International Journal of Chemical and Biochemical Sciences
(ISSN 2226-9614)

Journal Home page: www.iscientific.org/Journal.html

Evaluation of the Role of the Apparent Diffusion Coefficient in Differentiating Benign from Malignant Endometrial Lesions

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Abstract

Diffusion-weighted imaging (DWI) is a unique, noninvasive modality that provides excellent tissue contrast and was shown to improve the radiological diagnosis of malignant tumors. Purpose to evaluate the role of apparent diffusion coefficient (ADC) in differentiating benign from malignant endometrial lesions. Fifty patients present with endometrial lesions, their ages ranged from 24 to 75 years. Conventional T1, T2 weighted, and DW-MRI images with b values 0, 1000 s/mm2 were obtained. The mean ADC values of all lesions were calculated and recorded. Results were correlated with the final histopathological diagnosis reached by dilatation and curettage (D&C) or hysterectomy. After histopathological examination of 50 lesions, we found that when a cut-off value of (1.1x10-3mm2/s) was used for the ADC value, the sensitivity, specificity, PPV, NPV, and total accuracy rates were determined as 100%, 89%,100% 90.6% and 94% respectively. The mean ADC value for the malignant lesions was (0.90 ±0.05x10-3mm2/s) which was significantly lower than that for the benign lesions (1.35±0.04x10-3mm2/s). DWI and ADC together were found to be of high sensitivity and specificity in detecting and differentiating benign and malignant endometrial lesions. It is a non-invasive technique that adds more to the total accuracy of the conventional MR exam, increasing the confidence of the diagnosis.

Keywords: Endometrial Lesions –Diffusion Weighted Imaging-Apparent Diffusion Coefficient.

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1. Introduction

Endometrial cytology, biopsy, and curettage have been the cornerstones for reliably diagnosing endometrial cavity lesions. As these processes are commonly conducted blindly, however, they do not constantly give a decisive diagnosis. In addition, they are difficult to perform in patients with vaginal or cervical stenosis [1]. Diffusion weighted imaging (DWI) is a unique, noninvasive modality that provides excellent tissue contrast and was shown to improve the radiological diagnosis of malignant tumors. DWI is a method to visualize the three-dimensional microscopic movement of water molecules within the intra- and extracellular compartments. DWI visualizes the variability in water mobility due to changes in tissue cellularity, cell membrane integrity, and fluid viscosity. The more restricted the movement of water, the higher the signal intensity generated on DWI [2]. The apparent diffusion coefficient (ADC) can provide quantitative assessment by using different b-values to calculate the degree of diffusion; restricted diffusion is displayed as low signal intensity on an ADC map. The movement of water molecules is typically restricted within the tumor microenvironment due to the increased cellularity. Due to this restriction in movement of water molecules, most tumors demonstrate higher DWI signal intensity and lower ADC values when compared with adjacent normal tissue. Because of increased conspicuity, DWI can be utilized to improve tumor detection, staging, and response assessment [2].Using quantitative apparent diffusion coefficient (ADC) measurement of DWI provides a new tool for better distinguishing malignant from benign tumors. Interestingly, there is also evidence that ADC might improve the follow-up and monitoring of patients who receive anticancer therapies, including chemotherapy or radiation therapy [3]. The aim of this study is to evaluate the role of the apparent diffusion coefficient (ADC) in differentiating benign from malignant endometrial lesions.

1.1 Patients and Methods

This study was an observational prospective study conducted in Fayoum university hospital radiology department, including patients from the gynecology

outpatient-clinic, after approval of research and ethical committee. Population of study and sample size: Fifty patients presented with vaginal bleeding and preliminary pelvic ultrasound revealed endometrial lesion.

1.2 Inclusion criteria:

All patients were sent to Fayoum university hospital radiology department for evaluation of endometrial lesions and patients who consent.

1.3 Exclusion criteria:

Patient with absolute contraindication to MRI examination, declined consent, declined biopsy, and known histology.

2. Materials and methods:

Our study was conducted between November 2018 – June 2021. A MR imaging study of the pelvis was performed using Toshiba Vantage Titan 1.5T machine with phased array coil.

2.1 Statistical analysis:

Continuous variables were expressed as mean ± standard deviation or median (interquartile range), as appropriate based on the data distribution. Categorical variables were presented as frequency (percentage). Between-group comparisons for continuous data were performed using the student's t-test or Wilcoxon tests. The Chi-squared test or Fisher's exact test was used for categorical variables.

2.2 Ethical committee approval:

Informed consent from patients who are invited to participate in the research.

3. Results and Discussion

This study was conducted in Fayoum university hospital radiology department, between November 2018 – June 2021 including fifty patients presenting with abnormal uterine bleeding and preliminary pelvic ultrasound showing increased endometrial thickness or endometrial masses. Fifty patients were included in this study with the mean patient age was 52.5 ± 9.7 years (range 24-75 years), twenty-nine of them had benign lesions and twenty-one had malignant lesions presented in Table 1. The apparent diffusion coefficient (ADC) can provide quantitative assessment by using different b-values to calculate the degree of diffusion; restricted diffusion is displayed as low signal intensity on an ADC map [2]. Using quantitative apparent diffusion coefficient (ADC) measurement of DWI provides a new tool for better distinguishing malignant from benign tumors presented in Table 2. Interestingly, there is also evidence that ADC might improve the follow-up and monitoring of patients who receive anticancer therapies, including chemotherapy or radiation therapy [3].

