Histogram-based diffusion metrics for differentiation of benign & malignant gynecologic lesions

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Abstract---Purpose: To evaluate the ability of ADC based histogram parameters to differentiate between benign and malignant gynecologic lesions. Results: The study was performed on 100 cases having 66 benign lesions & 34 malignant lesions which were pathologically proved. There was statistically significant difference between benign and malignant lesions on qualitative diffusion weighted. The range of traditional partial slice mean ADC parameter for benign masses was $(1.095 \pm 0.315 \times 10^{-3} \text{ mm}^2/\text{s})$ and for malignant lesions was $(0.791 \pm 0.244 \times 10^{-3} \text{ mm}^2/\text{s})$ which was lower than the values of the benign lesions. There was statistically significant difference as regard mean and minimum ADC values (P = 0.01*). The cutoff mean & minimum ADC values used to differentiate benign lesions from malignant lesions were 0.905 & 0.680 x 10−3 mm2/s, respectively. We found that The sensitivity, specificity and accuracy of partial slice mean ADC were higher than histogram mean ADC. Conclusions: Mean & minimum ADC can differentiate between benign and malignant gynecologic lesions with less diagnostic performance than traditional partial slice mean ADC.
Introduction

Female genital tract tumors include endometrial, ovarian, cervical, vaginal and vulval cancer. Endometrial carcinoma (EC) is considered the most common female gynecologic malignancy. It is the fourth most common female genital tract tumor in the United States. While, in developing countries, it is considered the second most common female genital tract tumor. Outcome of the tumor depends on female age, tumor grade, myometrial infiltration and/or cervical stromal infiltration as well as the nodal infiltration. Preoperative imaging is essential in proper treatment planning (1).

Cervical carcinoma is considered the third commonest female genital tract tumor in the world, and although the occurrence is lower in the developed countries because of cervical screening, it is still the commonest cancer causing death in the young female (2). For diseased women, accurate staging and grading causing accurate & efficient treatment with better prognosis (3). Worldwide, ovarian neoplasm is considered the fifth most common female genital tract tumor. Sonography is the first imaging radiologic tool for the diagnosis of ovarian cancer (4). Preoperative etiologies of radiological indeterminate ovarian masses is crucial to avoid unnecessary surgeries in cases with benign ovarian lesions & to reduce the risk of missing neoplastic lesions (5). Primary vulvar cancer is uncommon tumor, representing from 5% to 8% of all female genital tract tumors in the United States (6).

Radiologic evaluation is an important diagnostic tool in patients with gynecologic tumors for disease extent and treatment planning. The essential roles for MR imaging are assessment of cervical & uterine local disease spread and characterization of the ovarian lesions (7). Non-functional (conventional) MRI provides uterine information, but, the lesion morphology still may not differentiate some of the benign and malignant uterine lesions (8). Furthermore, conventional MRI findings can't diagnose indeterminate ovarian masses and complementary radiologic sequences must be used to improve the diagnostic accuracy (9). DWI gives an idea about motion of water molecules, tissue cellularity, and the intact cell membrane (10). The quantitative apparent diffusion coefficient (ADC) value is derived from two or more b values. The 3-dimensional (3D) diffusion-based values give overall lesions information including the whole lesion heterogeneity (11).

Methods

Study population

This prospective study was done from February 2020 till February 2022 in the radiology department of teaching University Hospitals. 100 female patients were included in the study. Patients with clinically or sonographically detected gynecological lesions and patients with pathologically proven gynecological malignancies were included in our study. Patients with absolute contraindication
for MRI as aneurysm clips, coronary, peripheral artery stents and patients who refused to participate in the study were excluded.

**MR acquisition**

MRI was performed using a 1.5 T magnet (Ingenia; Philips Medical Systems, Best, Netherlands). Patients lie in a supine position using Phased array coils for abdominopelvic studies. The imaging protocol consisted of a conventional MRI and functional MRI including diffusion weighted image (DWI).

