7 How to Approach Anatomical Compartment; Extradural Foraminal Tumor

Jun Ho Lee and Chun Kee Chung

Abstract

Spinal extradural foraminal neoplasms are uncommon lesions that are constricted at the point they penetrate the intervertebral foramina or dura mater. Because of their varied locations, extradural foraminal neoplasms have features, clinical symptoms, and pathological characteristics that are unique compared with the more common intradural extramedullary (IDEM) tumors, consequently, their surgical approach and treatment should be also differentiated. Surgically, extradural extension into the foramen necessitates a more or less important resection of the facet joints. This raises the question of spinal stability and the need for additional fixation. However, recent progression of anatomy-preserving minimally invasive surgical techniques along with the concomitant evolution of their tools allows for excellent exposure while limiting damage to surrounding tissues through a minimized surgical corridor or modified approach method, followed by safe and completed resection of these extradural foraminal neoplasms.

Keywords

Extradural tumor · Intervertebral foramen · Minimally invasive approach · Laminectomy · Facetectomy

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7.1 Introduction

As defined by Heuer [1], spinal extradural foraminal neoplasms are uncommon lesions that are constricted at the point they penetrate the intervertebral foramina or dura mater and assume an hourglass (dumbbell) shape. Currently, the term 'dumbbell tumors' does not refer to the hourglass shape but is used as a conceptual term meaning separate tumors that connect and have two or more separate regions such as intradural space, epidural space, and locations outside the paravertebral space [2, 3].

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Because of their varied locations, extradural foraminal neoplasms have features, clinical symptoms, and pathological characteristics that are unique compared with the more common intradural extramedullary (IDEM) tumors, consequently, their surgical approach and treatment should be also differentiated. These lesions are traditionally resected via an open laminectomy and facetectomy approach and in cases requiring complete facetectomy (e.g., a nerve sheath tumor extending both medial and lateral to the facet joint), prior reports have rather recommended concomitant fusion for stabilization [4, 5]. However, recently, the use of mini-open surgical technique for the resection of these extradural spinal foraminal neoplasms that extend through the foramen and lateral to the facet have been reported [6]. In this chapter, the author describes about the features, surgical approaches, and their preceded considerations for these 'extradural-foraminal' tumors.

7.2 Classification and Epidemiology

In 2007, Ozawa et al. have featured and classified these 118 spinal extradural foraminal neoplasms from their 674 spinal cord tumors that were encountered at the Tohoku University School of Medicine during the period between 1988 and 2002 [5]. The pathological diagnoses included 81 schwannomas (69%), 14 neurofibromas (12%), nine neuroblastomas/ganglioneuromas (8%), six meningiomas (5%), and two hemangiomas (2%). Six tumors (5%) were of miscellaneous diagnoses, including an angiolipoma, a paraganglioma, a malignant peripheral nerve sheath tumor, a malignant lymphoma, a melanoma, and a rhabdomyosarcoma.

Neurogenic tumors consisting of schwannomas and neurofibromas accounted for 80% of the dumbbell tumors [5, 7]. Malignant tumors were found in 10 cases (8.5%). These malignant dumbbell tumors accounted for 64% of cases in pediatric patients and 2.8% in adult patients.

While the usual IDEM tumors appeared more commonly in the thoracic and lumbar spine than the cervical spine, these extradural foraminal neoplasms had more prevalence in the cervical spine (44%), followed by the thoracic spine (27%), and the lumbar spine (21%) [8–10]. Fifteen (18%) of 81 schwannomas were observed in the C-2 nerve root, thus having a higher rate than those in the other nerve roots [9, 11–13]. According to Eden classification [14], 9% of tumors were classified as Type 1, 33% as Type 2, 53% as Type 3, and 5% as Type 4 (Fig. 7.1). The tumors classified as Type 3 were most frequent. In the cervical spine, Type 2 was most frequent; however, in the thoracic spine, Type 3 was most frequent. In the schwannomas, Eden Type 3 accounted for 48% and was most frequent. In the neurofibromas, Type 2 accounted for 52% of the lesions. All neuroblastomas and anglioneuromas were Type 3. In the meningiomas, there were two Type 2 tumors and two Type 3 tumors. The Type 3

