# Posterior Paramedian Approach—A Simple Technique to Obtain a Lateral Viewing Angle for Spinal Lesions

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**Article**

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# Abstract

A wide lateral viewing angle is often necessary for spinal surgery. However, the skin and paraspinal muscles limit this angle in the traditional posterior midline approach.

This article describes a simple, less-invasive approach that provides good lateral viewing angles to spinal lesions.

The approach consisted of (1) a horizontal skin incision, (2) unilateral dissection and exposure of the laminae, (3) a horizontal fascial incision, and (4) application of retractors in the longitudinal direction with a minimal incision on the multifidus muscle.

We successfully used this approach on 24 patients with various spinal diseases. The pathology of the lesions included nine schwannomas, five meningiomas, four ossification of ligamentum flavum (OLF), three malignant tumors, and three others. There were nine cervical, twelve thoracic, two lumbar, and one sacral lesions. We could achieve gross total removal in most cases without significant complications. The approach provided an excellent surgical field for removing ventrally located tumors with minimal cord retraction.

This simple technique will be a valuable addition to the armamentarium of spine surgeons.


# Introduction

Although the standard posterior midline approach can manage most spinal lesions, it is not free from disadvantages. Removing the midline structures such as spinous processes, supra-spinous ligament, and paraspinal muscle attachments weakens the posterior tension band and affects the spinal stability[1]. Also, laterally retracted skin and the paraspinal muscles block the surgeon's lateral viewing angle[2,3]. This blockage is especially disadvantageous for a tumor located ventrally to the spinal cord, where an insufficient lateral viewing angle results in more spinal cord retraction. To compensate, the surgeon must make a longer skin incision and dissect longer spinal segments[2]. This blockage also prohibits the surgeon from approaching bilateral spinal lesions less invasively through a unilateral approach.

We developed a simple technique to overcome these shortcomings that enabled a surgeon to gain a sufficient lateral viewing angle with minimal invasiveness. The technique consisted of a horizontal skin incision, subperiosteal dissection of the ipsilateral lamina, a horizontal fascial incision, and retraction of the paraspinal muscle longitudinally to the spinal column. So far, we have used this approach in 24 patients with various spinal pathologies and obtained excellent results. We will describe this technique and its application in detail.

# Materials And Methods

# Study Design

This study is a retrospective observational study of a consecutive case series at a single teaching hospital. The Tokai University School of Medicine Review Board approved the study protocol (No. 21R179), and informed consent was obtained from all subjects and/or their legal guardians. All methods were performed in accordance with the relevant guidelines and regulations. The first author (a neurosurgeon with over 30 years of experience) operated on all cases from September 2015 to April 2021. Initially, we applied our approach to patients with spinal tumors located ventrally to the spinal cord. Later, as we recognized the usefulness of this approach, we gradually expanded its indication to other pathologies. The first author followed all the patients after surgery at the outpatient clinic. At the last clinical visit, he evaluated the patient's outcome with the modified MacCormick grade4 (Table 1).

# Operative Technique

Figure 1 shows the detail of this approach. With the patient in the prone position under general anesthesia, we determined the appropriate level on a lateral X-ray. We then made a 7 to 10-cm horizontal skin incision crossing the midline so that about one-third of the incision lay on the contralateral side (Figure 1A). A more prolonged longitudinal exposure required a longer skin incision. We then subperiosteally dissected the multifidus muscles off the ipsilateral spinous processes and laminae (Figure 1B). Next, we made a horizontal incision on the dorsal fascia covering the ipsilateral paraspinal muscles (Figure 1B). This fascial incision facilitated the lateral retraction of the muscles. We then made a horizontal incision on the most medial portion of the multifidus muscle as needed to obtain good exposure to the laminae. Finally, we placed a pair of self-retaining retractors to hold the surgical field (Figure 1C). We placed these retractors longitudinally to the spinal column so that there would be no obstacles to a lateral viewing angle (Figure 1D). We then approached the spinal canal through ipsilateral partial or complete hemilaminectomy.

# Estimation of postoperative pain

From June 2016 to August 2017, we performed a short survey of postoperative pain. We asked patients who underwent spinal tumor surgery (intradural schwannomas or meningiomas) in this period to evaluate the maximal postoperative wound pain with the visual analog scale (VAS). We compared the scores between two groups: those who underwent the posterior paramedian approach and those who underwent the standard bilateral laminectomy. The first author determined the surgical approach (standard or paramedian) individually. We performed Student's t-test using a statistical software package (R version 4.0.6, R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/). A p-value less than 0.05 was considered statistically significant.

## Results

# Case Series

Twenty-four patients underwent spinal surgery with the posterior paramedian approach during the study period. Table 2 shows the detailed information about the series. There were ten men and fourteen women with a mean age of 61.5 years and a standard deviation (SD) of 4.4. The mean follow-up period was 36.8 (SD 4.3) months. The series included nine schwannomas, five meningiomas, four OLF, three malignant tumors, and three others, of which nine were cervical, twelve thoracic, two lumbar, and one sacral lesion. The location of the tumors in the spinal canal was ventral or dumbbell/ventral in 10 cases, lateral or dumbbell/lateral in three cases, and dorsolateral in three cases. We previously reported Case 2 as a case report[5].

# Representative Cases

# Case 24

This 50-year-old man complained of severe pain radiating to his bilateral flank areas, and he also had mild gait disturbance. Neurological exams showed hypesthesia below the level of T9, hyperreflexia in both lower extremities, and positive Babinski signs on both sides. Thoracic-spine MRI revealed a mass lesion on the ventral side of the spinal cord at T9/10 (Fig. 2A). This lesion was inhomogeneously enhanced after gadolinium administration (Fig. 2B, C).

We chose the right posterior paramedian approach for this ventrally located tumor (Fig. 3A). After unilateral partial laminotomy of T9 and T10, the spinal cord still covered most of the tumor (Fig. 3B). We removed the tumor through a small space on the lateral side of the cord, repeating internal decompression and slight pulling out (Fig. 3C). The approach provided a wide and bright operative field with an excellent lateral viewing angle for the gross total removal of the tumor with minimal cord retraction (Fig. 3D). We removed only the medial portion of the facet joint, so fixation was unnecessary.

