

Value of Diffusion-Weighted MRI in the Characterization of Cervical Lymphadenopathy in Head and Neck Tumors

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ABSTRACT

Background: Apparent diffusion coefficient (ADC) is effective in distinguishing metastatic lymph nodes from benign lymph nodes. When ADC data are integrated with morphologic MRI, diagnostic results are significantly better than when MRI is assessed independently. We aimed to evaluate the diagnostic capabilities of diffusion-weighted (DW)-MRI and ADC values in distinguishing between benign and metastatic cervical lymph nodes

Methods: This prospective study was conducted on 54 patients, afflicted with lymphadenopathy of the cervical region were examined. All patients were subjected to Diagnostic MRI scans of the neck and histological examination [Seven patients had excisional biopsies and forty-seven underwent fine needle aspiration cytology].

Results: A low ADC1000 was a significant lower in malignant persons compared to benign patients ($P < 0.001$). Lymphoma patients had a significantly lower ADC1000 compared to malignant patients ($P < 0.001$). ADC1000 effectively distinguishes malignant lymph nodes with high accuracy at cutoff of < 1.21 , sensitivity of 94.1%, and specificity of 100%. For differentiating lymphoma patients, ADC1000 demonstrated excellent performance at a threshold of ≤ 0.91 , with 100% sensitivity, 96.6% specificity. ADC1000 is a highly reliable imaging biomarker for distinguishing malignancies and lymphoma with remarkable diagnostic accuracy.

Conclusions: The use of DW-MRI to evaluate cervical lymphadenopathy in patients with head and neck cancer offers promising results without invasive procedures. In a study of patients with head and neck cancer, DW-MRI showed remarkable diagnostic accuracy when used in conjunction with ADC data to distinguish between benign and metastatic cervical lymph nodes

Keywords: Cervical Lymphadenopathy ; MRI ; Head & Neck Tumors, Apparent Diffusion Coefficient

INTRODUCTION

Head and neck cancer is the seventh most common type of cancer worldwide and comprise of a diverse group of tumors affecting the upper aerodigestive tract. The most prevalent histology is squamous cell carcinoma, while there are other others [1].

Interconnected superficial and deep groups make up the lymph nodes in the head and neck. Head and neck lymph nodes are susceptible to cutaneous, upper aerodigestive tract, and systemic lymph node cancers [2].

There are two types of linked lymph nodes in the head and neck: deep and superficial. Skin cancer, upper aerodigestive tract cancer, and systemic lymph node cancer are three types of cancer that can impact the lymph nodes in the head and neck [3]. Magnetic resonance (MRI) diffusion imaging is a non-invasive method that can help differentiate between benign and malignant lymph nodes, as well as the many types of malignant lymphadenopathy [4]. The apparent diffusion coefficient

(ADC) is a useful diagnostic technique for distinguishing between lymph nodes that are benign and those that have spread. Combining ADC data with morphologic MRI examination yields significantly better diagnostic outcomes than MRI evaluation alone [5].

This study aimed to compare diffusion-weighted (DW)-MRI and ADC values for the detection of benign and metastatic cervical lymph nodes in patients with head and neck cancers, using histopathologic findings as standard

PATIENTS AND METHODS

This prospective study was conducted on 54 patients, both sexes, afflicted with lymphadenopathy of the cervical region were examined. The study was done from February 2022 and January 2024 after approval from the Ethical Committee Helwan University Hospitals, Cairo, Egypt. Patients or their legal guardians gave their written, informed consent.

Patients whose histological findings were not verified. No individuals were ruled out because they were unable to undergo MRI or because they had a history of intolerance to contrast were excluded from the study.

All patients were subjected to complete history taking, general examination, laboratory investigations [Renal function tests (blood urea and serum creatinine)], radiological investigations [Diagnostic MRI scans of the neck] and histological examination [Seven patients had excisional biopsies and forty-seven underwent fine needle aspiration cytology (FNAC)].

Magnetic resonance examination

Anyone planning to enter the magnetic field while wearing a detachable metallic implant (such as a dental prosthesis) must do so in order to avoid proportionate contraindication. A total of nine individuals were anesthetized eight of whom had claustrophobia and one who was uncooperative six hours prior to the MR scanning that was necessary. A gradual intravenous dosage of 1-2 mg/kg of ketamine sulphate (Ketalar®) was administered to produce sedation.

