Original Research Paper

Radio-Diagnosis

ROLE OF COLOUR DOPPLER IN CHARACTERISATION OF ADNEXAL MASSES

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ABSTRACT Adnexal masses predominantly include solid or cystic masses, however para-tubal cysts, hydrosalpinx and other non-ovarian masses are also included in the broader definition of adnexal masses. Common benign lesions are endometriomas, ectopic pregnancy, fibroids, and malignant lesions include ovarian malignancies and metastasis. Ultrasound is the mainstay when it comes to diagnosing adnexal masses. Trans-abdominal as well as Trans-vaginal scans are performed. Color doppler is also being recently employed in better characterisation of adnexal masses. Morphological analysis of adnexal masses is done to classify them as either low or high risk. Spectral Doppler waveform characteristics – Resistivity Index, Pulsatility Index and Peak Systolic Velocity correlate well with malignancy and are based on the fact that tumor vessels are morphologically abnormal.

INTRODUCTION

Bilaterally, the broad and round ligaments, fallopian tubes, ovaries and their associated vasculature extend from lateral uterine corpus forming the pelvic adnexa.[1] Most frequently, adnexal masses refer to ovarian masses or cysts; however paratubal cysts, hydrosalpinx, and other non-ovarian masses are also included within the broader definition of adnexal masses.[2] It includes benign lesions like endometriomas, ectopic pregnancy, uterine fibroids when pedunculated, polycystic ovaries, tubo-ovarian abscesses and malignant lesions including ovarian malignancies, fallopian tube malignancies and metastasis from other sites like breast and lungs.[3]

Ovarian or uterine tumors could be abdominal or adnexal masses presenting as including abdominal pain, bloating, urinary urgency and abnormal vaginal bleeding. Such varied clinical presentation could be caused by many different benign and malignant conditions.[4]

Pelvic ultrasonography to visualize the adnexa and the uterus is commonly performed in symptomatic and asymptomatic women of reproductive and menopausal age. Pelvic ultrasound today forms the primary examination mode in the evaluation of female pelvic masses. Transabdominal sonography (TAS) gives the global view of the pelvic organs, while Transvaginal sonography (TVS) adds specificity as it gives better information regarding tumor composition, texture, internal consistency and exact relationship with other pelvic organs. The greater enhancement allows better distinction of morphological characteristic of ovary like ovarian volume, cyst wall thickness, and presence of septa or papillary growth.

Colour doppler is a relatively recent diagnostic modality for assessment of adnexal masses. Transvaginal Colour Doppler has an additional advantage of close proximity of high frequency vaginal probe, allowing greater resolution of architectural detail. With the help of Duplex Colour Doppler blood flow can be displayed simultaneously with conventional B-mode image.

Morphological analysis of adnexal masses is done to classify them as either low or high risk. Spectral Doppler waveform characteristics – Resistivity Index, Pulsatility Index and Peak Systolic Velocity correlate well with malignancy and are based on the fact that tumor vessels are morphologically abnormal. This is based on Folkman's theory of neovascularisation according to which tumor cells elaborate tumor angiogenesis factor that promotes neovascularisation and therefore, by knowing the blood flow characteristics one can predict whether the tumor is benign or malignant.

Resistivity index is defined as the maximum systolic velocity minus end diastolic velocity divided by maximum systolic velocity. Pulsatility index is defined as maximum systolic velocity minus end diastolic velocity divided by mean systolic velocity.

The present study is being done to explore the role of Colour Doppler in characterization of adnexal masses and exclusion of ectopic pregnancy.

AIMS AND OBJECTIVES

AIMS-
- To measure and evaluate Color Doppler indices in adnexal masses.
- To identify cases with normal and abnormal flow

OBJECTIVES
- To find out association between abnormal flow indices and adnexal pathology.
- To evaluate the efficacy of Transvaginal Colour Doppler as an imaging modality in the exclusion of ectopic pregnancy among adnexal masses.

