

# **ROLE OF MRI DIFFUSION IN MEDIASTINAL MASSES**

*Essay*

*Submitted for partial fulfillment of  
Master Degree of Radiodiagnosis*

**By:**

***Mahmoud Sayed Abou Bakr***

*M.B.B.Ch*

*Faculty of Medicine*

*Ain Shams University*

***Supervised by***

**Prof. Dr. Mohamed El Gharib Abo El Maaty**

*Professor of Radiodiagnosis*

*Ain Shams University*

**Dr. Mohamed Gamal El Din Abdel Mutaleb**

*Lecturer of Radiodiagnosis*

*Ain Shams University*



# [وَقُلْ رَبِّ زِدْنِي عِلْمًا]

سورة طه الآية رقم 114



## **Acknowledgement**

*First of all, all gratitude is due to **God** almighty for blessing this work, until it has reached its end, as a part of his generous help, throughout my life.*

*Really I can hardly find the words to express my gratitude to **Prof. Dr. Mohamed El Gharib Abo El Maaty** Professor of Radiodiagnosis, faculty of medicine, Ain Shams University, for his supervision, continuous help, encouragement throughout this work and tremendous effort he has done in the meticulous revision of the whole work. It is a great honor to work under his guidance and supervision.*

*Really I can hardly find the words to express my gratitude to **Dr. Mohamed Gamal El Din Abdel Mutaleb** Lecturer of Radiodiagnosis, Faculty of Medicine, Ain Shams University for his continuous directions and meticulous revision throughout the whole work. I really appreciate their patience and support.*

*Last but not least, I dedicate this work to my family, whom without their sincere emotional support, pushing me forward this work would not have ever been completed.*



**Mahmoud Sayed Abou Bakr**

# Contents

List of Abbreviations .....	i
List of Tables .....	ii
List of Figures .....	iii
<b>Introduction</b> .....	1
<b>Aim of the Work</b> .....	4
<b>Chapter 1:</b>	
Anatomy of Mediastinum .....	5
<b>Chapter 2:</b>	
Mediastinal mass lesions.....	23
<b>Chapter 3</b>	
Diagnostic approach to mediastinal masses.....	40
<b>Chapter 4</b>	
MR diffusion imaging in mediastinal mass lesions.	64
<b>Summary</b> .....	94
<b>References</b> .....	97
<b>Arabic Summary</b> .....	--

---

## List of Abbreviations

---

ADC	:	Apparent diffusion coefficient
CT	:	Computed tomography
DWI	:	Diffusion weighted imaging
DWI	:	Diffusion-weighted magnetic resonance imaging
DW-MRI	:	Diffusion weighted-magnetic resonance imaging
HD	:	Hodgkin disease
IASLC	:	Study of Lung Cancer
IVC	:	Inferior vena cava
NHD	:	Non-Hodgkin disease
NSCLC	:	Non small cell lung cancer
PET/CT	:	Positron emission tomography/computed tomography
SCLC	:	Small cell lung cancer
SVC	:	Superior vena cava

## List of tables

<i>Table</i>	<i>Title</i>	<i>Page</i>
1	Nodal Stations and Zones in the IASLC Lymph Node Map	19
2	Showing anatomical compartmentalization of mediastinal mass lesions	24
3	Illustrates the TNM staging system for lung cancer	14

## List of Figures

<b><i>Fig.</i></b>	<b><i>Title</i></b>	<b><i>Page</i></b>
1	Felson's mediastinal compartments (lateral radiograph)	6
2	Heitzman's mediastinal compartments	7
3	Drawing illustrates the middle mediastinum (outlined in black)	9
4	Drawing illustrates the posterior mediastinum (outlined in black)	11
5	Illustration shows the IASLC lymph node map	18
6	(a, b, c and d) axial MRI images for demonstration of structures of mediastinum	21
7	(a) coronal (b) sagittal MRI images for demonstration of structures of mediastinum	22
8	Mediastinal goiter	25
9	Heterotopic mediastinal goiter	26
10	Thymic lymphoid hyperplasia in a 41-year-old woman with clinical diagnosis of myasthenia gravis	28
11	Thymic hyperplasia in a 43-year-old woman ( <i>arrows</i> )	29
12	Axial	32
13	Chest imaging shows heterogeneous contents of mediastinal teratomas	34
14	Nodular sclerosis Hodgkin lymphoma in a 44-year-old woman	36
15	Axial T1-weighted MR image of a 16-year-old man with a solid, large mass ( <i>arrows</i> ) in the anterior and superior mediastinum	38

