

Criteria	MacD	TV	nTBF
CBC	10/11	3/12	6/12
MacD	-	6/11	7/11
TV	-	-	12/14

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Solitary brain metastasis and glioblastoma multiforme: differentiation based on MRI and two-dimensional turbo spectroscopic imaging data

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Purpose/Introduction: Conventional MRI or clinical history cannot always distinguish between solitary metastases and glioblastomas, while they require a different therapeutic treatment. The peri-enhancing region in glioblastoma, in contrast to metastasis, contains infiltrating tumour cells and MR spectroscopic imaging can be used to study metabolic differences between the tumours [1,2]. Here, differences between glioblastoma and metastasis have been further investigated, by exploring the combination of MRI and two-dimensional turbo spectroscopic imaging (2D-TSI). Metabolic differences between the tumours are investigated and a semi-automatic algorithm is developed to differentiate metastases from glioblastomas using nosologic images [4].

Subjects and Methods: Data (5 glioblastomas, 5 metastases) were acquired at two centers as part of the routine clinical preoperative MRI and spectroscopy protocol [3]. MRI data (T1- (pre- and post-gadolinium injection) and T2-weighted images) and 2D-TSI (24x24, FOV 230x230 mm, slice thickness = 20 mm, TE = 272 ms, TR = 2000 ms) were acquired in 1.5T Philips magnets. Cho/Cr and Cho/NAA are calculated for the non-enhancing/non-T2 hyperintense region, peri-enhancing region (non-enhancing/T2 hyperintense) and the enhancing tumour. Cho/NAA maps are divided in affected and non-affected tissue by Otsu's threshold method and included in nosologic images to visualize potential tumour infiltration.

Results: Table 1 provides the averaged ratios in the different regions for glioblastomas and metastases. Cho/Cr and Cho/NAA are significantly higher in the peri-enhancing region and the enhancing tumour. Figure 1 provides a scatter plot of the difference between the ratio in the enhancing tumour and the ratio in the non-enhancing/non-T2 hyperintense region, allowing a clear separation of glioblastomas and metastases. Figure 2 shows the nosologic image for a patient with a glioblastoma. The white area, outside the abnormal area on T2, indicates tumour infiltration. This is not observed for metastases (Figure 3).

Discussion/Conclusion: This study illustrates the combined use of 2D-TSI and MRI data to differentiate glioblastoma multiforme from solitary metastases by means of two approaches. First, it was found that the Cho/Cr and Cho/NAA ratios are significantly higher for glioblastomas compared to metastases in the enhancing tumour and the peri-enhancing area, allowing a clear differentiation between the two tumour types. Secondly, the infiltrative nature of glioblastomas into the normal/surrounding/adjacent brain parenchyma, is detected using nosologic images, allowing a differentiation between both tumour types.

References:

[1] Di Costanzo A. et al., 2008, Eur Radiol 18, p1727;
[2] Law M. et al., 2002, Radiology 222, p715;
[3] eTUMOUR FP6-2002-LSCH-503094; www.etumour.net;
[4] Luts J. et al., 2009, NMR Biomed 22, p374;

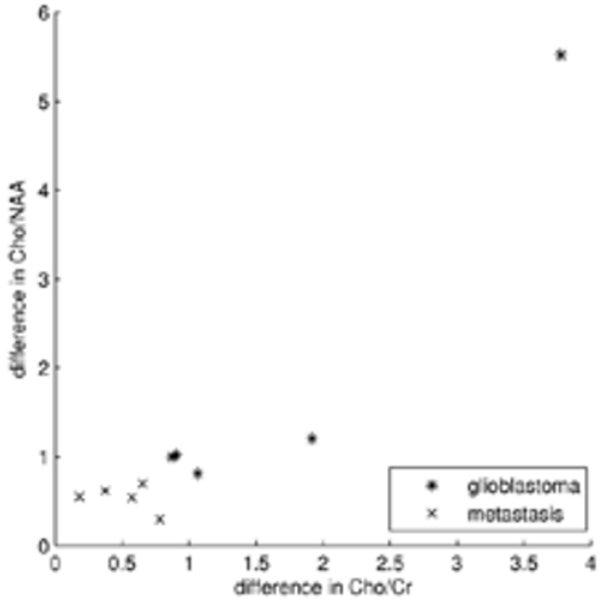


Figure 1: Difference between enhancing tumour and the non-enhancing/non-T2 hyperintense area for Cho/Cr and Cho/NAA. Glioblastomas and metastases are separated.