MATERIAL AND METHODS

Type of study- Prospective study

Place of study- MGM Medical College at its 'Mother And Child Hospital at Kalamboli', Navi Mumbai.

Period of study- November 2019 to November 2021.

Institute Ethics Committee approval will be obtained before start of study.

Written informed consent will be obtained from the patients.

All the scans will be performed in strict adherence with the PCPNDT act.

Sample Size: 60 cases

Study Protocol-
- It will be a prospective study to evaluate Colour Doppler in the characterization of adnexal masses and diagnosis of ectopic pregnancy.
- All the patients who come for ultrasound at Obstetric and Gynaecological Unit of the MOTHER AND CHILD HOSPITAL, KALMABOLI in the study period will be evaluated.
- When required, patients will be registered according to PCPNDT Act.
- Scan will be performed transabdominally with 3-5 MHz curvilinear transducer probe.
- Scan will be performed transvaginally with 4-8 MHz transducer probe.

Any mass found will be characterized by-
1. Location (intraovarian or extraovarian)
2. Size
3. External Contour (thin or thick walled, regularity of borders, etc)
4. Internal consistency (Cystic unilocular or multilocular with or without solid components, predominantly solid, or solid)

Colour Doppler will be performed and the Colour Doppler indices will be correlated with the clinic-pathological diagnosis.

Precautions To Be Taken
- Strict compliance with PCPNDT regulations
- Patient's consent to be taken.

Inclusion Criteria
- Gynaecological patients.
- Obstetric patients.
- Patients diagnosed/ incidentally detected with adnexal masses or ectopic pregnancy.
- Patients willing for the study and follow up.

Exclusion Criteria
- Patients diagnosed with non gynaecological/ non obstetric pelvic masses.
- Patients not willing for study and follow up.

RESULTS
The collected data was analysed using SPSS 23 software and appropriate statistical tests were used whenever required.

1. Age Distribution-
Regarding age distribution, the maximum number of cases in our study were 53 out of 60 cases (88%) in the 15-45 years age group, that is the reproductive age group. 7 out of 60 cases (12%) were in women above 45 years of age.

2. Distribution Of Symptoms-
In our study, 23% females presented with oligomenorrhoea, the most common symptom, 21% presented with menorrhagia making it the next most common symptom, 18% females were asymptomatic, 16% presented with weight fluctuations, 15% with pain, 13% presented with amenorrhoea, 10% with lump in lower and 8% with polymenorrhoea.

3. Associated Findings-
Regarding associated findings, 3 out of 60, that is 5% presented with evidence of distant organ involvement and 9 out of 60, that is 15% presented with evidence of free fluid in the abdomen. Rest of the patients did not show presence of any associated findings.

4. Vascularity-
41 out of 60 (68%) patients showed absence of vascularity on colour doppler imaging, 12% showed presence of peripheral vascularity, 1% showed presence of internal vascularity and 6% of patients showed presence of both peripheral and internal vascularity.

Pulsatility Index and Resistivity Index- 6 out of 60 patients, that is 10% patients showed PI <1 and RI <0.4. 13 out of 60, that is 22% patients showed PI >1 and RI>0.4. 41 patients, that is 68% patients did not show presence of blood flow on doppler study.

5. Location-
Most common location for adnexal lesions sonographically was left and right ovary as seen in 24 out of 60, that is 40% patients. Next most common location was right adnexa in 12% followed by left adnexa in 3% patients, bilateral adnexal lesions were seen in 3% patients and bilateral ovarian lesions in 2%.

6. Inner Wall Structure-
In our study, 50 out of 60 patients (83%) had smooth and regular inner wall structure and remaining 10% (17%) had irregular inner wall structure.

7. Septations-
44 out of 60 patients showed absence of any internal septations, 7 out of 60 (12%) showed thin septations and 9 out of 60 (15%) showed presence of thick septations.

