

PICTORIAL ESSAY

Abdominal Imaging

Role of Diffusion Weighted MRI in Characterization of Abdomino-Pelvic Lymphadenopathy

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ABSTRACT

Background: Abdomino-pelvic lymphadenopathies, are classified either benign or malignant. The benign lymphadenopathies include infection and inflammation while the malignant group consists of two subtypes, primary as lymphoma and secondary as metastatic.

Aim of the Work: The aim of the study was to determine if diffusion weighted magnetic resonance imaging could help in discrimination between benign and malignant abdomino-pelvic lymph nodes.

Patients and Methods: Twenty-four patients with pelvi-abdominal lymphadenopathies were included in this study.

The study was performed in Ain Shams university hospital, Air forces specialized hospital & Cairo specialized Hospital – Cleopatra Hospital Group (CHG) between December 2020 and June 2023 . Full clinical history of all patients was taken and their laboratory Investigations, Histopathological data and previous imaging were reviewed.



KEY WORDS

Diffusion Weighted MRI, Abdomino-Pelvic Lymphadenopathy



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All patients underwent conventional MR imaging using a 1.5T machine (Achieva and Ingenia, Philips medical system, Eindhoven, Netherlands) using a phased array coil, for characterization and detection of the lymph nodes, including ; Axial T1 WI, Axial T2 WI, Axial T2 SPAIR fat suppression, diffusion and ADC map sequences.

Results: We found a significant difference between ADC values of benign and malignant abdomino-pelvic lymph nodes, with a threshold ADC value equal to $1.1 \times 10^{-3} \text{ mm}^2/\text{sec}$. identified. This value could be used in the pre-treatment phase for better oncologic staging and assessment.

The higher accuracy of DWI using high b Values ($500 \& 1000 \text{ sec/mm}^2$), as compared with conventional MR imaging, was most beneficial in the detection of not only the enlarged but also the sub-centimetric metastatic lymph nodes.

These findings suggest that DWI can be complementary to conventional MRI hence the related size and morphologic criteria lack sufficient reliability for better detection and characterization of nodal metastasis. A significant difference between the ADC value of lymphoma and metastatic lymph nodes was also detected in our study, with a threshold equal to $0.78 \times 10^{-3} \text{ mm}^2/\text{sec}$ identified.

Conclusion: DWI can be a considered supportive tool in differentiation between benign and malignant lymph nodes and can to a lesser extent differentiate between the types of malignant lymphadenopathies.

Introduction

Lymphadenopathy means abnormal increase in size and/or altered consistency of the lymph nodes. It is important to differentiate benign from malignant lymph nodes (Abou Youssef et al., 2019).

The evaluation of lymphadenopathy is important as they serve as an excellent clue to underlying problems. They could be due to infections, autoimmune disorders or malignancies (whether metastatic or lymphomas) (Ghieda & Badr, 2020).

Assessment of lymphadenopathy remains one of the most challenging and often unsatisfactory issues for radiologists. Characterizing lymphadenopathy as benign or malignant using cross sectional imaging is currently limited and a biopsy is often needed to obtain a definitive diagnosis (Bure et al., 2017).

CT and MRI, with cross sectional imaging, use morphological characteristics for the nodal staging, such as size and shape (oval or round) of the node. The criteria used as indicators of metastatic node are a diameter, in short axis, $>1 \text{ cm}$ for oval nodes and $>0.8 \text{ cm}$ for round nodes. With such criteria, a meta-analysis was done and confirmed the limited value of morphological exams in lymph node staging (Muteganya et al., 2018).

Biopsy & Histopathology of the lymph node is accepted as the gold standard for accurate diagnosis of these neoplasms. But this is invasive procedures not only increases the patient's pain but also is costly, time consuming and has complications (Elhamdoust et al., 2020).

18-F fluorodeoxyglucose (FDG) positron emission tomography/computed tomography (PET/CT) is widely used for initial tumour staging, evaluation of treatment response, and detection of tumour recurrence. Consequently, the number of PET/CT detected suspicious lymph nodes is increasing, particularly in the neck. However, benign lymphadenopathy may also reveal hypermetabolism mimicking metastasis because PET/CT provides information about tissue glucose metabolism (Yoon et al., 2020).

MRI is an ideal tool to evaluate lymph nodes due to its excellent soft tissue contrast. Diffusion weighted imaging (DWI) is a method of signal contrast generation based on the differences in Brownian motion. DWI is a method to evaluate the molecular function and micro-architecture of the human body. DWI signal contrast can be quantified by apparent diffusion coefficient maps and it acts as a tool for treatment response evaluation and assessment of disease progression (Baliyan et al., 2016).

Mean ADC for malignant lesions could be lower than that for benign entities. DW-MRI could improve the diagnostic accuracy in differentiation between benign and malignant lymph nodes (Abou Youssef et al., 2019).

Aim of the Work

The aim of the study was to determine if diffusion weighted magnetic resonance imaging could help in discrimination between benign and malignant abdomino-pelvic lymph nodes. In this study, we reviewed the ADC values of lymph nodes visualized on abdomen-pelvic MRI images and correlate their values with lymph nodes morphological pattern, PET/CT and / or histopathology results.

