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Original

Application of the Y-method for Two Cases of Intradural Tumor in the Lumbar Region

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Abstract : We excised intradural tumors in the lumbar region by en bloc laminectomy using the Y-method. Incisions were made in the dura mater and arachnoid membrane using a T-saw to expose the surgical field. The laminectomy involved repositioning of the resected vertebral arches into their original positions and performing suture fixation with absorbable sutures. Bone fusion was achieved in the vertebral arch and spinous process, with posterior elements of the lumbar vertebra successfully preserved. The first case was a schwannoma and the second was a relatively rare epidermoid cyst.

Key words : epidermoid cyst, spinal cord tumor, Y-method

Introduction

A partial laminectomy, laminectomy, or hemilaminectomy may be necessary to excise an intradural tumor in the lumbar region depending on the tumor level. However, safety can be an issue during a partial laminectomy because of the narrow surgical field, and, in young patients, there is a risk of future intervertebral instability with a laminectomy. In addition, the narrow surgical field necessitates placement diagonal microscope in a hemilaminectomy. In this study, we describe two cases in which intradural tumors in the lumbar region were safely excised by exposing the surgical field and using a mini-incision with the Y-method[1)], a procedure for posterior decompression of lumbar spinal canal stenosis. The first case was a schwannoma removed by partial laminectomy. The second case was an epidermoid cyst removed by a laminectomy procedure in which the excised vertebral arch was reattached at its original position by suture fixation following tumorectomy. The total bone union, achieved postoperatively with the vertebral arch and spinous process, preserved the posterior elements of the lumbar vertebra. For the second case, we also review this relatively rare tumor based on the literature.

Cases and methods

Case 1 : A 39-year-old woman

Chief complaints : Pain and numbness from the left buttock to the facies posterior cruris.

History of present illness : The patient's chief complaints manifested in May 2007 ; however,

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Fig. 1. Myelography (case 1): The contrast medium was cupped.

she first saw a physician in July. Physiotherapy did not result in any improvement, and the patient was referred to our hospital for magnetic resonance imaging (MRI), which revealed a cauda equina tumor.

Medical history: Unremarkable.

Family history: Unremarkable.

Condition at admission: The patient exhibited a decreased deep tendon reflex in both lower extremities and frequent urination caused by bladder and rectal disturbance. Neither lower extremity muscle weakness nor sensory disturbance was observed, and no dermal abnormalities were noted.

Blood and biochemical testing: No abnormal findings.

Imaging findings: Radiography revealed no narrowing of the disc space, widening of the interpedicular space, or erosion of vertebral bodies, and no combined malformations such as rachischisis were found.

Myelographic findings: Well-defined cupping was observed at the L4/5 interlaminar level (Fig. 1).

MRI findings: Isointensity on T1-weighted imaging and hypointensity on T2-weighted imaging were observed mixed with some hyperintensity in the interior. The tumor showed a marked gadolinium-diethylenetriamine pentaacetic acid (Gd-DTPA) contrast effect (Fig. 2).

Operative findings: Exposure of the surgical field was performed using the Y-method with a 4-cm skin incision and segmentectomy of the L4 and L5 vertebral arches. The dura mater and arachnoid membrane were longitudinally cut, and a tumor covered by a 10 × 10 × 5-mm capsule was excised. The tumor, which originated in the S1 nerve rootlet, was carefully excised. The dura mater was sutured, and the split spinous process was firmly suture-fixated with absorbable sutures bilaterally and at the root.