8. Internal Echogenicity-
38 out of 60 (63%) of patients showed anechoic echogenicity whereas 13% and 12% showed anechoic with septae and heteroechoic echogenicity respectively. 5% patients showed hypoechoic echogenicity whereas 3% showed anechoic with fishnet pattern. 2% patients showed hyperechoic echogenicity and low-level echoes.

9. Wall Thickness-
38 out of 60 (63.3%) showed a wall thickness of 3mm. 9 out of 60 (15%) patients had wall thickness of 2mm and 4mm each. 2(3.3%) patients had wall thickness 5mm. 2(3.3%) patients were solid masses in which wall thickness could not be calculated.

10. Age And Radiological Diagnosis-
91.1% of benign lesions were radiologically diagnosed among women below 45 years, while malignant lesions were equally diagnosed in both age groups. Similarly, the radiological diagnosis had a statistically significant association with the age of women ($\chi 2$ – value (6.11 and p-value < 0.05).

11. Mean RI and Mean PI In Benign And Malignant Masses -
The mean RI was significantly higher (t-value = 3.84 and p-value < 0.05) for benign masses (0.65; SD: ±0.14) than malignant masses (0.37; SD: ± 0.02). Similarly, benign masses also had statistically higher (t-value = 3.57 and p-value < 0.05) mean PI (1.33; SD: ± 0.20) compared to malignant masses (0.96; SD: ± 0.03).

12. Radiological Diagnosis And Histo-pathological Diagnosis –
Out of histopathologically diagnosed benign lesions, 91.7% of lesions were correctly classified with radiological diagnosis. Both radiological and histopathological diagnoses correctly identified 66.7% of malignant lesions. The significant χ^2 – value (38.57 and p-value < 0.05) reported that radiological diagnosis and histopathological diagnosis were statistically associated. Similarly, the radiological diagnosis and histopathological diagnosis had moderate agreement (Cohen's Kappa Statistics = 0.609 and p-value < 0.05).

The sensitivity, specificity, positive predictive value, and negative predictive values for radiological diagnosis were

91.7%, 66.7%, 84.6% and 80% respectively. The accuracy of radiological diagnosis was 83.3%.

Table 1- Age Distribution

Age	Number	Percentage
15-45 years	53	88
>45 years	7	12

Table 2 – Associated Findings

Associated Findings	Number	Percentage
METASTASIS	3	5
ASCITES	9	15

Table 3 - Presence Of Vascularity

VASCULARITY	NUMBER	PERCENTAGE
ABSENT	41	68
INTERNAL	1	2
PERIPHERAL	12	20
PERIPHERAL AND INTERNAL	6	10

Table 4- Pulsatility Index

DOPPLER PARAMETER	ABSENT	<1	>1
PULSATILITY INDEX	41(68%)	6(10%)	13(22%)

Table 5- Resistivity Index

DOPPLER PARAMETER	ABSENT	<0.4	>0.4
RESISTIVITY INDEX	41(68%)	6(10%)	13(22%)

Table 6 – Inner Wall Structure

INNER WALL STRUCTURE	NUMBER	PERCENTAGE
SMOOTH AND REGULAR	50	83
IRREGULAR	10	17

Table 7- Presence Of Septations

SEPTATIONS	NUMBER	PERCENTAGE
ABSENT	44	73
THIN	7	12
THICK	9	15

Table 8- Internal Echogenicity

INTERNAL ECHOGENICITY	NUMBER	PERCENTAGE
ANECHOIC	38	63
ANECHOIC WITH SEPTAE	8	13
ANECHOIC WITH INCOMPLETE SEPTAE	2	3
HETEROECHOIC	7	12
HYPERECHOIC	1	2
HYPOECHOIC	3	5
LOW LEVEL ECHOES	1	2

Table 9- Wall Thickness

WALL THICKNESS	NUMBER	PERCENTAGE
Could not be calculated	2	3.3
2mm	9	15
3mm	38	63.3
4mm	9	15
5mm	2	3.3

