Research Article

MR Spectroscopy and Diffusion Weighted Imaging in Differentiation of Low Grade 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 ٣٤ patients; ١٠ 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 low grade neoplastic from non-neoplastic groups with ROC curve analysis, a threshold value of >٢ for Cho/Cr gave sensitivity ٧٠٪ and specificity ٧٩.١٧٪, a threshold value of ١.٣ for Cho/NAA gave sensitivity ٨٠٪ and specificity٧٠.٨٣٪, a threshold value of >٠.٨ for Cho/NAA+Cr gave sensitivity ٨٠٪ and specificity٧٩.١٧٪, a threshold value of ≤٠.٧ for NAA/Cho gave sensitivity ٧٠٪ and specificity ٨٣.٣٣٪ and a threshold value of ≤٠.٧ for NAA/Cr gave sensitivity ٧٠٪ and specificity ٨٣.٣٣٪. ADC was not statistically significant for differentiation of low grade neoplastic and non-neoplastic lesions with exclusion of pyogenic abscesses. **Conclusions:** Advanced neuro-imaging had an important role in differentiation of the low grade neoplastic and non-neoplastic lesions

Key words: Diffusion Weighted, Low Grade Neoplastic and MRS

Introduction

Low grade neoplasms in this study included ٥ cases of low grade astrocytoma, one case of dysembryoblastic neuroectodermal tumor, one case of hemangioblastoma, one case of pleomorphic xanastrocytoma, one case of gliomatosis cerebri and one case of low grade ependymoma

Non-neoplastic lesions include one case of focal cortical dysplasia, ٧ cases of pyogenic abscesses, two cases of encephalitis, one case of cerebritis, four demyelinating lesions, three ischemic lesions, one case of vasculitis and ٢ neuroglial cysts, one case of cerebrovascular malformation and two radiation induced changes

Results

Table (١): Spectroscopic data and ADC values for differentiation of low grade glioma from non-neoplastic lesions

Variable		Type		P value
		Non-neoplastic lesion (n=٢٤)	Low grade neoplasm (n=١٠)	
Cho/Cr	Range	(٠.٥-٤.١)	(١.٢-٣.٦)	
	Mean +/- SD	١.٦٦±٠.٨٧	٢.٣٦±٠.٧٥	< ٠.٠١٢*
Cho/NAA	Range	(٠.٤-٢.٩)	(٠.٥-٣.٢)	
	Mean +/- SD	١.٢٧±٠.٧٧	٢.٠٨±٠.٨١	< ٠.٠٢٣*
NAA/Cr	Range	(٠.٢-٣.٤)	(٠.٧-٢.٣)	
	Mean +/- SD	١.٣٢±٠.٧٤	١.٢٩±٠.٥٤	٠.٩٨٥
Cho/NAA+Cr	Range	(٠.٢-١.٧)	(٠.٤-١.٦)	
	Mean +/- SD	٠.٦٩±٠.٣٢	٠.٩٩±٠.٣١	< ٠.٠١٠*
NAA/Cho	Range	(٠.٣٨-٢.٨)	(٠.٢٨-١.٨)	
	Mean +/- SD	١.٣±٠.٦	٠.٧±٠.٥	٠.٠١٤*

- **Mann Whitney test for**

Table (٢): ADC in differentiation of low grade neoplasms and non-neoplastic lesions (pyogenic abscesses are excluded)

Variable		Type		P value
		Non-neoplastic (n=١٥)	Low grade neoplasm (n=١٠)	
ADC	Range	(٠.٤٨-٢.٣)	(٠.٨٤-١.٧)	٠.١٣٣
	Mean +/- SD	١.١٣±٠.٦١	١.٣١±٠.٢٥	

Table (٣): ADC in differentiation of low grade neoplasm and pyogenic brain abscesses

Variable		Type		P value
		Pyogenic abscesses (n=٧)	Low grade neoplasms (n=١٠)	
ADC	Range	(٠.٣-٠.٥)	(٠.٨-١.٧)	<٠.٠٠١*
	Mean +/- SD	٠.٤±٠.١	١.٣±٠.٢	