The aim of this study was to evaluate the role of the apparent diffusion coefficient (ADC) in differentiating benign from malignant endometrial lesions. In this prospective study conducted at Fayoum University hospital-radiology department, fifty patients presented with vaginal bleeding, and preliminary pelvic ultrasound revealed an endometrial lesion. The mean patient age was 52.5 ± 9.7 years. Twenty-one patients (42%) had malignant lesions (pathologically proven), eight of the malignant lesions were high-grade adenocarcinoma, and thirteen were well-differentiated endometrial carcinoma presented in Table 3. The mean ADC value of the malignant lesions was (0.90x10-3mm2/s). In this study, at a cutoff value =1.1x10-3mm2/s for ADC, the sensitivity was (100%), the specificity was (89%), the positive predictive value was (100%), the negative predictive value was (90.6%), and the total accuracy was (94%). The ADC values of the malignant lesions (0.90x10-3mm2/s) were significantly lower than those of the benign lesions((1.35x10-3mm2/s); this agrees with Çavuşoğlu, et al., [4] who stated that the mean ADC value was (0.8 x10 -3mm2/s) for endometrial cancer and the mean ADC value was (1.7x10-3mm2/s) for benign lesions with best cut off value of ADC to discriminate between benign and malignant lesions was(1.2 x10-3mm2/s) and Fujii et al., [5] who reported that the ADC values differed significantly between malignant (0.98±0.19) and benign lesions (1.44±0.34) at ADC value less than (1.15×10-3 mm2/s) as presented in Table 4.

As regards benign lesions, simple endometrial hyperplasia is the most common benign pathology detected in this study (ten cases) with a mean ADC value of about (1.41±0.24x10 -3mm2/s). This agrees with El-Sammak et al. [6], who reported endometrial hyperplasia as the most detected benign pathology in their study (fourteen cases) with a mean ADC value of about (1.43x10-3mm2/s). Mansour et al. [7] examined six cases of endometrial polyps, and all of them displayed homogeneous high T2 SI. They showed facilitated diffusion apart from one case showed restricted diffusion. The mean ADC value was about (1.865 ± 0.18x10-3mm2/s). In this study, six of the benign lesions were endometrial polyps; all of them displayed hyperintense SI in T2, DWI as well as ADC with high ADC values denoting facilitated diffusion. The mean value of ADC for endometrial polyp was (1.4±0.20x10 -3mm2/s). DWI and ADC together were found to be extremely sensitive and specific in detecting and differentiating benign and malignant endometrial lesions. This noninvasive technique increases the total accuracy of the conventional MR exam, increasing the confidence in the diagnosis.

3.1 Recommendation:

To increase confidence in the diagnosis, we recommend adding ADC examination and ADC value calculation to the conventional MR exam assessment of endometrial lesions.

Table 1: Descriptive statistics of patients according to age

Variable	Mean ± SD	Range
Age	52.5 ± 9.7	24-75

Table 2: Distribution of studied patients according to type of tumor

Type	N	%
Malignant:	21	42.0
Benign:	29	58.0
Total	50	100.0

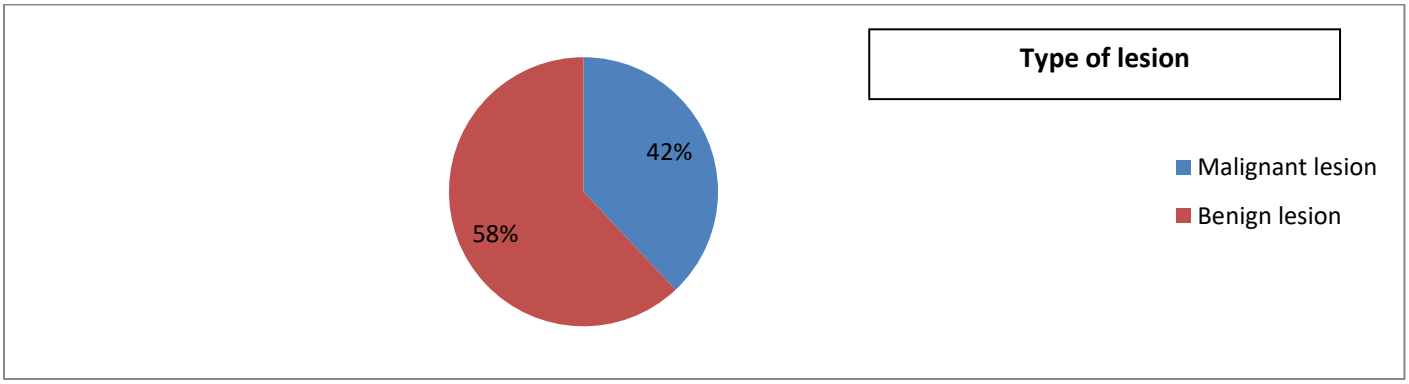


Fig. 1. Distribution of studied patients according to type of tumor.