Table 10- Sassone's Score

SASSONE'S SCORE	NUMBER	PERCENTAGE
<9	54	90
>9	6	10

Table 11- Age And Radiological Diagnosis

		Radiological Diagnosis		Total	χ^2 - value
		Benign (%)	Malignant (%)		
Age	< 45 years (%)	51 (91.1)	2 (50)	53	6.11 (p-value = 0.02)
	> 45 years (%)	5 (8.9)	2 (50)	7	
	Total	56	4	60	

Table 12- Mean PI and RI In Benign And Malignant Masses

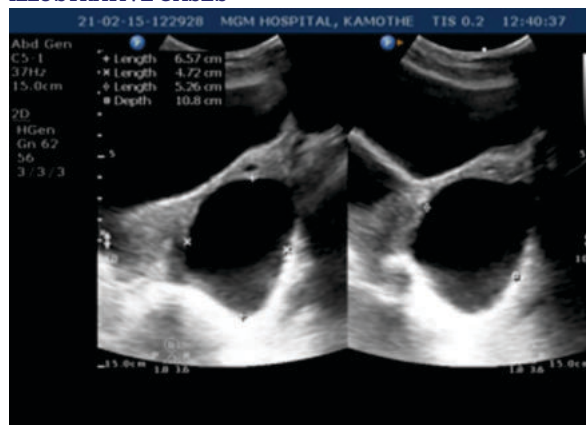|		Number	Mean	SD	t-value
RI	Benign	15	0.65	0.14	3.84 (p-value = 0.00)
	Malignant	4	0.37	0.02	
PI	Benign	15	1.33	0.20	3.57 (p-value = 0.00)
	Malignant	4	0.96	0.03	

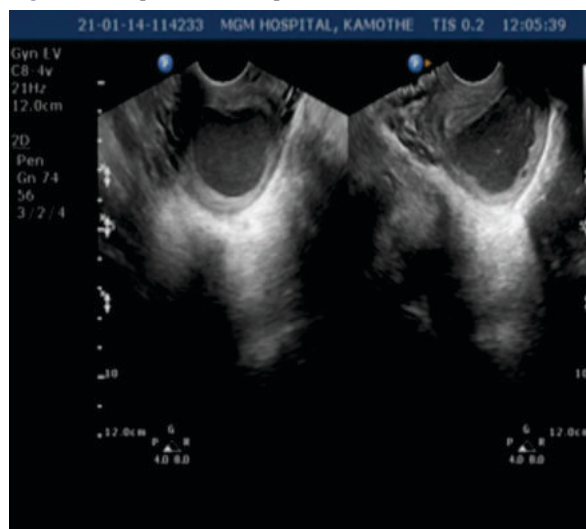### ILLUSTRATIVE CASES

Figure 1 - Simple Ovarian Cyst

Figure 2 - Hemorrhagic Ovarian Cyst With Multiple Thin Septae And Echoes Within

Figure 3 - Endometrioma With Low Level Ground Glass Echoes Within

Figure 4 - Complex Solid Adnexal Lesion With Internal And Peripheral Vascularity

Figure 5 & 6 - Complex Adnexal Lesion With Solid Component And Echoes Within

Figure 7 - Dilated Left Adnexal Lesion With Low Level Echoes Within And Evidence Of Incomplete Septae Within Suggestive Of Hydrosalpinx.

Figure 8 - Dilated Left Adnexal Lesion With Multiple Echoes Within And Evidence Of Incomplete Septae Within Suggestive Of Hematosalpinx/ Pyosalpinx.

Figure 9 - Complex Cystic Lesion With Solid Component And Echoes Within, The Solid Component Shows Evidence Of Vascularity

DISCUSSION

A prospective study was carried out from November 2019 to July 2021 on Role of Colour Doppler in characterisation of adnexal masses.

