Glucosamine CEST MRI in human breast cancer: Correlation with BI-RADS score

Rivlin M.[1,2], Sivan-Hoffmann R.[3], Hadar V.[4], Sukhotnik S.[4], Weisenberg-Cusnir N[4], Shmain-Naydenov O.[4], Zaiss M.[5,6], Weinmüller S.[5], Navon G.[1]

[1] School of Chemistry, Tel-Aviv University, Tel-Aviv, Israel, [2]Department of Biomedical Engineering, Tel-Aviv University, Tel-Aviv, Israel, [3]Department of Radiology, Meir Medical Center, Kfar-Sabba, Israel, [4]Department of Radiology, Breast imaging unit, Meir Medical Center, Kfar-Sabba, Israel, [5]Institute of Neuroradiology, University Clinic Erlangen, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany, [6]Department Artificial Intelligence in Biomedical Engineering, Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany.

INTRODUCTION:

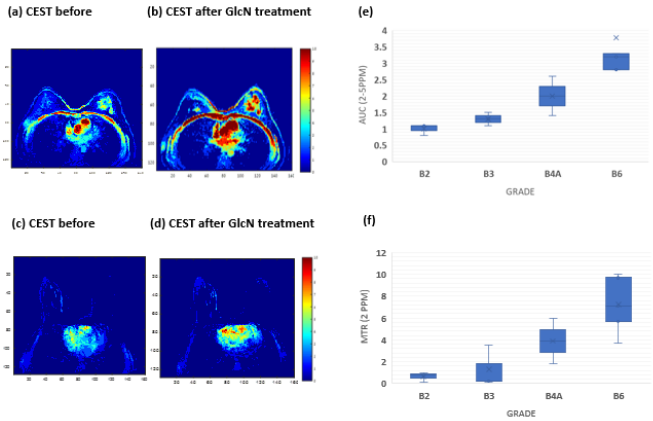
CEST-MRI could provide metabolic information on the tissue microenvironment of breast lesions prior to the detection of physiological and morphological alterations[1]. Recently, Glucosamine (GlcN), a commonly used food supplement with excellent safety profile, was shown to be an exogenous contrast agent for imaging human breast tumors[2]. GlcN is taken up by tumor cells via the glucose transporter. Some of its metabolic products also contribute to the CEST signal. Here, we extend our preliminary study by investigating whether GlcN can be utilized to determine the metabolic level of breast lesions using area under curve (AUC) based on magnetization transfer asymmetry ratio (MTRasym) analysis.

METHODS:

Fourteen participants (mean age, 49 years) were assessed after at least 4 h fasting and were scanned twice with snapshot GRE CEST MRI protocol on a 3T VIDA MRI scanner equipped with breast coil (18 channels, Siemens): before and 2 hours after drinking a solution of GlcN·HCl (184 mg/kg, PureBulk, US). The CEST protocol included a series of 34 saturation frequencies offsets in the range of ± 8 ppm, using a train of 5 gauss saturation pulses with 100 ms, interpulse delay of 60 ms and 1 ms pause between measurements and saturation attenuations of 2.5 μT. CEST sequence was applied with fat suppression and followed by a spiral-reordered 3D read-out. The CEST effects of lesions were quantified using AUC in the range of 2-5 ppm based on MTRasym analysis (from corrected Z spectra, based on B_0 field maps).

RESULTS:

The MTRasym CEST signal in malignant breast tumors increased after oral administration of GlcN solution. The averaged AUC increase ratio in suspected lesions following GlcN administration was 1.0+0.14 for BI-RADS category 2 lesions (N=3), 1.3+0.16 for BI-RADS category 3 lesions (N=4), 2.0+0.60 for BI-RADS category 4A lesions (N=2), and 3.8+1.52 for BI-RADS category 6 lesions (N=5) (pathology confirmed malignant findings).



In vivo CEST imaging of breast. Representative MTRasym maps (calculated at 2 ppm) before (a,c) and after GlcN administration (b,d) for patients with BI-RADS category 6 lesions (a,b) and BI-RADS category 3 lesion (c,d). Histograms with inclusive medians illustrate the averaged AUC* increase ratio (e) and averaged net MTRasym* (f) markers for the patients' grades (N=14). *Averaged over a maximum of 8 slices per patient.

CONCLUSION:

CEST MRI using AUC analysis can detect GlcN in human breast tumors and provide molecular-level diagnostic tools for differentiating benign and malignant breast tumors. Importantly, AUC calculations revealed an enhancement related to accumulation of GlcN and its metabolic products, hence may serve as an indicator for the metabolic profile of the finding. These results may open a new perspective for future research of GlcN uptake in breast tumors.

REFERENCES:

1. Hoffmann, E. *et al*. J Transl Med., 2023; 21: 577. 2. Rivlin M. *et al*. Europ. Radiol., 2022;32: 7365-7373.