Patients and Methods

Patients: Twenty-two patients with pelvi-abdominal lymphadenopathies were included in this study. The study was performed in Ain Shams university hospital, Air forces specialized hospital & Cairo specialized Hospital – CHG between December 2020 and June 2023. Full clinical history of all patients was taken and their laboratory Investigations, Histopathological data and previous imaging were reviewed.

Methodology: All patients underwent conventional MR imaging using a 1.5&3T machine (Achieva and Ingenia, Philips medical system, Eindhoven, Netherlands) using a phased array coil, for characterization and detection of the lymph nodes, including: **axial T1 WI:** TR= 10 msec, TE=4.58 msec. Matrix 179/320. Slice thickness 7-8 mm. slice gap 1-2 mm & FOV: 355 mm, **axial T2 WI:** TR > 445 msec, TE= 26-28 msec. Matrix 180-200x240. Slice thickness 7-8 mm. Slice gap 1-2 mm & FOV 365, **axial T2 SPAIR fat suppression sequence:** TR>U400 msec, TE=80 msec. Matrix 204x384, Slice thickness 7-8 mm, Slice gap 1-2 mm & FOV 365.

Then, Diffusion sequences: Respiratory-triggered fat-suppressed single-shot echo planar DW performed in transverse plane with tri-directional diffusion gradients by using b values 0, 500 & 1000 sec/mm² to increase sensitivity to cellular packing. TR> 1880 msec, TE=70 msec, NEX=3.

Matrix 256x256, slice thickness 7-8 mm, slice gap 1-2 mm and FOV as small as possible with 52% rectangular field of view. All imaging results were verified against a standard of reference. ADC maps were generated at b values 500 & 100 sec/mm², by drawing ROI on the solid part of the selected lymph node.

Imaging evaluation

The morphological features of each lymph node were recorded including size, shape, margin, signal characteristics as well as their number and sites. Then provisional diagnosis was reported. Then the diffusion images and ADC map were reviewed. To calculate ADC value of each lymph node, we drew ROI directly on ADC map within the solid part of each lymph node at the slice in which the largest ROI can be drawn.

The results were documented, calculated and analysed using suitable statistical analysis. Then, we cor-

related the ADC values of each lymph node with its morphological pattern, PET/CT and/or histopathology results.

The final diagnoses were reached according to Standard of reference (SOR): For lymph nodal characterization, all imaging results were refined against a predefined SOR. A range of procedures were identified as valid “gold standards” for the characterization of the benign and malignant lymph nodes. 14 cases of lymphomas and abdominopelvic malignancies were pathologically proven.

The standard of reference for 8 cases was the FDG PET CT findings (2 cases with malignant lymph nodes ; Cancer colon & HCC, and 6 cases with benign reactive lymph nodes).

A lymph node was considered malignant if its SUV max value was greater than 4 and it was considered benign if the SUV max value was less than 2.5.

Statistical Analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0 (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp).

Qualitative data were described using number and percent. The Shapiro-Wilk test was used to verify the normality of distribution. Quantitative data were described using range (minimum and maximum), mean, standard deviation, median and interquartile range (IQR). Significance of the obtained results was judged at the 5% level.

Case 1:

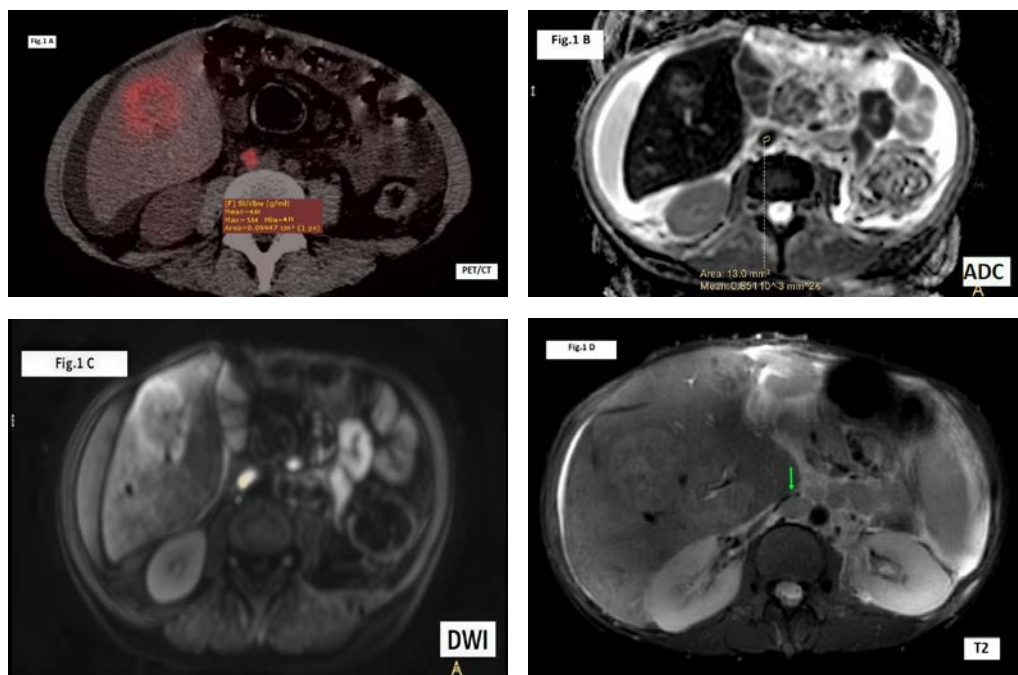
Clinical history: 37 years old lady with history of surgically managed cancer colon since 2018 followed by CTH, currently presented with metastatic bi-lobar hepatic masses.