Types of malignant lesions: eight of the malignant lesions were high grade adenocarcinoma (38%) and thirteen were well differentiated endometrial carcinoma (62%).

Table 3: Types of malignant lesions

Diagnoses	N	%
High grade adenocarcinoma	8	38.0
Well differentiated endometrial carcinoma	13	62.0
Total	21	100.0

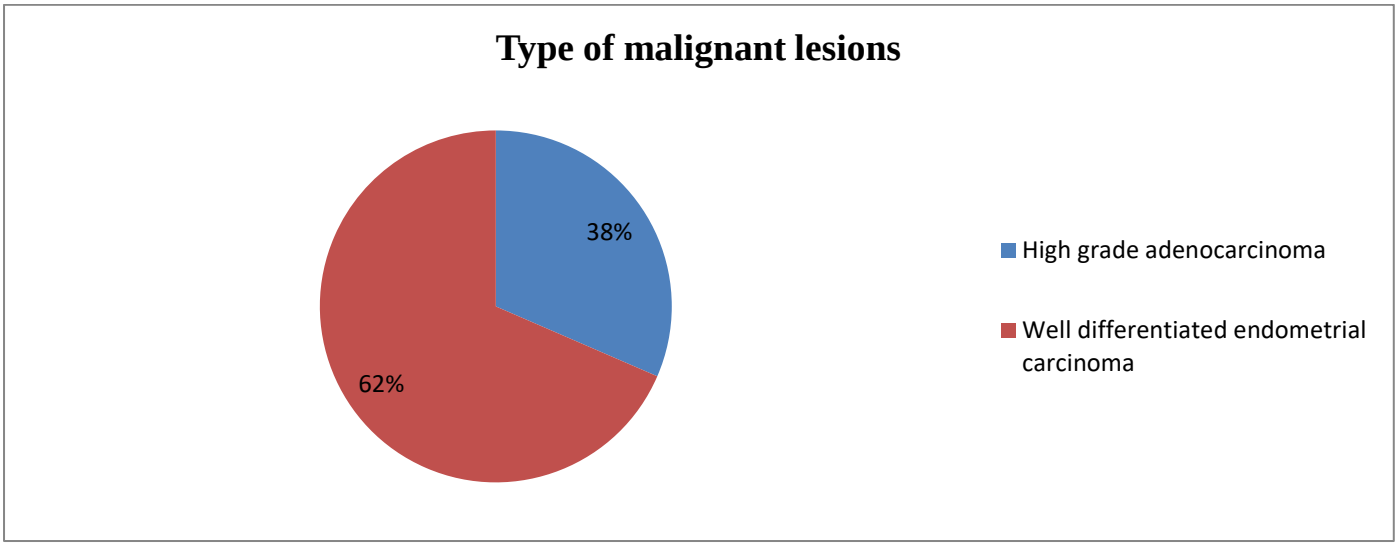


Fig. 2: Types and percentage of malignant lesions

Types of benign lesions: six of the benign lesions were disordered proliferative endometrium (21%), six were endometrial polyp (21%), ten were simple endometrial hyperplasia (34%) and seven were simple endometrial hyperplasia with polyp formation (24%).

