

# Endoscopic endonasal odontoidectomy in a child with chronic type 3 atlantoaxial rotatory fixation: case report and literature review

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## Abstract

**Introduction** Although the transoral transpharyngeal approach has been the standard approach to decompress the odontoid process, it bears some disadvantages including risk of infection, prolonged intubation or tracheostomy, need for nasogastric tube feeding, extended hospitalization, and possible effects of phonation. The endoscopic transnasal approach is a viable alternative, managing to avoid some of the pitfalls of the more accepted transoral transpharyngeal approach. However, there have only been a handful of adult cases and only three pediatric cases.

**Case report** We present the case of a 10-year-old girl with a chronic type 3 atlantoaxial rotator fixation and significant spinal cord compression from basilar invagination and a displaced odontoid process. We performed an endoscopic endonasal odontoidectomy prior to posterior occipitocervical fusion on the patient. She was neurologically intact with a well-healed wound at 7-month follow-up.

**Keywords** Endonasal endoscopy · Odontoidectomy · Atlantoaxial rotatory subluxation · Atlantoaxial rotatory fixation · Pediatric spine

## Introduction

The transoral transpharyngeal approach has been accepted as the standard procedure to decompress the odontoid process [1, 6, 7, 10, 14–16, 19–21]. Although significant refinements in anatomic knowledge [5, 17] and surgical technique have lowered morbidity and mortality [2, 4, 8] with this standard approach, there are still drawbacks including traversing the oral cavity and its bacterial flora and subsequent risk of infection, prolonged postoperative intubation or tracheostomy, the need for nasogastric tube feeding, extended hospitalization, and possible effects on phonation as the result of soft-palate splitting or hard-palate resection in some cases [13, 22]. In 2005, Kassam et al. [9] first reported the endoscopic transnasal approach for resection of the odontoid process to avoid some of the disadvantages of the standard approach.

This minimally invasive approach, more accurately described as minimal access but maximally invasive, for odontoidectomy has been used in a handful of adult reports [11, 18, 22] and three pediatric cases [7, 12]. Magrini et al. [12] reported a pediatric case involving an 11-year-old child with atlantoaxial instability and odontoid invagination in the setting of Down syndrome. Hankinson et al. [7] reported two cases of patients with Chiari I malformation and ventral brainstem compression that were successfully treated by odontoidectomy via the endoscopic endonasal approach.

We present the case of a 10-year-old girl on whom we performed an endoscopic endonasal odontoidectomy prior

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**Table 1** Fielding and Hawkins classification [3] for atlantoaxial rotatory subluxation

Type	Description
1	Rotatory subluxation without anterior displacement of the atlas (atlantodental interval 3 mm or less)
2	Rotatory subluxation with anterior displacement of the atlas of 3–5 mm
3	Rotatory subluxation with anterior displacement of more than 5 mm
4	Rotatory subluxation with posterior displacement usually associated with an odontoid fracture

to posterior occipitocervical fusion to address a chronic type 3 atlantoaxial rotatory fixation (Table 1) and significant spinal cord compression from basilar invagination and a displaced odontoid process. We add to the existing pediatric cases reported in the literature utilizing this approach.

## Case report

### History and examination

A 10-year-old girl with no significant medical history presents with a 10-month history of difficulty moving her neck. She did not have any history of trauma or pharyngitis, but she woke up one morning with pain in the neck and limited range of motion. She denied any weakness, extremity/neck pain, or bowel/bladder dysfunction. On examination, she did not have any motor or sensory deficits. She was normoreflexic and did not have any long-tract signs. There was no evidence of lower cranial nerve dysfunction. She had a significantly limited range of neck motion. Imaging studies demonstrated a fixed, Fielding and Hawkins type 3 C1–2 rotatory subluxation with an atlantodental interval of 10 mm and basilar invagination resulting in craniocervical junction stenosis (Figs. 1, 2, and 3). After discussion with the family, the decision was made to proceed with operative intervention to attempt closed reduction and possible open reduction and fixation. We did not recommend a preoperative trial of halo or Halter traction, as the deformity appeared fixed based on the chronicity of the CT imaging findings; additionally, our clinical impression was that this child would not tolerate prolonged traction.

