Research Article

MR Spectroscopy and Diffusion Weighted Imaging in Differentiation of Neoplastic and Non-neoplastic Lesions

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Abstract

Purpose: To compare the diagnostic performance of MR spectroscopy (MRS) and diffusion weighted imaging in differentiating neoplastic and non-neoplastic lesions**. Materials and Methods:** The maximum Cho/Cr, Cho/NAA, Cho/NAA+Cr, NAA/Cho, NAA/Cr and ADC are measured in ٨٠ patients; ٥٦ neoplastic lesions and ٢٤ non-neoplastic lesions, for each study group, Man Whitney test was used to compare the metabolites peaks and ADC of each group. The diagnostic performance was assessed with receiver operating characteristic (ROC) curve analysis. **Results:** For differentiation of brain masses into neoplastic and non-neoplastic groups a threshold value of ٢ for Cho/Cr gave sensitivity ٩٣٪ and specificity ٧٩.١٧٪, a threshold value of ١.٧ for Cho/NAA gave sensitivity ٨٧.٥٪ and specificity ٧٠.٨٣٪, a threshold value of ٠.٨ for Cho/NAA+Cr gave sensitivity ٩٢.٨٦٪ and specificity ٧٩.١٧٪, a threshold value of ≤٠.٧ for NAA/Cho gave sensitivity ٨٧.٥٪ and specificity ٨٣.٣٣٪ and a threshold value of ≤٠.٩ for NAA/Cr gave sensitivity ٦٩.٦٤٪ and specificity ٦٢.٥٪. ADC was not statistically significant for differentiation of neoplastic and non-neoplastic lesions. **Conclusions:** MR spectroscopy had an important role in differentiation of the neoplastic and non-neoplastic lesions

Key words: MR Spectroscopy, Neoplastic and metabolites

Introduction

Conventional imaging features are limited in differentiation of neoplastic and non-neoplastic lesions. These include anatomic based geometric imaging features as site, size, mass effect, hemorrhage, necrosis and contrast enhancment. These suffer from low specificity.

Introduction of recent imaging features as magnetic resonance spectroscopy and diffusion weighted imaging get insight into biochemical features and structural make-up of the lesion

Thus physiological aspect are added to high spatial reolution of conventional anatomic imaging

Results

Table (١): Spectroscopic data and ADC values for all patients

Variable		Type		P value
		Non-neoplastic (n=٢٤)	Neoplastic (n=٥٦)	
Cho/Cr	Range	(٠.٥-٤.١)	(١.٢-٢١)	< ٠.٠٠١*
	Mean +/- SD	١.٦٦±٠.٨٧	٦.٤١±٥.٣١	
Cho/NAA	Range	(٠.٤-٢.٩)	(٠.٥-٢٠.٥)	< ٠.٠٠١*
	Mean +/- SD	١.٢٧±٠.٧٧	٧.١١±٦.٠٥	
NAA/Cr	Range	(٠.٢-٣.٤)	(٠.١-٢.٩)	٠.٠٠٢*
	Mean +/- SD	١.٣٢±٠.٧٤	٠.٨٣±٠.٦٧	
Cho/NAA+Cr	Range	(٠.٢-١.٧)	(٠.٤-١٣.٤)	< ٠.٠٠١*
	Mean +/- SD	٠.٦٩±٠.٣٢	٢.٧٥±٢.٤٦	
NAA/Cho	Range	(٠.٣٨-٢.٨)	(٠.٠٢-٢)	< ٠.٠٠١*
	Mean +/- SD	١.٣±٠.٦	٠.٤±٠.٤	
ADC	Range	(٠.٣٤-٢.٣)** (٠.٤٨-٢.٣)***	(٠.٤-١.٧)	٠.٢٣٦**
	Mean +/- SD	٠.٩١±٠.٦١** ١.١٣±٦١***	٠.٨٨±٠.٣١	٠.٣٠٨***

Mann Whitney test for not normally distributed quantitative data between the two groups. *: Significant difference at p value < ٠.٠٥ **:With inclusion of pyogenic abscesses *: With exclusion of pyogenic abscesses**

