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Evaluation of Mediastinal Lymphadenopathy with Diffusion Weighted MRI

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ABSTRACT

Background: Staging and prognosis of malignant lymph nodes, as well as treatment planning, depend on the identification of mediastinal lymphadenopathy. MR images are used to distinguish between benign and malignant lymph nodes, including those of the mediastinum. Since many solid malignant and benign lesions on computed tomography (CT) appear remarkably similar, MRI provides a noninvasive way to further characterize mediastinal lesions. MRI has a greater contrast for soft tissues than CT.

Objective: The present study aimed to evaluate MRI diffusion's sensitivity and specificity for differentiating between benign and malignant lesions. Determine the mean ADC for malignant mediastinal lesions especially those with mediastinal lymphadenopathy.

Patients and methods: A descriptive study included 36 patients with mediastinal lymph nodes. Patients were referred from Chest, Oncology and Cardiothoracic departments in Assiut University Hospitals for MRI assessment after being initially diagnosed by CT. The study was conducted at the Radiology Department at Assiut University Hospitals, in the period between August 2019 and April 2020.

Results: ADC had 94% sensitivity and 88% specificity for diagnosing malignant mediastinal lymph nodes with overall accuracy of 92%, and area under receiver operating characteristic (ROC) curve was 0.92.

Conclusion: Non-invasive diffusion-weighted MRI is highly sensitive and specific in distinction between malignant and benign mediastinal enlargement of lymph nodes. This also offers important data for grading mediastinal cancer.

Keywords: Mediastinal lymphadenopathy, Diffusion Weighted MR, mediastinal malignancy.

INTRODUCTION

Mediastinal lymph nodes have a wide range of histological and radiological characteristics [(1)]. Despite the fact that some tumours, including thyroid masses and cysts, together with many solid malignant and benign lesions have highly accurate imaging clues on computed tomography (CT) [(2)].

Accurate mass identification is required to deliver the right care. The mediastinum's most used imaging method is CT; it cannot accurately distinguish between benign and malignant tumours in this area. On the other hand, as MRI can capture superb soft tissue detail, it offers useful diagnostic information when evaluating the mediastinum [(3)]. Standard MR imaging can also offer precise anatomic details regarding the position, margin, and contour of mediastinal masses [(4)]. In addition, specialised applications that reveal subtle metabolic and biophysical variations between tissues have been created in recent years. One of these techniques, diffusion-weighted magnetic resonance imaging (DWI), focuses on the translational mobility of water molecules to provide insight on the target tissue's microstructural features and show whether they promote or restrict such flexibility in proton transit [(5)]. DWI establishes the inner cellular density and water flow. Higher cellular density tissues have more intact cell membranes, which limits how much water can diffuse through them [(6)].

Quick imaging methods like echo-planar imaging (EPI) make it simpler to use DWI in thoracic imaging by minimising the negative effects of motion [(7)].

There aren't many studies that use DWI for mediastinal pathology. Mediastinal masses, including thymoma, teratoma, thyroid disease, and lymphoma, make up 50% of anterior mediastinal tumours. Congenital cysts are often found in the middle mediastinum while neurogenic tumours are frequently found in the posterior mediastinum [(8)].

Malignant lymphoma accounts for nearly 20% of all mediastinum neoplasms in adults and 50% in children. Notably, mediastinal involvement is seen in 80% HL and up to 45% NHLs [(9)].

Lymphadenopathy is an important discovery in inflammatory, infectious, and malignant illnesses [(10)]. Common causes of mediastinal lymphadenopathy include fungus infections, lymphoma, sarcoidosis, tuberculosis, and a number of other diseases [(11)].

PATIENTS AND METHODS

A descriptive study included 36 patients with mediastinal lymph nodes. Patients were referred from Chest, Oncology and Cardiothoracic departments in Assiut University Hospitals for MRI assessment after being initially diagnosed by CT.

The study was conducted at the Radiology Department at Assiut University Hospitals, in the period between August 2019 and April 2020.

Inclusion criteria: Patients who underwent CT imaging and had mediastinal lymphadenopathy.

Exclusion criteria:

If there are any general MRI restrictions for the patient (pacemakers, cochlear implants, cerebral aneurysm clips, ocular metallic foreign bodies, claustrophobia, bullets or shrapnel near great vessels or vital organs). The mass is purely cystic in type. Previous tthoracic surgery. Severely ill patients.

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Patient preparation: Psychological preparation of patient, the use of sedation if required and confirmation of absence of any paramagnetic material with the patient.

