Single Voxel and Chemical Shift Imaging (CSI) of Soft Tissue Sarcomas

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Objective

The objective of the study was to evaluate the role of choline as a tumor marker in (i) differentiating benign and malignant soft tissue sarcomas (ii) to distinguish between recurrent/residual tumors using in-vivo MR spectroscopy.

Materials and Methods

Twenty seven patients (males = 20, females = 7, Age = 39 ± 17 years) with soft tissue tumors were recruited for the study. MR examinations were performed at 1.5 T in a whole body MR scanner (Siemens, Avanto/Sonata) with a surface coil. After localization, T_2- weighted images were obtained in three planes to identify the location and boundaries of the tumor. Both single voxel MRS using PRESS (TR = 2000 ms, TE = 30-270 ms, NS = 128-256) and volume selective 2D chemical shift image (CSI) were performed. For CSI measurements a 10 – 20 mm slab with appropriate voxel volume, using PRESS sequence with the following acquisition parameters TR = 2000 ms, TE = 30-270 ms, NS = 4, FOV = 120 x120 mm. Simultaneous suppression of fat and water suppression was achieved in same patients with the use of MEGA pulses. The criterion for determining the presence of choline in a lesion is the appearance of an unperturbed resonance at 3.2 ppm from four to five voxels in the CSI grid placed inside the tumor.

Results

In eighteen patients with histopathologically proven malignant lesions (synovial sarcoma = 10, MPNST = 3, MFH = 2, lieomyosarcoma = 2, pleomorphic RMS = 1) choline resonance was observed, while in four benign lesions (hemangioma = 1, low grade liposarcoma = 3) no choline was observed from any of the voxel of the CSI grid. In five patients who underwent MR studies after surgery, choline signal was not observed indicating the absence of residual tumor. MR spectroscopy was found to be 100% sensitive and specific in differentiating malignant and benign soft tissue tumors. The positive predictive value and negative predictive value of this technique was also 100%.

Discussion

Dynamic contrast enhanced MR imaging is commonly used to differentiate benign and malignant soft tissue tumors. An early uptake of contrast again indicates malignancy of the lesion while slow enhancement of the tumor is characteristic of benign lesions. This method fails in differentiating benign tumors with high vascularity from benign tumors since tumors with high vascularity also show the same enhancement pattern of that of malignant tumor. Our MRS results reveal that it is possible to clearly distinguish between the malignant lesion from a benign tumor with 100% sensitivity and 100% specificity. Moreover, 100% correlation between the histology and the presence of choline in CSI was observed. Choline containing compounds (free choline, phosphocholine, phosphatidylcholine and glycerophosphocholine) are important constituents in cell membrane synthesis and their elevation in MR spectra represents an increased membrane phospholipids synthesis, often associated with highly proliferative malignant tumors. In our study all the malignant tumors showed the presence of choline signal, while in benign lesions no choline resonance was observed. In five patients, suspected for recurrence, no choline signal was observed indicating the absence of tumor. This finding was also supported by histopathological data. Recently the characterization of bone and soft tissue tumors has been evaluated by in-vivo ^{1}H MRS[1].

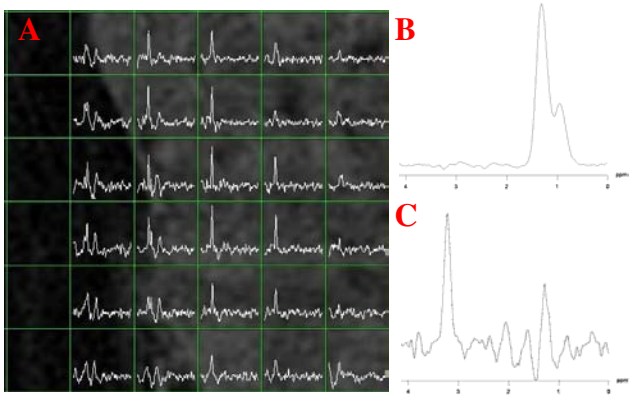

Fig.1. (a) Spectral map of Pleomorphic rhabdomyosarcoma in calf muscle. Spectra obtained from (b) hemangioma (c) synovial sarcoma

Conclusion

The interesting result of the study is the 100% sensitivity and 100% specificity of MRS in differentiating benign and malignant lesions. In-vivo MRS can be an alternative to invasive biopsies performed to differentiate a malignant lesion from benign lesion and also to detect the recurrent tumors in patients.

Reference

1. Wang C-K, et al., Radiology 2004; 232:599-605