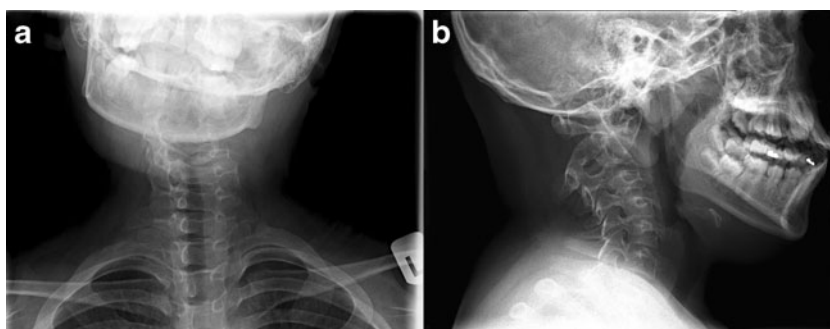
### First operation

The patient was taken to the operating room with motor- and somatosensory-evoked potential monitoring to place a halo vest and attempt closed reduction of the subluxation. Once the halo vest was placed, we unsuccessfully attempted to reduce her deformity with fluoroscopic guidance. The patient was then placed in the prone position for open reduction and fixation. An incision from theinion to the spinous process of C4 and the muscle was dissected down at the midline raphe to expose the occiput and lamina of C1–4. Occipital eyelets, C2 translaminar screws, and lateral mass screws at C3 and C4 were placed bilaterally. During rod placement, there was a substantial decrease in motor-evoked potentials. After C1 laminectomy, placement of a unilateral rod was attempted with the same result. Intraoperative ultrasound confirmed significant cord compression. At that time, the rods were removed, and motor signals returned to baseline. The procedure was aborted, and the wound was closed in layers. The patient was then extubated and was neurologically at her baseline. After careful study of her nasopharynx anatomy and its relationship to the upward displaced odontoid process on preoperative thin-cut CT, we then formulated a plan to decompress via an endonasal endoscopic odontoidectomy before completing posterior instrumentation.

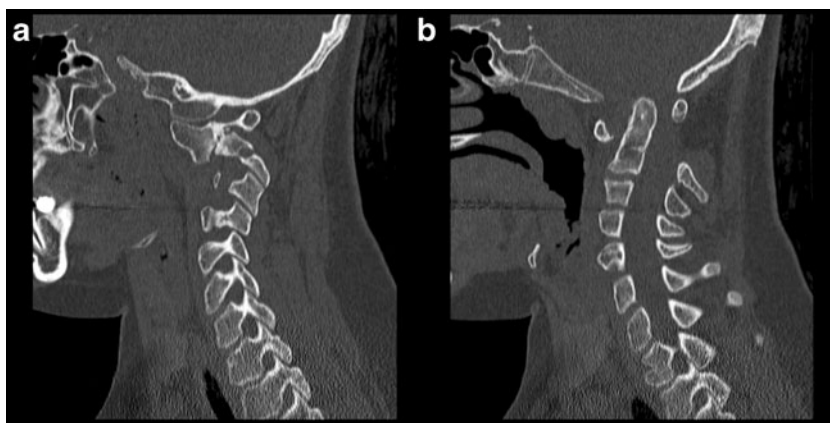
### Second operation

After induction of general endotracheal anesthesia, the patient was placed in the supine position. Motor- and sensory-evoked potentials were measured throughout the case. An

**Fig. 1** Preoperative (a) AP and (b) lateral standing radiographs of the cervical spine show atlantoaxial rotatory subluxation with an atlantodental interval >10 mm



