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Clinical study

Odontoid compression of the brainstem without basilar impression – "odontoid invagination"

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Summary We report five patients with odontoid invagination, in which the odontoid process bulges upward into the foramen magnum and compresses the brainstem without deformity of the occipital bone. Two patients had a craniovertebral abnormality associated with Chiari malformation without instability of the craniovertebral junction (stable odontoid invagination). The other three patients had dislocation of the craniovertebral junction due to iatrogenic destruction of the occipital condyle, rheumatoid arthritis or an anomaly of C2 (unstable odontoid invagination). Patients with stable odontoid invagination underwent a transoral odontoidectomy followed by occipitocervical fixation. Those with unstable odontoid invagination underwent cervical traction followed by posterior fixation in reducible cases, while in irreducible cases odontoidectomy with subsequent occipitocervical fixation was performed. Decompression of the neuraxis together with symptomatic improvement was achieved in all patients and none became unstable or developed new symptoms during follow-up ranging from 3 to 15 years.
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INTRODUCTION

Compression of the neuraxis by the odontoid process in the region adjacent to the foramen magnum is known as basilar impression or invagination, which is associated with a progressive deformity of the occipital bone. However, brainstem compression by the odontoid process not associated with deformity of the occipital bone has been occasionally observed. We present our surgical experience with patients suffering from this condition.

MATERIALS AND METHODS

Since 1986, we have surgically treated five patients, ranging in age from 9 to 64 years (mean 41.4), who presented with varying severity of symptoms and signs related to odontoid compression of the brainstem. A summary of the patients is shown in Table 1.

CASE PRESENTATION

Case 1

A 56 year-old woman presented with symptomatic odontoid compression of the medulla oblongata due to a craniovertebral abnormality associated with Chiari malformation and platybasia without craniovertebral instability. One-stage surgery comprising both anterior and posterior procedures was performed: transoral odontoidectomy combined with removal of the C1 anterior arch, and posterior fossa decompression without C1 laminectomy followed by posterior occiput-C4 fixation with plates and wires as well as with iliac bone grafting. Postoperatively, the patient had symptomatic improvement except for residual sensory impairment.

Case 2

A 22 year-old woman presented with a seven month history of headache, dysphagia, neurogenic bladder and dysesthesia in the right upper extremity. Although these symptoms improved after conservative therapy, they recurred accompanied by quadriparesis. Preoperative neuroimaging showed compression of the medulla oblongata by a long odontoid process associated with a Chiari malformation but without craniovertebral instability (Fig. 1A). She underwent posterior decompression with a C1 laminectomy. Bone chips harvested from the occipital craniectomy and laminectomy were placed between the occiput and C2 (Fig. 1B). Immediately after surgery she developed progressively worsening quadriparesis and complained of respiratory difficulty, therefore an emergency anterior decompression was performed 30 hours postoperatively. Under general anesthesia with orotracheal intubation, a halo vest was applied, after which the odontoid process was removed while preserving the rostral part of the C1 anterior arch. This was followed by iliac bone grafting between the C1 arch and C2 body (Fig. 1C). The halo vest was left in place for four months postoperatively, until a bony union had been established, both posteriorly and anteriorly. The patient had full recovery from her symptoms.

Case 3

A 51 year-old man presented with compression of the medulla oblongata caused by upward dislocation of the odontoid process and the right half of the atlas. This followed destruction of the right occipital condyle for a right-sided suboccipital craniectomy for a clival chordoma. After successful reduction by cervical traction followed by symptomatic improvement, he underwent posterior occiput-C4 fixation with plates and wires followed by iliac bone grafting between the occiput and C2. A halo vest was applied for 2 months postoperatively. This case has been reported elsewhere.[1]

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Table 1

Case No.	Age (yrs) / Sex	Preoperative symptoms and signs	Cause of odontoid invagination / associated lesions	Surgical management	Results	Follow-up (years)
1	56/F	Dysphagia, dysarthria, loss of gag bilat, numbness hands, weakness L arm	Craniovertebral anomaly, Chiari malformation, platybasia	One stage operation, odontoidectomy, posterior decompression, occipitocervical fixation, bone graft	Improved, residual tongue atrophy and numbness	11
2	22/F	Headache, dysphagia, loss of gag R, sensory disturbance 4 limbs R>L, weakness hands R>L and R leg, neurogenic bladder	Long odontoid, Chiari malformation	First operation – posterior decompression C1 laminectomy, bone graft. Second operation – odontoidectomy, bone graft. Post-op halo immobilization	Improved	6
3	51/M	Neck and pharyngeal pain, nystagmus, R CN 6 palsy, loss of gag R, tongue atrophy L/CN 12 palsy	Occipitoatlantal instability, destruction of R occipital condyle	Cervical traction, occipitocervical fixation, bone graft. Post-op halo immobilization	Improved, residual tongue atrophy	15
4	64/F	Neck pain and restricted movement, R hemiparesis	Locked AAD, rheumatoid arthritis	Cervical traction, C1-2 sublaminar wiring, bone graft	Improved	2.7
5	9/F	Neck pain, numbness upper limbs L>R, weakness hands R>L	Locked ADD, aplasia of L C2 superior articular process	Cervical traction. First operation – occipitocervical fixation, bone graft. Second operation – odontoidectomy, bone graft. Post-op halo immobilization	Improved	5

