Section: Radiodiagnosis

Research

DIFFUSION WEIGHTED IMAGING AND APPARENT DIFFUSION COEFFICIENT IN CHARACTERIZATION OF COMPLEX OVARIAN MASSES IN SOUTH INDIAN POPULATION

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Abstract

Background: Ovarian malignancy is a common malignancy among women and cause of death. Diagnostic laparotomy and histopathological examination are the best methods for diagnosis of ovarian malignancy. But it is important to explore other non-invasive methods pre-operatively for accurate diagnosis and planning of management. The aim is to assess the impact of addition of DWI & ADC to the routine conventional MRI sequences in classifying malignant and benign ovarian lesions and detection of malignant lymph nodes and peritoneal metastasis. **Materials and Methods:** A prospective observational study was done in patients who were diagnosed to have ovarian lesions either solid or complex cystic by trans-abdominal or transvaginal ultrasonography. MRI pelvis imaging was done including conventional and diffusion weighted imaging. The images were reviewed to comment on qualitative and quantitative analysis of ovarian lesions, lymph nodes and peritoneal deposits. **Result:** Results were compared with histopathological examination findings post-surgery which revealed 18 malignant and 17 benign ovarian lesions out of 35 patients. The average ADC value for malignant ovarian lesions was 1.0 x 10^{-3} mm^2/s which was lower than that of the benign ovarian lesions which was 1.4 x 10^{-3} mm^2/s. The cut off value below which malignancy was expected is less than 1.1 x 10^{-3} mm^2/s with 100% sensitivity and specificity. **Conclusion:** DWI and ADC in addition to the conventional MRI sequences helps in qualitative and quantitative analysis of ovarian lesions thus differentiating malignant from benign ovarian tumors.

INTRODUCTION

Ovarian malignancy is a common malignancy among women and cause of death. Early diagnosis and appropriate planning of management can lead to better prognosis. The time of diagnosis is very essential as higher the stage of disease worst the outcome is. Diagnostic laparotomy and HPE (histopathological examination) are the best methods for diagnosis of ovarian malignancy. But it is important to explore other non-invasive methods pre-operatively for accurate diagnosis and planning of management.[1,2,3,4,5,6,7,8,9,10]

There are many risk factors for ovarian malignancy like age above 50, family history, nulliparity and previous malignancy. Malignant ovarian tumors are mostly primary which constitute for about 95%. Metastasis to ovary can occur from gastric, colorectal, breast and pancreatic carcinomas. Malignant ovarian tumors can be of epithelial or non-epithelial origin. Epithelial tumors consists of endometrioid, serous, clear cell, mucinous and undifferentiated. Non-epithelial tumors consist of germ cell tumors and sex cord stromal tumors like dysgerminoma, yolk sac, teratoma and choriocarcinoma. Ovarian tumors can cause local spread after breaching the capsule with extension into adjacent structures. They can also cause spread by lymphatics to paraaortic lymph nodes and hematogenous spread to other organs.[2,3,12,13,14,15]

Ovarian lesions are usually initially diagnosed on ultrasonography when the patients present with various complaints like mass per abdomen, lower abdominal pain or urinary symptoms due to mass

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effect and compression. The patients are then suggested MRI (Magnetic resonance imaging) which is gold standard for female pelvis. MRI helps to assess the location, origin, morphology and signal intensity characteristics of the lesion. CT (computed tomography) is usually used to know the distant metastasis and lymph nodes pre-operatively. However it cannot characterize the lesion and patient is exposed to radiation. So it is necessary to explore other imaging techniques with no radiation and for better characterization of the lesion as well as staging.[16,17,18,19,20]

Tumors with malignant potential has a feature of neovascularization which assumes the metastatic character of the tumor. DW imaging (Diffusion weighted imaging) helps in assessing the tissue cellularity and cell membrane integrity by analyzing the degree of diffusion of free water molecules. ADC (Apparent diffusion coefficient) quantifies the diffusivity of water molecules within tissues. The increase in tissue cellularity or cell density reduces ADC value. Tumors with malignant potential usually have hypercellularity, therefore ADC values help in differentiation of malignant from benign lesions.[1] Prior research studies have certified the usefulness of DWI in various cancers.[21,22]

The study was aimed to assess the impact of addition of DWI & ADC to the routine conventional MRI sequences in classifying malignant and benign ovarian lesions and detection of malignant lymph nodes and peritoneal metastasis.[23,24]

