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Diagnostic Value of Diffusion Weighted MRI In Differentiation of Benign From Malignant Thyroid Nodules Assuming Histopathology As Gold Standard In SMS Medical College Jaipur In 2018-2019

[1]Dr. Rahul Dev, [2]Dr. Meenu Bagarhatta, [3]Dr. Kuldeep mendiratta, [4]Dr. Usha Jaipal

[1]Resident Doctor, [2,3,4] Senior Professor,

Department of Radio-Diagnosis & Modern Imaging, S.M.S Medical College & Attached Group of Hospitals, Jaipur, Rajasthan

Corresponding Author: Dr. Meenu Bagarhatta**,** Senior Professor, Department of Radio-Diagnosis & Modern Imaging, S.M.S Medical College & Attached Group of Hospitals, Jaipur, Rajasthan

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Abstract

Background: Preoperative differentiation of benign from malignant thyroid nodules remains a challenge.The aim of this study is to find out the efficacy of DWI MRI in differentiation of benign from malignant Thyroid nodule assuming histopathalogical as gold standard.

Methods: DWI was performed in patients with thyroid nodule by means of a 3-T scanner magnetic resonance imaging (MRI). Images were obtained at *b* value of 0, 500, and 1000 mm^2/s to draw an ADC (apparent diffusion coefficient) map. Findings were compared with postoperative histopathologic results.

Results: Mean ADC 1000 in benign tumor $1.78\pm0.37\times10^{-3}$ mm^2/s and in malignant tumor was $0.72\pm0.32\times10^{-3}$ mm^2/s. The difference of ADC was found statistically significant.

Conclusion: DWI is highly accurate for discrimination between benign and malignant thyroid nodules.

Keyword: MRI, DWI, ADC, CNS.

Introduction

Thyroid gland is unique among endocrine glands in that it is the first endocrine gland to appear in the fetus, largest of all endocrine glands (Weighing about 25 gm) and because of its superficial location it is only one, which is amenable to direct physical examination. Thyroid is common site of both benign and malignant conditions therefore early diagnosis is very important for better management and survival of patient. [1]

Magnetic resonance imaging (MRI) of thyroid like CT can be used to evaluate the content of entire neck. Yousem et al concluded that advantage of MRI over CT includes improved soft tissue discrimination and lack of beam hardening artifacts; however, MRI is not superior in identification of malignant lymphadenopathy.[2]

Diffusion-weighted MR imaging (DWI) is an emerging technique for central nervous system (CNS) diseases. DWI is sensitive to changes in the microstructural organization of tissue that may affect water diffusion. It

has been used in various forms to evaluate head and neck tumors. The Apparent Diffusion Coefficient (ADC) value, a metric obtained from DWI scans, could be a quantitative parameter for distinguishing malignant tumors from benign lesions.[3-4]

In our current study, we assess the ability of DWI and ADC to differentiate benign from malignant thyroid nodule.

Material and Method

Study Type: Cross-sectional and prospective (Quantitative) study.

Study Design: Observational study

Study Duration: Data collection for study was start after approval from the institutional research and review board up to June 2019 or till sample size achieved, whichever, is earlier. Then it will take another 2 months to processing the data and write the thesis.

Study Location: Department of Radio-diagnosis, SMS hospital Jaipur, Rajasthan.

Study Area: Out-patient and in-patient of ENT, Surgery, Medicine and oncology department, SMS Hospital, Jaipur, Rajasthan.

Inclusion Criteria

- All patients with USG determined thyroid nodules and lesions larger than 1 cm in the greatest minimal transverse diameter will be included in study.
- Age 18-70 year
- Those who give written informed consent to be included in study.

Exclusion Criteria

- Those who previously underwent thyroid surgery due to either malignant or benign reason will be excluded from study.
- Purely cystic nodules.
- Patients with thyroid nodule unfit to undergo MRI like metallic aneurysms clips, pacemakers, metallic vascular clamp placement.
- Non compliant patient.
- Patients with history of claustrophobia.
- Those who underwent previous radiation therapy and thyroiditis will be excluded from study.
- Patients having lesions less than 1cm in the greatest minimal transverse diameter will be excluded from study

This study included patient with thyroid nodules on the basis of ultrasonographic examination. Their age ranged from 18-70 years. Prior to examination, written and informed consent from patient/guardian. Preliminary gray scale ultrasonographic and color doppler sonography was done for all patients.