For the MR imaging examinations, the 1.5-T GE Healthcare Signa EXCITE scanner was used. Conventional and diffusion-weighted magnetic resonance imaging (MR) scans of supine patients using a typical receive-only head and neck coil revealed nodes that extended from the skull base to the suprasternal notch. The first step was to conduct T2-weighted fast spin-echo sequences in both the axial and coronal directions. The following step was to use the parameters listed in the table to conduct axial T1-weighted sequences with or without fat-suppression. The conditions given in the table were used to obtain a single-shot echo-planar DWI sequence. A b value of up to 1000 s/mm² was used for the acquisition. We were able to deliver trustworthy evaluations despite lower signal-to-noise ratios by employing a high b value of 1000 s/mm². In order to create pixel-wise ADC maps, we used the GE Healthcare Advantage Workstation, version 4.2, which is available for purchase. Using a monoexponential algorithm to scan the data, the ADC maps were generated. One 20-milliliter saline flush followed the intravenous administration of 2-milliliters per second of dotarem® (Gurbet) gadoteric acid via a power injector. A dose of 0.1 mmol/kg of body weight of gadolinium was given to subjects with normal renal function, which was defined as an estimated glomerular filtration rate (GFR) greater than 60 ml/min/1.73 m². Participating subjects' GFRs averaged 60 ml/min/1.73 m². Both the axial and coronal planes were used for fat suppression in post-contrast T1-weighted imaging.

Using well recognized criteria for assessing anatomical imaging data, the lymph nodes were described. We begin by identifying the specific area of the body where the lymph nodes are swollen and then characterize them using a numerical classification scheme. After that, we took note with respect to the parenchymal homogeneity and the size and shape of the lymph nodes and contrast enhancement.

MRI can differentiate cancerous from benign lymph nodes through characteristics like size, shape, signal intensity, enhancement patterns, and additional features. Malignant nodes are typically larger (10.6 mm vs. 5.5 mm for benign) and rounder, while benign nodes are oval. Signal intensity on standard T1- and T2-weighted imaging isn't reliable for distinguishing the two. Malignant nodes show heterogeneous enhancement with contrast, resembling the main tumor, and may have necrosis or calcification. Benign nodes usually have a large central hilum, while malignant ones have a short or absent hilum. By utilizing b-values between 0 and 1000 to quantify sensitivity and specificity, diffusion-weighted (DW) imaging with ADC maps aids in quantitatively evaluating nodes. Using receiver operating characteristic analysis, we find the best ADC threshold for differentiating benign from malignant nodes by comparing the mean ADC values from ROIs with histopathologic data, which helps to refine the diagnosis.

STATISTICAL ANALYSIS

For the statistical analysis, an application called SPSS v26 was utilized. This software was produced by IBM and is based in Chicago, IL, USA. As quantitative variables, we utilized standard deviation (SD) and mean, and we compared the two groups using an unpaired Student's t-test. The qualitative variables were analyzed using Chi-square or Fisher's exact test when appropriate. The results were presented as percentages and frequencies. Analyzing the specificity, accuracy, precision, and positive and negative predictive characteristics of the diagnostic test. For statistical significance, a two-tailed P value below 0.05 is required.

RESULTS

The obtained results showed a demographic data, LN results, histopathological evaluation of LN samples and ADC (Table 1).

Study participants' lymph nodes identified size of lymph nodes and afflicted lymph nodes' anatomical position using standard MRI (Table 2).

Table 1: Demographic data, LN results, histopathological evaluation of LN samples and ADC of the studied patients

		N=54
Age (years)		40.7 ± 17.4
Sex	Male	28(51.9%)
	Female	26(48.1%)
LN parenchyma	Homogenous	20(37.0%)
	Heterogenous	34(63.0%)
LN size (cm)		1.97 ± 0.79
Histopathological diagnosis		
Squamous Cell Carcinoma		13(24.1%)
Mucoepidermoid carcinoma		1(1.9%)
Papillary thyroid carcinoma		1(1.9%)
Rhabdomyosarcoma		1(1.9%)
Metastatic undifferentiated carcinoma		5(9.3%)
Metastatic of unknown origin		6(11.1%)
Hodgkin lymphoma		5(9.3%)
Non-Hodgkin lymphoma		2(3.7%)
Chronic nonspecific inflammation		10(81.5%)
Acute Reactive lymphadenitis		7(13.0%)
Infantile fibromatosis		2(3.7%)
Reactive lymphoid hyperplasia		1(1.9%)
ADC	Restricted (malignant)	34(63.0%)
	Facilitated (benign)	20(37.0%)

Data are presented as mean ± SD or frequency (%). LN: Lymph node, ADC: Apparent diffusion coefficient.

