

Original Research Article


Comparative evaluation of USG and color doppler with CT/ MR in ovarian masses

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Abstract

Background: Ovarian cancer is an important cause of morbidity and mortality, especially in the middle aged women. It has the worst prognosis among all gynecological malignancies.

Materials and methods: The study was conducted in the Department of Radio diagnosis, Departments of Obstetrics and Gynecology, Tata Main Hospital and Diagnostic Centre of Meherbai Tata Memorial Hospital, Jamshedpur for a period of 24 months i.e. from September 2011 to July 2013. All patients referred from various Departments, particularly Departments of Obstetrics and Gynecology and General Surgery, with a radiological diagnosis of ovarian masses were included in the study.

Results: Sensitivity, positive predictive value, diagnostic accuracy of USG (67%, 79.41% and 64.7%) in detecting size was more than CT and MRI while specificity of CT in detecting size was maximum (75%). Negative predictive value of MRI (42.8%) was more than USG and CT.

Conclusion: Ultrasound is a simple, non-invasive, non-ionizing, low cost, easily available, reproducible, time saving tool for evaluation of ovarian masses. It should be the first investigation to be done in young/middle age females or pregnant women where CT is not advisable.

Key words

USG, Color Doppler, CT, MR, Ovarian mass.

Introduction

Ovarian cancer is an important cause of morbidity and mortality, especially in the middle

aged women. It has the worst prognosis among all gynecological malignancies. Ovarian cancer is the sixth most common cancer (age

standardized incidence rate: 6.6/ 100,000) and the seventh leading cause of cancer deaths (age standardized mortality rate: 4.0 /100,000) among women worldwide [1].

The risk of a woman developing ovarian cancer is 1 in 71 [2]. The overall 5-year survival is approximately 45%, primarily due to the late stage at diagnosis of the disease. The early detection of ovarian carcinoma continues to be a formidable challenge and an elusive task [3].

During the year 2002, it ranked third in frequency (4.1%) among all cancers in women, with an estimated 02, 04,499 new cases occurring in the world [1]. The age-standardized incidence rate (ASR-World) varied from as low as 0.06 per 100,000 women in China, Hong Kong to a high of 16.3 in Switzerland, St Gall-Appenzell [4].

In most of population based cancer registries in India, ovarian cancer is the third leading site of cancer among women, trailing behind cervix and breast cancer. The age adjusted incidence rates of ovarian cancer vary between 5.4 and 8.0 per 100,000 populations in different part of country [5].

Aim and objective

- Evaluation of ovarian mass according to age (premenopausal women or postmenopausal women).
- To correlate the clinical presentation and radiological findings of ovarian mass.
- To predict the nature of an ovarian mass (benign/ malignant) according to following criteria on conventional and doppler US as size, solid/cystic components, irregularities in the wall of a mass, thick septations, papillary projections, and neovascularity/ resistive index (RI), pulsatility index (PI) and compare these finding with CT / MR imaging.

- To correlate USG/ Doppler, CT or MR findings with histopathological/ post-operative findings wherever possible.

Materials and methods

Design: This was a Prospective study.

Study area:

The study was conducted in the Department of Radio diagnosis, Departments of Obstetrics and Gynecology, Tata Main Hospital and Diagnostic Centre of Meherbai Tata Memorial Hospital, Jamshedpur for a period of 24 months i.e. from September 2011 to July 2013.

Tata Main Hospital is an ISO 9001-2008 certified 920 bedded multidisciplinary industrial hospital and referral centre. 90 to 100 ultrasounds and 300 to 350 radiographs are being done daily including special investigations. Various ultrasound guided interventions are being done on daily basis.

Study population:

The study group included both OPD and indoor patients comprising of:

- Employees of Tata steel company and their families.
- General population of Jamshedpur.

Sample size and selection criteria:

All patients referred from various Departments, particularly Departments of Obstetrics and Gynecology and General Surgery, with a radiological diagnosis of ovarian masses were included in the study. After informed written consent, patients were recruited into the study. Approval of the Institutional Ethical Committee was taken to conduct the above study. Secrecy and confidentiality was maintained.

Patient exclusion criteria:

- Patients presenting with adnexal (tubal)/ uterine mass.
- A patient who show regression of size of large ovarian cyst in follow up scan.