MRI scan protocol: The majority of MR exams were performed using Philips Healthcare's Sense Xl Torso 16-channel phased array torso coil and Philips Medical Systems' Achieva 1.5T equipment. All patients underwent normal MRI thorax procedures, including respiratory triggering and ECG gating. To create ADC maps, the MR system performed a linear regression analysis using all three b values on the natural log of signal intensity.The statistical significance of the variation in measurements will be assessed using the student T-test. The process will be carried out three times, and a final mean ADC value will be calculated from the average of these measurements. The results of MRI diffusion were compared to histopathological assessment (the gold standard investigation) to determine its sensitivity and specificity and to determine the mean ADC for malignant lymph nodes.

Images analysis:

For analysis and post-processing, all of the acquired MR images were uploaded to a computer workstation (Extended WorkSpace 2.6.3.3, Nederland B.V. Best, Netherlands). The varied pulse sequences in MR images were evaluated visually for quality, and the ADC values of the mediastinal lesions were measured for quantitative evaluation.

Qualitative assessment:

In comparison to the muscle signal detected following the same pulse pattern on the T1, T2, and STIR WI, the lymph nodes' positions (anterior, middle, and posterior mediastinum), morphological details like form and edge, as well as, their dimensions and connections to neighboring structures, were documented. Signal strength on the matching ADC map and high b value (b = 1000 s/mm2) DWI, features on MR imaging that are related, such as pleural effusion.

Quantitative assessment:

To obtain the ADC values, a ROI (region of interest) inside the lesion was traced on the trace ADC maps. The visual regions that were believed to be the most limited received ROIs, with the exception of areas that were clearly cystic or necrotic. Three ROIs on the cranial, middle, and caudal parts of the lesion were set, and average mean and minimum ADC values (ADC mean and ADC min) were acquired to prevent picture selection bias.

Ethical Consideration:

This study was ethically approved by the Institutional Review Board of the Faculty of Medicine, Assiut University. Written informed consent was obtained from all participants. This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

Statistical Analysis

The collected data were introduced and statistically analyzed using SPSS (Statistical Package for the Social Science, version 20, IBM, and Armonk, New York). Qualitative data were defined as numbers and percentages. Chi-Square test and Fisher's exact test were used to compare the nominal data between patients with benign lymph nodes and those with malignant lymph nodes. Quantitative data were tested for normality by Kolmogorov-Smirnov test. Normal distribution of variables was described as mean and standard deviation (SD) or median (range), and independent sample t-test was used for comparison between groups. The accuracy of the ADC's diagnosis of malignant mediastinal lymphadenopathy was assessed using the receiver operating characteristic curve. P value ≤0.05 was considered to be statistically significant.

RESULTS

Table 1 summarizes the demographic data of the studied patients.

Table 1: Baseline data of enrolled patients.

Variable	N= 36
Age (years) Range	46.87 ± 17.42 16-76
Sex Male Female	 20 (55.6%) 16 (44.4%)

The most frequent presentations were dyspnea (44.4%) and fatigue (19.4%). Only 9 (25%) patients were asymptomatic (**Table 2**).

Table 2: Presentation of enrolled patients.

Variable	**N= 36**
Asymptomatic	9 (25%)
Dyspnea	16 (44.4%)
Fatigue	7 (19.4%)
Cough	2 (5.6%)
Fever	2 (5.6%)

Up to 28 (77.8%) patients had malignant lesions based on histopathological evaluation of the studied patients with enlarged mediastinal lymph nodes. **Table 3** summarizes the histopathology of the lesions of the studied patients.

Table 3: Histopathology and nature of the lesions among enrolled patients.

Lesions	N= 36	
Nature of the lesion		
Benign lesion	8 (22.2%)	
Malignant lesion	28 (77.8%)	
Histopathology	No and %	Mean ADC values (mm^2/second)
Non-hodgkin lymphoma	12 (33.3%)	$0.975 \pm 0.116 \times 10^{-3}$
Hodgkin lymphoma	8 (22.2%)	$0.845 \pm 0.125 \times 10^{-3}$
Metastatic lesions	8 (22.2%)	
-Mets from cancer thyroid	3 (8.3 %)	1.2×10^{-3}
-Adenocarcinoma of bronchus	5 (13.9%)	0.887×10^{-3}
Inflammatory nodules	4 (11.1%)	1.6×10^{-3}
Abscess	2 (5.6 %)	1.5×10^{-3}
Retrosternal goiter	2 (5.6%)	$1.68 \pm 0.458 \times 10^{-3}$

Up to 28 cases showed restricted diffusion, which represented 77.8%, whereas 8 cases showed facilitated diffusion, which represented 22.2% (**Table 4**).

Table 4: Charactesitics of the studied mediastinal lymph nodes.