Table 2: Study participants' lymph nodes identified, size of lymph nodes and afflicted lymph nodes' anatomical position using standard MRI

		Benign LN's (n=20)	Malignant LN's (n=34)
Shape	Oval	20(100%)	13(38%)
	Rounded	0(0.0%)	21(62%)
Border	Smooth	17(85.0%)	16(47%)
	Non-smooth	3(15.0%)	18(53%)

Enhancement	Homogeneous	19(95%)	5(15%)
	Heterogeneous	1(5%)	29(85%)
Hilum	Preserved	17(85%)	15(44%)
	Lost	3(15%)	19(56%)
Necrosis	Present	3(15%)	16(47%)
	Absent	17(85%)	18(53%)
Calcification	Present	0(0.0%)	7(21%)
	Absent	20(100%)	27(79%)
LN size		1.72 ± 0.57	2.1 ± 0.87
Afflicted lymph nodes' anatomical position			
Group I		10	14
Group II		17	32
Group III		4	9
Group IV		5	11
Group V		16	27
Group VI		7	11

Data are presented as frequency (%) or number. MRI: Magnetic resonance imaging, LN: Lymph node.

A low ADC1000 (mean = 1.06 ± 0.14) was found in malignant persons compared to benign patients (mean = 1.91 ± 0.38), and this difference was significant (P<0.001). Lymphoma patients had a significantly lower ADC1000 compared to malignant patients (P< 0.001) (Table 3).

The ROC curve analysis revealed that ADC1000 effectively distinguishes malignant lymph nodes with high accuracy. At a cutoff of < 1.21, it achieved a sensitivity of 94.1%, specificity of 100%, PPV of 100%, and NPV of 90.9% (AUC=0.99, P< 0.001). For differentiating lymphoma patients, ADC1000 demonstrated excellent performance at a threshold of ≤ 0.91, with 100% sensitivity, 96.6% specificity, and NPV of 100% (AUC=0.97, P< 0.001). These findings indicate that ADC1000 is a highly reliable imaging biomarker for distinguishing malignancies and lymphoma with remarkable diagnostic accuracy (Figure 1).

Table 3: Analysis of ADC1000 x 10³ in individuals with benign and cancerous conditions and analysis of lymphoma and malignant patients using ADC1000 (x10³)

	Malignant (n=34)	Benign (n=20)	Test of Sign.	P
ADC1000 (x 10³)	1.06 ± 0.14	1.91 ± 0.38	T=11.6	<0.001*
	Malignant (n= 29)	Lymphoma (n= 5)		
B1000 (ADC)	1.1 ± 0.11	0.83 ± 0.08	T=4.8	<0.001*

Mean ± SD. * Significant P <0.05, T-test for independent samples, LN: Lymph node, ADC: Apparent diffusion coefficient.

(a)	(b)
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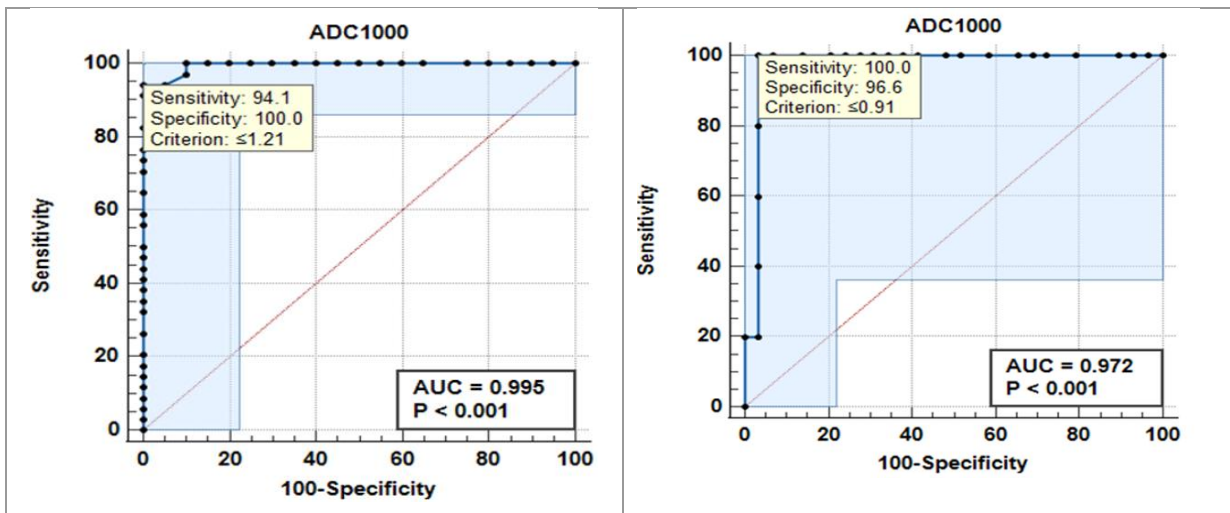
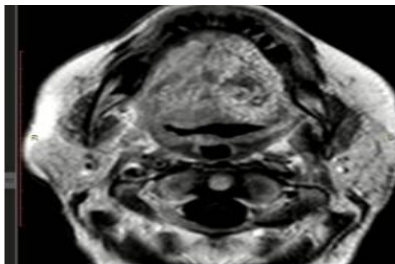
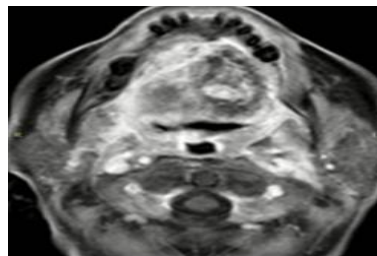