Pathological diagnosis: Schwannoma

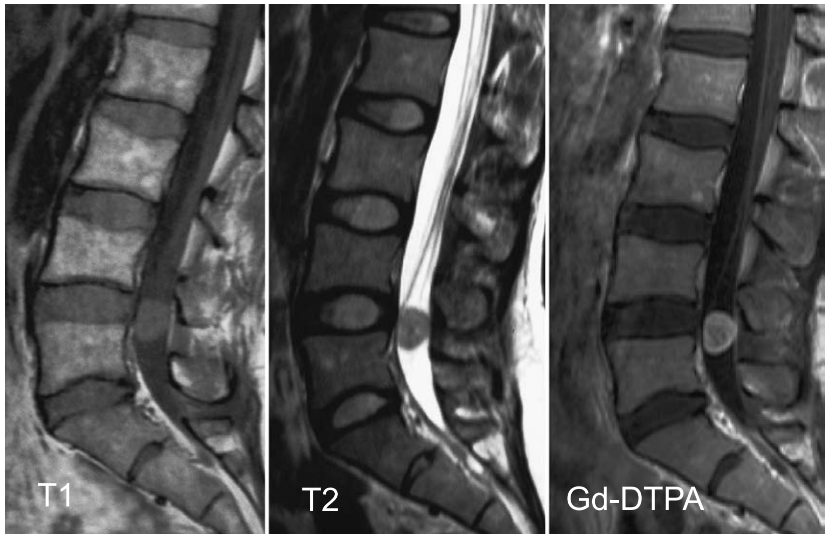


Fig. 2. Magnetic resonance imaging (MRI): Representative isointensity on T1-weighted imaging, hypointensity on T2-weighted imaging, and some hyperintensity in the interior, with a marked contrast effect.

Fig. 3. Computed tomography (CT) scan (3 months postoperatively): Bone union was evident in the osteotomy section.

Postoperative course: The patient experienced no postoperative discomfort despite wearing a simple corset for 2 weeks. Pain and numbness in the lower extremities vanished 3 months postoperatively, and the patient no longer experienced frequent urination. Computed tomography (CT) revealed bone union in the split spinous process (Fig. 3).

Case 2: A 29-year-old woman

Chief complaints: Pain in the coccygeal region, dull pain from the left buttock to the posterior surface of the thigh, and pain and numbness in the lateral lower extremities.

History of present illness: The patient sustained a coccygeal fracture by falling from a

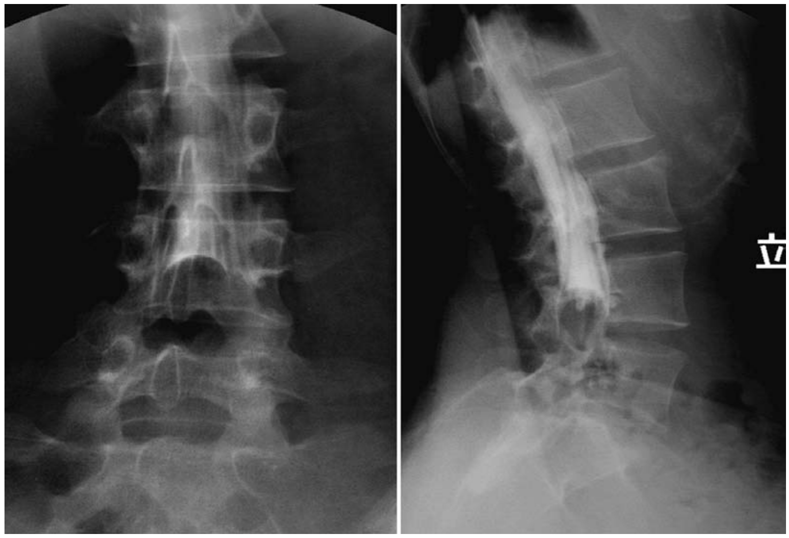


Fig. 4. Myelography (case 2): The contrast medium was cupped.

snowboard in March 2005. Anti-inflammatory drugs prescribed by a local physician improved the symptoms that manifested in January 2006. However, the symptoms subsequently reappeared and then again disappeared. The patient was referred to our hospital in September 2006 for MRI investigation due to worsening pain in the coccygeal region in August 2006, and a cauda equina tumor was revealed.

Medical history: Unremarkable.

Family history: Unremarkable.

Condition at admission: Manual muscle testing of the left extensor hallucis longus muscle revealed a decreased score of 4. Neither sensory disturbance nor bladder or rectal disturbance was observed, and the deep tendon reflex was normal. No dermal abnormalities were found.

Blood and biochemical testing: No abnormal findings.

Imaging findings: Radiography identified no narrowing of the disc space, widening of the interpedicular space, or erosion of vertebral bodies, and there were no combined malformations such as rachischisis.

Myelographic findings: Well-defined cupping was observed at the inferior border of the L4 vertebral body (Fig. 4).

MRI findings: Mixed hypointensity on T1-weighted imaging with some hyperintensity in the interior, and isointensity on T2-weighted imaging was observed, with a well-defined tumor exhibiting almost no Gd-DTPA contrast effect (Fig. 5).