**Fig. 2** Preoperative (a) left parasagittal and (b) mid-sagittal CT scan of the cervical spine demonstrate bony remodeling of the left lateral mass of C1 and C2 reflecting the chronicity of the injury, and the associated spinal canal stenosis from displacement of the odontoid process and basilar invagination



endoscope was inserted intranasally (Fig. 4) and the inferior turbinate, outfractured. The middle turbinate was resected. The sphenoid sinus was then opened widely and laterally. The nasal septum was then submucosally resected, and a nasopharyngeal muscular mucosal flap was harvested. The anterior arch of C1 was then exposed and removed using a pneumatic drill to provide visualization of the dens. The dissection was carried out to expose the dens from the tip to the synchondrosis (Fig. 5). A drill was then used to remove the anterior wall and medullary bone of the odontoid until the eggshell-thin posterior cortex remained; this was then removed using curettage. Fluoroscopy was used to ensure decompression. The mucosal flap was then placed in position and silicone Doyle nasal splints were placed in the nasal cavity. The patient, in good condition, was then taken to the ICU for recovery.

### Third operation

After induction of general endotracheal anesthesia, the patient was turned prone in a halo vest. Neuromonitoring was used throughout the case. The patient's posterior cervical wound was reopened, and the dissection was carried down to expose the previously placed instrumentation. Rods were

then placed bilaterally to complete the reduction and internal fixation. There were no motor or sensory signal changes during this time. The wound was then closed, and the patient was taken out of the halo vest, extubated, and transferred to the ICU in good condition.

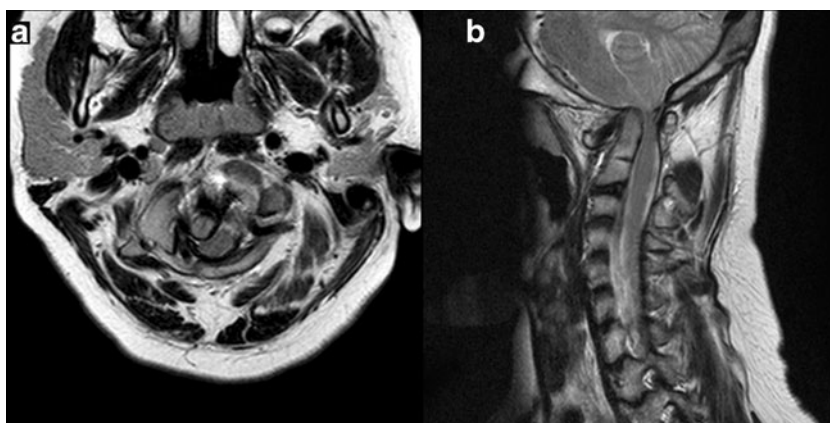
### Postoperative course

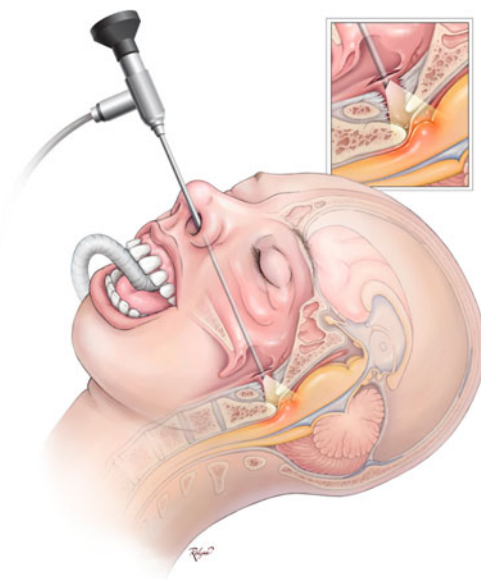
The patient's postoperative course was uncomplicated; she remained neurologically intact. Postoperative imaging (Fig. 6) showed good decompression, with instrumentation in good position. The patient was discharged home and at 7-month follow-up, was neurologically intact with a well-healed wound. She never had problems with phonation or dysphagia. Radiographs showed that there was no evidence of instrumentation failure, no loss of spinal alignment, and evidence of bony healing as of 7-month follow-up.