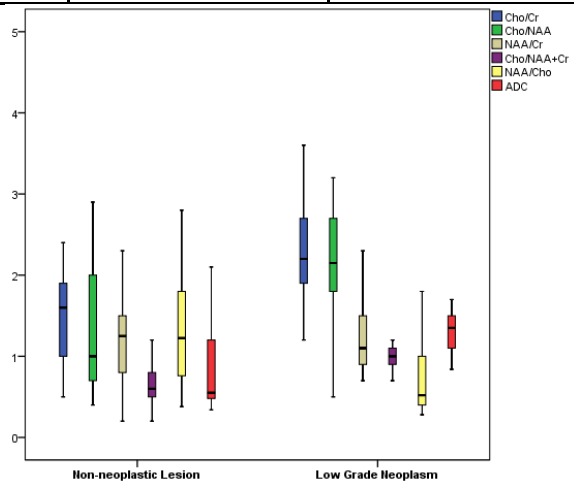

Figure (١): Box plot for spectroscopic data and ADC values for low grade neoplasms and non-neoplastic lesions

Table (٣): ROC curve analysis for prediction of low grade neoplasm from non-neoplastic lesions

Variable	AUC	Std. error	P value	٩٥٪ CI	
				Lower bound	Upper bound
Cho/Cr	٠.٧٧٥	٠.٠٨٦	٠.٠٠١*	٠.٦	٠.٩
Cho/NAA	٠.٧٥٠	٠.٠٩٨	٠.٠١١*	٠.٥٧٢	٠.٨٨٢
Cho/NAA+Cr	٠.٧٨٣	٠.٠٩٤	٠.٠٠٣*	٠.٦٠٩	٠.٩٠٦
NAA/Cho	٠.٧٧١	٠.١	٠.٠٠٥*	٠.٦	٠.٩

Variable	Optimal cutoff	Sensitivity	Specificity	PPV	NPV	Accuracy
Cho/Cr	>٢	٧٠	٧٩.١٧	٥٨.٣	٨٦.٤	٧٦.٥
Cho/NAA	>١.٣	٨٠	٧٠.٨٣	٥٣.٣	٨٩.٥	٧٣.٥
Cho/NAA+Cr	>٠.٨	٨٠	٧٩.١٧	٦١.٥	٩٠.٥	٧٩.٤
NAA/Cho	≤٠.٧	٧٠	٨٣.٣٣	٦٣.٦	٨٧	٧٩.٤

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

Regarding Cho/NAA, there is statistical significance for differentiation between low grade neoplasms from non-neoplastic lesions. At a cut off value (>١.٣) lesions with higher value were suggested to be low grade neoplasm

Regarding NAA/Cr, there is no statistical significance for differentiation between low grade neoplasms from non-neoplastic lesions

Regarding Cho/Cr+NAA, there is statistical significance for differentiation between low grade neoplasms from non-neoplastic lesions. At a cut off value (>٠.٨) lesions with higher value were suggested to be low neoplasm

Regarding ADC, there is no statistical significance for differentiation of low grade neoplasms from non-neoplastic lesions