Variable	N= 36
Homogenous	20 (55.6%)
Amalgamated	10 (27.8%)
Necrotic	4 (11.1%)
Punctate	2 (5.6%)

All patients with benign lesions had facilitated DWI, while those patients with malignant lesions had restricted DWI (**Table 5**).

Table 5: DWI based on nature of lesion.

Variable	Benign lesion (n=8)	Malignant lesion (n=28)	*P* value
DWI			
Facilitated	8 (100%)	0	<0.001
Restricted	0	28 (100%)	

ADC had 94% sensitivity and 88% specificity for diagnosing malignant mediastinal masses.

DISCUSSION

To detect DWI in a transverse plane, three b values—50 s/mm2, 400 s/mm^2, and 800 s/mm^2—were applied. The bulk of these techniques, according to **Daye et *al.*** are most successful when they decrease motion artefacts and SNR (signal to noise ratio), as well as when they increase field of view, slice thickness, decrease ROI, and use surface coil [(12)]. We suggest that using ADC measures on DWI may help with non-invasive mediastinal tumour classification. Our literature search revealed that there haven't been many attempts to use DWI for this purpose [(13)].

As it was additionally demonstrated that threatening mediastinal sores had lower mean ADC values than harmless ones, ADC esteem is a promising painless imaging procedure that guides in assessing and describing mediastinal tumours [(14)]. We proposed more exploration. This planned review's primary objective was to work on harmless strategies for recognizing patients with mediastinal lymphadenopathy by further assessing DW-limit X-ray's to characterize threatening mediastinal sores utilizing their ADC values. In our review, 36 patients of either sex participated.

The enlisted patients were in age from 16 to 76, with a mean period of 46.87 (SD 17.42) years. The conclusive determination for mediastinal malignancies was made by biopsy and histological investigation [(15)]. For most of patients, a CT-directed Tru cut biopsy was utilized, though for different patients, a U/S directed biopsy was utilized, bronchoscopy, mediastinoscopy, or thoracotomy. The most incessant introductions were dyspnoea (44.4%) and weariness (19.4%).

Hack was available in 2 (5.6%) patients. Two (5.6%) patients had fever. These side effects relied upon the mass' area and were welcomed on by the mass impact of mediastinal sores. Nine (25%) of the patients in the review showed no side effects, which is in concurrence with a concentrate by **Arif *et al.*** [(10)], distributed in the diary. The mediastinum is minuscule, and there are regularly indications of pressure or direct attack of other physical tissues (hack, dyspnoea, dryness, dysphagia or predominant vena cava impediment disorder).

In our study there were 75% of patients presented with symptoms and 25% were asymptomatic and this is closely agreeing with **Akshatha *et al.*** [(16)] who authored because the mediastinum is a small area, any bulk that emerges from it will squeeze the other structures, creating situations that could be fatal. Sixty percent of individuals have symptoms when they first arrive. The presentation might range from mild, accidentally discovered lesions on imaging to severe, life-threatening presentations. **Akshatha *et al.*** [(17)] Lymphoma was the most prevalent malignant tumour (50%) in his study, and this is consistent with our study's findings that 28 (77.8%) patients had malignant lesions whereas 8 (22.2%) patients had benign lesions. The majority of the mediastinal masses were malignant lesions [(2)].

The most frequent diagnosis was non-Hodgkin lymphoma followed by Hodgkin lymphoma, so the lymphoma was the commonest malignant tumor in our study (55.6%).

Up to 28 (77.8%) patients had malignant lesions while 8 (22.2%) patients had benign lesions based on histopathological evaluation whole of them with enlarged mediastinal lymph nodes. The most frequent diagnosis was non-Hodgkin lymphoma (33.3%) [mean ADC 0.975±0.116 $x10^{-3}mm^2$/sec] followed by Hodgkin lymphoma (22.2%) [mean ADC 0.845±0.125 $x10^{-3}mm^2$/sec] and retrosternal goiter (5.6%) [mean ADC 1.68 ±0.458 $x10^{-3}$ mm^2/sec] and another eight patients had metastatic lesions three patients with meets from cancer thyroid [mean ADC value about1.2 $x10^{-3}mm^2$/sec] and 5 cases of adenocarcinoma of bronchus [mean ADC value 0.887 $x10^{-3}mm^2$/sec], 4 with inflammatory nodules [mean ADC value about 1.6 $x10^{-3}$ mm^2/sec] and finally 2 cases with abscesses [mean ADC value about 1.5 $x10^{-3}mm^2$/sec]. In our study, the most common mediastinal mass was lymphoma, a finding that agrees with **Thacker *et al.*** [16].

Up to 28 cases showed restricted diffusion, which represented 77.8 %, whereas 8 cases showed facilitated diffusion, which represented 22.2%.