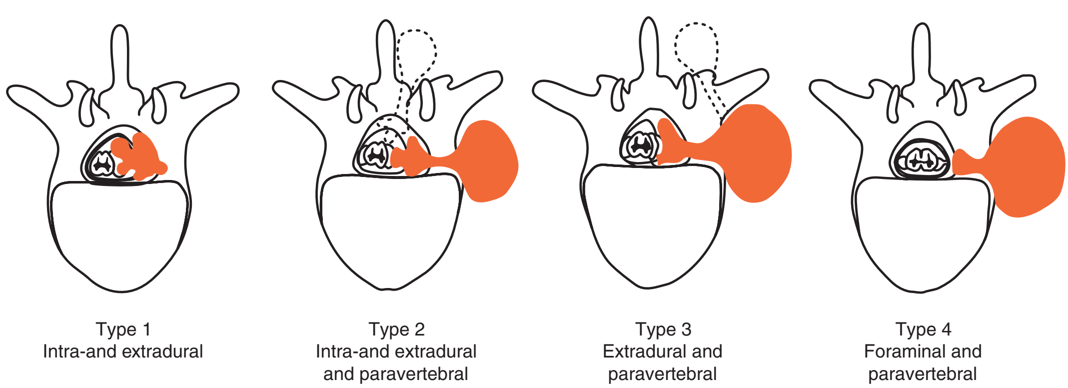

Fig. 7.1 A diagram of Eden's classification for dumb-bell shaped tumors of the spine

meningiomas had been recurrent at the epidural space and paravertebral region after excision of the intradural tumors.

7.3 Diagnosis

Pain is the most common presenting symptom being either local (50%) or radicular (30%). Very rarely patients present with symptoms due to raised intracranial pressure associated with papilledema [15] or hydrocephalus [16, 17]. At the time of diagnosis, motor deficit is rare and usually moderate including 30% and 15% of radicular and medullary deficits, respectively [9, 11]. Sphincter disturbances are exceptionally observed.

MRI is the best imaging tool as it offers all the relevant information for diagnosis, localization, and surgical strategy. It permits to define any type of extension (intradural, extradural, foraminal, and extraspinal). It shows very well the cystic and hemorrhagic forms [18]. Conversely, it is generally difficult to differentiate schwannomas from solitary neurofibromas. MRI is also quite sufficient to demonstrate the relationship between the schwannoma and the vertebral artery (VA). In case of foraminal extension, the VA is most of the important to evaluate the size of both VAs.

A computerized tomography (CT) scan may still be useful to appreciate the bony erosion in foraminal and extraspinal types. It varies from a limited widening of the intervertebral foramen to a large defect in one or several vertebral bodies and/or facet joints.

7.4 Strategy of Surgical Treatment

7.4.1 Conventional Midline Access

In the vast majority of neoplasms with an intradural location, there is a common agreement to use the midline posterior approach through a single- or two-level laminectomy, hemilaminectomy, or laminoplasty [19], followed with a vertical paramedian incision of the dura, curved laterally at both extremities and an en bloc excision can be achieved after a limited number of rootlets (one or two) that give origin to the schwannoma are separated from the others and sacrificed (Fig. 7.2).

In case of concomitant extra- and intradural components (dumbbell form), some modifications must be added;

- The laminectomy is extended laterally toward the facets [20].
- A dural contraincision perpendicular to the paramedian incision directed to the foramen is performed. The dura always adheres to the tumor capsule and has to be cut around the tumor at the level of intra-/extradural communication. This might result in an unrepairable dural defect, which needs to be closed with a patch after tumor removal.
- The extradural component is resected until the distal root is reached. It may be necessary to resect some more bone toward the neural foramen (medial aspect of the facet joint).

