Alar ligament research

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Construct validity of clinical tests for alar ligament integrity: an evaluation using magnetic resonance imaging.

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Source

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Abstract

BACKGROUND:

The alar ligaments are integral to limiting occipito-atlanto-axial rotation and lateral flexion and enhancing craniocervical stability. Clinical testing of these ligaments is advocated prior to the application of some cervical spine manual therapy procedures. Given the absence of validation of these tests and the potential consequences if manipulation is applied to an unstable upper cervical spine segment, exploration of these tests is necessary.

OBJECTIVE:

The purpose of this study was to examine the direct effect of the side-bending and rotation stress tests on alar ligaments using magnetic resonance imaging (MRI).

DESIGN:

This was a within-participant experimental study.

METHODS:

Sixteen participants underwent MRI in neutral and end-range stress test positions using proton density-weighted sequences in a 3-Tesla system. Measurements followed a standardized protocol relative to the position of the axis. Distances were measured from dens tip to the inferior margin of the foramen magnum and from midsubstance of the dental attachment of the ligament to its occipital insertion. Between-side differences were calculated for each measurement to account for inherent asymmetries in morphology. Differences were compared between the test and neutral positions using a Wilcoxon signed rank test.

RESULTS:

Side-bending stress tests produced a median between-side difference in ligament length of +1.15 mm. Rotation stress tests produced a median between-side difference in ligament length of +2.08 mm. Both results indicate increased measurement of the contralateral alar ligament. Limitations Assessment could be made only in the neutral position due to imaging limitations. Clinical texts state that tests should be performed in 3 positions: neutral, flexion, and extension.

CONCLUSIONS:

Both side-bending and rotation stress testing result in a measurable increase in length of the contralateral alar ligament. This finding is consistent with mechanisms that have been described to support their use in clinical practice.

**Biomechanics of the Upper Cervical Spine, Alar Ligament Damage, & Atlanto-Axial Rotatory Fixations**

White and Panjabi describe the occipito-atlanto-axial articulations as “*the most complex joints of the axial skeleton, both anatomically and kinetically.*”

First, it is important to note that lateral translation of the atlas on the axis is an aberrant motion.

“The literature shows that this articulation [C0/C1] has very little motion in lateral flexion and rotation to each side (0-5 degrees in most cases). During lateral flexion, there is a slight amount of ipsilateral translation of the atlas.” – Eriksen, Upper Cervical Subluxation Complex, pg 3

“Translatory movements at the occipital-atlanto-axial complex are small. Between the occiput and C1 there is insignificant translation.” White and Panjabi, Clinical Biomechanics of the Spine, 1978.

“During lateral flexion, a frontal section taken vertically through the occiput, the atlas, the axis, and C3 shows that there is no movement at the atlanto-axial joint.” Kapandji IA, The Physiology of the Joints, 3rd edition, 1974.

“If lateral bending alone occurs without atlanto-axial rotation, the lateral capsular ligaments remain tight and there is no lateral shifting of the atlas on the axis.” Hohl M, Baker HR. The Atlanto-Axial Joint, Roentgenographic and Anatomical Study of Normal and Abnormal Motion. J Bone Joint Surg, 1964; 46(8):1739-1752.

 The alar ligament on the left limits rotation & translation of the atlas on the axis to the right. When the ligament on one side is disrupted, there will be a widening of the joint space on that side between the dens and the atlas.

“The alar ligaments limit or check rotation and lateral flexion of the occipto-atlantal and atlanto-axial joints and are therefore referred to as *check ligaments.* During right lateral flexion, motion is checked by the left upper portion connected to the ring of the atlas. The left alar ligament controls right axial rotation.” – p.5

 “[The alar ligaments] are very important check ligaments which limit rotation of the skull and the atlas on the axis and prevent lateral subluxation of the skull and the atlas on the axis. In this connection, it must be kept in mind that the skull and atlas move very much as one unit and that there is only a little side to side gliding movement between them because the condyles of the skull fit snugly into the elliptical cuplike superior facets of the lateral masses of the atlas…. If one of the accessory atlantoaxial ligaments is stretched or severed, rotation of the atlas occurs because these ligaments check rotation when intact. If, at the same time, the alar ligament and the accessory atlantoaxial ligament are cut on the same side, subluxation of the head and the atlas on the axis and rotation of the axis occur because both guy wires are broken on the same side.” – Jackson R, The Cervical Syndrome, 4th edition, Charles C. Thomas, 1977.

 “…the lower cervical spine functions as a unit, every muscle activating several segments, while the upper cervical spine may carry out specific movements in one segment.” Penning L. Normal Movements of the Cervical Spine. Am J Roentgenol, 1978; 130(2):317-326.

“The complex interaction amongst C0, C1, and C2 and their associated ligaments strongly suggest that the C0-C1-C2 complex should be tested as one unit.” Goel VK, Clark, CR, Gallaes K, Liu YK. Moment-Rotation Relationships of the Ligamentous Occipito-Atlanto-Axial Complex. J Biomechanics, 1988; 21(8):673-680.

 “It can be concluded that defective ligaments in the upper cervical spine become apparent on x-ray films in the sidebending position.” Reich C, Dvorak J. The Functional Evaluation of Craniocervical Ligaments in Sidebending using X-Ray. Man Med, 1986:108-113.

“The study of functional CT scans of the upper cervical spine shows clearly that one-sided lesion of alar ligament can result in increased axial rotation of the occipto-atlanto-axial complex to the opposite side. The mean increase is 10.8 degrees, or 30% of the original mean rotation…. [T]he alar ligament can resist only 240 N before failure (for comparison the cruciate ligament of the knee has a failure load of about 600-800 N…. [I]t is possible that the increased rotation can irritate not only the vertebral artery but also the vertebral nerve and the mechanoreceptor and nociceptors of the apophyseal joint capsules. This may result in a number of clinical symptoms and signs such as headache, dizziness, nystagmus, Horner syndrome.” Dvorak J, Panjabi M, Gerber M, Wichmann W. CT Functional Diagnostics of the Rotatory Instability of Upper Cervical Spine, 1. An Experimental Study on Cadavers. Spine 1987; 12(3):197-205.