Method:

A short history of patients presenting in the OPD/ Gynecology ward and subsequently found to have an ovarian mass on clinical and radiological evaluation was taken. After clinical workup, the patients abdominal/pelvic USG with Doppler was done in the Department of Radio-Diagnosis to characterize the lesion. Patients for further evaluation was refer to Diagnostic centre of Meherbai Tata Memorial Hospital, Jamshedpur for CT/MR imaging. Follow-up of patients was done till definitive diagnosis is made by follow up/ post-operative histopathological finding.

Machine specification

Ultrasound machines:

- LOGIQ PRO 5 [GE] with 10-12 MHz probe.

- SSD DYNVIEW-II [Aloka, Tokyo] with 7.5 MHz probe.
- TOSHIBA

CT scan machine:

- Model- SIEMENS - SOMATOM EMOTION

MRI machine:

- Model- SIEMENS - MAGNETON 1.0 TESLA.

Data analysis:

Data was entered in Microsoft excel sheet. All the data was analyzed using tables and charts. Statistical analysis was done to obtain sensitivity, specificity, positive predictive value, negative predictive value and accuracy.

Table – 1: Frequency of different classes of non-neoplastic and neoplastic (benign and malignant ovarian masses). (n =65; No. of cases of each histological type was given).

	Classes of ovarian masses	Total patients recruited	Patients Excluded (as size of mass regress on follow up)	Final no. of patient Included in study
	Non-neoplastic			
1	Follicular cyst	11	11	0
2	Hemorrhagic cyst	6	2	4
3	Endometriomas	6	0	6
4	Torsion	2	0	2
5	Corpus luteal cyst	3	1	2
6	Theca lutein cyst	1	0	1
7	Tuberculosis	1	0	1
8	Benign paraovarian cyst	1	0	1
	Total	31	14	17
	Neoplastic			
	Benign			
1	Surface epithelial Tumor			
	Serous cyst adenoma	6	0	6
	Mucinous cyst adenoma	4	0	4
2	Germ cell tumor			
	Mature teratoma (dermoid cyst)	5	0	5
3	Sex cord stromal Tumor			
	Sclerosing stromal tumor	1	0	1
	Fibroma	1	0	1
	Total	17	0	17
	Malignant tumors			

1	Surface epithelial Tumor			
	Serous cyst adenocarcinoma	8	0	8
	Mucinous cyst adenocarcinoma	3	0	3
	Endometrioid carcinoma	-	-	-
	Clear cell carcinoma	-	-	-
	Malignant Brenner tumors	-	-	-
2	Germ Cell tumor			
	Yolk sac tumors	-	-	-
	Dysgerminoma	4	0	4
	Mixed YST and choriocarcinoma	-	-	-
	Teratocarcinoma	-	-	-
3	Sex cord stromal Tumor			
	Granulose cell tumors	-	-	-
	Sarcoma	2	0	2
4	Metastatic tumor			
	Krukenberg tumor	-	-	-
	Total	17	0	17
	Grand total	65	14	51

Table - 2: Frequency of masses in different age groups (n=51).

Diagnosis	Age group in years						Total
	Up to 20	21-30	31-40	41-50	51-60	>60	
Non-neoplastic							
Follicular cyst	-	-	-	-	-	-	-
Hemorrhagic cyst	1	1	1	1			4
Endometriomas		1+1	1+1	1+1			6
Torsion			1	1			2
Corpus luteal cyst			1+1				2
Theca lutein cyst		1					1
Tuberculosis			1				1
Benign paraovarian cyst				1			1
Total	1	4	7	5	0	0	17
Neoplastic (benign)							
Serous cyst adenoma		1			1+1+1+1	1	6
Mucinous cyst adenoma			1+1	1	1		4
Sclerosing stromal tumour				1			1
Fibroma				1			1
Mature teratoma (dermoid cyst)		1	1	1+1	1		5
Total	0	2	3	5	6	1	17
Neoplastic (malignant)							
Serous cyst adenocarcinoma			1	1+1+1	1+1	1+1	8
Mucinous adenocarcinoma					1+1+1		3
Dysgerminoma	1+1+1	1					4
Sarcoma						1+1	2

Total	3	1	1	3	5	4	17
Grand total	4	7	11	13	11	5	51

Table - 3: Distribution of ovarian masses according to menopausal status.

	Non malignant	Malignant	Total
Pre-menopausal	22	7	29
Post-menopausal	12	10	22
Total	34	17	51

P value= 0.14 (Not significant)

Table – 4: Distribution of symptom in ovarian masses.

