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Diffusion-weighted imaging: Effects of intravascular contrast agent on apparent diffusion coefficient measures of ovarian neoplasms

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Abstract

Background: Magnetic resonance (MR) diffusion-weighted imaging (DWI) use will help in better characterization of ovarian tumors. The effect of gadolinium contrast agents on ADC measurements is not very well understood. More information is needed to standardize MRI protocols by determining whether performing DWI prior to or after dynamic contrast imaging (DCE) MRI makes a difference for evaluation of ovarian tumors

Settings and design: Prospective Study done on 36 patients selected based on universal sampling, at KVG Medical College and Hospital, Sullia with Study population being women with newly diagnosed ovarian tumors who underwent CEMRI study to evaluate the nature of tumor and extent.

Results: In benign and malignant ovarian tumors, Pre contrast mean ADC was comparable to Post contrast mean ADC value and with statistically insignificant P value. The contrast agent did not make much difference for measurement of ADC values in benign and malignant tumors. Also, ADC values of solid and cystic components in both benign and malignant tumors before and after administration of contrast were comparable.

Conclusion: Our findings support the possibility that DWI optimized may be obtained before or after DCE-MRI without compromising important clinical information.

Keywords: DCE-MRI, DWI, ADC, Ovarian tumors, pre and post contrast

Introduction

Ovarian tumors are one of the main indications for gynecological surgery. Characterization of ovarian tumors preoperatively is important for explaining patients about possible management plan especially for the surgical part.

Magnetic resonance imaging (MRI) is of great help in identifying malignant lesions, particularly when ultrasound findings are not optimal or indeterminate. MRI can reveal imaging features like papillary projections, nodularity, septae, solid component and signal intensity changes on T1- and T2-weighted images, but none of these criteria can accurately distinguish between benign and malignant nature of tumors.

Magnetic resonance (MR) diffusion-weighted imaging (DWI) use will help in better characterization of ovarian tumors. Diffusion-weighted imaging is dependent on micro diffusion of water alterations, in both intracellular as well as extracellular spaces. Differences in the apparent diffusion coefficient (ADC) of benign and malignant adnexal masses are reported to have proven value especially in complex lesions. Typically, malignant ovarian tumors demonstrate lower ADC values compared to the benign neoplasms, reflecting higher cellular density.

The effect of gadolinium contrast agents on ADC measurements is not very well understood, and previous literature and studies have shown varied mixed results [1, 8]. Given the varied results in the current literature, more information is needed to standardize MRI protocols by determining whether performing DWI prior to or after dynamic contrast imaging (DCE) MRI makes a difference for evaluation of ovarian tumors.

Aims & objectives

1. To determine whether apparent diffusion coefficient (ADC) measures of ovarian tumors at 1.5 tesla (T) are affected by gadolinium administration.
2. To determine ADC values in benign and malignant tumors

Materials and methods

This was a Prospective Study done from November 2020 to March 2022(15-month duration) On 36 patients selected based on universal sampling, at KVG Medical College and Hospital, Sullia with Study population being women with newly diagnosed ovarian tumors who underwent CEMRI study to evaluate the nature of tumor and extent.

Inclusion criteria

1. Women referred from gynaec OPD for evaluation of ovarian neoplasms
2. With normal RFT

Exclusion criteria

1. Failed to follow up in our institute with HPE reports.
2. Pregnant women were excluded from the study.

Protocol

MRI was performed with a Philips Achieve Tx 1.5 tesla (T) scanner using a dedicated abdomino-pelvic protocol. All

pelvic MRIs included a T2-weighted fast spin echo sequence, T1-weighted non-fat-suppressed sequence, T1 weighted fat-suppressed DCE-MRI sequences, and DWI sequences before and after the DCE-MRI. Data collection performed according to the hospital regulations, after approval by the hospital authorities and consent by the patient.

Statistical analysis

The data will be entered in the Microsoft office excel 2007 and IBSS version 22 will be used for analysis. The data will be presented in the form of tables, and percentages. Paired t test will be used to assess the statistical significance. P value of < 0.05 will be considered significant.