Postoperatively, the patient immediately made a good neurological recovery. There was minimal wound-related pain either in the postoperative period or later. We could confirm gross total removal on a postoperative MRI (Fig. 4). The patient returned to his normal activities and was doing well six months after surgery.

# Case 19

This 75-year-old woman gradually worsened her gait with bilateral leg numbness. On exam, she had hyperreflexia in both lower extremities with positive Babinski signs. A thoracolumbar spine MRI showed spinal canal stenosis at T10/11 with thickening of the shadow of the yellow ligament (Fig. 5A, B). A thoracic-spine CT showed bilateral ossification of the yellow ligament at this level (Fig. 5C). We planned to remove the OYL through a unilateral laminotomy to avoid unnecessary spine fusion. For this purpose, we chose the posterior paramedian approach.

With a horizontal skin incision, we dissected the multifidus muscle off the left side of the spinous processes of T10 and T11. We exposed the ossified yellow ligament with partial hemilaminectomy at T10 and 11. We carefully removed bilateral OLF with an ultrasonic aspirator (SONOPET, Stryker, Kalamazoo, MI, U.S.A.) under an operating microscope.

The patient made an uneventful recovery after surgery. Her gait disturbance fully recovered after a month of rehabilitation. Some numbness in both lower extremities remained. Postoperative MRI and CT showed good cord decompression (Fig. 5D, E, F). After 19 months of follow-up, her condition was stable with well-kept alignment. She had no complaint of back pain.

# Case 4

This two-year-old boy had a right upper extremity weakness, which rapidly progressed to complete paralysis of his right arm. A cervical-spine MRI showed an ovoid-shaped mass on the ventral side of the spinal cord at the level of C5 and 6 (Fig. 6A, B), which extended into the right C5/6 foramen and exited along with the right longus colli muscle (Fig. 6C, D). We took the patient to the operating room on a semi-emergency basis.

Because of the age and size of this boy, an anterior approach did not seem to be feasible. If we approached posteriorly, however, because of the tumor's location on the ventral side, a lateral viewing angle seemed to be necessary. Thus, we chose the posterior paramedian approach, which could give us an excellent lateral viewing angle to the ventral side of the cord. Its unilateral approach seemed less invasive than the standard laminectomy, even if there was some inevitable muscle damage on the ipsilateral side.

With C5, 6 hemilaminectomies, we could achieve a good exposure of the ventral tumor with a comfortably wide surgical field despite the unilateral approach on a two-year-old boy (Fig. 6E). The tumor was malignant and seemed to extend along the C7 motor root. Thanks to the good lateral viewing angle, we could carefully dissect the tumor from the ventral side of the spinal cord under direct microscopic vision. We could completely remove the tumor inside the spinal canal through unilateral laminectomy (Fig. 6F). We removed the tumor in the medial part of the foramen but left its lateral part.

The patient made an uneventful recovery from surgery. Postoperative MRI showed good spinal cord decompression (Fig. 6G, H). His right upper-extremity weakness gradually improved, and he recovered full strength in about a month. The pathology was a desmoplastic small round cell tumor, and he was transferred to our pediatric oncology service and received chemotherapy. However, the patient died one year after surgery because of the spread of the malignant tumor.

# Case 2

This 79-year-old woman presented with weakness in her right hand and gait disturbance. Cervical-spine MRI showed a mass located on the ventral side of the cord at the level of C2 (Fig. 7A, B). We selected the posterior paramedian approach because the surgery required a wide lateral viewing angle.

The tumor was removed using the right-sided posterior paramedian approach through a C2 hemilaminectomy. The patient achieved full neurological recovery after surgery with no surgical complication. Postoperative MRI showed gross total removal of the tumor (Fig. 7C, D). The patient complained of no neck pain or shoulder fatiguability postoperatively. There was no detectable muscle atrophy one year after surgery (Fig. 7E).

# Outcomes and Complications

We could achieve MacCormick grade I in 18 cases and grade II in four cases (Table 2). One patient (Case 22) with dissemination from a germ cell tumor had an outcome of grade IV. One patient (Case 3) died one year after surgery because of a malignant tumor. We could achieve gross total removal in all five meningiomas. We achieved gross total removal in three of the five dumbbell-shaped schwannomas and left a portion of the tumor outside the foramen in two. The unilateral laminotomy achieved good bilateral decompression for the four OLF cases. We could obtain MacCormick grade I results in 14 of the 17 tumor cases. One patient (Case 3) with cervical schwannoma originating from a motor root developed postoperative biceps weakness, which recovered to a nearly normal level in three months. There was no CSF leak or wound problem, and no patient complained of significant wound pain during the follow-up period.

Table 1
Modified MacCormick Scale

| **I** | **Intact neurologically, normal ambulation, minimal dysesthesia** |
|---|---|
| II | Mild motor or sensory deficit, functional independence |
| III | Moderate deficit, limitation of function, independent w/external aid |
| IV | Severe motor or sensory deficit, limited function, dependent |
| V | Paraplegia or quadriplegia, even w/flickering movement |

