Combined endoscopic endonasal and posterior cervical approach to a clival chordoma

Anthony Minh Tien Chau, Amanda Lazzaro, Ralph Jasper Mobbs, Charles Teo

Faculty of Medicine, University of New South Wales, Sydney, Australia
Centre for Minimally Invasive Neurosurgery, Suite 3, Level 7, Prince of Wales Private Hospital, Barker Street, Randwick, New South Wales, 2031, Australia

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Abstract
Chordomas in the clival-cervical region present challenges to the neurosurgical team due to their encroaching nature, proximity to critical neurovascular structures and often large size due to late presentation. This report illustrates the utility of a staged approach when confronted with such a pervasive tumour. We describe the adaptive combination of two approaches, the endoscopic endonasal transsphenoidal plus posterior cervical approaches, in the surgical management of a clival chordoma extending inferiorly to C3 in an 18-year-old male.

1. Introduction
Chordomas are neoplasms of bone arising from the embryonic remnants of the notochord and comprising approximately 1% to 4% of all primary malignant bone tumours.1 Of 400 cases recorded by the National Cancer Institute in the USA from 1973 to 1995, the distribution within the axial skeleton was reported as 32% at cranial sites, 32.8% spinal and 29.2% sacral.2 The peak incidence of chordomas is in the fourth decade of life and it affects twice as many males as females.

Although slow-growing and rarely metastasising, clival chordomas have a poor prognosis due to their anatomical position, locally destructive capacity and late presentation when the lesion is large. Pain is the cardinal complaint with neurological deficits, commonly cranial nerve palsies, dependent on tumour location.1 Median survival at 5 years is approximately 70%.1 Surgery is widely considered the fundamental procedure in managing chordomas, whether supplemented by radiotherapy or not.3

2. Case report
An 18-year-old South American male presented with a history of long-standing neck pain. Neurological examination revealed a right hypoglossal nerve palsy and cervical myelopathy with increased reflexes and tone in all extremities.

CT scan revealed a large destructive bony lesion measuring 8 cm by 6 cm by 5 cm involving the clivus and extending inferiorly to C3. There was significant compression of the brain stem, upper cervical cord and the right hypoglossal nerve, with occlusion of the right C1/2 and C2/3 intervertebral foramina. T2-weighted MRI revealed a hyperintense mass consistent with a clival chordoma (Fig. 1).

The presence of brainstem and cord displacement indicated urgent surgical intervention. It was decided that the patient should undergo a multistage endoscopically-assisted endonasal transsphenoidal, transclival procedure followed by a posterior cervical approach with posterolateral fusion and fixation.

2.1. Surgical technique
2.1.1. Stage 1
An intracranial resection of the tumour as far as the apex of the dens via an endoscopic endonasal approach (EEA) was performed (Fig. 2A). Following a stereotactic assisted bilateral endonasal exposure performed by an ear-nose-and-throat surgeon, a clivectomy was performed from the sella turcica to the foramen magnum. The tumour bulk was removed and the brainstem decompressed until pituitary dura was noted and the lateral magnus was clear. The anterior C1 arch and C2 odontoid process were then drilled and prevertebral and epidural tumour was removed. The lateral gutters were also explored. Cranial nerves VI, IX, X, and XII were decompressed extradurally. The deficiency was repaired with an abdominal fat graft. Operative time was 18 hours.

Postoperative MRI showed residual extradural tumour dorsal to the dens and the body of C2 extending to C3/4 and through the right C2/3 foramen, abutting the right vertebral artery (Fig. 2A). Furthermore, there was a smaller nodule of tumour occupying the left side of the epidural space at the C1/2 level.