Operative findings: The surgical field was exposed by splitting the L3 and L4 spinous process with a 5-cm skin incision as per the Y-method. The tumor was located in a position ventral to the L4 vertebral arch, which was consequently cut bilaterally en bloc into a funnel shape at the medial part of the facet joint using a T-saw. The dura mater and arachnoid membrane were cut with a microscope positioned directly above the surgical field, to reveal a 15 × 15 × 17-mm encapsulated tumor located ventral to the cauda equina and adhering to the cauda equine. We

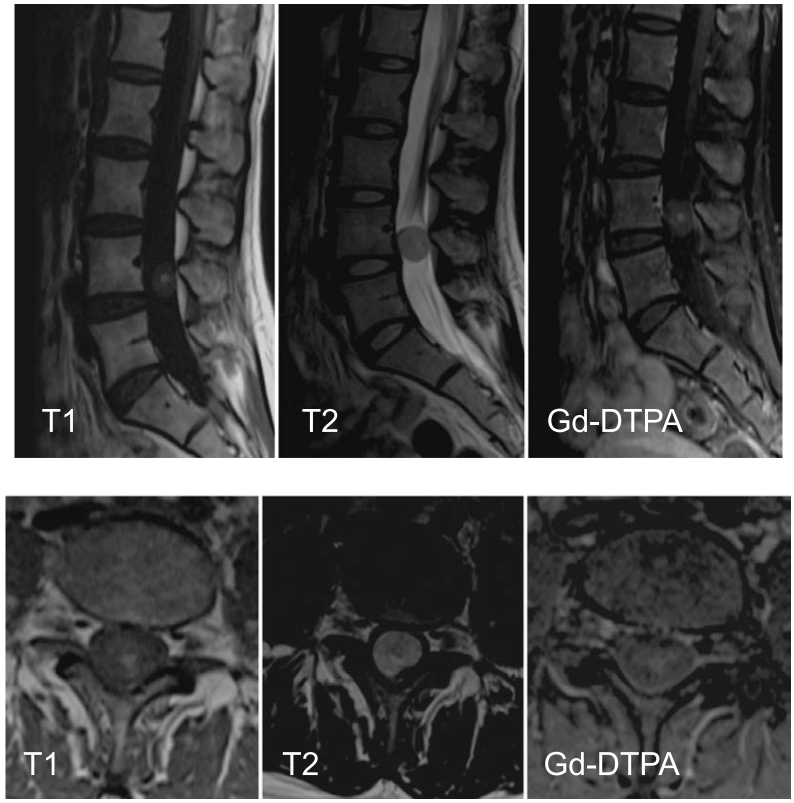


Fig. 5. Magnetic resonance imaging (MRI) (a) sagittal section, (b) horizontal section: A mixture of hypointensity on T1-weighted imaging with some hyperintensity in the interior was observed, and isointensity was observed on T2-weighted imaging. The tumor exhibited almost no gadolinium-diethylenetriamine pentaacetic acid (Gd-DTPA) contrast effect.

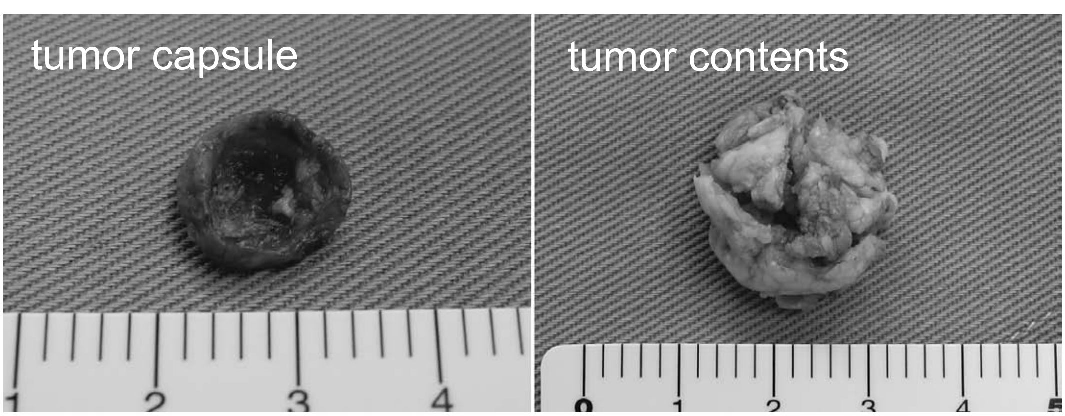


Fig. 6. Removed tumor capsule and contents..

