatively minimally invasive surgical method, but the common adjacency of paravertebral tumors and the aorta, inferior vena cava and other organs makes it inaccessible for laparoscopic surgery.^{4,9-16} With the introduction of the OLIF (oblique lumbar interbody fusion, OLIF) surgical technique in 2012 and the development and innovation of this surgical technique by scholars and surgeons^{17,18}, the minimally invasive surgical technique can reach specific surgical area via lateral retroperitoneal approach and lumbar paravertebral tumor resection can be performed, it has the advantages of being safe, effective and with less blood loss, meanwhile, this technique prevent damaging spine stability. From June 2019 to December 2020, Xuanwu Hospital of Capital Medical University performed surgical treatment for 6 cases of lumbar paravertebral tumors via lateral retroperitoneal approach, all came out with satisfactory clinical results, which are reported and summarized as follows.

1. Subjects And Methods

1. Clinical data

Inclusion criteria: Preoperative MRI examination to make clear that:

- ☒ The paravertebral tumor is located outside of the spinal canal, behind the peritoneum, and there is no space-occupying tissue (tumor) in the intervertebral foramen.
- ☒ The location of the tumor corresponds to the lumbar spine segments.
- ☒ Complete follow-up data.

Exclusion criteria:

- ☒ Tumors in the lumbar intervertebral foramen or in the spinal canal.
- ☒ The location of the tumor corresponds to higher or lower spine segments such as thoracic spine or sacral spine.
- ☒ Existence of systemic diseases that cannot tolerate surgical treatment, such as coagulation dysfunction.

1.2 Radiological imaging data

All patients in this group underwent X-Ray, CT and enhanced MRI examinations. General X-Ray examination confirmed that there was no enlargement of intervertebral foramen, and no spinal deformity or other manifestations. CT examination utilized thin-layer slices scanning and three-dimensional reconstruction was conducted to clarify the relationship between the tumor and the bony structures, whether there was expression of bony structure erosion or other manifestations, at the same time, CT examination provided imaging evidence for the evaluation of spine stability. Enhanced magnetic resonance imaging examination revealed that localized para-lumbar spine mass was located outside the spinal canal and behind the peritoneum. T1-weighted image showed equal or lower inhomogeneous signal (Fig 1A), T2-weighted image showed equal or slightly higher inhomogeneous signal (Fig 1B), gad-enhanced image showed mild inhomogeneous enhancement, clear boundary and no tumor in the intervertebral foramen (Fig 1C, D). Corresponding segments for paravertebral tumors were located para T12-L1 in 1 case, L1-L2 in 1 case, L1-L3 in 2 cases, and L5-S1 in 2 cases. There were 4 cases on the left side and 2 cases on the right side.

1.3 Surgical methods

This group of cases are operated all by the same surgeon. After general anesthesia tracheal intubation, take the lateral position (the affected side facing upward), operating table was adjusted to jackknife position, and the iliac crest and intercostal space on the affected side are fully extended. The projection of lumbar intervertebral space in interest on the lateral side of the skin is acquired and located with the C-arm imaging system. A straight incision on the skin started from the projection of anterior edge of the vertebral body that went anteriorly parallel to the external oblique muscle was made (Fig 1G), the skin and subcutaneous tissue was cut open (cut off the ribs or spread the intercostal space with spreaders if necessary), muscles of the abdominal wall was separated layer by layer along the muscle bundle direction of external oblique muscle, internal oblique muscle, and transversus abdominis muscles, blunt dissection with fingers was made to separate retroperitoneum, under the condition where kidney, ureter, peritoneum, intestine and other abdominal structures were fully protected, peritoneum was retracted to the ventral side with retractors, exposing the retroperitoneal space (Fig 1E). The deep retroperitoneal paravertebral space was gradually separated by the dissector, fully exposing the tumor. The relationship between the tumor and surrounding tissues, especially with blood vessels and nerves were distinguished and analyzed. If the tumor was encapsulated, the capsule was cut open with scalpel, the tumor was separated along the inner wall of the capsule, the proximal and distal nerve connections were cut off and the tumor was completely removed (Fig 1F). If the tumor is relatively large in size, it can be removed in pieces. Bleeding was completely stopped in the residual cavity, the retractors were removed, and the transversus abdominis, internal oblique muscle, external oblique muscle, subcutaneous tissue and skin was sutured layer by layer.