2.1.2. Stage 2
Subtotal microsurgical resection of the remaining tumour was carried out under endoscopic guidance 2 days later (Fig. 2B) with
present significant challenges to the neurosurgeon, not only

3. Discussion

union at the craniocervical articulation. Growth of the residual tumour. Follow-up CT scan revealed a solid residual neurological deficit and neck pain with no observable nerve palsy as a complication. At 12 months, there was minimal postoperative at another institution with mild transient accessory approach. Proton beam radiotherapy was commenced 3 months reoperation using fat graft and fibrin glue via a repeat transnasal sal cerebrospinal fluid (CSF) leak 2 weeks postoperatively requiring placement anterior to the dura at C2/C3 due to excessive bleeding.

entry through an incision spanning the external occipital protu-

berance to C5. The right posterior arch and lateral mass of C1, right C2 lamina and spinous process, and right C3 superior lamina were removed. The right C2 nerve root was also sacrificed. A sta-
bilisation procedure from the occiput to C4 was performed using onlay bone graft from the iliac crest for posterolateral bone fusion, with instrumentation consisting of an occipital plate, C1 lateral mass fixation and C2–C4 lateral mass screws (Fig. 3). Haemostatic material was required anterior to the cord at C2/3. Time taken was 11 hours.

2.2. Postoperative course

Final histopathological findings were consistent with a clival chordoma. The patient recovered well; however, he suffered a naso cerebrospinal fluid (CSF) leak 2 weeks postoperatively requiring reoperation using fat graft and fibrin glue via a repeat transnasal approach. Proton beam radiotherapy was commenced 3 months postoperative at another institution with mild transient accessory nerve palsy as a complication. At 12 months, there was minimal residual neurological deficit and neck pain with no observable growth of the residual tumour. Follow-up CT scan revealed a solid union at the craniocervical articulation.

3. Discussion

Clival chordomas are largely midline, extradural lesions that present significant challenges to the neurosurgeon, not only for their locality but for their preponderance to invade and en-
case critical surrounding neurovascular structures. Evidence sug-
gests that an aggressive surgical approach to achieve total resection on primary presentation is warranted, as chordoma recurrence is frequent and typically more aggressive. However due to their encroaching nature, true oncological resection of chordomas can rarely be achieved, at least not without signifi-
cant morbidity. In these patients, a cytoreductive resection should be pursued.

Many lateral and paramedian surgical approaches have

been employed to access chordomas of the clivus and upper cervical spine, including transbasal, transmaxillary, facial trans-
location, midfacial degloving, transoral and anterior cervical approaches. This is attributable to the variable course of the notochord and hence the diverse origins and projections of skull-base chordomas. In determining the best approach for the individual, numerous factors are taken into consideration including the goals of surgery, extent and pattern of tumour infiltration and experience of the surgical team. In this report, we have described a unique and effective combination of a minimally invasive EEA followed by a posterior cervical procedure.

There has been growing interest in minimally-invasive ante-
rior approaches for resection of clival chordomas as these are extracerebral approaches that avoid brain manipulation and are on a relatively less vascularized, shorter surgical route. With the advent of neuronavigational tools, the EEA is gaining popularity as it provides a direct but slightly angled trajectory to the clivus with wider and more panoramic visualization com-
pared to the traditional microscopic transsphenoidal approach.

As the endoscope obviates the need for retracting instrumenta-
tion used in microscopic procedures and can confer angled-
sight, greater maneuverability is permitted whilst minimising tissue trauma. This aids significantly when pursuing the radical removal of a tumour that has expanded laterally beyond its midline origins.

As the literature expands, the limitations as well as benefits of the EEA continue to be defined. Recent chordoma series suggest that the EEA used alone may be most successful when applied to smaller chordomas; specifically the maximal values of 4 cm diameter or 80 cm³ volume has been suggested by one group to be amenable to optimal resection. Limitations exist particularly for the clival chordoma that has extended too far laterally beyond the width-limiting cavernous carotid arteries. Maneuvers which are risky because of the paucity of anatomical landmarks and potential for vascular complication may be required if radical resec-
tion is sought. While the soft intracapsular tumour may be readily debulked, lateral bone margins may prove particularly chal-
 lenging in this instance requiring expert use of dedicated instru-
mentation with extended exposure or a secondary lateral skull-
base approach.

