Original Research Article

Role of Diffusion Weighted MRI and contrast enhanced MRI in Diagnosis of Uterine Cervical Mass

Abstract

Background: Cervical cancer is one the most frequently diagnosed malignant diseases in females, affecting approximately 16 out of 100 000 women**.** Diffusion-weighted (DW) MRI is a newly developed technique characterized by an apparent diffusion coefficient (ADC). The reason for this work was to investigate the role of DW and contrast enhanced MRI (CE) in diagnosis of uterine cervical mass to differentiate a benign from cancerous lesions.

Methods: This prospective study was done on 20 patients with uterine cervical masses. All patients were subjected to Personal, Past, Family history taking. Comprehensive clinical examinations Ultrasound: Previous pelvi-abdominal US, TVUS and Laboratory investigations including renal and liver functions and pregnancy test.

Results: The majority of patients (65%) had cervical masses in supravaginal portion while 35% had lesions in vaginal portion. The mean value of DWI findings was 0.88± 0.25. There was statistically significant increase in the size of mass in cases with malignant tumor compared to a benign one (p= 0.012). There was a significant increase in DWI findings in benign group compared to malignant group (p <0.001). The ROC curve showed that the best cutoff of DWI was ≤ 0.9 with 100% specificity and sensitivity.

Conclusions: DWI could significantly predict patients with malignant lesion of uterine cervical mass at cut off value ≤ 0.9 with 100% accuracy, 100% sensitivity, 100% specificity, 100% PPV and 100% NPV.

Keywords: uterine cervical mass, malignant, MRI, diagnosis, DWI

Introduction:

Cervical malignancy is one of the most common malignant illnesses identified in women, affecting roughly 16 out of every 100,000 women. It is the third most prevalent female genital cancer in the globe, behind uterine body and ovarian cancers [1-3].

The diagnosis of cervical malignancy is suspected based on symptoms, findings of clinical exams, and positive screening cytology results, and confirmed by biopsy. Before considering surgical treatment or chemoradiation therapy, it is necessary to determine the disease's extent [4, 5].

Magnetic resonance imaging (MRI) is the best radiodiagnostic tool for assessing the spread of cervical cancer, complementing the clinical examination. This diagnostic method allows for a more precise determination of the optimal treatment strategy for each patient, be it surgery, radio-therapy, or chemoradio-therapy. Clearer MRI images depict the cervical tumour, its dissemination to neighbouring tissues and organs, and lymph node metastases [6, 7].

Diffusion-weighted magnetic resonance imaging (MRI) is a relatively recent technique. This examination is predicated on the variety of water molecule movement in tissues and is described by an apparent diffusion coefficient (ADC) [8, 9].

The goal of this study was to assess the usefulness of DW and contrast-enhanced MRI in the diagnosis of uterine cervical mass and the distinction between benign and cancerous lesions.

Patients and Methods:

This prospective study was carried out on 20 patients aged from 29 to 76 years old, with uterine cervical masses admitted from Oncology Department and Obstetrics and Gynecology Department to the radiodiagnosis department between 2018 to 2020.

The Ethical Committee, Faculty of Medicine, Tanta University approved this study. Informed consent was obtained from all enrolled cases.

Exclusion criteria: Contraindications for MRI as: Aneurysm clips, any metallic fragments or foreign bodies, Coronary and peripheral artery stents, Aortic stent graft, Prosthetic heart valves, Vena Cava filters, Cardiac pacemaker, Implanted cardioverter defibrillator (ICD), Electronic implant or device e.g., Insulin pump or other infusion pump, Cochlear implant, Known claustrophobia.

All patients were subjected to Personal, Past, Family history taking. Comprehensive clinical examinations Ultrasound: Previous pelvi-abdominal US, TVUS and Laboratory investigations including renal and liver functions and pregnancy test.

