POST-TRAUMATIC ALAR LIGAMENT INSTABILITY: A CASE REPORT REVIEWING ANATOMY AND RADIOGRAPHIC FINDINGS

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ABSTRACT

The aim of this case study was to review the anatomic and radiographic findings associated with post traumatic alar ligament instability. The craniovertebral junction is the most mobile region of the cervical spine and its stability is thus of utmost importance. The intricate alar ligaments play a crucial role in maintaining this stability and protecting the craniovertebral junction from excessive contralateral rotation and/or lateral flexion. When alar ligament injury is suspected, for instance following a significant whiplash injury, as was in this case, a thorough radiologic examination should be carried out. The atlanto-dental interspace and para-odontoid spaces should be assessed in both neutral and stressed positions to rule out any instability. If these above measurements are within normal limits, upper cervical neurologic concern is reduced and chiropractic care can begin. If alar ligament instability is noted however, conservative chiropractic care can still proceed but with the use of low force techniques when addressing the upper cervical spine. (Chiropr J Australia 2017;45:44-52

Key Indexing Terms: Craniovertebral Junction; Alar Ligament; Instability; Upper Cervical Trauma

INTRODUCTION

The area between the neck and the head is known as the craniovertebral junction (CVJ) and is comprised of the occiput, atlas and axis. The bony framework, joint architecture, and the complex muscles and ligaments in this area, make it the most mobile region in the cervical spine, without compromising too much stability.(1-3) This is crucial, as there are vital neurovascular structures, such as the vertebral artery that travel through this area.(1,2) The fundamental component to all this stability within the CVJ is the interaction of these intricate ligaments, mainly the alar ligaments, which will be the focus of this case report.

The pair of alar ligaments are on average 11mm long and run obliquely, connecting the posterolateral surface of the upper third of the dens to the anteromedial surfaces of the occipital condyles.(1,2,4-7) Some sources claim that the alar ligaments have a second portion that travels laterally, forming attachments to the lateral masses of atlas.2,5,7 These ligaments are given the term “check ligaments” as there function is to stabilize and protect the CVJ, most specifically restricting excessive contralateral rotation and/or lateral flexion.(2,5,6-10)

When trauma occurs in this area, such as a whiplash in a motor vehicle accident it can lead to overstretching of these alar ligaments, which can normally only handle less than 10% stretch before damage and instability ensues at the CVJ. (7,8) This is because the alar ligaments are most vulnerable to the rotation motion that can occur in said trauma. (2,3,7) This instability can occur with or without fractures and long-term symptomatology is seen in a majority of patients, with 12-16% of patients having impairments that affect their activities of daily living. (3,8,11)

CASE REPORT

A 22-year-old male had a chief complaint of neck and upper back pain spanning from C5 to T3. He had this pain for the past year and a half and stated that prolonged sitting or standing would provoke this pain. He also complained of occasional headaches, but was not overly concerned with them. The patient noted that roughly 2 years ago he was involved in a single motor vehicle accident where he crashed into a tree. He reported that airbags were deployed and that he had suffered a whiplash injury at that time. Throughout his childhood, he recalls 4 concussions mostly involving bicycle accidents, with the most recent at the age of 16.

Physical examination revealed lower cervical spine pain in flexion and a reduction of left lateral flexion and left head rotation. Orthopaedic testing included maximal cervical compression, cervical foraminal compression, modified Spurling's, cervical distraction and Jackson's, all of which were negative. The shoulder depression test was positive bilaterally, more so on the right, which could indicate concomitant muscular dysfunction, joint inflammation or dural sleeve adhesions. A thorough neurological examination was conducted, consisting of motor, sensory, reflex, cranial nerve and cerebellar testing, all of which were within normal limits. Based upon the patient's cervico-thoracic spinal complaint, previous history of concussions and whiplash, a 3-view cervical spine x-ray series was ordered.