MRI findings: Multiple enlarged lymph nodes are seen at porta hepatis, precaval, interaortocaval and pre pancreatic groups, and all shows high signal in DWI and low signal in ADC denoting diffusion restriction.

ADC Value: 0.85x10⁻³ mm²/sec.

PET/CT findings: The enlarged porta hepatis, precaval, interaortocaval and pre pancreatic lymph nodes appeared FDG-avid with SUV max 4.8.

Diagnosis: Malignant metastatic pre-aortic, porta hepatis and pre caval lymph node.

**Case 2:**

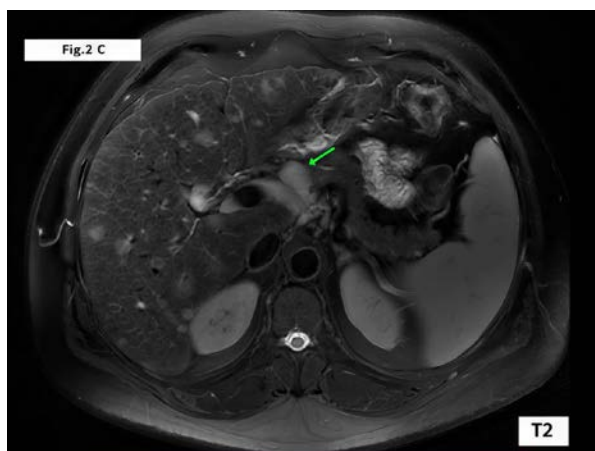
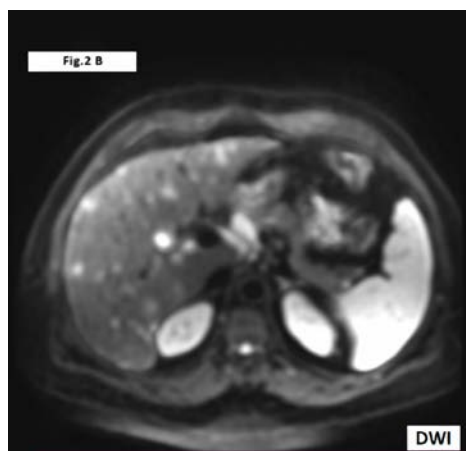
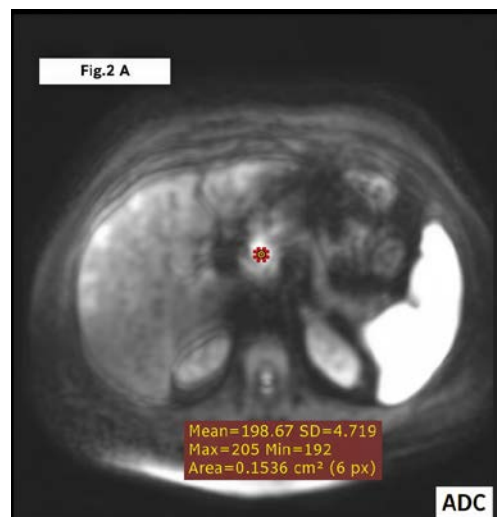
Clinical history: 50 years old Gentleman with history of jaundice and abdominal pain underwent imaging studies.

MRI findings: Bulky pancreatic head with multiple hepatic focal lesions and enlarged pre pancreatic lymph node showing high signal in DWI and low signal in ADC denoting diffusion restriction.

ADC Value: $1.9 \times 10^{-3} \text{ mm}^2/\text{sec}$.

PET/CT findings: The enlarged peri-pancreatic lymph nodes appeared Non FDG-avid.

Diagnosis: Inflammatory enlarged peri pancreatic lymph node.



Case 3:

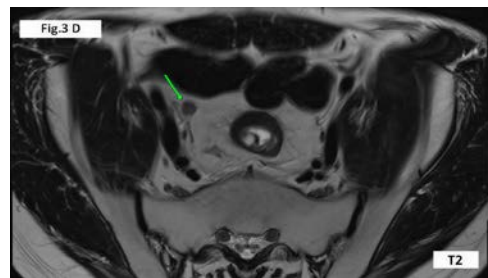
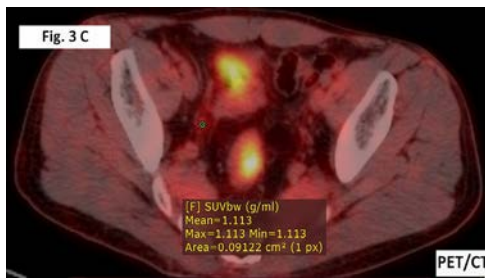
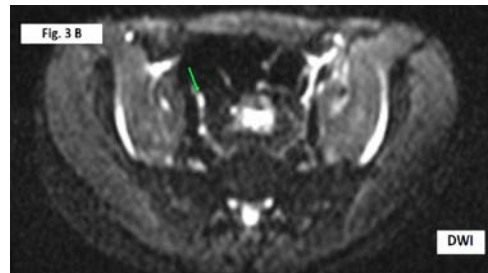
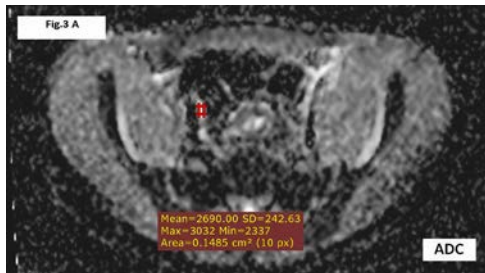
Clinical history: 40 years old Gentleman with history of medically treated cancer upper rectum.