## List of Figures (Cont.)

<b><i>Fig.</i></b>	<b><i>Title</i></b>	<b><i>Page</i></b>
16	Axial non contrast CT scan that shows bilateral subcarinal and hilar enlarged lymph nodes in a case of sarcoidosis	40
17	Computer tomography in the axial	46
18	Duplication cyst in a 42-year-old	47
19	MR scan demonstrating pericardial cyst presenting as a large cystic mass in right anterior hemithorax	49
20	Lymphadenopathy	50
21	AP window lymphadenopathy	51
22	Paraspinal abscess	51
23	Paraspinal abscess	51
24	Descending thoracic aortic aneurysm	52
25	Enhanced CT scan of the chest shows large, septated anterior mediastinal mass containing fat, calcification and bony elements (teratoma)	53
26	Contrast-enhanced CT scan reveals a thin-walled water-attenuation lesion (*) in the right cardiophrenic angle (pericardial cyst)	54
27	Contrast-enhanced CT scan reveals a middle Mediastinal Mass (right atrial myxoma)	55
28	PET (a) and PET/CT (b) images showing 9.0-mm metastatic lymph nodes in left paraaortic area ( <i>straight arrows</i> and <i>arrowheads</i> ) in 70-year-old man with stage T2 adenocarcinoma in left upper lobe ( <i>curved arrows</i> )	60



### List of Figures (Cont.)

<b><i>Fig.</i></b>	<b><i>Title</i></b>	<b><i>Page</i></b>
29	14-year-old girl with lymphoma showing multiple enlarged mediastinal and right cervical lymph nodes are noted on CT (left) , with increased uptake on coronal F18-FDG PET (middle) and F18-FDG PET/CT fusion image (right)	61
30	Depiction of the diffusion of water molecules in intracellular spaces (bluearrows), across cell membranes (red arrows), and extracellular spaces (green arrows). The majority of water diffusion takes place in the extracellular space and, consequently, determines the overall diffusion signal	64
31	The inverse relationship of the speed of diffusion to the number of cells	66
32	A-B: Diagram showing measuring water diffusion according to Stejskal and Tanner 1965 experiment	68
33	Visual lesion characterization with DWI	71
34	Thymic non-Hodgkin lymphoma, a 71-year-old man with anterior mediastinal mass	75
35	MR and PET/CT images of a 39-year-old woman with lung adenocarcinoma	79

### List of Figures (Cont.)

<b><i>Fig.</i></b>	<b><i>Title</i></b>	<b><i>Page</i></b>
36	(1) Sagittal T2-weighted image shows extensive collapse of left lung without clear definition of central bronchogenic carcinoma borders. Note the presence of apical loculated pleural effusion (arrow). (2) Sagittal DWI using a $b$ value of 1,000 s/mm <sup>2</sup> at the same level shows a central area of restricted diffusion corresponding to bronchogenic carcinoma. (3) Fusion imaging of T2-weighted and DWI allows better differentiation of the tumor borders (asterisk) from post-obstructive pneumonitis	80
37	(a) Axial CT scan showing a 7 mm lymph node in the subcarinal position (arrow), with no sign of metastatic spread. (b) Axial T1 weighted fat saturation image showing enhancement of the lymph node, suggesting metastatic disease. (c) Diffusion-weighted imaging reported a high-signal lymph node that suggested metastatic spread. Biopsy confirmed a small cell lung cancer metastasis	83