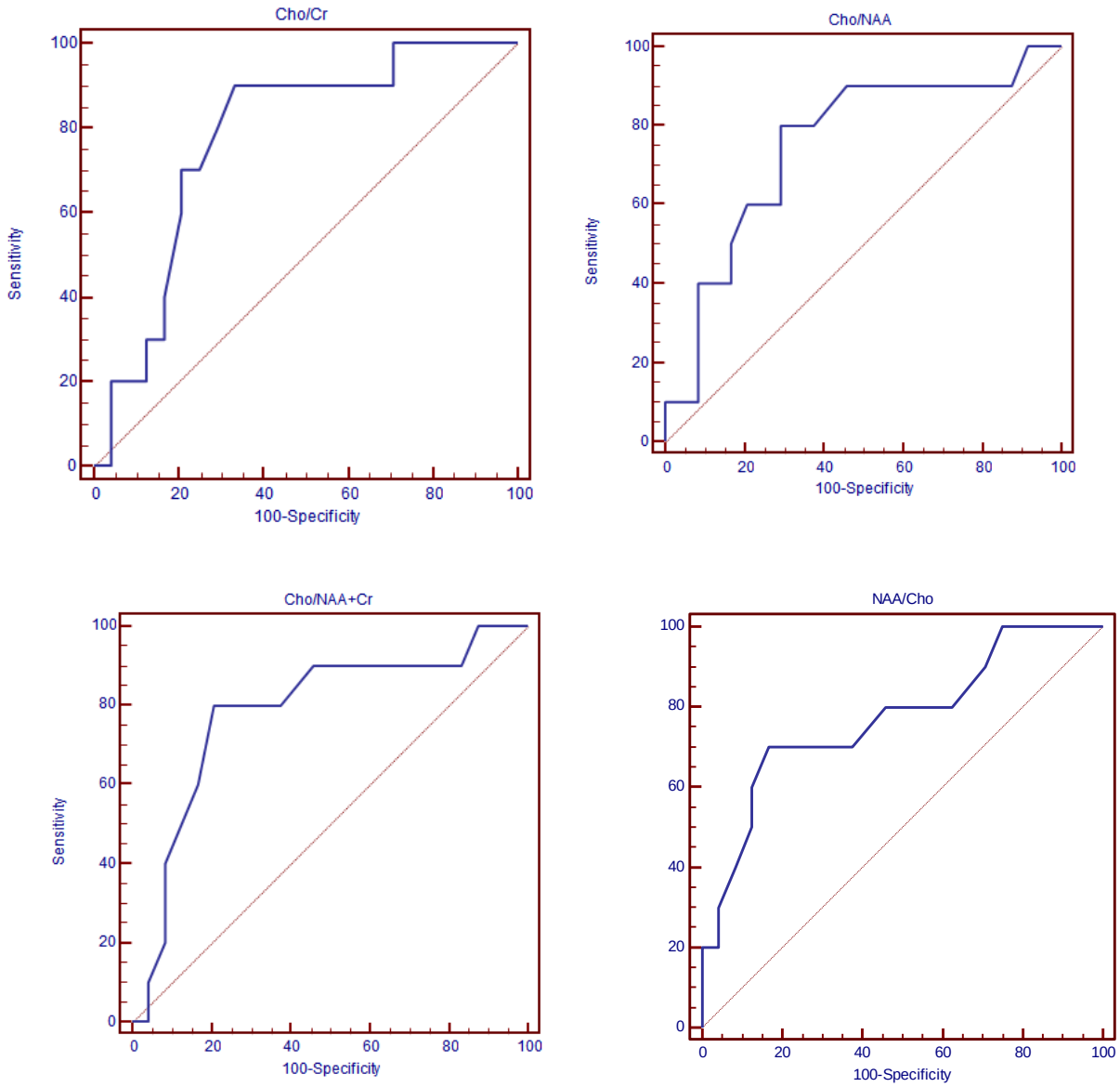

Figure (٢) ROC curve for prediction of low grade neoplasm from non-neoplastic lesions

Discussion

In this study, one case of gliomatosis cerebri showed Cho/Cr١.٨, Cho/NAA ٢.٧, Cho/NAA+Cr١.٤, NAA/Cr ١ and ADC ١.٤ x ١٠$^{-٣}$ mm/sec. In a study done by Desclee P et al.,[١] on ١٢ case of gliomatosis cerebri, ٣ cases shows elevated Cho/NAA and decreased NAA/Cr and nine cases shows no remarkable changes of Cho/NAA or NAA/Cr