“[T]he alar and transverse ligaments consist mainly of collagen fibers that can only be stretched by 10-20% of their original length before irreversible damage or even rupture occurs.” Eriksen, p 21

“If the head is in slight rotation, a rear-end impact will force the head into further rotation before extension occurs.  This has important consequences because cervical rotation prestresses various cervical structures, including the capsules of zygapophyseal joints, intervertebral discs, and the alar ligament complex, making them more susceptible to injury.”  ~ Bamsley, in Spine: State of the Art Review, Cervical Flexion-Extension/Whiplash Injuries Handley & Belfus, Sept. 1993, p. 329

 There is substantial evidence in the literature to support biomechanical analysis of the C0/C1/C2 complex.

“[I]nvestigators have sought to improve the diagnostic value of plain radiography by supplementing with biomechanical analysis.… Mayer et al reported that symptomatic patients exhibited abnormally located instantaneous axes of rotation…. These results implied a segmental relationship between the source of symptoms and the location of the kinematic abnormality…. By definition, fewer than 4% of asymptomatic individuals would be expected to exhibit IAR’s in the regions outside the normal range used in the current study, yet 46% and 72% of patients with neck pain have IAR’s outside this range. IAR’s may therefore find a legitimate place in medico-legal proceedings, for in a patient with otherwise normal plain radiographs, an abnormal IAR indicates a biomechanical disturbance that essentially does not occur in normal persons but occurs significantly more frequently in patients with pain.” Amevo B, Aprill C, Bogduk N. Abnormal Instantaneous Axes of Rotation in Patients with Neck Pain. Spine, 1992; 17(7):748-756.

“…51% of chiropractors routinely take radiographs for biomechanical and postural assessment. Some 63% of doctors of chiropractic also used radiographic line drawing to locate spinal subluxations. Radiographic analysis to assess the biomechanical component of the vertebral subluxation is within the standard of care of the chiropractic profession and is further supported by the Council on Chiropractic Practice and International Chiropractors Association (ICA) guidelines.” –Eriksen, pg 22. J Manipulative Physiol Ther, 1997; 20[5]:311-314. Vertebral Subluxation in Chiropractic Practice, Number 1. Council on Chiropractic Clinical Practice Guideline, 1998. Recommended Clinical Protocols and Guidelines for the Practice of Chiropractic, International Chiropractors Association, 2000.

 The joints of the cervical spine, being synovial, require motion to function effectively, and under normal circumstances, will not degenerate.

“The normal human synovial joint will not wear out with normal use and under normal loads.” Kapandji, Phys Joint Vol 3.

 Subluxations in the upper cervical complex can drastically alter neurological function.

“The configuration of the misalignment pattern may be a better predictor of the degree of neurological insult…. Dr. John F. Grostic proposed that 0.75 degrees of atlas misalignment around the occipital condyles is the minimum amount of slippage required to cause neurological interference.” Eriksen, pg 16

“…[A]t the extreme of physiological axial rotation (~47 degrees) the spinal canal was reduced by 61%. It was determined that an atlanto-axial subluxation of up to 9 mm would reduce the area of the spinal canal in the neutral position to 60%.... [T]he cord is vulnerable toward the end point of cervical rotation.” Tucker SK, Taylor BA. Spinal Canal Capacity in Simulated Displacements of the Atlantoaxial Segment: A Skeletal Study. J Bone Joint Surg, 1998; 80(6):1073-1078.

“Adjusting the atlas is not a simple procedure. It is as delicate as the most complicated surgery and does require an endless process of study and discipline.” Sweat RW. Minimum Force vs. Moderate Force in the Occipital-Atlanto-Axial Subluxation Complex. Am Chiropr, February 1988:22-24.

It is highly probable that so-called “congenital malformations” of C0 (occipital condyles), C1, & C2, may be due to radiographic errors in positioning and analysis. Alar ligament damage may be responsible for this false appearance.

**Odontoid lateral mass asymmetry: do we over-investigate?**

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**Objectives:** This study aimed to evaluate the necessity for furtherradiological investigation in patients with suspected traumaticrotatory subluxation of the atlanto-axial complex on plain radiographyfollowing acute cervical trauma and outline guidelines for assessmentof patients with atlanto-axial asymmetry on plain radiography.

**Methods:** A retrospective review of all patients who had undergoneatlanto-axial CT scanning as a result of radiographic C1–C2asymmetry following cervical spine trauma. The plain *x* ray andCT images were reviewed retrospectively and correlated withthe clinical presentation and outcome.

**Results and conclusion:** Records of 29 patients (16 men, 13 women;age range 21–44 years) were reviewed. All patients werefound to have atlanto-odontoid asymmetry on the initial plain*x* ray. CT images of none of the patients revealed rotatory subluxation.Ten patients (32%) were found to have congenital odontoid lateralmass asymmetry. All patients were treated conservatively withoutany further intervention. **On review, in 19 patients the orientationof the *x* ray beam in combination with head rotation was foundto be at fault.** Approximately 1050 trauma cervical spine *x* rayswere taken in the department where this study was conductedover the period 1999–2001. This study identified 10 patientsout of a total of 29 as having congenital odontoid lateral massasymmetry. This represents approximately 1% of the patientsattending the emergency department. Thus congenital odontoidlateral mass asymmetry should be considered in the differentialdiagnosis following acute cervical trauma.

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“[T]he headclamps were placed slightly higher on the parietal area of the skull instead of over the atlanto-occipital joint, to allow free, unhindered motion in the sub-occipital area. Placing the clamps over or near the atlas may affect its normal range of motion. “Pseudo-subluxation” and “pseudo-dislocation” are terms applied to the anterior displacement of C2 on C3 frequently seen in infants and young children. Physiologic anterior displacement of C2 on C3 occurs in 24% of children under the age of 8 years. The roentgen appearance of the cervico-cranium in frontal projection, i.e., the “open-mouth” view, is seen in Figure 1.14. The important observations are that the atlas sits squarely upon the axis with the dens equidistant between the lateral masses of the atlas, that the lateral atlanto-axial joint spaces are open and their contiguous surfaces parallel, that the lateral margins of the lateral atlanto-axial surfaces are precisely superimposed and symmetrical, and that the bifid spinous process of the axis is in the midline.” Harris JH. The Radiology of Acute Cervical Spine Trauma, 3rd edition, Williams & Wilkins, Baltimore/London, 1996.

“This study determined that, of the 24 skulls studied, all had a normal biological variation on the three variables examined. These differences were not, however, statistically significant. These results seem to indicate that the occipital condyles are relatively symmetrical structures with respect to each other.” Febbo T, Morrison R, Bartlett P. A Preliminary Study of Occipital Condyle Asymmetry in Dried Specimens, Chirop Technique, 1990; 2(2):49-52.