1.4 Observation and evaluation indicators and statistical methods

In this study, the operation time (the time from the start of skin incision to the end of skin suturing), the amount of blood loss, the length of the surgical incision, and the length of the hospital stay (the time from admission to discharge) were selected as the observation indicators; the effectiveness of tumor resection was evaluated by comparing preoperative and postoperative enhanced MRI; At follow-up, the scoring method of Barthel Index was used to score the patient's ability of daily living activities. At the same time, follow-ups also include the level of patient's clinical symptom relief, whether there is abdominal infection, incisional infection, incisional hernia, or death. The mean standard deviation was used as the statistical method.

2. Results

2.1 General information

All the 6 patients in this group were male, aged between 19–66 years old, with an average of (42.2 ± 19.4) years old. 2 cases of patients were found during asymptomatic physical examination, 2 cases of patients were found through symptoms of back pain, 1 case of patient was found through symptoms of hip pain and 1 case of patient was found through symptoms of pain in the left waist and calf. ADL scores preoperatively was 100 for every patient (Table 1). Postoperative pathological diagnosis result revealed 4 cases of schwannoma, 1 case of ganglioneuroma, 1 case of malignant small round cell tumor.

Table 1
ADL score of patients with lumbar paravertebral tumors pre and postoperatively

The Ability to Perform Activities of Daily Living (ADL) Score			
	Preoperative	Postoperative	Follow-up after 3 months
Patient 1	100	90	100
Patient 2	100	90	100
Patient 3	100	85	95
Patient 4	100	65	90
Patient 5	100	100	100
Patient 6	100	95	100

2.2 Operation results

The operation time ranged from 56 to 181 minutes, with an average of (94.8 ± 48.3) minutes. The volume of blood loss was between 5-100ml, with an average of (31.7 ± 37.5) ml. The length of the surgical incision was 6-7cm, with an average of (6.7 ± 0.5) cm. The hospitalization length was between 5-11 days,

with an average of (8.7±2.6) days. The resection rate of paravertebral tumors was 100%, indicated by postoperative enhanced magnetic resonance imaging re-examination.

The patients' original symptom of back pain was completely relieved postoperatively and patients with hip pain and left waist and calf pain reported symptom relief after surgeries.

2.3 Follow-up results and complications

Enhanced magnetic resonance imaging was performed postoperatively during follow-ups, for all six patients, there were no recurrence of tumors, no abdominal cavity infection and no incisional infection, no incisional hernia, and no death cases (Fig 1H, I). The follow-up conducted after three months of surgeries revealed no significant decrease of the ADL score compared with that score before the operation, all six patients were able to perform daily task and self-care. Only 1 patient still experienced pain around surgical incision, which affected daily dressing.

3. Discussion

Lumbar paravertebral tumors in the retroperitoneal space are mainly neurogenic tumors, and schwannomas are very common among them. In this group of cases, 5 cases are neurogenic tumors, of which 4 cases are schwannomas.^{1, 2} Due to the loose tissue structure of the retroperitoneum, the tumor was not noticed until very large in size. Most patients had no obvious or specific symptoms. Some patients with schwannoma had nerve root symptoms. Among the cases in this group, there were 2 asymptomatic patients, 2 patients with lower back pain, 1 patient with hip pain, and 1 patient with left waist and calf pain.³⁻⁶ Patients usually requires surgical treatment.^{6, 9} Due to the low disease incidence of lumbar paravertebral retroperitoneal tumors and relatively slow improvement of traditional surgical instruments, the surgical treatment methods are limited. Traditional invasive open surgeries or trans-muscular tumorectomy via posterior approach are more traumatic to patients.^{4, 6, 7} With the advancement of surgical instruments, the continuous deepening of minimally invasive surgical concept and the improvement of surgeons' surgical technique, laparoscopy is gradually being used for the treatment of retroperitoneal tumors when the operating positions and volume are relatively ideal.⁹ In addition, when the tumor is located near the vertebra, adjacent to major blood vessels or organs, it often requires more meticulous operation, which increases the risk of surgery.^{4, 9}

Due to the emergence of the minimally invasive approach through the lateral retroperitoneal space, surgeons can treat lumbar paravertebral tumors minimally invasively through this approach. This approach can achieve the same minimally invasive purpose as laparoscopic surgery, besides, it can also safely treat paravertebral tumors that are adjacent to major blood vessel and those with a complicated relation with the surrounding anatomical structure. All patients in this group were treated with lateral retroperitoneal approach to remove lumbar paravertebral tumors. The average operation time in this group was (94.8 ± 48.3) minutes, the average blood loss was (31.7 ± 37.5) ml, and the average hospital stay was (8.7 ± 2.6) days. No complications such as abdominal cavity infection, incisional infection, or

incisional hernia were observed. Compared with traditional surgical methods, the microsurgical treatment of lumbar paravertebral tumors via lateral retroperitoneal approach has the advantages of less trauma, shorter operation time, and less blood loss.^{4, 6, 7}