Figure (1): B1000 (ADC) ROC curve for (A) cancer patient classification, (B) individuals with discriminate lymphoma

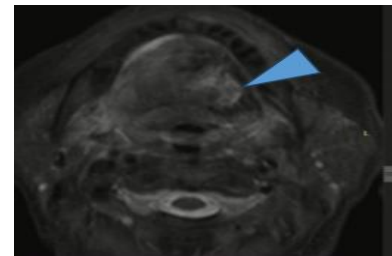
Case 1: A woman in her 69s who had squamous cell carcinoma of the tongue before was evaluated for recurrence or residual tumors after a left hemi-glossectomy and flap. MR findings : The following is the current status after the removal of the tongue mass and installation of the flap: - There is mild heterogeneous augmentation of the surgical bed and the flap. Big masses not seen on MRI. There are two enormous deep cervical lymph nodes, one on each side; the biggest of them is at level V on the left, and it measures 9 x 6 mm. The maximal axial diameters of the right lower deep cervical ill-defined lesion are 1.8 x 0.7 cm; the lesion shows strong T1 and T2WI signals with central diffusion limitation and peripheral enhancement; and ultrasound evaluation is warranted. In terms of size, the biggest one is 1.8 cm across. Following the left hemi-glossectomy, the patient's status is as follows: slightly limited diffusion signal, low T1 and high T2 fat sat signals, and a tiny, irregularly shaped operating bed or floor of the mouth. Metastatic illness should be taken seriously when there is a slightly conspicuous oblong-shaped lymph node at level IIb in slightly restricted diffusion in the lymph node located in the left upper deep cervical region. The ADC value is $1.09 \times 10^{-3} \text{ mm}^2 / \text{sec}$. Indications for a DWI-MR diagnosis of malignant lymphadenopathy. The biopsy's results: Malignancy of the Blood and Tongue Squamous Cell Carcinoma (**Figure 2**).



