High Cervical Lateral Approach to Safely Remove the Cystic Retro-odontoid Pseudotumor: Technical Note

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Abstract

Surgery for neoplastic or vascular lesions at the craniovertebral junction remains one of the major challenges for neurosurgeons, because of issues such as the complex functional anatomy and vascular structures. We present three cases in which the high cervical lateral approach was used to safely remove the cystic retro-odontoid pseudotumor, not associated with rheumatoid arthritis, severely compressing the spinal cord. The mean age of patients was 74.7 years (range, 73–77 years). Neurological condition was assessed based on the neurosurgical cervical spine scale. A high cervical lateral approach was applied to remove the pseudotumor safely. Mean duration of follow-up after surgery was 21.3 months (range, 18–24 months). Mean recovery rate was 77.8%. All patients showed acceptable or satisfactory functional recovery, although one patient (Case 2) developed mild paralysis of the facial and spinal accessory nerve on the surgical approach side, but that completely recovered within about 1 month after surgery. Postoperative assessment at the recent follow-up suggested no significant aggravation of neck movement. This technical note suggests that the high cervical lateral approach can be considered as a surgical option for cystic retro-odontoid pseudotumor, not associated with rheumatoid arthritis, severely compressing the spinal cord. Safe management of the vertebral artery is one of the key considerations.

Key words: atlantoaxial instability, high cervical lateral approach, retro-odontoid pseudotumor, spinal accessory nerve, vertebral artery

Introduction

Surgery for neoplastic or vascular lesions at the craniovertebral junction is still a major challenge for neurosurgeons. However, several issues need to be resolved, such as the complex functional anatomy or the presence of vascular structures. Although the majority of cases can be well treated using a posterior standard approach, lesions located on the ventral side of the craniovertebral junction need to be treated with careful consideration regarding surgical access and the technique to avoid injury to the spinal cord or vertebral artery (VA). The transoral approach used to be one choice for such ventral lesions, but may carry a high risk of postoperative infection or cerebrospinal fluid leakage.[1,2] Several technical modifications have been

proposed, including the posterolateral, anterolateral or lateral approaches.[3–11] In this technical note, we present the high cervical lateral approach for safe removal of cystic retro-odontoid pseudotumor, not associated with rheumatoid arthritis, severely compressing the spinal cord. The technique presented here may not be brand-new, but can be considered a new idea for retro-odontoid pseudotumor that is now becoming more frequent among elderly patients, although inclusion in the surgical strategy of decompression alone or posterior cervical fusion remains controversial.[12–14]

Surgical Technique

Patient population

This study included three patients (one male, two females) with cystic retro-odontoid pseudotumor, not associated with rheumatoid arthritis, severely compressing the spinal cord. Mean age was 74.7 years (range, 73–77 years). Neurological condition was assessed based on the neurosurgical cervical spine

scale (NCSS).[15] Postoperative functional assessment was conducted at least 3 months after surgery.

Surgical indications and methods

Surgical indications for the high cervical lateral approach included the neurological condition of myelopathy caused by cystic retro-odontoid pseudotumor, not associated with rheumatoid arthritis, severely compressing the spinal cord. The cases showing the clinical symptoms or signs related with the instability at C1/2 joints were excluded from the surgical indication. The approach side was determined based on the paramedian location of cystic retro-odontoid pseudotumor. The patient was placed in the lateral oblique position with the head secured by three-point fixation with the neck mildly extended and the chin slightly turned toward the down side (Fig. 1A). The curved skin incision was made in the retroauricular area surrounding the mastoid process (Fig. 1B). The sternocleidomastoid muscle was reflected anteriorly with the skin flap to expose the suboccipital muscle layers. The lateral part of the splenium capitis muscle was divided at