However, when viewed on x-ray, “Analysis implied a lack of symmetry between condyles.” Febbo TA, Morrison R, Valente R. Asymmetry of the Occipital Condyles: A Computer-Assisted Analysis. JMPT, 1992; 15(9):565-569. This suggests that the data from radiographs may be misleading when determining condylar asymmetry, especially when 100% of dry specimens evidenced no bilateral asymmetries.

**Chiropractic & Osteopathy**

Case report **Open Access**

**Post-traumatic upper cervical subluxation visualized by MRI: a case report**

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**Abstract**

**Background:** This paper describes MRI findings of upper cervical subluxation due to alar ligament disruption following a vehicular collision. Incidental findings included the presence of a myodural bridge and a spinal cord syrinx. Chiropractic management of the patient is discussed.

**Case presentation:** A 21-year old female presented with complaints of acute, debilitating upper neck pain with unremitting sub-occipital headache and dizziness following a vehicular collision.

Initial emergency department and neurologic investigations included x-ray and CT evaluation of the head and neck. Due to persistent pain, the patient sought chiropractic care. MRI of the upper cervical spine revealed previously unrecognized clinical entities.

**Conclusion:** This case highlights the identification of upper cervical ligamentous injury that produced vertebral subluxation following a traumatic incident. MRI evaluation provided visualization of previously undetected injury. The patient experienced improvement through chiropractic care.

Chiropractic evaluation was performed. Decreased intersegmental motion and fixations were noted affecting CO/1 and C1/2. Thermographic instrumentation revealed asymmetry of heat patterns of the upper cervical spine.

**Flexion and extension stress x-ray views failed to reveal spinal hypermobility or increase in the Atlanto-Dental Interval that would suggest instability**. Due to the mechanism and severity of the patient's collisioncombined with persistent severe symptoms affecting the upper cervical spine not previously imaged, a high-resolutionMRI of Occiput-C7 was ordered. The attending neuroradiologist reported a cervical spinal cord syrinx thatextended from C2-C7. (Figure 1). No other abnormalities were noted.

Upon over-reading the study in our office, **the MRI images revealed left alar ligament disruption as evidenced by increased signal on T2 weighted images (See Figures 2 and 3). Left lateral translational subluxation was visualized.**

Upon re-evaluation, the neuroradiologist concurred with these opinions, suggested that additional coronal views may provide improved visualization and wrote an addendum to his report.

**An incidental finding included a visualized myodural bridge intervening between the rectus capitis posterior minor (RCPMi) and the spinal cord dura**. (Figure 4) A normal appearing RCPMi was visualized on axial viewswith good margins, composition and cross-sectional area (Figure 5).

***Literature review***

The patient in this case suffered cervical acceleration/deceleration (CAD) Grade III injury. As described by Croft, a CAD Grade III injury represents a moderate severity injury with associated limitation of motion, ligamentous instability and neurologic findings [10]. The utilization of MRI of the upper cervical spine helped to objectively define the presence of ligamentous involvement.

Undiagnosed spinal trauma can significantly impair biomechanic function. Core ligamentous, disk, endplate, zygapophyseal, muscular and neural tissue injuries produce significant prognostic complications as evidenced by

the following studies:

Uhrenholt et al. reported subtle lesions found exclusively in MVA victims included annular fibrosis tears, disc disruption with herniation, avulsions/separations between the endplate and vertebra, articular cartilage microfractures, hemarthrosis, capsular swelling or bruising, new vertebral fractures, bruising of synovial folds. They concluded that negative clinical and radiologic exam do not prove the absence of patho-anatomical lesions [11].

Panjabi reported soft tissue injuries associated with whiplash often may not be visualized on routine radiographs or CT scans. Soft tissues involved in low velocity whiplash seldom tear completely and are often stretched beyond the elastic limits, resulting in incomplete injuries [12]. In cadaveric studies, Taylor and Twomey demonstrated undiagnosed disc rim lesions, facet capsular tears and zygapophyseal articular fractures not appreciated through xray evaluation [4]. Kaplan et al. report that visualized annular tears termed, "High Intensity Zones," represent linear fissures through all or part of the disc annulus. They report that nerve ingrowth from the surface of the disc may lead to pain [13].

Ito reported chronic pain resulting from low-speed collisions may be explained by partial tears of soft tissues including annular fibers, ligaments and avascular cartilage. Because of poor blood supply, these tissues may not completely heal following injury. Resulting injuries produce altered cervical spine kinematics that can lead to accelerated degenerative changes and clinical instability[14].

Spinal ligaments are readily visualized utilizing MRI. High resolution T2 weighted images have been shown to reliably provide evidence of spinal ligament, capsular and muscular trauma as evidenced by increased signal intensity that corresponds to acute inflammation. Benedetti and Krakenes provide MRI evidence of alar ligament disruption as evidenced by signal hyperintensity and subluxation [2,3].

Conflicting studies exist that questions the reliability of increased T2 signal in the region of the alar ligament visualized on MRI. Roy et al. reported increased signal in the region of the alar ligament in one third of the ligaments evaluated in fifteen asymptomatic subjects [15]. Pfirrmann reported asymmetric high signal intensity of the alar ligament in the majority of non-injured cases [16].

However, Krakene points out that Roy and Pfirrmann's findings may not be accurate due to inadequate imaging protocols, the use of a small magnet (0.5 Tesla) and poor image quality.

Regarding care related to whiplash associated disorders, Rosenfeld reported that active intervention was more beneficial than rest protocols [17]. Sowa et al. reported promising clinical evidence continues to accumulate for the effectiveness of motion-based therapies in the treatment of low back pain. Their results demonstrate the anti-inflammatory and protective effect of tensile force on the annulus of the intervertebral disc, suggesting that **motion** **can be beneficial to inflamed cells** [18].

The existence of the cervical myodural bridge was originally established by Hack et al. **The relationship of this anatomic entity and its relationship to cervicogenic headache have been documented** [19]. Hack has hypothesized that exertion through the myodural bridge may exert tensionthrough the pain sensitive dura. Furthermore, he indicates that **chiropractic adjustive procedures likely**

**prove beneficial through this anatomic relationship.**

Hallgren has demonstrated the effect of injury and denervation in the genesis of atrophic and fatty infiltrated changes of the Rectus Capitus Posterior Minor on MRI [20]. Elliott et al. reviewed the relationship of paraspinal core muscle atrophic changes following spinal dysfunction [21].