## List of Figures (Cont.)

<b>Fig.</b>	<b>Title</b>	<b>Page</b>
38	(a) Axial balanced TFE shows a large right mediastinal mass ( <i>asterisk</i> ) with hilar and prevascular lymph nodes ( <i>arrows</i> ). (b, c ) DWI with a <i>b</i> value of 800 s/ mm <sup>2</sup> and ADC map show severe restriction of diffusion within the mass (asterisk). Note the hyper intensity on DWI of thoracic vertebral body, ribs, and scapula in relation to bone metastasis (arrows). (d) DWI with a <i>b</i> value of 800 s/mm <sup>2</sup> demonstrates several focal liver lesions with restricted diffusion corresponding to metastasis	85
39	(a) Transverse black blood TSE T2-weighted image shows a large right pleural effusion with secondary lung collapse. (b) DWI with a <i>b</i> value of 800 s/mm <sup>2</sup> shows how most of the pleural effusion is not visible, except a hyperintense area in the posterior aspect of right hemithorax ( <i>open arrow</i> ) and a hyperintense nodule in the anterior right pleura ( <i>arrowhead</i> ), which corresponds to a pleural metastasis. (c) Areas of restricted diffusion ( <i>open arrow</i> )are identified within the effusion with ADC values between $2.9 \times 10^{-3}$ mm <sup>2</sup> /s and $3.1 \times 10^{-3}$ mm <sup>2</sup> /s, which suggest malignant effusion. Thoracentesis and cytology proved adenocarcinoma cells	87

### List of Figures (Cont.)

<b><i>Fig.</i></b>	<b><i>Title</i></b>	<b><i>Page</i></b>
40	Diffusion-weighted images with b values of 50 and 800 s/ mm <sup>2</sup> and their corresponding (ADC) map in a 22-year-old patient with Hodgkin lymphoma showing anterior mediastinal (arrow head), right hilar and subcarinal (open arrow) lymph nodes with restricted diffusion and low signal on ADC map, The subcarinal mass is more conspicuous on b800 image	91
41	Hodgkin disease, a 61-year-old man with multiple hilar and mediastinal lymphadenopathies	92
42	Non necrotic lymph nodes in a 40-year-old woman with sarcoidosis, ADC map showing that the lymph nodes at the upper para-tracheal and para-aortic exhibit high signal intensity (arrow). ADC value =1.560x10 <sup>-3</sup> mm <sup>2</sup> /s	93

---

## Introduction

MRI of the chest using fast acquisition sequences with a high temporal resolution has become feasible with the recent developments in gradient technology and multichannel coils. Experience with thoracic applications of diffusion weighted imaging (DWI) techniques is still growing, and preliminary studies have reported promising results (*Biederer et al., 2012*).

DWI involves the acquisition of a magnetic resonance signal related to random thermal motion (Brownian motion) or the “diffusion” of water protons in tissue (*Türkbey et al., 2012*).

Diffusion weighted-magnetic resonance imaging (DW-MRI) of the abdomen and thoracic cavity has become possible with fast imaging time that minimizes the effect of gross physiological motion from respiration and cardiac movement. There is growing interest in the application of diffusion weighted imaging (DWI) in the evaluation of patients with cancer (*Nasr et al., 2016*).

Diffusion-weighted imaging may be useful beside other modalities in differentiating lymphoma from sarcoidosis in mediastinal and hilar lymphadenopathy. The ADC value in the lymphoma group was lower than in the sarcoidosis group (*Gümüştalı et al., 2013*).

DWI is also recently used to characterize lung lesions, to predict tumor invasiveness in early-stage lung cancer, to detect tumors in collapsed lungs, and for nodal staging of lung cancer (*Türkbeğ et al., 2012*).

MRI can detect and stage lung cancer, and this method could be an excellent alternative to CT or PET/CT in the investigation of lung malignancies and other diseases (*Hochhegger et al., 2011*).

Recent studies concluded that lung cancers were easily visualized by DWI, and that differentiating central lung cancer from post-obstructive lobar collapse by DWI is feasible. Quantitative analysis of DWI also enables differentiation of lymph nodes with and without metastasis (*Nakayama et al., 2010*).

Potential future applications of DWI in malignancies include monitoring the treatment response after

chemotherapy or radiation, discriminating post-therapeutic changes from residual tumors, and detecting recurrent cancer (*Türkbey et al., 2012*).

MRI is emerging as a valuable lung imaging modality, together with x-ray and CT. It offers a unique combination of morphological and functional information in a single examination without any radiation burden to the patient. (*Biederer et al., 2012*).

Differentiation of malignant mediastinal tumors from benign lesions is essential for treatment planning as well as for prediction of prognosis (*Nasr et al., 2016*).