This hemilaminectomy combined with the medial partial facetectomy had a great advantage for excising the dumbbell tumor. Because most tumors were located unilaterally in the spinal canal and paravertebral space, the tumors could be excised easily from the posterolateral enough large space provided by the hemilaminectomy and facetectomy. In addition, the spinal stability can be reconstructed or augmented easily by either wiring or contralateral facet fusion, because the hemilaminectomy and facetectomy can minimize damage to spinal stability by preserving the spinous process, supra- and intraspinous ligaments, and contralateral facet joint.

7.4.2 Modification for Dominantly Extradural and Foraminal Component

The above-mentioned posterior approach with facetectomy [3, 21] might necessitate an additional fixation procedure and sometimes a complementary anterior or lateral approach if the extraspinal component is large. Lu et al. have demonstrated a mini-open treatment of

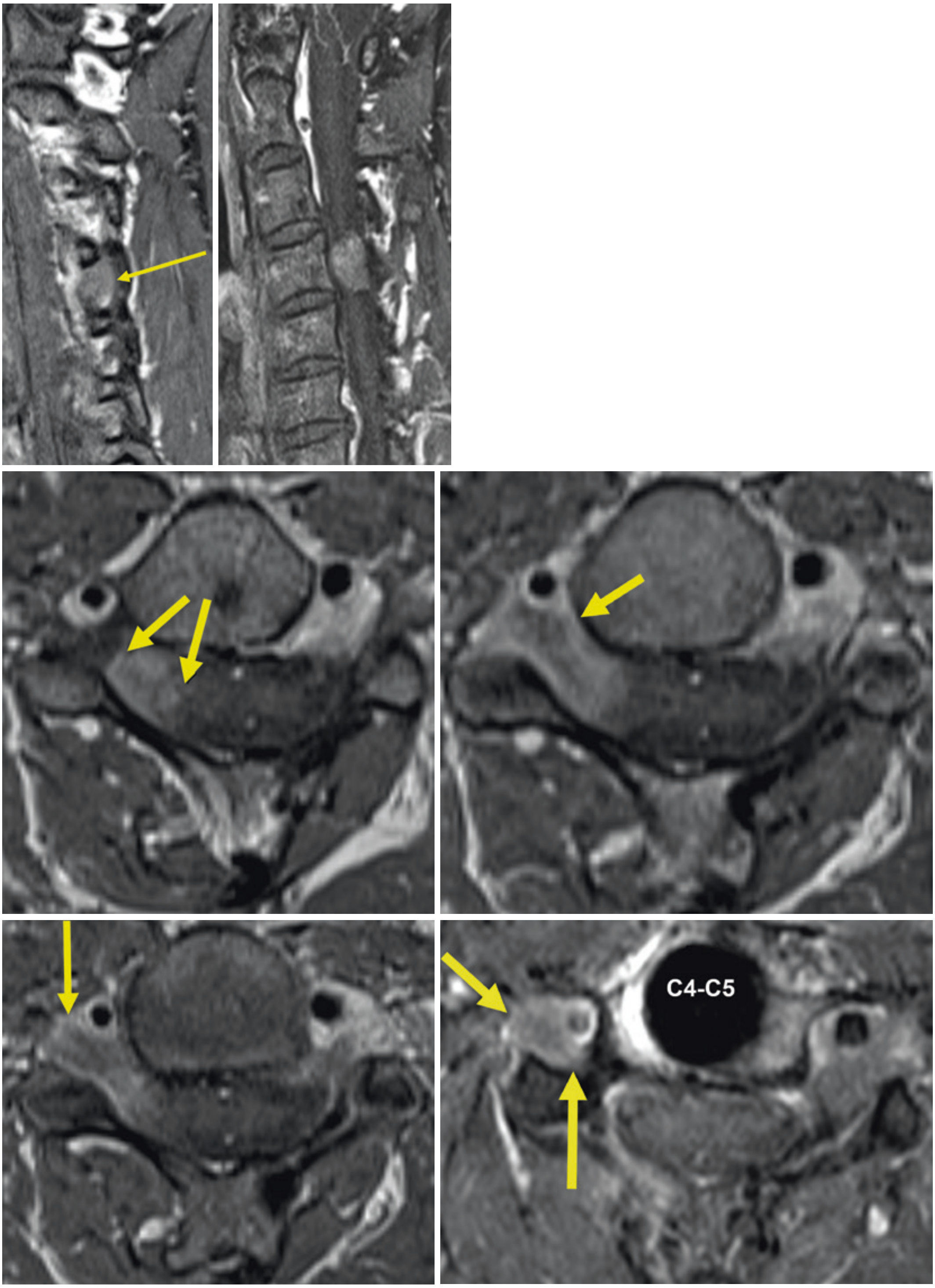

Fig. 7.2 An illustrative case of 40-year-old male with neurofibroma existing at intradural—extramedullary portion of the right side inside of the spinal canal at the C4-5 level, with