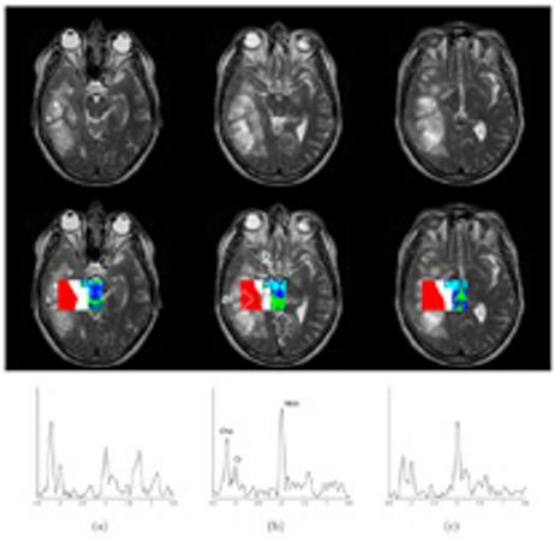


Figure 2: Top: T2-weighted MR images of three neighbor slices included in the 2D-TSI slice for a patient with a glioblastoma tumour. Middle: the corresponding nosologic images. Colors: dark blue = gray matter; light blue = white matter; green = CSF; red = abnormal on T2; white = normal on T2, abnormal Cho/NAA. Bottom: MR spectra from voxels that are indicated on the nosologic image of the middle MRI slice. MR spectrum (b) originates from the infiltrated area, showing increased Cho with respect to Cr and a higher Cho/NAA ratio.

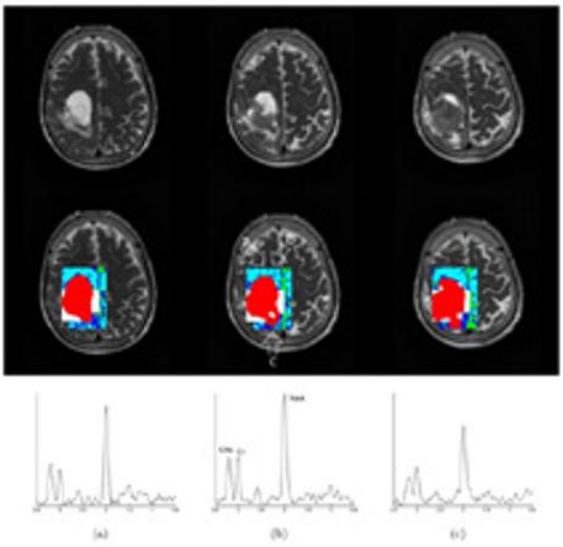


Figure 3: Top: T2-weighted MR images of three neighbor slices included in the 2D-TSI slice for a patient with a metastasis tumour. Middle: the corresponding nosologic images. Bottom: MR spectra from voxels that are indicated on the nosologic image of the middle MRI slice. The MR spectra show increased NAA with respect to Cho, while Cho and Cr levels are similar.



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Correlations between different MR images for estimation of borders of human brain tumors at 3T

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Introduction: Correlations between concentrations of choline compounds [Cho] and diffusion trace values (Tr_{ADC}) have proven to be useful for better estimation of borders of brain tumors in individual subject examined at 1.5T [1]. The aim of this study is to verify this technique on 3T and test if using of other MRI modalities (diffusion tensor imaging (DTI), T1 and T2 relaxometry) among 1H spectroscopic imaging (CSI) can provide additional information to achieved results.

Methods: Twelve patients with histologically proved diagnosis (5xGII, 2xGIII, 3xGIV, 2x tumorous cells not confirmed) and 24 healthy controls were examined on 3T scanner. Stereotactic biopsy was made within 2 days after MR examination. The measurement protocol consists of anatomical T2-weighted MR images, CSI (2D PRESS-SI, 16x16, FOV=160x160x15mm, TR/TE/NA=1510ms/30 and 135ms/4), DTI (EPI-SE, TR/TE/NA=6800ms/98ms/3, 20 directions, b=0,1000s/mm2), T2 relaxometry (CPMG, TR/TE/NA=3000/13.2-422.4/1, 32 points), T1 relaxometry (SE, TR/TE/NA=3200-50ms/6.9ms/1-16, 7 points). SI data were analyzed using the program CULICH [2] and LCModel [3]. Relaxation data were calculated using home-made program ViDi. Mean diffusivity (MD) and fractional anisotropy (FA) were processed using the program FSL. Correlations were calculated using home-made program CORIMA [1] with automatic identification of pixels in normal tissue according to control data.

Results: Existence of several different regions among positive and negative [Cho]-MD correlations were reconfirmed at 3T. Moreover different types of correlation with different slopes were also recognized using other MR modalities, e.g. [Metabolites]-MD, [Metabolites]-T2, MD-T2, MD-T1 (Fig.1). Existence and slope of positive [Cho]-MD correlation differs between tumor grades. More prominent differences between areas of gray and white matter were observed compared to 1.5T. Pixels representing normal tissue in different modalities did not match exactly. Biopsy results corresponded to the suspected tissue pathology (Fig.1).

Conclusion: Combinations of correlations between different MR modalities verify and improve identification of brain tissue state. Several limitations were observed on 3T. Quality of images, non-homogenous excitation of CSI and higher differences between gray and white matter can create false correlation. Therefore this method should be used as semi-automatic.

Acknowledgments:

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References:

[1] Wagnerova D et al. The correlation between 1H MRS Choline concentrations and MR diffusion trace values in human brain tumors. Magn Reson Mater Phy 2009;22(1):19-31

[2] Jiru F et al. LCModel for Spectroscopic Imaging. Magn Reson Mater Phy 2003 16(Suppl 1): S211,No.401

[3] Provencher SW. Estimation of metabolite concentrations from localized in vivo proton NMR spectra. Magn Reson Med. 1993;30(6):672-9.