Table 2
Summary of the Series

| Case | Age/Sex | Pathology | Location | Type | Resection | Follow-up | MacCormick Scale |
|---|---|---|---|---|---|---|---|
| 1 | 38/m | schwannoma | thoracic | dumbbell/lateral | gross total | 73 | I |
| 2 | 79/f | meningioma | cervical | ventral | gross total | 70 | I |
| 3 | 69/f | schwannoma | cervical | dumbbell/ventral | subtotal | 58 | II |
| 4 | 2/m | DSRCT | cervical | dumbbell/ventral | subtotal* | 12 | Dead |
| 5 | 62/f | meningioma | cervical | dorsolateral | gross total | 55 | I |
| 6 | 76/f | schwannoma | cervical | ventral | gross total | 54 | I |
| 7 | 67/m | schwannoma | sacral | dumbbell/dorsal | Gross total | 53 | I |
| 8 | 81/f | schwannoma | thoracic | dorsolateral | Gross total | 51 | I |
| 9 | 73/f | OLF | thoracic | dorsal | Gross total | 51 | I |
| 10 | 60/f | meningioma | cervical | ventral | Gross total | 51 | I |
| 11 | 56/m | schwannoma | lumbar | lateral | Gross total | 50 | I |
| 12 | 77/f | meningioma | thoracic | dorsolateral | Gross total | 50 | I |
| 13 | 70/f | meningioma | thoracic | lateral | Gross total | 46 | I |
| 14 | 37/f | schwannoma | lumbar | lateral | Gross total | 38 | I |
| 15 | 74/f | OLF | thoracic | dorsal | Gross total | 37 | II |
| 16 | 78m | arachnoid cyst | cervical | ventral | subtotal | 30 | II |
| 17 | 31f | germ cell tumor | thoracic | ventral | subtotal | 24 | IV |
| 18 | 60f | schwannoma | cervical | dumbbell/ventral | subtotal* | 21 | I |
| 19 | 75f | OLF | thoracic | dorsal | Gross total | 19 | I |

DSRCT: desmoplastic small round cell tumor

| Case | Age/Sex | Pathology | Location | Type | Resection | Follow-up | MacCormick Scale |
|---|---|---|---|---|---|---|---|
| 20 | 85m | OLF | thoracic | dorsal | Gross total | 10 | II |
| 21 | 80m | CSM | cervical | n/a | n/a | 10 | I |
| 22 | 18m | germ cell tumor | thoracic | ventral | subtotal | 8 | I |
| 23 | 78m | dural AVF | thoracic | lateral | n/a | 7 | I |
| 24 | 50m | schwannoma | thoracic | ventral | Gross total | 6 | I |
| DSRCT: desmoplastic small round cell tumor | | | | | | | |

CSM: cervical spondylotic myelopathy

# Postoperative Pain

Six patients underwent the posterior paramedian approach (cervical 3, thoracic 1, lumbar 2), and seven patients underwent the standard bilateral laminectomy (cervical 3, thoracic 2, lumbar 1). The mean VAS score was significantly smaller ($p = 0.04$) in the paramedian approach group (mean 3.1, SD 2.0) compared to the standard approach group (mean 5.6, SD 2.0).

## Discussion

We have described a simple surgical technique for spine surgery that provided a wide operative field and an excellent lateral viewing angle. We used this technique for 24 cases of various spinal pathologies, including spinal tumors and OLF, with excellent results. In spinal tumors located ventrally, the wide lateral viewing angle reduced the amount of spinal cord retraction. It also provided an excellent surgical field for removing bilateral OLF through a unilateral approach preserving the midline structures.

When a tumor is located on the ventral side of the spinal cord, a posterior approach requires some spinal cord retraction. However, retracting an already compressed spinal cord poses some risk of postoperative neurological deficits[2,3]. To reduce this spinal cord retraction, one needs to have a lateral viewing angle. However, with the midline skin incision, the skin and the paraspinal muscles block the lateral viewing angle.

We could solve this problem by incising the skin and the dorsal fascia horizontally. With a horizontal skin incision, the skin was no more an obstacle. Incising the dorsal fascia and the medial portion of the multifidus muscle, we could easily retract the paraspinal muscles, which presented no more obstacles. The skin incision could be elongated laterally during surgery, making this technique flexible. Also, our approach required shorter exposure segments because of its good lateral viewing angle.

Recently, a few clinical series have shown that minimally invasive surgery (MIS) can provide a satisfactory outcome for patients with intradural extramedullary tumors.[6,7] Our approach may be considered a modification of MIS. Both approaches use the less invasive unilateral laminectomy, and MIS makes a smaller paraspinal skin incision, incises the fascia, and retracts the muscle with a tubular retractor. Our technique uses unilateral subperiosteal dissection, fascial incision, minimal muscle incision, and longitudinal retraction. Although dissection is more expansive in our approach, actual damage to the muscle may be comparable to that of MIS. In MIS, however, a narrow tubular retractor makes microsurgical manipulation technically challenging[6], while our approach provides a wide operative field for comfortable surgical maneuvers. Also, MIS may not be currently indicated for ventrally located intradural tumors6, while our approach is feasible.

Some cases may require more complex approaches such as posterolateral approaches and their variations (costotransversectomy and extracavitary approaches[8,9]), usually with facet removal[2,10], and anterior or lateral approaches (anterior or lateral approaches to the cervical spine[11,12], transthoracic approach[13], retroperitoneal approach[14]). However, these approaches are more invasive and often associated with complications. For example, unilateral facet removal tends to cause postoperative instability[10], and corpectomy in anterior approaches requires fixation with cages and plates[14,15]. Also, their approach routes are often not familiar to ordinary spine surgeons. On the other hand, the unilateral midline dissection in our approach provides straightforward anatomy familiar to spine surgeons, and it also preserves the facet joint ensuring postoperative stability.

There is a trade-off between the better exposure attainable by an approach and its invasiveness and complexity. The best strategy will be to adopt the most straightforward and least invasive technique that enables the surgeon to remove the lesion safely. As far as the arachnoid membrane is well-defined between the tumor and the cord, most intradural extramedullary tumors located ventrally can be removed safely from the posterolateral angle3. Thus, those cases that require complex and invasive approaches will be relatively rare. We believe that our approach provides a well-balanced solution with its good exposure combined with simple, familiar, and less-invasive techniques for most ventrally located tumors.

One may be concerned that our approach damages the ipsilateral paraspinal muscles resulting in short-term or long-term complications. Our experience did not support this concern, and none of our patients had a stability problem or outstanding complaints related to paraspinal muscles. Our survey on postoperative pain suggested that our approach caused less postoperative pain than the standard technique. Thus, we believe that our technique has more advantages: less invasiveness of a short-segment unilateral approach, a wider lateral viewing angle, and familiar anatomy, compared to its minor disadvantage: the limited damage to the multifidus muscle.