Symptoms	Malignancy status of ovarian mass			
	Non-malignant		Malignant	
	No.	%	No.	%
Asymptomatic	5	11.76	1	11.76
Abdominal pain	21	56.86	8	56.86
Abdominal distension	7	39.21	13	39.21
Weight loss	3	11.76	3	11.76
Metrorrhagia	3	7.8	1	7.8
Non-specific symptom	12	31.37	4	31.37

Table – 5: Distribution of benign and malignant tumors in one or both ovaries.

Diagnosis		Not malignant	Malignant	Total
Bilateral		5	1	6
Unilateral	RT	17	5	22
	LT	12	7	19
Not determined		0	4	4

Table – 6A: USG features.

USG Feature	Criteria	Nonmalignant	Malignant	Total	P value
Size	< 500	27	7	34	0.31 (Not Significant)
	> 500	11	6	17	
Solid component	Absent	21	7	28	0.23 (Not Significant)
	Present	13	10	23	
Cystic component	Absent	4	5	9	0.24 (Not Significant)
	Present	30	12	42	
Mural nodule / Papillary Projection	Absent	31	7	38	0.0003 (Highly Significant)
	Present	3	10	13	
Wall thickness	Absent (mostly solid)	2	8	10	0.0009 (Highly Significant)
	Thin ≤ 3 mm	20	4	24	
	Thick >3 mm	12	5	17	
Septa	No septa	17	6	23	0.00006 (Highly Significant)
	Thin ≤ 3 mm	15	1	16	
	Thick > 3 mm	2	10	12	
Echogenicity	Anechoic	8	0	8	0.05

	Anechoic + Internal Echoes	6	4	10	(Significant)
	Hypo echoic	-	-	-	
	Hyper echoic	4	6	10	
	Hetero echoic	16	7	23	
Ascites	Absent	26	4	30	0.0006 (Highly Significant)
	Present	8	13	21	
Calcifications	Absent	29	15	44	1 (Not Significant)
	Present	5	2	7	
Lymph node	Absent(short axis <1 cm)	32	10	42	0.003 (Highly Significant)
	Present(short axis >1 cm)	2	7	9	
Peritoneal implants/ Distant metastasis	Absent	34	14	48	0.03 (Significant)
	Present	0	3	3	

Table - 6B: Color doppler study.

No. of patients		Nonmalignant	Malignant	Total	P value
Vascular Characteristic	Absent flow	26	9	35	0.11 (not significant)
	Present	8	8	16	
R.I value	(≤ 0.4)	1	7	8	0.01 (Significant)
	(> 0.4)	7	1	8	
P.I value	(≤ 0.8)	3	7	10	0.11 (not significant)
	(> 0.8)	5	1	6	

Table - 7: CT features.

CT feature	Criteria	Non-malignant	Malignant	Total	P value
Size	< 5 cm	5	3	8	1 (Not Significant)
	> 5 cm	13	9	22	
Solid component	Absent	10	0	10	0.004(Highly significant)
	Present	8	12	20	
Cystic component	Absent	1	4	5	0.13 (Not Significant)
	Present	17	8	25	
Mural nodule / Papillary Projection	Absent	16	7	23	0.08 (Not Significant)
	Present	2	5	7	
Wall thickness	Absent (mostly solid)	2	4	6	0.02 (Significant)
	Thin ≤ 3 mm	14	2	16	
	Thick >3 mm	2	6	8	
Septa	No septa	13	2	15	0.44 (Not Significant)
	Thin ≤ 3 mm	2	1	3	
	Thick > 3 mm	3	9	12	

Mass	Unilocular	10	1	11	0.03 (Significant)
	Multilocular	5	7	12	
Necrosis	Absent	18	6	24	0.0015 (Highly Significant)
	Present	0	6	6	
Pre contrast	Hypo dense	10	2	12	0.06 (Not Significant)
	Hyperdense	1	3	4	
	Heterodense	7	7	14	
Post contrast	Enhancing	8	11	18	0.02 (Significant)
	Non enhancing	10	1	11	
Calcifications	Absent	14	11	25	0.6 (Not Significant)
	Present	4	1	5	
Ascites	Absent	16	4	20	0.004 (Highly Significant)
	Present	2	8	10	
Lymph node	Absent(short axis <1 cm)	17	7	24	0.03 (Significant)
	Present(short axis >1 cm)	1	5	6	
Peritoneal implants/ Distant metastasis	Absent	18	9	27	0.05 (Significant)
	Present	0	3	3	

Table – 8: MRI features.