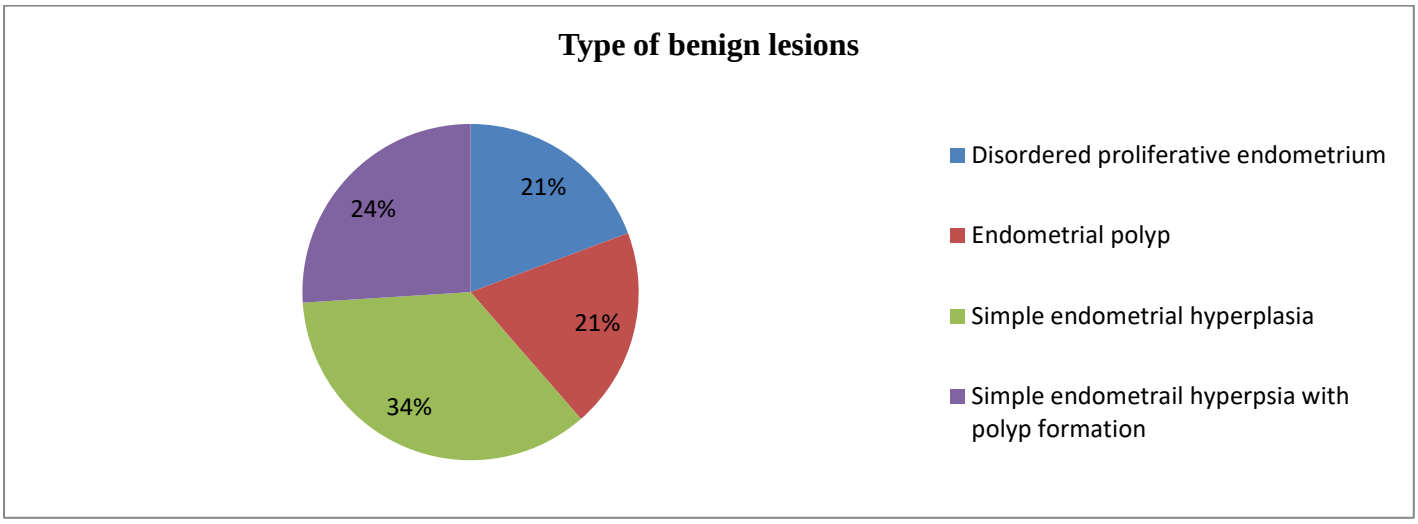


Fig. 3: Types and percentage of benign lesions

Table 4: Differences in ADC value as regards type of lesion

	Mean	SD	Range		P-value
Malignancy					
Malignant	0.90	0.05	0.80	1.1	<0.0001 (S)
Benign	1.35	0.04	0.90	1.80	
Pathology					
Disordered proliferative endometrium	1.38	0.15	1.20	1.60	<0.0001 (S)
Endometrial polyp	1.40	0.20	1.20	1.60	
Simple endometrial hyperplasia	1.41	0.24	1.10	1.80	
Simple endometrial hyperplasia with polyp formation	1.48	0.23	1.20	1.70	
High grade adenocarcinoma	0.84	0.04	0.80	0.91	
Well differentiated endometrial carcinoma	0.94	0.04	0.80	1.1	

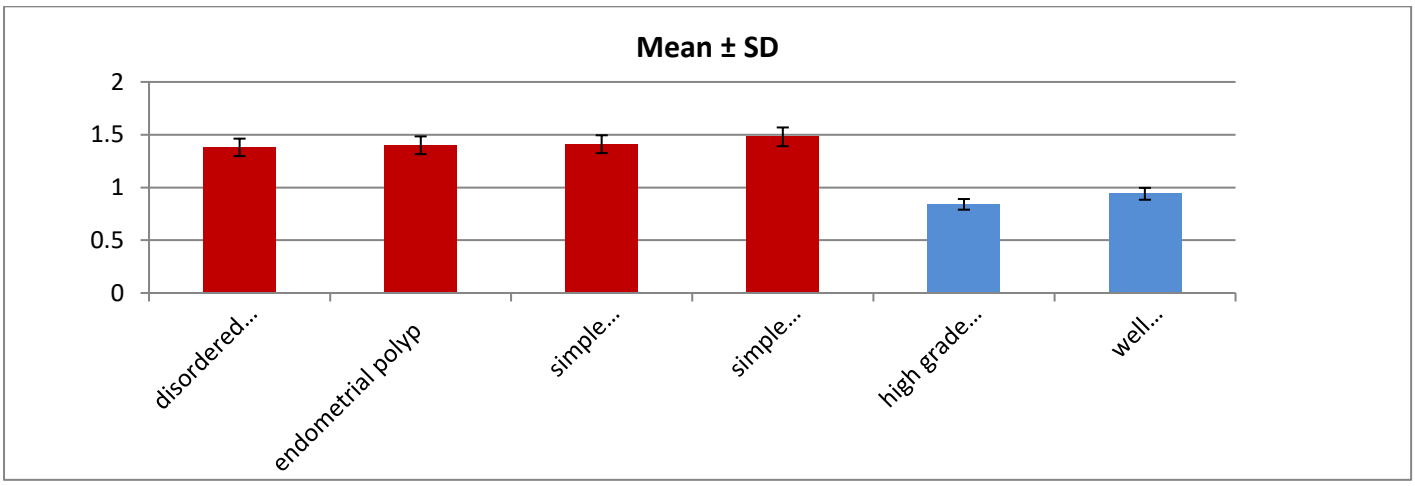


Fig. 4: Mean of ADC value of different pathologies

Diagnostic accuracy of ADC compared to final pathological diagnosis in differentiating malignant from benign lesions: The ADC shows (100%) sensitivity, (89%) specificity, (100%) positive predictive value, (90.6%) negative predictive value and (94%) total accuracy when the cutoff value =1.1x10^{-3}mm^2/s, area under curve (AUC) = 0.993, P value = <0.0001.