The development, timing and etiology of post-traumatic syrinx development are often unknown. Trauma has been implicated. The onset of new symptoms in a patient who has already sustained significant cord injury can be catastrophic and devastating [22].

Flexion/extension x-ray views of the cervical spine did not reveal segmental instability. Typical MRI protocols failed to adequately image the upper cervical spine [13]. As such, **it is possible that practitioners are providing spinal care to**

**undetected injured alar ligaments unbeknownst to them.**

The decision making process to provide chiropractic adjustment to a presumed alar ligament injury was made based upon the overwhelming evidence that supports the therapeutic benefit of motion based therapies. **Spinal articular structures are dependent upon movement during healing to re-establish and promote segmental motion, structural integrity, alignment of scar tissue along stress planes, improve proprioception, synovial and lymphatic fluid drainage, disc and cartilage health [24,25].**

**Clinicians must realize that typical cervical spine MRI protocols**

**may not include adequate visualization of CO/C1/**

**C2. Ligamentous injuries may be missed if imaging is not**

**requested of the upper cervical spine.**

**Scoliosis**

Case Report **Open Access**

**Atlanto-axial rotatory fixation in a girl with Spondylocarpotarsal**

**synostosis syndrome**

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**Abstract**

We report a 15-year-old girl who presented with spinal malsegmentation, associated with other skeletal anomalies. The spinal malsegmentation was subsequently discovered to be part of the spondylocarpotarsal synostosis syndrome. In addition, a distinctive craniocervical malformation was identified, which included atlanto-axial rotatory fixation. The clinical and the radiographic findings are described, and we emphasise the importance of computerised tomography to characterize the craniocervical malformation complex. To the best of our knowledge, this is the first clinical report of a child with spondylocarpotarsal synostosis associated with atlanto-axial rotatory fixation.

**Background**

There have been more than 20 clinical reports of the Spondylocarpotarsal synostosis syndrome, (SSS), a condition in which patients primarily present with scoliosis/kyphoscoliosis. It is characterised, by failure of normal spinal segmentation, resulting in block vertebrae and fusion of posterior elements. Carpal and/or tarsal coalition, pes planus, dental enamel hypoplasia, decreased range of motion or dislocation of the elbow, renal anomalies, and hearing loss, are additional features. Our patient presented with scoliosis, and later, with persistent torticollis. Radiographic evaluation of the cervicocranium, which

is traditionally based on the anteroposterior (openmouth) and lateral spine radiography, was not contributory.

CT scans revealed atlanto-axial rotatory fixation.

Atlanto-axial rotary fixation, (AARF) has been reported in connection with Marfan syndrome. Radiographic analysis of patients with Marfan syndrome has shown that, atlantoaxial rotatory subluxation can also occur. An increased atlanto-axial translation, larger odontoid height, and basilar impression are more prevalent in the Marfan-population compared to age-matched controls [1]. Some clinical reports describe the association of Spondylocarpotarsal synostosis syndrome and cervical malformations, [2,3].

The cause of SSS is unknown, although autosomal recessive inheritance has been suggested. We herein reported a patient with SSS, with the additional atlanto-axial rotator fixation. To the best of our knowledge neither AARF nor the role of computerized tomography to investigate the craniocervical junction, have been reported in patients with SSS.

Atlanto-axial subluxation is a rotational disorder of the atlanto-axial joint, that results in either limited rotation of the neck, or, in rare cases, fixation. The anterior facet of C1 becomes locked on the facet of C2, causing impaired rotation

at this joint. It can occur with or without C1-C2 dislocation [6,7].

The entity of atlanto-axial dislocation was first described by Corner [8] who reviewed 20 cases. Since then there have been a remarkable number of cases of this not uncommon and potentially catastrophic condition [9-11]. Chiapparini et al. [12] described atlanto-axial rotator fixation in four pediatric cases, as a rare cause of torticollis that may occur spontaneously or in association with trauma or upper respiratory tract infection. Subluxation has also been described following retropharangeal abscess, tonsillectomy, or pharyngoplasty [13,14]. Other forms of atlanto-axial dislocation develop following acute cervical trauma or due to slow erosion around the joints in, for example rheumatoid arthritis, ankylosing spondylitis, and tubercular arthritis [13].

Fielding and Hawkins [15,16], studied a series of seventeen cases. All patients had torticollis and a diminished range of movement. The typical head position was lateral flexion to one side, rotation toward the opposite side and

slight flexion – the " cock robin" position. None of the reported cases manifested other clinical and or radiological features in favor of a syndromic association.

Hertzka et al., [1], described atlanto-axial rotatory dislocation in a series of three patients with Marfan syndrome. Two of his patients developed acute torticollis postoperatively, following pectus excavatum repair. The diagnosis was made in the third patient after she presented to the emergency room with a weeklong history of unresolved neck pain, following minor trauma. Hobbs et al., [17] described the diagnostic criteria in Marfan syndrome.

Based on the present study, we suggest that the mechanism of the rotatory dislocation of C1-C2 is due to the existence of two adverse factors. First, the presence of a unilateral cervical unsegmented bar. Second, the congenital **ligamental laxity which possibly caused further injury** **to the poor ligamental fixation of the scoliotic cervical** **region, and specifically the atlas-axis complex.** **We believe** **that the craniocervical junction is a vulnerable and sensitive** **area needs detailed evaluation in patients with congenital** **scoliosis.**

**Conclusion**

1) The classical applied methodology of studying scoliotic patients should be modified in accordance with unusual findings. Particular attention and prompt assessment should be paid to other associated anomalies such as; unusual phenotypic features, musculoskeletal ligamentous hyperlaxity/articular stiffness, small hands or fingers (brachydactyly)/unusual long fingers (arachnodactyly), unusual long arm span (dolichostenomelia)/unusually short arms and or forearms (rhizomelia).

**CT demonstration of rotatory Atlanto-Axial subluxation.**

Rajagopal KV, Lakhkar BN, Banavali S. Indian J Radiol Imaging 2000;10:175-176

Rotatory atlantoaxial fixation is a common cause of a spontaneous torticollis in children. The normal rotation of the atlas on the axis becomes limited or fixed in rotatory atlantoaxial subluxation [1]. The etiology of this condition is not known, but it may be related to increased laxity of the alar and transverse ligaments and of capsular structures secondary to inflammation or trauma. The importance of recognizing atlantoaxial fixation lies in the fact that it may indicate a compromised atlantoaxial complex with the potential to cause neural damage or even death. Most authors now agree that the subluxation is related to increased laxity of the alar and transverse ligament and capsular structures caused by inflammation or trauma.

