ASSESSMENT OF TUMOR BLOOD FLOW AND ITS CORRELATION WITH HISTOPATHOLOGIC FEATURES IN WARTHIN TUMORS AND PLEOMORPHIC ADENOMAS OF THE SALIVARY GLAND USING PULSED-CONTINUOUS ARTERIAL SPIN LABELING IMAGES

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Purpose: Thus far, the apparent diffusion coefficient (ADC) and the different patterns of contrast enhancement have been valuable for the differential diagnosis of Warthin tumors and pleomorphic adenomas in the salivary gland. Although the use of arterial spin labeling (ASL) perfusion has expanded beyond just the central nervous system (CNS) in recent years, it remains unclear whether ASL provides accurate measurements of tumor blood flow (TBF) in head and neck tumors. Therefore, this study aimed to evaluate the use of pulsed continuous ASL (pcASL) in salivary gland tumors and to investigate the correlation between TBF and histopathologic features of Warthin tumors and pleomorphic adenomas with the aim of determining the value of ASL-TBF in the differential diagnosis of salivary gland tumors.

Materials and Methods: Perfusion-weighted MRI using pcASL was performed in 17 patients with Warthin tumors (n = 9) or pleomorphic adenomas (n = 8) located in the salivary gland. All tumors were pathologically confirmed. A 3-dimensional spiral fast spin echo sequence with background suppression was used for pcASL perfusion imaging.[1] Other acquisition parameters for pcASL were as follows: duration = 1.5 s, 7 arms with 512 points in each spiral arm, phase encoding in the z direction = 30–40 steps, section thickness = 4 mm, TR/TE = 4700/10.5 ms, post-labeling delay = 1.5 s, image matrix = 128 × 128, and NEX = 2. We developed a region of interest (ROI)-selection software tool (IDL) that enabled placement of the ROI on T1-weighted (T1W) images and the subsequent automatic acquisition of pcASL TBF values corresponding to the ROI on the tumor. The ROI was set in the tumor with a T1W image, and the mean TBF value was obtained. For calculating TBF, we used the same model and conditions as those used for calculating cerebral blood flow (CBF) in the CNS. Immunohistochemical analysis of CD34 was also performed. Slides were examined at low-power magnification to identify areas with the highest density of microvessels. In each case, the most vascularized area was selected, and the microvessels within one high-power magnification (200×) field were counted. The stained microvascular density (MVD) was calculated using MacSCOPE. The difference in TBF between Warthin tumors and pleomorphic adenomas was examined using Mann–Whitney U–test. The correlation between MVD and TBF was evaluated using a single linear regression analysis and Spearman's rank correlation coefficient (r_s) test.

Results: TBF was significantly higher in Warthin tumor than in pleomorphic adenoma ($p < 0.01$) (Fig. 1). In addition, a strong positive correlation was noted between MVD and TBF ($r_s = 0.93$, $p < 0.01$) in the analysis that included all the tumors (Fig. 2). We show representative cases of Warthin tumor and pleomorphic adenoma in figs. 3 and 4, respectively.

Fig. 1 Tumor blood flow (TBF) in Warthin tumors (WTs) and pleomorphic adenomas (PAs). Note the significant difference between WTs and PAs ($p < 0.01$).

Fig. 2 Scatterplot of the microvascular density (MVD) with respect to the tumor blood flow (TBF) in 17 salivary gland tumors. The regression line is shown (y = 0.38x + 21.32: R^2 = 0.74). Note the positive correlation between the MVD and TBF ($r_s = 0.93$, $p < 0.01$).

Discussion and Conclusion: This study demonstrated a significant difference in TBF between Warthin tumors and pleomorphic adenomas located in the salivary gland. The significant correlation between the MVD and TBF indicates that pcASL may provide a precise evaluation of tumor perfusion. Thus, differential diagnosis between Warthin tumors and pleomorphic adenomas in the salivary gland may be possible without using contrast material.
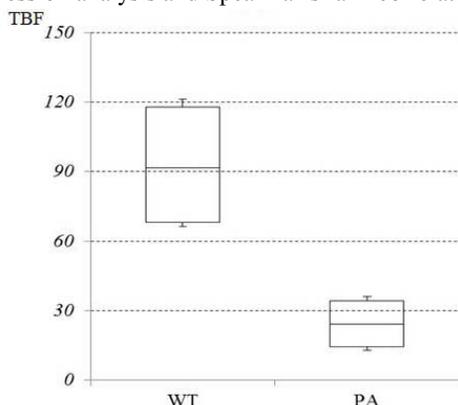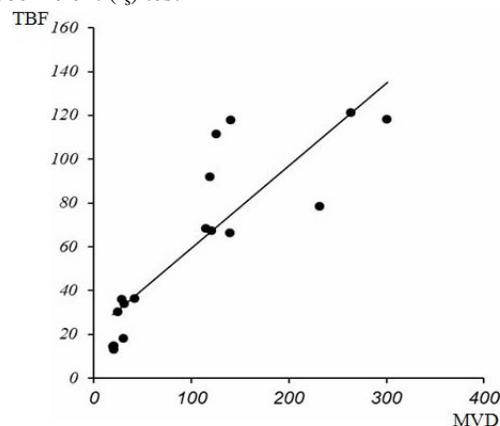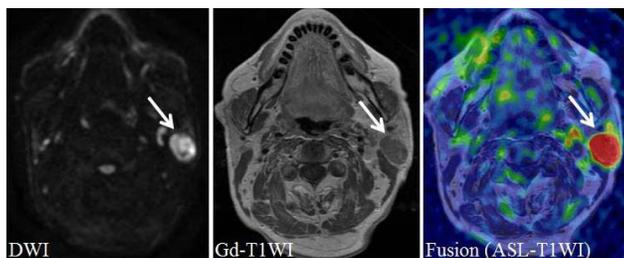

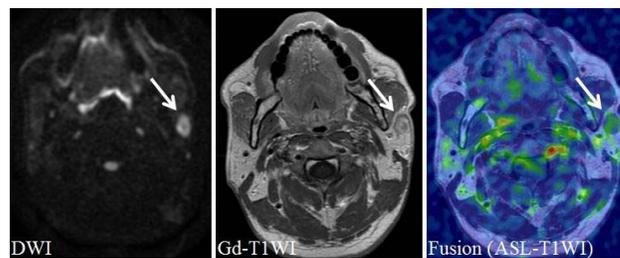**Fig.3** Representative case of Warthin tumor.

Fig.4 Representative case of pleomorphic adenoma.

Reference
1. Dai W, et al. *Magn Reson Med.* 2008;60: 1488-1497