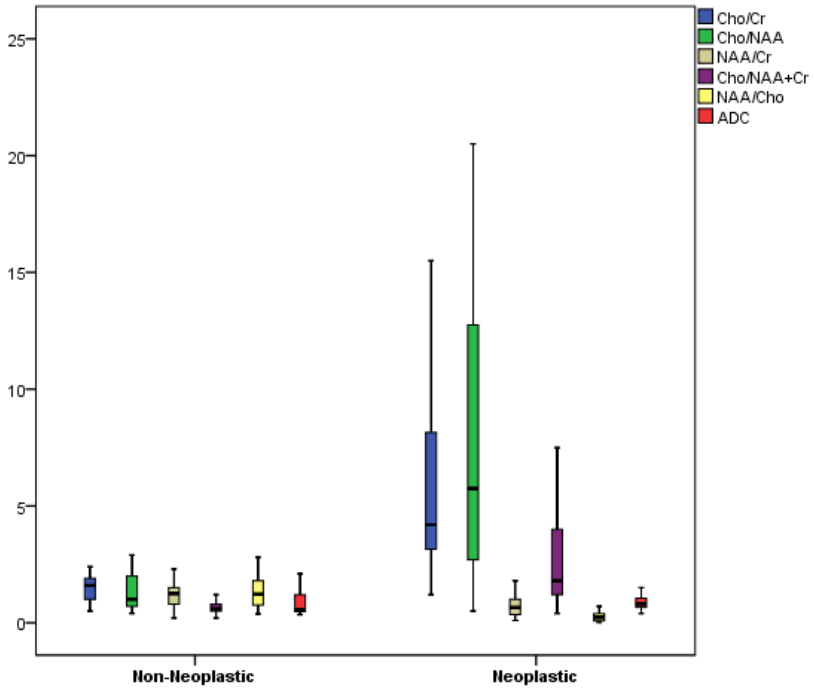

Figure (١): Box plot for overall spectroscopic data and ADC values for all patients (neoplastic and non-neoplastic groups)

Table (٢): ROC curve analysis for prediction of neoplastic lesions

Variable	AUC	Std. error	P value	٩٥٪ CI	
				Lower bound	Upper bound
Cho/Cr	٠.٩٣٠	٠.٠٣١	< ٠.٠٠١*	٠.٨٦٩	٠.٩٩١
Cho/NAA	٠.٩٣١	٠.٠٣٠	< ٠.٠٠١*	٠.٨٧٢	٠.٩٩١
NAA/Cr	٠.٧٣٩	٠.٠٦٤	٠.٠٠٢*	٠.٦١٤	٠.٨٦٤
Cho/NAA+Cr	٠.٩٣٩	٠.٠٣١	< ٠.٠٠١*	٠.٨٧٨	٠.٩٩٩
NAA/Cho	٠.٩١٨	٠.٠٣	<٠.٠٠١*	٠.٨٤	٠.٩٧

Variable	Optimal cutoff	Sensitivity	Specificity	PPV	NPV	Accuracy
Cho/Cr	>٢	٩٢.٨٦	٧٩.١٧	٩١.٢	٨٢.٦	٨٨.٨
Cho/NAA	>١.٧	٨٧.٥	٧٠.٨٣	٨٧.٥	٧٠.٨	٨٢.٥
NAA/Cr	≤٠.٩	٦٩.٦٤	٦٢.٥	٨١.٢	٤٦.٩	٦٧.٥
Cho/NAA+Cr	>٠.٨	٩٢.٨٦	٧٩.١٧	٩١.٢	٨٢.٦	٨٨.٨
NAA/Cho	≤٠.٧	٨٧.٥	٨٣.٣٣	٩٢.٥	٧٤.١	٨٦.٣