extension to neural foramen as well as to the dorsal aspect of vertebral artery (VA) and its groove. Ipsilateral hemilaminectomy—medial partial facetectomy through a paramedian surgical access directed to the foramen was performed to evacuate the compacted lesion. Despite a considerable elaboration to remove the whole portion of the neurofibroma, still a remnant portion of the tumor at the most lateral portion inside the VA groove could be noted

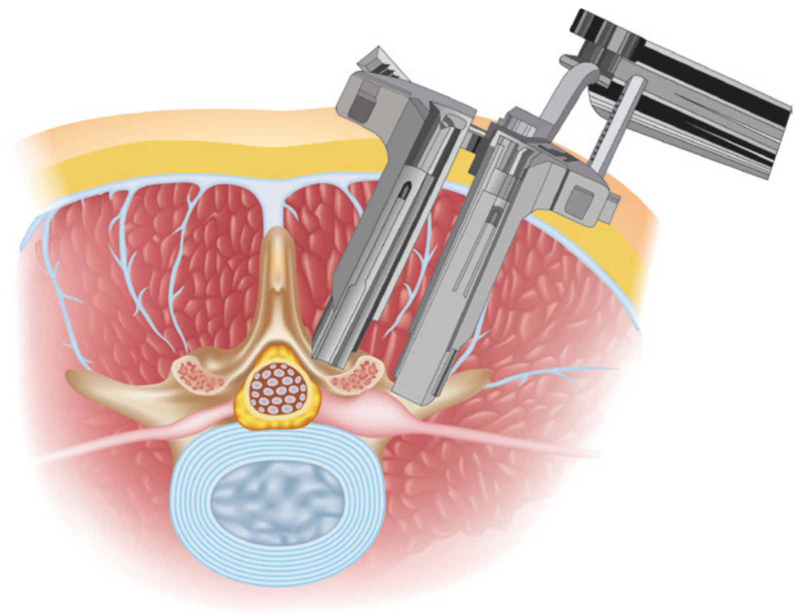

Fig. 7.3 Illustration of a foraminal nerve sheath tumor being removed through a mini-open approach with an expandable tubular retractor. (courtesy from Lu D et al. J Neurosurg Spine 2009)

extradural spinal nerve sheath tumors that extend through the intervertebral foramen and lateral to the facet that it is performed through the Wiltse's plane, approximately 3–4 cm lateral to the conventional midline access (Fig. 7.3). They found that, especially for foraminal lumbar nerve sheath tumors, this mini-open approach is feasible with acceptable amount of blood loss and operative time. Additionally, this can be applied for reoperative cases who harbor such foraminal tumors but had undergone prior midline surgery.