Regarding age distribution, in our study the maximum number of cases in our study, that is 53 out of 60 cases (88%) in the 15-45 years age group, that is the reproductive age group. 7 out of 60 cases (12%) were in women above 45 years of age. This was in accordance with study conducted by Raina et al. which showed maximum number of cases 34 (42.50%) were in a group of 30-39 years followed by 21 cases (26.25%) in the age group 20-29 years. There were 13 (16.25%) cases in 40-49 years and 12 cases (15%) in age group 50 and above.

Regarding loculations and echogenicity of the masses, in our study, 63% of the masses were anechoic and unilocular. All the unilocular and anechoic masses were benign. The malignant masses in our study were complex, solid cystic and multilocular. This was in accordance with study conducted by Khurana et al. which showed most of the benign lesions were unilocular (77.1%) and all the borderline lesions and most of the malignant lesions were multilocular (77.8%). Similar studies were conducted by Tailor et al which showed that 67.3% of the benign tumors and 46.7% of the malignant lesions were unilocular and study by Kobal B et al reported that multilocular benign lesions were 31.8% and malignant lesions were 62.5% malignant. Thus, the present study and other studies mentioned above suggest that the malignant lesions are predominantly multilocular.

Regarding colour flow in the masses, in our study, 41 out of 60 (68%) patients showed absence of vascularity on colour doppler imaging, 12% showed presence of peripheral vascularity, 1% showed presence of internal vascularity and 6% of patients showed presence of both peripheral and internal vascularity. Majority of the malignant lesions had presence of both peripheral internal central vascularity and the benign lesions showed peripheral vascularity. This was in accordance with study conducted by Fleischen et al., Kurjak et al., Carter et al. and Stein et al. who found a statistically significant difference between vascularity in benign lesions (which tended to be peripheral) and that in malignant lesions (which tended to be internal). The data also yielded a higher percentage of malignant lesions with internal flow (77%) than of benign lesions with such flow.

Regarding Pulsatility index and Resistivity index-In our study 6 out of 60 patients, that is 10% patients showed PI <1 and RI <0.4. 13 out of 60, that is 22% patients showed PI >1 and RI>0.4. 41 patients, that is 68% patients did not show presence of blood flow on doppler study. Majority of patients with malignant lesions showed PI <1 and RI <0.4. This was in accordance with the studies conducted by Stein et al., Goyal et al., Ko-Hui Tung et al., Shazia et al. and Gupta et al. which suggested that using Doppler study, malignant neoplasms offered a lower resistance to blood flow as measured by resistance index (RI) and pulsatility index (PI). Mean RI and PI were significantly lower in malignant masses compared to malignant masses (p value <0.001). Mean RI for benign and malignant masses in the present study was 0.72 and 0.34 while mean PI for benign and malignant adnexal masses was 1.95 and 0.97 respectively.

CONCLUSION

In our study of 60 cases, we conclude that majority of cases of adnexal masses in routine ultrasound practice are benign lesions predominantly consisting of simple ovarian cysts and hemorrhagic cysts. Majority of these lesions can be recognised by their B mode ultrasound characteristics. Ultrasound is an excellent modality in terms of availability, cost effectiveness, less time consumption, simplicity and safety as it is free of ionising radiations. Ultrasonography also has the benefits of being portable. It is the first imaging modality in pelvic pathologies in females and it helps to differentiate solid from cystic masses. Advent of Ultrasonography in pelvic pathologies has led to an early diagnosis of neoplastic lesions.

With the widespread use of transvaginal ultrasound, the diagnosis of pelvic lesions has become easier and early intervention can be done in necessary cases. Scoring systems like Sassone's system helps in the preliminary classification of masses in benign and malignant categories.

Gray scale ultrasound in combination with Doppler imaging provides added benefit in confident diagnosis of pelvic masses and in better evaluation and differentiation of benign from malignant masses.

Colour doppler imaging helps in establishment of confident diagnosis of benign or malignant lesions when coupled with B mode ultrasound as compared to gray scale ultrasound alone.

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