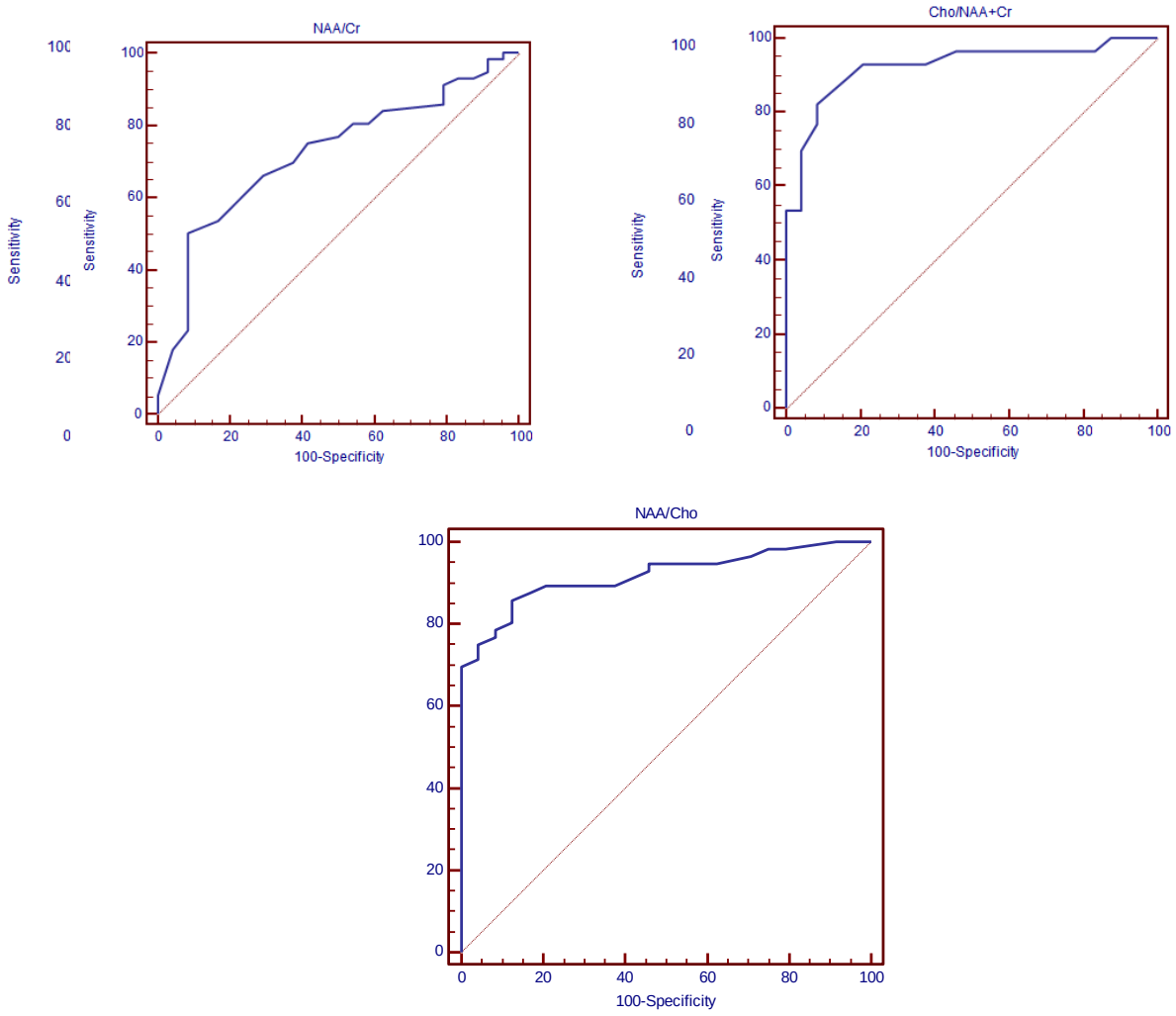

Figure (٣) Roc curves for prediction of neoplastic lesion

Regarding Cho/Cr, there is statistical significance for differentiation between neoplastic and non-neoplastic lesions. At a cut off value (>٢) lesions with higher value were suggested to be neoplastic
Regarding Cho/NAA, there is statistical significance for differentiation between neoplastic and non-neoplastic lesions. At a cut off value (>١.٧) lesions with higher value were suggested to be neoplastic.

