

Atlantoaxial Instability: Clinical Implications of Newer Understanding

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ABSTRACT

Atlantoaxial joint is the most mobile joint of the spine. The joint architecture is supremely designed to permit circumferential movements that allow the human to say both 'Yes' and 'No' and a host of other gestures. The atlas and axis bones function in unison and the bones and ligaments are specially crafted to allow movements, keep head firmly attached to the spine and permit a safe and unrestricted passage to the most crucial arteries and nerves and spinal cord. To conduct its activity of circumferential movements the joint surfaces are flat and round and there is no restriction to movements that can happen when the joint is of a hinge or a ball and socket type.

KEY WORDS: Atlantoaxial instability, craniovertebral junction, odontoid process

INTRODUCTION

The atlantoaxial joint is the most mobile joint of the spine. The joint architecture is supremely designed to permit circumferential movements that allow the human to say both 'Yes' and 'No' and a host of other gestures. The atlas and axis bones function in unison and the bones and ligaments are specially crafted to allow movements, keep head firmly attached to the spine and permit a safe and unrestricted passage to the most crucial arteries and nerves and spinal cord. To conduct its activity of circumferential movements, the joint surfaces are flat and round and there is no restriction to movements that can happen when the joint is of a hinge or a ball and socket type.

The odontoid process resembles an intervertebral disc in its function (3). Both disc and the odontoid process are like opera conductors and control the movements of the region without actually participating in any activity (17). All the movements of the spine are centred on the facets, and not on the disc or on the odontoid process. This fact can be observed by an array of large and small, strong and strategic muscles located around them. On the contrary, the muscles located around the disc or the odontoid process are only a thin and flimsy layer. The disc and odontoid process form the brain of movements that are centred on and

articulated at the facets. We recently likened the situation at the craniovertebral junction to a two-wheeled rickshaw maneuvered by a rickshaw puller (3). The rickshaw puller was likened to the odontoid process whilst the large wheels simulated the facets. The role of the rickshaw puller is to direct the rickshaw and control the movements without actually participating in any kind of weight bearing or movement activity that happens at the wheels. The site of fulcrum of movement and activity is also the site of abnormal activity. All the atlantoaxial instability is focussed at the facets.

Atlantoaxial facets are the most mobile joints of the entire spine. Whilst only translatory movements are possible in other facet joints, there are circumferential movements at the atlantoaxial joints. Whilst only vertical instability is possible in other facet joints, there can be circumferential axial, anteroposterior and lateral dislocation at the atlantoaxial joint (10,11,14-16). The wide range of movements at the atlantoaxial joint and the joint architecture subjects it to a multitude of stresses and strains and makes it prone to develop instability. Our current experience suggests that the atlantoaxial joint has the potential to be the most unstable facet joint of the spine. The nature of instability of the atlantoaxial joint needs to be evaluated and understood in a three-dimensional perspective.

Atlantoaxial instability has been traditionally evaluated by abnormal alteration in the atlantodental interval. The parameter has been popularly used as it was relatively easily assessed by conventional plain radiological examination. With the advent of computer-based imaging, the impingement and compression of the brainstem-spinal cord by the odontoid process is more easily recognised. The pressure effects observed on the spinal cord and the dynamicity of the abnormal movements of the odontoid process dictated the treatment for about two decades. Facetal alignments and malalignments in the subaxial spine are not observed on conventional and even modern radiological imaging due to their oblique profile and lateral location. However, facetal malalignments are relatively easily observed in the atlantoaxial facets due to their brick over brick pattern of construction and alignments (2). Type A facetal instability is defined as the situation when in neutral head position the facet of atlas is dislocated anterior to the facet of axis. Type B facetal instability is when in the neutral head position; the facet of atlas is dislocated posterior to the facet of axis. Type C facetal instability is when the facets of atlas and axis are in alignment and the instability of the atlantoaxial joint can be identified only by direct manipulation of the bones during surgery (2).

Evaluation of atlantoaxial instability by facetal malalignments has opened up a new chapter in the understanding of

the subject and has opened up newer vistas for evaluation and increased the scope and possibilities of treatment. Type A facetal instability is associated with posterior migration of the odontoid process and its direct impingement into the neural structures. Considering the fact that neural compromise is relatively early in such cases, the clinical manifestations are rather acute in nature. Acute atlantoaxial dislocation and Group A basilar invagination is usually associated with Type A facetal dislocation (1). In Type B and C, there is no abnormal alteration of the atlantodental interval and there is no direct compression of the neural structures by the odontoid process. The subarachnoid spaces posterior to the odontoid process may be intact and normal. Considering that neural compression is not a manifestation, the symptom complex is rather chronic in such cases. Group B basilar invagination, generalised cervical spondylotic disease and long and multiple segment ossified posterior longitudinal ligament (OPLL) are more often associated with Types B and C facetal dislocation (4,6 -9).