MRI: The patient is positioned supine with an empty urine bladder during imaging. Utilization of a pelvic or cardiac array multichannel surface coil. It is not advised to have an enlarged urine bladder since it might enhance phase ghost artefacts and squeeze the uterus. Placement of saturation bands along the anterior and posterior body fat walls is beneficial for reducing ghosting caused by respiratory motion artefact.

Using conventional closed MRI (GE sigma explorer) 1.5 T scanner equipment. Axial T1-weighted (TR/TE,500/10ms) and axial T2-weighted (TR/TE,3300/100ms) with slice thickness 6 mm, gap 1mm, FOV 32-42 cm and matrix 256x256. Sagittal T2- weighted and coronal T2- weighted with slice thickness 8-10 mm, gap 1mm, FOV 40-50 cm and matrix 256x256.Diffusion weighted imaging (DW-MRI) will be acquired in the axial plane prior to administration of contrast medium by using a single shot echo – planner imaging sequences. With *b* values (0,300,600) TR/TE ,5000/70 with slice thickness 6mm, gap 1mm, FOV 36-40 cm and matrix 128x128.CE MRI: Post contrast T1 fat – sat images were obtained immediately after manually injected gadolinium at a dose of 0.1 mmol/kg (Maximum 20 ml). Images were obtained sequentially at 0, 30, 60, 90 and 120 sec. A combination of T2 – weighted images, DWI-MR images sequences, and CE MR imaging were used in staging of cervical carcinoma.

Interpretation of DWI: On DW pictures, benign lesions had a low signal intensity, but the equivalent ADC maps exhibited a high signal intensity. Malignant lesions had a high signal intensity on DW images and a low signal intensity on ADC maps (Restricted), avoiding areas of decreasing signal intensity that may suggest necrotic areas. ADC maps were developed for the quantitative study of DWI. Tumor areas of interest (ROIs) were manually defined, then the mean ADC values ($x10^{-3}$) were automatically generated on the workstation.

Statistical analysis:

The data were tabulated and statistically analysed using SPSS programme software version 26.0, Microsoft Excel 2016, and MedCalC programme software version 19.0. Using the Shapiro Walk test, the normal distribution of the data was examined. The quantitative data were reported as the mean standard deviation (Standard deviation). Frequencies and relative percentages were used to depict qualitative data. Significative if the p value is less than 0.05 Analysis of the receiver operating characteristic (ROC) curve was utilised to determine the optimal cut-off value. For qualitative data, inferences were drawn using the Chi square test for independent groups. The level of significance was determined to be P value < 0.05.

Results:

According to patient characteristics and size and site of cervical mass of the studied patients, the majority of patients (65%) had cervical masses in supravaginal portion while 35% had lesions in vaginal portion. Table 1

Table (1): Average and range of age and size and site of cervical mass in the studied group

		Study group(n=20)
Age (years) Mean± SD		51.95±12.48
Age groups	**20- 30**	1 (5 %)
	>30- 40	3 (15 %)
	>40- 50	6 (30 %)
	>50- 60	6 (30%)
	>60	4 (20%)
Size of cervical mass	**Mean± SD**	4.99± 1.9
	≤ 5 cm	12 (60%)
	>5 cm	8 (40.0%)
Site of cervical mass	**Supravaginal portion**	13 (65.0%)
	vaginal portion	7 (35.0%)

SD= Standard deviation, data was presented as mean±SD or frequency and percentage

The mean value of DWI findings was 0.88± 0.25 (Table 2).