The advantage is that, since it is performed in the Wiltse plane, lateral to the scar tissue from the prior operation, this de novo approach through a relatively virgin tissue plane reduces the time for untoward dissecting scar tissue from the dura in patients who have undergone prior laminectomies. Furthermore, this lateral approach allows for same surgical route for concomitant pedicle screw placement and posterolateral fusion.

However, especially at the cervical level, it does not permit a proper visualization of the important vital structures and control of the vertebral artery (VA), which may be hazardous. In the case of huge extension to outside of foramen, the posterior approach might be adjunct with an concomitant anterior approach [2, 3]. George et al. have proposed as the other option is to use the anterolateral approach which, in their experience, is more advisable since any component from extraspinal to intradural can be resected with a perfect control of the VA and no need for additional fixation (Fig. 7.4) [12, 13, 22, 23]. Their suggested surgical steps would be;

- The skin incision is vertical along the medial border of the sternocleidomastoid (SM) muscle at the corresponding level and extended over 6–7 cm.
- The field is opened by first exposing the medial aspect of the sternocleidomastoid muscle (SM), which is then retracted laterally until the internal jugular vein (IJV) is reached. The lateral aspect of the IJV is separated from the SM and retracted medially. The retractors are progressively moved down into the field. In contrast to a classical anterior cervical approach, all the