the base of the skull, leaving enough bony attachment to allow reapproximation, and was mobilized medially and posteriorly to avoid the injury of the spinal accessory nerve (Fig. 1C). The longissimus capitis muscle was partially divided at the base of the mastoid process and reflected anteriorly. At this point, the tip of the transverse process of C1 was identifiable by palpation 1 cm inferior and 1 cm anterior to the mastoid tip. The transverse process of C2 was shorter and more difficult to palpate and might be easily confused with the C2 and C3 facet junction. The attachments of the superior oblique capitis and inferior oblique capitis muscles were divided at the transverse process of C1. The vertebral artery just above the vascular groove of C1 lamina came clearly into view, and the remaining muscle fibers running between the transverse processes of C1 and C2 were divided. The lateral aspect of the arch of C1 and the C2 lamina was partially seen (Fig. 1D). Curettes were used to reflect the muscle attachments from the lamina of C2 and the inferior portion of C1. Muscle attachments to the superior portion of the C1 arch were removed using an angled
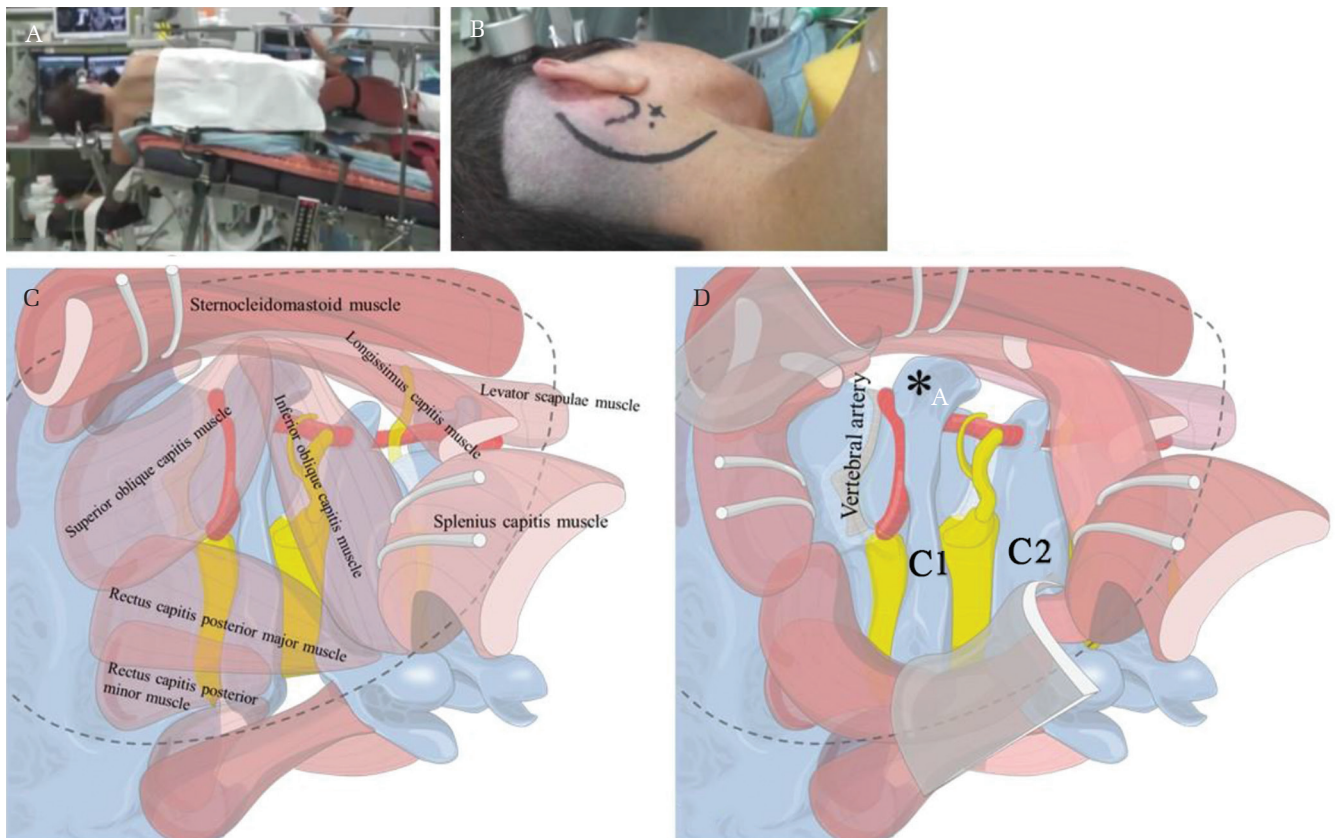

Fig. 1 Surgical technique for the high cervical lateral approach. (A) Patient position. (B) Retroauricular curved skin incision. Please note the imaginary point of the transverse process of C1 (X). (C and D) Schematic drawings showing the surgical steps for minimal but sufficient exposure of the lateral part of the high cervical spine. The vertebral artery is located within the suboccipital triangle. Please note the transverse process of C1 (*).

curette, keeping the plane of dissection subperiosteal to avoid injury to the vertebral artery. The muscle attachments were removed almost to the posterior midline. Using a high-speed drill with diamond burrs, the exposed arch of C1 and the lamina of C2 were partially removed. To control venous bleeding from the epidural venous plexus, meticulous hemostasis by bipolar coagulation or hemostatic agents was repeated as needed during the surgery. The C2 nerve root was resected when full exposure of the lateral surface of the dural tube was necessary. The cystic pseudotumor was easily accessed and removed without any significant retraction of the dural tube. Complete removal of the cystic pseudotumor was unnecessary. Subtotal or partial removal was sufficient to achieve decompression of the dural tube. After removal of the cystic pseudotumor, the muscles were reapproximated in the usual fashion. A cervical collar was used to reduce patient discomfort during the first few weeks postoperatively.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional Research Committee and with the 1964 Declaration of Helsinki and its later amendments. Informed consent was obtained from all individual participants included in this study.