3.1 Treatment method

This study applied microsurgical treatment of lumbar paravertebral tumors through the lateral retroperitoneal approach, several considerations are as follows:

- i. The tumor can be directly removed through the minimally invasive lateral retroperitoneal approach, and to take advantages of performing surgical operation in the natural interstitial space can reduce damage to surrounding tissues compared with trans-abdominal or trans-muscular approaches.
- ii. The surgical trauma from performing lateral abdominal wall incision is relatively smaller than that of trans-abdominal and posterior trans-muscular tissue separation, which is beneficial to the patient's postoperative recovery.
- iii. Through the lateral retroperitoneal approach, operating under direct view with the help of surgical microscope, the surgical field is clear, and the operating space is sufficient, operations are not affected by the position or volume of the tumor. Also, it can help avoid passing through major blood vessels and important nerve structures, thus reduce the corresponding damages and complications. At the same time, proper utilization of surgical instruments by surgeons can reduce the retraction and damage to the surrounding tissue, avoiding conditions such as ureteral damages, sympathetic nerve injury, lumbar plexus injury, etc.
- iv. The lateral approach does not affect the stability of the spine, result in no need of internal fixation, it can reduce implants use, also reduces the cost of hospitalization.

3.2 Indications for surgery

- i. Paravertebral tumors of the lumbar spine. The highest tumor corresponding segment in this group of cases is the thoracic 12 spine segment. If continues upward, due to the interference of the pleura, the surgical operation becomes more difficult and the risk of pleural damage is increased. If the position of the tumor is too low, the operation space gets limited due to the interference of the iliac crest, also, the blood vessels are abundant anteriorly to the sacrum, which increases the risk of surgery.¹⁹
- ii. The spinal canal and intervertebral foramen are not affected by the tumor. If the intervertebral foramen and spinal canal are involved, excessive retraction during tumor resection may damage the spinal nerve root or cauda equina, leading to nerve function damaging, which brings a high risk.
- iii. Retroperitoneal tumors. The retroperitoneal space is relatively wide and maneuverable.

3.3 Essential Technique

- i. According to the specific position of the lumbar spine segments corresponding to the tumor, the tumor position is marked laterally on the skin under the C-arm imaging system, and the surgical

- incision is identified. The incision runs along the ribs. If the ribs are interfering the incision, part of the ribs can be removed. It is also feasible to spread the intercostal space if the tumor is small in size.
- ii. Retract the abdominal wall and other tissue around the tumor. Enter the retroperitoneal space and bluntly separate the retroperitoneal fat with fingers to avoid entering the peritoneum to avoid damaging the ureter and blood vessels.^{20,21} In particular, do not excessively retract the psoas major muscle, avoid irritating the psoas major and lumbar plexus, which may result in hip flexion weakness and deficiency postoperatively.²²⁻²⁵
 - iii. The principles of tumor resection should be followed strictly, tumor capsules should be distinguished carefully and the tumors should be removed completely.
 - iv. To close the incision of abdominal wall, the transversus abdominis, internal oblique muscle, and external oblique muscle should be sutured tightly layer by layer to avoid iatrogenic incisional hernia caused by the increased pressure in the abdominal cavity.

4. Conclusion

Microsurgical treatment of lumbar paravertebral tumors via lateral retroperitoneal approach has the advantages of short operation time, minimal invasiveness, quick recovery, and few complications. With the advancement and development of surgical techniques and instruments, this surgical method will be further promoted and applied into clinical practices.

Declarations

Ethics approval and consent to participate

This study was approved by The Ethics Committee of Xuanwu Hospital Capital Medical University. Written informed consent was obtained from the patients and/or their legal guardians for publication, and any accompanying images, sex, age of these patients. The authors state that all methods were carried out in accordance with relevant guidelines and regulations in this study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Author' contributions

LZ and SCC wrote the main manuscript text, prepared figures 1 and Table 1, KW collected the data and revised the manuscript, HW conceptualized the original idea. All authors read and approved the final manuscript.

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Availability of data and materials

All data generated or analysed during this study are available from the cor-responding author on reasonable request.