Our approach can be applied not only to spinal tumors but also to other pathologies. It was beneficial for bilateral removal of OLF through a unilateral laminotomy. Surgery on OLF is associated with a relatively high complication rate[16], and the unilateral approach, albeit its better preservation of stability, poses a further technical challenge[17]. For this problem, our approach was quite valuable.

There are some shortcomings of this study. It is a retrospective observational study at a single center without a comparative group, and the responsible pathology is inhomogeneous. The outcome measurement was surgeon-oriented. A detailed MRI analysis of the postoperative paraspinal muscle will be necessary for the future.

# Conclusions

We described a simple, less-invasive unilateral approach to spinal lesions with a wide lateral viewing angle. This approach can be a valuable addition to the spine surgeon's armamentarium.

# Declarations

### Data Availability

All data generated or analysed during this study are included in this published article.

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# Figures

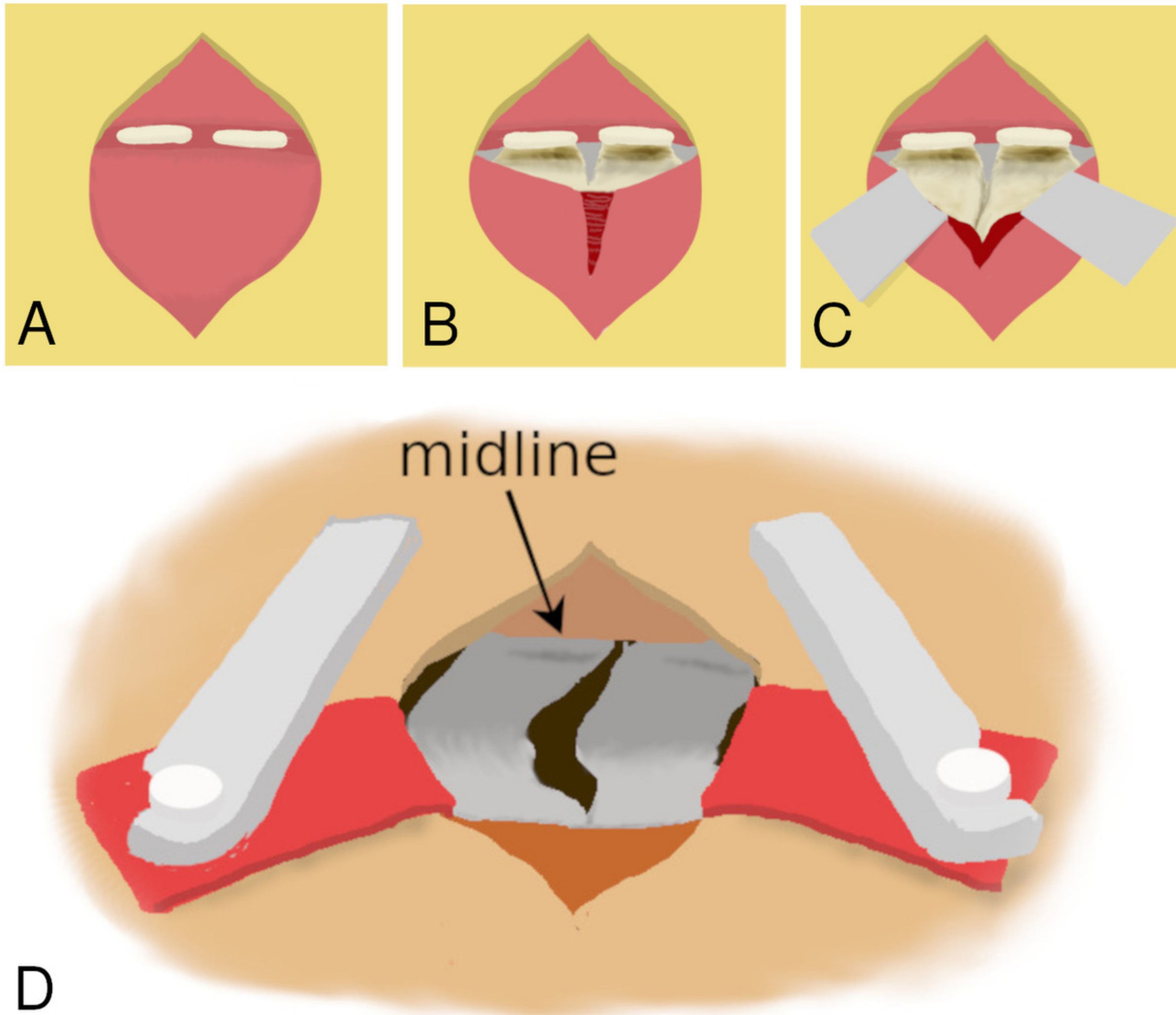



**Figure 1**

Schemes to show the operative technique. A: We make a horizontal skin incision crossing the midline over the appropriate level. B: We make a horizontal incision on the dorsal fascia after unilateral dissection of the spinous processes. C: We expose the unilateral laminae after incising the medial portion of the multifidus muscle. D: We hold the paraspinal muscles with a pair of retractors placed longitudinally, thus obtaining a wide surgical field with an excellent lateral viewing angle.

