Odontoid pseudotumor and serial postfusion radiographic evaluation in a patient with a C1–2 mass

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Odontoid pseudotumor is a mass occurring around the odontoid process in the cervical spine and can cause significant neurological symptoms at the craniovertebral junction due to compression of the spinal cord and cervicomedullary junction at this level. A literature review was performed to provide input on options for treatment and prognosis for this lesion. The literature search found 12 papers in which pseudotumor was treated with posterior decompression and fixation. Posterior decompression and fixation with serial imaging to monitor the size of the pseudotumor postsurgery is a safe and effective treatment option for odontoid pseudotumors.

http://thejns.org/doi/abs/10.3171/2014.10.SPINE13987

KEY WORDS pseudotumor; craniovertebral junction; posterior fusion; cervical

Odontoid pseudotumor is a mass occurring around the odontoid process in the cervical spine, and can cause significant neurological symptoms at the craniovertebral junction due to compression of the spinal cord and cervicomedullary junction at this level.1,22,25 This in turn can lead to severe neurological deficit in patients, which can range from mild myelopathy to complete paralysis in severe cases.21,22 A retroodontoid mass can occur in patients due to a variety of conditions such as rheumatoid arthritis,13,15,16 long-term dialysis,17,22 mucinous degeneration of transverse ligament of the atlas,6,22 or migrated disc herniation.13,21,22 Moreover, retroodontoid pseudotumor can also occur idiopathically. It is postulated that degenerative changes and ligamentous calcification can cause immobility and instability of the lower cervical segments, thus increasing the mechanical stress on the atlantoaxial joint resulting in pseudotumor formation.3,19 In this paper we report the case of a 78-year-old man with a C1–2 mass, diagnosed after the patient presented with myelopathic and spastic quadriparetic symptoms. We provide a description of the treatment for this condition, including radiographic follow-up, as well as review the literature on the subject to provide options for treatment and prognosis for this lesion.

Case Report

History and Examination

We report the case of a 78-year-old active businessman who presented to the emergency room with a 3-week history of significant difficulty with gait and fine motor movements. The patient reported having a 1-year history of progressively worsening symptoms of pain, numbness, and tingling initially in the lower extremities and progressing to the upper extremities. He also complained of worsening bilateral lower-extremity weakness and difficulty ambulating. The patient had a medical history of hypertension and prostate cancer, treated with radiation 10 years prior and with a normal prostate-specific antigen. The patient also had a smoking history (one-quarter pack per day for 15 years), but quit approximately 7 years prior to the presenting symptoms.

On physical examination, the patient had spastic weakness in the bilateral upper and lower extremity (3/5 to 4/5), profound myelopathic reflexes with hyperreflexia present throughout bilateral upper and lower extremities, clonus in bilateral lower extremities, upgoing bilateral Babinski reflexes, and bilateral positive Hoffman reflex. He had intact sensation and intact rectal tone, with some impairment of proprioception. He underwent MRI of the cervical spine, which showed a C1–2 mass with severe compression of the spinal cord (Fig. 1). The initial differential diagnosis included the following: metastatic tumor (given the patient’s history of prostate cancer and a smoking history); a craniovertebral junction tumor such as meningioma; a rheumatoid pannus; or odontoid pseudotumor. The patient was started on Decadron, with mild initial improvement of his symptoms. Initial evaluation included a transoral biopsy...
of the lesion; the transoral biopsy was performed due to
the patient’s smoking history and his history of prostate
cancer. Biopsy results were nondiagnostic for malignancy,
and only consisted of cartilage and soft connective tissue.
Given these biopsy findings, a complete rheumatoid ar-
thritis workup was performed by the rheumatology ser-
vice. All rheumatological workup was negative for rheu-
matoid arthritis.