Fielding and Hawkin's classifies atlantoaxial rotatory subluxation into four types [1].
Type I - Rotatory fixation without anterior displacement of the atlas.
Type II - Rotatory fixation with anterior displacement of the atlas - of three to five millimeters.
Type III - Rotatory fixation with anterior displacement of more than five millimeters.
Type IV - Rotatory fixation with posterior displacement.

Interpretation of a plain radiograph of a child who has rotatory atlantoaxial subluxation is often difficult. A plain film in patients whose heads are rotated, whether voluntarily or pathologically, as in atlantoaxial fixation or torticollis, shows a rotated appearance of C1 on C2, with asymmetry of distance between the odontoid and the lateral masses of C1 [2]. Open mouth radiograph of the upper cervical spine can be performed with the patient rotating the head to each side, but these are often difficult to interpret [1] [5]. The lack of cooperation on the part of the patient or diminished active movement of the neck may render it impossible to make these radiographs.

Atlantoaxial fixation indicates a compromised atlantoaxial complex with the potential of causing neural damage or even death.

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| **CASE REPORT** |

**Traumatic atlantoaxial rotatory subluxation**

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**ABSTRACT**
Atlantoaxial rotatory subluxation should be considered in thepresentation of traumatic torticollis. This case report discussesthe characteristic radiographic findings and appropriate management.

**Keywords:** Atlantoaxial subluxation; cervical spine; trauma; torticollis

Torticollis is a relatively frequent presenting sign to an emergencydepartment. It describes lateral flexion of the neck and contralateralrotation, with a variable degree of flexion. The causes maybe divided into traumatic and non-traumatic. The differentialdiagnosis of non-traumatic torticollis should include, particularlyin children, congenital cervical spine anomalies, head and neckinfection (for example, otitis media, pharyngitis, or retropharyngealabscess), and tumours in the posterior fossa or upper cervicalspine.[1](http://emj.bmj.com/cgi/content/full/22/9/671#R1) Other causes include drug-induced torticollis—forexample, with phenothiazines—and the movement disorderspasmodic torticollis. Traumatic causes of torticollis includeatlantoaxial rotatory subluxation, atlantoaxial dislocation,cervical vertebral fractures, and injury to the cervical musculature.

This article highlights a case of atlantoaxial rotatory subluxationwith the aim of improving awareness of this condition to enableearly recognition. Appropriate management options and outcomesare discussed.

**DISCUSSION**
The atlantoaxial joint primarily facilitates rotation and isstabilised in the anteroposterior plane by the transverse ligamentand joint capsule. The alar ligaments, which pass from the lateraloccipital processes to the posterolateral margin of the odontoidapex, prevent anterior shift of the atlas on the axis but mainlyfunction in preventing excessive rotation at the atlantoaxialjoint. There is evidence from magnetic resonance imaging tosuggest that alar ligament disruption is the mechanism by whichrotatory subluxation occurs.[2,](http://emj.bmj.com/cgi/content/full/22/9/671#R2)[3](http://emj.bmj.com/cgi/content/full/22/9/671#R3) The lateral mass of the atlasrotating posteriorly locks behind the ipsilateral lateral mass.Conditions with associated ligamentous laxity or congenitalatlantoaxial abnormalities therefore carry an increased incidenceof rotatory subluxation. These include Down’s syndrome,Morquio’s syndrome, Marfan’s syndrome, and rheumatoidarthritis. Grisel’s syndrome describes non-traumatic subluxationof the atlantoaxial joint from inflammatory ligamentous laxityfollowing an infectious process.[4](http://emj.bmj.com/cgi/content/full/22/9/671#R4)

Traumatic atlantoaxial rotatory subluxation is predominantlya paediatric phenomenon, with rare occurrence in adults.[5,](http://emj.bmj.com/cgi/content/full/22/9/671#R5)[6](http://emj.bmj.com/cgi/content/full/22/9/671#R6)It should be included in the differential diagnosis of patientspresenting with torticollis following even minor trauma. Twoclassification systems for rotatory subluxation have been described:the Fielding and Hawkins system,[7](http://emj.bmj.com/cgi/content/full/22/9/671#R7) and that of White and Panjabi.[8](http://emj.bmj.com/cgi/content/full/22/9/671#R8)These are based on radiological findings, describing the directionof atlantal displacement and the pivotal axis.

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Proof of Ligament Injury After Whiplash Trauma

Much of the research on whiplash injuries over the last few years has focused on the ligaments of the spine as the source of chronic pain and loss of function. Ligament injuries are problematic for two reasons: first, such injuries can be impossible to detect using plain x-rays or CT scans; and, second, torn ligaments can cause permanent disability if untreated.

A 2004 study1 found that the transverse ligament could be injured from rear-end collisions. A new study2 from Norway adds some exciting new insight to the nature of ligament injuries from auto collisions, and provides some new information on the role of head position at the time of the collision.

Previous researchers have found that head position can be an important risk factor in whiplash; patients who have their heads turned at the moment of the crash are much more likely to be injured. This is due to the fact that combined extension of the neck with rotation places severe strains on the ligaments of the spine.

To investigate this issue, the authors of this recent study2 performed MRIs on 92 whiplash patients and 30 healthy control subjects. All of the whiplash patients had normal x-ray results one week after the collision. The MRI was performed an average of six years after the collision.

The transverse ligament limits the motion of the 1st Cervical Vertebrae (Atlas) and the 2nd Cervical Vertebrae (Axis). **If the head is turned during a rear-end collision, this ligament can be stretched or torn, resulting in chronic pain and loss of neck function.**

The authors found significant differences between the whiplash patients and control subjects:

* “For all the neck structures considered, the chronic whiplash patients had significantly more MRI high-grade changes than the controls…”
* The alar ligament was the most commonly injured structure, as 66% of the whiplash patients showed significant damage to the ligament.
* “The patients who had the head rotated at the instant of collision had more often high-grade MRI changes of the alar ligaments than those with the head in a neutral position. A total of 61.7% of the patients with rotated neck position had alar ligament grade 3 lesions, as opposed to only 4.4% in the patient group with neutral neck position.”
* “The association between head position and high-grade lesions (grade 2-3) of the alar ligaments was more pronounced in rear-end…than in front collisions.”
* “High-grade lesions to the transverse ligament were also more common among patients with the head turned at the instant of the collision. Similar results appeared for the tectorial membrane, although with rather few high-grade changes.”
* “Severe MRI changes in the transverse ligament and the posterior atlanto-occipital membrane were considerably more common in front-end than in rear-end collisions.”