considered removing the entire capsule en bloc; however, we finally decided to remove the contents and then the capsule because of the thinness of the capsule. The tumor resembled bean curd lees; it was lobated like a cauliflower with a pearly white surface (Fig. 6). The dura mater was sutured. Holes were opened in the cut vertebral arch with an air drill at three

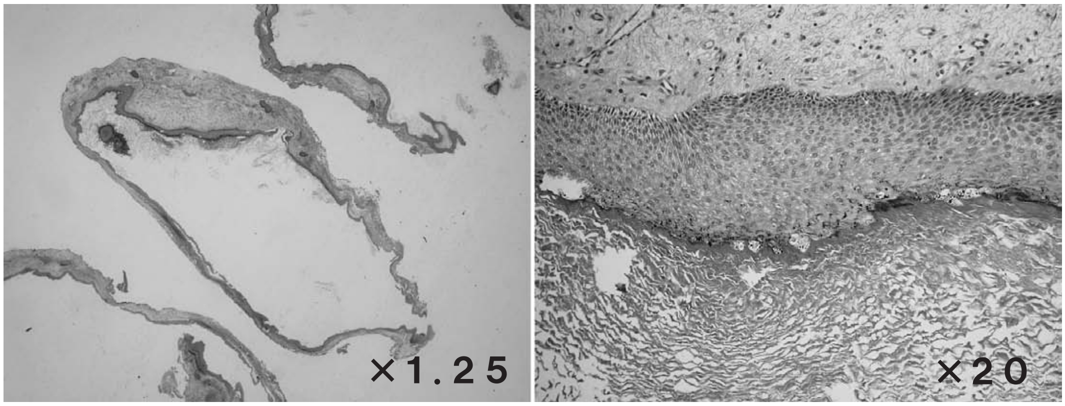
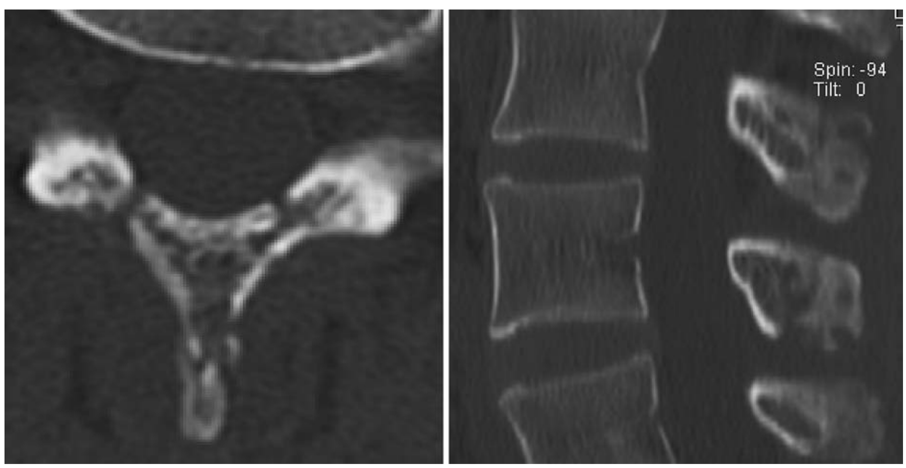
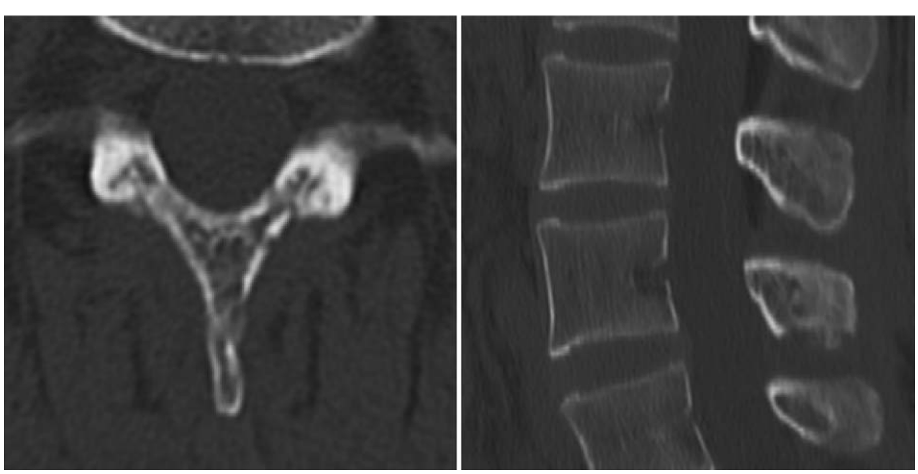


Fig. 7. Histopathological imaging (hematoxylin and eosin staining).