In this study one case of DNET showed Cho/Cr١.٢, Cho/NAA ٠.٥, Cho/NAA+Cr ٠.٤, NAA/Cr١.٢ and ADC ١.٥x١٠$^{-٣}$ mm/sec. Wang et al.,[٢] show decreased NAA in DNET compared with contralateral normal appearing parenchyma with corresponding mild increase in Cho/NAA ratios, likely due to reduction of neuronal integrity and not due to change of cellular turnover

In this study one case of hemangioblastoma showed Cho/Cr ٢.٧, Cho/NAA ١.٨, Cho/NAA+Cr ١.١, NAA/Cr١.٥ and ADC ١.٣ x١٠$^{-٣}$ mm/sec. Isobe T., et al.,[٣] described high lipid peak, no lactate without gross intra tumoral necrosis as unique features of hemangioblastoma, also reported absence of NAA that reflect non-neuronal and extra medullary origin of the lesion

In this study one case of pleomorphic xanastrocytoma show Cho/Cr ٣.٦, Cho/NAA ٢.٧, Cho/NAA+Cr١.١, NAA/Cr ٠.٧ and ADC ١.١ x١٠-٣ mm/sec. Choudri U. et al.,(٤) in a case report of anaplastic variant of PXA show high Cho/Cr and high Cho/NAA ratios in the enhancing areas

In this study one case of focal cortical dysplasia was detected and showed Cho/Cr١.٣, Cho/NAA ١, Cho/NAA+Cr ٠.٦, NAA/Cr ١.٣ and ADC ١.٣ x١٠-٣ mm/sec. Leite C.C. et al., (٥) in a study carried on ١٦ patient of cortical dysplasia demonstrated reduced NAA/Cr in cortical developmental malformation ١.٦٢±٤٤ SD compared with the contra lateral normal appearing white matter ٢.٤٨±٠.٢٨

In this study cerebral abscess, the presence of amino acid peak at ٠.٩ ppm was specific for cerebral pyogenic abscesses. Acetate and Succinate/Pyruvate was specific but less sensitive for cerebral abscesses. In a study by Pal D., et al.,(٦) that include ١٩٤ abscesses it shows that resonance of amino acids was observed in ٨٠٪ of abscesses with sensitivity and specificity ٧٢٪ and ٣٢٪ respectively

In this study one case of vasculitis due to systemic lupus erythromatosus show Cho/Cr ٢.٨, Cho/NAA ٢.١, Cho/NAA+Cr ٠.٧, NAA/Cr ٠.٧ and ADC ٠.٨ x١٠-٣ mm/sec. It also show lactate peak. Panchal Neeraji(٧) in a case report of CNS vasculitis demonstrated marked elevation of glutamine/glutamate peak, marked elevation of lipid peak, mild decrease in NAA and only minimal elevation of choline

In this study ٣ case of ischemic lesions were reported showed the following mean Cho/Cr ١.٧±٠.٢٦, mean Cho/NAA ١.٠٧±٠.٢٥, mean Cho/NAA+Cr ١.١-١.٥, mean ١.٢٧±٠.٢١, mean NAA/Cr ٠.٧±٠.١٧and mean ADC values ٠.٥٢±٠.٠٤. Alin Aiqin et al.,(٨) have demonstrated time interval changes in metabolites spectrum of ٤٧ patients with cerebral infarction. There is sequential reduction of NAA/Cho and more increase in Lact/Cr ratio after ٦ hours

Regarding demyelinating lesions, in this study there were ٤ cases of demyelination. They show spectroscopic metabolites ratios as following mean Cho/Cr ٢.٢٣±١.٣٤, mean Cho/NAA ١.٢٣±١.١٢, mean Cho/NAA+Cr ٠.٧٧±٠.٦٣, mean NAA/Cr ١.٨±٠.٦٨ and mean ADC values ١.٠٦±٠.١١. Barker F. et al.,(٩) in a study carried on ٥ patients with ADEM compared with ١٥ control healthy children revealed that the mean NAA in ADEM were lower than control healthy group and there was no significant difference in Cho concentration between ADEM and healthy group

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