MRI findings: Few prominent lymph nodes are seen at right internal iliac groups showing high signal in DWI and low signal in ADC denoting diffusion restriction.

ADC Value: $2.6 \times 10^{-3} \text{ mm}^2/\text{sec}$.

PET/CT findings: No metabolically active prominent internal iliac lymph nodes. SUV max=1.1.

Diagnosis: Non-Malignant prominent mesorectal lymph node.

**Case 4:**

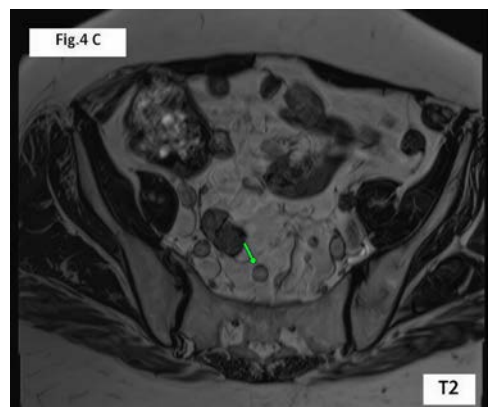
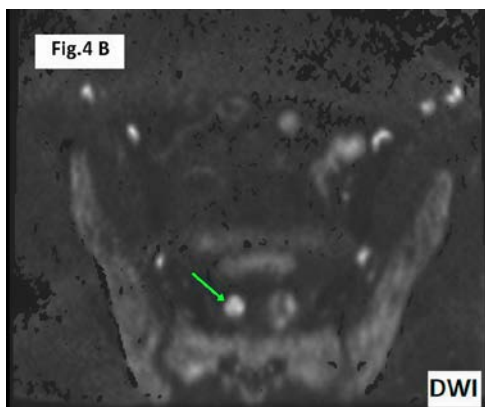
Clinical history: 54 Years old lady with history of biopsy proven rectal carcinoma of adenocarcinoma type.

MRI findings: Few prominent pre sacral suspicious enlarged lymph nodes, all shows high signal in DWI and low signal in ADC denoting diffusion restriction.

ADC Value: $0.87 \times 10^{-3} \text{ mm}^2/\text{sec}$.

Biopsy findings: proved metastatic adenocarcinoma.

Diagnosis: Malignant metastatic pre sacral lymph node.



Case 5:

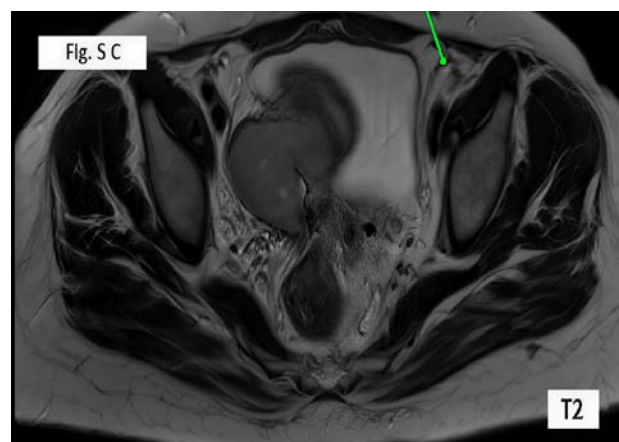
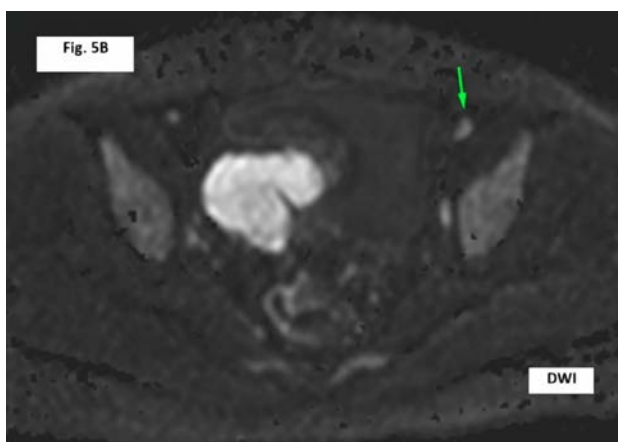
Clinical history: 54 years old Lady with given history of TAH & BSO for pathologically proven benign findings including endometrial hyperplasia, adenomyosis, degenerated leiomyoma, chronic cervicitis and adnexal mucinous cystadenoma and tubo-ovarian abscess with no reported malignancy with recent history of bleeding per vagina and altered bowel habits.

MRI findings: bilateral internal iliac enlarged lymph nodes.

ADC Value: $1.03 \times 10^{-3} \text{ mm}^2/\text{sec}$.

Biopsy findings: No evidence of malignancy.

Diagnosis: Inflammatory reactive left internal iliac lymph node.