The conventional MRI protocol included High-resolution different T2WI planes including both axial & sagittal with the following parameters; repetition time (TR)/echo time (TE) range 3304–6310/46–120 milliseconds., field of view (FOV) 20–25 cm., slice thickness 4–6 mm., interslice gap 1–2 mm. and matrix 180 × 354 to 360 × 510. We performed axial T1 weighted imaging using the following parameters; repetition time/echo time range 380–720/7.5–15 milliseconds. Field of view 20–25 cm. slice thickness 5–6 mm. interslice gap 1–3 mm and matrix 178 × 322 to 282 × 402. We did coronal STIR using the following parameters; TR/TE range 452–656/12–18milliseconds. FOV 22–26 cm. slice thickness 4mm. interslice gap 1mm and matrix 162 × 222.

Functional diffusion was obtained in the axial plane using a single-shot EPI with the following parameters; repetition time/echo time range 8,002-10,002/70-100, FOV 20 - 25 cm. slice thickness 4mm. intersection gap 1 mm. and matrix 126 × 126. The used b values were 0, 500 and 1000 s/mm². Generation of corresponding ADC maps for quantitative evaluation.

**Post-processing and image interpretation**

**Conventional MRI**
The MRI images were assessed using the following criteria
Size of the Lesion, contour of the lesion (well defined or not), signal intensity on both T1& T2 weighted images, the associated cystic components.

**DWI-MRI**
For the lesion visual analysis, the signal intensity of the lesions on was compared to myometrial signal intensity. If the lesion had equal or lower signal compared to myometrium, it was isointense–hypointense. If it showed higher signal intensity compared to the myometrium and the lesion was hyperintense.

So the lesions were classified into restricted, non-restricted diffusion, lesions with T2 shine through and black out sign. When the lesion showed a high SI on DWI with low signal on ADC map, it was restricted and when the lesion revealed low SI on DWI with high on ADC map it was the non-restricted lesion, when it displayed high SI on both DWI and ADC map it was categorized in the non-restricted T2 shine through lesions group and when it displayed low SI on both DWI and ADC map it was categorized in non-restricted black out sign lesions.
ADC based Histogram

By outlining the whole lesion in all cuts & obtaining multiple values including volumetric minimum ADC, maximum ADC, mean ADC, skewness & kurtosis. We evaluated these different parameters in different gynecologic lesions to differentiate between benign and malignant lesions.

Pathological examinations

The pathological examination was done for all malignant patients (no 34) & some benign lesions (no16). The pathological examination was done either laparoscopic or postoperative pathology.

Statistical analysis

Data was analyzed using SPSS (Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp). Qualitative data were analyzed using number and percent. Quantitative data were analyzed using median (minimum and maximum) for non-normally data and mean, standard deviation for normally data. Significance of the results was done at the (0.05) level. For qualitative data Chi-Square test, Monte Carlo and Fischer exact test for comparison of 2 or more groups were used, for quantitative data between groups: we used Mann-Whitney U test & we used ROC for diagnostic accuracy. We used the curve to obtain sensitivity and specificity, PPV, NPV and diagnostic accuracy.

Results

Our study was done on 100 female patients; the mean age for benign lesions was 43 years which was lower than for malignant lesions 61 years for with significant statistical difference between them (p<0.001*). The patients with benign gynecologic lesions were 66 (representing 66 % of all patients) and the patients with malignant gynecologic lesions were 34 (representing 34 % of all patients).

Fibroid was the most common benign lesion with number about 26 (representing 39.3% of total benign patients). Cervical & endometrial carcinoma were the most common malignant pathology encountered in the study with number equal 13 patients in each group (representing 38.2 % of total malignant patients).

Conventional MRI

Conventional MRI findings of uterine lesions showed significant difference as regard margin definition, T2WI signal intensity (SI) (P <0.001*) between benign & malignant lesions, for cervical lesions, margin definition was statistically significant different between benign & malignant lesions (P value <0.001*) and for ovarian lesions, T2WI SI, intralesional blood signal & associated thick septae and internal solid nodules showed significant different between benign & malignant lesions (P <0.04*, = 0.002*,<0.001*)
The use of conventional MRI in differentiating benign from malignant lesions could correctly diagnose 78/100 that yielded a 97.1% sensitivity, 68.2% specificity and 78% diagnostic accuracy.