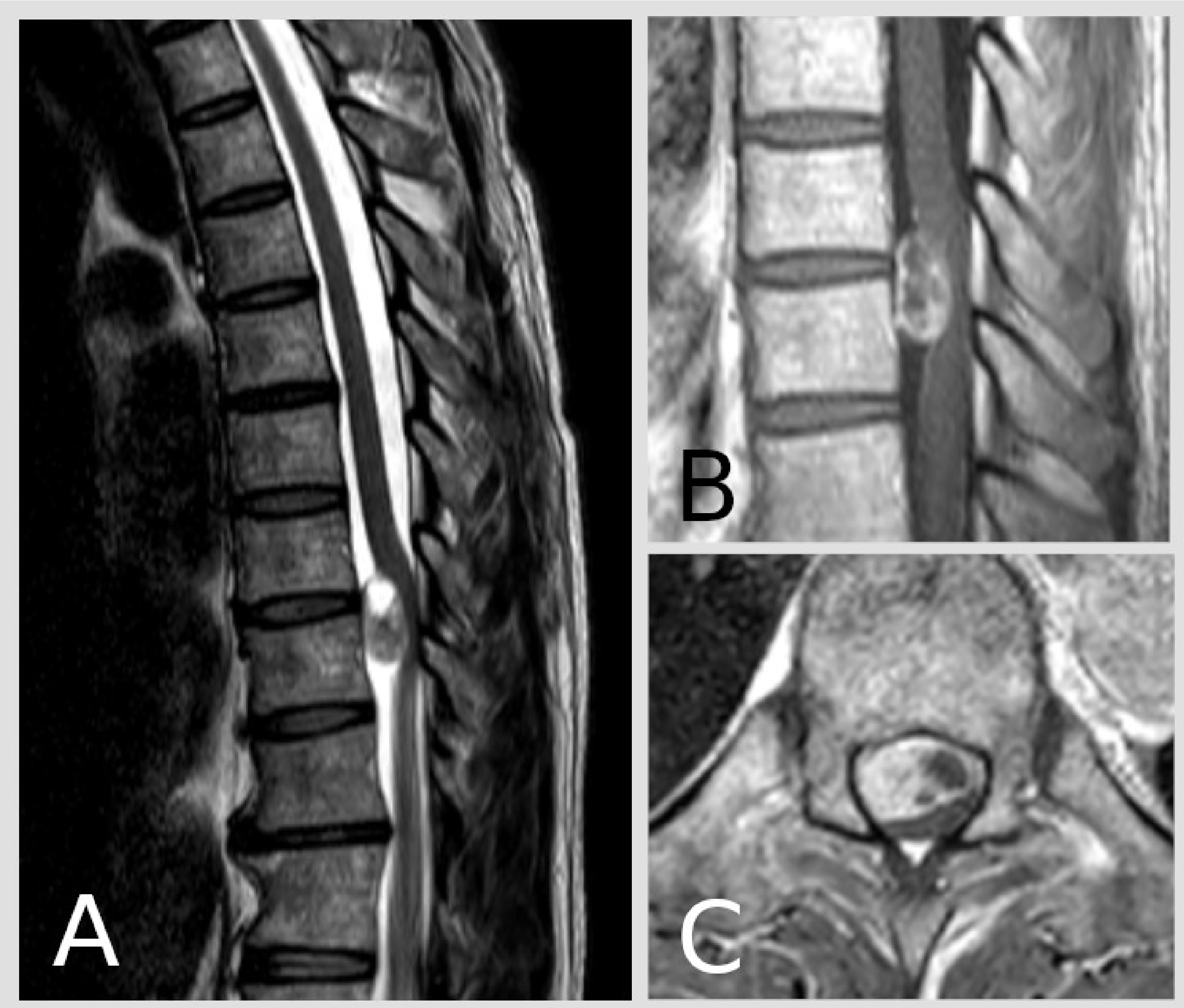



**Figure 2**

Preoperative MRI of Case 24. A: A T2-weighted sagittal image showing a round, well-demarcated mass at the level of T10. B: A T1-weighted sagittal image after gadolinium administration, and the mass is inhomogeneously enhanced. C: A T1-weighted axial image showing the mass located on the ventral side of the spinal cord, which is severely compressed dorsally.