Radiographic Findings

The APOM view revealed a reduced left para-odontoid space along with a widened right para-odontoid space measuring 12mm (Figure 1). The neutral lateral view showed a normal atlanto-dental interspace (ADI) of 2mm (Figure 2). This asymmetry of the para-odontoid space and the lateral displacement of C1 could represent a rotatory atlanto-axial subluxation or alar ligament instability.(12) The possibility of a fracture at C1 still exists; however, it is unlikely. There is an expectation of a lateral offset greater than 3mm with a fracture of C1 or a rupture of the transverse ligament of the upper cervical spine.(12,13) The mechanism of injury for the typical Jefferson's (burst) fracture at C1 drives the lateral masses of C1 to be laterally displaced relative to the C2 body and up to 50% of patients with this injury will experience persistent neck pain, stiffness and a painful, typically burning sensation of the occipital region (dysesthesia). (12) Given the radiographic findings along with the patient's history and physical examination findings, ligamentous instability was the main concern. Flexion and extension as well as lateral bending APOM stress views were then ordered. The flexion and extension views demonstrated normal

measurements with the expected V configuration of the ADI space in flexion (Figures 3 & 4). To measure this properly you can measure the central portion of the space or measure the distance of the upper and lower portions of the ADI space and then average the two. For this patient the upper portion was 4mm and the lower portion was 2mm giving an average of 3mm; the mid-portion of the joint was also measured at 3mm indicating no laxity of the transverse ligament. However, the lateral bending APOM stress views showed some instability, possibly indicating a ligamentous issue (Figures 5 &6, Table 1).

Table 1. Para-odontoid space measurements

	LEFT Para-odontoid Space	RIGHT Para-odontoid Space
APOM Left Lateral Bending	11mm	4mm
Neutral APOM	5mm	12mm
APOM Right Lateral Bending	4mm	13mm

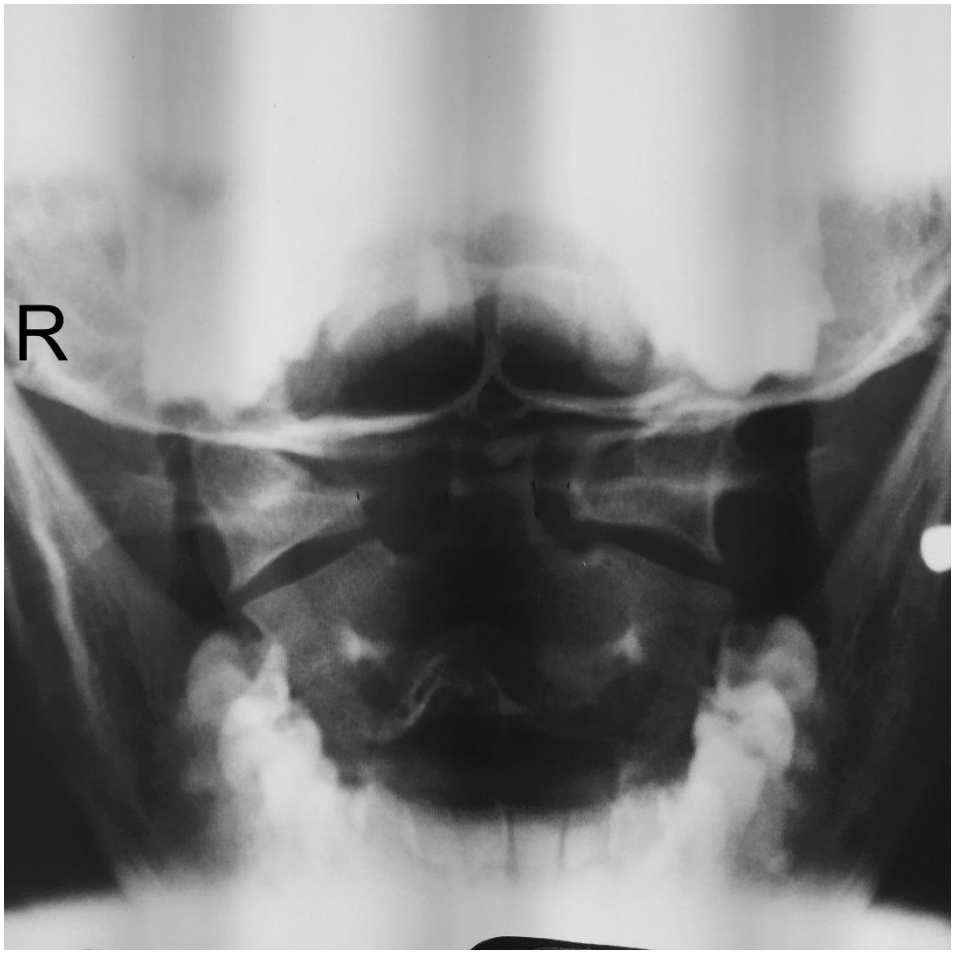


Figure 1. Widened para-odontoid space

Figure 2. Neutral view, with normal ADI.