Results

In present study, maximum cases(35.56%) were from 46-50 years age group followed by 28.89% cases were from 31-45 years age group, 20.00% cases were less than 30 years age group, 13.33% cases were 61-75 years age group, 2.22% cases were >75 years age group. Maximum cases (82.22%) were female and 17.78% cases were male.

Table 1: Distribution of cases according to histopathological diagnosis

Histopathological diagnosis	No of cases	Percentage
Benign	30	66.67
Malignant	15	33.33
Total	45	100.00

In present study, 66.667% cases were benign and 33.33% cases were malignant.

Table 2: Distribution of cases according to calcification and type of tumor

Calcification	Benign		Malignant		p-value
	No	Percentage	No	Percentage	
Present	03	10	7	46.67	0.001(S)
Absent	27	90	8	53.33	
Total	30	100.00	15	100.00	

In present study, out of total 30 benign cases, 3 cases were present with calcification (10%) and in malignant condition out of 15 cases 46.67% cases were present with calcification. The association between calcification and type of tumor was found statistically significant.

Table 3: Distribution of cases according to Size of tumor and type of tumor

Size	Benign		Malignant		p-value
	Mean	SD	Mean	SD	
Length	50.12	9.12	42.16	16.30	0.001(S)
Breadth	27.41	6.23	21.12	13.58	0.001(S)

In present study, mean length of benign tumor was 50.12±9.12 mm and in malignant tumor was 42.16±16.30 mm. Mean breadth of benign tumor was 27.41±6.23 mm and in malignant tumor was 21.12±13.58 mm. The difference between size of tumor was found statistically significant.

Table 4: Distribution of cases according to T1 & T2 intensity finding and type of tumor

MRI Finding		Benign		Malignant		p-value
		No	Percentage	No	Percentage	
TI	Iso intense	13	43.00	10	67.00	NA
	Hypointense	15	50.00	0	0.00	
	Hyper intense	2	7.00	0	0.00	
	Heterogenus hyperintense	0	0.00	5	33.00	
T 2	Iso intense	22	73.33	0	0.00	0.001(S)
	Hyper intense	1	3.33	11	73.33	
	Heterogenus hyperintense	7	23.33	4	26.67	

In present study, benign nodule on T1-weighted image shows 43% patients were isointense signal, 50% were hypointense signal and 7% were heterogenous hyperintense signal and on T2-weighted image 73.33% patients were isointense, 3.33% patients were hyperintense & 23.33% patients were heterogenous hyper intense and in malignant tumor maximum 73.33% patients were heterogenous hyper intense.

Table 5: Distribution of cases according to ADC and type of tumor

ADC	Benign		Malignant		p-value
	Mean	SD	Mean	SD	
ADC 500	1.83	0.38	0.76	0.31	0.001(S)
ADC 1000	1.78	0.37	0.72	0.32	0.001(S)

In present study, mean ADC 500 in benign tumor $1.83\pm0.38\times10^{-3}$ mm^2/s and in malignant tumor was $0.76\pm0.31\times10^{-3}$ mm^2/s. The difference of ADC was found statistically significant.

Mean ADC 1000 in benign tumor $1.78\pm0.37\times10^{-3}$ mm^2/s and in malignant tumor was $0.72\pm0.32\times10^{-3}$ mm^2/s. The difference of ADC was found statistically significant.

Table 6. Diagnostic accuracy of ADC level

Area under the ROC curve (AUC)	0.964
Standard Error [a]	0.0299
95% Confidence interval [b]	0.862 to 0.997
z statistic	15.543
Significance level P (Area=0.5)	<0.0001
Youden index J	0.9000
Associated criterion	≤0.97
Sensitivity	93.33
Specificity	96.67

According to the final pathology results, the best cutoff for the mean ADC value was calculated as $0.97\times10^{-3}mm^2/s$ with a sensitivity of 93.33%, a specifity of 96.67%, a positive predictive value of 83.33%, and a negative predictive value of 89.13%. It was determined that the detection of a mean ADC$\leq0.97\times10^{-3}mm^2/s$ was associated with 15 times higher risk of malignancy (P=.0.001)

Discussion

In present study, mean ADC 500 in benign tumor $1.83\pm0.38\times10^{-3}$ mm^2/s and in malignant tumor was $0.76\pm0.31\times10^{-3}$ mm^2/s. The difference of ADC was found statistically significant.Mean ADC 1000 in benign tumor $1.78\pm0.37\times10^{-3}$ mm^2/s and in malignant tumor was $0.72\pm0.32\times10^{-3}$ mm^2/s. The difference of ADC was found statistically significant. According to the final pathology results, the best cutoff for the mean ADC value was calculated as $0.97\times10^{-3}mm^2/s$ with a sensitivity of 93.33%, a specifity of 96.67%, a positive predictive value of 83.33%, and a negative predictive value of 89.13%. It was determined that the detection of a mean ADC$\leq0.97\times10^{-3}mm^2/s$ was associated with 15 times higher risk of malignancy (P=.0.001).