(a)



(b)

Fig. 8. Bone union
a : Early bone union in the osteotomy section was observed 6 weeks postoperatively, b : Bone union was achieved at 3 months postoperatively when the osteotomy line had disappeared.

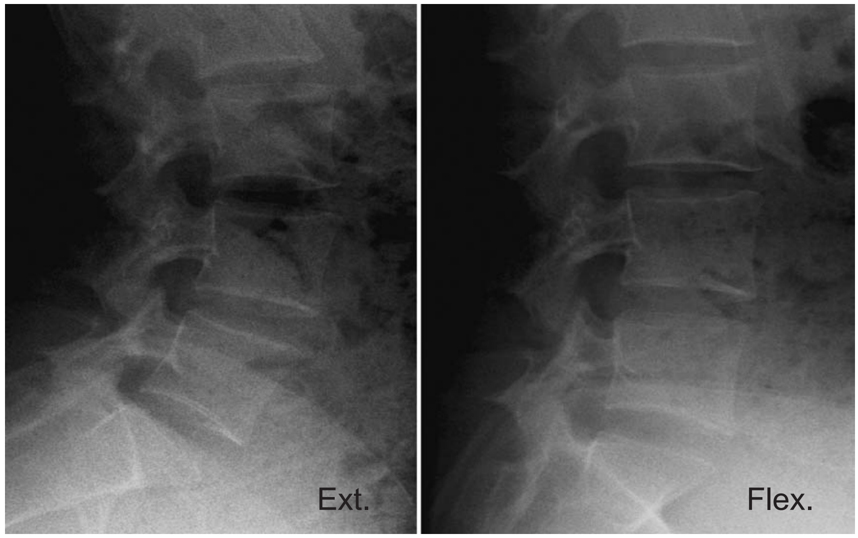


Fig. 9. Intervertebral instability was not observed on functional X-rays taken 6 months postoperatively.

locations bilaterally and craniocaudally, and suture fixation was repositioned with number two absorbable sutures. The Y-method was completed at a location dorsal to this site. The solidity of the vertebral arch and spinous process was tested by applying pressure with a finger and was found to be favorable because it moved very little.

Pathological diagnosis : A cystic lesion, covered by stratified squamous epithelium associated with keratinization, was diagnosed as an epidermoid cyst because no skin or hair tissue was observed (Fig. 7).

Postoperative course : The patient wore a hard corset for 2 months. Early bone union in the osteotomy section was observed on CT conducted 6 weeks postoperatively (Fig. 8a), and bone union was achieved at 3 months postoperatively (Fig. 8b). No recurrence or abnormality was found on MRI performed 3 months postoperatively. No intervertebral instability was identified on functional X-rays (lateral view) taken 6 months postoperatively, and the osteotomy section in the vertebral arch had disappeared in the frontal view (Fig. 9). Preoperative pain and numbness vanished, and muscle strength was recovered.

The Y-method

In this procedure, the supraspinous and interspinous ligaments are cut longitudinally with a scalpel, and the width of the dorsal side of the spinous process is confirmed. Several small holes are made with an air drill to allow the central-most splitting position, with the holes serving as pin sites for the chisel. The spinous process is then split down the center using a chisel with tape attached at the depth planned by preoperative CT so that the chisel does not go too deep (Fig. 10a). It is possible to split the spinous process exactly centrally by verifying bilateral resistance by lightly rocking the chisel left and right while advancing it forward. A cut is made with the bilateral base at an angle while tilting the chisel to be as externally oriented as possible to avoid damaging the vertebral arch once the desired depth is attained (Fig. 10b).