MRI feature	Criteria	Non-malignant	Malignant	Total	P value
Size (smallest dimension)	< 5 cm	2	2	4	1 (Not Significant)
	> 5 cm	4	3	7	
Solid component	Absent	1	1	2	1 (Not Significant)
	Present	5	4	9	
Cystic component	Absent	2	1	3	1 (Not Significant)
	Present	4	4	8	
Mural nodule / Papillary Projection	Absent	5	2	7	0.24 (Not Significant)
	Present	1	3	4	
Wall thickness	Absent (mostly solid)	2	1	3	1 (Not Significant)
	Thin \leq 3 mm	3	1	4	
	Thick >3 mm	1	3	4	
Septa	No septa	4	2	6	0.32 (Not Significant)
	Thin \leq 3 mm	1	0	1	
	Thick > 3 mm	1	3	4	
Mass	Absent	2	1	3	0.88 (Not Significant)
	Unilocular	2	2	4	
	Multilocular	2	2	4	

Necrosis		Absent	6	4	10	0.45 (Not Significant)
		Present	0	1	1	
T1WI	Pre contrast	Hypo Intense	2	3	5	0.16 (Not Significant)
		Iso Intense	1	2	3	
		Hyper Intense	3	0	3	
	Post contrast	Enhancing	2	4	6	0.24 (Not Significant)
		Non enhancing	4	1	5	
T2WI		Hypo Intense	1	0	1	0.36 (Not Significant)
		Iso Intense	0	1	1	
		Hyper Intense	5	4	9	
Calcifications		Absent	6	4	10	0.45 (Not Significant)
		Present	0	1	1	
Ascites		Absent	4	1	5	0.24 (Not Significant)
		Present	2	4	6	
Lymph node		Absent(short axis <1 cm)	6	4	10	0.45 (Not Significant)
		Present(short axis >1 cm)	0	1	1	
Peritoneal implants/ Distant metastasis		Absent	6	4	10	0.45 (Not Significant)
		Present	0	1	1	

Table – 9: Size.

USG feature	Criteria	Non-malignant	Malignant	Total
Size (Volume in cc)	< 500	27	7	34
	> 500	11	6	17
	Total	38	13	51

CT feature	Criteria	Non-malignant	Malignant	Total
Size (smallest dimension)	< 5 cm	5	3	8
	> 5 cm	13	9	22
	Total	18	12	30

MRI feature	Criteria	Non-malignant	Malignant	Total
Size (smallest dimension)	< 5 cm	2	2	4
	> 5 cm	4	3	7
	Total	6	5	11

		USG	CT	MRI
1	SN =a/a+c X 100	67	27.7	33.3
2	SP= d/b+d X 100	46.15	75	60
3	PPV= a/a+b X 100	79.41	62.5	50
4	NPV= d/c+d X 100	35.29	40.9	42.8

5	DA= a+d /a+b+c+d X 100	64.7	46.6	45.45
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Table – 10: Solid components.

USG Feature	Criteria	Non-malignant	Malignant	Total
Solid component	Absent	21	7	28
	Present	13	10	23
	Total	34	17	51

CT feature	Criteria	Non-malignant	Malignant	Total
Solid component	Absent	10	0	10
	Present	8	12	20
	Total	18	12	30

MRI feature	Criteria	Non-malignant	Malignant	Total
Solid component	Absent	1	1	2
	Present	5	4	9
	Total	6	5	11

		USG	CT	MRI
1	SN =a/a+c X 100	61.76	55.55	16
2	SP= d/b+d X 100	58.8	100	80.0
3	PPV= a/a+b X 100	75	100	50.0
4	NPV= d/c+d X 100	43	60	44.4
5	DA= a+d /a+b+c+d X 100	60	73.3	45.45

Table – 11: Cystic components.