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Figures

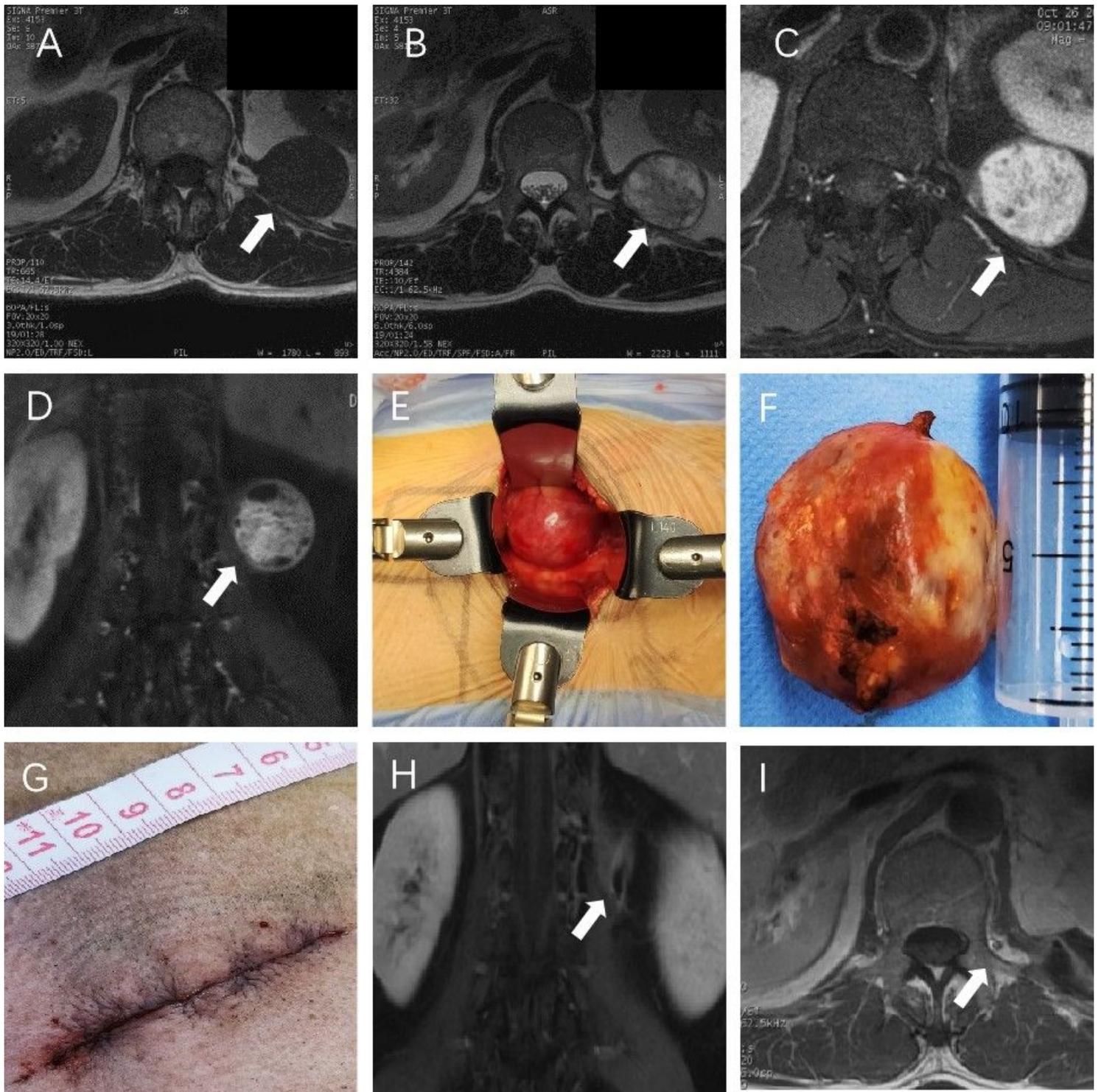


Figure 1

Microsurgical treatment of lumbar paravertebral tumors via lateral retroperitoneal approach:

A: MRI T1-weighted: A round-like paravertebral tumor (White arrow) at the posterior side of the kidney in the retroperitoneum, low signal.

B: MRI T2-weighted: small amount of mixed and uneven high signal, round-like tumor (White arrow).

C: MRI Gad-enhanced T1-weighted: Axial view, a round-like tumor (White arrow) posterior to the kidney can be observed, significantly enhanced.

D: MRI Gad-enhanced T1-weighted: Coronal view, a round-like tumor (White arrow) can be observed at L1-2 vertebral body level.

E: Intraoperative image: A 14cm deep retractor fully exposes the tumor after retraction.

F: Postoperative image: The tumor was completely resected along the inner surface of the capsule, about 4cm in diameter.

G: Postoperative image: The surgical incision length is about 7cm.

H&I: Postoperative MRI image: Image of retroperitoneal space, complete removal of the tumor (White arrow) located posterior to the kidney.