**Results**

This study was carried out on 24 patients with evident or suspected abdominal or pelvic lymphadenopathy referred to Ain Shams university hospital, Air forces spe-

cialized hospital & Cairo specialized Hospital. The results will be showed in the following tables and figures.

Table (1) shows demographic characteristics of studied cases. The age of studied cases ranged between 37 years

Table 1: Demographic data among the studied patients.

Description		Studied cases (N= 24)	
		N	%
Gender	Male	16	66.7%
	Female	8	33.3%
Age groups	30- 40 years	3	12.5%
	41- 50 years	9	37.5%
	51- 60 years	6	25.0%
	> 60 years	6	25.0%
Age (years)	Mean± SD	52.63± 10.46	
	Range	37.0 – 71.0	

SD: standard deviation

and 71 years with mean age was 52.63 ± 10.46 years. The age group between 41-50 years was the most frequent

(37.5%). Regarding gender, there were 16 (66.7%) males and 8 (33.3%) females with male to female ratio was 2:1.

Table 2: Diseases (source of lymphadenopathy) among the studied patients.

Parameters		Studied cases (N= 24)	
		N	%
Diseases	HCC	5	20.8%
	Rectal carcinoma	4	16.7%
	Metastatic cancer colon	3	12.5%
	Hodgkin lymphoma	3	12.5%
	Pancreatic mass	2	8.3%
	Hepatitis	2	8.3%
	Non-Hodgkin lymphoma	1	4.2%
	Chronic cervicitis	1	4.2%
	Pancreatitis	1	4.2%
	Endometrial hyperplasia	1	4.2%
	Tubo-ovarian abscess	1	4.2%

HCC: Hepatocellular carcinoma

Hepatocellular carcinoma was the most common disease found in the studied cases representing (20.8%) followed by rectal carcinoma in 4 (16.7%) cases then metastatic cancer colon in 3 (12.5%) cases, Hodgkin lymphoma in 3 (12.5%) cases, pancreatic mass, Hepatitis in two (8.3%) cases. Other diseases was illustrated in **table (2)**.

Table 3: L.N MRI characteristics among the studied patients.

Description		Studied cases (N= 24)	
		N	%
Number of L.Ns	≤ 10 L.Ns	11	45.8%
	> 10 L.Ns	13	54.2%
	Mean $\pm$ SD	13.17 $\pm$ 8.41	
	Median	12.5	
	Range	4.0 – 32.0	
Size of L.Ns (mm)	Mean $\pm$ SD	9.86 $\pm$ 3.33	
	Median	10.0	
	Range	4.0 – 18.0	

Table 3: L.N MRI characteristics among the studied patients.

Description		Studied cases (N= 24)	
		N	%
Site of L.Ns	Pre-pancreatic	6	8.3%
	Int. iliac	3	4.2%
	Para-aortic	3	4.2%
	Rt. Mesorectal	3	8.3%
	Iliac	2	4.2%
	Porta hepatis	2	4.2%
	Aorto-caval	1	4.2%
	Ext. Iliac	1	4.2%
	pre sacral	1	4.2%
	pre caval	1	4.2%
	All	1	4.2%

SD: standard deviation

Table (3) shows that the mean number of lymph nodes in a patient was 13.17 ± 8.41 and ranged from 4 to 32 L.Ns with half of cases (54.2%) had more than 10 L.Ns. The mean size of lymph nodes that measure as length of short axis of LN was 9.86 ± 3.33 mm and ranged from 4 to 18 mm. According to site of L.Ns, Pre-pancreatic site was the most frequent site found (8.3%).

Table 4: MRI findings among the studied patients.

Description		Studied cases (N= 24)	
		N	%
DWI	Restricted	24	100.0%
ADC Value	Mean± SD	1.95± 0.56	
	Median	0.97	
	Range	0.58 – 2.60	

SD: standard deviation

Table (4) shows MRI findings among the studied patients. All cases had restricted DWI. The mean ADC Value was 1.95 ± 0.56 and ranged from 0.58 to 2.6.

Table 5: PET/CT Standardized Uptake Values (SUVs) and biopsy among the studied patients.

		Studied cases (N= 24)	
PET/CT (SUVs) (n= 12)	Mean± SD	2.94± 2.51	
	Median	1.90	
	Range	1.1 – 7.5	
Biopsy	Done	12	50.0%
	Not done	12	50.0%

SD: standard deviation, SUVs: Standardized Uptake Values ()

Table (5) shows that the mean PET/CT Standardized Uptake Values (SUVs) was 2.94± 2.51 and ranged from 1.1 to 7.5. Biopsy was taken for 12 cases only.

Table 6: Pathology of L.Ns studied patients regarding grade.

		Studied cases (N= 24)	
Parameters		N	%
Pathology	Benign	11	45.8%
	Malignant	13	54.2%

n: number, %: percentage

It was observed that there was 11 (45.8%) cases had benign lesions while 13 (54.2%) cases had malignant lesions (**Table 6**).

Table 7: Demographic data among malignant and benign L.Ns.