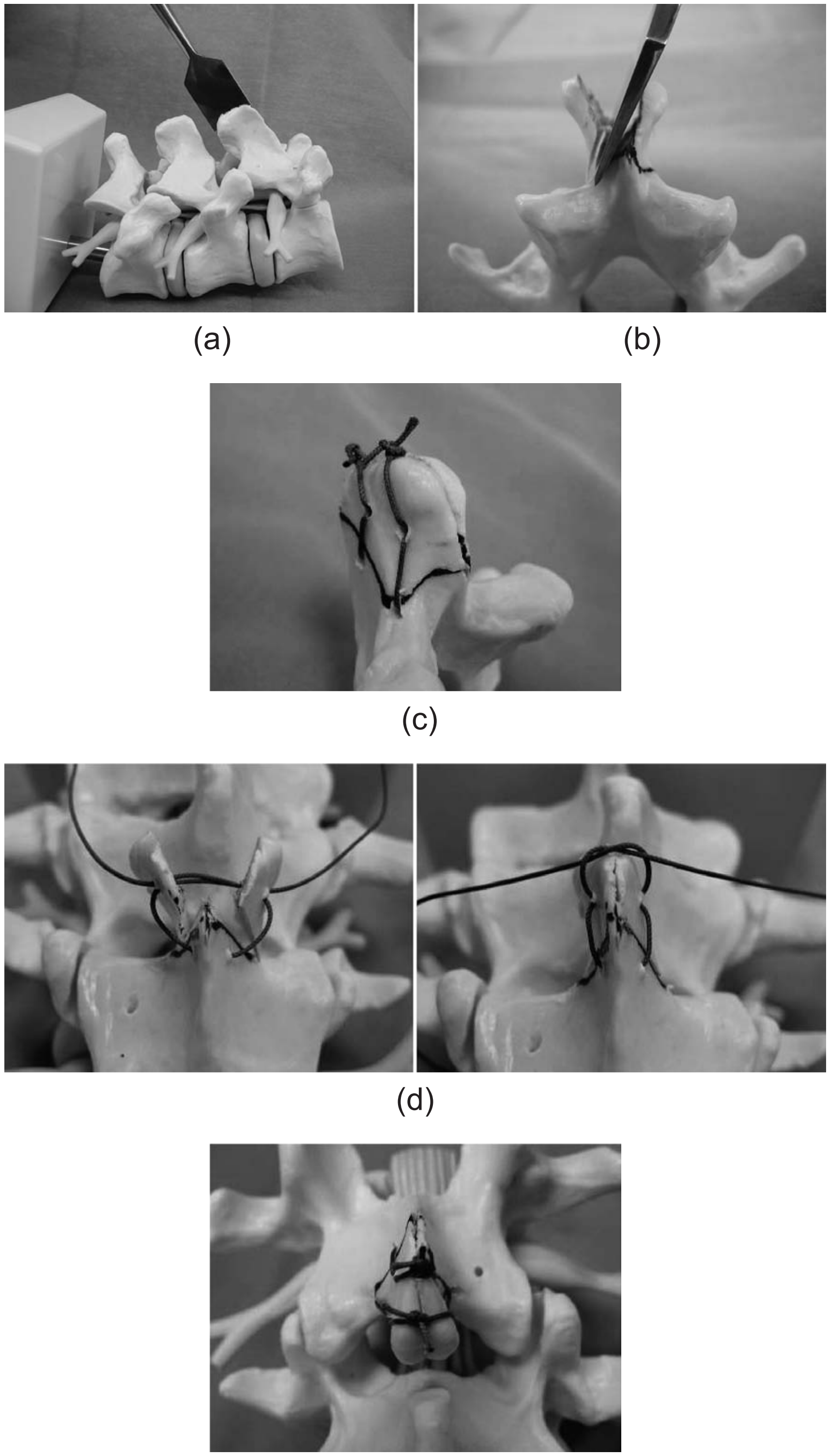


Fig. 10. The Y-method
a : The spinous process was split down the center. b : The spinous process was cut bilaterally and at the base with a chisel tilted externally. c : Burr holes were made at two locations in the craniocaudal orientation of the split spinous process with an air drill. d, e : The dorsal side of the spinous process was tightly sutured using a Chinese eight-character orientation through the burr holes.