Operation

The patient underwent a suboccipital craniectomy, pos-
terior cervical decompression, occipitocervical instrumen-
tation, and fusion of his cervical spine within days of his
presentation to the emergency room. Given the severity of
central stenosis and foraminal stenosis due to herniated
discs and multilevel degenerative spondylosis with intrin-
sic cord changes, decompression included a suboccipital
 craniectomy and C1–5 laminectomies with foraminoto-
mies. Hardware placed included the following: occipital
plate; C-1 lateral mass screw; C-2 pedicle screw; and C-3,
C-4, and C-5 lateral mass screw placement for stabiliza-
tion and fusion of the occiput to C-5 (Fig. 2). Intraoperative
neuromonitoring revealed a significant improvement in
amplitude and latency in all extremities immediately fol-
lowing completion of the C-1 laminectomy. Postoperative
imaging revealed excellent placement and alignment of the
hardware with wide decompression of the neural elements
(Fig. 3). The CT scans and flexion-extension radiographic
imaging obtained at 12 months postoperatively revealed
excellent fusion from the occiput down to C-5 without evi-
dence of instability.

Postoperative Course

The patient was transferred to the NeurolCU with im-
mediate improvement in neurological examination after
surgery. One year after surgery, the patient was at near
normal status on neurological examination, with signif-
ciant improvement in gait, fine motor skill, and strength as
well as improvement of myelopathy. On serial radiological
examination, the MRI of the cervical spine showed near
resolution of the pseudotumor, without impingement on
the spinal cord (Fig. 4).

Discussion

Odontoid pseudotumor can cause significant myelopa-
thy in patients with rheumatoid arthritis, long-term dialysis,
degeneration of transverse ligament of the atlas, migrated
disc herniation, anterior subluxation of the atlantoaxial
joint, spondylosis, and pseudarthrosis following fracture
Odontoid pseudotumor treatment

Our patient did not have a history of trauma, fracture of the odontoid process, rheumatoid arthritis, or history of dialysis. The histopathological analysis of the biopsy specimen showed that the mass was nonneoplastic and was consistent with cartilage and soft connective tissue. Other authors have reported similar cases in the literature as well. Yamaguchi et al. reported a series of 3 cases of idiopathic pseudotumor, in which the patients underwent laminectomy and posterior fusion with complete resolution of symptoms and reduction or disappearance of the mass. Additionally, our literature review gives several descriptions of the histopathological appearance of a pseudotumor specimen. Crockard et al. describes the mass associated with pseudotumor as degenerative fibrochondral tissue without evidence of inflammation, similar to the histopathological description in the case we report. Sze et al. determined that the pseudotumor tissue formation was the direct result of chronic atlantoaxial subluxation and had the appearance of a granuloma.

Pseudotumor can arise from different ligaments or parts of the ligaments comprising the atlantoaxial joint. Figure 5A illustrates the various ligaments in this region. The cruciate ligament passes from the atlas through the foramen magnum to attach on the posterior surface of the clivus in the cranial base (Fig. 5A). The apical ligament arises anterior to the tip of the odontoid, usually from a small coronal groove, and inserts into the anterior rim of the foramen magnum at the basion (Fig. 5B). The alar ligaments connect the sides of the odontoid to the tubercles on the medial side of the occipital condyle (Fig. 4A). The tectorial membrane is the most superficial layer toward the dura mater, and it is continuous with the posterior longitudinal ligament (Fig. 4B). Although these ligaments are interconnected, our literature review revealed that the most common site of occurrence of the pseudotumor was from the band of the cruciate ligament (Fig. 5C). In the case of our patient, it is difficult to identify which ligament is primarily involved due to the considerable size of the pseudotumor mass (Fig. 1).

Traditionally, 2 approaches have been used for the treatment of odontoid pseudotumor. Some surgeons advocate the direct anterior resection of the pseudotumor via a transoral or a transnasal approach. The most significant advantage of this procedure traditionally was the ability to analyze the tissue directly by histopathological analysis, to evaluate for a neoplastic process. However, this approach has been traditionally fraught with many complications including complicated postoperative management, an increased risk of infection, need for external fixation and/or fusion due to instability, delayed extubation due to the risk of palatal dehiscence, pharyngeal hemorrhage, and airway edema. However, with the current state of neuronavigation, obtaining a small tissue biopsy sample is easier and poses less risk to the patient. In our case we opted to obtain a minimally invasive transoral biopsy sample by using fluoroscopy to decrease the risk to the patient while obtaining a specimen to evaluate for malignancy.

