Locally Advanced Rectal Cancer: Post-chemoradiotherapy Apparent Diffusion Coefficient (ADC) Histogram Analysis for Predicting a Complete Response

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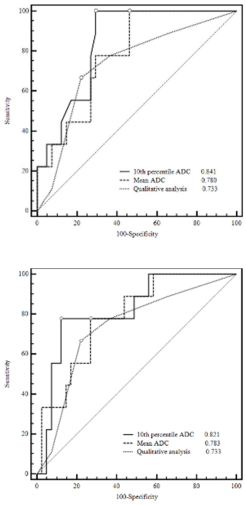
Target audience: Radiologist, subspecial abdominal radiologist or colorectal surgeon

Purpose: The purpose of our study is to investigate whether quantitative post-chemoradiotherapy (CRT) apparent diffusion coefficient (ADC) analysis based on the histogram can be helpful to predict a pathologic complete reponse (pCR) in locally advanced rectal cancer (LARC), compared with pre-existing mean ADC analysis.

Materials and Methods: Fifty patients who underwent preoperative CRT followed by surgery were enrolled in this retrospective study, non-pCR (n=41) and pCR (n=9), respectively. ADC histogram analysis encompassing the whole tumor was performed on two post-CRT ADC_{600} and ADC_{1000} (b factors 0,600 vs.0, 1000 s/mm2) maps. Mean, minimum, maximum, SD, mode, 10th, 25th, 50th, 75th, 90th percentile ADCs and skewness, kurtosis, entropy, uniformity were derived. Histogram-derived quantitative parameters between non-pCR and pCR groups were compared by using Student *t* test. Diagnostic performance for predicting pCR was evaluated with ROC curve analysis, and compared with pairwise comparison and McNemar test.

Results: On both maps, 10^{th}, 25^{th}, mean and mode ADCs in pCR group were significantly higher than that in non-pCR groups. As the grade of percentile ADC increased, the diagnostic performance decreased. 10th percentile ADCs showed the best diagnostic performance on both maps. In comparison of diagnostic performance between 10th percentile and mean ADC, there was no significant difference on both ADC_{600} (P =.190) and ADC_{1000} (P =.545) maps. However, the specificity was significantly improved on both ADC_{600} (70.7% vs. 53.7%; P =.031) and ADC_{1000} (87.8% vs. 73.2%; P =.039) maps

ADC parameter	A_Z (95% CI)	Sensitivity (%)	Specificity (%)	Criterion (x10^{-3}mm^2/s)	*P*
ADC_{600} map					
10^{th} percentile	0.841 (0.711-0.929)	100	70.7	> 1.13	< 0.001
25^{th} percentile	0.798 (0.661-0.898)	88.9	68.3	> 1.333	< 0.001
Mean	0.780 (0.641-0.885)	100	53.7	> 1.542	< 0.001
Mode	0.756 (0.614-0.866)	88.9	68.3	> 1.475	.003
ADC_{1000} map					
10^{th} percentile	0.821 (0.687-0.915)	77.8	87.8	> 1.1	< 0.001
25^{th} percentile	0.818 (0.684-0.913)	88.9	78.0	> 1.243	< 0.001
Mean	0.783 (0.644-0.887)	77.8	73.2	> 1.521	< 0.001
Mode	0.724 (0.579-0.841)	88.9	61.0	> 1.284	.008



Discussion: The heterogeneity within tumor could be overlooked when using mean ADC as the representative within the tumor (1). Our study demonstrated that lower percentile (10^{th} and 25^{th}) post-CRT ADC values could be used as a quantitative parameter rather than mean ADC value to discriminate pCR from non-pCR. Especially, 10^{th} percentile ADC value revealed the best diagnostic performance for predicting pCR. Even though ROC curves analysis was not significantly different between 10th percentile and mean ADC, interestingly, 10^{th} percentile ADC quantitative parameter made significantly an increase of the specificity for predicting pCR. Given that in surgeons' aspect, non-pCR group must have unconditional surgery after preoperative CRT due to residual tumor cell, enhancing the specificity by using post-CRT 10th percentile ADC based on the histogram can be very meaningful in clinical practice.

Conclusion: Post-CRT ADC histogram analysis is helpful for predicting pCR in LARC, especially, in improving the specificity, compared with mean ADC.

References: 1. Kim SH, Lee JY, Lee JM, Han JK, Choi BI. Apparent diffusion coefficient for evaluating tumour response to neoadjuvant chemoradiation therapy for locally advanced rectal cancer. Eur Radiol 2011;21(5):987-995.

2. Kang Y, Choi SH, Kim YJ, et al. Gliomas: Histogram analysis of apparent diffusion coefficient maps with standard- or high-b-value diffusion-weighted MR imaging--correlation with tumor grade. Radiology 2011;261(3):882-890.