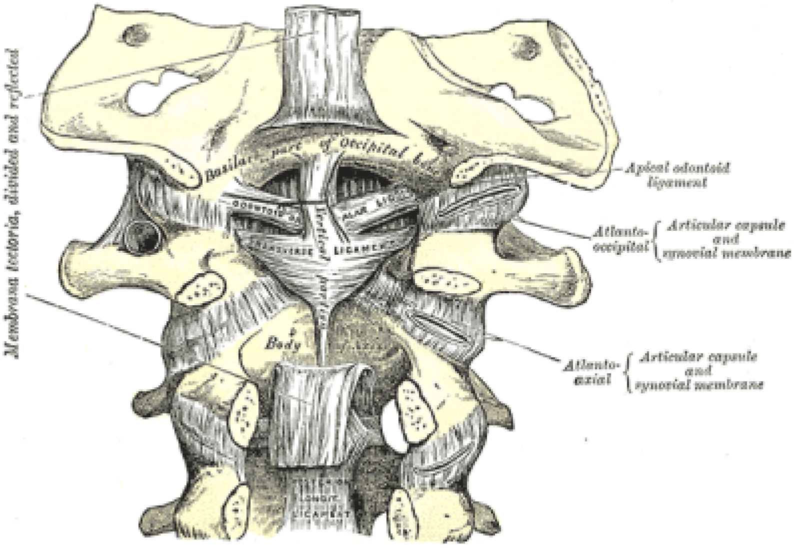
Alar ligament



Apical ligament, alar ligament, and transverse ligaments provide further stabilization by allowing spinal column rotation; this prevents posterior displacement of the dens in relation to the atlas.

The alar ligaments connect the sides of the dens on the axis to tubercles on the medial side of the occipital condyle.

They are short, tough, fibrous cords that attach on the skull and on the axis, and function to check side-to-side movements of the head when it is turned. Because of their function, the alar ligaments are also known as the “check ligaments of the odontoid”.

The alar ligaments are two strong, rounded cords of about 0.5 cm in diameter that run from the sides of the foramen magnum of the skull to the dens of the axis

They span almost horizontally, creating an angle between them of at least 140°

The alar ligaments, along with the transverse ligament of the atlas, derive from the axial component of the first cervical sclerotome.

The function of the alar ligaments is to limit the amount of rotation of the head, and by their action on the dens of the axis, they attach the skull to the axis, the second cervical vertebra.

The alar ligaments are prone to tearing if a force is applied when the head is flexed and in rotation.

If an alar ligament is ruptured, the range of rotation of the head relative to the neck increases beyond the normal limit of 20 degrees.

Nineteen upper cervical spine specimens were dissected to examine the macroscopic and functional anatomy of alar ligaments. They are on both sides, symmetrically placed, approximately 10-13 mm long and elliptical in cross-section 3 X 6 mm in diameter. The fiber orientation is dependent on the height of dens axis, mostly in the cranial caudal direction. In 12 specimens there was a ligamentous connection between dens and lateral mass of the atlas as a part of the alar ligament. In 2 specimens anterior atlanto-dental ligament was identified. The computerized tomographic (CT) images can clearly show alar ligaments in axial, coronal, and sagittal planes. The ligaments limit the axial rotation in the occipito-atlanto-axial complex (to the right by left alar and vice versa) as well as in side bending. The ligament is most stretched, and consequently most vulnerable, when the head is rotated and in addition flexed. This mechanism, common in whiplash injury, could lead to irreversible overstretching or rupture of the ligaments especially as the ligaments consist of mainly collagen fibers [1)].

The alar ligament restrains rotation of the upper cervical spine, whereas the transverse ligament restricts flexion as well as anterior displacement of the atlas. A lesion in one or both structures can produce damage to the neural structures and/or cause pain. To investigate the possible role of each of these ligaments, a mechanical and histologic study of the upper cervical spine was made. The bone-ligament-bone complex of the alar and transverse ligaments was subjected to uniaxial mechanical testing in seven specimens. The alar ligaments had an in vitro strength of 200 N, and the transverse ligaments had an in vitro strength of 350 N. Histologic analysis revealed a mainly collagenous nature of these ligaments. Clinical evidence (broken odontoid processes) suggests that the transverse ligament is strong enough to withstand physiologic loads. The alar ligament, on the other hand, due to its lower strength and its axial direction of loading, might be prone to injury and therefore require stabilization of the appropriate vertebra more often than normally is assumed [2)].

Morphology

In terms of morphology, their appearance varies and is visible on MRI. Dark signal of the AL on proton-density (PD)-weighted images is generally considered the norm, but the etiology of frequently observed signal hyperintensities is poorly understood. Using spectral fat suppression, signal hyperintensities can be differentiated into fat- and nonfat-related hyperintensities (NFH). Although signal hyperintensities have no evident association with whiplash-associated disorder, age-related degeneration has often been theorized. Therefore, this study investigates the signal intensities of the ALs on 3.0-T MRI with special reference to age. Expanding thereon, the authors investigated the relationship between signal hyperintensities and patient characteristics, such as height, weight, and sex.

Sixty-six healthy volunteers were scanned using 3.0-T PD-weighted MRI, including spectral fat suppression of the craniocervical junction. The study population was separated into 2 groups (old vs young) using 2 approaches: dichotomization at the median age (40.0 years) and the calculated threshold (28.5 years) using receiver operating characteristics (ROC). The AL was independently characterized with respect to continuity, course, shape, signal intensity, and graduation of homogeneity by 2 experienced neuroradiologists. Signal intensity was differentiated into fat-related hyperintensity and NFH. Univariate and multivariate logistic regression models were employed to investigate the relationship between patient characteristics and signal intensities. RESULTS Two different AL patterns were observed: inhomogeneous (33.3%) and homogeneous (66.7%). The latter pattern was mostly surrounded by a small dark rim (56.8%). Fat could be identified in 15.9% of all ALs (21 of 132 patients), and NFH was identified in 17.4% of all ALs (23 of 132 patients). Here, 28.5 years was the preferred threshold, demonstrating a relatively high sensitivity for dichotomizing the population based on the ROC of NFH. The most relevant factor for having NFH was being older than the calculated threshold (odds ratio [OR] 3.420, $p = 0.051$). Fat-related hyperintensities occurred significantly more frequently in men than women (OR 0.110 and $p = 0.007$ for women; OR 9.075 and $p = 0.007$ for men). Height was the second most significant factor: for every 1-cm increase, the odds of having fat lesions increased by approximately 10% (OR 1.102; p = 0.017).

This study shows that AL signal hyperintensities are substantially influenced by age, sex, and height in healthy individuals. Regarding fat-related hyperintensities, the most relevant factors proved to be sex and height. The odds of detecting NFH increased almost significantly after a relatively young age (> 28.5 years) and were remarkably more frequent in individuals older than 28.5 years. The authors caution presumptions equating signal alterations with age-related deterioration. Instead, they suggest that dispositional factors such as sex and height are more relevant in the AL constitution. Signal alterations in ALs naturally occur in healthy symptom-free individuals, underscoring the importance of cautiously interpreting such lesions on posttraumatic MRI scans [3].

1)

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2)

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3)

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