This study provides some very important findings relevant for those who represent whiplash injury patients:

* Front-end collision can cause ligament injury from hyper-flexion. The authors write that, “front-end collisions should be included in the definition of potential causes of a whiplash trauma, not only rear-end or side impact.”
* Head position is an important risk factor in whiplash injuries, as a turned head at the time of impact dramatically increases the changes of ligament injury. When working with whiplash patients, it is critical to take a careful history, with particular emphasis on the position of the occupant’s head at the time of impact.
* MRI exams of the ligaments of the upper cervical spine can be a useful tool in diagnosing chronic whiplash pain. The authors of this study looked for increased signal intensity in the affected structures.

The authors conclude their study, “the difference in MRI-verified lesions between [whiplash] patients and control persons, and in particular the association with head position and impact direction at the time of the accident, indicate that these lesions are caused by the whiplash trauma.”

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**Rotatory fixation at the C1-C2 level**

Pate, Deborah

Roentgen Report

Rotatory fixations at the C1 2 level are extremely common. I am not going to discuss the etiology, because there isn't enough space for me to review that topic, but I will review the radiographic features and remind everyone that the anterior-posterior, open-mouth (APOM) view is really important, even if some insurance covers only AP and lateral views as a limited series of the cervical spine. (That is another issue I do not intend to discuss.)

For most patients an AP, lateral and APOM would be the minimal radiographic evaluation I would perform if there were a history of recent trauma and headaches. I don't believe one can get any reasonable idea about what is happening biomechanically at the atlantoaxial region without the APOM. Rotatory fixation is often difficult to evaluate even with an APOM. The view needs to be perfectly aligned to demonstrate the relationship between the dens and the lateral masses.

Patient cooperation is crucial. Once I have the patient's head aligned, I place a sponge to the back of the patient's head. If the sponge falls, I know the patient has moved sometime between my walking away to take the film and my return. Getting the patient to keep the mouth open is also difficult, but sometimes it helps to ask the patient to attempt a yawn. I also increase my kVp by one or two time stations from the AP view, depending on how wide the patient opens his mouth.

In the APOM, the odontoid should sit equidistant between the articular masses of the atlas. The lateral atlantoaxial (AA) joints are symmetrical in position and configuration. Normally, the principal motion of the AA articulation is rotation, although flexion, extension, lateral translation and vertical approximation also occur to some degree at this level.

It is estimated that approximately half of all rotatory cervical motion occurs at the AA joints; between the anterior arch of the atlas and the odontoid process of the dens; the posterior median AA joint; between the dens and the transverse ligament, encircling the odontoid process and preventing the anterior shift of the atlas on the axis and supporting structures; the paired alar ligaments (AL); and the apical ligament of the dens.

In normal individuals, rotation of the head to either side occurs with the axis of rotation at the anterior aspect of the odontoid process. Rotatory fixation represents the abnormal fixation of atlas and axis in a position of rotation, and has been described in numerous articles, of which those by Fielding and his colleagues should be emphasized (mainly because it was Fielding who developed the four basic classifications of rotatory fixation). They are:

1. Type I rotatory fixation without anterior displacement of the atlas.

2. Type II rotatory fixation with anterior displacement of the atlas of 3-5 mm, indicating a deficient transverse ligament.

3. Type III rotatory fixation with anterior displacement of more than five mm, indicating a ruptured transverse ligament.

4. Type IV rotatory fixation with posterior displacement indicating fracture of the dens.

Most of us will only see Type I in our offices. If there is asymmetry between the dens and the lateral masses on the APOM, lateral views in the APOM projection should be performed, especially if there is a history of trauma. Excessive lateral side slippage of C1 on C2 is indicative of rupture or laxity of the accessory ligaments (check ligaments). Cervicocranial axial rotation is primarily limited by the AL, supported by the tectorial membrane, the accessory AA ligaments and the joint capsules.

In axial rotation of C2, the AL on the contralateral side of rotation limits the degree of rotation. When the head is fixed and lateral bending is performed, the atlas will remain fixed with the head, and when the AL are intact, the tension on the contralateral AL ligament will cause the spinous process of C2 to deviate to the contralateral side. The accessory AA ligaments prevent excessive lateral slippage of the lateral masses. As an exercise in biomechanics, let's look at Jackson's description (Figure 2) of ligamentous injuries to the C1-C2 articulations:

The lateral bending accentuates the stress on these ligaments and allows us to determine if the complex of ligaments is patent before manipulation. I am not making any recommendations on manipulation, but I would recommend before any adjustment is performed that one determine if further damage to the ligament complex is possible.

The following case is from Joseph Howe,DC,DACBR, who so kindly wrote the "Upper Cervical Check Ligament Damage" chapter in a book that Sharon Jaeger,DACBR, and I wrote several years ago. See if you can determine the diagnosis. (You may also refer to the captions.)

A printable version of Dr. Pate's article is available on line at www.ChiroWeb.com/ columnist/pate. You may also leave a comment or ask a question at her "Talk Back" forum at the same location.

Deborah Pate, DC,DACBR.

Dr. Pate's articles, a "Talk Back" forum, and a brief biography of the author are available on fine at www.ChiroWeb.com/columnist/pate.

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**Spinal Ligament Damage**

**An Identifiable Component of S*oft* Tissue Damage When Using Motion X-Ray**

Written by Glenn Stirling, DC

In an article written for ICBC’s quarterly journal, Recovery, Nikoai Bogduk M.D states that “In the Western societies, the annual incidence of whiplash claims is about 1 per 1000 people, but a claim does not equal a case…. Most patients recover, usually in a matter of months. Some 20% of patients still have symptoms after a year, but only about 5% are severely disabled.”1 For the 10-20% of victims who develop chronic symptoms, the available data indicates that their condition is not imaginary or fictitious. Although cases of fraud and malingering do occur, they are rare.2 The biomechanics data, the postmortem data, and the clinical data agree that injuries can and do occur.3 These injuries are typically categorized as “soft tissue injury”.