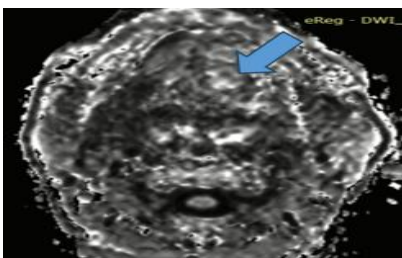
A: Axial T1 Pre-Contrast



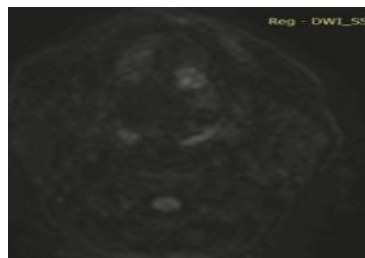
B: Axial T1 Post Contrast Fat Sat



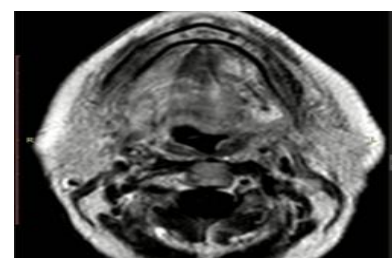
C: T2 Fat Sat



D: DWI



E: ADC



F: Axial T1 Pre Contrast

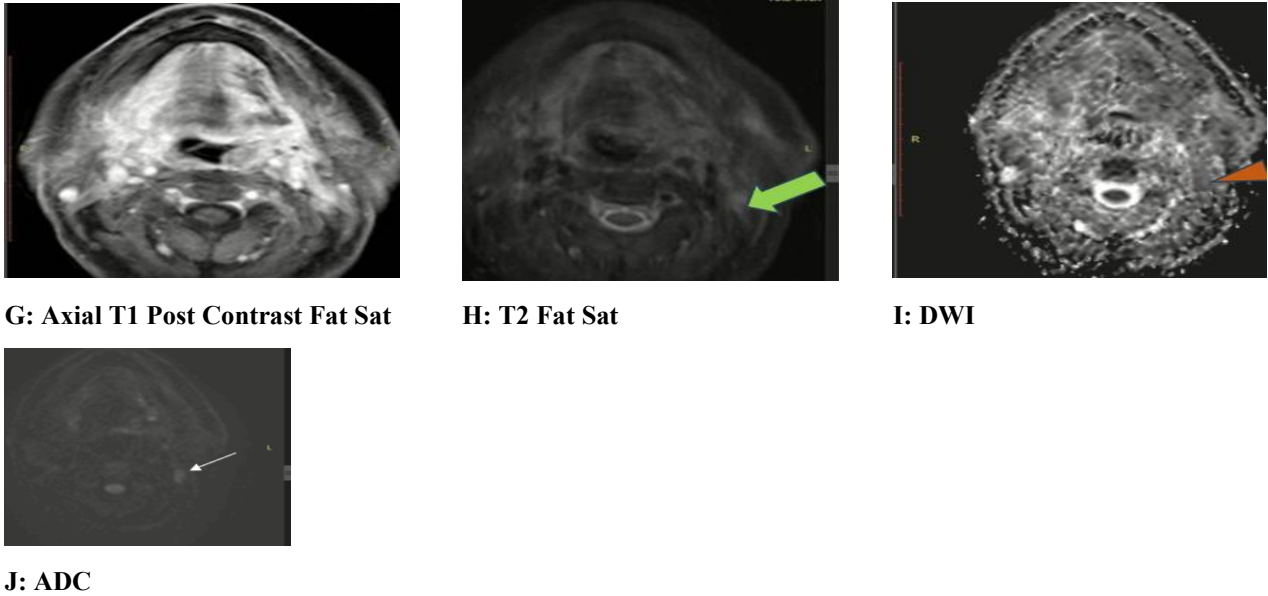
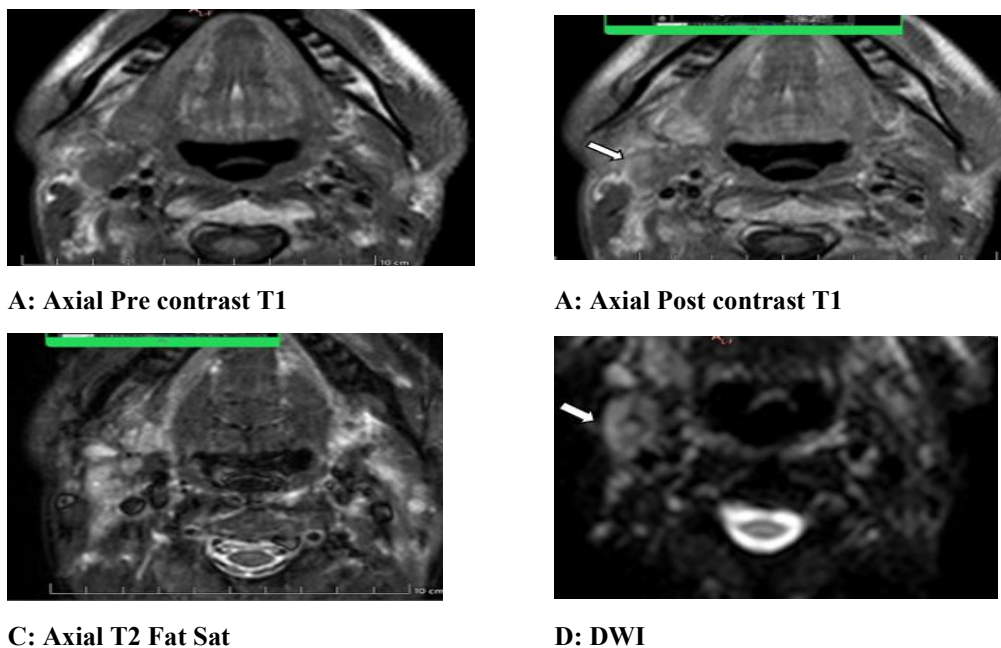
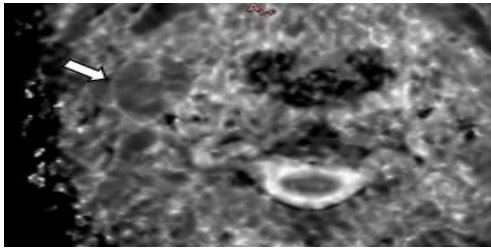