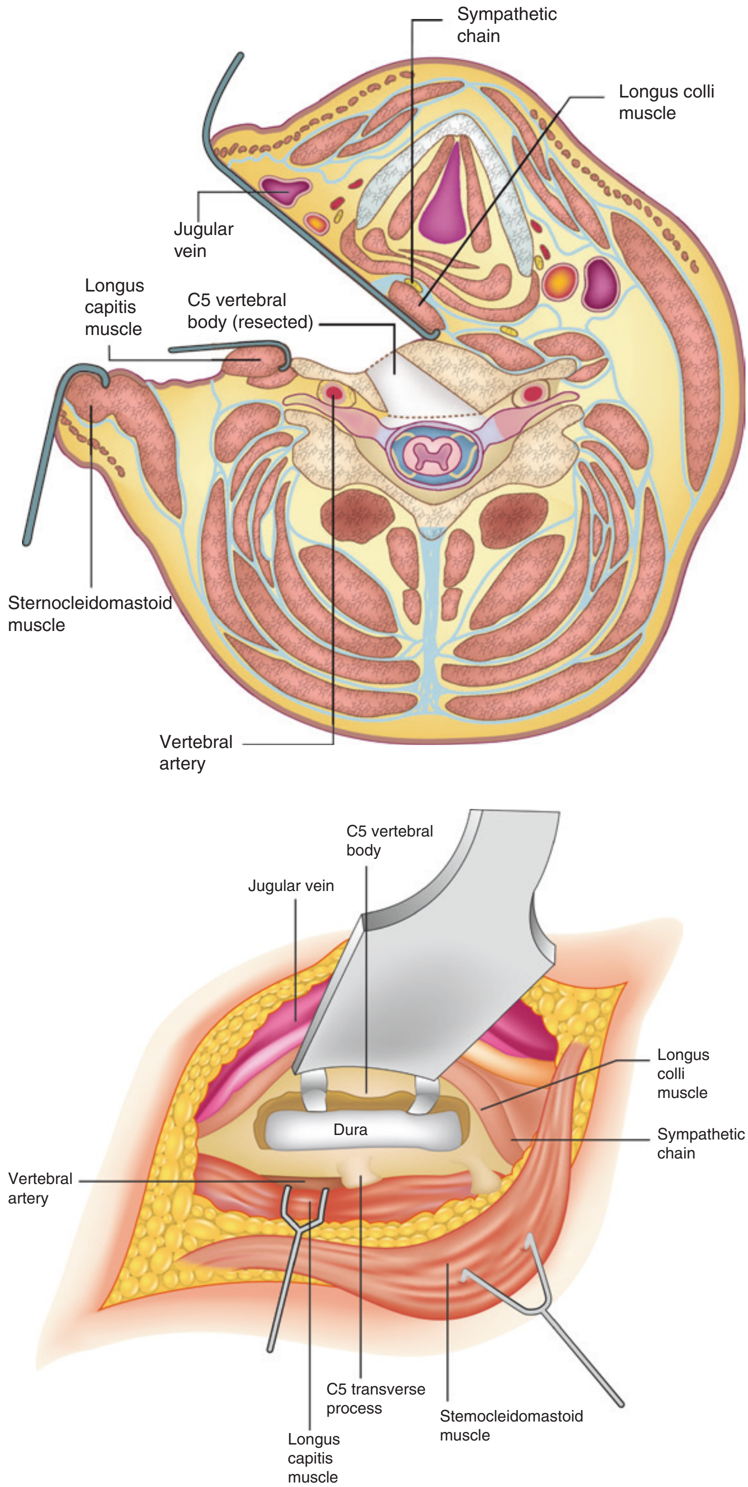

Fig. 7.4 Illustration showing the dissection plane. The neurovascular package is retracted medially and the cervical spine is reached anterolaterally. (courtesy from Kiris T et al. Neurosurgery 2008)

vasculo-nervous elements are kept undissected in their sheath and retracted medially together with the trachea and esophagus using a malleable blade.

- The anterolateral aspect of the vertebral bodies becomes apparent. In the depth of the field, there is a fatty and lymphatic sheath, which is retracted medially to expose the prevertebral muscles (longus colli and longus capitis).
- The sympathetic trunk running over these muscles is retracted medially. This trunk is in close relationship with the fascia. As such, it is safe to dissect the fascia away from the underlying muscles and retract medially along with the trunk [24].
- The longus colli muscle is retracted medially above the transverse processes and then longitudinally along the vertebral bodies so that the transverse processes come onto view with the tumor in between the two of them [24].
- The VA is controlled above and below the tumor after resection of the transverse processes.
- The far lateral retraction of the longus capitis muscle permits the exposure laterally of the distal root. The nonfunctional, distal root is cut after coagulation and the tumor can then be debulked progressing from lateral to medial, underneath the VA.
- Then the VA is mobilized laterally and the tumor remnants, medial to it, are removed.
- Sometimes a little amount of the bone on the posterolateral aspect of the vertebral bodies needs to be drilled away; this realizes an enlargement of the intervertebral foramen whenever it has not been sufficiently done by the tumor itself.
- After having resected the extradural part of the tumor, the dura is cut around the tumor where it goes intradurally. The intradural component can then be pulled out and removed progressively until the proximal root becomes visible.
- The root is cut and the last intradural piece of tumor is removed.
- The dural defect is covered using artificial dural or can be packed with a piece of fat taken from the fatty sheath, and onlayed with fibrin glue [25].

7.5 Potential Complications

Extradural extension into the foramen necessitates a more or less important resection of the facet joints. This raises the question of spinal stability and the need of additional fixation.

The extraspinal extension of those tumors, displacing the VA, can better be resected with adequate exposure of the VA using the anterolateral approach. The VA must be controlled above and below so that any injury can be easily repaired. In this view, evaluation of the size of the VA on preoperative MRI is essential.

There is a potential complication, related to the injury of a radiculomedullary artery arising at the tumoral level, without supply of the medulla by a collateral network, causing medullary ischemia.

Horner’s syndrome due to damage of the sympathetic trunk (during the anterolateral approach) may be transiently observed after excessive manipulations but should recover, except if the sympathetic trunk has been cut.

7.6 Conclusion

Spinal extradural neoplasms that traverse the intervertebral foramen can be safely resected using a minimized surgical corridor or approach modification, which allows for excellent exposure while limiting damage to surrounding tissues. In order to accomplish this task without subsequent untoward complication incurrence, capability to convert the two-dimensional preoperative imaging information into 3D anatomical interpretation would be essential.

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