Alternatively, some surgeons recommend posterior decompression and fusion with or without direct mass resection. The posterior approach with decompression and fusion carries fewer potential complications and risks to the patient than an anterior only or a combined approach. We obtained serial MRI evaluation at 3, 6, and 12 months postoperatively to ensure the reduction of the size of the mass, because any increased size or decline in neurological status would have prompted an anterior resection (Fig. 4). Grob and colleagues and Yamaguchi et al. used this approach in their patients to treat deformity of the atlantoaxial region with minimal complications and reduction or resolution of the pseudotumor. The extent of the fusion should be evaluated for each patient individually based on clinical, neurophysiological, and radiographic findings. For a small pseudotumor, a C1–2 fusion may fix the unsta-
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<td>Rosenberg et al., 1991</td>
<td>Intermittent paresthesias of the lt hand spreading progressively to the lt forearm, arm, &amp; leg; decreased hearing in lt ear &amp; recent 2-day history of numbness over the entire lt side of the body</td>
<td>Retroodontoid ruptured discs appearing as a mass</td>
<td>Suboccipital craniectomy w/ C-1, C-2, &amp; partial C-3 laminectomies &amp; mass drainage</td>
<td>Marked reduction in the size of the retroodontoid mass, w/o evidence of recurrence on MRI</td>
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<td>Choe et al., 1993</td>
<td>Numbness of hands &amp; feet &amp; weakness of extremities, progressive difficulty in balancing, &amp; lower occipital headache; positive Romberg sign &amp; mild dysmetria</td>
<td>Synovial cyst of the dens causing spinal cord compression</td>
<td>Transoral resection of C-1 arch &amp; dens, cyst removal, &amp; upper cervical spine fusion</td>
<td>Recovery of strength &amp; sensation in the patient's arms &amp; legs</td>
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<td>Cho et al., 2001</td>
<td>Hearing difficulties in the rt ear &amp; occasional pain in the rt temporal bone &amp; temporomandibular joint</td>
<td>Idiopathic inflammatory pseudotumor</td>
<td>60 mg prednisolone/day for 10 days &amp; tapered over the following 4 days, &amp; 2 subsequent RT treatments</td>
<td>Short-term symptomatic relief w/recurrence of mass at 4-mo follow-up</td>
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<td>Zorzon et al., 2001</td>
<td>Numbness, incoordination, &amp; clumsiness in both hands, gait instability, &amp; bladder &amp; bowel dysfunction</td>
<td>Synovial cysts of the atlantoaxial articulation</td>
<td>C-1 hemilaminectomy &amp; partial C-2 hemilaminectomy, complete evacuation of the cyst contents, &amp; subtotal removal of the cyst wall</td>
<td>Symptomatic relief w/o recurrence of cyst</td>
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<td>Jun et al., 2002</td>
<td>Spastic tetraparesis, loss of joint position sensation, &amp; stiffness in the legs</td>
<td>Retroodontoid pseudotumor w/ diffuse idiopathic skeletal hyperostosis</td>
<td>Transoral removal of the extradural mass &amp; dorsal atlantoaxial fusion</td>
<td>Marked decrease in spasticity &amp; improved muscle strength</td>
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<td>Sagiuchi et al., 2006</td>
<td>Spastic tetraparesis, 4/5 strength in all extremities, all deep tendon reflexes hyperreactive, bilat Babinski sign, dysesthelia in patient's hands &amp; toes</td>
<td>Extrudal cyst extending posteriorly to the dens &amp; compressing the upper cervical cord, &amp; atlantoaxial subluxation</td>
<td>Cyst: Philadelphia collar; atlantoaxial subluxation: C1–2 posterior fusion</td>
<td>Spontaneous regression of cyst &amp; successful C1–2 posterior fusion for atlantoaxial subluxation</td>
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<td>Ito et al., 2007</td>
<td>Occipital pain, numbness of both UEs, &amp; mild weakness of the rt UE</td>
<td>Rheumatoid arthritis–negative atlantoaxial dislocation complicated by an extradural mass in the craniovertebral junction</td>
<td>C-1 laminectomy w/ posterior fixation of atlantoaxial dislocation</td>
<td>Motor weakness of the rt UE &amp; sensory disturbance of both UEs improved, &amp; 3-mo follow-up imaging showed reduced retroodontoid mass size</td>
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<td>Takami et al., 2007</td>
<td>Progressive myelopathy manifesting as clumsy hand &amp; gait disturbance after a fall</td>
<td>Retroodontoid pseudotumor</td>
<td>C-1 laminectomy &amp; posterior C1–2 fixation w/ individual screw placement in C-1 &amp; C-2</td>
<td>At 6 mos postop, no evidence of instability in the atlantoaxial joint &amp; diminished retroodontoid pseudotumor</td>
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<td>Cecchi et al., 2008</td>
<td>Progressive tetraparesis, ataxic gait, &amp; cervical pain</td>
<td>Atlantoaxial degenerative articular cyst</td>
<td>Philadelphia collar &amp; a short-term course of NSAIDs &amp; corticosteroids</td>
<td>Almost complete regression of atlantoaxial cyst &amp; symptomatic relief</td>
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<td>Goel &amp; Dange, 2008</td>
<td>Spastic quadriparesis &amp; only able to walk w/ the aid of crutches</td>
<td>Rheumatoid retroodontoid pannus, fixed atlantoaxial dislocation, basilar invagination, &amp; significant cord compression</td>
<td>Lateral mass reconstruction w/ distraction of the facets &amp; impactation of a spiked metal spacer &amp; bone graft w/in the joint</td>
<td>Complete disappearance of retroodontoid pannus &amp; reduction of basilar invagination &amp; atlantoaxial dislocation</td>
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<td>Tanaka et al., 2010</td>
<td>Severe myelopathy w/ motor weakness of both UEs, sensory disturbance in all 4 extremities, clumsy hand movements, increased deep tendon reflex, &amp; a positive Babinski reflex</td>
<td>Retroodontoid pseudotumor</td>
<td>Surgical decompression of posterior spinal canal by laminectomy of the atlas &amp; the axis &amp; posterior C1–2 transarticular fixation w/o mass resection</td>
<td>Immediate symptomatic relief &amp; marked reduction in mass size &amp; spinal compression</td>
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RT = radiotherapy; UE = upper extremity.
ble segment and help reduce the mass. For larger masses, which involve multiple ligaments around the odontoid and produce craniovertebral spinal cord compression, a larger surgery may be needed with extensive decompression and fusion including C-1 and the occiput.