Figure (2): Case 1 Tongue SCC, status post left hemi-glossectomy and flap to assess recurrence/remnants

Case 2: A male patient, age 31, who had recently developed localized swelling in his neck, attended for follow-up. Magnetic resonance results: There are the right upper cervical area has a modest number of inseparable lymph nodes or merged. They measure 2.2 cm in total and are either not moving at all or are moving little. The submental lymph node has progressed to 1.4 cm in size, up from 8 mm. Measurements: The biggest one has a diameter of 2.2 cm. ADC of the skull where it meets the mouth (the very tip of the epiglottis seen) shows a slightly enlarged irregularly shaped right upper deep cervical lymphadenopathy with thick cortex and partial obliteration of hilar fat. The images also show iso/mild hypointense T1, mild hypertense T2, and mild inhomogeneous post contrast enhancement. The images are presented as A, B, C, and D, respectively. Restricted diffusion signal is present at the Diffusion weighted sequence. Extranodal spiculation or reticulation is not seen. No lymphatic infiltration seen outside of nodes. The ADC's value is $1.19 \times 10^{-3} \text{ mm}^2 / \text{sec}$. Malignant lymphadenopathy: a DWI-MR diagnostic suggestion. The findings of the biopsy: Head and neck lymph nodes metastasized undifferentiated carcinoma with an unknown primary tumor and malignant lymph nodes (**Figure 3**).





E: ADC

Figure (3): Case 5 A 31-year-old male patient presented for follow up with new focal neck swelling

DISCUSSION

Cervical lymph node enlargement could be a result of a patient's complaint or an unrelated finding during an oral health examination. Rather than being an illness in and of itself, the condition is more likely to be a sign of a more systemic issue [6].

Regarding LN size, the average LN size of all patients analyzed in this research was 1.97 ± 0.79 cm. Twenty patients (37%) had homogeneous LN parenchyma, whereas thirty-four patients (63%) had heterogeneous LN parenchyma. While over half of the patients with enlarged cervical lymph nodes had lymph nodes ranging between 1 and 2 cm, nearly half (41.7%) had lymph nodes measuring more than 2 cm, according to a research by Kumar and Sakalecha [7].

Twenty patients (37% benign) and thirty-four patients (63% malignant) with limited diffusion were included in the current investigation. Sumith et al. [8] included 54 individuals who had a background of lymphadenopathy in their research. In their investigation, Kanmaz and Karavas [9] used 32 consecutive patients who had echo planar DW-MRI for tumors in their heads and necks. In seventeen instances (53.1%), benign masses were found, whereas fifteen cases (46.0%) were found to have malignant masses.

The research found that LN sizes ranged from 1.1 to 5.6 in malignant individuals, with an average size of 2.1 ± 0.87 . In individuals without malignant tumors, the average size of the LN was 1.72 ± 0.57 , ranging from 1.0 to 3. Elbadry and Mohammad [10] research including cervical adenopathy patients revealed that, on average, malignant lymph nodes had a short axis to long axis ratio (S/L) of 0.66 for 1ry and 2ry nodes, and 0.63 for 2ry nodes that were benign. Inflammatory nodes had an average S/L ratio of 0.42, whereas granulomatous nodes had a ratio of 0.44. It was also in agreement with the research of Wang et al. [11] discovered that benign retropharyngeal lymph nodes were significantly smaller in size compared to metastatic ones.

In this research, scientists found that ADC1000 was substantially lower in malignant patients compared to benign patients. Similarly, Elbadry and Mohammad [10] found a significant difference between benign and malignant lymph nodes in patients with cervical lymphadenopathy; the former exhibited a lower average ADC value. Comparative studies on neck lymph node characterization using diffusion-weighted MRI and ADC were conducted by Sumith et al. [8] the mean ADC value for malignant lesions was $0.83 \pm 0.16 \times 10^{-3} \text{ mm}^2/\text{s}$, whereas for benign lesions it was $1.1 \pm 0.11 \times 10^{-3} \text{ mm}^2/\text{s}$.

