Atlantoaxial instability in monozygotic twin sisters: degenerative or congenital disease?

Report of 2 cases

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The authors report on two 70-year-old monozygotic twin sisters who both suffered severe nontraumatic atlantoaxial instability. If either had been a solitary case, degenerative atlantoaxial instability would have been the most straightforward diagnosis. In this case report the authors attempt to answer the question of whether an underlying congenital predisposition might be involved.

(http://thejns.org/doi/abs/10.3171/2013.12.SPINE1327)

Key Words • atlantoaxial instability • monozygotic twins • congenital • degenerative disease

Atlantoaxial instability can occur as a result of traumatic disruption of the transverse ligaments with or without fracture and is a potentially life-threatening situation. Nontraumatic causes of atlantoaxial instability, such as rheumatoid arthritis causing progressive destruction of the C1–2 joints, os odontoideum resulting in insufficiency of the odontoid peg, or metabolic diseases with ligamentous insufficiency, can lead to progressive or repetitive narrowing of the anteroposterior diameter of the spinal canal with compression of the spinal cord and subsequent myelopathy. Severe degeneration of the C1–2 joints may rarely produce a similar condition.

In this paper, we report the medical history of two 70-year-old monozygotic twin sisters who both suffered from severe atlantoaxial instability and had identical radiographic features. Signs of inflammatory or metabolic disease, clear congenital disorders, or traumatic injuries could not be identified. Had either sister been a solitary case, degenerative atlantoaxial instability would have been the most straightforward diagnosis. In this case, however, the question arises as to whether an underlying congenital predisposition might be involved.

Case Reports

Case 1

History and Examination. Twin A, a 70-year-old woman, experienced progressive bilateral paresthesia in both hands, with neck pain beginning at 63 years of age. There was no history of trauma. Laboratory tests were negative for rheumatoid arthritis. Her neurological clinical examination was normal.

Lateral radiographs (Fig. 1A) and CT scans (Fig. 2A) of the cervical spine in the neutral position showed a widened distance (10.3 mm) between the anterior surface of the odontoid and the posterior surface of the anterior arc of C-1. Dynamic radiographs confirmed atlantoaxial instability with an atlantodental interval of 3 mm in extension and 12 mm in flexion (Fig. 1B and C). Cervical MRI showed a partially cystic structure anterior to the odontoid in the atlantodental joint space. The anterior aspect of this lesion appeared hypointense on T2-weighted images, highly suggestive of thickened synovial tissue (Fig. 2B). The posterior part of the lesion demonstrated a T2 hyperintense signal. On T1-weighted images, the lesion appeared heterogeneously hypointense with small zones of a hyperintense signal. Marked spinal cord compression with associated myelomalacia was found (Fig. 2B). Thickening of the atlantoaxial ligament was observed. The apical ligament could not be demonstrated on MRI or on CT. There was no bone erosion of the odontoid. Axial and sagittal reconstructed CT scans showed soft-tissue calcifications on the top of the odontoid, probably due to degenerative changes of the proximal part of the apical ligament (Fig. 2A).

Operation and Postoperative Course. This patient
was treated with a posterior C1–2 open reduction and fixation according to Harms’ technique. Postoperatively, the paresthesia disappeared and she regained capacity for normal daily activities. Postoperative radiographs of the cervical spine show a good reduction and fixation (Fig. 2C and D). At long-term follow-up (60 months) only mild intermittent axial neck pain was present. A neurological examination showed no abnormalities with normal motor and sensory function, normal reflexes, and a normal gait.

**Case 2**

**History and Examination.** Twin B presented with neck pain and paresthesia in her right hand at the age of 68 years, months after a benign fall. Testing for rheumatoid arthritis was negative. Neurological clinical examination revealed hyperalgesia in the fingertips of both hands and a mild weakness (4+/5) of the right hand.

Identical to the first case, atlantoaxial instability could be visualized on conventional radiographs (Fig. 3) and sagittal CT (Fig. 4A). A widened atlantodental interval (11 mm) was demonstrated on the lateral image in the neutral position and flexion of the cervical spine. The distance decreased to 3 mm during extension in a lateral view of C1–2. On MRI, a cystic lesion was visualized in the atlantodental joint, similar to the findings in her twin sister. The content of this lesion appeared hyperintense on T2-weighted imaging (Fig. 4B) and homogeneously hypointense on T1-weighted imaging. The anterior atlantoaxial and atlantoaxial ligaments appeared hypertrophic. Secondary narrowing of the spinal canal with severe spinal cord compression and associated myelomalacia was demonstrated on MRI and CT.

**Operation and Postoperative Course.** This patient was treated with a C–1 laminectomy and occipitocervical fusion (each sister was treated by a different surgeon). This surgical strategy was chosen because of the potential risk of incomplete reduction with persistent compression of the spinal cord. Because of the laminectomy, C1–2 fixation was considered to be insufficiently supportive and a more radical fixation was performed. Postoperative radiographs of the cervical spine show a good reduction and fixation (Fig. 4C). At long-term follow-up (36 months) her paresthesia almost completely disappeared and she had resumed daily activities that were previously not possible. Her neurological examination was normal except for a restriction in head movement.