USG Feature	Criteria	Non-malignant	Malignant	Total
Cystic component	Absent	4	5	9
	Present	30	12	42
	Total	34	17	51

CT feature	Criteria	Non-malignant	Malignant	Total
Cystic component	Absent	1	4	5
	Present	17	8	25
	Total	18	12	30

MRI feature	Criteria	Non-malignant	Malignant	Total
Cystic component	Absent	2	1	3
	Present	4	4	8
	Total	6	5	11

		USG	CT	MRI
1	SN =a/a+c X 100	11.76	5.55	33.3

2	SP= d/b+d X 100	70.58	66.6	80.0
3	PPV= a/a+b X 100	44.44	20.0	66.6
4	NPV= d/c+d X 100	28.57	32.0	50.0
5	DA= a+d /a+b+c+d X 100	33.33	30.0	54.54

Table – 12: Wall thickness.

USG Feature	Criteria	Non-malignant	Malignant	Total
Wall thickness	Absent (mostly solid)	2(a)	8(b)	10(a+b)
	Thin \leq 3 mm	20(c)	4(d)	24(c+d)
	Thick >3 mm	12 (a+c)	5(b+d)	17(a+b+c+d)

CT feature	Criteria	Non-malignant	Malignant	Total
Wall thickness	Absent (mostly solid)	2	4	6
	Thin \leq 3 mm	14	2	16
	Thick >3 mm	2	6	8

MRI feature	Criteria	Non-malignant	Malignant	Total
Wall thickness	Absent (mostly solid)	2	1	3
	Thin \leq 3 mm	3	1	4
	Thick >3 mm	1	3	4

		USG (%)	CT (%)	MRI (%)
1	SN =a/a+c X 100	62.5 (%)	87.5 (%)	75.0 %
2	SP= d/b+d X 100	55.5 %)	75.0 (%)	75.0
3	PPV= a/a+b X 100	83.3 (%)	87.5 (%)	75.0
4	NPV= d/c+d X 100	29.41 (%)	75.0 (%)	75.0
5	DA= a+d /a+b+c+d X 100	60.97 (%)	83.3 (%)	75.0

Table – 13: Septal thickness.

USG Feature	Criteria	Non-malignant	Malignant	Total
Septa	No septa	17 (a)	6(b)	23(a+b)
	Thin \leq 3 mm	15(c)	1(d)	16(c+d)
	Thick > 3 mm	2(a+c)	10(b+d)	12(a+b+c+d)

CT feature	Criteria	Non-malignant	Malignant	Total
Septa	No septa	13	2	15
	Thin \leq 3 mm	2	1	3
	Thick > 3 mm	3	9	12

MRI feature	Criteria	Non-malignant	Malignant	Total
Septa	No septa	4	2	6
	Thin \leq 3 mm	1	0	1
	Thick > 3 mm	1	3	4

		USG (%)	CT (%)	MRI (%)
1	SN =a/a+c X 100	88.23	40.0	50.0
2	SP= d/b+d X 100	90.9	90.0	100
3	PPV= a/a+b X 100	93.7	66.6	100
4	NPV= d/c+d X 100	83.3	90.0	100
5	DA= a+d /a+b+c+d X 100	89.28	73.3	80.0

Table – 14: Papillary Projections/ Mural Nodule.

USG Feature	Criteria	Non-malignant	Malignant	Total
Mural nodule / Papillary Projection	Absent	31	7	38
	Present	3	10	13

CT feature	Criteria	Non-malignant	Malignant	Total
Mural nodule / Papillary Projection	Absent	16	7	23
	Present	2	5	7

MRI feature	Criteria	Non-malignant	Malignant	Total
Mural nodule / Papillary Projection	Absent	5	2	7
	Present	1	3	4

		USG (%)	CT (%)	MRI (%)
1	SN =a/a+c X 100	91.17	88.88	83.33
2	SP= d/b+d X 100	58.88	41.66	60.0
3	PPV= a/a+b X 100	81.57	69.5	71.4
4	NPV= d/c+d X 100	76.9	71.4	75.0
5	DA= a+d /a+b+c+d X 100	80.39	70	72.7

Table – 15: Neovascularity.

1. Resistive Index (RI)

No. of patients	Criteria	Non-malignant	Malignant	
R.I value	(≤ 0.4)	1	7	8
	(> 0.4)	7	1	8

		USG (%)
1	SN =a/a+c X 100	12.5
2	SP= d/b+d X 100	12.5
3	PPV= a/a+b X 100	12.5
4	NPV= d/c+d X 100	12.5
5	DA= a+d /a+b+c+d X 100	12.5

2. Pulsatility Index (PI)

No. of patients		Non Malignant	Malignant	

P.I value	(≤ 0.8)	3	7	10
	(> 0.8)	5	1	6

		USG (%)
1	SN = $a/a+c \times 100$	37.5
2	SP= $d/b+d \times 100$	12.5
3	PPV= $a/a+b \times 100$	30.0
4	NPV= $d/c+d \times 100$	16.6
5	DA= $a+d /a+b+c+d \times 100$	25.0

Table - 16A: Diagnostic correlation of USG/ Doppler with CT /MRI scan & final diagnosis (follow up/ histopathology) in non-malignant masses.