Another constraint of the EEA is apparent in inferior extension of the clival chordoma. Hence in our case where tumour involve-
ment extended as inferiorly as C3, upper cervical infiltration of the tumour was addressed through a direct posterior cervical ap-
proach. Although the right C2 nerve required excision, the right vertebral artery was particularly preserved in the event of tumour recurrence (not uncommon) involving a sole remaining left verte-
bral artery.

Reconstruction following skull-base surgery remains an

important area for improvement, with CSF leak remaining a widely recognised and hazardous complication especially when dural invasion has occurred. Following endoscopic endonasal re-
moval of clival chordomas, CSF leak occurs in a reported 0% to 25% of case series in the literature. Lumbar drainage may
be performed initially, but in this case immediate surgical repair was preferred.

4. Conclusion

The EEA exploits the anatomical corridor of the nasal cavity and sinuses to allow for excellent visualisation of midline chordomas and may be complemented by a direct secondary approach, in this case a posterior cervical approach, when tumour involvement is extensive. We report how this adaptive, staged approach may provide for good extent of resection with corresponding clinical results. This can add to the armamentarium of the neurosurgeon when managing clival chordomas.

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Bilateral psoas abscesses caused by methicillin-resistant *Staphylococcus aureus* (MRSA) after posterolateral fusion of the lumbar spine

Aldo F. Berti b, Alejandro Santillana a,*, Aldo F. Berti Jr. c

a Division of Interventional Neuroradiology, Department of Neurosurgery, New York Presbyterian Hospital, Weill Cornell Medical College, 525 East 68th Street, New York 10065, USA

b Department of Surgery, Section of Neurosurgery, University of Miami Hospital, Miami, Florida, USA

c Miami Neurosurgical Center, Miami, Florida, USA

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**A B S T R A C T**

Psoas abscess following spine surgery is a rare condition that can be overlooked or delayed as a result of its vague clinical manifestations. Gone unchecked, it can lead to severe morbidity and even death. We present a 71-year-old female patient who developed bilateral psoas abscess immediately following L2 through S1 posterior instrumented fusion. The patient underwent CT-guided percutaneous drainage of the bilateral psoas abscess and blood cultures revealed methicillin-resistant *Staphylococcus aureus* (MRSA) sensitive to vancomycin. Following surgical re-exploration, debridement and removal of part of the instrumentation, the patient received antibiotic treatment for 12 weeks and at 1-year follow-up the patient continues asymptomatic.

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1. Introduction

Pyogenic abscess of the psoas muscles following instrumented spinal fusion is a rare condition with lethality approaching 100% if untreated.1,2 Before the widespread availability of CT scan, 70% of retrofascial abscesses were diagnosed at autopsy.2 CT scans, and more recently, MRI, have improved detection of psoas abscesses and led to an increased reported incidence of the disease.3,4 Prior to 1985, an average of 3.9 cases per year was reported. The number of cases described in the literature reached a maximum in 1992, when 12 cases were reported worldwide.3 The absolute incidence among unpublished work is not known but is believed to have increased in recent years.6 Because the differential diagnosis of post-operative pain is broad, the diagnosis of post-operative psoas abscess can be challenging. Here we report a patient with bilateral psoas abscess caused by methicillin-resistant *Staphylococcus aureus* (MRSA) following transpedicular fixation and posterolateral fusion of the lumbar spine.

2. Case report

A 71-year-old female who previously underwent discectomy at L4–L5 20 years prior and interlaminar and interbody fusion at L3–L4 and L4–L5 5 years prior, for treatment of adult degenerative scoliosis, was admitted to the hospital with the diagnosis of lumbar spinal canal stenosis and bilateral lumbar radiculopathy. These conditions were symptomatic, manifesting with gait instability and neurogenic claudication. She underwent takedown of her previous instrumentation at L3–L4 and L4–L5, with bilateral wide decompressive laminectomies, medial facetectomies, ample foraminotomies, discectomies and external neurolysis at L2–L3.