**Qualitative DWI assessment (visual assessment)**

The visual assessment showed statistically significant difference between benign and neoplastic lesions (P<0.001). ALL malignant gynecologic lesions (34/34) were restricted diffusion. One the other hand benign gynecologic lesions showed different patterns; 23 cases (23/66) were classified restricted diffusion, 14 lesions (14/66) displayed iso intense SI in both DWI & ADC map (non- restricted diffusion) 21 lesions displayed low SI in both DWI &ADC map (non –restricted black out sign) &the remaining 8 cases displayed high SI in both DWI & ADC map (non-restricted t2 shine through). The use of qualitative DWI yielded a 100% sensitivity, 65.1% specificity, 59.6% PPV, 100% NPV and 77% diagnostic accuracy among the studied being & malignant lesions [table (1)].

**Quantitative assessment (partial slice ADC measurement):**

The mean ADC values showed statistically significant difference between both benign & neoplastic lesions (P < 0.001). The ADC value yielded 90.9% sensitivity, 74.6% specificity, 80% diagnostic accuracy when using 0.950 x 10–3 mm2/s as a cutoff value with AUC of 0.830 [table (2), figure (1)]. The combined ADC and DWI increased the specificity, PPV and diagnostic accuracy as shown in table [table (3)].

**ADC based histogram**

ADC based histogram was done for 80 patients 29 malignant &51 benign cases. There was statistically significant difference between benign lesions and malignant lesions as regard mean and minimum ADC values (P = 0.01*, 0.023*) and no statistically difference between benign and malignant lesions as regard maximum ADC, kurtosis and skewness. The cutoff mean &minimum ADC values used to differentiate benign lesions from malignant lesions were 0.905 & 0.680 x 10-3 mm2/s, respectively with AUC of 0.655 &0.653 respectively yielding 72 % & 76% sensitivity, 56.5% & 54.3% specificity and 62.5% & 61.9% diagnostic accuracy, [table (4), figure (2)]. The sensitivity, specificity, PPV, NPV and accuracy of partial slice mean ADC were higher than histogram mean ADC as shown in [Table (5)].

**Discussion**

MRI has an essential role in different gynecologic lesions from detection to recurrent disease assessment. Functional MRI can aid establish a correct diagnosis, although it is sometimes essential to do biopsy and histopathological analysis (12). Our study aimed to highlight the added value of ADC based diffusion metrics in differentiating benign and malignant gynecologic lesions.

Our study was performed on 100 female patients; their ages ranged from 23 to 81 years with mean age 46.6 years. The mean age of patients with benign lesions
was 43.53 Years (12.33 SD), and that of patients with malignant lesions was 61.52 Years (10.38 SD). This correlates with the study done by Otero-Garcia et al., (12) who reported that endometrial carcinoma (EC) usually presents in old age group in the beyond 50 years old. Among the 100 patients included in this study, we had 66 benign lesions & 34 malignant lesions, all malignant lesions were pathologically proved. The most common benign lesions was fibroid (n=26; 26%) and the most common malignant lesions was cervical carcinoma (N=13) this correlates with Duc and Huy, (13) who concluded that the uterine fibroid is the most common gynecologic tumor.

The conventional MRI findings of different gynecologic lesions including T1WI signal intensity (SI), T2WI SI, border definition, presence of cystic change and presence of papillary nodules or thick septa were assessed in our study. The use of conventional MRI in differentiation benign from malignant lesions could correctly diagnose 78/100 that yielded a 97.1% sensitivity, 68.2% specificity and 78% diagnostic accuracy. DW-MRI is a promising tool that does not require exogenous contrast material administration. When DWI is combined with conventional MRI, it becomes an excellent diagnostic tool in differentiation between benign and malignant lesions (14).

The qualitative DWI assessment revealed statistically significant difference among both benign & neoplastic lesions (P<0.001). All malignant lesions (n=34) showed restricted diffusion. On the other hand the majority of benign lesions revealed non-restricted diffusion as following; low SI on both DWI and ADC map (black out sign) (n= 21), iso intense signal in both DWI & ADC map (n=14) & high SI in both DWI & ADC map (T2 shine through) (n=8). Although the DWI SI could diagnose all malignant gynecologic lesions, some benign lesions revealed restricted diffusion too, our results were in line with that of Addley et al., (15).

As regard the endometrial lesions, the DWI was a gold standard sequence in differentiation both endometrial carcinoma and sarcoma from the benign endometrial lesions including endometrial hyperplasia (n=2) which displayed high SI in both DWI & ADC map (T2 shine through of endometrium) & endometrial polyp (n=4) which displayed Low SI in both DWI & ADC map (black out sign) this is matching with the studies done by Lee et al., (16).