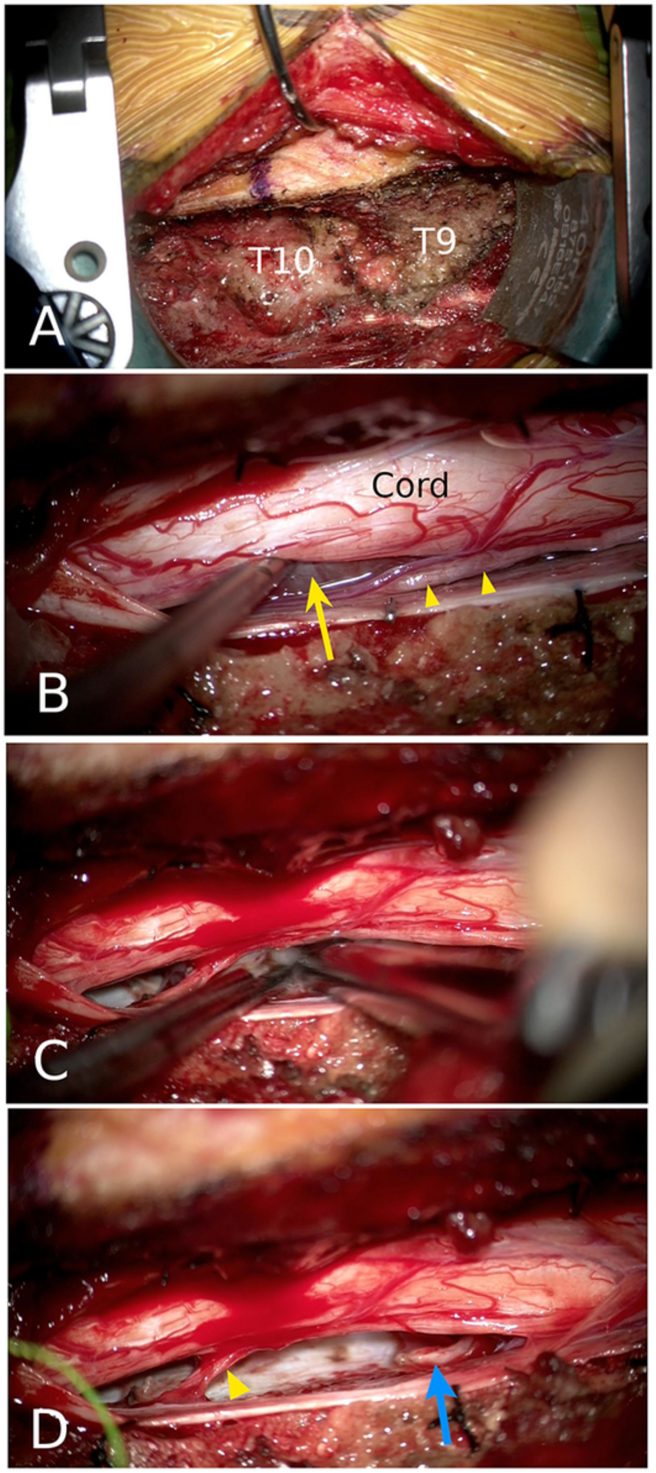
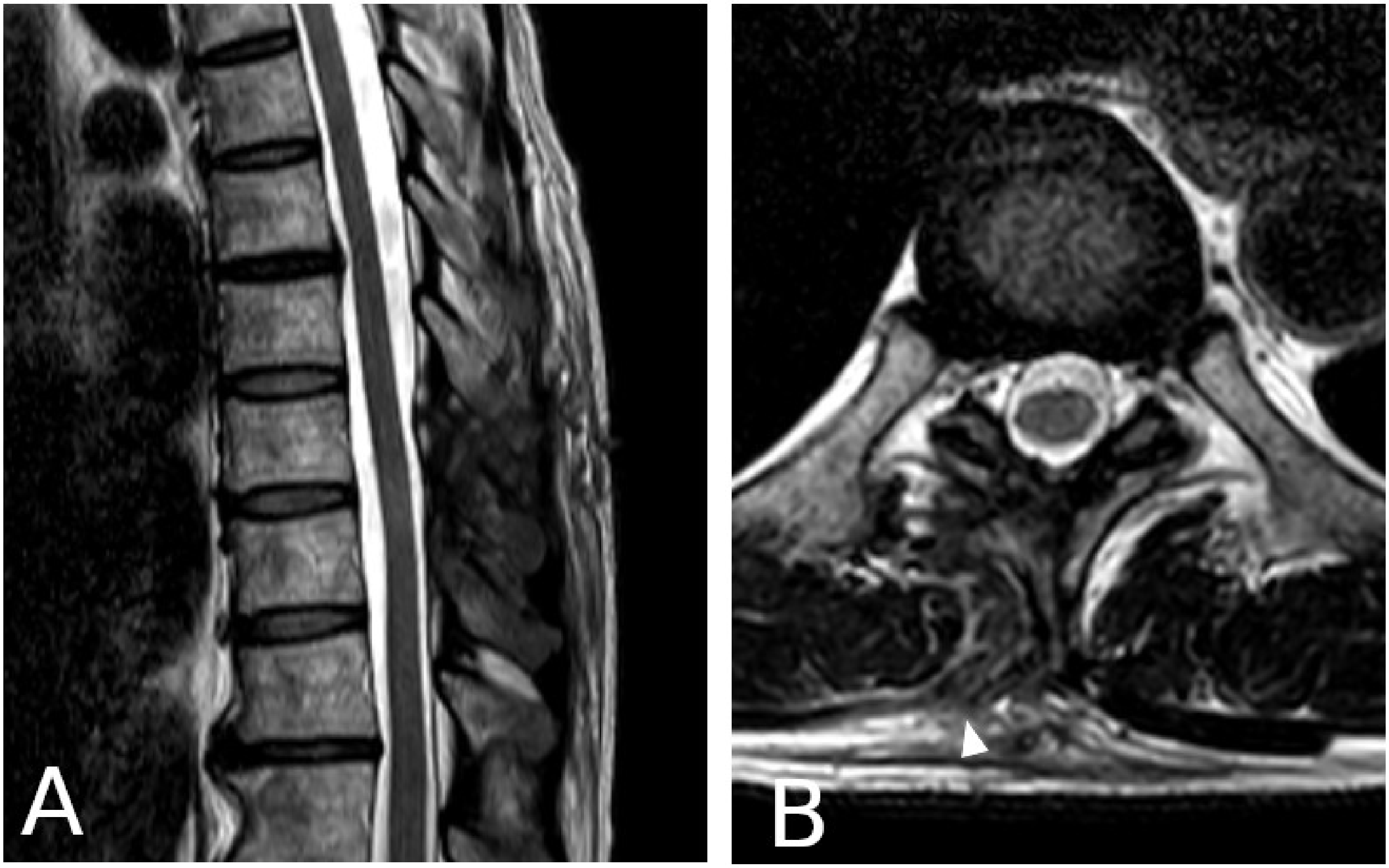



**Figure 3**

Operative images of Case 24. A: Exposure of the right T9 and T10 laminae. B: Exposure of the tumor on the ventral side of the cord. Arrow: tumor, arrowheads: right T10 posterior root, C: Internal decompression of the tumor with an ultrasonic aspirator. D: After removal of the tumor. Arrowhead: right T10 posterior root. Blue arrow: Right T10 motor root (tumor origin)




#### Figure 4

Postoperative MRI of Case 24. A: T2-weighted sagittal image. B: T2-weighted axial image one month after surgery shows gross total removal. Note the minimal damage to the paraspinal muscles (arrowhead).