Table (2): DWI findings in the studied group

Parameters	Studied group(n=20)
DWI findings (Mean± SD)	0.88± 0.25

SD= Standard deviation, data was presented as mean±SD

There was statistically significant increase in the size of mass in patients with malignant tumor compared to benign tumor (p= 0.012). There was no statistically significant difference between benign and malignant groups regarding age (p= 0.222). Also, there was no statistically significant difference between benign and malignant groups regarding site of mass (p= 0.948). Table 3

Table (3): Comparison between benign and malignant masses regarding age of patient, size and site of mass

		Benign (n = 3)	Malignant (n = 17)	Test value	P-value
Age (years) Mean± SD		43.67± 13.32	53.41± 12.16	T=0.127	0.222
Size of mass (cm) Mean± SD		2.57± 1.29	5.41± 1.67	T=2.79	0.012
Site of mass	**Supravaginal portion**	2 (66.7%)	11 (64.7%)	X^2=0.004	0.948
	vaginal portion	1 (33.3%)	6 (35.3%)		

p≤0.05 is considered statistically significant, SD= standard deviation, comparison between groups done by Student T test

There was a significant increase in DWI findings in benign group compared to malignant group (p <0.001). **Table 4**

Table (4): Comparison between benign and malignant masses regarding DWI finding

	Benign (n = 3)	**Malignant (n = 17)**	**Test value**	**P-value**
DWI findings (ADC)	1.45± 0.09	0.78± 0.06	T=16.3	**<0.001**

p≤0.05 is considered statistically significant, SD= standard deviation,

The ROC curve showed that the best cutoff of DWI was ≤ 0.9 with 100% specificity and sensitivity. Figure1

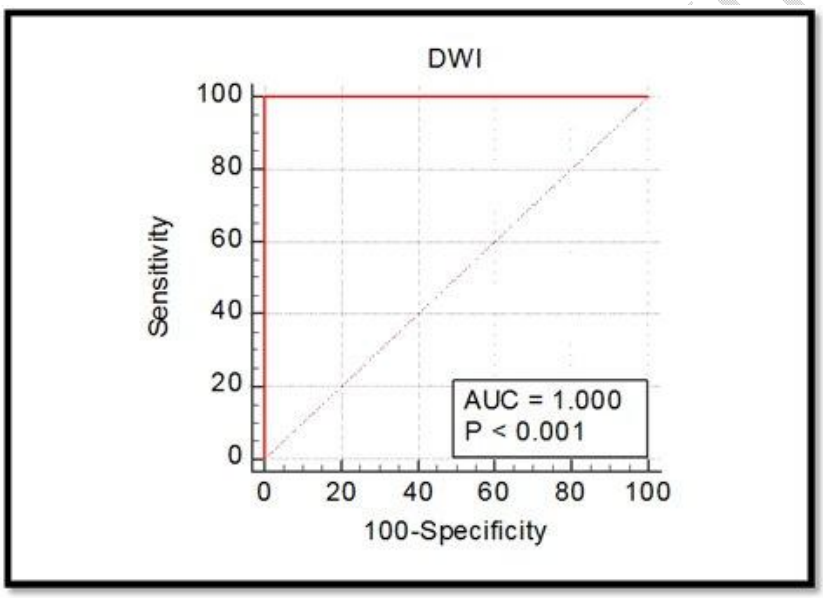
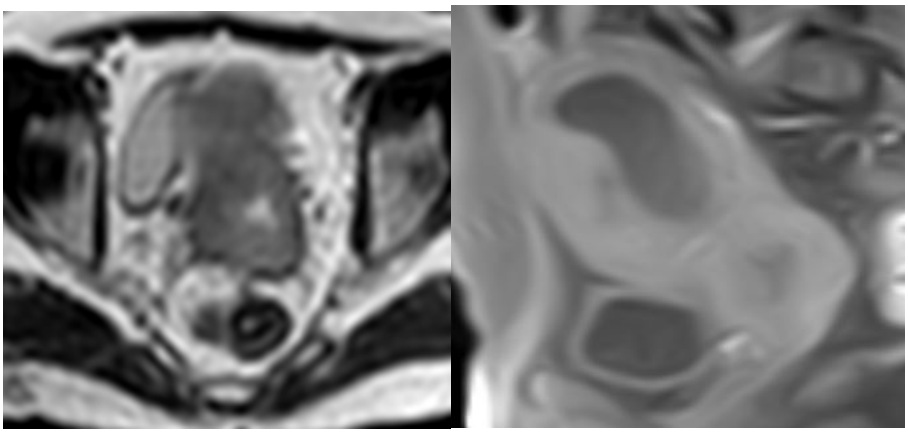