DWI in myometrial lesions can differentiate between usual fibroid and infiltrating uterine sarcoma as in our study 18 cases of fibroid showed low SI in both DWI & ADC map (non-restricted diffusion) while the 1 case of infiltrating uterine sarcoma (low grade endometrial stromal sarcoma) showed high SI in DWI & low SI in ADC map (restricted diffusion) this is in agreement with the study of Gupta et al., (17). But there was overlap between cellular leiomyoma and uterine sarcoma in DWI, we found in our study 8 cases of fibroid revealed restricted diffusion similar to infiltrating endometrial stromal sarcoma this is also matching with the study of Demulder and Ascher, (18). So the differentiation between cellular fibroid and uterine sarcoma is still problematic.

The DWI of the cervical lesions in our study can differentiate between the cervical fibroid and cervical carcinoma as we had 13 cases of cervical carcinoma with restricted diffusion & 2 cases of cervical fibroid with free diffusion this is also
matching with the study of Nasr and Mohamed, (19). Regarding the ovarian lesions, in our study we found that all malignant lesions (4 serous adenocarcinoma, 1 granulosa cell carcinoma, 1 mucinous cyst adenocarcinoma) & some benign lesions (13 endometrioma, 2 tubo ovarian abscess, 2 dermoid) showed restricted diffusion this is matching with the study of Agostinho et al., (20) who reported that some benign lesions revealed restricted diffusion including tubo ovarian abscess, dermoid, hemorrhagic cyst, endometrioma & ovarian torsion. So combination of DWI & conventional MRI is helpful for ovarian lesions discrimination.

Qualitative visual assessment in DWI could differentiate between benign and malignant gynecologic lesions with 100% sensitivity, 65.1% specificity, 59.6% PPV, 100% NPV and 77% accuracy. This discrepancy between DWI and pathological diagnosis could be due to the presence of highly cellular lesion, viscid pus & blood. Our results were in accordance with the published research by Demulder and ascher, (18) who found that all studied inflammatory pelvic lesions and cellular fibroid displayed restricted diffusion. When we added DWI to conventional MRI findings, we improved the specificity (82% vs. 68.2%), PPV (73.3% vs. 61.1%), NPV (98.2% vs. 97.8%) and diagnostic accuracy (87% vs.78%), this is matching with the study of Yuan et al., (21).

As regard the quantitative diffusion assessment in our study, the malignant lesions ADC value was (0.791 x 10−3 mm2/s) which was statistically significantly lower than that of benign lesions (1.05 x 10−3 mm2/s) with 0.95 x 10−3 mm2/s) cutoff ADC value to differentiate benign from malignant lesions, 17 cases of benign lesions (false positive) were lower than (0.95 x 10−3 mm2/s) while 3 cases malignant lesions (false negative) were higher than this value ( range 0.98 - 1.1x x 10−3 mm2/s) yielding 90.9% sensitivity, 74.6% specificity & 80% accuracy, the AUC was 0.830.

The explanation was different cut off ADC values have been used to discriminate neoplastic from benign lesions. Our results were consistent with Motoshima et al., (30) who published the mean ADC values between the benign and malignant tumors varied significantly. Using a cutoff ADC value of 1x10−3 mm2/sec, discriminating benign from malignant lesions yielding 74% sensitivity,, 80% specificity, 94% positive predictive value, and 44% negative predictive value (NPV).

The lower ADC value within some benign lesions can be explained by the presence of dense cellularity, pus & blood which are a fluid with high viscosity and this led to decreased ADC readings. Our results were in line with the published research by Demulder and ascher, (18). When we combined qualitative DWI to ADC measurements we improved the specificity from 65.1 % to 80.3%, PPV from 59.6% to 69.7% and the diagnostic accuracy from 77% to 83%.

Apparent diffusion coefficient (ADC) values obtained from diffusion-weighted imaging (DWI) have shown promise in the characterization of different lesions as benign or malignant (22).

The evaluation of histogram-based texture metrics on the ADC map has been applied in breast, neurological and abdominopelvic imaging to distinguish benign from malignant tumors, predict tumor grade, and assess treatment response.
Therefore, the purpose of our investigation was to assess the utility of histogram-based ADC measurements. We evaluate different parameters in differentiation between benign and malignant lesions, the parameters were mean, minimum, maximum ADC, kurtosis and skewness.