Most of histopathological subtypes of lesions were evaluated separately in terms of patient demographics and MR imaging findings.

Out of the selected patients, 2 (5.6%) had punctate calcification. When assessing a sore quantitatively, In light of the fact that it wouldn't misjudge cancer cellularity in that frame of mind of a generally necrotic growth and hypothetically distinguishes the area of most noteworthy growth cellularity, a few creators suggested using least ADC as opposed to mean ADC [18]. An assortment of harmless and threatening lymph hubs is found in the mediastinum, characterization of these mediastinal lymph hubs has significant restorative and prognostic importance. The presence of nodal metastases limits helpful choices and furthermore shows more regrettable anticipation [19].

CONCLUSION

Non-invasive diffusion-weighted MRI is highly sensitive and specific in distinction between malignant and benign mediastinal enlargement of lymph nodes. This also offers important data for grading mediastinal cancer.

REFERENCES

1. **Haruki T (2015):** Mediastinal nodal involvement in patients with clinical stage I non–small-cell lung cancer: possibility of rational lymph node dissection. Journal of Thoracic Oncology, 10(6):930-6.
2. **Carter W (2017):** ITMIG classification of mediastinal compartments and multidisciplinary approach to mediastinal masses. Radiographics, 37(2):413-36.
3. **Madan R (2018):** Cystic mediastinal masses and the role of MRI. Clinical Imaging, 50:68-77.
4. **Campos, J. H. & Sharma A (2022):** Radiology of the Thorax. Cohen's Comprehensive Thoracic Anesthesia. In Cohen, E. (Ed.) (1st Edition), Chapter 3: pp. 33-51. DOI: 10.1016/B978-0-323-71301-6.00003-2.
5. **Saba L, Jasjit S (2019):** Neurological Disorders and Imaging Physics, Volume 1: Application of multiple sclerosis. https://iopscience.iop.org/book/edit/978-0-7503-1759-7
6. **Maxfield M (2018):** Diffusion Magnetic Resonance Imaging. https://www.elsevier.com/books/duke-review-of-mri-physics-case-review-series/978-0-323-53038-5.
7. **Lei O (2021):** Values of Apparent Diffusion Coefficient and Lesion-to-Spinal Cord Signal Intensity in Diagnosing Solitary Pulmonary Lesions: Turbo Spin-Echo versus Echo-Planar Imaging Diffusion-Weighted Imaging. BioMed Research International. 12021:3345953. doi: 10.1155/2021/3345953.
8. **Choi J, Jae Y (2021):** Mesenchymal Tumors of the Mediastinum: An Update on Diagnostic Approach. Advances in Anatomic Pathology, 28(5):351-81.
9. **Trebeschi S, Bodalal Z, Boellaard T *et al.* (2021):** Prognostic Value of Deep Learning-Mediated Treatment Monitoring in Lung Cancer Patients Receiving Immunotherapy. Front Oncol.,2;11:609054. doi: 10.3389/fonc.2021.609054.
10. **Arif S, Jensen V (2020):** Mediastinal masses: A Systematic Approach to Differential Diagnosis. https://dx.doi.org/10.26044/ecr2020/C-00575
11. **Iyer H (2021):** Mediastinal lymphadenopathy: a practical approach. Expert Review of Respiratory Medicine, 15(10):1317-34.
12. **Daye D, Ackman J (2017):** Characterization of mediastinal masses by MRI: techniques and applications. Appl Radiol., 46:10-22.
13. **Usuda K (2015):** Diffusion weighted imaging can distinguish benign from malignant mediastinal tumors and mass lesions: Comparison with positron emission tomography. Asian Pacific Journal of Cancer Prevention, 16(15):6469-75.
14. **Broncano J (2019):** Role of advanced magnetic resonance imaging in the assessment of malignancies of the mediastinum. World Journal of Radiology, 11(3):27.
15. **Malik R (2019):** Anterior mediastinal masses—A multidisciplinary pathway for safe diagnostic procedures. Journal of Pediatric Surgery, 54(2):251-4.
16. **Akshatha R, Seshadri S, Teerthanath S *et al.* (2014):** A study of clinical characteristicsof mediastinal mass. J Clin diagnostic Res., 8(2):77.
17. **Aroor A (2014):** A study of clinical characteristics of mediastinal mass. Journal of Clinical and Diagnostic Research, 8(2):77.
18. **Ferjaoui R (2021):** Machine learning for evolutive lymphoma and residual masses recognition in whole body diffusion weighted magnetic resonance images. Computer Methods and Programs in Biomedicine, 209:106320.
19. **Razek A, Abdel K (2011):** Characterization of mediastinal lymphadenopathy with diffusion-weighted imaging. Magnetic Resonance Imaging, 29(2):167-72.