Figure (1): ROC curve of CT in prediction of malignant cervical lesions

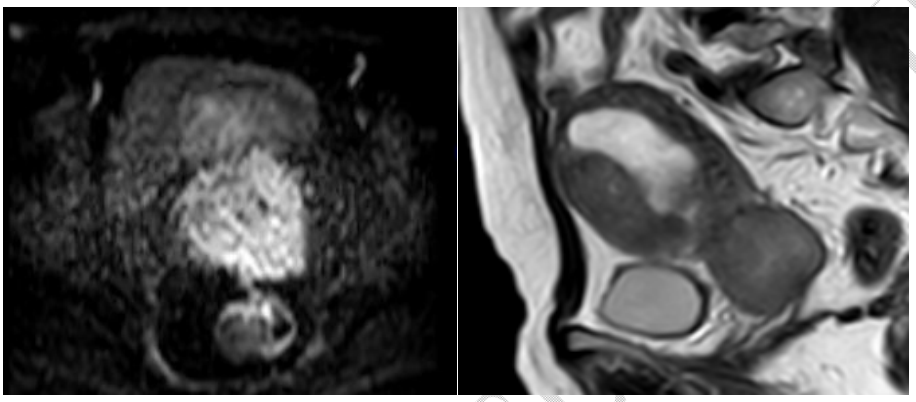
Illustrated Cases:

Case 1:

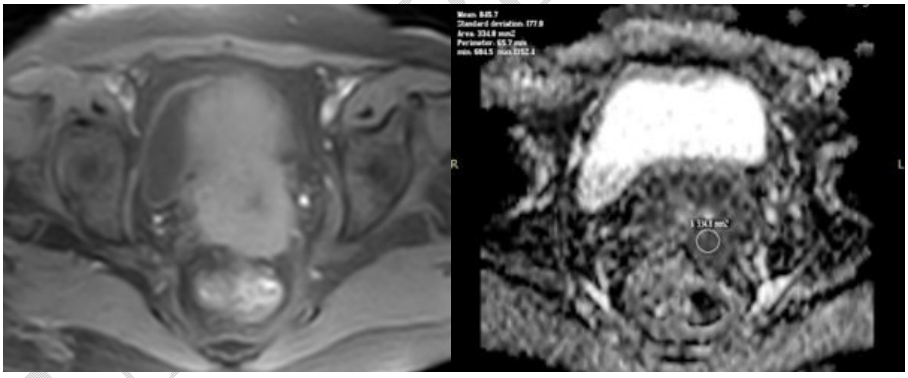
A seventy-six years-old female presented with vaginal bleeding; Vaginal US revealed cervical mass. Hence the patient was referred for pelvic MRI.



(A) Sagittal T1 **(B) Axial T2**



(C) Sagittal T2 **(D) DWI**



(E) Axial T1 with Contrast **(F) ADC**

Figure (2):

*** A: Sagittal T1 revealed heterogeneous cervical mass measuring 4.5x4.5x5.5cm (AP, Transverse, CC) dimensions, the mass showing low signal intensity in T1.**

*** B: Axial T2 revealed cervical mass high signal intensity in T2.**

*** C: Sagittal T2 revealed well defined cervical mass seen extending to the dome of the vagina obstructing the uterine cavity with retained blood within.**

*** D: Axial DWI showing restricted diffusion of the cervical mass**

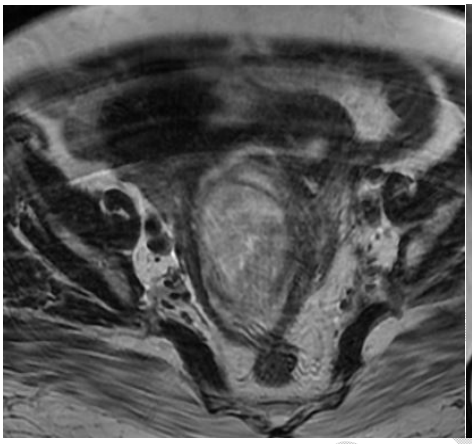
*** E: Axial T1 with contrast showing heterogeneous enhancement**