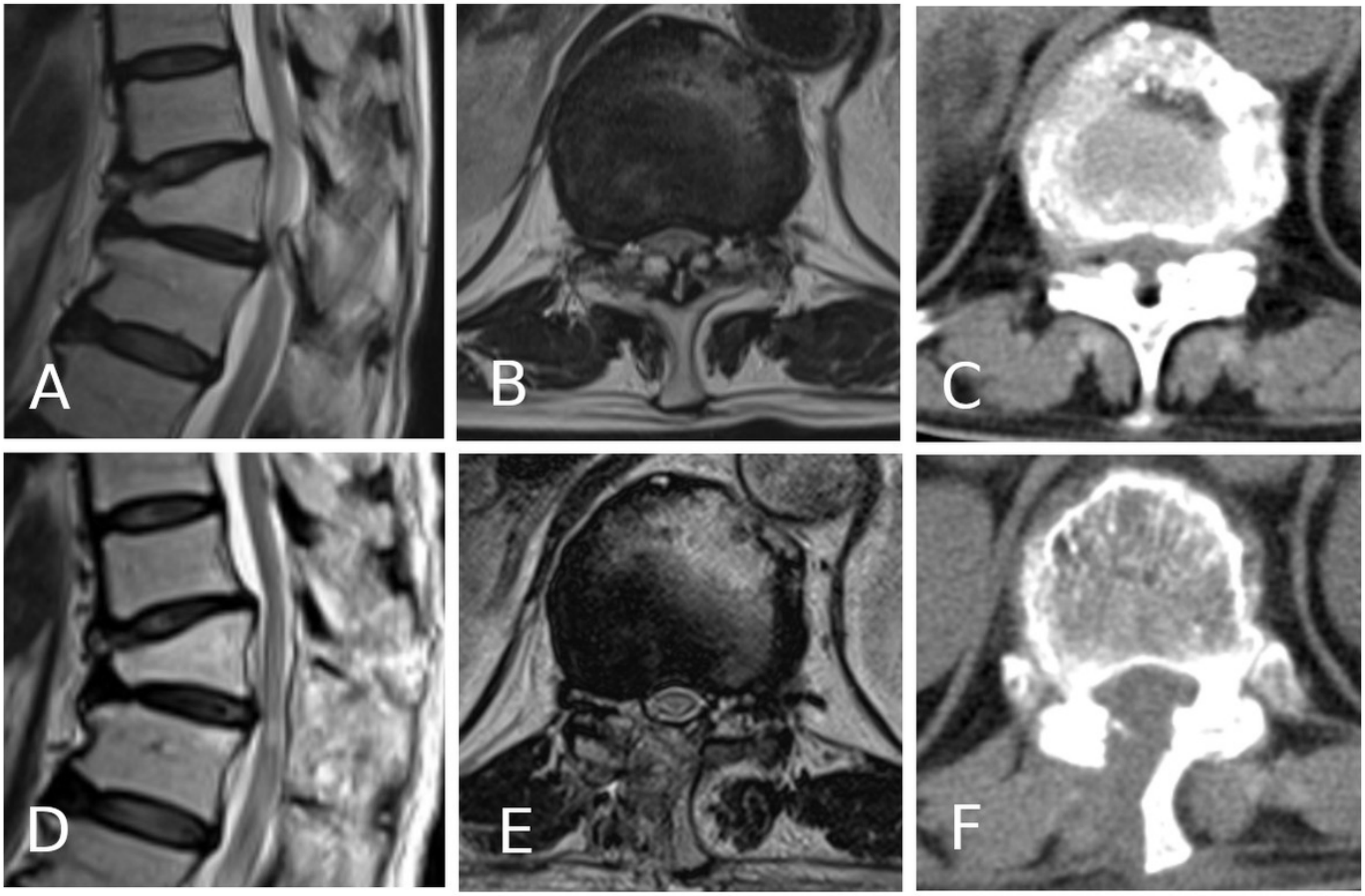



**Figure 5**

Pre- and postoperative images of Case 19. The upper row shows the preoperative, and the lower row shows the postoperative images. A: A sagittal T2-weighted MRI showed cord compression at T10/11. B: An axial T2-weighted MRI showing the cord compression. C. An axial CT showing bilateral ossification of the ligamentum flavum (OLF). D. Postoperative sagittal MRI showing good decompression. E. postoperative axial MRI showing good decompression. F. postoperative CT showing good removal of the bilateral OLF.