In our study The ADC based histogram was done for (80) patients, (51) benign & (29) malignant. we found that minimum & mean ADC values were statistically significant between benign and malignant lesions, the mean ADC value for benign lesion was 1.063 ×10⁻³ mm²/sec & for malignant lesion was 0.895×10⁻³ mm²/sec and when (0.905 x 10⁻³ mm²/s) used as a cutoff ADC value to differentiate benign from malignant lesions, the sensitivity was 72.4 %, specificity 56.8 %, accuracy 62.5% and the AUC 0.655. The minimum ADC value for benign lesion was 0.774 ×10⁻³ mm²/sec & for malignant lesion was 0.613×10⁻³ mm²/sec and when (0.68 x 10⁻³ mm²/s) used as a cutoff ADC value to differentiate benign from malignant lesions, the sensitivity was 76.0%, specificity 54.3 %, accuracy 61.9% and the AUC 0.653. This is in agreement with Guan et al. 2016 who published that all histogram parameters of cervical cancer were significantly lower than normal cervical tissues & also matching with Kierans et al., (23) who found that mean & minimum ADC parameters were lower in malignant endometrial lesions.

In our study, when we compare the partial slice mean ADC and histogram based mean ADC we found that the sensitivity, specificity, PPV, NPV and accuracy of partial slice mean ADC were higher than histogram based mean ADC, this is not similar to the research published by Ozturk et al., (25) who reported that the diagnostic performance of histogram mean ADC and partial slice mean ADC were similar. This could be explained due to technical post processing difference as the partial slice mean ADC was taken within the most solid restricted portion while the ADC based histogram was obtained by outlining the whole lesion including both solid & cystic parts leading to different ADC values.

In addition, we had variable gynecologic pathologies, 22 out of 51 benign lesions with restricted diffusion had lower mean ADC value (<0.905) increasing the number of false positive lesions, on the other hand we had different histologic malignant tumors 8 cases out of 29 with ADC values ranging from (0.93 - 1.2 x10⁻³ mm²/s) more than the used cutoff value leading to false negative results, these leaded to decreased sensitivity & specificity of histogram based mean ADC compared to partial slice mean ADC.

**Limitations**

This study has some limitations;
Variable gynecologic lesions with Small number of patients in some pathologic categories. DWI image quality in the pelvis is affected by technical problems. So, the use of fused T2-WI and DWI with signal suppression (DWIBS) can improve its diagnostic performance.

For the ADC calculation, the selection of the area in the gynecologic lesions may not represent the lesion when it was done within necrotic or hemorrhagic
portions. So, the use of diffusion metrics based histogram of the entire lesion may be a more accurate method to avoid sample selection bias.

**Conclusions**

We concluded that ADC based diffusion metrics could differentiate between benign and malignant gynecologic lesions & unfortunately with less diagnostic performance comparing to traditional partial slice mean ADC in different gynecologic lesions.

**List of abbreviations**

DWI: Diffusion-Weighted Imaging; EC: endometrial cancer; FIGO: International Federation of Gynecology and Obstetrics ; STIR: Short Tau inversion recovery sequence; T1WI: T1-weighted imaging; T2WI: T2-weighted imaging; MRI: Magnetic resonance imaging; PPV: Positive predictive value; NPV: Negative predictive value; FSE: Fast Spin Echo; FOV: Field of view; TI: Inversion time, TR: Repetition time; TE: Echo time; ms: Millisecond; mm: Millimeter; ROI: Region Of Interest; AUC: Area under the curve; MCC: Matthews Correlation Coefficient; CI: Confidence interval; TP: True Positive; TN: True Negative; FP: False Positive; FN: False Negative.

**References**


Tables

**Table (1):** Validity of qualitative DWI MRI in differentiating malignant from benign gynecologic lesions.

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualitative DWI MRI</td>
<td>100</td>
<td>65.1</td>
<td>59.6</td>
<td>100</td>
</tr>
</tbody>
</table>

PPV: positive predictive value, NPV: Negative predictive value.

**Table (2):** Receiver operating characteristics of ADC value in differentiating malignant from benign gynecologic lesions.