*** F: The apparent diffusion coefficient (ADC) map demonstrated heterogeneous enhancement of the cervical mass low ADC values (0.72 x10 $^{-3}$ mm^2/sec)**

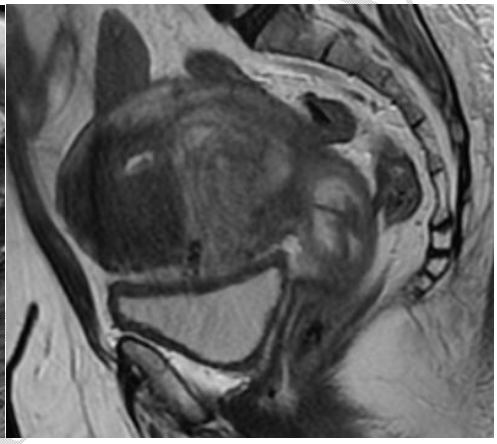
- MRI picture suggestive of cancer cervix.
- The mass proved to be squamous cell carcinoma histopathologically.

Case 2:

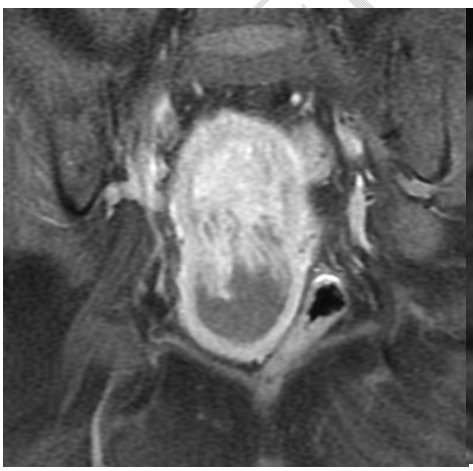
A sixty years old female presented with post-menopausal bleeding. Vaginal ultrasound revealed cervical mass. Hence the patient was referred for pelvic MRI.