Soft tissue injury is most commonly trivialized as a sprain/strain that should self resolve within weeks to months. Dr. Michael Freeman, co-editor of the Journal of Whiplash and Related Disorders states the following: “The term ‘soft tissue injury’ is so nebulous and trivializing of a wide variety of injury types ranging in severity from symptoms of a few days to a lifetime of debilitating pain that it should be completely abandoned.”4

It is this writer’s opinion that the term “soft tissue injury” serves only the insurance industry by encapsulating a wide range of injuries under one easily dismissed umbrella. The pain suffered by chronic whiplash victims cannot and should not be so easily dismissed.

However, as many doctors, lawyers and frustrated accident victims know, finding the source of chronic pain following whiplash has been very difficult using conventional technologies. This article will discuss some reasons for the difficulty and how visible evidence of whiplash damage can be determined through the advanced technology of Digital Motion X-ray.

**Common Sources of Pain Following Whiplash**

Three common sources of pain following a whiplash event are the disc, the facet, and the alar ligaments.5

**1) Discs**

Spinal discs are the cartilage between each vertebra. Typically there are 23 cartilaginous discs in the spine with five in the cervical spine (neck) and an additional disc uniting C7 with T1 for a potential of 6 discs in the neck region. The disc has been nicknamed the great retaining ligament of the spine due to its tremendous inherent strength.

Discs can be injured in a whiplash event however actual damage to the nucleus pulposis (the centre gel of the disc) is quite rare.6

The imaging modality of choice for disc injury is MRI and the incidence of disc injury is accepted to be around 20 cases per 1000 imaged patients. Rarely is MRI beneficial in proving other injuries in the neck. Although many hold MRI as the gold standard most researchers find routine MRI studies of patients injured in a whiplash event to be of no value.7

**2) Facet Joint – also known as zygapophyseal or “z” joints**

Facet joints are comprised of two zygapophyseal surfaces from two adjacent vertebrae encapsulated by a (capsular) ligament.

Essentially the facet capsule limits the range of motion of the zygapophyseal joint surfaces (facets) on both sides of the neck. There are 5 facet capsules on each side of the neck for a total of 10 facet capsules. There are two additional facet capsules between C7-T1 which are often considered when discussing facet joint injury to the neck creating a possible total of 12 facet joints that can be considered for potential injury in the neck region after a whiplash or other trauma.

The predominant symptom of facet joint damage is neck pain in a somewhat predictable pattern.8 Headaches from neck injury also follow somewhat predictable pain patterns.9 At least 60% of chronic pain whiplash victims have facet joint damage. The diagnostic procedure of choice is an anesthetic block10 but many injured patients are not managed to the point of receiving this approach. A facet block is an invasive procedure that is not easily or quickly accessed. Hence, the typical therapeutic approach for patients with soft tissue injury is to receive months of physiotherapy, months of massage therapy and/or instructions for continued use of anti-depressant medications along with exercise and stretching, rather than ongoing diagnostic efforts being made to find the source of chronic pain and treat it more specifically.

Researchers have compared conventional imaging with tissue slices harvested at autopsy. Those findings show ligament and or facet joint capsule (ligament) damage in each whiplash case even when conventional imaging (plain x-ray, routine CT, MRI) appeared normal.11

Fortunately, a motion x-ray exam will easily reveal facet injury12 and it is definitely easier on the patient than an autopsy. With a motion x-ray, the interpreter is able to compare the movement in the patient’s normal joints with those that gap or move aberrantly. A digital motion x-ray of the neck will yield approx 2700 images (increasing diagnostic ability) while exposing the patient to about the same dose of radiation as a standard neck x-ray of 3-6 images.

**3) Alar Ligaments**

The anatomy of the neck and base of the skull is complex and would require a dedicated article just for the introduction. Suffice to say that ligaments stabilize the area while allowing the complex integrated range of motion of the skull and bones of the neck.

The paired alar ligaments stabilize from the second vertebra (C2) to the base of the skull restricting C1 and C2 in lateral flexion and rotation. These joints are so restricting that in normal lateral bending of the neck there should be no movement between C1 and C2. Consequently if motion translation (sliding) is seen on a motion x-ray, the instability can be documented.

Alar ligament injury is more commonly in suspicion when the mechanism of injury includes a rear end accident while the victims head is turned at impact.13 The many variables and forces at work during the split second of a motor vehicle crash make it very possible for these stabilizing ligaments to be injured.

Total failure of a ligament (rupture) is likely to result in dislocation, surgery or death. The term sub failure is applied to fraying, stretching or weakening of ligaments. Sub failures are rarely surgical. However, “sub failure injuries to the cervical soft tissues may lead to cervical spine instability and clinical symptoms”.14 Instability of the alar ligaments is a common basis for ongoing complaints such as headache, neck pain, and shoulder pain. Often these victims cannot sleep on their stomach or turn their head from side to side without triggering neck pain, headaches, or other symptoms.

Only the worst instabilities will obtain surgical stabilization. Individuals who don’t require surgery tend to have their complaints minimized and trivialized (it’s only soft tissue) even though resolution is unlikely and permanent injury likely.

Prolotherapy and the use of a limiting cervical collar for certain activities are partial solutions to the challenge of alar ligament damage. Although permanent injury cannot be confirmed until 2 years post trauma, the outcome of ligament injury can be predicted at 3 months.15

In most clinical practices the alar ligaments are rarely imaged or considered as components of whiplash injury. They are so uncommonly reported that in 31 years I have seen only one incidence reported in the many medical and IME reports that have crossed my desk. Although “ligament injury is extremely common”16 they are obviously not being diagnosed or reported. In a study conducted by J. Krakenes, et al, it is stated that **alar ligament injury is apparent in as many as 9 out of 10 late whiplash candidates** (over two years since injury).17 In another study 66.3% of whiplash victims (6 years post-trauma) demonstrated evidence of alar ligament injury.18

**Determining Ligament Injury**

While a complete rupture of spinal ligaments may show on an MRI; stretching, fraying or laxity of these ligaments (instability of varying degrees) does not image on the typical MRI protocol used for diagnosing whiplash injuries. However, there are imaging processes being used in Europe19 and North America20 that can reveal ligament damage such as the proton density-weighted MRI which images the ligament quality; and dynamic or functional x-ray, MRI, and CT which reveal ligament damage by examining how the ligament functions. Functional x-rays such as the **digital motion x-ray will not specifically image spinal ligaments, but it will** **image the function of the ligaments while they are trying to do their job of stabilizing the neck.**

Fluoroscopic, dynamic or functional x-ray evaluation for instability is an accepted procedure in Canada used by the medical and chiropractic21 professions. One has to wonder why they are not utilized more routinely for diagnosing whiplash injuries. Routine plain film, CT, and MRI commonly used are more effective for evaluating injuries that are apparent while the patient refrains from all movement. Functional/motion studies, on the other hand, should be used for evaluating injuries that are symptomatic when the patient moves. They are also effective when evaluating a patient who continues to experience chronic pain six weeks or more following a whiplash event.