Nakahira et al. investigated the efficacy of DW-MRI on distinguishing malignant thyroid nodules. They found that the mean ADC value for the benign nodules was $1.93\pm0.37\times10^{-3}mm^2/s$, and the mean ADC value for the malignant nodules was $1.20\pm0.25\times10^{-3}mm^2/s$. They concluded that the mean ADC value of the malignant nodules was significantly lower than the benign nodules (P<.01).[5] In another study, El-Hariri et al. evaluated 56 thyroid nodules of 37 patients with nodular goiter via DW-MRI, and they found the mean ADC value to be $1.85\pm0.24\times10^{-3}mm^2/s$ for the benign nodule group, whereas this value was calculated to be $0.89\pm0.27\times10^{-3}mm^2/s$ for the malignant nodule group, once again, demonstrating that the mean ADC value of the malignant nodules was significantly lower (P<.01).[6]

In their series of 42 thyroid nodules, Nakahira et al. reported that the best cutoff value for ADC was $1.60\times10^{-3}mm^2/s$ in order to distinguish malignant nodules from benign thyroid nodules with a sensitivity of 94.73%, a specifity of 82.60%, a positive predictive value of 81.82%, and a negative predictive value of 95.00%[6]

Likewise, El-Hariri et al. evaluated 56 thyroid nodules in their study, and stated that they calculated the best cutoff value for ADC to be $1.5\times10^{-3}mm^2/s$.[7]

Conclusion

In conclusion, as a non-invasive and inexpensive modality, US remains to be the most important and initial step for the evaluation of thyroid nodules. However, only US examination alone is inadequate for reaching the definitive diagnosis in most cases, and for this reason, US guided FNAC and cytopathological evaluation is indicated in most cases that possess suspicious US findings. Although cytopathological results are obtained via FNAC, these results may not always reflect the features of the overall thyroid tissue. Controversies still exist for the evaluation and management of thyroid nodules diagnosed with either atypia of undetermined significance, or indeterminate cytology as results of FNAC. In these cases, further imaging modalities such as MRI and DW-MRI with ADC measurements may aid the clinician through the evaluation of thyroid nodules, and may avoid repeated FNAC. In the present study, according to the results of cervical DW-MRI, the mean ADC values were detected to be significantly lower for malignant nodules, and a mean ADC$\leq0.97\times10^{-3}mm^2/s$ was associated with 15 times higher risk of malignancy. The ADC value

determined at thyroid DW-MRI may be considered as a predictive parameter for the detection of thyroid cancer.

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Legends Figures

Figure: Axial diffusion weighted image with corresponding ADC map showing no diffusion restriction. Apparent diffusion coefficient map shows high ADC values 2.4 x 10-3mm2/sec. On histopathology benign follicular nodule.

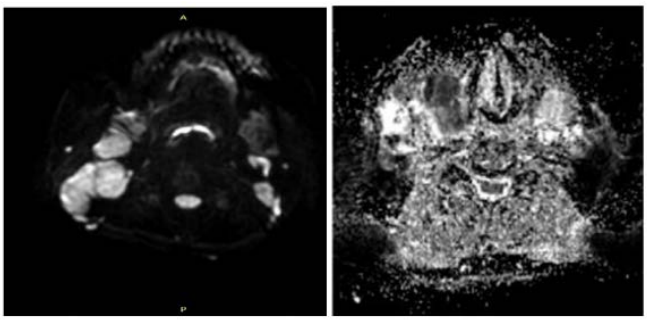

Figure: Axial diffusion weighted axial image shows high signal intensity with corresponding ADC fall seen on ADC map suggestive of diffusion restriction with corresponding fall in ADC. ADC value of lesion was 0.97x 10-3mm2/sec On Histopathology - mass was papillary carcinoma.