		DIAGNOSIS ON USG/ COLOUR DOPPLER	CORRECT ON USG	DIAGNOSIS ON CT	CORRECT ON CT	DIAGNOSIS ON MRI	CORRECT ON MRI	FINAL DIAGNOSIS /HISTOPATHOLOGY
1	Haemorrhagic cyst	4	4	1	1	-	-	4
2	Endometriomas	6	5	2	2	1	1	6
3	Corpus luteal cyst	2	2	-	-	-	-	2
4	Torsion	2	1	1	0	-	-	2
5	Tuberculosis	1	0	1	0	-	-	1
6	Theca lutein cyst	1	1	-	-	-	-	1
7	Benign paraovarian cyst	1	0	1	1	-	-	1
8	Serous cyst adenoma	6	3	5	3	1	1	6
9	Mucinous cystadenoma	4	3	3	3	1	0	4
10	Mature teratoma (Dermoid cyst)	5	5	3	3	2	2	5
11	Sclerosing stromal tumor	1	1	1	1	-	-	1
12	Fibroma	1	1	-	-	1	1	1
	TOTAL	34	26	18	14	6	5	34

Results

Frequency of different classes of non-neoplastic and neoplastic (benign and malignant ovarian masses) was as per **Table – 1**. Frequency of masses in different age groups was as per **Table – 2**. Distribution of ovarian masses according to menopausal status was as per **Table – 3**. Distribution of symptom in ovarian masses was as per **Table – 4**. Distribution of benign and malignant tumors in one or both ovaries was as per **Table – 5**. USG features were as per **Table – 6A**. Color doppler study was as per **Table – 6B**.

CT features was **Table – 7**. MRI features was as per **Table – 8**.

Sensitivity, positive predictive value, diagnostic accuracy of USG (67%, 79.41% and 64.7%) in detecting size was more than CT and MRI while specificity of CT in detecting size was maximum (75%). Negative predictive value of MRI (42.8%) was more than USG and CT (**Table – 9**).

Sensitivity of USG (61.76%) in detecting solid component was more than CT and MRI (55.55%

and 16%) while specificity, positive predictive value, negative predictive value and diagnostic accuracy of CT (100%, 100%, 60%, and 73.3% respectively) in detecting solid component was more than USG and MRI. Positive predictive

value, diagnostic accuracy of USG was more than MRI while specificity and negative predictive value of MRI was more than USG (Table – 10).

Table - 16B: Diagnostic correlation of USG/ Doppler with CT scan /MRI and final diagnosis (Follow Up/ Histopathology) in malignant masses.

	FINAL DIAGNOSIS /HISTOPATHOLOGY	NO OF CASE DIAGNOSED ON USG/COLOUR DOPPLER	DIAGNOSIS CORRECT ON USG /COLOUR DOPPLER	DIAGNOSIS ON CT	DIAGNOSIS CORRECT ON CT	DIAGNOSIS ON MRI	DIAGNOSIS CORRECT ON MRI	FINAL DIAGNOSIS /HISTOPATHOLOGY
1	Serous cyst adenocarcinoma	8	6	5	3	3	2	8
2	Mucinous cyst adenocarcinoma	3	3	2	2	1	1	4
3	Dysgerminoma	4	4	3	3	1	1	3
4	Sarcoma	2	2	2	2	-	-	2
	TOTAL (15)	17	15	12	10	5	4	17

Table – 17: Accuracy of US in detecting malignancy in ovarian mass.

