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Original Research Paper

Radiology

ROLE OF DWI IN DIFFERENTIATING BENIGN AND MALIGNANT THYROID NODULES AND ITS COMPARISON WITH HISTOPATHOLOGY

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ABSTRACT Thyroid nodule is a discrete lesion, radiologically distinct from surrounding thyroid parenchyma. It may be benign or malignant. Sonography is the imaging modality to detect a thyroid nodule but it is operator dependent and is inferior in evaluation of extension. Non-contrast MRI is the favoured modality in cases with equivocal USG findings, extrathyroidal extension, in assessment of lymph node status, and in staging of diseases, which may help in providing appropriate case management. In conjunction with conventional sequences and with added new sequences like DWI, MRI may provide qualitative and quantitative information which helps in confident and accurate diagnosis of thyroid nodules.

KEYWORDS : DWI, MRI, Papillary cell carcinoma

Introduction

Diseases of the thyroid gland are common and comprise a spectrum of entities causing systemic disease (Grave's disease) or a localised abnormality in the thyroid gland such as nodular enlargement (goitre) or a tumour mass. After diabetes mellitus, the thyroid gland is the most common organ to cause endocrine disorders. In India, there are 2,16,000 new cases of thyroid malignancies per year and hence the role of radiological imaging becomes important. Therefore, early detection of thyroid nodules with their characterization into benign and malignant becomes important for appropriate case management.

The imaging modality of choice for the investigation of thyroid nodules is high-resolution US. Although individual US features may be of limited value, when multiple signs of thyroid malignancy appear in combination (such as taller than wider, markedly hypoechoic, absent halo, spiculated margins, microcalicfications, internal flow pattern, lymph node involvement), it is possible to make an accurate prediction.

MRI has advantages of being a multi-planar modality, better spatial resolution, and uses no ionizing radiation so can be used to facilitate clinical management in patients with thyroid nodules by depicting certain lesions that do not require treatment and suggesting specific surgical approaches for others.

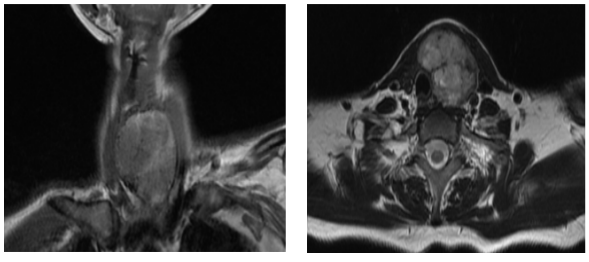
The purpose of our study was to evaluate role of DWI-MRI in assessment and characterization of thyroid nodule.

MATERIAL AND METHODS

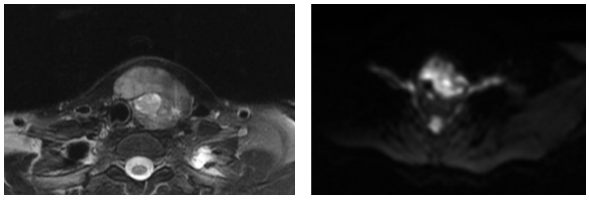
This prospective study was done in the Department of Radio-diagnosis & Krssna diagnostic centre of M.G.M. Medical College, Indore, Madhya Pradesh after getting approval by our Institutional Scientific Review Board. A total of 70 patients referred to our department with strong clinical suspicion of a thyroid nodule and/or those diagnosed on USG were evaluated on MRI. The final study group comprised of 60 patients as some patients were excluded from the study because they lost follow up or lacked histopathology correlation.

MRI Equipment

MRI examination was performed on 3 TESLA, 97 CHANNEL MAGNETIC RESONANCE IMAGING equipment using a dedicated neck coil for imaging the thyroid. The sequences used were Axial T1W, Axial and Coronal T2W, STIR and DWI.



