Magnetic Resonance Imaging of the Transverse Ligament of the Atlas and the Alar Ligaments Using Ultrashort TE (UTE) Pulse Sequences

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INTRODUCTION

The presence of fibrocartilage within a ligament can be related to local function including resisting compression and shearing forces. At sites where ligaments or tendons are compressed, the predominant collagen typically changes from Type I (associated with fibrous connective tissue) to Type II (associated with fibrocartilage), and the predominant large molecules may be aggrecans which are associated with cartilage rather than lumican. Histological features of cartilage are also observed in these regions (1).

These biochemical and histological studies have been of considerable interest, but it has not been possible to correlate them with imaging findings in either the transverse ligament of the Atlas or the alar ligaments. X-ray computed tomography shows no specific features and MR studies with conventional clinical pulse sequences show a low to intermediate tissue signal without differentiation of tissues components.

Ultrashort echo time (UTE) pulse sequences with TEs 20-50 times shorter than those of conventional clinical sequences demonstrate higher signal from tissues which have short T_2s such as tendons and ligaments and can also allow different short T_2 tissue components to be identified within them. For example, enthesis and sesamoid fibrocartilage can be differentiated from fibrous connective tissue at the insertion of the Achilles tendon (2).

In this study we have used UTE pulse sequences to examine the transverse ligament of the Atlas and the alar ligaments and to see whether any differences were detectable within them, and if such differences were detectible whether they correlated with the known distribution of fibrocartilage.

SUBJECTS AND METHODS

UTE sequences were acquired with echoes at 0.08, 5.95, 11.08, and 17.70 ms (3). Difference images formed by subtraction of subsequent echo images from the first echo image were produced. Fields of view of 20-26 cm were employed with a slice thickness of 4 mm. Two to 20 multiple interleaved slices were obtained. TRs of 500 ms were used with conventional and fat-suppressed sequences with flip angles (for long T_2 components of 45° to 80°) and slice gaps of 10% to 100%. All studies were performed on a Symphony 1.5T system (Siemens, Erlangen, Germany).

Six normal volunteers (4 males, 2 females age 29-61 years) were examined. None had a history of significant musculoskeletal disease or neck trauma.

RESULTS

In all six cases the transverse ligament of the Atlas and the alar ligaments were demonstrated. The transverse ligament showed intermediate signal intensity with a higher signal centrally in the region posterior to the dens and laterally to the body of the atlas (Fig. 1). This was also seen in subtraction images and with fat suppressed UTE. The alar ligaments displayed high signal at their dentine attachment as well as at their occipital attachment.

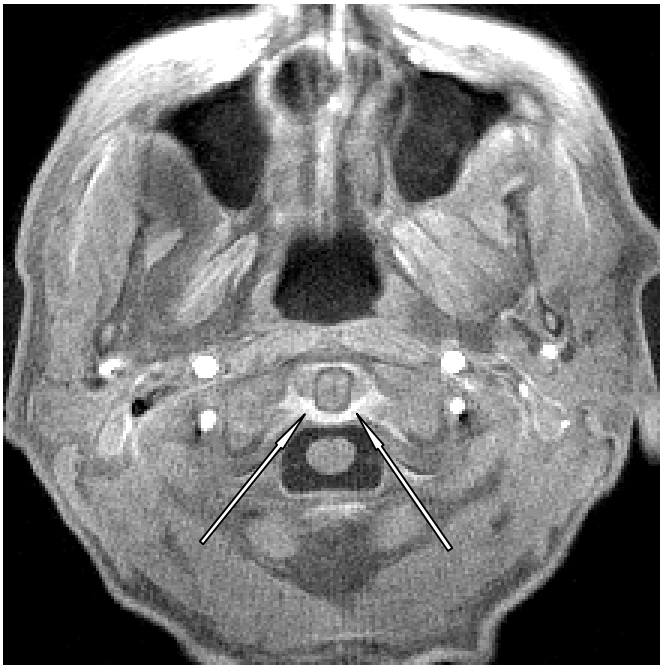

Fig. 1. Transverse ligament of the atlas, axial slice. High signal is seen within the ligament posterior to the odontoid process and extending laterally (arrows).

DISCUSSION

Both the transverse ligament of the Atlas and the alar ligaments showed patterns of signal intensity which closely parallel the known distribution of fibrocartilage within them as determined histologically and biochemically (4,5). The distribution is also consistent with study of the mechanical forces experienced by the ligament and the function of fibrocartilage in resisting compressive and shear forces.

The increase in signal probably reflects a decrease in T_1 in fibrocartilage relative to fibrous connective tissue. The high signal on difference images reflects a decrease in T_2. This is the pattern observed in sesamoid fibrocartilage in the Achilles tendon. Sesamoid fibrocartilage typically has a basket-weave pattern of fibers rather than the parallel fiber pattern seen in fibrous connective tissue of ligaments subject only to tensile forces. This may also have contributed to differences in conspicuity.

The demonstration of changes consistent with the presence of fibrocartilage may be relevant to both rheumatoid arthritis and seronegative spondyloarthropathies in both of which fibrocartilage is an antigenic target (6,7).

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