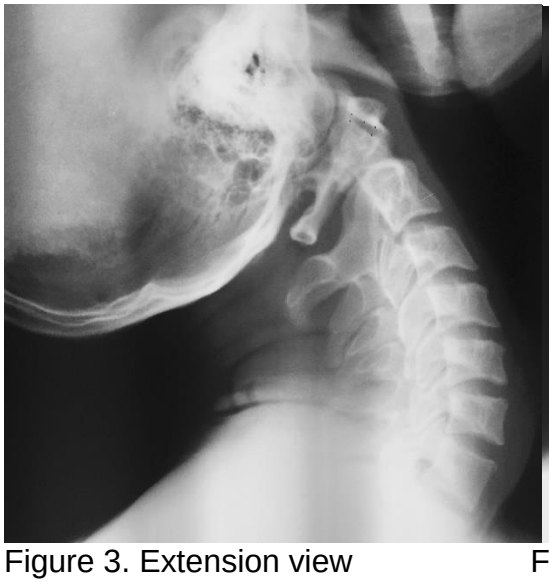
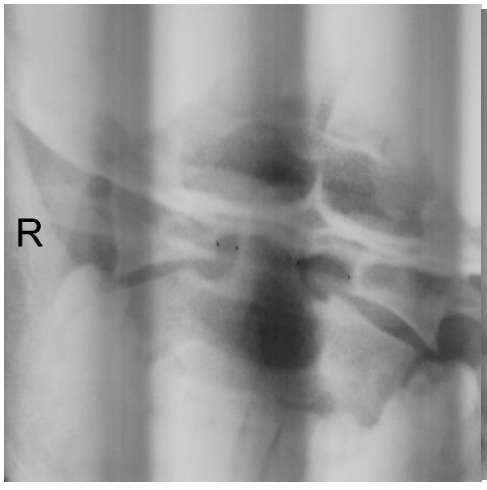


Figure 3. Extension view

Figure 4. Flexion view



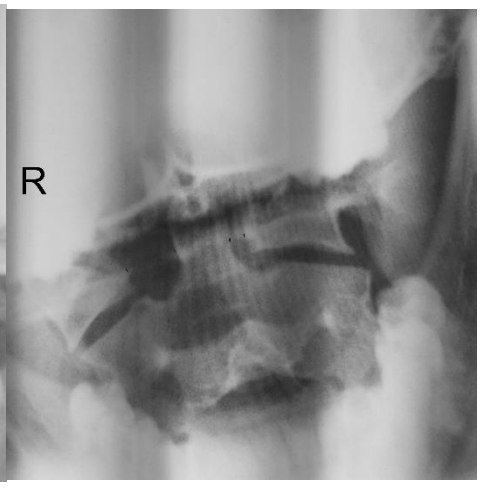


Figure 5. Lateral bend

Figure 6. Lateral bend

DISCUSSION

The standard series for evaluating patients with suspected trauma of the cervical spine includes the APLC, APOM and lateral cervical views. (14) When evaluating the APOM view it is crucial to take note of both the para-odontoid spaces, which is the area between the medial border of the lateral mass of atlas and the lateral border of the dens. (11) An accurate assessment can only be made in patients whom are properly positioned with no head rotation, with an expected threshold value in mind to determine whether asymmetry is present or absent. (11) When asymmetry is identified on the initial APOM view, four additional APOM views should be taken, including left and right sided rotation and lateral flexion views, with true asymmetry persisting in all views. (15)

