Minimally Invasive Resection of a Gangliocytic Paraganglioma of the Cauda Equina: A Case Report and Review of Literature

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Abstract
Gangliocytic paraganglioma (GP) is considered a rare neuroendocrine tumor (NET) most often located in the distal half of the duodenum. Insufficient reports describe tumors of this histological type located in the distal parts of the spinal canal, the conus medullaris and cauda equina. To date, nine cases of GP of the cauda equina and one case of GP of conus medullaris have been described. After analyzing all available treatment reports of GP, a study described it as a tumor with an extremely good prognosis in cases of total tumor removal. Here, we present a case of a female patient with a GP at the level of the L4 vertebra treated at Burdenko Neurosurgical Center using a minimally invasive approach through a tubular retractor. The tumor was removed en bloc through an intralaminar opening, and the patient was discharged two days after surgery with total regression of symptoms.

Introduction
Gangliocytic paraganglioma (GP) is considered a rare neuroendocrine tumor (NET) consisting of three main components: epithelioid, ganglion-like, and spindle-shaped (Schwann-like) cells [1].

GP was first described as "ganglioneuroma" by Dahl et al. in 1957, and Kepes et al. coined the term "gangliocytic paraganglioma" in 1971 [2]. Despite the fact that GP is often localized in the distal half of the duodenum, there are rare reports that this tumor can also be found in the distal parts of the spinal canal (conus medullaris and cauda equina) [1,3-11]. The first report on GP of the cauda equina by Lerman et al. was published in 1972 [1]. To date, according to available literature, nine cases of GP of the cauda equina [1,3-9,11] and one case of GP of conus medullaris [10] have been described.

In this article, we describe the first case of resection of a gangliocytic paraganglioma in a 55-year-old patient using a minimally invasive spine surgery (MISS) through a tubular retractor.

Case Presentation
A 55-year-old female was referred to the Burdenko Neurosurgical Center by her primary care physician with complaints of severe lumbar pain radiating to both lower extremities along the lateral surface of the thigh and skin. About a week before admission, the patient noticed an increase in urination frequency and sensation of incomplete emptying of the bladder. On neurologic examination, no decrease in lower limb muscle strength or sensory disturbances were found. From the patient’s history, it became known that she experienced pain for about 1.5 years, for which she was treated conservatively with moderate to minimal improvement. Gradually, the symptoms progressed, and conservative pain management became ineffective.

The patient’s magnetic resonance imaging (MRI) scan of the lumbar spine revealed an intradural tumor at the level of the L4 vertebra, hyperintense in the T1-weighted image, hypointense in the T2-weighted image, and actively accumulating contrast, 1.35 × 1 cm in size (Figures 1, 2). She had no previous surgical history, and her comorbidities included hypothyroidism, for which she received treatment.

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FIGURE 1: Sagittal (A) and axial (B) T2-weighted MRI showing an intradural mass at the level of the L4 vertebrae (arrows).

MRI: magnetic resonance imaging

FIGURE 2: Sagittal (A) and axial (B) T1-weighted MRI with contrast enhancement showing an intradural homogeneous contrast-enhancing mass at the level of the L4 vertebrae (arrows).

MRI: magnetic resonance imaging

It is worth noting that the issue of preoperative verification of the histological type of tumor is difficult, and we all agree that the diagnosis becomes clear and is typically made after surgical excision [1-11]. In this connection, the preoperative diagnosis was made without specification: an intradural neoplasm at the level of the L4 vertebra.

Due to the small size of the tumor and the modern availability of low-trauma surgical techniques, we decided to excise the tumor through a minimally invasive spine surgery (MISS) using a tubular retractor system.

Surgery was performed the next day after admission. The patient was positioned prone on a Wilson frame, and the L4 level was identified on lateral fluoroscopy. A 2-cm skin incision 5 cm off midline was made, after which a transmuscular approach was performed using sequentially placed dilators. We used an EasyGo tubular retractor, which was inserted after the dilators, its position verified using lateral fluoroscopy and fixed to the operative table (Figure 3). Using a high-speed diamond burr, an intralaminar opening was made at the level of the L3-L4 vertebrae. The dura was opened with a linear incision, tucked, and sutured to the sides.
Intradurally, the roots of the cauda equina were located around a dense roundish mass at the time of surgery, presumably a schwannoma. The roots of the cauda equina were moved away from the tumor, and the proximal and distal parts of the nerve from which the tumor was growing were determined. Direct stimulation of the pathological nerve root yielded no neurophysiological response, after which the distal and proximal parts of the root were coagulated and cut with microscissors (Figure 4).