USG S/O Malignancy	Final diagnosis (Follow up/ Histopathology)		Total
	Malignant	Nonmalignant	
Positive	(a)15	(b)8	23(a+b)
Negative	(c) 2	(d)26	28(c+d)
Total	(a+c)17	(b+d)34	51(a+b+c+d)

P value (Chi square) = 0.00001 (highly significant)

- ❖ Sensitivity (True positive) = $a/a+c \times 100 = 88.23\%$
- ❖ Specificity (True negative) = $d/b+d \times 100 = 76.47\%$
- ❖ Positive Predictive Value = $a/a+b \times 100 = 65.21\%$
- ❖ Negative Predictive Value = $d/c+d \times 100 = 92.85\%$
- ❖ Diagnostic Accuracy = $a+d /a+b+c+d \times 100 = 80.39\%$

Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of MRI (33.3%, 80.0%, 66.6%, 50.0% and 54.54% respectively) in detecting cystic component was more than CT and USG. Sensitivity, specificity, positive predictive value and diagnostic accuracy of USG (11.76%, 70.58%, 44.44%, and 33.33 respectively) in detecting cystic component were more than CT (Table – 11).

Sensitivity, positive predictive value, diagnostic accuracy of CT (all 87.5%) in detecting wall thickness was more than USG (62.5%, 83.3%, 60.97% respectively) and MRI (all 75.0%) while specificity, negative predictive value and of CT in detecting Wall Thickness is comparable with MRI (all 75.0%) but more than USG (55.5% and 29.41 respectively) (Table – 12).

Specificity, positive predictive value, negative predictive value (each 100%) of MRI in detecting

Septal Thickness was more than USG and CT. While Sensitivity (88.23%), diagnostic accuracy of USG (89.2%) in detecting Septal Thickness is more than MRI and CT (**Table – 13**).

Sensitivity, positive predictive value, negative predictive value and diagnostic accuracy of USG

in detecting Papillary Projections/ Mural Nodule was more than CT and MRI while specificity of MRI in detecting Papillary Projections/ Mural Nodule was more than USG and CT (**Table – 14**).

Table – 18: Accuracy of CT in detecting malignancy in ovarian mass.

CT S/O Malignancy	Final diagnosis (Follow up /MRI/ Histopathology)		Total
	Malignant	Non-malignant	
Positive	(a)10	(b)4	(a+b)14
Negative	(c)2	(d)14	(c+d)16
Total	(a+c)12	(b+d)18	(a+b+c+d)30

P value (Chi square) = 0.002 (Significant)

- ❖ Sensitivity (True positive) = $a/a+c \times 100 = 83.33\%$
- ❖ Specificity (True negative) = $d/b+d \times 100 = 77.77\%$
- ❖ Positive Predictive Value = $a/a+b \times 100 = 71.42\%$
- ❖ Negative Predictive Value = $d/c+d \times 100 = 87.5\%$
- ❖ Diagnostic Accuracy = $a+d /a+b+c+d \times 100 = 80\%$

Table – 19: Accuracy of MRI in detecting malignancy in ovarian mass.

MRI S/O Malignancy	Final diagnosis / Histopathology		Total
	Malignant	Non-malignant	
Positive	(a) 4	(b)1	(a+b)5
Negative	(c) 1	(d) 5	(c+d) 6
Total	(a+c) 5	(b+d) 6	(a+b+c+d) 11

P value (Chi square) = 0.08 (non significant)

- ❖ Sensitivity (True positive) = $a/a+c \times 100 = 80\%$
- ❖ Specificity (True negative) = $d/b+d \times 100 = 83.33\%$
- ❖ Positive Predictive Value = $a/a+b \times 100 = 80\%$
- ❖ Negative Predictive Value = $d/c+d \times 100 = 83.33\%$
- ❖ Diagnostic Accuracy = $a+d /a+b+c+d \times 100 = 81.81\%$

Neovascularity was as per **Table – 15**. Diagnostic correlation of USG/ Doppler with CT /MRI scan and final diagnosis (follow up/ histopathology) in non-malignant masses was as per **Table – 16A**. Diagnostic correlation of USG/ Doppler with CT scan /MRI and final diagnosis (Follow Up/ Histopathology) in malignant masses was as per **Table – 16B**. Accuracy of US in detecting malignancy in ovarian mass was as per **Table – 17**. Accuracy of CT in detecting malignancy in ovarian mass was as per **Table – 18**. Accuracy of MRI in detecting malignancy in ovarian mass was as per **Table – 19**.

Discussion

The present study was undertaken to find the efficacy of USG /Color Doppler, CT and MRI in diagnosing ovarian masses, evaluate the sonographic, CT and MRI features of Ovarian masses and to correlate this diagnosis with final diagnosis (Made on follow up/ histopathological or post-operative findings/ diagnosis).