### Discussion

Many cases of type 3 or 4 atlantoaxial rotatory fixation (Table 1) are reducible. In chronic or irreducible cases,

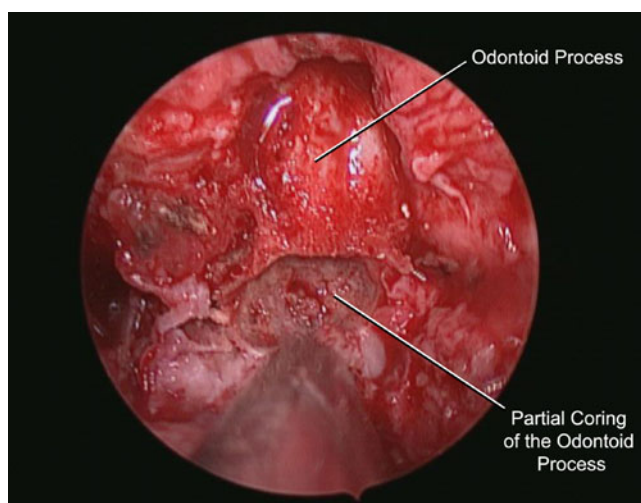
**Fig. 3** Preoperative T2-weighted (a) axial and (b) sagittal MRI of the cervical spine show significant spinal cord compression but without evidence of myelomalacia





**Fig. 4** Artist's rendition of the endoscopic endonasal approach to the odontoid process

ventral decompression of the spinal cord (prior to open reduction and posterior stabilization) may be necessary. The transoral transpharyngeal approach has been the standard approach for odontoidectomy [1, 6, 10, 14–16, 19–21]. This approach has been proven efficacious in the majority of cases. Some disadvantages of this approach include a limited operative view, a deep working distance, and potential contamination by normal oral flora [13, 22]. Reported complications include dehiscence of the posterior pharynx, alteration in phonation, tongue edema, possible need for prolonged intubation or tracheostomy, and the avoidance of oral intake [13, 22]. Exposure can be improved by transmandibular extension, LeFort osteotomies, or by use of an



**Fig. 5** Intraoperative photograph during the endoscopic endonasal approach for odontoidectomy outlines the contour and view of the odontoid process just prior to resection



**Fig. 6** Postodontoidectomy mid-sagittal CT shows a complete resection of the anterior arch of C1 and tip and body of the odontoid process adequately decompressing the spinal cord

endoscope [13]. The use of a transnasal endoscopic odontoidectomy circumvents some shortcomings of the transoral approach, including the need for a posterior pharyngeal incision.

The endoscopic endonasal approach for odontoidectomy seems ideally suited for the pediatric patient, especially when considering a child's narrow oral cavity as Magrini et al. [12], Hankinson et al. [7], and we have demonstrated in our case reports. The primary limitation of this approach is its relatively small operative field, in both the rostrocaudal and lateral directions. This limitation reflects the anatomy—such as the location of the hard palate and the size of the nostril—which prohibits placement of endoscopes and instruments. The most caudal level that can be reached by instruments through this approach is the C1 anterior arch; similar anatomic obstacles preclude resection of structures off-midline. Therefore, the endoscopic endonasal route for odontoidectomy lends itself to more severe cases of basilar invagination, as seen in our case (Fig. 2b). In addition, the small and deep working space makes it impossible to reconstruct with bone grafts or repair a dural tear with suture, predisposing the patient to persistent CSF fistula or recurrent meningitis [22].

Although, there are technical challenges for the surgeon, the patient ultimately benefits. Our patient tolerated the procedure well. She did not require prolonged orotracheal intubation and quickly resumed oral feeding. There was no tongue or palatal edema, and no dysphagia or dysphonia. She was discharged home within a week of the procedure.

## Conclusions

We present the rare case of a 10-year-old girl with atlantoaxial rotatory subluxation who underwent ventral decompression



via an endoscopic endonasal odontoidectomy. Possible advantages over the standard transoral odontoidectomy include avoidance of prolonged intubation, reduced need for tube feeding, decreased risk of phonation, and possible decreased risk of infection from a lower bacterial load in the nasopharynx compared to the oropharynx. We find this minimal access, maximally invasive approach a safe and efficacious alternative to decompressing the ventral craniovertebral junction especially in the pediatric age group. The technical challenges encountered with this approach may be overcome by familiarity with the endoscopic approach and specialized instruments, such as a long, angled high-speed drill.

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