Asymmetry of the para-odontoid space has been discussed in several studies, and its clinical significance is still being argued. (4,11,14,16) In any given population with no history of trauma, this asymmetry is said to be a common normal variant with an incidence of 54.5% to 92.2% when assessed via a CT scan. (4,11,16) This is the optimal method of assessment and involves measuring the middle 3rd of the para-odontoid space, which has an acceptable degree of variance of 0.99±1.05mm. (14) On an APOM radiograph this acceptable normal degree of variance is said to be 1.04±0.97mm.14 Despite the fact that there is a normal degree of variance, any asymmetry still requires a more careful analysis of the CVJ and practitioners should speculate the possibility of a fracture or dislocation until the contrary is proven.(15,16) Some studies have claimed that this asymmetry in trauma is due to a rotatory atlanto-axial subluxation. (14) A definite diagnosis of a rotatory atlanto-axial subluxation however, requires not only an increase in asymmetry of the para-odontoid space but a loss of alignment between atlas and axis as well. (14)

As mentioned above, the alar ligaments play a significant role in maintaining the overall stability and integrity of the CVJ. Thus, it is highly recommended that these ligaments be stressed before a high velocity, low amplitude adjustment is

administered to the upper cervical spine. (6) These ligaments vary in their orientation, mainly due to the height differences between the dens and the occipital condyles.6 Because of this discrepancy, the alar ligaments should be tested in several planes on x-ray when ligamentous injury is suspected. (6)

There is a disagreement within the literature in regards to the neutral state of these alar ligaments. Some sources claim that the ligaments are taut in the neutral state, while others believe them to be lax. (3,7) With 1 study claiming that only laxity of the alar ligaments in the neutral position could explain the wide range of normal neutral measurements recorded in their experiments. (3) This is of utmost importance when trying to understand the functionality of these ligaments. (7) The alar ligaments themselves are short and thick and thus it is possible to ascertain that some fibres would be taut, and some lax in their neutral state.(7)

It is important to note that the two alar ligaments do not operate individually from each other when restricting rotation at the CVJ. (7) Several studies state that when one alar ligament is compromised, the entire process of preserving the CVJ stability is disturbed. (2,4,7,8) Rotation increases bilaterally, however there is a greater degree of change at the contralateral side. (7,8) Rotation is not the only motion that is affected by a compromised alar ligament. Studies have shown that lateral flexion, extension and flexion are all affected to varying degrees. (2,3,5) One study revealed that when one alar ligament is transected, there would be a significant increase in contralateral lateral flexion. (3) In regards to flexion and extension, the alar ligaments play a greater role in limiting flexion at the CVJ. (7) One study shows there is a considerable amount of increased flexion with the transection of the alar ligament and only trivial changes in extension. (7) The results of the above studies however were limited as they were executed on cadavers. It was not possible for them to solely transect the alar ligaments without damaging the tectorial membrane, therefore the studies could not say with certainty whether the findings were due to alar ligament transection or a combination of both. (3)

Advanced imaging is a potential step for assessment of the alar ligaments as the CVJ is well visualised on midsagittal MRI and reconstructed CT.(1) MRI is advantageous due to its superior sensitivity to soft tissue injury and thus could potentially be the preferred diagnostic tool for ligamentous injuries. (17) Before analysing the alar ligaments on MRI, one should be aware that normal ligaments appear as a low-signal intensity on all sequences. (18) When analysing the CVJ on MRI, one study suggested giving a grading to the alar ligament in regards to the ratio between any high-signal region and the total span of the alar ligament in a single sagittal sequence. (8) This study concluded that high-grade changes of the alar ligaments were seen dramatically more frequently in patients following a whiplash accident, when compared to that of the normal population. (8) In contrast to this, one study reported that the normal population could have high-signal intensity evident at the alar ligaments and thus that finding alone has no diagnostic value. (19)

Overall, clinical instability is what is of value to the practitioner as it is a potentially disabling condition, however it is both well recognised and appropriately treated. (5) It is important to note that clinical instability differs from biomechanical instability as it

comprises pain, neurologic dysfunction, and deformity in the acute stage and over time. The muscles in the area play a very important role in ensuring that the CVJ is stable, as when the ligaments fail an extra load is placed onto these muscles and this would explain why the patient had a positive shoulder depression orthopaedic test. (7) I believe that these altered biomechanics may predispose this area to premature degenerative changes as a consequence.

The management of these patients should be conservative and although the risk with chiropractic adjusting is minimal, caution along with low force techniques should be implemented in the upper cervical spine. This patient presented with lower cervical and upper thoracic spine findings with occasional headaches and was to be managed with the Diversified technique to the lower spine and Activator as a force application to address the upper cervical spine. Unfortunately, the patient was lost for follow-up.