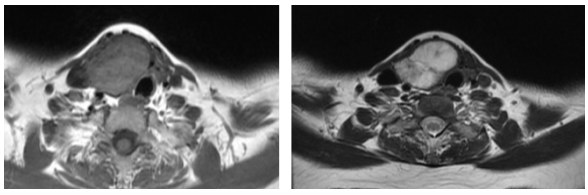
A. T1 Cor B. T2 Axial



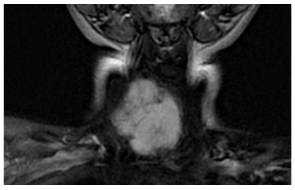
C. STIR D. DWI

Fig 1- Coronal and Axial T1, T2 and STIR sequences (A,B,C) shows heterogenous hyperintense relatively well defined lesion with microcalcifiaction in left lobe of thyroid and displacing trachea towards right side. On DWI (D) restriction of diffusion is seen. The mean ADC value was 1.3 x 10-3 mm2/sec.

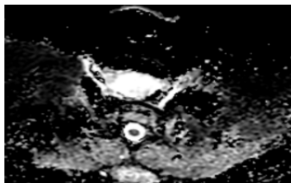
Diagnosis- Papillary thyroid carcinoma.



A. T1 Axial B. T2 Axial



C STIR



D. ADC

Fig.10- A well defined lesion with sorrounding hypointense rim(pseudocapsule) showing iso to hyperintense signal intensity on T1WI and marked hyperintense signal intensity on T2WI and STIR sequence, seen in right lobe of thyroid (A,B,C). Mean ADC value was 1.9x 10-3 mm2/s.(D)

Diagnosis-Adenoma

Result

In our study most common age group of patients was 30-39 years (43.3%) with mean age of 37.57 years. Majority of patients were females constituting 85% of cases. 56.67% of patients in our study had unilateral lesions. 81.67% of thyroid nodules had wider than taller shape. Poorly defined thyroid nodules were seen in 58.33 % of patients. Metastatic lymph nodes were seen in 20% of patients with cervical lymph nodes.

Table: 1 Classification of lesions and their ADC value.

S.No		Type of lesion	No. Of Cases	ADC value
1.	Benign	MNG	24	2.1
		Benign hyperplastic Nodule	6	2.0
		Colloid cyst	5	2.3
		Hemorrhagic cyst	2	1.2
		Follicular adenoma	9	1.9
2	Malignant	Papillary thyroid carcinoma	8	1.35
		Follicular cell carcinoma	2	1.28
		Medullary carcinoma	1	1.1
		Anaplastic carcinoma	1	0.82
		Lymphoma	1	0.86
		Metastasis	1	1.2

Table: 2 Classification of patients on MRI and follow up

S.No.	Type of Lesion	MRI morphology	ADC value	MRI morphology +ADC value	Follow up
2	Benign	48	43	46	45
3	Malignant	12	17	14	15
	Total	60	60	60	60

On MRI, MNG was the most common benign lesion constituting 40%. Papillary cell carcinoma was the most common malignant neoplasm (53.3%) Follow up of all patients was done with surgery and histopathological correlation with either biopsy or FNAC and final diagnosis was made.

Discussion

On MRI, lesion were identified using T1W, T2W, STIR, DWI sequences. The lesions were characterized on the basis of their morphology and then the ADC value of these lesions were calculated from the corresponding ADC maps.

76.67% lesions were benign in our study of which multinodular goitre was the most common lesion constituting 52% of lesions followed by adenoma (19.5%). Benign Hyperplastic nodule, colloid cyst, and hemorrhagic cyst constituted 13%, 10.8% and 4.3% of cases respectively.

We found that most of the benign thyroid nodules were multiple (41.6%) with well-defined margins (53.337%), peripheral calcification (16.67%), hemorrhage (18.33%), intact pseudocapsule (11.33%) and involved both lobes of thyroid (41.33%). These lesions appeared iso to hyperintense on T1WI, hyperintense on T2WI and showed diffusion restriction.

On MR imaging, multinodular goitre was seen as normal to diffusely enlarged thyroid with multiple well defined nodules of varying sizes showing iso to hypointensity on T1WI and heterogenous hyperintensity on T2WI. Adenoma appeared as well defined round to oval lesions with sorrounding pseudocapsule, on T1WI it appeared iso to hyperintense and markedly hyperintense on T2WI. Colloid cyst were round to oval in shape with well-defined margins and appeared hyperintense on both T1WI and T2WI. Hemorrhagic cysts were round in shape and had well defined sharp margins. They showed high signal intensity on both T1 and T2-weighted sequences with peripheral hypointense rim due to hemosiderin deposition. Benign hyperplastic nodule were well defined and appeared homogenous in signal intensity. They were iso to hyperintense on T1WI and hyperintense on T2WI.