The tumor was removed en bloc, followed by a water-tight dural closure with 5-0 Prolene sutures and strengthened by placement of a fibrin-collagen patch. Fascia and soft tissue were sutured in a continuous manner. Figure 5 shows the size of the tumor in comparison with the size of the skin incision.
Overall, the surgery was uneventful and lasted 180 minutes. Postoperatively, the patient’s symptoms improved. The patient was discharged two days after the surgery. At discharge, the patient complained only of minimal pain in the postoperative wound, with no lower back pain or radicular pain. Bladder dysfunction regressed completely a month after discharge. Three months after surgery, a control MRI was performed (Figure 6).
The pathological examination revealed that the tumor turned out to be trifractional, consisting of the following (Figures 7-10): monomorphic cells with oval nuclei - chief cells (type I), tending to perivascular arrangement, with sparse, inconspicuous supporting cells (type II); numerous clusters of large ganglion-like cells with rounded nuclei, distinct nucleoli, and abundant weakly granular cytoplasm; and a few schwannoma-like areas represented by a spindle cell component. Immunohistochemical study revealed immunopositivity of chief cells to synaptophysin and CKAE1/3, ganglion-like cells to synaptophysin, supporting cells to S100, and schwannoma-like regions to GFAP and S100. Thus, the morphological picture and immunophenotype of the tumor corresponded to gangliocytic paraganglioma.
FIGURE 7: Staining with hematoxylin and eosin (×200): clusters of large ganglion-like cells surrounded by smaller chief cells.

FIGURE 8: Immunohistochemical staining with synaptophysin (×200): positive expression in ganglion-like and chief cells.
Discussion

Gangliocytic paraganglioma is a rare tumor with a good prognosis, usually arising in the small intestine (especially the duodenum) [2]. In a study by Okubo et al. in 2018, data from 263 patients with GP were collected and analyzed [2]. The vast majority of GP was detected in the duodenum (89.7%), and GP of the conus medullaris and cauda equina accounted for only 2.3% (six cases) [2].

In this regard, being an extremely rare tumor, GP remains poorly studied. In their study, Shankar et al. tried to explain how three types of cells (epithelioid, spindle-shaped (Schwann-like), and ganglion-like) can occur in a single tumor and noted that the combination of cytokeratin-positive neuroendocrine, ganglion, and Schwann cells suggests that all these cell types are of neoplastic origin [3]. On this basis, they concluded that this lesion reflects the ability of neural crest-derived sympatoadrenal cells to undergo divergent differentiation, leading to the formation of neuroendocrine and ganglionic cellular components. In addition, some studies have shown that hypoxia promotes the dedifferentiation of neuroblastic elements into immature neural crest cells [12].

Okubo et al. collected all available reports of GP and analyze treatment results [2]. It is worth noting that the number of studies analyzed by Okubo et al. appeared to be quite limited, and they seemed to describe tumors of duodenal origin. Therefore, this should be made clear in the discussion. They described GP as a tumor with an extremely good prognosis and only one recurrence, most likely associated with possible subtotal tumor resection. They argued that patients, after total tumor removal, did not require adjuvant therapy
since there was no recurrence or metastatic spread. On the contrary, it is still unclear whether residual tumors of this type can be treated by radiation or chemotherapy alone without surgery [2].

It is worth emphasizing that for the patient, three months after surgery, no tumor recurrence was noted on the postoperative control MRI. We summarized the available data on surgical treatment of GP in Table 1.

| Author/year | Sex/age | Localization/size | Symptoms | Surgical approach | Results |
|-------------|---------|-------------------|----------|-------------------|---------|
| Lerman et al. (1972) [1] | Male/29 | Tumor at the level of L2-L1/2 × 2 cm | Lower back pain radiating to the left lower limb | Laminectomy L2-L3-L4 | Total regression of symptoms |
| Schmitt et al. (1982) [4] | Male/33 | Tumor at the level of L4-L5/4 × 2.5 × 2.5 cm | Lower back pain radiating to the left lower limb, paralysis of the elevating muscles of the left foot | Laminectomy L4-L5 | Total regression of symptoms with a slight sensorimotor deficiency in the left leg |
| Djindjian et al. (1990) [5] | Male/36 | Tumor expanded from just below the conus medullaris down to the L5 vertebrae/N/A | Lower back pain with lower paraplegia | Laminectomy L1-L5 | Total regression of symptoms |
| Vural et al. (2008) [8] | Male/17 | Tumor at the level of the L4, exiting through the right L4-L5 intervertebral foramen into the right psoas muscle/5 × 3 × 4.5 cm | Lower back pain with bilateral sciatica and difficulty in ambulation | Laminectomy L4 and right unilateral facetectomy | Total regression of symptoms |
| Shankar et al. (2010) [3] | Male/48 | Tumor at the L2-L3 level/2.6 × 1.7 × 1.2 cm | Lower back pain and an intermittent tingling sensation in the inguinal area | Laminectomy L2-L3 | Total regression of symptoms |
| Sable et al. (2014) [11] | Male/58 | Tumor at the L2 level/2.5 × 2 × 1.5 cm | Lower back pain radiating to the right lower limb, mild weakness in the right external hallucis longus muscle (4/5) | N/A | Total regression of symptoms |
| Akbik et al. (2016) [7] | Male/68 | Tumor at the L5-S2 level/6 × 6.2 cm | Perianal paresthesia and significant postvoid residuals | Laminectomy L5-S2 | Marked improvement in paresthesia in the primary perianal distribution; however, daily catheterization for urinary retention was required |
| Nagose et al. (2019) [10] | Male/42 | Tumor at the Th12-L2 level/3 × 2.5 × 2 cm | Difficulty walking, pain, and tingling in the right leg | Laminectomy | Total regression of symptoms |
| Lal et al. (2021) [9] | Male/35 | Tumor at the Th11-L2 level/12 × 1.6 × 2.5 cm | Lower limb weakness | Laminectomy | Total regression of symptoms |
| Present case | Female/55 | Tumor at the L4 level/1.35 × 1 cm | Lower back pain radiating to both lower limbs | L3-L4 interlaminar approach through a tubular retractor | Total regression of symptoms |