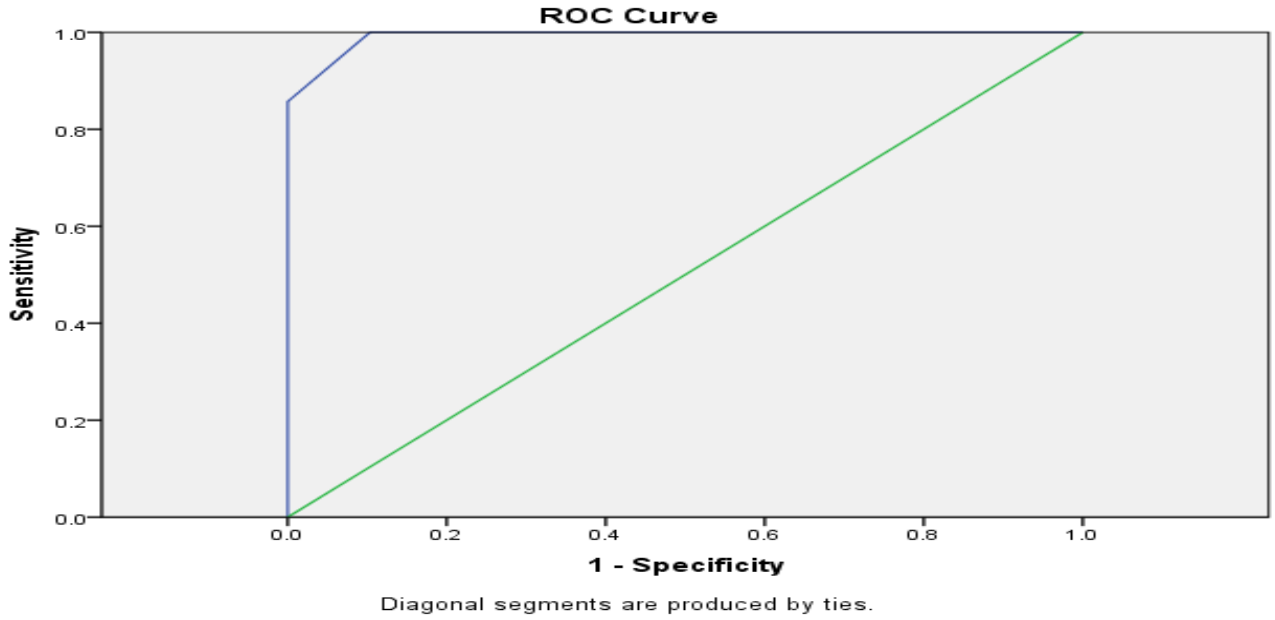


Figure 5 : ROC curve of ADC Value, when cut off value of1.1x10-3 mm2/s, area under curve (AUC) =0.993, P value = <0.0001

Case No.1: A 61-year-old female patient presented with postmenopausal bleeding, pathologically proven to be well differentiated endometrial carcinoma.

