

# Parotid sparing volume-dependent perfusion characteristics of acute radiation injury: investigated by fat-saturated dynamic contrast-enhanced MRI

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## Introduction

The highly radiosensitive parotid glands could be protected by using parotid sparing techniques such 3D-conformal radiotherapy (3DCRT) or intensity modulated radiotherapy (IMRT). A prior study has shown that dynamic contrast-enhanced (DCE) MRI allows quantitative measurements of parotid perfusion characteristics in late radiation injury at a mean radiation dose of 36 Gy [1]. To the best of our knowledge, the parotid perfusion characteristics in acute radiation injury in patients receiving parotid-sparing radiotherapy have never been documented yet. In this study, we aimed to evaluate the parotid perfusion characteristics in acute radiation injury and to quantify the relationship between the parotid-sparing volume (PSV) and perfusion alterations.

## Material and Method

### Subject

Fifteen patients (11 male and 4 female) were included in this study. They were pathologically proven as nasopharyngeal carcinoma (NPC) and received MR studies before and within 3 months after radiotherapy (RT). The age of patients was  $49.1 \pm 14.2$  years. The RT dose was delivered to parotid glands at  $27.47 \pm 3.96$  Gy, using intensity modulated RT (IMRT) technique. PSV, which was defined as the percentage volume of parotid gland with exposed radiation dose less than 25 Gy, was calculated by a radiation oncologist.

### Image acquisition

All MRI examinations were performed on a 1.5T clinical system (GE Healthcare, Signa HDx, USA). A fast spin-echo sequence was adopted, and fat saturation was utilized for a better differentiation from the parotid gland and the surrounding fatty tissue. TE and TR were set to be 12.63 and 400 ms respectively. The temporal resolution was 12.3 seconds, and 20 dynamics were acquired in total. Gd-DTPA was injected intravenously within 3 seconds with a dose of 0.1mmol/kg.

### Data analysis

Here we took the 2-compartment Brix pharmacokinetic model to analyze the DCE data. Besides the parameters ( $A$ ,  $k_{21}$ , and  $k_{el}$ ) which were provided by the Brix model, other parameters including peak enhancement (PE), time-to-peak (TTP) and slope, were also calculated. PE is defined as the maximum value of the fit curve, TTP refers the time when the curve meets its maximum, and slope is defined as the ratio of PE/TTP. Normality of the perfusion parameters was examined using Q-Q plots and Kolmogorov-Smirnov tests. Paired t-test was performed for comparison pre-RT and post-RT perfusion parameters, while Pearson's correlation test was adopted to evaluate the relationship of PSV and the perfusion parameters. A  $P$  value less than 0.05 was considered as statistically significant.

## Result

As shown in Fig. 1, the result of the perfusion alteration exhibited significantly higher values in  $A$ , PE, TTP and slope, along with a significantly lower value in  $k_{el}$ . Meanwhile in  $k_{21}$ , an insignificant higher value was found. Fig. 2 showed significant correlations between perfusion parameters ( $A$ ,  $k_{21}$ , and slope) and PSV.

## Discussion and conclusion

The higher values of PE, TTP and lower value of  $k_{el}$  in our study are consistent with the observation on the irradiated parotid glands [1]. The insignificant change of  $k_{21}$  in our study is consistent with a previous study of irradiated parotid glands in acute stage [2]. Nevertheless, our results further demonstrate that the perfusion alterations are negatively associated with the PSV regarding the parameter  $A$ ,  $k_{21}$ , and slope. It also highlights that PSV plays an important role in differentiating the change of perfusion characteristics, especially when the change is as subtle as in  $k_{21}$  and is not disclosed by using the paired t-test.

In conclusion, the perfusion alterations of the irradiated glands might be enhanced by taking PSV in to consideration especially when the changes are subtle.

## Reference

- Juan CJ, et al. Eur Radiol. 2008
- Lee K-H, et al. Proc. ISMRM. 2009

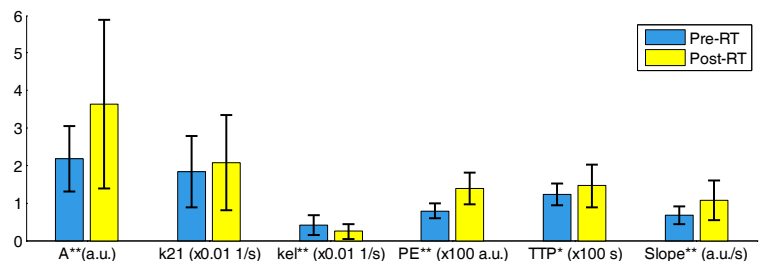


Fig. 1. The paired t-test on the effect of pre- and post- RT. All parameters except  $k_{21}$  exhibit statistical significance. (\*  $p < 0.05$ ; \*\*  $p < 0.005$ )

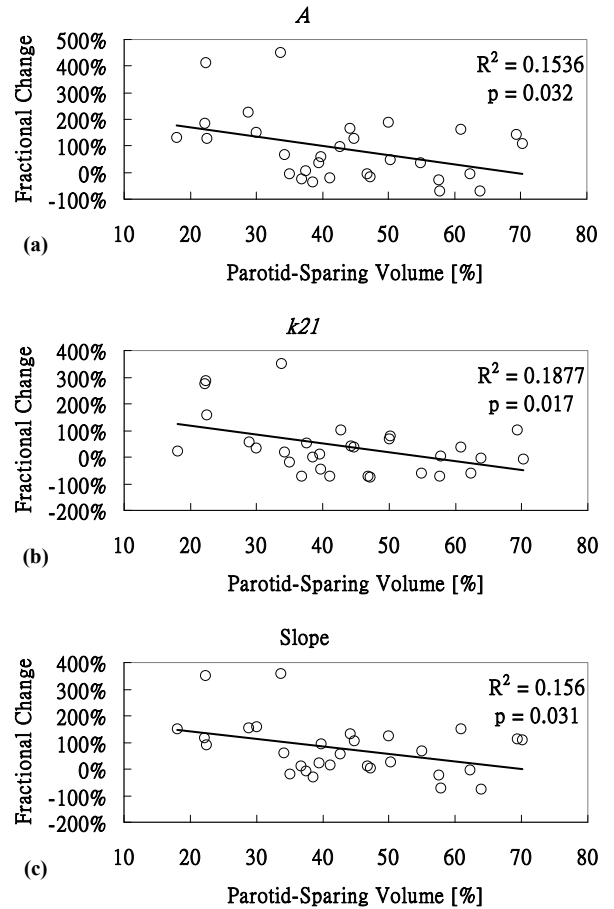


Fig. 2. Significant ( $p < 0.05$ ) negative association between the normalized parameter changes and the corresponding PSV are shown. (a) parameter  $A$ , (b)  $k_{21}$ , and (c) the slope.