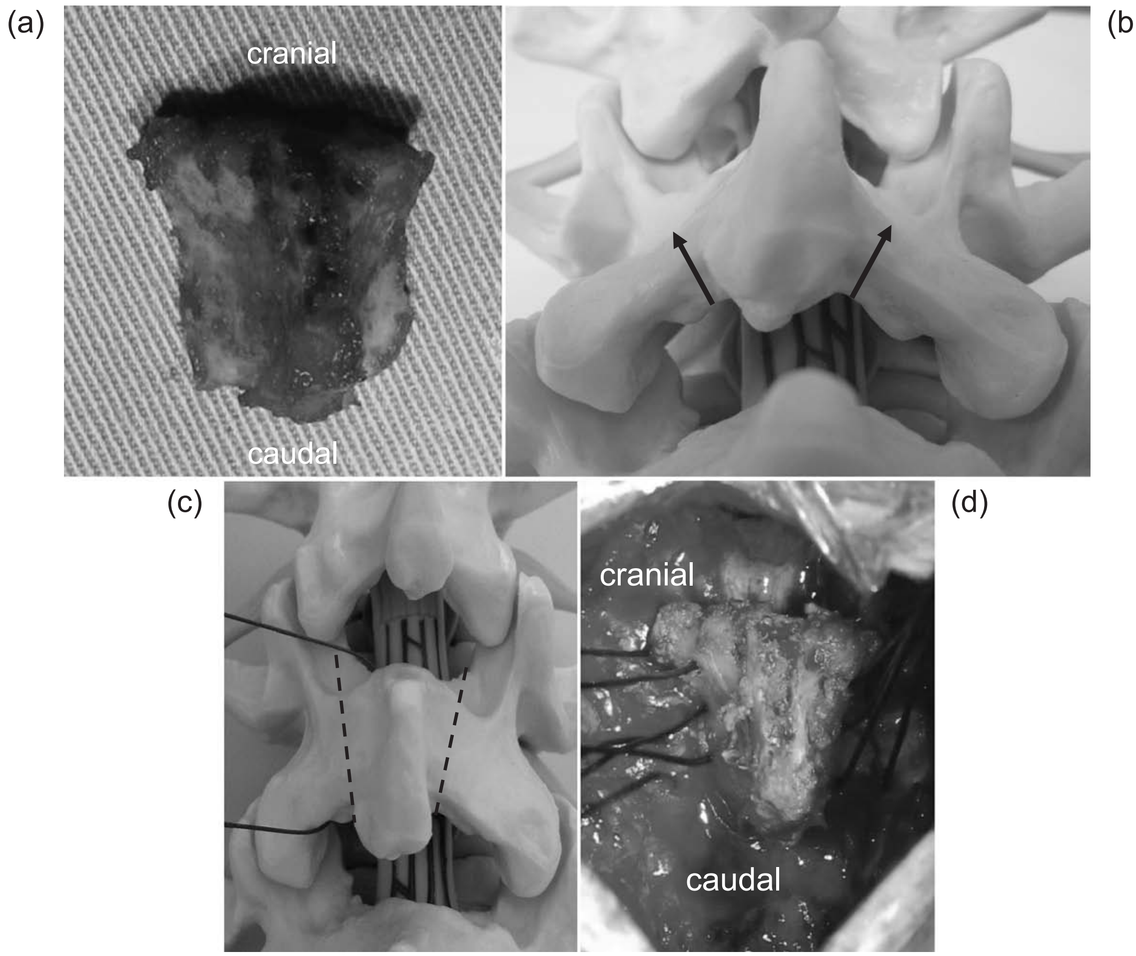


Fig. 11. Repositioning fixation of the vertebral arch
a : Vertebral arch removed en bloc. b : The vertebral arch was cut using a T-saw in a “V” shape from the ventral to the dorsal side to avoid it falling into the spinal canal following repositioning suturing. c : A “V”-shaped cut is made from the caudal to the cranial side to avoid the vertebral arch being pulled into the run of the multifidus muscle. d : Suture fixation was accomplished by making holes with an air drill at three craniocaudal locations.

The surgical field is then bilaterally exposed with a Casper retractor, with the supraspinous and interspinous ligaments and paraspinal muscles still attached to the split spinous process. Burr holes are made at two locations in the craniocaudal orientation of the split spinous process using an air drill following decompression, and at two locations in the base of the spinous process (Fig. 10c). The dorsal side of the spinous process is tightly sutured by passing number two absorbable sutures in a Chinese eight-character pattern (resembles two eyebrows during a frown, pointing up where they come together) through the burr holes (Fig. 10d, e). Finally, suture fixation returns the base of the spinous process and the bisected spinous process to their original locations.

The vertebral arch reduction fixation method

The vertebral arch is cut en bloc using a T-saw bilaterally at the medial part of the facet joint (Fig. 11a). The vertebral arch is then cut using a T-saw in a “V” shape from the ventral to the dorsal side so that it does not fall into the spinal canal following reduction suturing (Fig. 11b). A "V"-shaped cut is made from the caudal to the cranial side to avoid the vertebral arch from being pulled into the run of the multifidus muscle (Fig. 11c). Suture fixation is accomplished with number two absorbable sutures by making holes with an air drill at three craniocaudal locations on the vertebral arch (Fig. 11d).