Essentially, in cases with Type B and C facetal dislocation, there is instability without any demonstrable or identifiable neural compression. The symptom complex is longstanding and is a secondary response to primary atlantoaxial instability. However, associated musculoskeletal and neural malformation should be understood and evaluated and accordingly the atlantoaxial instability needs to be identified

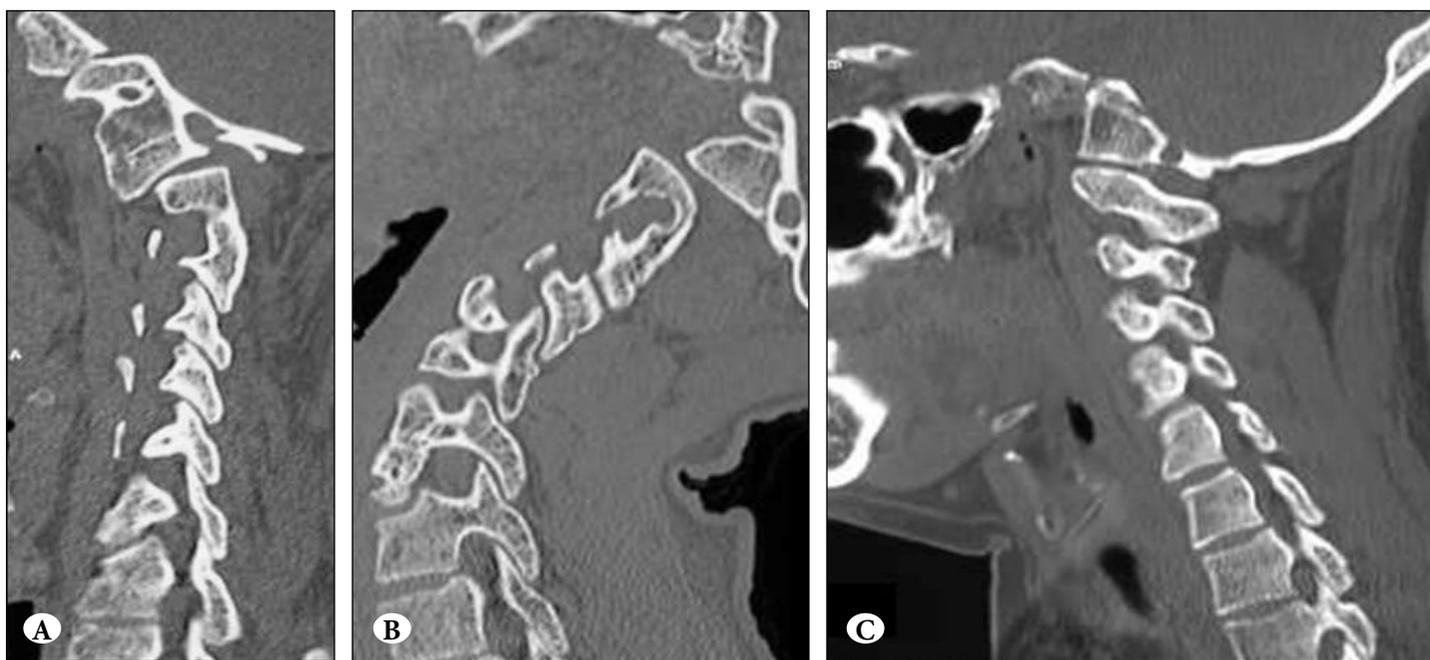


Figure 1: Images showing types of atlantoaxial instability based on facetal alignment. **A)** Sagittal image of the atlantoaxial facets showing Type A facetal instability when the facet of atlas dislocated anterior to the facet of axis. **B)** Sagittal image of the atlantoaxial facets showing Type B facetal instability when in the neutral head position, the facet of atlas is dislocated posterior to the facet of axis. **C)** Sagittal cut through the atlantoaxial facets showing Type C facetal instability when the facets of atlas and axis are in alignment.

and treated. If the instability can be identified on the preoperative radiological assessment and by secondary evidences, correct treatment that has the potential to save the function and life of the individual is possible.