MATERIALS AND METHODS

The study was done from June 2021 till February 2022 in KIMS (Kempegowda institute of medical sciences), Bengaluru, Karnataka, India. Thirty-five patients of varying ages were included in the study with ovarian lesions either solid or complex cystic diagnosed by trans-abdominal or transvaginal ultrasonography. MRI pelvis imaging was done for all the patients using 1.5T GE SIGNA 16 CHANNEL MRI unit with body Torso coil, after written consent was taken. MRI examination included conventional and diffusion weighted imaging. Inj. Buscopan was given 20 minutes before MRI to reduce the bowel movements hence reducing artifacts and improving the image quality. The exclusion criteria were patients with past adnexal surgeries or who had received radiotherapy/ chemotherapy and patients with contraindication to MRI.

Analysis of Data

Two senior radiologists with 8-12 years of experience have reviewed the MR images. First location, morphology and signal intensity characteristics of the ovarian lesions were described on routine conventional MR sequences. DWI was then reviewed to see whether diffusion restriction is present or absent. Diffusion restriction is considered to be present when the lesion shows increased signal on T2 and DWI with decreased signal on ADC. 3D ADC maps were generated using FuncTool software in Advantage Windows workstation 4.6 GE Healthcare. The ADC maps was synced with T2W images to identify solid components of the lesion. The ROI (region of interest) was placed on the solid components of lesions and ADC values were calculated. A ROC (receiver operating characteristic) curve was obtained to evaluate the diagnostic ability of the measured ADC values in differentiating malignant from benign ovarian lesions.

RESULTS

The findings on MRI were compared with HPE findings post surgery which revealed 18 malignant and 17 benign ovarian lesions out of 35 patients. Bilateral ovarian lesions were seen in five patients but the most suspicious lesion was only taken into consideration. All the malignant and three benign ovarian lesions like mature cystic teratoma, fibrothecoma and endometrioma showed diffusion restriction.

The average ADC value of malignant ovarian lesions was 1.0 x 10^{-3} mm^2/s which was much lower than that of the benign ovarian lesions which was 1.4 x 10^{-3} mm^2/s. The cut off value below which malignancy is considered is less than 1.1 x 10^{-3} mm^2/s with a sensitivity and specificity of 100%. The average ADC value for malignant lymph nodes was lower than the non-malignant lymph nodes which measured 0.97 ± 0.06 x 10^{-3} mm^2/s and 1.27 ± 0.04 x 10^{-3} mm^2/s sequentially. Peritoneal carcinomatosis was seen in only 3 patients with average ADC value of 1.0 ± 0.05 x 10^{-3} mm^2/s.

Benign ovarian lesions included six serous cystadenomas, two mature cystic teratomas, four mucinous cystadenomas, one fibrothecoma, one cystadenofibroma, two brenner tumors and one endometriosis. Malignant ovarian lesions included six mucinous cystadenocarcinomas, three serous cystadenocarcinomas, two dysgerminomas, two granulosa cell tumors, three papillary serous cystadenocarcinomas and two germ cell tumors.

Table 1: Comparison of Ovarian lesion Characteristics based on HPE Findings using Chi Square Test.

Variable	Category	Benign		Malignant		P-Value
		n	%	n	%	
Nature	Complex Cystic	15	88.2%	10	55.6%	0.03*
	Solid	2	11.8%	8	44.4%	
Diffusion Weighted Imaging	Diffusion Restriction	3	17.6%	18	100.0%	0.001*
	Diffusion Facilitation	14	82.4%	0	0.0%	
Lymph Nodes	Absent	14	82.4%	11	61.1%	0.16

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	Present	3	17.6%	7	38.9%	
Peritoneal Deposits	Absent	17	100.0%	15	83.3%	0.08
	Present	0	0.0%	3	16.7%	

* Statistically Significant

Table 2: Comparison of mean ADC values between Benign & Malignant Ovarian Lesions using Mann Whitney Test

HPE	N	Mean	SD	Mean Diff	P-Value
Benign	17	1.400	0.134	0.382	<0.001*
Malignant	18	1.018	0.095		

* Statistically Significant

Table 3: Comparison of mean ADC values between Benign & Malignant Lymph Nodes using Mann Whitney Test