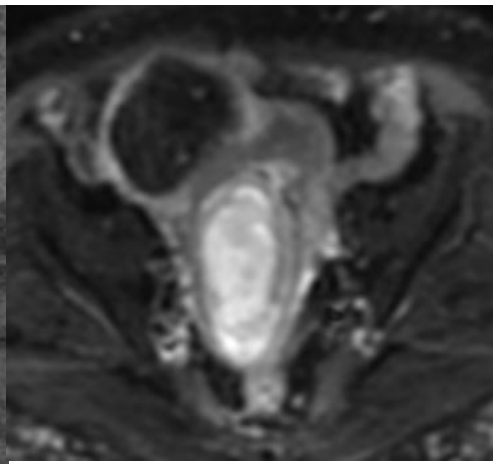
Axial T2



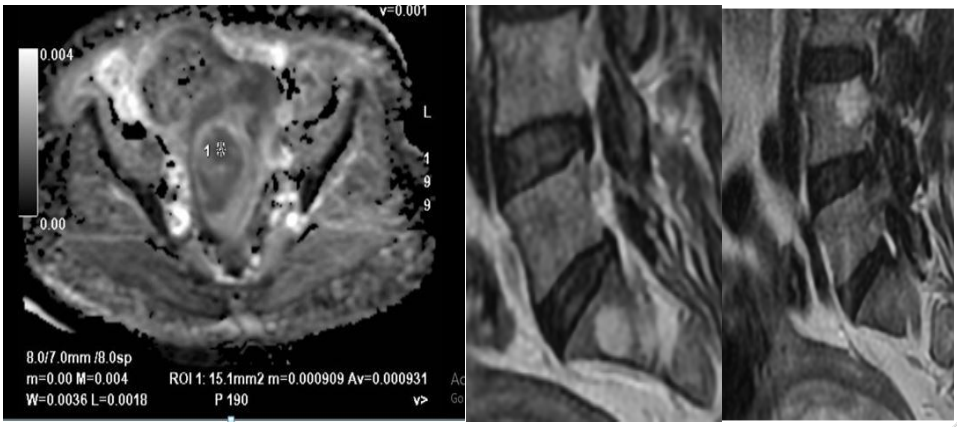
(B) Sagittal T2



(C) Coronal T1 with contrast



(D)Axial DWI



(E) AXIAL ADC **(F)Sagittal T2**

Figure(3):

***A&B: Axial and Sagittal T2WI MRI show large well defined cervical mass measuring 6.5x4x4.5cm (AP, Transverse CC) dimensions, the mass showing heterogeneous high signal intensity. The mass touching posterior wall of bladder with loss of fat plane separating between them.**

***C: Coronal T1WI MRI with contrast showing heterogeneous enhancement.**

***D: Axial DWI MRI show significant restriction in the form of high signal intensity of the mass.**

***E: ADC map showing low value of the cervical mass = (0.9×10^{-3} mm^2/sec).**

***F: Sagittal T2W2 MRI show metastatic lesion in vertebrae L4 and S1 in the form of low signal intensity T1 and high signal intensity T2**

- MRI picture suggestive of cancer cervix.
- The mass proved to be squamous cell carcinoma histopathologically

Discussion

Cervical cancer is one of the most common cancers identified in women, affecting roughly 16 out of every 100,000 women. It is the third most prevalent female genital cancer in the globe, behind uterine body and ovarian cancers [1-3]. In Egypt, cervical cancer is the 13th most common disease and the 10th most common cancer between the ages of 15 and 44. [10]. This study was done on 20 female patients their age 30-76 years (Mean age ±SD= 51.95± 12.48 years) Age distribution in our study coincides with **Mokhtar et al.** [11] A biopsy verified the

presence of cervical cancer in 70 women in whom it had been suspected clinically or by transvaginal ultrasound. The ages of their patients ranged from 38 to 82 years (mean age 59.4). Regarding the age, **Elkady et al.** [12] found that the most common age group affected by cancer cervix was between (30-70) years old and that the mean age of the studied group was 50 ±10.56. This coincides with our study. The mean age of patients was 51.95± 12.48 years similar figure was observed in the **Mansour et al.** [13] study, which reported that the age of the patients ranged from (30-80) years old and the mean age was 49. **Lin et al.** [14] found that the age of their patients in their study ranging from 30 – 87 years with mean age 56 years. And this coincides with our study. Concerning Mass size, our study revealed that mean size of the cervical masses was 4.99± 1.9 cm and it ranged from 1.5 to 8.3 cm. the majority of patients (60%) had cervical masses less than or equal 5 cm while 40% had lesions more than 5 cm. Opposite to our results, **Mokhtar et al.** [11] stated that the cervical masses size ranged between 2–5 cm in 20% of their patients and more than 5 cm in approximately 80% of them. As regards the pathological examination, the majority of our cases were malignant (85%) while only 15% were of benign nature. This proportion was to some extent in accordance with **Mokhtar et al.** [11] who documented that 94.3% of cases were diagnosed as malignant cervical lesions while only 5.7% had benign lesions. Regarding the pathology: **Elkady et al.**[12] they found squamous cell carcinoma represents (61.5%) of cases indicates the commonest histological type of cancer cervix.

This is in agreement with our study, pathological types among our studied group. Squamous cell carcinoma was the most common type presented in our study group (60%) while leiomyoma was the least type found (5%). This incidence was nearly compatible with the studies done by **Mansour et al.** [13], which reported that the most common pathological type of the examined cancer cervix was the squamous cell carcinoma representing 72% of the total studies cases.