For the purpose of distinguishing benign from malignant lymph nodes throughout the body, Seber et al. [12] contrasted diffusion-weighted MRI with C-MRI. According to Seber et al. [12] typically, benign lymph nodes had an average ADC value of $0.97 \pm 0.16 \times 10^{-3} \text{ mm}^2/\text{s}$, while cancerous lymph nodes had an average ADC value of $0.76 \pm 0.19 \times 10^{-3} \text{ mm}^2/\text{s}$. Taha Ali [13] agreed with this research and discovered that metastatic lymph nodes had a much lower average ADC of $0.93 \pm 0.13 \times 10^{-3} \text{ mm}^2/\text{s}$ compared to normal neck lymph nodes.

The ROC curve demonstrates that ADC1000 has a sensitivity of 94.1%, a specificity of 100%, a PPV of 100%, and an NPV of 90.9% when used to differentiate between persons with malignancies at a cutoff level less than 1.21.

In earlier research, different thresholds were employed; however, in Taha Ali's [13] study, a cutoff ADC value of $1.15 \times 10^{-3} \text{ mm}^2/\text{s}$ was chosen for the purpose of distinguishing between benign and malignant neck lymph nodes. The analysis also took into account other factors such as sensitivity, specificity, PPV, NPV, Kappa test, and p values of 96%, 88.9%, 0.84, 88.9%, and <0.0001 , respectively. According to Kanmaz and Karavas [9] determined that the best results for predicting cancer were obtained by using an ADC value of $1.13 \times 10^{-3} \text{ mm}^2/\text{s}$ or below. This method had a sensitivity of 93.33%, a specificity of 82.35%, PPV of 82.35%, and NPV of 93.33%.

Our cut-off ADC values for malignant and benign lymph node differentiation were somewhat lower than those found by Razeq et al. [14] in cervical lymphadenopathy. The ADC cutoff value for differentiating normal lymph nodes from malignant ones was determined by Abdul Razeq et al. [15] node differentiation was $1.38 \times 10^{-3} \text{ mm}^2/\text{s}$, indicating somewhat higher sensitivity but much lower specificity. Research by Kumar and Sakalecha [7] showing that cervical lymph nodes with Using

an ADC cut off value of $1.0 \times 10^{-3} \text{mm}^2/\text{s}$, benign or malignant could be successfully categorized with a sensitivity of 100% and a specificity of 95.24%. Sumith et al. [8] discovered that ADC had an accuracy of 80.77% and a precision of 71.43% in detecting malignant lesions in DWI scanning when a cutoff value of $0.98 \times 10^{-3} \text{mm}^2/\text{s}$ was used. In their study, Seber et al. [12] discovered that using an ADC value of $0.8 \times 10^{-3} \text{mm}^2/\text{s}$ resulted in a sensitivity of 76.4%, specificity of 85.7%, PPV of 86.6%, and NPV of 75%.

When compared to other research, this one had the highest specificity while having similar sensitivity. Lymphoma patients had a significantly lower ADC1000 compared to malignant patients. As per Taha Ali [13] found that the mean ADC of lymphomatous lymph nodes was substantially lower than that of malignant neck lymph nodes. Similarly, Eissa et al. [16] showed a notable difference between the two categories, with a p-value of just 0.041. According to studies done by Vidiri et al. [17] SCCs really had a considerably higher ADC value than lymphomas.

The ROC curve results demonstrated that ADC1000 can detect lymphoma patients at a cut-off level of ≤ 0.91 with a sensitivity of 100%, specificity of 96.6%, PPV of 83.3%, and NPV of 100% (AUC = 0.97, $P < 0.001$).

With a sensitivity of 57.1%, specificity of 100%, PPV of 100%, and NPV of 95.2%, Shiraishi et al. [18] demonstrated that a potential cutoff ADC value for differentiating malignant lymphoma from SCC is $0.89 \times 10^{-3} \text{mm}^2/\text{s}$.

In their study, Vidiri et al. [17] determined that $0.83 \times 10^3 \text{mm}^2/\text{s}$ and $0.73 \times 10^3 \text{mm}^2/\text{s}$ were the ideal cutoff values for ADC mean and ADC median, respectively, as lymphoma predictors.

The study's sample size was limited, which was one of its limitations. The lack of MRI technology at Badr University was the primary impediment to our research, therefore we had to obtain our case samples from the National Cancer Institute.

CONCLUSIONS:

The use of DW-MRI to assess cervical lymphadenopathy in HNC patients without invasive procedures is highly encouraging. Utilizing DW-MRI in conjunction with ADC values proved to be highly accurate in diagnosing metastatic cervical lymph nodes from benign ones in patients with head and neck cancer. Both sensitivity and specificity were very high.