Based on MRI morphology, 80% lesions were characterized as benign. When ADC values were considered alone, 71.67% lesions were characterized as benign. Considering MRI morphology with DWI and ADC values 76.67% cases were benign, which turned out to be 75% on histopathological follow up. Mean ADC value of benign lesion was 2.0x10-3mm2/s. Colloid cysts had the highest ADC values of all lesion in our study with mean ADC values of $2.30 \pm 0.3 \times 10$-3mm2 /sec because of high thyroglobulin content. Hemorrhagic cysts had comparatively lower ADC values (1.2× 10-3mm2 /sec) than colloid cyst, because of hemorrhage within the cyst and were misdiagnosed as neoplastic on the basis of low ADC value.

On MR imaging, most of the benign lymph nodes were homogenous, oval in shape with regular margins and had a short axis diameter of <1cm, on the other hand malignant lymph nodes were heterogeneous, round to oval in shape with irregular margins and had short axis diameter of >1cm. Calcification, cystic/necrotic area, hemorrhage were also present. Based on MRI morphology 20% lymph nodes appeared malignant while 80% appeared benign. We found that malignant lesions were mostly unilateral (21.67%), ill-defined with spiculated and lobulated margins (11.67%), appeard taller than wider (11.67%), showed microcalcification (5%) and hemorrhage (21.67%) with absent pseudocapsule (21.33%). These lesions appeared iso to hyperintense on T1WI, hyperintense on T2WI and showed diffusion restriction. The mean ADC value of malignant lesions in our study [1.2 ± 0.2 x 10-3 mm2/s] was significantly lower than benign lesions [2.0 ± 0.32 x 10-3 mm2/s].

Malignant lesions of the thyroid constituted 23.3% of cases in our study which were diagnosed by morphological characteristics of lesions and low ADC values (<1.5 x 10-3 mm2/sec). Papillary carcinoma was the most common malignant lesion seen in our study constituting 53.3% cases.

We tried to subtype malignant lesions on the basis of morphological characteristics (e.g presence of calcification, lymph node enlargement, pseudocapsule) and found 21% cases of papillary carcinoma, 7% case of anaplastic carcinoma, 7% case of medullary carcinoma. These diagnoses were later confirmed on histopathological follow up. However, subtyping on the basis of ADC values was not possible because all the malignant lesions were showing low ADC values. Therefore 64.3% malignant lesions were uncharacterised on the basis of both morphological and ADC values.

On retrospective analysis, out of nine cases of papillary carcinoma, five appeared ill-defined with spiculated and lobulated margins. Two cases were misdiagnosed as adenoma on the basis of MRI morphology because those lesions had well defined margins, wider than taller shape. However, when DWI and ADC value were considered, low ADC values were found in these cases and diagnosis of malignant lesion was made. One case of papillary carcinoma was misdiagnosed as benign hyperplastic nodule on MRI with DWI and ADC because it appeared well defined, wider than taller, no calcification, and had high ADC value. Follicular carcinoma appeared well defined to ill-defined. Out of these two cases of follicular carcinoma, one was misdiagnosed as adenoma based on MRI morphology, however this error was eliminated when MRI morphology was considered along with ADC value. Lymphoma appeared ill-defined, lobulated with metastatic cervical lymph nodes. Metastasis from renal neoplasm appeared well defined with low ADC value.

Considering the morphological characteristics of T1W and T2W images with DWI and ADC value, the sensitivity, specificity, PPV and NPV of non-contrast MRI was 93.3%, 100%, 100% and 97.8% respectively. In conjunction with conventional sequences and with added new sequences like DWI, MRI may provide qualitative and quantitative information which helps in confident and accurate diagnosis of thyroid nodules.

Conclusion

We conclude that USG remains the first imaging modality to detect a thyroid nodule, however non-contrast MRI has emerged as a new promising non-invasive imaging approach for characterization of thyroid nodule. Conventional MRI with DWI and ADC values reliably differentiate benign and malignant thyroid nodule, however, it doesn't not help in subtyping of malignant lesions but it can evaluate extension and invasion of adjacent structure, detect metastatic lymph nodes and help in preoperative staging thus aid in early diagnosis of lesions and thereby reducing the morbidity and mortality and provide good preoperative assessment of lesions for better surgical planning and management.

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