Discussion

Epidermoid cysts comprise $<1\%$ of central nervous system tumors, with only 25% of cases involving the intraspine[2]. Approximately 66% of tumors in the spinal canal occur in the lumbosacral region[3]; however, this is a relatively site, comprising approximately 2% of all spinal cord tumors[4]. Hypotheses regarding the source of these tumors include the congenital developmental abnormality theory[5] and the acquired injury theory[6]. The first theory proposes that a dermal system ectoblast strays into the neural tube at 3–5 weeks of gestation. While cases are often complicated by congenital cutaneous fistula, spina bifida, or pigmented nevus, and many cases of intradural extramedullary tumors occur, there are also cases of intramedullary tumors[7, 8]. The acquired injury theory states that the cause is skin tissue transplanted into the spinal canal by a lumbar puncture, with most cases occurring as an intradural extramedullary tumor.

Visciani *et al*[9] reported the average occurrence of epidermoid cysts at 5～7 years after lumbar puncture. The present case did not include dermal abnormalities or complicated malformations; however, the cause was probably congenital because there was no history of lumbar puncture. MRI is a useful diagnostic tool in such cases because it is important to distinguish an epidermoid cyst from a schwannoma, with the latter often showing hypoisointensity on T1-weighted imaging and hyperintensity on T2-weighted imaging, with a marked contrast effect. In addition, there is no unified MRI view of epidermoid cysts, with some cases involving hypoisointensity on T1-weighted imaging and hyperintensity in the interior, some involving hyperintensity on T2-weighted imaging, and others involving hypoisointensity. Such cysts may exhibit rim enhancement[10], including a heterogeneously contrasting border, with almost no contrast effect.

The possibility of schwannoma could not be ruled out in case 2 even when considering an epidermoid cyst in the preoperative differential diagnosis because almost no contrast effect was found and some hyperintensity within the region of hypointensity on T1-weighted imaging was also identified. Treatment of schwannoma generally involves surgical removal of this space-occupying intraspinal lesion; however, it is not uncommon for symptoms to take a long time to manifest, due to the often slow growth of tumors arising in the lumbosacral region. Cases often exhibit involvement with the cauda equina and a thin capsule, making en bloc removal problematic. Nevertheless, safe and complete removal is important because of the risk of recurrence from tumor remnants. Tumorectomy based on partial laminectomy or laminectomy is usually appropriate, depending on the tumor level. Preserving posterior elements of the lumbar vertebra is desirable in the case of laminectomy for children because there is a risk of future intervertebral instability. Such cases include reports of repositioning laminoplasty using a T-saw, a method developed by Kawahara and Tomita[11]. Another reported method involves fixing the vertebral arch with absorbable screws following tumorectomy by en bloc removal of the vertebral arch[12]. While the tumor in the present case 1 was at a level amenable to tumorectomy by a Y-method-based partial laminectomy, case 2 necessitated laminectomy, with reconstruction of the vertebral arch due to the patient age. In case 2, it was possible to reconstruct the posterior extensor mechanism by repositioning-suture fixation of the vertebral arch at an angle and direction suitable for cutting the arch to expose the surgical field using the Y-method, which does not involve stress on the paraspinal and multifidus muscles. Preserving posterior elements of the lumbar vertebra is important when considering the decades of life remaining for children, and exposing the surgical field is relatively easy in the unlikely event of recurrence because the bone and muscle have been preserved. Safe tumorectomy is thus possible by excising intradural tumors with a wide surgical field that allows positioning of a microscope directly above the field through the concomitant use of the Y-method and repositioning-suture fixation of the vertebral arch.

We reported two cases involving the excision of intradural tumors in the lumbar region. Case 2 involved a relatively rare epidermoid cyst. We exposed the operative field by the Y-method alone in case 1 and excised the tumor by partial laminectomy. In case 2, we exposed the operative field using the Y-method, removed the tumor en bloc, and then performed repositioning suturing to return the vertebral arch to its original position. Bone union was achieved in the vertebral arch and spinous process, and the posterior supporting tissue was successfully preserved.

In conclusion, we could safely excise intradural tumors with a wide microscope-assisted field using the Y-method and T-saw-based laminectomy.

Conflict of interest

The authors have declared no conflict of interest.

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