In a motion study the patient is asked to move through a specific protocol designed to stress specific ligaments. Ligaments normally restrain or hold joints within a certain range of motion. If this range is excessive it can be measured or compared to other similar joints to determine ligament injury/damage/sub-failure.

The image clarity obtained in a digital motion x-ray22 makes this comparison relatively easy. Unlike standard x-ray or fluoroscopic images, digital motion x-ray images (see image) show the bones in shades of black with black cortical margins on a white background making the function of ligaments during motion easier to assess.

**Why is Ligament Injury Commonly Overlooked?**

It may be challenging to accept the fact that there are significant gaps in medical education. The data shows that “There is a marked discrepancy between the musculoskeletal knowledge and skill requirements of a primary care physician and the time devoted to musculoskeletal education in Canadian Medical Schools”.23 In simplest terms, primary care physicians have about two weeks of training in all musculoskeletal disorders (muscle, bone and joint) most of it relative to surgical need like hip and knee replacement or multiple trauma follow up. Almost none of their few hours of musculoskeletal training are related to the topic of this article.

The injured public and lawyers rely on these ‘experts’ (with virtually no training in this area) to understand and properly manage many whiplash victims with chronic pain. Early in this article, research was quoted that suggests ligament injury is extremely common. If this is the case, why don’t the findings and reports of doctors reflect this fact? From an experienced practitioner’s perspective, evaluating instability or the subtle nuances of sub failure of ligaments following trauma is an advanced topic unsuited to novices in musculoskeletal disorders. And yet reports and diagnosis from the ill trained, continue to direct the management of whiplash victims with chronic pain.

Not so long ago, one of my worst cases (advanced instability) was reviewed by a two doctors in Vancouver. One doctor who viewed the x-ray images declared the patient to be normal saying “I see this all the time”. The other doctor felt the study supported his original diagnosis of ligament damage. How can the first doctor say the images of someone with advanced instability are “normal”? Was this doctor trained in musculoskeletal studies with the knowledge to interpret the subtleties of a motion x-ray? One can only assume not.

Although the diagnostic value of the x-ray was obvious to the second doctor it went unrecognized by the first doctor. Ignorance is no excuse for overlooking an obvious diagnosis.

**In Conclusion**

Research and experience demonstrate that spinal ligament (soft tissue) damage is an identifiable component in whiplash injury. The incidence of long term sufferers is around 20% of cases. The pain that persists in these cases must not be trivialized under the “soft tissue injury” umbrella. The injury will not spontaneously resolve if it has not done so within 2-3 months post-trauma. At 3 months permanent injury can be predicted and confirmed at two years. Disc injury in the neck is rare while facet injury and alar ligament injury are common and may be permanent. The biomechanical data, post mortem data and clinical data objectively show that these injuries are not imaginary. Ligament sub failures can be imaged with functional motion x-ray however referral for motion x-ray has yet to become routine in chronic cases. Some in the medical and chiropractic profession in Europe, and North America utilize motion x-ray in diagnosing these injuries. Pain Management, a Practical Guide for Clinicians published in 2002 states that “Digital motion radiography is currently a valuable diagnostic method in evaluating painful hyper mobility and instability due to posttraumatic and degenerative pathology of the capsular and axial ligaments”.24 It is this writer’s hope that the knowledge and use of digital motion xray in diagnosing spinal ligament sub failure will become the norm and give patients, doctors, and lawyers the accurate assessment needed to secure proper treatment and appropriate remuneration for subsequent lifestyle changes and ongoing treatment.

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Pitfalls of magnetic resonance imaging of alar ligament

**Neuroradiology**

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**Abstract**An observational study of variations in the appearance of the alar ligament on magnetic resonance imaging (MRI) and the normal range of lateral flexion and rotation of the atlas was performed to validate some of the premises underlying the use of MRI for the detection of injuries to the alar ligament. Fifteen healthy volunteers were included. Three sets of coronal proton-density images, and axial T2-weighted images of the craniovertebral junction, were obtained at 0.5 T with the neck in neutral position and laterally flexed (coronal proton density) or rotated (axial T2). Five of the subjects also underwent imaging at 1.5 T. The scans were independently examined twice by two radiologists. The presence of alar ligaments was recorded and a three-point scale used to grade the extent of hyperintensity exhibited by the structures: the ligament were graded as 2 and 3 if, respectively, less or more of its cross-section was hyperintense, whereas grade 1 represented a hypointense ligament. The effect of lateral flexion on image quality was assessed. Concordance analysis of the data were performed before and after dichotomising the data on grading. The atlanto-axial angle and rotation of the atlas were measured. The magnitude of movement to right was normalised to that to the left to give, respectively, the flexion index and the rotation index. The alar ligaments were most reliably seen on coronal proton-density scans, with a Maxwells RE of 0.96 as compared with 0.46 for sagittal images. Flexion of the neck improved definition of the ligaments in only rare instances. Inter-observer disagreement was marked with respect to grading of the ligament on both coronal [composite proportion of agreement (p0)=0.44; 95% confidence intervals: 0.26, 0.64)] and sagittal scans [p0=0.40 (0.19, 0.63)]. Dichotomising the data did not appreciably improve reliability [Maxwells RE: –0.11 (coronal scans), –0.20 (sagittal scans)]: for ligaments which demonstrated hypertensive areas (grades 2 and 3) there was complete lack of agreement for both coronal [p2=0 (0, 0.25)] and sagittal scans [p2=0 (0–0.30)]. A large response bias was found in the reports of both readers albeit in opposite directions. There was poor concordance between scans obtained at different field strengths [RE (coronal images)=0.25; RE (sagittal images)=0.14). Mean flexion index and mean rotation index were 1.00 (SD 0.03) and 1.01 (SD 0.06), respectively. **The MR imaging may not be the investigation of choice for the investigation of subtle injuries to the alar ligament.**