REFERENCES

- [1] Mody MD, Rocco JW, Yom SS, Haddad RI, Saba NF. Head and neck cancer. *Lancet*. 2021;39:2289-99.
- [2] Assadsangabi R, Babaei R, Songco C, Ivanovic V, Bobinski M, Chen YJ, et al. Multimodality oncologic evaluation of superficial neck and facial lymph nodes. *Radiol Med*. 2021;126:1074-84.
- [3] Singh NK, Awasthi P, Gupta A, Anand N, Giri BS, Hassan MI, et al. Identifying Porphyromonas gingivalis-infected hub genes and molecular mechanisms of oral squamous cell carcinoma pathogenesis. *Discov Appl Sci*. 2025;7:1-17.
- [4] Ghieda UE, Badr AA-R. Diffusion-weighted magnetic resonance imaging in characterization of neck lymph nodes in head and neck cancer. *Matrix*. 2020;320:256-.
- [5] Zhou Y, Yu T, Rui X, Jin T, Huang Z, Huang Z. Effectiveness of diffusion-weighted imaging in predicting cervical lymph node metastasis in head and neck malignancies. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2021;131:122-9.
- [6] Verma R, Khera S. Cervical lymphadenopathy: a review. *Int J Health Sci Res*. 2020;10:292-8.
- [7] Kumar J. Diffusion-weighted magnetic resonance imaging of cholesteatoma: Navigating the multifarious techniques. *Indian J Radiol Imaging*. 2024;34:3-5.
- [8] Sumith KM, Vinoth T, Jenikar P, Kumar MV. Diffusion-weighted imaging in differentiating benign versus malignant lymphadenopathy: A cross-sectional study. *Current Medical Issues*. 2023;21:93-7.
- [9] Kanmaz L, Karavas E. The role of diffusion-weighted magnetic resonance imaging in the differentiation of head and neck masses. *J Clin Med*. 2018;70:17-25.
- [10] Elbadry MS, Mohammad MA. Benign versus malignant cervical lymph nodes; differentiation by diffusion weighted MRI. *Benha Med J*. 2022;39:194-209.
- [11] Wang P, Hu S, Wang X, Ge Y, Zhao J, Qiao H, et al. Synthetic MRI in differentiating benign from metastatic retropharyngeal lymph node: combination with diffusion-weighted imaging. *Eur Radiol*. 2023;33:152-61.
- [12] Seber T, Caglar E, Uylar T, Karaman N, Aktas E, Aribas BK. Diagnostic value of diffusion-weighted magnetic resonance imaging: differentiation of benign and malignant lymph nodes in different regions of the body. *Clin Imaging*. 2015;39:856-62.
- [13] Ali TFT, El Hariri MA. Combined diffusion-weighted MRI and MR spectroscopy: Feasibility to improve the MRI capability in differentiation between benign and malignant neck lymphadenopathy. *Egypt J Radiol Nucl*

Med. 2017;48:97-106.

- [14] Abdel Razek AAK, Elsebaie NA, Gamaleldin OA, AbdelKhalek A, Mukherji SK. Role of MR Imaging in Head and Neck Squamous Cell Carcinoma. *Magn Reson Imaging Clin N Am.* 2022;30:1-18.
- [15] Abdel Razek AA, Soliman NY, Elkhamary S, Alsharaway MK, Tawfik A. Role of diffusion-weighted MR imaging in cervical lymphadenopathy. *Eur Radiol.* 2006;16:1468-77.
- [16] Eissa L, Manosur M, Darweesh R. The additive diagnostic role of diffusion-weighted magnetic resonance and chemical shift imaging (CSI) in differentiation between malignant and benign cervical lymph nodes. *Egypt J Radiol Nucl Med.* 2023;54:161-85.
- [17] Vidiri A, Minosse S, Piludu F, Pellini R, Cristalli G, Kayal R, et al. Cervical lymphadenopathy: can the histogram analysis of apparent diffusion coefficient help to differentiate between lymphoma and squamous cell carcinoma in patients with unknown clinical primary tumor? *Radiol Med.* 2019;124:19-26.
- [18] Shiraishi T, Chikui T, Inadomi D, Hashimoto M, Horio C, Kagawa T, et al. MRI findings of extranodal malignant lymphoma and squamous cell carcinoma in the head and neck regions. *Oral Radiology.* 2016;32:98-104..