Results

Table 1: Age: Median age - 56yrs (28-74)

Age Group of females (in yrs)	numbers
20-40	3
40-60	14
>60	19

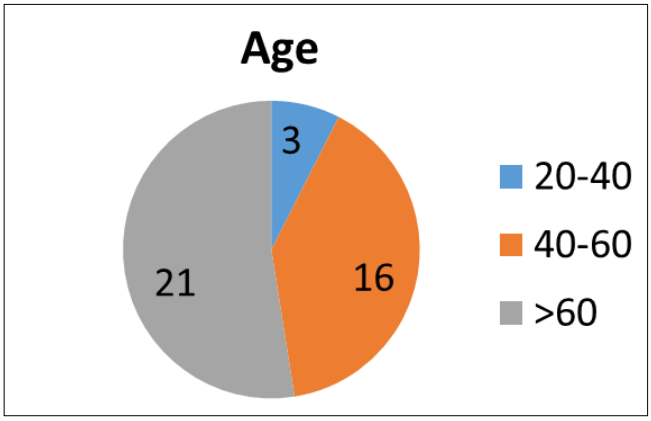

Fig 1

Table 2: Ovarian tumors

Ovarian Tumors	Numbers
Benign	21
Malignant	15

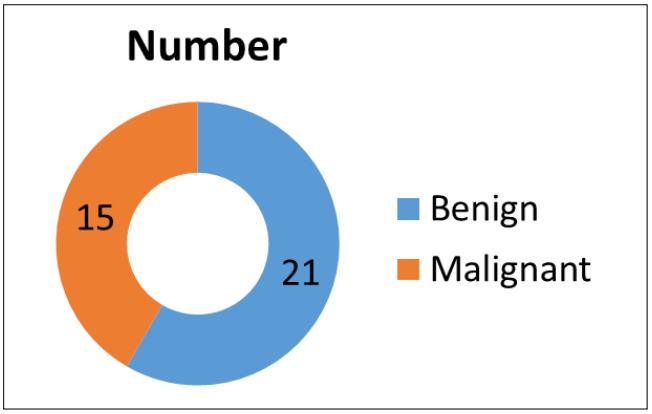

Fig 2

Table 3: Size characteristics (Longest Dimensions)

Size (in mm)	Numbers
<50	0
51-100	3
101-150	12
151`-200	15
201-250	4
>250	2

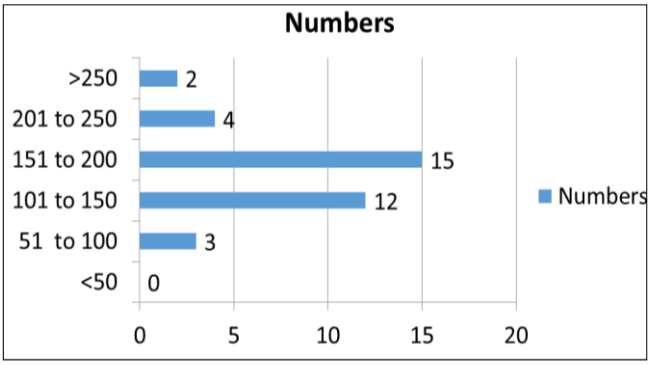

Fig 3

In benign ovarian tumors, Pre contrast mean ADC was 1.48± 0.46 and Post contrast mean ADC value was 1.40±0.62 with statistically insignificant P value as shown in Table 4.

So it can be concluded that the contrast agent did not make much difference for measurement of ADC values in benign tumors.

Table 4

Type of ovarian tumor	No of lesions	Pre contrast ADC range	Pre contrast mean ADC	Post contrast ADC range	Post contrast ADC mean	ADC difference	P value
benign tumors	21	0.48,2.21	1.48±0.46	0.20,2.32	1.40±0.62	0.08 (3.4 %)	0.86
Serous cystadenoma	10	0.48, 2.21	1.52±0.19	0.52, 2.3	1.36±0.23		
Mucinous cyst adenoma	8	1.12, 1.79	1.48±0.20	1.22,1.88	1.51±0.18		
Fibro thecoma	1	1.2	1.2	1.22	1.22		
Cystadeno fibroma	1	0.89	0.89	0.9	0.9		
Brenner's Tumor	1	1.23	1.23	1.48	1.48		

In malignant ovarian tumors, Pre contrast mean ADC was 0.91±0.20 and post contrast mean ADC value was 0.94±0.23 with statistically insignificant P value as shown in Table5.