		Benign		Malignant		Test value	p- value*
		N	%	N	%		
Gender	Male	8	72.7%	8	61.5%	X2= 0.336	0.562
	Female	3	27.3%	5	38.5%		
Age (years)	Mean± SD	51.45± 9.87		53.62± 11.24		T=0.496	0.625
	Range	38.0 – 70.0		37.0 – 71.0			

p≤0.05 is statistically significant, p≤0.01 is highly statistically significant, SD: standard deviation, X2: Chi-Square Test, T: Student T Test

This table shows no significant difference was found between benign and malignant lesions regarding gender (p=0.562) and age (p=0.625).

Table 8: L.N characteristics among Benign and malignant lesions.

Description		Benign (N= 11)		Malignant (N= 13)		Test value	p- value*
		N	%	N	%		
Number of L.Ns	Mean± SD	10.91± 9.31		15.08± 7.39		T=1.223	0.234
	Range	4.0 – 32.0		4.0 – 30.0			
Size of L.Ns (mm)	Mean± SD	8.82± 3.37		10.75± 2.75		T=1.447	0.162
	Range	4.0 – 15.0		7.0 – 18.0			
Site of L.Ns	All	0	0.0%	1	7.7%	X ² = 37.9	<0.001
	Aorto-caval	1	9.1%	0	0.0%		
	Ext. Iliac	0	0.0%	1	7.7%		
	Iliac	0	0.0%	2	15.4%		
	Int. iliac	2	18.2%	1	7.7%		
	Para-aortic	1	9.1%	2	15.4%		
	Porta hepatis	2	18.2%	0	0.0%		
	Pre-caval	0	0.0%	1	7.7%		
	pre-sacral	0	0.0%	1	7.7%		
	Pre-pancreatic	4	36.4%	2	15.4%		
	Rt. Mesorectal	1	9.1%	2	15.4%		

p≤0.05 is statistically significant, *p*≤0.01 is highly statistically significant, SD: standard deviation, X2: Chi-Square Test, T: Student T Test

This table shows no significant difference was found between benign and malignant lesions regarding number and size of L.Ns. While, there was significant difference was found between them regarding site of L.Ns (*p*<0.001).

Table 9: MRI findings among the studied patients.

Description		Benign (N= 11)		Malignant (N= 13)		Test value	p- value*
		N	%	N	%		
DWI	Restricted	11	100.0%	13	100.0%	-	-
ADC Value	Mean± SD	1.65± 0.54		0.81± 0.13		T=5.452	<0.001
	Range	1.1 – 2.60		0.58 – 1.00			

p≤0.05 is statistically significant, *p*≤0.01 is highly statistically significant, SD: standard deviation, T: Student T Test

This table shows the mean ADC value was 1.65± 0.54x10⁻³ in benign lesions and 0.81± 0.13x10⁻³ in malignant lesions. ADC Value was significantly lower in malignant lesions compared to benign lesions (*p*<0.001).

Table 10: PET/CT Standardized Uptake Values (SUVs) among the studied patients.

		Benign (N= 11)	Malignant (N= 13)	Test value	p- value*
PET/CT (SUVs) (n= 12)	Mean± SD	1.5± 0.4	6.2± 2.2	$z_{MWU} = 2.415$	0.017
	Median	1.5 (1.1- 1.9)	7.5 (3.7- 7.5)		
	Range	1.1 – 2.0	3.7 – 7.5		

$p \leq 0.05$ is statistically significant, $p \leq 0.01$ is highly statistically significant, SD: standard deviation, ZMWU: Mann-Whitney Test

This table shows the median (range) of PET/CT (SUVs) was 1.5 (1.1- 2) in benign lesions and 7.5 (3.7- 7.5) in malignant lesions. PET/CT (SUVs) was significantly higher in malignant lesions compared to benign lesions ($p=0.017$).

Table 11: ROC curve analysis of ADC value in differentiating benign from malignant lesions.

Variable	AUC	P-value	Cutoff	Sensitivity	Specificity	PPV	NPV
ADC value	0.846	<0.001*	1.0	74.6%	81.8%	80.4%	76.3%

ROC curve analysis and table (11) shows that ADC value of MRI are good predictor for differentiating benign from malignant lesions with area under the curve 0.846 and sensitivity and specificity was 74.6% and 81.8% respectively ($p < 0.001$).

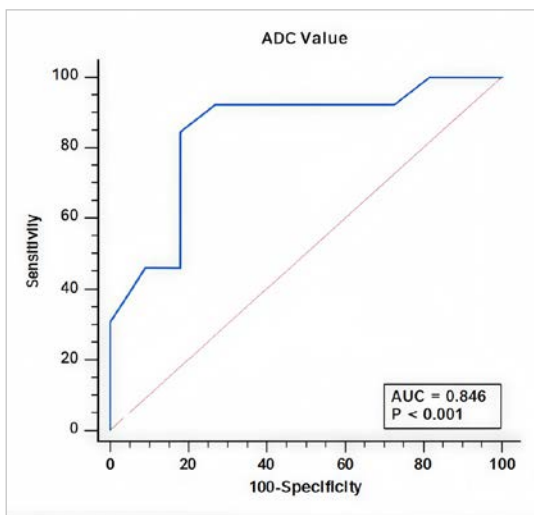


Figure (1): ROC curve of ADC value in differentiating benign from malignant lesions.