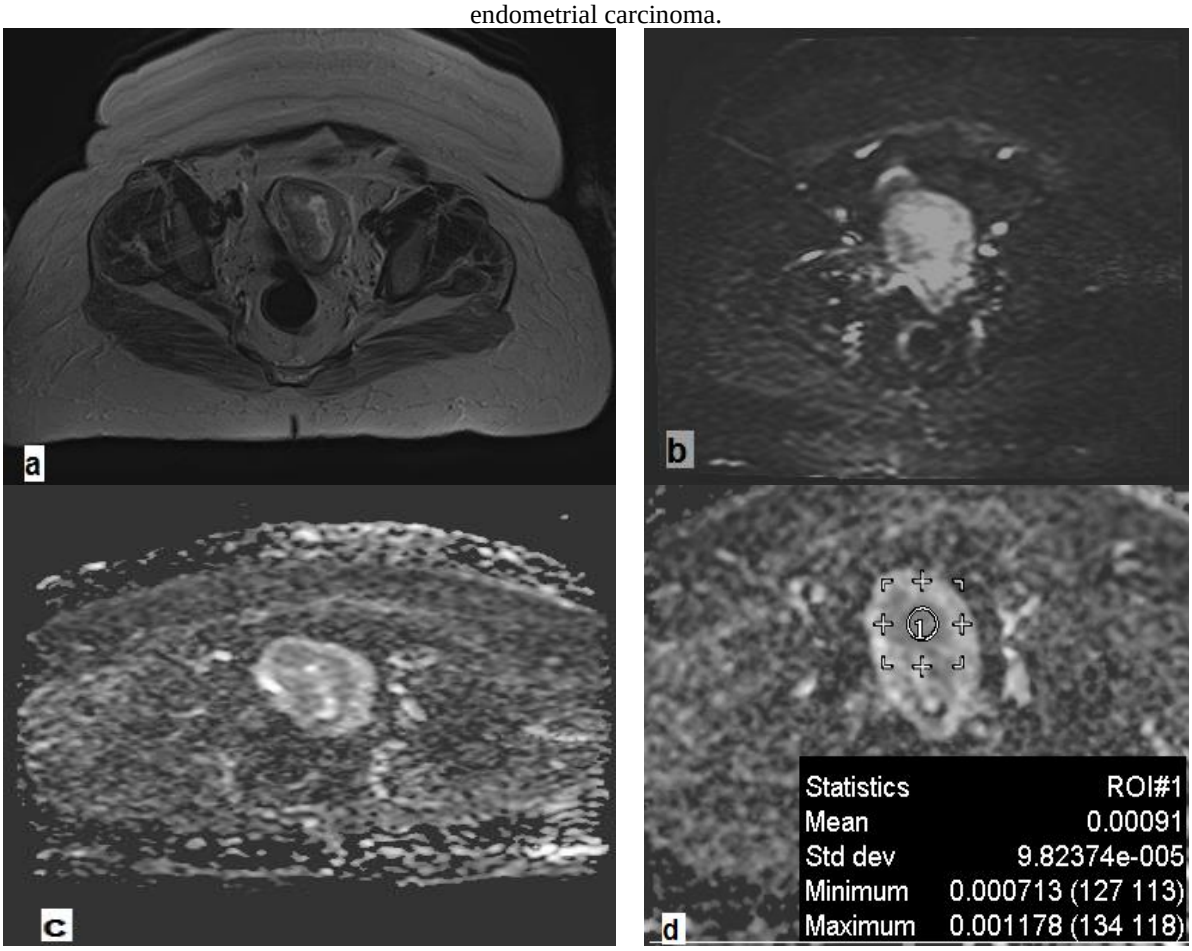
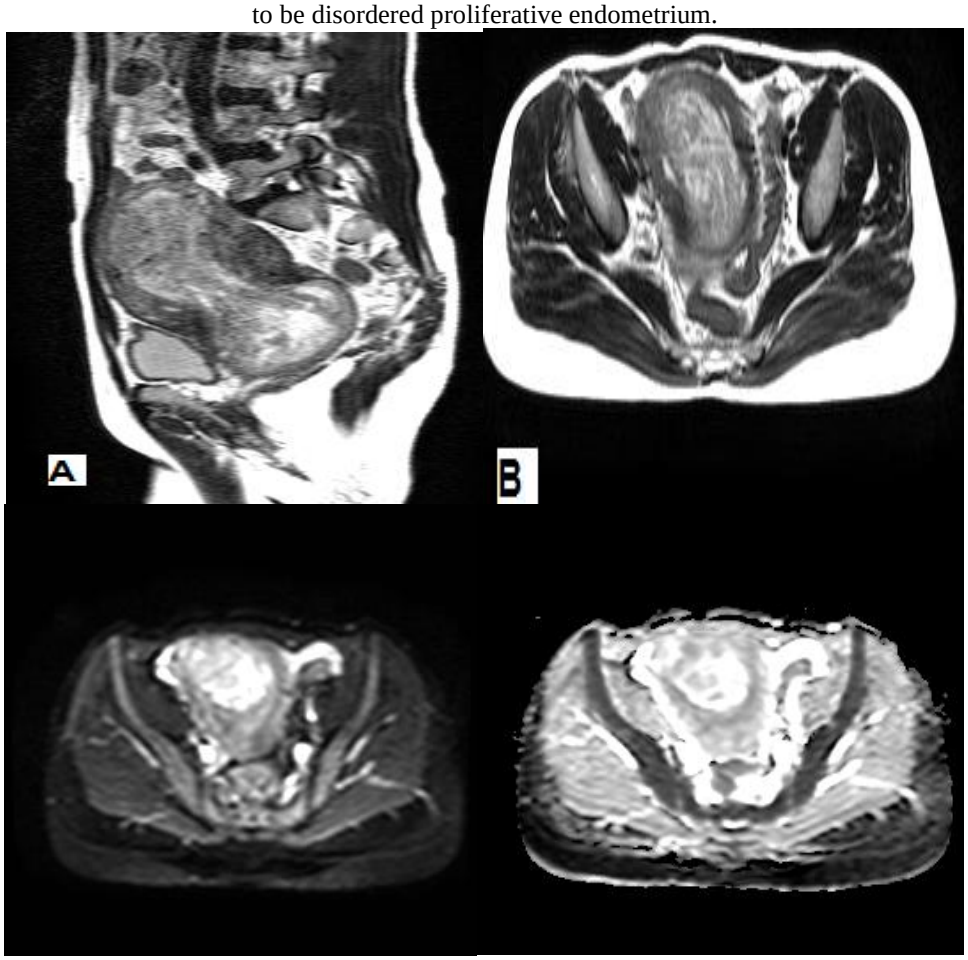


Figure 6: (a) Axial T2-WI showing low SI endometrial mass. (b) Axial DWI showing high SI, (c) axial ADC map showed restricted diffusion (low ADC signal). (d)The ADC value was measured=0.91 x10 $^{-3}$ mm^2/s, pathologically proven well differentiated endometrial carcinoma.

Case No.2: A 24-year-old female patient presented with mass protruding from the cervix, the mass reaching up to (45 mm) at maximal AP diameter in the uterine cavity and up to (70 mm) at maximal AP diameter in the cervical canal ,pathologically proven to be disordered proliferative endometrium.