Postoperative Assessment

Mean operation time was 5 h and 11 min, and mean total estimated blood loss during surgery was 303 mL. No patients received blood transfusion. Pathological examination demonstrated that the tissue obtained during the surgery comprised degenerative cartilaginous tissue, suggesting the clinical diagnosis of cystic retro-odontoid pseudotumor.

Functional outcome was assessed based on the NCSS. Mean duration of follow-up after surgery was 21.3 months (range, 18–24 months). Mean recovery rate was 77.8%. Although one patient (Case 2)

developed mild paralysis of the facial and spinal accessory nerves on the surgical approach side, with complete recovery within about 1 month after surgery, final functional assessment showed acceptable or satisfactory functional recovery in all cases. This transient paralysis of the facial and spinal accessory nerves on the surgical approach side may have been caused by indirect compression of those nerves during excessive wound opening. Postoperative assessment at recent follow-ups suggested no significant aggravation of neck movement. Clinical data are summarized in Table 1.

Illustrative Case

Case 1

A 74-year-old man presented with gradual onset of gait disturbance and severe manual clumsiness, especially on the right side. Preoperative functional condition was grade 2 for lower extremity function, grade 2 for upper extremity function, grade 2 for pain and sensory disturbance and grade B for performance status. Preoperative magnetic resonance images (MRI) showed the cystic retro-odontoid pseudotumor compressing the spinal cord severely at C2. He underwent a right high cervical lateral approach for safe removal of the cystic lesion (Figs. 2A–D). Total operation time was 6 h and 47 min and total estimated blood loss was 530 mL. Postoperative MRI early after surgery revealed satisfactory resection of the lesion (Figs. 3A–D), and postoperative computed tomography (CT) revealed minimal but sufficient opening of the lateral part of the C1 lamina. Postoperative MRI obtained early and 2 years after surgery showed satisfactory decompression of the spinal cord (Figs. 3E and 3F). The postoperative course was uneventful. Neurological function gradually improved after surgery. Functional grade at 6 months postoperatively was grade 5 for lower extremity function, grade 5 for upper extremity function, grade 3 for pain and sensory disturbance, and grade E for performance status. The patient did not complain of any aggravation of neck movement

Table 1 Case summary

Case no.	Age	Sex	Surgery			Postoperative follow-up (months)	Recurrence	NCSS		
			Resection	EBL (mL)	Operation time (h:min)			Preoperative	Postoperative	Improvement (%)
1	74	Male	Partial	530	6:47	24	None	2:2:2:B	5:5:3:E	87.5
2	77	Female	Partial	360	5:10	22	None	3:2:1:B	4:4:3:D	62.5
3	73	Female	Partial	20	3:35	18	None	4:2:2:B	5:5:3:E	83.3