CONCLUSION

The principle role of the alar ligaments is to stabilise the CVJ, primarily checking contralateral rotation and lateral flexion. The three view cervical series is essential to properly evaluate the upper cervical spine and rule out instability. Asymmetry of the para-odontoid space in the absence of lateral displacement of the lateral masses of C1 relative to C2 may indicate an alar ligament injury. A thorough evaluation of the upper cervical spine in stress including flexion/extension and APOM lateral flexion and rotation views are highly recommended as in this case. Once the ADI space is determined to be intact then upper cervical neurologic concern can be minimised and an appropriate conservative management of the patient can begin.

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REFERENCES

1. Sankhe SS, Kumar SK. Neuroimaging in craniovertebral anomalies as seen in the tropics. Neuroimaging Clin N Am 2011;21:879-895
2. Smorgick Y, Fischgrund JS. Occipitocervical Injuries. Sem Spine Surg 2013;25:14-22.
3. Panjabi M, Dvorak J, Crisco JJ, Oda T, Hilibrand A, Grob D. Flexion, extension, and lateral bending of the upper cervical spine in response to alar ligament transections. J Spinal Disord 1991;4:157-167
4. Ajmal M, O'Rourke SK. Odontoid Lateral Mass Interval (OLMI) Asymmetry and Rotatory Subluxation: A Retrospective Study in Cervical Spine Injury. J Surg Orthop Adv 2005;14:23-26
5. Harris MB, Duval MJ, Davis JA Jr, Bernini PM. Anatomical and Roentgenographic Features of Atlantooccipital Instability. J Spinal Disorders 1993;6:5-10

6. Osmotherly PG, Rawson OA, Rowe LJ. The Relationship Between Dens Height and Alar Ligament Orientation: A Radiologic Study. J Manipulative Physiol Ther 2011;34:181-187
7. Panjabi M, Dvorak J, Crisco JJ, Oda T, Wang P, Grob D. Effects of alar ligament transection on upper cervical spine rotation. J Orthop Res 1991;9:584-593
8. Krakenes J, Kaale BR. Magnetic resonance imaging assessment of craniovertebral ligaments and membranes after whiplash trauma. Spine 2006;31:2820-2826
9. Yoganandan N, Pintar FA. Frontiers in whiplash trauma: clinical & biomechanical. IOS Press, The Netherlands; 2000
10. Craner GD, Darby SA. Clinical anatomy of the spine, spinal cord, and ANS. 3rd Ed. Elsevier, Mosby: MO;2013
11. Billmann F, Bokor-Billmann T, Burnett C, Kiffner E. Occurrence and significance of odontoid lateral mass interspace asymmetry in trauma patients. World J Surg 2013;37:1988-1995
12. Yochum T, Rowe L. Yochum and Rowe's essentials of skeletal radiology. 5th Ed. Philadelphia: F. A. Davis Company; 2011
13. Resnick D. Diagnosis of bone and joint disorders. 3rd Ed. Philadelphia: WB Saunders Company; 1995
14. Wolansky LJ, Rajaraman V, Seo C, Patel N, Kazmi K, Doddakashi S, Siegel S. The lateral atlanto-dens interval: normal range of asymmetry. American Soc Emergency Radiol 1999;6:290-293
15. Harty JA, Lenehan B, O'Rourke SK. Odontoid lateral mass asymmetry: do we over-investigate? Emerg Med J 2005;22:625-627
16. Lee S, Joyce S, Seeger J. Asymmetry of the odontoid-lateral mass interspaces: a radiographic finding of questionable clinical significance. Ann Emerg Med 1986;15:1173-1176
17. Chiu WC, Haan JM, Cushing BM, Kramer ME, Scalea TM. Ligamentous injuries of the cervical spine in unreliable blunt trauma patients: incidence, evaluation, and outcome. J Trauma 2001;50:457-463
18. Hodgson RJ, O'Connor PJ. Grainger AJ. Tendon and ligament imaging. Br J Radiol 2012;85:1157-1172.
19. Lummel N, Zeif C, Kloetzer A, Linn J, Bruckmann H. Bitterling H. Variability of morphology and signal intensity of alar ligaments in healthy volunteers using MR Imaging. Am J Neuroradiol.2011;32:125-130