The principle evidence of atlantoaxial instability is pain in the nape of neck. Neck muscle spasm, restriction of neck movements wherein there is hyperextension of the neck and restriction of neck flexion, shortening of neck and torticollis are the neck features that are suggestive of atlantoaxial instability. Vertebral bodies fusion, reduction in the disc space height, assimilation of atlas, platybasia, bifid anterior and posterior arches of atlas and several such features are plain radiological parameters that suggest the presence of atlantoaxial instability (13). Chiari 1 malformation and syringomyelia are neural manifestations that are suggestive of atlantoaxial instability (4,9). Atlantoaxial instability is the primary pathological event and all other soft tissue, bone and neural alterations are secondary events that are probably protective in their function. If appropriate treatment by atlantoaxial stabilization is done, reversal of symptoms and reversal of all morphological alterations is possible. The instability in these cases can be taken as present even if there are no corroborative radiological findings. This understanding has the potential to provide hope of relief from devastating symptoms for these patients.

DISCUSSION

In general, multi-level cervical spondylosis has been considered conventionally to involve C3-7 cervical segments. As we mature further into the analysis of the subject we identify that atlantoaxial instability is frequently associated with multilevel spinal spondylosis. Long-standing atlantoaxial instability can by itself cause degenerative alterations in the subaxial spine (6,7). It may also be a fact that atlantoaxial instability may be the primary pathology and degeneration of subaxial cervical spine may be secondary events. The atlantoaxial instability may be diagnosed on the basis of facet malalignment or can even be diagnosed on basis of direct manipulation of bones during surgery. It does appear that ignoring atlantoaxial instability in multilevel spinal degeneration can be a major cause of failure of surgical treatment. Recently we identified that cases with OPLL (ossified posterior longitudinal ligament) can be associated with atlantoaxial instability (8,12). It may also be that subtle and longstanding atlantoaxial instability is the primary event and OPLL is a secondary manifestations. Atlantoaxial instability may be the primary focus of treatment.

REFERENCES

1. Goel A. Treatment of basilar invagination by atlantoaxial joint distraction and direct lateral mass fixation. *J Neurosurg Spine*. 1:281-286, 2004.
2. Goel A. Goel's classification of atlantoaxial "facet" dislocation. *J Craniovertebr Junction Spine*. 5:3-8, 2014.
3. Goel A. Treatment of odontoid fractures. *Neurol India*. 63:7-8, 2015.
4. Goel A. Chiari malformation – Is atlantoaxial instability the cause? Outcome analysis of 65 patients with Chiari malformation treated by atlantoaxial fixation. *J Neurosurg Spine*. 22:116-127, 2015.
5. Goel A. Vertical facet instability: Is it the point of genesis of spinal spondylotic disease? *J Craniovertebr Junction Spine*. 6:47-48, 2015.
6. Goel A. Atlantoaxial instability associated with single or multi-level cervical spondylotic myelopathy. *J Craniovertebr Junction Spine*. 6:141-143, 2015.
7. Goel A. Posterior atlantoaxial 'facet' instability associated with cervical spondylotic disease *J Craniovertebr Junction Spine*. 6:51-55, 2015.
8. Goel A. Is atlantoaxial instability the cause of "high" cervical ossified posterior longitudinal ligament? Analysis on the basis of surgical treatment of seven patients. *J Craniovertebr Junction Spine*. 7:20-25, 2016.
9. Goel A, Desai KI: Surgery for syringomyelia: An analysis based on 163 surgical cases. *Acta Neurochir (Wien)*. 142:293-302, 2000.
10. Goel A, Desai K, Muzumdar D: Atlantoaxial fixation using plate and screw method: A report of 160 treated patients. *Neurosurgery*. 51:1351-1357, 2002.
11. Goel A, Laheri VK. Plate and screw fixation for atlanto-axial dislocation. (Technical report). *Acta Neurochir (Wien)*. 129:47-53, 1994.
12. Goel A, Nadkarni T, Shah A, Rai S, Rangarajan V, Kulkarni A. Is only stabilization an ideal treatment of OPLL? Report of early results with a preliminary experience with 14 cases. *World Neurosurg*. 84:813-819, 2015.
13. Goel A, Shah A. Reversal of longstanding musculoskeletal changes in basilar invagination after surgical decompression and stabilization. *J Neurosurg Spine* 10:220-227, 2009.
14. Goel A, Shah A, Rajan S: Vertical mobile and reducible atlantoaxial dislocation. Clinical article. *Vertical mobile atlantoaxial dislocation*. *J Neurosurg Spine*. 11:9-14, 2009.
15. Goel A, Shah A. Lateral atlantoaxial facet dislocation in craniocervical region tuberculosis: Report of a case and analysis of an alternative treatment. *Acta Neurochirurgica*. 52:709, 2010.
16. Goel A, Shah A. Atlantoaxial facet locking: treatment by facet manipulation and fixation. Experience in 14 cases. *J Neurosurg Spine*. 14:3-9, 2011.
17. Kothari M, Goel A. The so-called intervertebral disc: A 4-D reverie. *Neurol India* 55:97-98, 2007.

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