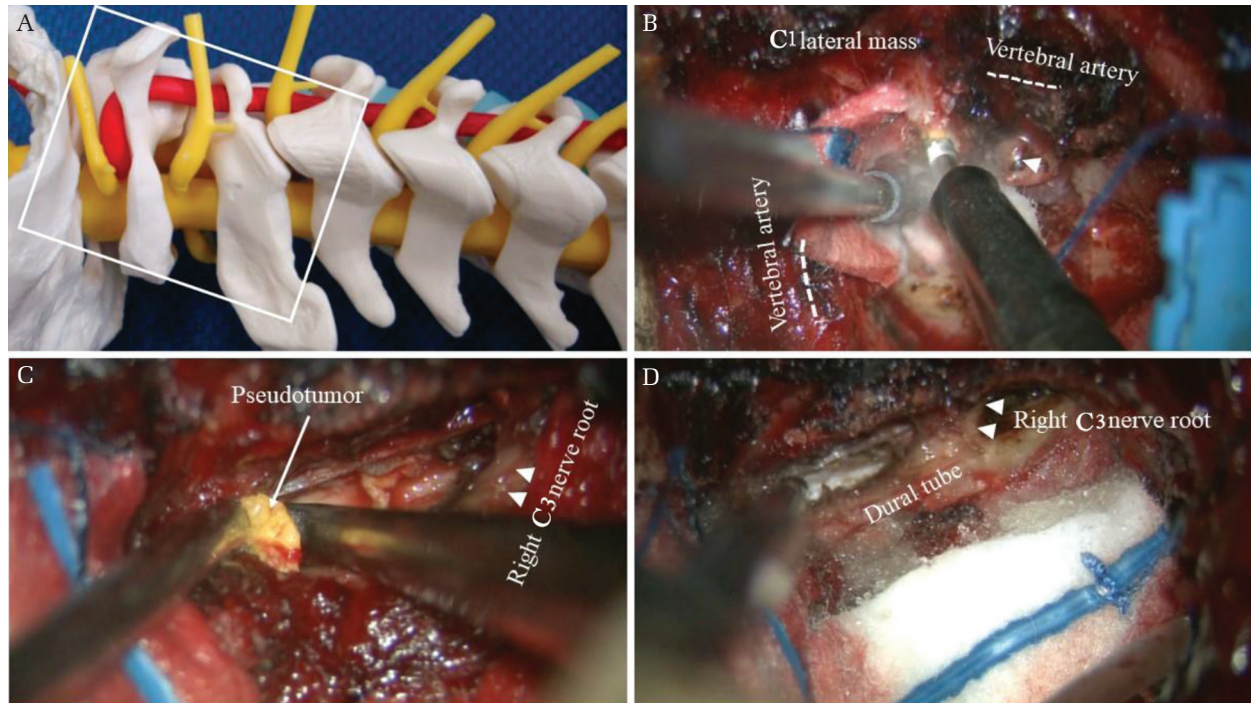EBL: estimated blood loss during surgery, NCSS: Neurosurgical cervical spine scale.

Fig. 2 Intraoperative photographs showing the removal of cystic retro-odontoid pseudotumor compressing the spinal cord severely at C2. Intraoperative photographs (B–D) correspond to the boxed area in the spine model (A). (B) The lateral part of C1 and C2 laminae was resected to expose the cystic retro-odontoid pseudotumor in the ventral extradural area. (C) The cystic retro-odontoid pseudotumor was removed piece-by-piece. (D) Satisfactory decompression of the dural tube was obtained.
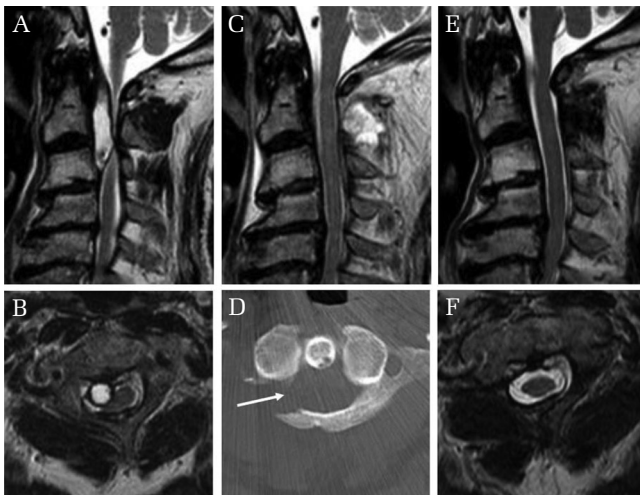

Fig. 3 Illustrative case (Case 1). (A and B) T2-weighted MR images before surgery showing the cystic retro-odontoid pseudotumor compressing the spinal cord severely at C2. Please note the paramedian location of cystic retro-odontoid pseudotumor. (C) T2-weighted MR images early after surgery showing the satisfactory decompression. (D) Axial CT images early after surgery showing the partial laminectomy of C1. Please note the approach direction (*white arrow*). (E and F) T2-weighted MR images 2 years after surgery showing no recurrence.

or neuropathic pain in the area of C2 nerve root on the approach side.

Discussion

This high cervical lateral approach was first described by Henry in 1973 for exposure of the vertebral artery between C1 and C2, and further refined by Shucart and Klériga in 1980.[3] Similar technical ideas such as anterolateral or posterolateral approaches to the foramen magnum, anterolateral extradural approach for C2 and C3 or an extreme lateral approach to intradural lesions of the cervical spine and foramen magnum followed.[4–11] The technical advantages of such high cervical lateral approaches may include direct visualization and exposure of ventral-to-lateral lesions located at the high cervical spine, so mechanical stress on the spinal cord can be minimized. Although several disadvantages are seen, such as the deep and narrow operative field, possible risk of vertebral artery injury on the approach side, or possible paralysis of the facial or accessory nerves, careful dissection based on sufficient understanding of the regional anatomy may help the surgeons accomplish safe exposure of the lesion.[16,17]