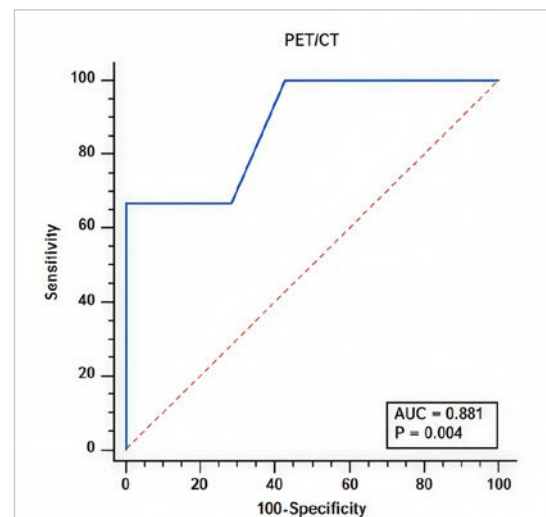


Figure (2): ROC curve of PET/CT in differentiating benign from malignant lesions.

Table 12: ROC curve analysis of PET/CT in differentiating benign from malignant lesions.

Variable	AUC	P-value	Cutoff	Sensitivity	Specificity	PPV	NPV
PET/CT	0.881	0.004	3.7	66.7%	100%	100%	75%

ROC curve analysis and table (12) shows that PET/CT are good predictor for differentiating benign from malignant lesions with area under the curve 0.881 and sensitivity and specificity was 66.7% and 100% respectively ($p=0.004$).

Discussion

The enlargement of lymph nodes is referred to as lymphadenopathy. The lymph nodes are tiny glands that filter fluid from the lymphatic system. As the lymphatic system is a complicated component of the immune system engaged in filtering substances in the body, they are split into parts known as follicles, which are further separated into B zones and T zones, which constitute the basic location of lymphocytic maturation (*Maini and Nagalli, 2023*).

Because abnormal lymphocyte proliferation can be caused by inflammation, infection, or cancer, clinicians must perform a detailed history and physical to screen for lymphadenopathy. Careful examination of all pertinent anatomic regions, including the neck, supraclavicular, axillary, and inguinal regions, should be performed. With a few exceptions, the size of a typical lymph node in an adult should be less than 1 cm (*Mohseni et al., 2014*).

There are several potential causes of lymphadenopathy, ranging from infectious, autoimmune, malignant, and lymphoproliferative. In addition, abdominal pain represents a frequent symptom for referral to emergency departments and/or internal medicine outpatient setting. Similarly, fever, fatigue and weight loss are non-specific manifestations of abdomino-pelvic lymphadenopathy (*Mirijello et al., 2023*).

The early diagnosis and proper staging of cancer lymph nodes using imaging is critical in clinical practice. To differentiate between pathological and normal states, traditional CT or MRI rely on size thresholds and subjective, non-quantitative assessment of morphologic features. This approach has been demonstrated to have low diagnostic accuracy (*Herneth et al., 2010*).

Whole body diffusion weighted MRI (WB-DWI) has emerged as a functional imaging technique, which can aid lymph node characterization by providing informa-

tion on tissue characteristics over a large field of view within reasonable acquisition times – properties, which make it a desirable staging and screening technique. WB-DWI was deemed an alternative to established 18FDG PET/CT for lymphoma staging. DWI detects microstructural and cellular alterations in malignant versus benign lymph nodes and can be quantified by calculation of the apparent diffusion coefficient (ADC) (*Kharuzhyk et al., 2020*).

Therefore, the aim of the present study was to determine if diffusion weighted magnetic resonance imaging can help in discrimination between benign and malignant abdomino-pelvic lymph nodes. And reviewed the ADC values of lymph nodes visualized on abdomen-pelvic MRI images and correlate their values with lymph nodes morphological pattern, PET/CT and / or histopathology results.

The current study was a retrospective study conducted on 24 patients with abdomino pelvic lymphadenopathy. The number of included patients is considered an average number when compared to that included in similar studies, where *Muehe et al., 2020* concluded a similar study on 42 patient. *Akdumanet et al., 2008* conducted a similar study on 28 patients. *Eiber et al., 2010* conducted a similar study in cases of prostatic cancer and included 29 patients, and *Rechichi et al., 2013* included 40 patients in hist study on nodal metastasis in endometrial carcinoma. *Papalia et al., 2012* included 36 patients in his study, which was on nodal metastasis in urinary bladder cancer patients. Other studies included a large number of patients such as *Theony et al. 2014* who included 120 patients in hist study and *Kim et al., 2008* who included 125 patient.

The study was conducted with high b value (500 & 1000 sec/ mm²) to overcome the effect of capillary diffusion in extracellular extravascular space, as high as b value will result in the reduction of signal from moving

protons in the vessels and fluid in the bowel. Thus improving the specificity of the contrast on DWI.

Furthermore, the differences in the relative contrast ratio between malignant and benign lesions were increased at high b values. This was similar to other studies which also used high b values. Where **Thoeny et al. (2014)** also used b values 500 & 1000 sec/mm² and **Rechichi et al. (2013)** and **Yo Mizukami (2011)** used b value of 1000 sec/mm².

In our study, Malignant lymph nodes had significantly lower ADC values than benign lymph nodes. The mean ADC value for malignant lymph nodes is $0.81 \pm 0.13 \times 10^{-3}$ mm²/sec and for benign lymph nodes is $1.65 \pm 0.54 \times 10^{-3}$ mm²/sec.

