Section: Radiodiagnosis

Original Research Article

ADVANCED MRI IN DIFFERENTIATING MALIGNANT AND BENIGN ORBITAL MASSES- ANALYTICAL STUDY

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ABSTRACT

Background: Lesions of the orbit are usually classified based on the histological subtypes of the masses or based on their location. The addition of new techniques in MRI (magnetic resonance imaging) can help differentiate orbital masses into benign and malignant lesions. The aim is to assess advanced magnetic resonance techniques can be used to improve the diagnostic capacity for distinguishing between benign and malignant orbital masses.
Materials and Methods: During the specified study period, 52 subjects; 24 males and 28 females with a mean age of 34.6 years who presented to the Institute with orbital masses were evaluated. Advanced MRI methods, including dynamic (DCE)< MRS and DWI on a 1.5T scanner, were used for all subjects. A statistical analysis was performed on the collected data.
Results: The study's specificity, sensitivity, positive predictive value, and negative predictive value were found to be 75%, 72.2%, 86.6%, and 54.5%, respectively. The sensitivity and specificity of lesions with P=Tp<141.5 s were approximately 94.4% and 87.5%, respectively, and the positive and negative predictive values for malignancy were 94.4% and 87.5%, respectively. The lesions with slope >0.47 showed positive and negative predictive values for malignancy of 66.6% and 100%, respectively, and specificity and sensitivity of almost 78% and 100%, respectively. Additionally, type I and III curves showed a significant difference with p=0.002. Specificity, sensitivity, negative predictive value, and positive predictive value for the presence of chlorine peaks were 94.4%, 62.5%, 83.3%, and 85%, respectively.
Conclusion: Advanced magnetic resonance imaging (MRI) that incorporates perfusion parameters, MRS, and DW can greatly enhance radiologists' ability to distinguish between benign and malignant orbital masses.
Keywords: MRI, orbital masses, benign orbital masses, malignant orbital masses, advanced MRI.

INTRODUCTION

Conventional imaging modalities like magnetic resonance imaging (MRI) and multidetector computed tomography (MDCT) have not demonstrated enough specificity and sensitivity to distinguish between benign and malignant orbital lesions, and there is a significant risk of misdiagnosing cases involving unexpected and uncommon entities.[1,2]
The addition of magnetic resonance imaging techniques like MRS (magnetic resonance spectroscopy), DWI (diffusion-weighted imaging), and MRS (magnetic resonance spectroscopy) to conventional MRI sequencing can help provide different forms of the tissue contrast and can help for better characterization of the orbital lesions, thanks to various advancements in the techniques and technologies for imaging in radiodiagnosis. Nevertheless, there is a dearth of information on the subject in the literature.[3,4]
Therefore, the goal of the current study was to assess how well-advanced magnetic resonance techniques can be used to improve the diagnostic capacity for distinguishing between benign and malignant orbital masses.

MATERIALS AND METHODS

The purpose of the prospective assessment study described in Materials and Methods is to determine how well-advanced magnetic resonance techniques can be used to improve the diagnostic ability for differentiating between benign and malignant orbital masses. The Institute's Department of Radiology provided the study participants. Prior to participation, each subject provided both written and verbal informed consent.

52 subjects—24 males and 28 females—with a mean age of 34.6 years who had MRIs at the Institute during the specified study period were evaluated. The subjects presented to the Institute with the complaint of reduced visual acuity and/or proptosis. Subjects with claustrophobia, metallic implants, large calcification or necrosis of orbital masses, and unwillingness to participate in the current study were among the exclusion criteria for the study.

The two skilled radiologists evaluated all of the imaging data. Every region of interest (ROI) for DWI was created by hand. After modifying the size for regions of interest according to the size of the lesion, ADC (apparent diffusion coefficient) values were computed. ROI of 0.014 cm2 areas was created for lesions with a maximum diameter of less than 2 cm, and at least two regions of interest, excluding the necrotic lesion area, were placed for lesions with a diameter greater than 2 cm, and their mean ADC values were evaluated. ADC values were expressed as 10-3mm2/s. Depending on the size and shape of the lesion, either multiple voxels or CSI (chemical shift imaging) using SVS (single voxel spectroscopy) were used for MRS. Using CHESS and other volume fat suppression modalities, fat and water suppression was automatically performed prior to all spectroscopic evaluations.