F = female, M = male, R = right, L = left, bilat = bilateral, CN = cranial nerve, AAD = atlantoaxial dislocation.

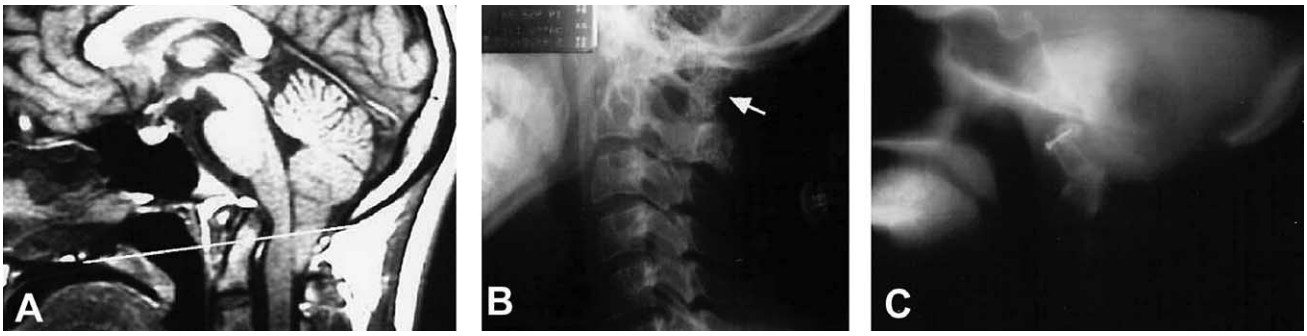

Fig. 1 Case 2. A. Preoperative sagittal T1-weighted MRI showing compression of the medulla oblongata by an elongated odontoid process, associated with a Chiari malformation. The tip of the odontoid process is 10 mm above McGregor's line (white line). B. Postoperative plain x-ray after posterior decompression with a C1 laminectomy and fusion. Bone graft was placed between the occiput and C2 (arrow). C. Postoperative midsagittal tomogram after transoral odontoidectomy. A piece of iliac bone is inserted between the remaining rostral part of the C1 arch and the C2 body and fixed with mini-screws to the residual C1 arch.

Case 4

A 64 year-old woman with rheumatoid arthritis developed compression of the medulla oblongata by an odontoid process dislocated upward due to atlantoaxial dislocation (AAD) associated with locked facets of C1. AAD was reduced by cervical traction followed by symptomatic improvement. The patient also underwent posterior C1-2 fixation with sublaminar wiring and iliac bone grafting.

Case 5

A 9 year-old girl noticed motor weakness in the right upper extremity during exercise 2 months before admission, and gradually developed neck pain, difficulties with using chopsticks and writing, and numbness in the upper extremities, predominantly on the left. Radiological examination showed an upward dislocation of the odontoid process into the foramen magnum (Fig. 2A), a defect of the C1 lamina, os odontoideum, partial fusion of the C3-4 laminae and aplasia of the superior articular process of C2 on the left side (Fig. 3C) as well as AAD with locked facets of C1 (Fig. 3B). MRI revealed severe compression of the medulla oblongata by the odontoid process (Fig. 3A). The locked AAD was reduced using cervical traction, which also resulted in improvement of the motor weakness (Fig. 2B). She underwent posterior occiput-C4 fixation using titanium plates, wires and screws followed by iliac bone grafting between the occiput and C2. She was discharged 1.5 months postoperatively. However, she gradually developed quadriparesis and radiological examination demonstrated re-dislocation of C1 and recurrent odontoid invagination (Fig. 2C). We now consider that external immobilization using a halo vest should have been used postoperatively until a bony union had been obtained. After readmission cervical traction was performed, resulting in some improvement of motor weakness but without a significant reduction. She therefore underwent a transoral odontoidectomy 4 months after the first surgery. With the patient in a halo vest, transoral odontoidectomy was performed with preservation of

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