In our study, the ADC values were calculated for the malignant cervical lesions and the benign lesions. There was statistically significant decrease in DWI values in patients with malignant tumor compared to benign tumor ($p< 0.001$). The mean ADC values for malignant lesions was $0.78 \times 10^{-3} \pm 0.06$ SDmm^2/s while the mean ADC value for benign lesions was 1.45×10^{-3} mm^2/s. This was in agreement with **Mokhtar et al.**[11] the mean ADC values for malignant lesions in their work was $0.82 \times 10^{-3} \pm 0.1$ SDmm^2/s while the mean ADC value for benign lesions was 1.56×10^{-3} mm^2/s. This also was in agreement with **Kuang et al.** [15] discovered that the mean ADC values for cervical cancer were $0.916 \times 10^{-3} \pm 0.15$ SDmm^2/s, $1.396 \times 10^{-3} \pm 0.15$ SD mm^2 /s, and $1.426\ 10^{-3} \pm 0.11$ SD mm^2 /s for cervical polyp. At both ADC maps, a significant differences between the ADC values of cervical cancer and those of benign cervical lesions was observed (leiomyoma and polyps; $P < 0.001$); however, insignificant difference between cervical leiomyoma and polyps was found.

Our study agreed with **Rauch et al.** [16] who concluded that cervical cancers appeared hyperintense on DW images. The malignant tissue ADC value was significantly low in comparison to the normal tissue as the mean ADC values of cervical carcinoma were 0.75×10^{-3} mm^2/s. These corresponded to **Lin et al.** [14] study which suggests that cervical malignant tissue appeared to be hyperintense on DWI and the ADC value measurement was significantly low; as the mean ADC values for cervical carcinoma (0.69×10^{-3} mm^2/s).

Regarding to CE MRI, **Mokhtar et al.** [11] Contrast-enhanced MRI revealed heterogeneous post-contrast enhancement in 40/70 (57%) patients, homogeneous post-contrast enhancement in 20/70 (28.5%), and mural enhancement in 4/70 (9%) patients. Contrast-enhanced MRI revealed heterogeneous post-contrast enhancement in 17/20 (85%) instances, homogeneous post-contrast enhancement in 1/20 (5%) cases, and no contrast enhancement in 2/20 (10%) cases, according to our findings. Our results were in agreement with **Marwa et al.** [17] who found that in Dynamic contrast-enhanced MRI (DCE-MRI) showed heterogeneous post-

contrast enhancement in 17/20, (85%), homogenous post-contrast enhancement in 2/20 (10%) and mural enhancement in 1/20 (5%) cases. In the present study using ROC-curve analysis, DWI predicted patients with malignant lesion with accuracy, sensitivity, specificity, PPV and NPV was 100%, 100%, 100%, 100% and 100% respectively ($p< 0.001$). The cut off value was ≤ 0.9. The area under the curve was 1.00 (0.832-1.000) with a significant P value < 0.001.

On the other hand, **Mokhtar et al.** [11] reported that DWI-MRI demonstrated 100% sensitivity, 50% specificity, 97% accuracy, 97% PPV, and 100% NPV. They attributed the poor specificity % in their investigation to the small number of truly negative patients. Chen et al. [18] determined that the sensitivity and specificity of DW-MRI for detecting tumours were 100 percent and 84.8%, respectively. **Kuang et al.** [15] reported 75 cases of cervical cancer and 47 cases of benign cervical lesions (25 cases of cervical leiomyoma and 22 cases of cervical polyps), and that DWI-MRI performed significantly better than routine MRI and revealed high accuracy (0.95); 95% sensitivity, 96% specificity, 95% accuracy, 97% positive predictive value, and 92% negative predictive value.

Conclusions:

DWI predicted patients with malignant lesion of uterine cervical mass at cut off value ≤ 0.9 with 100% accuracy, 100% sensitivity, 100% specificity, 100% PPV and 100% NPV.

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