Conclusions

Odontoid pseudotumor is a mass that surrounds the odontoid process and can cause significant neurological complications due to compression of the neural elements, including brainstem and upper cervical spinal cord. Managing a lesion such as this requires careful assessment and evaluation. From our literature review it appears that in the absence of a neoplastic process, a posterior craniovertebral decompression and fusion can be safely performed to decompress and stabilize the patient’s spine and prevent further injury (Table 1). Resection of the mass may be performed at this time, although our serial radiographic follow-up and the literature review indicate that the pseudotumor mass regresses over time once the decompression and stabilization procedure has been performed. This finding supports the previous literature (Crockard et al. and Sze et al.) findings that chronic instability and degeneration may form the pseudotumor, and that stabilization of this joint can arrest or reverse the pseudotumor. Serial MR images can be used to monitor the reduction in size of the mass. Our patient demonstrated near resolution of his pseudotumor on radiological examination and a near normal neurological examination at 1 year postsurgery. It appears from our literature search that posterior decompression and fixation with serial imaging to monitor the size of the pseudotumor postsurgery is a safe and effective treatment option for odontoid pseudotumors.

Acknowledgment

The authors would like to acknowledge Christian Rafla for his assistance in the literature search.

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Conception and design: Yanni, Halim. Acquisition of data: all authors. Analysis and interpretation of data: all authors. Drafting the article: Alexandru, Halim. Critically revising the article: Yanni, Halim. Reviewed submitted version of manuscript: all authors. Statistical analysis: all authors. Administrative/technical/material support: all authors. Study supervision: Yanni.

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