Contribution of DWI to diagnosis and staging of cervical cancer

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Cervical cancer is the second most common female malignancy worldwide. Although its incidence has decreased in developed countries due to screening with Pap smear and it is a preventable disease by the recently found vaccine against human papilloma virus (HPV), it is still the leading cause of death related to cancer among women in developing countries (1-3). Among the imaging modalities used in preoperative evaluation of cervical cancer magnetic resonance imaging (MRI) is excellent to show the internal anatomy. Diffusion weighted imaging (DWI), which drives its contrast from regional differences in mobility of water molecules (4), is a relatively new technique to evaluate malignancies. Although it is widely used in detection and evaluation of acute stroke (5), with the recent advances in MRI technology that reduced the artefacts interfering the image interpretation, DWI has been used in body imaging (6,7). Apparent diffusion coefficient (ADC) maps calculated from DWI images provide a quantitative measure that reflects all forms of intravoxel incoherent motion and are desensitized to the underlying scan parameters (8). It has been reported that quantitative evaluation of ADC might be useful for distinguishing between malignant and benign tissues (9). The aim of this study was to determine whether the ADC measurements had any contribution in differentiation of normal cervical tissue and malignant lesions preoperatively, and in malignant lesions was there a correlation between the mean ADC values and tumor type, grade or stage.
Methods and Materials

In the study group there were 25 patients who had cervical cancer proved histopathologically and in the control group there were 20 patients with otherwise normal uterus. The MR data, obtained via a 1.5-T MR scanner (Avanto; Siemens, Erlangen, Germany) using an eight-channel body coil, was evaluated retrospectively. In patient group ADC measurements were performed on reconstructed ADC maps with the largest region of interest (ROI) within the tumor. For each ADC value measurement three ROIs were placed and the average of them was used for the analysis. In the control group ADC measurements of the normal cervical tissue were done by setting the ROIs excluding the stroma hence ADC calculation of tissues with short T2 values may result in error values (10). Comparisons between groups were analyzed by t test with a P value < 0.05 was considered as statistically different. Mean ADC values in patient group and control group were compared. Also in study group mean ADC values were compared between histopathologic subtypes, tumor grades and stages.
Results

The average age of the patient group (aged between 52 and 74) was 60.7±7.6 and that of control group (aged between 47 and 72) was 58.6±8.1. There was no statistically difference between the average ages (p> 0.05).

The mean ADC value of the study group was 0.96±0.15 x 10^{-3} mm²/sn and in the control group the mean ADC value was 1.67±0.17 x 10^{-3} mm²/sn. In study group the mean ADC values were statistically lower than that of the control group (p <0.05), (Figure 1).

There were 21 patients with squamous cell cancer and 4 patients with adenocarcinoma with mean ADC values of 0.95 x 10^{-3} mm²/sn and 0.91 x 10^{-3} mm²/sn, respectively. According to histopathologic subtypes there was no significant difference between mean ADC values (p> 0.05) (Table 1). There was also no significant difference between the mean ADC values of the tumor grades (grade I n: 13 , grade II n: 7 and grade III n: 5 with mean ADC values of 0.95 x 10^{-3} mm²/sn, 0.94 x 10^{-3} mm²/sn and 0.97 x 10^{-3} mm²/sn, respectively; p> 0.05) (Table 2).

In FIGO classification stages I and IIa are considered early stage and stages IIb or more are considered late stage (11). 11 patients were in the early stage with 10 patients in stage Ib and 1 in stage IIa; where as 14 patients were in the late stage with 3 patients in stage IIb, 2 patients in stage IIIa, 4 patients in stage IIIb, 4 patients in stage IVa and 1 patient in stage IVb. The mean ADC values in early stage cervical cancer (0.86±0.05 x 10^{-3} mm²/s) were significantly lower than the mean ADC values in late stage disease (0.98±0.06 x 10^{-3} mm²/s) (p<0.05). The comparison of mean ADC values between early and late stages is shown in Figure 2.
Images for this section:

Fig. 1: Fig 1: Comparison of the mean ADC values between cervical cancer and normal cervical tissue showing significant difference between them (p

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**Fig. 2:** Comparison of mean ADC values for early and late stage cervical cancer according to FIGO classification. There was a significant difference between early and late stage cervical cancer ($p$)

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**Table 1:** Comparison of ADC values according to histopathological subtypes.

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<table>
<thead>
<tr>
<th>Histopathology</th>
<th>Patients</th>
<th>mean ADC value</th>
</tr>
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<tbody>
<tr>
<td>Squamous cell cancer</td>
<td>n: 21</td>
<td>0.95</td>
</tr>
<tr>
<td>Adenocarcinoma</td>
<td>n: 4</td>
<td>0.91</td>
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</table>
Table 2: Table 2: Comparison of ADC values according to tumor grade.

<table>
<thead>
<tr>
<th>Tumor grade</th>
<th>Patients</th>
<th>Mean ADC value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>13</td>
<td>0.95</td>
</tr>
<tr>
<td>Grade II</td>
<td>7</td>
<td>0.94</td>
</tr>
<tr>
<td>Grade III</td>
<td>5</td>
<td>0.97</td>
</tr>
</tbody>
</table>
Conclusion

Among the imaging modalities used in the treatment planning of cervical cancer, MRI with high soft tissue resolution is the most valuable imaging modality in the evaluation of tumor size, depth of cervical invasion and extend of locoregional spread (12,13). DWI, which has been recently used in diagnosis of malignant lesions, can distinguish the normal uterine cervix from cervical cancer and benign lymph nodes from malignant ones (14).

In the study of Naganawa et al. mean ADC values in cervical cancer were significantly lower than that of control group (10). Despite of small study population this study had shown that ADC measurement had a potential value for distinguishing normal cervical tissue from cancerous cervical tissue. With a larger study population McVeigh et al. reported that mean ADC values of patients with cervical cancer is significantly lower than ADC values of normal cervix (8). Also in regard to FIGO classification mean ADC values were found to be lower in stages Ib/Iia than in stage IIb and stages III/IV as it is found in this study. The significant difference between the FIGO stages may be an useful factor in the treatment planning especially for the cases in which extend of the disease couldn't be determined precisely. Another study by Zhang et al. reported lower mean ADC values in patients with cervical cancer compared with normal cervix (15). Also it is reported that there was an increase in ADC values after radiotherapy which was indicating that DWI might be used to monitorize the response to therapy.

Although there are no similiar studies with larger populations upon the use of ADC measurements in cervical cancer, existing studies along with this study indicate that ADC value measurements may provide useful information in diagnosis of cervical cancer as well as in preoperative assesment of the tumor stage.
References