The VA between its origin from the subclavian artery and the vertebral union can be divided into four segments. The first segment is that between the subclavian artery and the transverse foramen of C6. The second is the segment within the transverse foramens of C6–2. The third segment (V3) is the tortuous segment between the transverse foramens of C2 and C1. V3 forms a laterally convex curve to reach the transverse foramen of C1, then runs backward and makes a curve upward at the lateral mass of C1 to enter the vascular groove. The fourth segment is the segment between C1 and the vertebral union. V3 is the key anatomical segment in this kind of surgery.[18,19] The unique anatomical structure here requires surgeons to pay particular attention to the loops, branches, supporting fibrous rings, adjacent nerves, and surrounding venous structures. V3 is located within the suboccipital triangle bordered by three muscles: superomedially by the rectus capitis posterior major muscle; superolaterally by the superior oblique muscle; and inferolaterally by the inferior oblique muscle. The triangle includes the V3 and C1 nerves, both of which lie in a vascular groove on the upper surface of the lateral part of the C1 posterior arch. The triangle deep to these three key muscles is covered by a layer of dense fibrofatty tissue. Careful reflection of the muscles forming the suboccipital triangle results in safe exposure of V3, which is surrounded by the venous plexus called the suboccipital cavernous sinus. The V3 should be safely exposed with minimal blood loss, avoiding profuse bleeding from the venous plexus and direct VA injury. The transverse process of C1 should be the anatomical landmark for identifying the suboccipital triangle. The tip of the transverse process of C1 can be identified by palpation 1 cm inferior and 1 cm anterior to the mastoid tip. The transverse process of C2 is much shorter and more difficult to palpate than C1, and is easily confused with the C2 and C3 facet joint.

The accessory nerve exits the skull base through the jugular foramen with the glossopharyngeal and vagus nerves.[20,21] These nerves lie compactly between the internal carotid artery and internal jugular vein. The accessory nerve spirals backward, passing the superficial surface of internal jugular vein, and travels for 3–4 cm on the levator scapulae muscle, then penetrates the deep surface of the sternocleidomastoid muscle. Its branches are divided into the sternocleidomastoid muscle, and further emerge in the posterior neck triangle just below the point of the upper and middle one-third of the sternocleidomastoid muscle. The branches further pass beneath the anterior border of the trapezius muscle. The branches are engulfed in fibrofatty tissue and associated with a chain of lymph nodes throughout its course in the posterior neck triangle. To avoid paralysis of the accessory nerve, an understanding of this regional anatomy is absolutely necessary. Limitations to surgical manipulation down to the posterior neck triangle are also important. This high cervical lateral approach should be limited down to the C3 level without any extensive dissection around the posterior neck triangle.

One potential criticism is the intentional resection of the C2 nerve root on the approach side that crosses the operative field and may present an obstacle to safe and wide exposure of the lesion.[22,23] In our previous clinical research focusing on the disadvantage of C2 nerve root resection to achieve safe, wide exposure of lateral atlantoaxial joints in posterior C1 and C2 instrumented fixation, no patients reported allodynia or C2 distribution neuropathic pain during follow-up, and only 12.5% of all analyzed patients did not demonstrate satisfactory recovery of C2 sensory disturbance.[23] Although C2 nerve root resection is still contentious and has not been fully justified, C2 nerve root resection may be recognized as a technical option for safe surgery.

The surgical strategy for retro-odontoid pseudo-tumor in the elderly patients is still under debate.[12–14] Posterior C1/2 fusion may be the basic choice, but the decompression alone with or without resection of retro-odontoid pseudotumor may be good enough in some cases. It is needless to say that the surgical selection should be done carefully for each patient. The high cervical lateral approach presented here may not be the best choice, but one of the surgical choices, although there may be another concern of the postoperative instability at C1/2 joints. One of the advantages of this approach is the preservation of posterior cervical muscle layers compared with posterior standard approach. The postoperative assessment may indicate that the high cervical lateral approach appears to be less invasive and comparable with other procedures, when applied appropriately. Long-term outcome including the recurrence needs to be carefully followed. This technical note suggests that the high cervical lateral approach can be successfully applied in selected cases of cystic retro-odontoid pseudotumor, not associated with rheumatoid arthritis, severely compressing the spinal cord, and can be considered among the surgical options including posterior decompression with or without spine fusion. Safe management of the vertebral artery is one of the key considerations.

Conflicts of Interest Disclosure

indirectly to the subject of this manuscript. All authors report no conflicts of interest concerning the materials or methods used in this study or the findings specified in this paper. All authors who are members of The Japan Neurosurgical Society (JNS) have registered online Self-reported COI Disclosure Statement Forms through the website for JNS members.

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