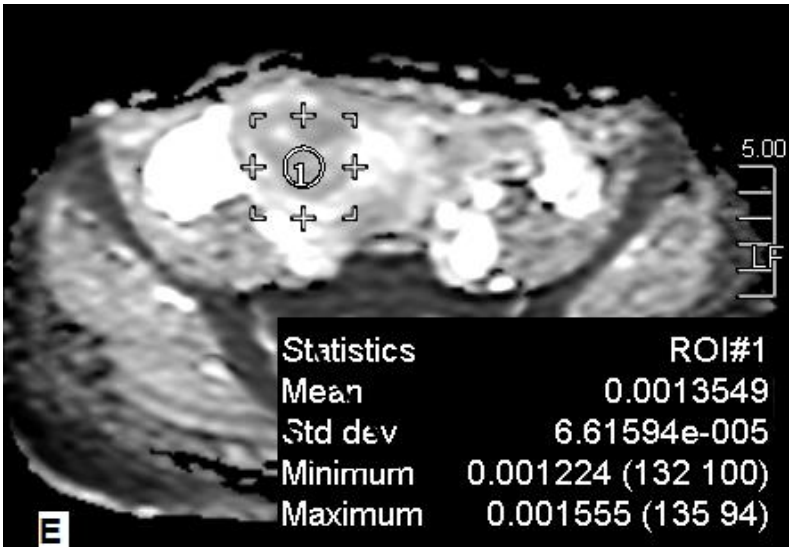


Fig. 7: (A) and (B) sagittal and axial T2 WIs showing large endocervical mass distending the uterine cavity protruding through the cervix and displaying inhomogeneous hyperintense SI, (C) and (D) axial DWI and ADC WIs showing the mass displaying mixed hypo and hyperintense SI, (E) shows the ADC value of the lesion of about (1.3x10-3mm2/s), pathologically proven to be disordered proliferative endometrium

Case No.3: A 58-year-old female patient presented with perimenopausal bleeding with endometrial thickness of about (20 mm), pathologically proven to be simple endometrial hyperplasia.

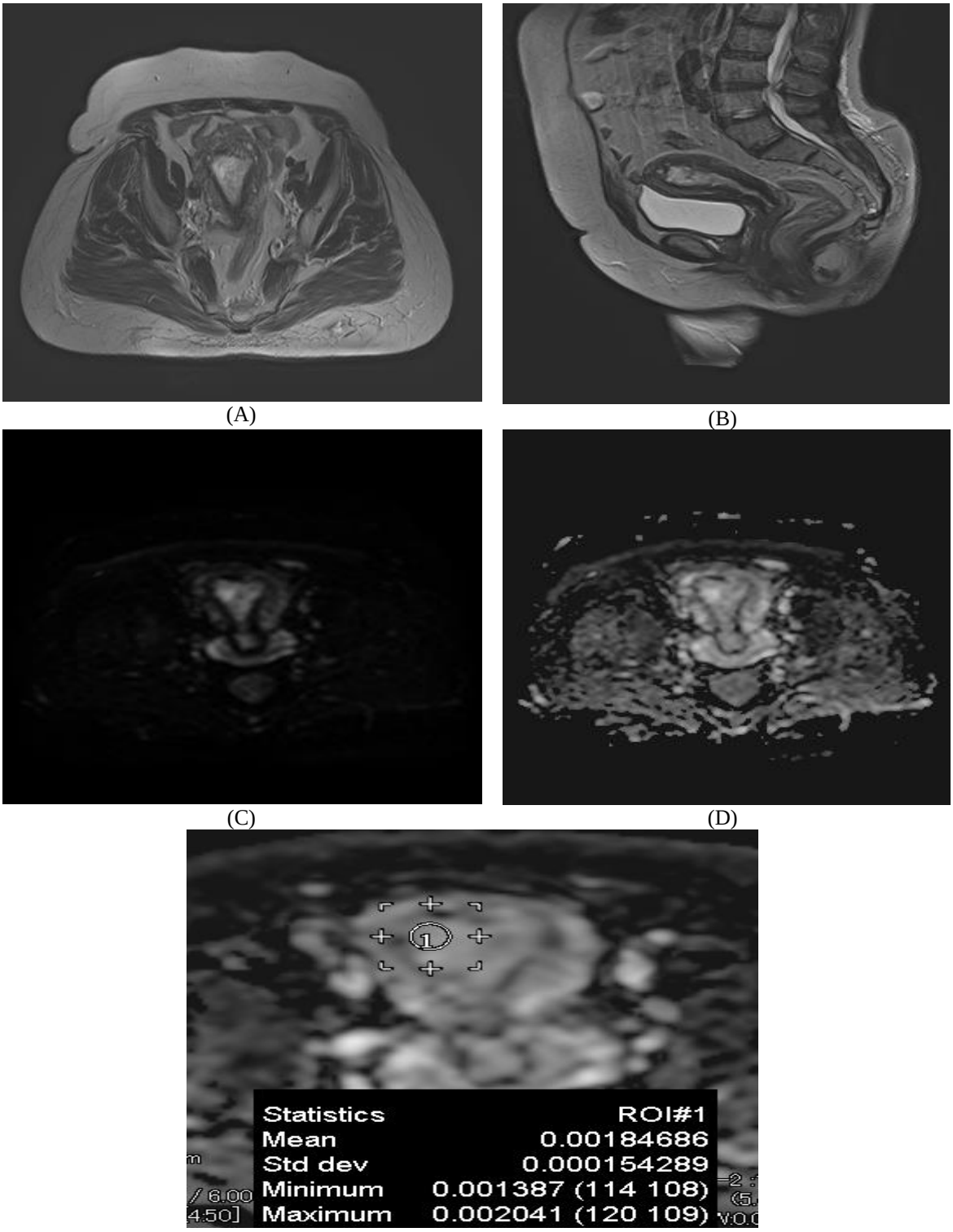


Fig. 8 : (A) and (B) axial and sagittal T2 WI showing increased endometrial thickening that displayed hyperintense SI, (C) and (D) are DWI and ADC images showing hyperintense SI of the lesion,(E) ADC value of the lesion is of about ($1.8x10^{-3}$mm2/s),pathologically proven to be simple endometrial hyperplasia

Case No.4: A 36-year-old patient presented with menorrhagia and examination revealed mass protruding from the cervix, pathologically proven to be endometrial polyp.

