MR Imaging of Peripheral Nerves with Short and Ultrashort Echo Pulse Sequences

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Introduction

Magnetic resonance (MR) imaging of the peripheral nervous system was first described in 1982 and received a considerable boost with the advent of surface coils and fat suppressed T2 weighted sequences in 1985. These basic methods have been supplemented with contrast enhancement, fast spin echo, diffusion weighting and steady state methods. Most clinical approaches use TEs of 10-20 msec or longer. Of interest is the contribution from short T2 components within nerves which are not routinely detected with longer TE approaches. This is of particular interest in peripheral nerves because there is significant ordered collagen in all three layers of peripheral nerves and this tissue tends to have a short T2 (1). Magic angle effects attributable to this collagen have been observed previously (2). In this study we describe imaging of peripheral nerves in tissue samples, intact cadavers and human subjects using short and ultrashort echo time (TE) pulse sequences. The emphasis was on detection of short T2 components within nerves.

Material and Methods

All examinations were performed on a clinical 3T HDx scanner (GE Healthcare) and used planar or contained surface coils. Isotropic 3D ultrashort TE (UTE) pulse sequences were used with a minimum TE of 56μs. Fields of view of 4x4 to 10x10 cm were used with matrix sizes of 320x320 to 448x448. 3D spoiled gradient echo (SPGR) sequences with TEs of 5-14 ms were used with fields of view of 3x3 to 8x8 cm and matrix sizes of 320x320 to 484x484. 2D multi echo spin echo (SE) sequences were also performed. These had TEs from 22 to 146 ms slice thickness 0.7-2 mm and 384x384 matrix size.

Results

In studies of the median, ulnar and sciatic nerve subtraction of later echos of TEs 2-6 ms from the first UTE resulted in high signal consistent with the presence of short T2 components in the external and internal epineurium and to a lesser extent the perineurium and endoneurium (Fig.1). The UTE, SPGR and multi-echo sequences showed relatively high signal from the perineurium (Fig 2). This was consistent with a short T2 and long T2 relative to epineurium and endoneurium. Blood vessels with evidence of a long T1 and T2 were seen within the epineurium.

Discussion

The short T2 components present in the external and internal epineurium were probably in large part a consequence of the presence of collagen. The use of long TE pulse sequences, in association with fat suppression, may mean that low or zero signal from the epineurium is not distinguished from suppressed fat. The high signal in the perineurium on UTE and SPGR sequences is consistent with a short T1. The long T2 signal from peripheral nerves is generally attributed to neural components, fluid in the endoneurium and blood, but the high signal seen at longer echo times in the perineurium suggests that this tissue may make a significant contribution to this signal detected with routine clinical pulse sequences. High signal in the perineurium has been recognized in studies of isolated peripheral nerve at 7.4T with both T1 weighted and T2 weighted sequences (3,4) but not in studies in human subjects.

References

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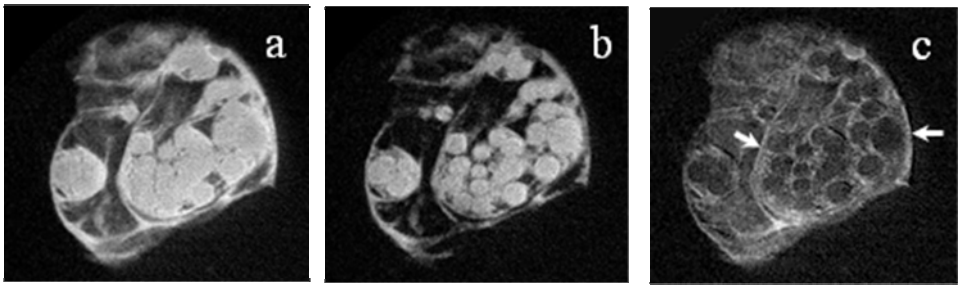

Fig. 1. Sciatic nerve axial section. (a) UTE TE 56 μs, (b) SPGR TE 6ms, (c) subtraction image (a-b). The subtraction image shows evidence of short T2 components, particularly in the epineurium (arrows).

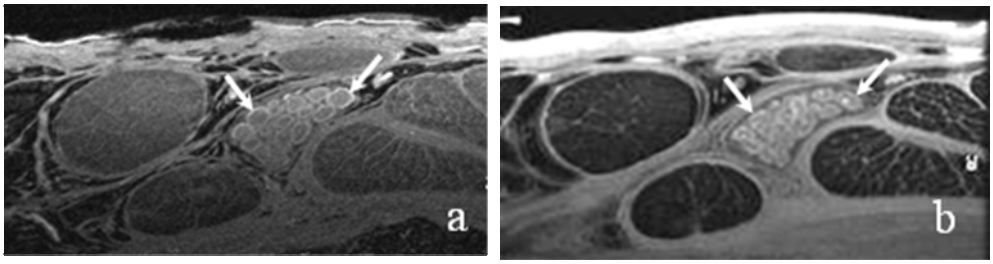

Fig. 2. Median nerve axial sections. (a) SPGR image TE 6ms, (b) SE image TE 40ms. Panel (a) shows high signal in the perineurium (arrows) consistent with a relatively short T1 and (b) also shows high signal in this region (arrows) consistent with a long T2. High signal is also seen in (b) from blood vessels.