So, it can be concluded that the contrast agent did not make much difference for measurement of ADC values in malignant tumors.

Table 5

Type of ovarian tumor	N	Precontrast ADC range	Pre contrast mean ADC	Post contrast ADC range	Post contrast ADC mean	P value
Malignant Tumors	15	0.5,1.45	0.91±0.20	0.54,1.50	0.94±0.23	0.3
Serous Cystadeno carcinoma	6	0.66,1.35	0.97±0.20	0.70,1.37	0.99±0.22	
Mucinous Cystadeno carcinoma	3	0.65,1.31	0.89±0.19	0.68,1.35	0.92±0.23	
Serous borderline tumor	2	0.78,1.45	1.05±0.19	0.80,1.49	1.09±0.24	
Mucinous borderline tumor	1	0.99	0.99	1.31	1.31	
Clear cell adenocarcinoma	1	0.82	0.82	1.12	1.12	
Endometriod adenocarcinoma	1	0.93	0.93	1.23	1.23	

ADC values of solid and cystic components in both benign and malignant tumors before and after administration of contrast, did not make statistically significant difference in Table 6 and 7.

Table 6

Differences between ADC values of SOLID component in benign and malignant tumors			P Value	
	Minimum	Maximum	Mean	
ADC in Malignant	0.13	0.90	0.56±0.26	0.13
ADC in Malignant post contrast	0.15	0.95	0.61±0.23	
ADC in benign	1.1	1.55	1.18±0.24	0.21
ADC in benign post contrast	1.14	1.67	1.23±0.20	

Table 7

Differences between ADC values of Cystic component in benign and malignant tumors			P Value	
	Minimum	**Maximum**	**Mean**	
ADC in Malignant	0.9	2.66	2.4±0.73	0.18
ADC in Malignant post contrast	0.94	2.57	2.35±0.23	
ADC in benign	1.8	2.9	2.54±0.35	0.45
ADC in benign post contrast	1.76	2.82	2.12±0.22	

Discussion

DWI is increasingly being incorporated into MRI protocols due to its potential for improving characterization of ovarian lesions. However, controversy still exists regarding the effects of gadolinium-based contrast agents on DWI measures.

In our study, ADC values were not significantly different after the DCE-MRI sequence in ovarian tumors, which is in agreement with the majority of the prior studies that found no statistically significant change in ADC values after contrast administration.

Several factors of our study design may explain why ovarian tumor ADC values were not significantly affected by contrast. These include field strength (3T versus 1.5T), contrast agent type, and repetition time (TR) [2, 6].

The late timing of the post-contrast DWI acquisition, approximately 9 minutes after injection, may also explain why our study did not identify significant alterations in lesion ADC. At this timing, much of the contrast has leaked from the microvasculature to the extracellular space (and perhaps even washed out of the tumor region) [7].

Gadolinium is known to reduce signal-to-noise (SNR). As a result, the diffusion-weighted images may have a lower SNR, closer to the noise floor, and result in an artificially increased (or decreased, at higher b values) ADC calculation [8]

Limitations

We investigated only a single delayed post-contrast DWI time point of 9 minutes after injection and one type of contrast agent (Gadopentetate Dimeglumine). Other agents may produce different findings.

The number of b values was limited due to scan time restrictions (B0 and B800).

Institutional based study with less number of sample size.

Conclusion

ADC measures using our approach were not significantly changed after contrast administration for ovarian tumors at 1.5T.

Our findings support the possibility that DWI optimized may be obtained before or after DCE-MRI without compromising important clinical information.

Benign ovarian tumors had higher ADC values compared to malignant tumors, consistent with some of the previous studies.

Further studies are needed to support our study due to limited study sample.

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