In terms of DCE, six additional datasets were obtained five minutes after injection, and the coronal dataset with the lesion was obtained right before contrast injection. After applying several regions of interest, the one with the greatest enhancement pattern was chosen. The size of the lesion was evaluated for the area of interest. The mean pixel value was used to calculate the SI (signal intensity) of each dynamic sequence slice.

For every mass, a representative ROI and matching TIC (time-intensity curve) were obtained. Three different types of enhancement curves were observed: type I (persistent type), which showed continuous progressive enhancement; type II (plateau type), which showed a sharp rise in enhancement followed by a plateau; and type III (washout pattern), which showed a rapid rise in enhancement followed by a rapid decline with a final signal intensity of less than 90% of peak signal intensity.

The baseline signal intensity (SIpre), Simax (maximum signal intensity at the peak of enhancement), and Tpre, Tpeak (times corresponding to these signal intensities) were calculated for each TIC [Table 1].

Table 1: Parameters used for MRI in study subjects

S. No		DWI	T1W1 axial	T2W1 axial	T2W1 cor	T1W1 pre and post contrast	DCE	PC T1W1
1	Flip angle	1	12	150	150	9	70	12
2	Acquired voxel size (mm3)	1.8 x 1.0 x 4.0	0.6 x 0.6 x 1	0.7 x 0.5 x 2.5	0.5 x 0.5 x 3.5	1.1 x 1.0 1.0	1.1 x 1.0 x 2	0.6 x 0.6 x 1
3	Slice thickness (mm3)	4	1	2.5	3.5	1	2	1
4	TR/TE (ms)	3600/95	20/3.69	3000/89	4000/79	1800/3.77	175/2	20/3.69
5	Sequence type	Ep2d	Vibe_fs	Tse_fs	Tse_fs	Mprage	Fl2d	Vibe_fs

Final diagnosis in all cases was attained via histopathological assessment following magnetic resonance imaging. The data gathered were statistically analyzed using SPSS (Statistical Package for the Social Sciences) software version 24.0. (IBM Corp., Armonk. NY, USA) for assessment of descriptive measures, Student t-test, ANOVA (analysis of variance). The results were expressed as mean and standard deviation and frequency and percentages. The p-value of <0.05 was considered.

RESULTS

The goal of the current prospective assessment study was to determine how well-advanced magnetic resonance techniques can be used to improve the diagnostic capacity for distinguishing between benign and malignant orbital masses. 52 subjects—24 men and 28 women—with a mean age of 34.6 years who came to the Institute with orbital masses during the specified study period were evaluated in this study. Table 2 describes the location of orbital masses. Of the 52 individuals evaluated in the study, 30.7% (n=16) of the lesions were malignant and 69.2% (n=36) of the orbital masses were histologically benign. [Table 2] summarizes the lesions' histopathological distribution.

The average ADC values for benign and malignant orbital masses are evaluated independently [Table 3]. MRI demonstrated sensitivity, specificity, positive predictive values, and negative predictive values of 72.2%, 75%, 86.6%, and 54.5%, respectively, in distinguishing benign orbital masses from malignant masses.

Slope and Tp showed statistically significant differences between benign and malignant lesions with p<0.001 for DCE parameters of benign and malignant lesions [Table 4]. Tp had sensitivity, specificity, positive predictive values, and negative predictive values of 94.45, 87.5%, 94.4%, and 87.5%, respectively, while Slope had sensitivity, specificity, positive predictive values, and negative predictive values of 100%, 78%, 66.6%, and 100% [Table 5].

In terms of the quantity of lesions with distinct enhancement curves, all lesions with type I patterns were benign, while type III lesions were malignant. Out of 20 lesions with type II curves, six were malignant and fourteen were benign. One MPNST, carcinoma NOS, and lymphoma were the malignant lesions exhibiting a type II curve. The type I and III curves have an o-value of 0.002. Using values of ER, PH, SI (max), and SI (pre), there was no discernible difference between benign and malignant lesions.

MRS data were evaluated for each subject. The generated kappa value was 0.875, indicating almost perfect agreement between the choline peak and malignancy. Sensitivity, specificity, positive predictive values, and negative predictive values of 62.5%, 94.4%, 83.3%, and 85% were obtained for malignancy using choline peak.