TABLE 1: Present articles on the surgical treatment of GP at the cauda equina.
tumor resection can be achieved using a minimally invasive surgical approach with no significant difference in surgical outcomes [14].

**Conclusions**

In our experience, patients with cauda equina root tumors, with the proper experience and skill of the surgeon, can and should be operated on using a minimally invasive approach (MISS) due to their best orthopedic postoperative outcome, which is no less important for patients.

**Additional Information**

**Disclosures**

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**References**

1. Lerman RI, Kaplan ES, Daman L: Ganglioneuroma–paraganglioma of the intradural filum terminale. Case report. J Neurosurg. 1972, 36:652-8. 10.3171/jns.1972.36.5.0652
2. Okubo Y, Yoshioka E, Suzuki M, Washimi K, Kawachi K, Kameda Y, Yokose T: Diagnosis, pathological findings, and clinical management of gangliocytic paraganglioma: a systematic review. Front Oncol. 2018, 8:291. 10.3389/fonc.2018.00291
3. Shankar GM, Chen L, Kim AH, Ross GL, Folkert RD, Friedlander RM: Composite ganglioneuroma-paraganglioma of the filum terminale. J Neurosurg Spine. 2010, 12:709-15. 10.3171/2009.12.SPINE09482
4. Schmitt HP, Wurster K, Bauer M, Parsch K: Mixed chemodectoma-ganglioneuroma of the conus medullaris region. Acta Neuropathol. 1982, 57:275-81. 10.1007/BF00692183
5. Djindjian M, Ayache P, Brugières P, Malapert M, Poirier J: Giant gangliocytic paraganglioma of the filum terminale. Case report. J Neurosurg. 1990, 73:459-61. 10.3171/jns.1990.73.3.0459
6. Pytel P, Krausz T, Wollmann R, Utset MF: Ganglioneuromatous paraganglioma of the cauda equina—a pathological case study. Hum Pathol. 2005, 36:444-6. 10.1016/j.humpath.2005.01.024
7. Akkik OS, Floruta C, Chohan MO, SantaCruz KS, Carlson AP: A unique case of an aggressive gangliocytic paraganglioma of the filum terminale. Case Rep Surg. 2016, 2016:1252594. 10.1155/2016/1252594
8. Vural M, Arslantas A, Isiksoy S, Adapinar B, Atasoy M, Soylenemoglu F: Gangliocytic paraganglioma of the cauda equina with significant calcification: first description in pediatric age. Zentralbl Neurochir. 2008, 69:47-50. 10.1055/s-2007-983162
9. Lal S, Pant I, Chaturvedi S, Sarma P: Gangliocytic paraganglioma of the spine. Autops Case Rep. 2021, 11:e2021277. 10.4322/acr.2021.277
10. Nagose VB, Iadhav VA: Gangliocytic paraganglioma of Dorsolumbar spine: a rare tumor at rare site. Asian J Neurosurg. 2019, 14:907-10. 10.4103/ajns.AJNS_30_19
11. Sahle MN, Nawha A, Suri V, Singh PK, Garg A, Sharma MC, Sarkar C: Gangliocytic paraganglioma of filum terminale: report of a rare case. Neurol India. 2014, 62:543-5. 10.4103/0028-3886.144456
12. Jögi A, Öra I, Nilsson H, et al.: Hypoxia alters gene expression in human neuroblastoma cells toward an immature and neural crest-like phenotype. Proc Natl Acad Sci U S A. 2002, 99:7021-6. 10.1073/pnas.102660199
13. Helal A, Yolcu YU, Kamath A, Wahood W, Bydon M: Minimally invasive versus open surgery for patients undergoing intradural extramedullary spinal cord tumor resection: a systematic review and meta-analysis. Clin Neurol Neurosurg. 2021, 214:107176. 10.1016/j.clineuro.2022.107176
14. Choi EH, Chan AT, Gong AD, et al.: Comparison of minimally invasive total versus subtotal resection of spinal tumors: a systematic review and meta-analysis. World Neurosurg. 2021, 151:e543-54. 10.1016/j.wneu.2021.04.045