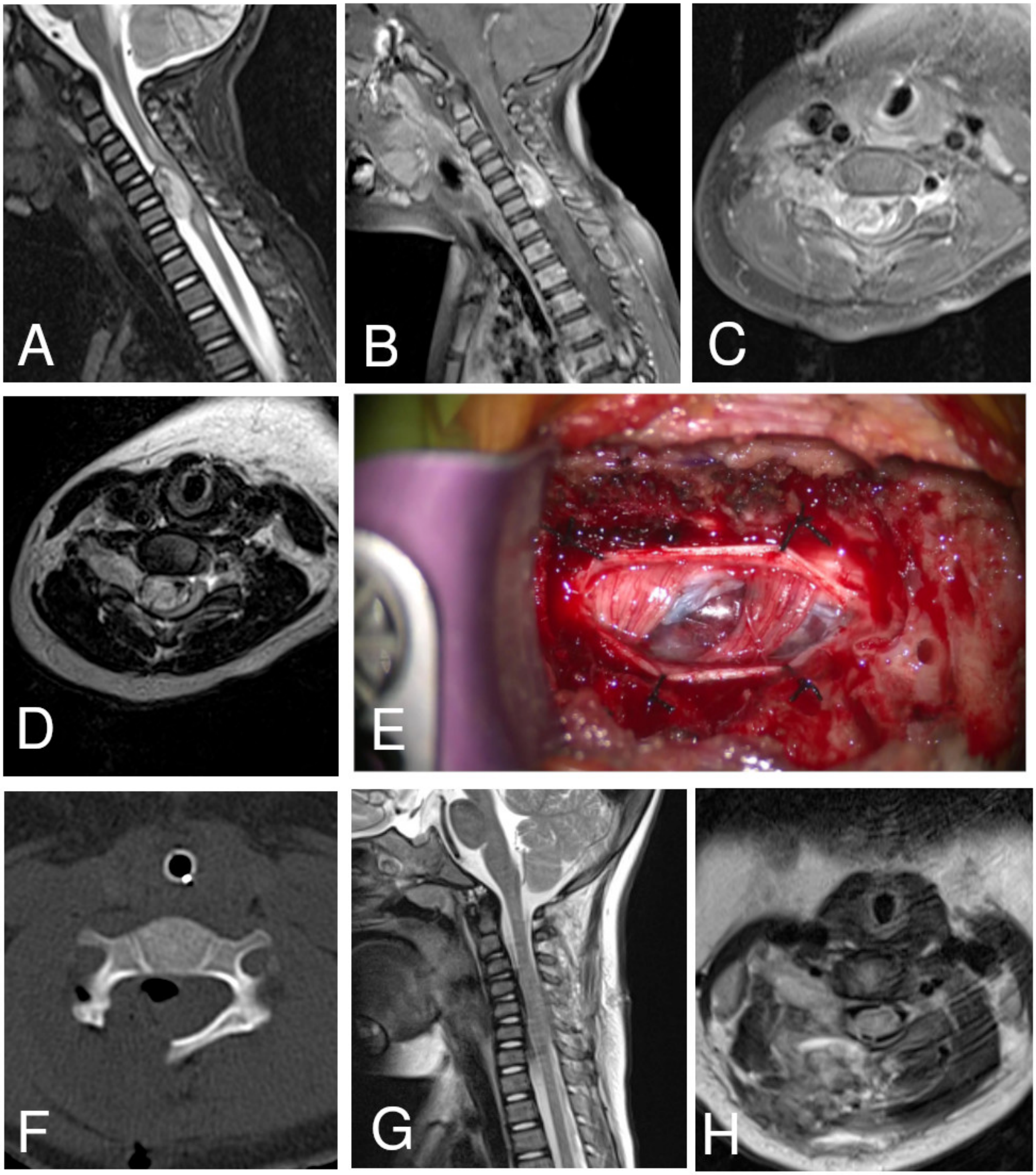



**Figure 6**

Images of Case 4. A. Preoperative sagittal T2-weighted MRI showing a tumor compressing the cord from the ventral side. B. Preoperative sagittal T1-weighted MRI after gadolinium administration. C. Preoperative axial T1-weighted MRI after gadolinium administration shows the tumor's expansion into the intervertebral foramen. D. Preoperative axial T2-weighted image showing the severe cord compression from the ventral side. E. An intraoperative image after dural opening. The tumor is seen beyond the posterior roots. F. Postoperative axial CT showing the unilateral laminotomy. G. Postoperative sagittal T2-weighted MRI shows good tumor removal inside the canal. H. Postoperative axial T1-weighted image after gadolinium administration.

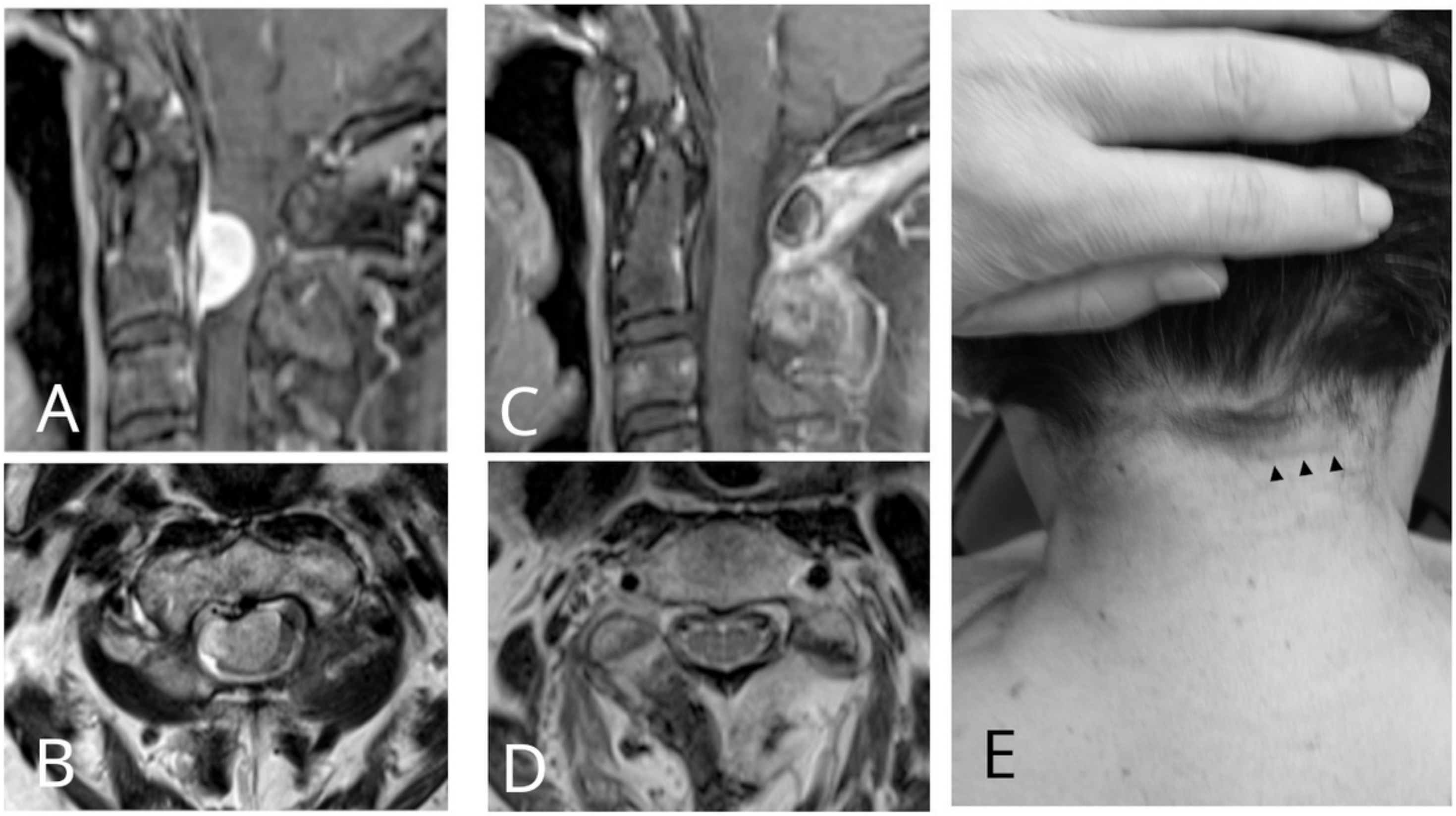



**Figure 7**

A. Preoperative T1-weighted MRI after gadolinium enhancement (sagittal view) showing a ventral mass at C2. B. Preoperative T2-weighted MRI (axial view). C. Postoperative T1-weighted MRI after gadolunium enhancement (sagittal view). D. Postoperative T2-weighted MRI (axial view). E. Surgical wound one year after surgery (arrowheads) showing no muscular atrophy.