1H-MRS and 18FDG PET: Metabolism in head and neck cancers

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Introduction

Today, with many treatment options available, pretreatment radiological evaluation is gaining widespread acceptance for better patient management [1]. Proton MR Spectroscopy (^{1}H-MRS) and ^{18}Fluoro-deoxyglucose (FDG) PET provide insight in the tumor metabolism [2]. These techniques are indicators of malignant grade in several cancers [2]. Few studies have correlated ^{1}H-MRS and ^{18}FDG PET in brain gliomas and have found conflicting reports regarding the relationship between the two [3,4]. ^{1}H-MRS provides data for metabolites; choline (product of phospholipid metabolism) and lactate (end product of anaerobic glycolysis) which enhance prognostication and patient selection and thus helps in improving overall patient treatment [5]. Similarly, ^{18}FDG PET evaluates the regional glucose utilization rate (GUR; reflecting glucose metabolism) which has shown to be valuable for staging patients [6]. In the present study to better understand the metabolism in head and neck we attempted to assess whether there is a correlation between ^{1}H-MRS and ^{18}FDG PET data.

Material and Methods

Patients 18 newly diagnosed head and neck cancer patients with metastatic nodes (M/F: 16/2, age: 56±11y) were included. Tumor metabolism was assessed using ^{1}H-MRS and ^{18}FDG PET imaging prior to chemo-radiation therapy or surgery. ***MRI*** MRI/^{1}H-MRS was performed on a 1.5 Tesla GE Excite scanner using a 4-channel neurovascular phased-array coil. The protocol consisted of standard clinical MR imaging covering the entire neck or oral cavity/tongue or nasopharynx using T2-weighted and T1-weighted images. During ^{1}H-MRS, spectra were acquired on the tumor identified on T2-weighted images, and a volume of interest (≥2cc) was placed over the node. Single voxel spectroscopy data (PRESS, TR/TE=1600/136 and 256 averages) was obtained. Additionally, a spectrum (16 averages) was recorded of unsuppressed water. ***PET*** For ^{18}FDG PET imaging, F18-fluoride was produced by the cyclotron by proton irradiation of an enriched O-18 water target in a small-volume titanium chamber. 10 to 18 mCi of ^{18}FDG was administered by IV and image acquisition at the PET/CT scanner (Discovery ST) started after 2 hours of the injection. PET/CT images were reconstructed with the standard reconstruction array processor and corrected for attenuation. ***Analysis*** ^{1}H-MRS spectra were analyzed using LCModel (Version 6.2-0X) [7]. The metabolite basis set (PRESS, TE 136 ms, 1.5 T) including simulated macromolecule peaks was kindly provided by Dr. Provencher. The ppm range included for analysis was -1 to 3.8 ppm. The standard 'breast' setting was used, which provides concentration estimates for choline and lipids. Choline concentrations are reported in arbitrary units, relative to water (Cho/W). Metabolite estimates were excluded from analysis, if the Cramer-Rao lower bounds (CRLB) exceeded the 50% range. ^{18}FDG images were transferred to a workstation for image analysis. ^{18}FDG uptake by the tumor was assessed by an experienced nuclear medicine physician. Semi-quantitative analysis included calculation of tumor-to-muscle ratios as standardized uptake value (SUV) measurements. This was followed by the evaluation of CT and PET/CT images. Whole blood samples collected from each patient were counted in a calibrated multichannel gamma well counter and the blood activity was expressed in as µCi/ml, decay corrected to time of injection. Correlation between Cho/W concentrations and ^{18}FDG were calculated using Pearson correlation ($p<0.05$).

