Feasibility of Dynamic Contrast Enhanced MRI in Oral Cavity Cancer: A Comparison between Reference Region Model, General Kinetic Model and Pathological Grading

S-C. Chin[1], Y-P. Liao[2], Y-T. Chuang[1], and H-L. Liu[2]

[1]Department of medical imaging and intervention, Chang-Gung Medical Center, Guei-Shan, Tao-Yuan, Taiwan, [2]Chang Gung University, Department of Medical Imaging and Radiological Sciences, Guei-Shan, Tao-Yuan, Taiwan

Purpose: The growing importance of dynamic contrast-enhanced MRI (DCE-MRI) in the oncological application prompted us to examine its clinical feasibility in patients with suboptimal scanning condition, in our case: the patients of malignant oral cavity tumors susceptible to motion artifact and image distortion due to coughing, swallowing, fixed dental implant and etc. We aimed to examine (1) how successful the DCE-MRI was in image distortion-prone oral cavity and (2) if the consistency exists in two main T_1-weighted DCE-MRI perfusion parameters (K^{trans} and V_e) generated from two different pharmacokinetic models: general kinetic model (GKM) [1] and reference region model (RRM) [2,3], the former one was regarded as the standard DCE-MRI protocol and the latter one was advantaged by no AIF need, but hampered by relatively suboptimal SNR, and (3) to assess if the DCE-MRI parameters are relevant to the pathologic tumor grading.

Materials and Methods: Within one year period, 22 patients aged 34-80 years (mean age, 50 ± 10 years) who had oral cavity squamous cell carcinomas were enrolled for preoperative MRI evaluation. Surgical pathologic findings were the reference standard for the tumor grading, while the K^{trans} and V_e were calculated from DCE-MRI data using two pharmacokinetic models (GKM and RRM). For the RRM analysis, the concentration time curve of a reference region was obtained from the tumor ROI and then fitted to Kovar's method to estimate K^{trans} and V_e. The posterior neck muscle away from the tumor used as reference region for normalization was the same for two models.

Results: (1) Of the 22 cases, the data from 18 cases were analyzable with the DCE quantification (Fig 1). Four cases with severe imaging distortion and insufficient lesion delineation were excluded. The successful rate of DCE-MRI in this study was 82%. (2) Spearman's rank correlation coefficient test was used for DCE parameters between GKM and RRM methods. The significant correlation was noted between K^{trans} from RRM and GKM in both absolute and normalized values and V_e from RRM and GKM in absolute value (V_e can not be normalized). The correlation of K^{trans} between RRM and GKM became much better in normalized data compared to absolute value (table: The correlation of DCE parameters between GKM method and RRM method disclosed that the high correlation (underlined) in normalized K^{trans} and significance (P<.05) (in bold). (3) Mann-Whitney U test was used for assessing the possible correlation between DCE parameters and pathologic grading. It revealed no correlation between the pathological grading and the DCE parameters (K^{trans}, normalized K^{trans} and V_e).

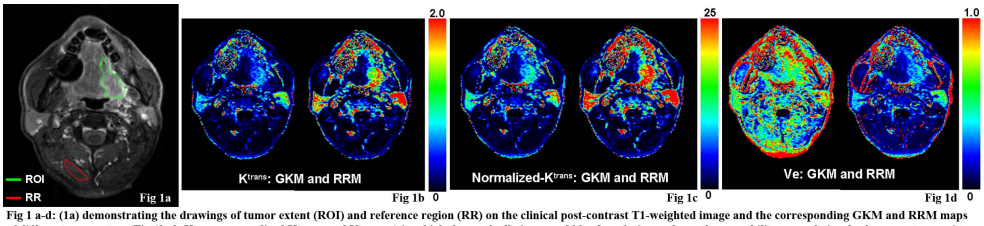

Fig 1 a-d: (1a) demonstrating the drawings of tumor extent (ROI) and reference region (RR) on the clinical post-contrast T1-weighted image and the corresponding GKM and RRM maps of different parameters (Fig 1b-d: Ktrans, normalized Ktrans and Ve maps) in which the markedly increased blood perfusion and vessel permeability were obviously shown on tumor sites.

		r value	P value
$K^{trans,\ GKM}$	$K^{trans,\ RRM}$	0.4799	**0.022**
$K^{trans\text{-}neck,\ GKM}$	$K^{trans\text{-}neck,\ RRM}$	0.4159	**0.043**
$N\text{-}K^{trans,\ GKM}$	$N\text{-}K^{trans,\ RRM}$	0.9298	**<0.001**
$V_{e,\ GKM}$	$V_{e,\ RRM}$	0.5975	**0.004**

Conclusion: Due to the inherent low resolution of the DCE-MRI maps, to find a correct carotid artery position, is sometimes difficult. We find that RRM is more suitable than GKM in some certain clinical setting given the fact of the consistent K^{trans} data between RRM and GKM, particularly after the normalization process. On the other hand, the permeability parameters, K^{trans} and V_e, do not correlate with the pathologic grading. This is presumably consistent with previous studies where the kinetic parameters derived from T_1-weighted DCE-MRI are more of correlated with microvascular density and vascular endothelial growth factor while the kinetic parameters derived from T_2 susceptibility-weighted MRI are more correlated with pathological tumor grading.

Reference: [1] Tofts et al, MRM:1995, JMRI:1999 [2] Kovar et al, ISMRM: 1998 [3] Yankeelov et al, 2005