The ADC measurements of benign and malignant lymph nodes were significantly different with a P value <0.0001.

This supports similar previous findings where **Muehe et al, 2020** reported that the mean ADC value for normal lymph nodes was $1.578 \pm 0.420 \times 10^{-3}$ mm²/sec and $0.852 \pm 0.206 \times 10^{-3}$ mm²/sec for malignant lymph nodes, with P values <0.0001. **Beer et al., 2011** reported that a highly significant difference was observed between the mean ADC values in benign and malignant lymph nodes (ADC values of 1.60 ± 0.24 Vs. $1.09 \pm 0.23 \times 10^{-3}$ mm²/sec respectively) with P values <0.0001. **Eiber et al., 2010** stated that there was a statistically significant difference between the ADC values of malignant lymph nodes ($1.07 \pm 0.23 \times 10^{-3}$ mm²/sec) and benign lymph nodes ($1.54 \pm 0.25 \times 10^{-3}$ mm²/sec) with a P value 0.01. Also, **Akudumanet et al., 2008** stated that the ADC values of malignant ($1.84 \pm 0.37 \times 10^{-3}$ mm²/sec) were significantly lower than those of benign ($2.38 \pm 0.29 \times 10^{-3}$ mm²/sec) of a P value <0.0005.

In our study, we found a good accuracy of the ADC value differentiation between malignant and benign lymph nodes at a cutoff value 1×10^{-3} mm²/sec with sensitivity of 74.6% and specificity of 81.8%. This result is rather comparable to that concluded by **Eiber et al., 2010** who concluded a higher ADC value cut off (1.30×10^{-3} mm²/sec) with 86.0% sensitivity and 85.3% specificity. **Papalia et al., 2012** concluded a cut off ADC value 0.86×10^{-3} mm²/sec with a slightly higher sensitivity (76.4%), and slightly higher specificity (89.4%). **Rechichi et al. 2013**, concluded a cut off for minimum ADC value 0.807×10^{-3} mm²/sec with a higher sensitivity (100%) and specificity (98.3%).

In our study, the mean ADC value of metastatic lymph nodes ($0.95 \pm 0.13 \times 10^{-3}$ mm²/sec) was significantly higher than that of lymphomatous lymph nodes $0.68 \pm 0.13 \times 10^{-3}$ mm²/sec with a P value <0.001. An ADC cut off value of 0.76×10^{-3} mm²/sec was conducted to differentiate between them 80% sensitivity and 87.5% specificity. A similar findings were stated by **Y. Zhang et al., 2013** in a study on the role of DWI in cervical lymphadenopathies, where they stated that the mean ADC value of the solid component of metastatic lymph nodes is $0.9 \pm 0.16 \times 10^{-3}$ mm²/sec, was significantly higher (p<0.01) than that of lymphomatous lymph nodes ($0.64 \pm 0.13 \times 10^{-3}$ mm²/sec). They concluded a slightly higher ADC value cut off (0.77×10^{-3} mm²/sec) with 83% sensitivity and 89% specificity.

A similar findings were stated by, **Freihat et al., 2020** in a study on role of DWI derived for Pet/MRI for lymph nodes assessment in patents with head and neck squamous cell carcinoma, where they stated the mean ADC value for metastatic lymph nodes is $0.899 \pm 0.99 \times 10^{-3}$ mm²/sec while the ADC mean value of normal lymph nodes ($1.267 \pm 0.88 \times 10^{-3}$ mm²/sec), with a cut off value about $1.138 \pm 0.75 \times 10^{-3}$ mm²/sec) was used as an optimal threshold value to differentiate between metastatic and normal nodes. They concluded a higher sensitivity (92.3%) and higher specificity (98.6%).

The absolute ADC values of the different types of lymph nodes were not similar to these of other studies, which is probably due to differences in technique applied (b Value breath measurement methods and mathematical technique applied). **Qayyum, 2009** stated that ADC measurements obtained from breath hold diffusion weighted technique can't be directly translated into those obtained with free breathing or respiratory triggered techniques, which are reportedly associated with high ADC values. Also, stated that ADC measurements may vary not only with different imaging parameters, but also within different types of scanners.

In our study, 4 patients with metastatic lymph nodes, have undergone follow-up MRI after receiving a course of therapy, either radiotherapy, chemotherapy or combined. The lymph nodes show size regression denoting good therapeutic response.

In DWI, these lymph nodes shows less diffusion restriction and a high ADC values in the follow-up MRI. Similar findings were stated by **Thoeny & Ross, 2010**, where they stated that studies have shown that suc-

successful treatment of a many tumor types can be detected using DWI-MRI as an early increase in the apparent diffusion co-efficient values. They also stated during

successful treatment, the loss of cellularity in the tumor in lower intensity in the high b-value image or high signal intensity on the corresponding ADC map. **R**



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Mustafa Mohamed El Shahat Hafez, Prof. Dr. Yasser Ali Mohamed Abd El Mawla, Prof.Dr. Ahmed Mohamed Hussein, Dr. Mohamed Yosry Mohamed Desoki. Role of Diffusion Weighted MRI in Characterization of Abdomino-Pelvic Lymphadenopathy, *Hell J Radiol* 2026; 11(3): 64-77.



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