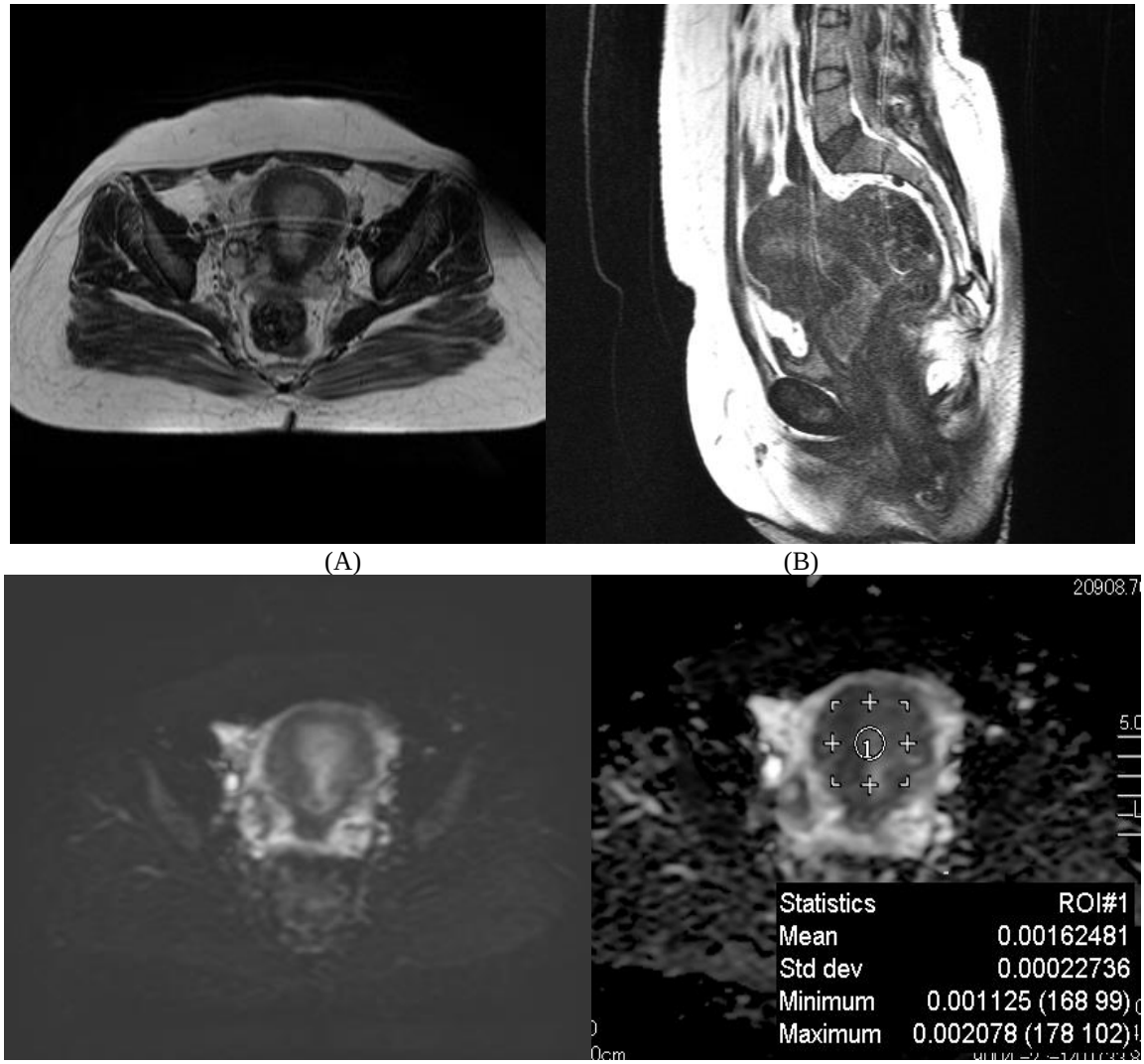


Fig. 9: (A) and (B) axial and sagittal T2 WIs showing hyperintense endometrial lesion, (C) DWI showing hyperintense SI of the lesion that remains hyperintense in ADC map with ADC value of about ($1.6x10^{-3}mm^2/s$), pathologically proven to be endometrial polyp.

4. Conclusions

DWI and ADC together were found to be of high sensitivity and specificity in detecting and differentiating benign and malignant endometrial lesions. It is a non-invasive technique that adds more to the total accuracy of the conventional MR exam increasing the confidence of the diagnosis.

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