Quantification of parotid fat content and ADC using IDEAL gradient echo imaging and PROPELLER-DWI

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Introduction: Parotid glands contain adipose cells in the alveolar connective tissue and sebaceous glands that release lipid-secretary sebum [1]. The effect of parotid fat on parotid ADC measurement has been unavoidably neglected by the single-shot spin-echo echoplanar diffusion-weighted imaging (EP-DWI), which is essentially equipped by fat-saturation to eliminate chemical shift artifact. Understanding the relationship between the parotid ADC and parotid fat content is clinically important since the parotid fat content might have individual variations in healthy people and might change after radiation therapy. Whether the parotid ADC measurements are influenced by parotid fat content has not been previously documented yet. In this study, we aimed to quantify the parotid fat fraction in healthy volunteers in different ages, to characterize the relationship among the parotid ADC, parotid fat fraction and age using MRI noninvasively.

Materials and Methods: This study was of the approval of the Institutional Review Board at our hospital. A total of 35 healthy volunteers were recruited (15 men & 16 women with an age distribution of 32%, 32% and 36% corresponding to 20-30, 31-40 and 41-65 years). All MR scans were performed at a 1.5 T whole-body scanner (GE Healthcare, Signa HDx, US) (maximum gradient of 50mT/m; 8NV head and neck array coil). Pulse sequences including PROPLLER DWI-FSE (PROP-DWI) *with* and *without* fat-saturation (TR/TE/NEX/ETL, 7600/122/1.8/24), T1WI-FSE *with* and *without* fat-saturation (750/11/1/4), and 3D IDEAL FSPGR (TR/TEs/α: 9.0/1.97, 3.53, 4.99/10˚) were used. Scan parameters included field of view of 240 × 240 mm, matrix size of 128 × 128 for DWI and 256 × 256 for T1WI and IDEAL imaging, slice thickness of 5 mm and slice spacing of 1.0 mm. DW-MRI were obtained with motion-probing diffusion gradient (b = 0 and 1000 s/mm^2) being applied on each of three orthogonal directions. ADC maps were generated on personal computer by using a pixel-by-pixel computation according to the logarithmic equation: ADC = $\ln[SI_0/SI_{1000}]/(b_{1000}-b_0)$, where SI_0 and SI_{1000} was the signal intensity of DW images corresponding to the b value of 0 and 1000 s/mm^2, respectively. IDEAL fat and water images were reconstructed from complex data according to the original IDEAL algorithm [2]. The fat fraction images were calculated by $I_{fat}/(I_{fat}+I_{water})$ on IDEAL images and by $(1-I_{fat\text{-}sat}/I_{non\text{-}sat})$ on both T1WI and PROP-T2WI. A total of three contiguous slices covering the largest areas of the parotid glands were included for analysis. At each slice, a polygonal region of interest (ROI) enclosing the entire parotid gland was placed on either parotid gland for computation of fat fraction and ADC. Linear regression was used to characterize the relationship between parameters..

Results: Fig. 1 showed the axial images through the parotid glands and fat content images calculated from the T1WI, PROP-T2WI and IDEAL gradient echo images. The fat content images generated from PROP-T2WI appeared noisier comparing to that from T1WI and IDEAL. Linear regression showed that the parotid fat content was slightly positively associated with age with a R^2 ranging from 0.30 to 0.35 (Fig. 2A, B & C). On the contrary, the parotid ADC was negatively correlated with the parotid fat content. The correlation was much higher when IDEAL or PROP-T2WI was used for parotid fat quantification (R^2 of 0.75 and 0.72, respectively) as compared to that computed based on T1WI (R^2 of 0.42).