Lymph nodes	N	Mean	SD	Mean Diff	P-Value
Benign	3	1.273	0.042	0.300	<0.001*
Malignant	7	0.973	0.068		

* Statistically Significant

Table 4: Comparison of the Findings between MRI & HPE among the study samples using McNemar's Test

Finding	MRI		HPE		P-Value
	n	%	n	%	
Benign	16	45.7%	17	48.6%	1.00
Malignant	19	54.3%	18	51.4%	

Table 5: ROC Curve analysis for ADC values for determining the cut-off between Benign & Malignant Conditions

Variable	AUC	Std. Error	95% Conf. Interval		P-Value	Cut off	Sn (%)	Sp (%)
			Lower	Upper				
ADC Values	1.00	0.00	0.90	1.00	<0.001*	≤1.18	100.00	100.00

* Statistically Significant

DISCUSSION

In most of the patients ovarian lesions are usually diagnosed very late with extensive metastasis decreasing the survival rate of the patient. DWI and ADC in addition to other conventional MR sequences helps in qualitative as well as quantitative examination of ovarian lesions thereby increasing the precision of non-contrast conventional images.

Contrast MRI helps in better characterization of ovarian lesions which helps in proper diagnosis, but when contrast media is contraindicated like in renal failure patients or pregnant individuals, adding DWI and ADC would be appropriate choice of sequences.

Many studies were done previously to evaluate the impact of DWI and ADC values in differentiation of borderline malignant from benign ovarian lesions which showed notable difference in ADC values among them.[25,26,27,28]

Ali et al,[1] has done a study which included fifty-one patients out of which twenty-three were malignant ovarian tumors and twenty-eight were benign ovarian tumors. The average 3D ADC values were 1.516 ± 0.6 × 10^{-3} mm^2/s and 0.977 ± 0.3 × 10^{-3} mm^2/s for benign and malignant ovarian lesions sequentially. According to their study cut off value for malignancy was considered to be less than 1.17 × 10^{-3} mm^2/s showing 75% specificity and 69.9% sensitivity.

Takeuchi et al,[9] conducted a study with a sample size of 49 revealing 10 benign and 39 malignant/borderline malignant ovarian tumors. There was remarkable variance among average 2D ADC values of malignant and benign tumors which were 1.03 ± 0.19 × 10^{-3} mm^2/s and 1.38 ± 0.30 × 10^{-3} mm^2/s sequentially. The cut off value for malignancy was considered to be less than 1.15 which had 80% specificity and 74% sensitivity.

Li et al,[10] has done a study which included 127 patients with 46 benign and 81 malignant ovarian lesions. The average 2D ADC values were 1.69 × 10^{-3} mm^2/s ± 0.25 SD and 1.03 × 10^{-3} mm^2/s ± 0.22 SD for benign and malignant lesions sequentially. The cut off value for malignancy was considered to be less than was 1.25 × 10^{-3} mm^2/s which showed 90.1% sensitivity and 89.9% specificity.

Zhang et al,[2] has done a study including 191 patients revealing 202 ovarian lesions (74 benign and 128 malignant). According to their study cut off value for malignancy was considered to be less than 1.2 × 10^{-3} mm^2/s.

Few benign tumors such as endometriomas and mature cystic teratomas show reduced ADC values because of their morphological characteristics as stated by many previous research articles. This is because of presence of more collagen-producing fibroblastic cells and abundant network of collagen fibres in extracellular matrix limiting the movement of water molecules.[30,31,32]

Fujii et al,[11] has done a study including 123 ovarian lesions revealing 42 malignant and 81 benign lesions. They suggested that DW imaging and ADC values were not beneficial in differentiating benign from malignant ovarian lesions. This is because the benign lesions in their study predominantly included eighteen mature cystic teratomas, seven fibromas and twenty-four endometriomas which showed low ADC values leading to an absence of difference among the ADC values of malignant and benign lesions.

Our study had a limitation as the number of cases are less. A future comparative study is recommended

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with more sample size and better pathological distribution to appraise the diagnostic ability of ADC maps in ovarian cancer. ROI and inter-observer variableness can affect ADC values, hence proper standardized methods should be established and followed.[33,34,35]

CONCLUSION

DWI and ADC in addition to the conventional MRI sequences helps in qualitative and quantitative analysis of ovarian lesions thus differentiating malignant from benign ovarian tumors.

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