Subject	Age / sex	Tumor site	Node	FDG SUV	Cho/W
1	52 / m	Tonsil	R	10.7	3.74
2	41 / m	BOT	R	12.4	8.28
3	41 / m	Nasopharynx	R	9.3	5.40
5	79 / m	unknown	R	7.5	6.57
6	43 / m	Tonsil	R	11.7	5.44
7	48 / m	unknown	L	22	11.20
8	62 / m	BOT	R	9.1	6.12
9	62 / m	BOT	R	8.6	7.78
10	44 / m	unknown	L	10.5	9.00
11	53 / m	unknown	R	1.8	2.15
13	61 / f	BOT	L	16.2	4.96
14	57 / f	unknown	L	6.3	5.40
16	59 / m	BOT	R	8.8	2.98
17	69 / m	BOT	R	14.1	6.00
18	68 / m	Tonsil	L	8.8	8.14

Table 1: Patient characteristics and results, BOT: base of tongue, Node: (L: left, R: right), FDG SUV: ^{18}F-deoxyglucose standardized uptake value, Cho/W: choline over water ratio (arbitrary units).

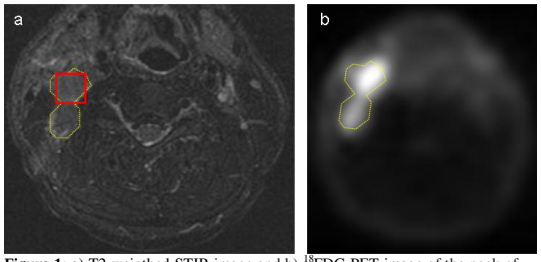

Figure 1: a) T2-weigthed STIR image and b) ^{18}FDG PET image of the neck of patient 9 with node marked in yellow. The voxel of interest for ^{1}H-MRS is indicated in red in a).

Results

In Table 1, the results from 15 patients are shown. Three patients (pt 4, 12 and 15) were excluded for analysis. Two had CRLB that exceeded the 50% threshold, and 1 patient had an extremely high Cho/W concentration (value between an interquartile range of 1.5 and 3, hence an outlier [8]). Figure 1a displays the prescribed PRESS box on the right node of patient 9; Figure 1b shows the corresponding ^{18}FDG PET image; and Figure 2 shows the LCModel fit for the ^{1}H-MRS data of this node. A correlation analysis of Cho/W concentration estimates and ^{18}FDG SUV PET uptake yielded a positive Pearson correlation's coefficient of r=0.584 (p = 0.022, Figure 3).

Conclusion

The results in the present study show a positive correlation between choline levels as assessed by ^{1}H-MRS with glucose levels as indicated by ^{18}FDG uptake. This observation is indicative of a correlation between glucose metabolism (^{18}FDG) and an increased cellular proliferation (choline).

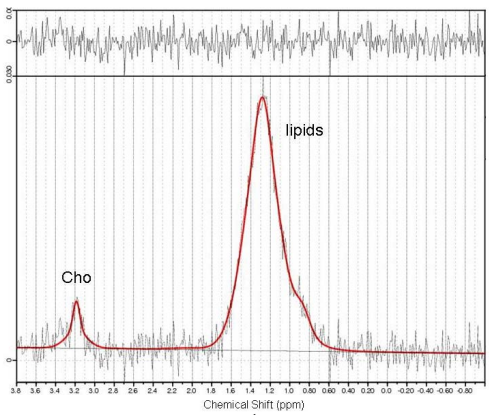

Figure 2: Analysis output of localized ^{1}H-MRS spectra from the right node of patient 9. The in vivo spectrum (thin grey curve) has been estimated with the LCModel output (thick red curve), and the difference of these spectra (residue) is plotted at the top. Cho, choline.

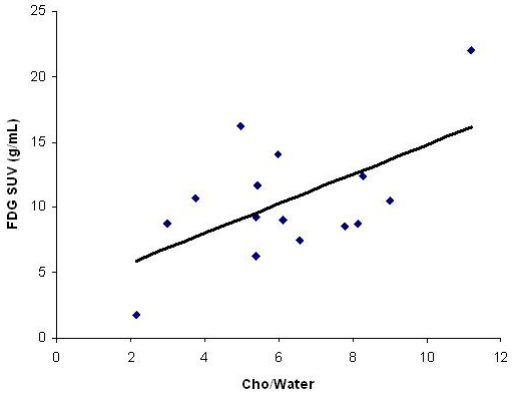

Figure 3: Scatterplot displaying Cho/W concentrations (arbitrary units) as function of ^{18}FDG uptake (g/mL). The linear regression line is indicated in black. Pearson correlation's coefficient is 0.584, p = 0.022.

References

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