Regarding NAA/Cr, there is statistical significance for differentiation between neoplastic and non-neoplastic lesions. At a cut off value (≤٠.٩) lesions with higher value were suggested to be non-neoplastic
Regarding Cho/NAA+Cr, there is statistical significance for differentiation between neoplastic and non-neoplastic lesions. At a cut off value (>٠.٨) lesions with higher value were suggested to be neoplastic
Regarding ADC values, no statistical significance for differentiation between neoplastic and non-neoplastic lesions

Discussion

Noninvasive and accurate differentiation between neoplastic and non-neoplastic brain lesions is important in determining the correct treatment plan [١, ٢]

For differentiation of neoplastic from non-neoplastic lesions, using ROC curve analysis, a threshold value of ٢ for Cho/Cr gave sensitivity ٩٣٪, specificity ٧٩.١٧٪ and accuracy of ٨٨.٨٪, a threshold value of ١.٧ for Cho/NAA gave sensitivity ٨٧.٥٪, specificity ٧٠.٨٣٪ and accuracy of ٨٢.٥ %, a threshold value of ٠.٨ for Cho/NAA+Cr gave sensitivity ٩٢.٨٦٪, specificity٧٩.١٧٪ and accuracy of ٨٨.٨٪, a threshold value of ≤٠.٧ for NAA/Cho gave sensitivity ٨٧.٥٪ specificity ٨٣.٣٣٪ and a threshold value of ≤٠.٩ for NAA/Cr gave sensitivity ٦٩.٦٤٪, specificity ٦٢.٥٪ and accuracy ٦٧.٥٪.

Elevated Cho along with decreased Naa is typically regarded as a diagnostic feature of brain tumors[٣]

Ozan Karatag et al.,[٦] reported that Cho/Cr > ١.٩٨ show sensitivity ٧١.٨٪ and specificity ١٠٠٪ & Cho/Naa >١.٨٣ show sensitivity of ٨٧.٢ and specificity of ١٠٠٪ & Naa/Cr ≤ ١.٢٣ show sensitivity of ٨٤.٦٪ and specificity of ٥٧.١٪ & Cho+Cr/Naa > ٢.٨ show ٨٤.٦٪ sensitivity and ١٠٠٪ specificity in differentiation of neoplastic versus non-neoplastic lesions

Butzen J et al.,[٧] reported that Cho/Naa > ١ show sensitivity of ٧٩٪ and specificity of ٧٧٪ as an indicator of neoplastic process

Al-Okaili et al.,[٤] used a lesional Cho/Naa ratio of ٢.٢ calculated from evaluation of ٢٣٢ published studies to separate primary high-grade neoplasms from mimicking low grade and non-neoplastic lesions

McKnight et al.,[٥] reported that Cho/Naa ratio correlate with cell density and cell proliferation index, a ratio greater than ٢ show sensitivity ٩٦٪ and specificity ٧٠٪ in differentiating neoplastic versus non-neoplastic lesion

In this study regarding diffusion (ADC values), it was not statistically significant in differentiation of neoplastic from non-neoplastic lesions, in neoplastic lesions. As many non-neoplastic lesions as abscesses and ischemic lesions show remarkable diffusion restrictions, abscesses ranging ٠.٣-٠.٥ with mean value ٠.٤٣±٠.٠٧ and ischemic lesions ranging ٠.٥-٠.٦ with mean value ٠.٥٢±٠.٠٤; Abscesses shows diffusion restriction due to viscid and highly cellular inflammatory contents & ischemic lesions shows diffusion restriction due to cytotoxic hydropic swelling with remarkable attenuation of extra cellular spaces limiting water Brownian motion in extra cellular spaces. In apparently solid compartment of high grade neoplasms as GBM, metastatic deposits, anaplastic astrocytoma, anaplastic ependymoma and medulloblastoma, also diffusion restriction is noted in most of the lesion but to a lesser extent. Even after exclusion of ٧ cases of pyogenic abscesses, no statistical significance could be detected in between neoplastic (٠.٨٨±٠.٣١) and non-neoplastic groups (١.١٣±٠.٦١)

Baghdadi A. et al.,[٨] in agreement with this study, found that ADC is not significant in differentiation of neoplastic versus non-neoplastic brain lesions in a study included

٧٥ space occupying lesions, ٤٦ neoplastic lesion and ٢٩ non-neoplastic lesions

Conclusions

MR spectroscopy had an important role in differentiation of the neoplastic and non-neoplastic lesions

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