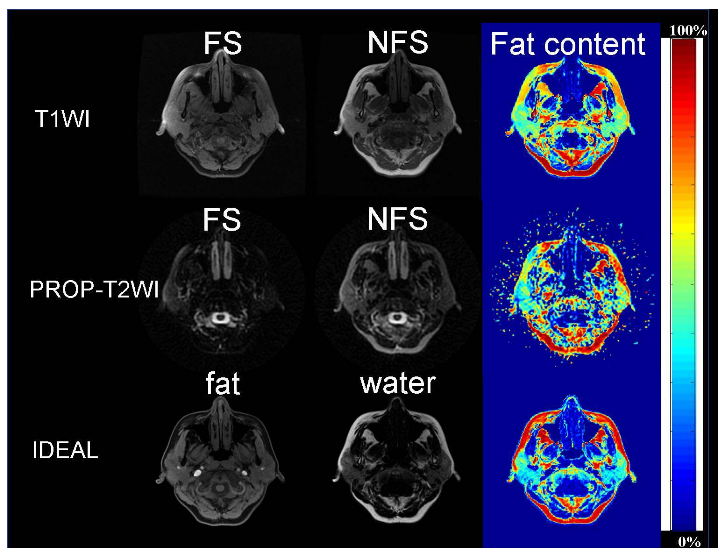

Fig. 1. Fat content mages computed from T1WI, PROP-T2WI and IDEAL.

Discussion & Conclusion: In this study, the parotid fat contents of healthy volunteers are successfully quantified by three different pulse sequences using RF saturation (T1WI & PROP-T2WI) and IDEAL gradient echo imaging. Our results suggest that IDEAL gradient echo imaging is superior to T1WI and PROP-T2WI in overall performation correlating the parotid fat content to the age and to the parotid ADC in healthy volunteers. The fundamental knowledge of aging effect on the change of parotid fat content and then the shift of parotid ADC is believed important for further researches dealing with pathologies of parotid glands in aging society and in patients treated by radiotherapy, whose parotid fat contents both increase.

Reference:

1. Martinez-Madrigal F, et al. Am J Surg Pathol 1989;13:879.
2. Scott BR, et al, MRM 2004;51:35.

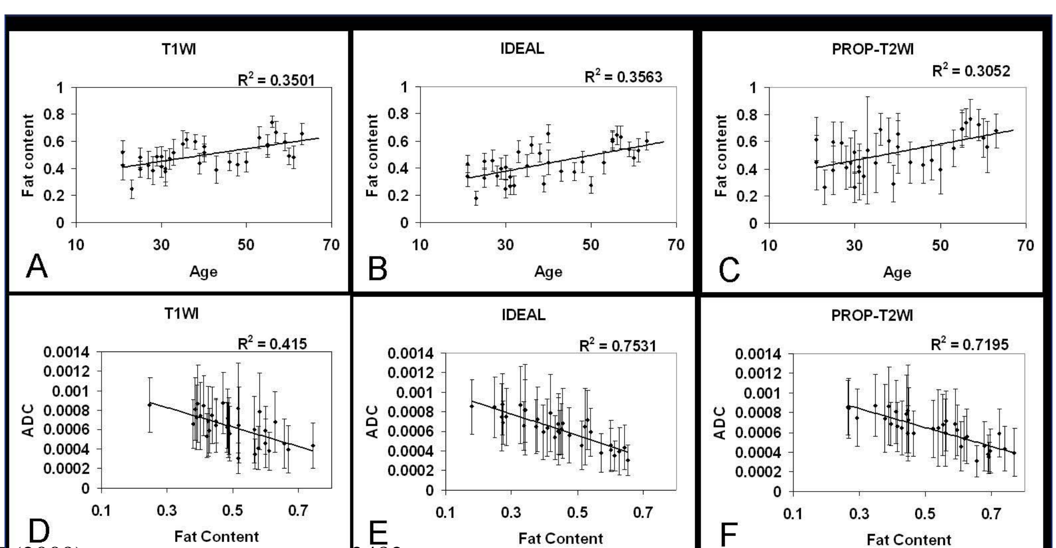

Fig. 2. Scatter plots of parotid fat content versus age (A, B & C) and parotid ADC versus parotid fat content (D, E & F) computed from the T1WI, PROP-T2WI and IDEAL gradient echo images.