**Discussion**

Nontraumatic atlantoaxial instability is a rare condition. Most cases are secondary to rheumatoid arthritis or metabolic or congenital disorders. Degenerative atlantoaxial instability is an exceptional condition. Our 2 patients, monozygotic twin sisters, both presented in their 7th decade of life with neurological symptoms caused by atlantoaxial instability and secondary spinal cord compression. Previous reports of atlantoaxial instability in monozygotic twins all describe a clear underlying diagnosis such as os odontoideum and Down syndrome.13,17

The sisters showed no history of severe trauma, rheumatoid arthritis, or an underlying metabolic or congenital disorder. Hence, these findings are strongly suggestive of a degenerative cause of atlantoaxial instability. However, the fact that they have almost identical clinical and imaging findings, as well as their genetic profile, suggests the existence of a congenital predisposing factor. We discussed the probability of an underlying genetic disorder with the department of human genetics. No genetic testing was considered relevant because of the lack of any other signs of genetic disorders.

**Factors in Favor of Degenerative Disease**

Degenerative atlantoaxial joint osteoarthritis can result in atlantoaxial instability. In a retrospective study with a series of 108 patients with atlantoaxial joint arthritis,
Goel et al. noted that instability may be caused by degeneration of the articular cartilage, subsequent reduction in joint space, and secondary buckling and incompetence of ligaments. In their experience the process of atlantoaxial joint arthritis is initiated or exacerbated by a subtle or manifest trauma. One of our twin patients did suffer a subtle neck trauma months before symptom onset.

**Imaging Findings.** Radiological findings associated with degenerative atlantoaxial instability are reduction in the height of the lateral mass complex, periodontoid and periarticular ligamentous hypertrophy, osteophyte-like bone formation, and periodontoid (including atlantodental joint and retroodontoid region) soft-tissue mass. Both twin sisters had hypertrophy of the atlantodental and atlantoaxial ligaments as well as a cystic lesion in the atlantodental joint (Figs. 2B and 4B).

**Cystic Lesions.** Although rare, degenerative spinal synovial cysts at the C1–2 junction associated with atlantoaxial instability have been reported. Most atlantodental joint cysts, however, have a retroodontoid extension causing medullary compression, and these lesions are frequently misdiagnosed as either rheumatoid pannus or tumor. In our cases the cysts were located within the atlantodental joint. The atlantodental joint is a true synovial joint and is responsible for a large proportion of normal cervical mobility. The cause of spinal degenerative articular cysts is unclear, but a degenerative origin is assumed because minor damage after excessive or chronic stress to articular surfaces may produce reactive proliferation of synovium with secondary accumulation of mucinous fluid.

**Ligamentous Failure.** In preventing atlantoaxial instability, the most important ligament is the transverse ligament, which is the largest, strongest, and thickest ligament in the upper cervical spine. Studies of horizontal translation showed that an anterior dislocation of C-1 on C-2 can occur with an insufficiency of the transverse ligament alone. The alar ligaments and the tectorial membrane did not prevent dislocation after the transverse ligament was transected. Unfortunately, in our cases the transverse ligaments could not be identified, either on MRI or on CT.
However, on plain radiographs, clear signs of ligamentous insufficiency can be depicted (Figs. 1 and 3).

Factors in Favor of Congenital Disease

In the absence of a congenital syndrome or other congenital diseases in which atlantoaxial instability can be a clinical hallmark, the only hereditary factor in this case report appears to be the fact that the patients are monozygotic twin sisters. The striking resemblance of their imaging features, however, suggests a congenital influence. In several twin studies, a genetic factor in the pathogenesis of cervical spondylosis is suggested. Bull et al. found that the cervical spines in twins developed and degenerated in similar fashions. Palmer et al., in a report on lateral cervical spine radiographs of 23 pairs of twins, found a close similarity in the shape of the vertebrae of twins, particularly if monozygotic. They also describe a similar pattern of degenerative changes in identical twins. Sambrook et al., in a study of degenerative disc disease in identical twins, found that heritability was 74% for the lumbar spine and 73% for the cervical spine. Battie et al. concluded in their review of the Twin Spine Study that although environmental factors play an important role, disc degeneration appears to be determined in great part by genetic influences. Mukerji and Sinar, in their review, reported that given the nature of degenerative disc disease and the role of environmental factors in the degenerative process, it would be helpful to consider a multifactorial genetic model for this disease process rather than focusing on a single gene, although multiple genes have been identified to be associated with disc degeneration.

Conclusions

Nontraumatic C1–2 instability is a rare condition, usually secondary to rheumatic, metabolic, or congenital conditions. Although no congenital syndrome appears to be present in our 2 cases, it is striking that this rare condition appeared in an almost identical way in monozygotic twins, suggesting a genetic predisposing factor. The symptoms of myelopathy only appeared in their 7th decade of life, which emphasizes the role degeneration must have played. The presence of a synovial atlantoaxial joint cyst in both cases, a sign of joint degeneration, also supports the latter possibility. We therefore conclude that both sisters developed the same rare degenerative condition based on a strong genetic predisposition.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: de Jong, Verfaillie. Acquisition of data: Lauweryns, Goffin, Depreitere. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: de Jong. Study supervision: Depreitere.

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Fig. 4. Case 2. A: Sagittal CT scan showing clear atlantoaxial dislocation and secondary narrowing of the spinal canal. B: Midsagittal T2-weighted MR image showing a well-circumscribed cystic lesion (arrow) in the widened atlantoaxial interval with spinal cord compression and myelomalacia. C: Postoperative sagittal radiograph demonstrating reduction of the atlantoaxial dislocation and occipitocervical fusion.
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Manuscript submitted March 6, 2013.
Accepted December 16, 2013.
Portions of this work were presented in poster form at the annual meeting of the Belgian Society of Neurosurgery in Liège in March 2008.
Please include this information when citing this paper: published online January 31, 2014; DOI: 10.3171/2013.12.SPINE13227.
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