<table>
<thead>
<tr>
<th>AUC (95%CI)</th>
<th>P-Value</th>
<th>Cutoff point</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC value</td>
<td>0.830 (0.735-0.925)</td>
<td>&lt;0.001*</td>
<td>0.950</td>
<td>90.9</td>
<td>74.6</td>
<td>63.8</td>
<td>94.3</td>
</tr>
</tbody>
</table>

AUC: Area Under curve, PPV: positive predictive value, NPV: Negative predictive value.

**Table (3):** Validity of ADC and DW-MRI in differentiating benign from malignant lesions:

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>DWI</td>
<td>100</td>
<td>65.1</td>
<td>59.6</td>
<td>100</td>
</tr>
<tr>
<td>Mean ADC</td>
<td>90.9</td>
<td>74.6</td>
<td>63.8</td>
<td>94.3</td>
</tr>
<tr>
<td>Combined DWI &amp;ADC</td>
<td>88.2</td>
<td>80.3*</td>
<td>69.7*</td>
<td>9239*</td>
</tr>
</tbody>
</table>

PPV: positive predictive value, NPV: Negative predictive value.
**Table (4):** Validity of ADC based histogram parameters among the studied gynecologic lesions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>AUC (95%CI)</th>
<th>P-Value</th>
<th>Cutoff Point</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ADC value</td>
<td>0.655 (0.522-0.788)</td>
<td>0.032*</td>
<td>0.905</td>
<td>72.0</td>
<td>56.5</td>
<td>57.4</td>
<td>79.4</td>
<td>62.5</td>
</tr>
<tr>
<td>Minimum ADC</td>
<td>0.653 (0.525-0.782)</td>
<td>0.034*</td>
<td>0.680</td>
<td>76.0</td>
<td>54.3</td>
<td>47.5</td>
<td>80.6</td>
<td>61.9</td>
</tr>
<tr>
<td>Maximum ADC</td>
<td>0.552 (0.401-0.702)</td>
<td>0.474</td>
<td>1.255</td>
<td>56.0</td>
<td>58.7</td>
<td>42.4</td>
<td>71.8</td>
<td>58.3</td>
</tr>
</tbody>
</table>

AUC: Area Under curve, PPV: positive predictive value, NPV: Negative predictive value.

**Table (5):** Validity of histogram parameters and partial slice mean ADC in the studied cases

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial slice Mean ADC</td>
<td>90.9*</td>
<td>74.6*</td>
<td>63.8*</td>
<td>94.3*</td>
<td>80*</td>
</tr>
<tr>
<td>Diffusion based histogram metrics</td>
<td>72</td>
<td>65.5</td>
<td>57.4</td>
<td>79.4</td>
<td>62.5</td>
</tr>
</tbody>
</table>

PPV: positive predictive value, NPV: Negative predictive value.
Figures:

**Figure (1):** Receiver operating curve for mean ADC value in differentiating malignant from benign gynecologic lesions.

**Figure (2):** Receiver operating curve for ADC based histogram parameters in differentiating malignant from benign gynecologic lesions.

**Figure (3):** 61-year-old female pathologically proved stage IA endometrial cancer.  
(A) Sagittal T2WI (B) Axial T2WI showed ill-defined endometrial soft tissue mass of intermediate signal (C) Axial DWI, (D) Axial ADC map showed restricted diffusion. The mean ADC value = 0.86 x 10^{-3} mm^2/s (restricted diffusion). (E) Whole lesion ADC based histogram showed the following parameters mean ADC 0.8 x10^{-3}, maximum ADC 0.9 x10^{-3}, minimum ADC 0.7x10^{-3}, kurtosis 1.8 x10^{-3} & skewness .45x10^{-3}mm^2/s.

**Figure (4):** 65-year-old female pathologically proved benign endometrial polyp.  
(A) Sagittal T2WI (B) Axial T2WI showed well defined endometrial mass of low SI, intact Junctional zone. (C)Axial DWI, (D) Axial ADC map showed low SI in both DWI and ADC map with T2shine through of endometrium (black out sign). The mean ADC value = 0.9 x 10^{-3} mm^2/s (non-restricted diffusion, black out sign). (E) Whole lesion ADC based histogram showed the following parameters mean ADC 1.1x10^{-3}, maximum ADC 1.3 x10^{-3}, minimum ADC .9 x10^{-3}, kurtosis 2.5 x10^{-3} & skewness .49 x10^{-3}mm^2/s.
Diagonal segments are produced by ties.