Table 2: location and Histopathological distribution of malignant and benign orbital masses

S. No	Location	Number (n)
1.	Intra- extraconal	10
2.	Extraconal	18
3.	Intraconal	24
1.	Malignant	
a)	Extramedullary myeloid tumor	4
b)	Carcinoma NOS	4
c)	MONST	4
d)	Lymphoma	2
e)	SCC	2
f)	Total	16
2.	Benign	
a)	Neurogenic tumor (unspecified)	2
b)	Cavernous lymphangioma	2
c)	Low-grade glioma	2
d)	Dermoid cyst	2
e)	Optic nerve meningioma	2
f)	Basal cell adenoma	2
g)	Arteriovenous malformation	2
h)	Fungal granuloma	4
i)	Hemangioma	4
j)	Pleomorphic adenoma	6
k)	Schwannoma	8
l)	Total	36

Table 3: Distribution of mean ADC (103 mm2/sec) values for malignant and benign lesions

S. No	Biopsy	Number (n)	Mean	p-value
1	Mean ADC benign	36	1.187±0.439	0.005
2	Mean ADC malignant	16	0.711±0.112	

Table 4: DCE parameters distribution with corresponding p-values

S. No	Biopsy	Number (n)	Mean	p-value
1	SI (pre)			0.866
a)	Benign	36	324.58±86.29	
b)	Malignant	16	331.43±114.82	
2	SI (max)			
a)	Benign	36	588.39±146.01	0.825
b)	Malignant	16	603.91±204.70	
3	Tp			
a)	Benign	36	241.26±67.10	<0.001
b)	Malignant	16	118.23±32.0	
4	PH			
a)	Benign	36	263.79±125.86	0.539
b)	Malignant	16	272.49±97.64	
5	ER (%)			
a)	Benign	36	86.8±45.5	0.824
b)	Malignant	16	83.1±17.5	
6	Stope			
a)	Benign	36	0.34±16.8	<0.001
b)	Malignant	16	0.73±0.34	

Table 5: Number of lesions depicting different enhancement curves

S. No	Biopsy	Benign	Malignant
1	Type I	22	0
2	Type II	14	6
3	Type III	0	10

DISCUSSION

The current study evaluated 52 participants with orbital masses, 24 of whom were male and 28 of whom were female, with a mean age of 34.6 years. MRI demonstrated sensitivity, specificity, positive predictive values, and negative predictive values of 72.2%, 75%, 86.6%, and 54.5%, respectively, in distinguishing benign orbital masses from malignant masses. These findings were similar to those of studies by Roshdy N et al. (2010) and Wang CK et al. (2004), whose authors reported similar MRI results for benign and malignant orbital lesions in their study subjects.[5,6]

According to the study's findings, Slope and Tp showed statistically significant differences between benign and malignant lesions with $p<0.001$ for the DCE parameters of malignant and benign lesions. Tp's sensitivity, specificity, positive predictive values, and negative predictive values were 94.45, 87.5%, 94.4%, and 87.5%, respectively, while the slope's were 100%, 78%, 66.6%, and 100%. The DCE parameters of malignant and benign orbital lesions reported in the current study were similar to those reported by Yuan Y et al. (2013) and Razek AA et al. (2011).[7-9]

Regarding a number of lesions with various enhancement curves, it was observed that all lesions with a type I pattern were benign, while lesions with a type III pattern were malignant. Of the twenty lesions with type II curves, six were malignant and fourteen were benign.[10]

One MPNST, carcinoma NOS, and lymphoma were the malignant lesions exhibiting a type II curve. The type I and III curves have a p-value of 0.002. Using values of ER, PH, SI (max), and SI (pre), there was no discernible difference between benign and malignant lesions. These results were in line with those of Xu XQ et al. (2016) and Sepahdari AR et al. (2010), who also reported lesions showing distinct enhancement curves similar to the current study.[11]

Additionally, it was observed that MRS data were evaluated for every subject. The generated kappa value was 0.875, indicating almost perfect agreement between the choline peak and malignancy.[12]

Sensitivity, specificity, positive predictive values, and negative predictive values of 62.5%, 94.4%, 83.3%, and 85% were obtained for malignancy using choline peak. These findings were consistent with those of Xu XQ et al. (2017) and Lecler A et al. (2017), whose MRS data were similar to those of the current study.

CONCLUSION

Within its limitations, the current study concludes that radiologists' ability to distinguish between benign and malignant orbital masses can be greatly enhanced by using advanced MRI (magnetic resonance imaging) with perfusion parameters, MRS, and DW. Nevertheless, more multi-institutional research with a bigger sample size will aid in drawing firm conclusions.

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