A total of 65 patients referred from various departments of Tata Main Hospital were recruited into study. Out of these 65 patients total of 14 patients were excluded as size of mass regressed on follow up. (According to exclusion

criteria) The study group finally comprised of 51 patients.

Incidence of ovarian mass

In our study non-neoplastic lesions were 47.69% (31/65) and neoplastic lesions were 52.31% (34/65). Neoplastic lesions were 26.15% (17/65) benign and 26.15% (17/65) malignant.

Study conducted by Ashraf A, et al. shows non-neoplastic lesions were 40.09% (85/212) and neoplastic lesions were 59.91% (127/212). Neoplastic lesions contained 64.57% (82/127) benign and 35.43% (45/127) malignant [6].

The higher incidence of benign tumors is also documented in various other studies, where it is 85%, 78%, 89.7% and 72.73% respectively and ratio of benign to malignant tumors is higher in these studies as compared to our study. No borderline tumor was found in our study [7, 8, 9, 10]. Tanwani documented 31.4% non-neoplastic lesions, 46.4% benign tumors and 22.2% malignant tumors [11].

In our study, the most common non-neoplastic lesion was Follicular cyst (11/35) 35.48 % followed by Hemorrhagic cyst and Endometriomas (both 19.35%).

The study conducted by Ashraf A, et al. shows that among non-neoplastic lesion, luteal cyst was most common (44.70%, 38/82) followed by simple serous cysts (35.29%, 30/82) [6].

The pattern of distribution of non-neoplastic lesions is quite variable in other studies, for example incidence of endometriotic cysts were 3% and 20% respectively, hemorrhagic cysts 80% and follicular cyst 86% [7, 8].

Among neoplastic lesions (both benign and malignant) in our study Surface epithelial tumor are most common (21/34 = 61.76%) followed by Germ Cell tumor and Sex cord stromal Tumor (26.47% and 11.77% respectively).

Surface epithelial Tumor

Among the major histological classes, the commonest type of ovarian neoplasm seen in our study was surface epithelial tumors (21/34 = 61.76%), whether benign (10/34 = 28.57% or malignant (11/34 = 32.35%). Similar incidence of epithelial tumors as in our study was found in several other studies by Ahmad Z, et al., Gatphol ED, et al., Tyagi SP, et al., i.e. 64%, 66%, 70% respectively and higher incidence of epithelial tumors than in our study was found by Guppey AE, et al., i.e. 90% [12, 13, 14, 15].

Other studies also showed that serous tumors (whether benign or malignant) were more common than Mucinous tumors (31/67 vs. 22/67 cases) [6, 15, 16].

The studies carried out by Khanum, Rehman and Aziz, et al. also observed serous cyst-adenomas to be the commonest tumors [18].

The frequency of malignant tumors in our study was highest for serous cyst adenocarcinoma (8/34) followed by Mucinous cyst adenocarcinoma (7/34). Similar pattern of distribution of malignant tumors are shown by many other studies [9, 10]. However, Study conducted by Yasmeen, et al. shows endometrioid carcinoma to be more prevalent [16].

Germ cell tumors (GCT)

We found that germ cell tumors comprised 26.47% of all ovarian neoplasm. Similar incidence was reported by Western data (Jacob IJ, et al. [19]), and data collected by Aria M, et al. [20], and Ahmad Z, et al. [12] but higher incidence of Germ cell tumors (GCT) than in our study was seen in several other studies like Jha R, et al. [21], Sah, et al. [22] who found germ cell tumor to comprise 42.2%, 43.4% of all ovarian neoplasm respectively.

This difference may be due to variations in sample size but genetic, socio-economical and environmental factors may also be involved.

Germ cell tumors (GCTs) comprise the second largest group in our study in which benign tumors dominated the malignant ones (5 vs. 4 /34). Among the benign GCTs our study showed the highest incidence of mature teratomas, dermoid cysts followed by Dysgerminoma (31 and 17/55 respectively). A study conducted by Ahmad, et al. and Thanikasalanm, et al. [23] (conducted in India) shows teratomas to be the predominant GCT (20, 24). 95.0% of ovarian germ cell tumors are mature cystic teratomas in the western world and only 3.0% of ovarian teratomas are immature [23, 24]. Similar figures have been found also in Jha R, et.al. [21].

Sex cord stromal Tumor

Sex cord stromal tumors (SCSTs) were the least common in our study. The frequency in our study was 11.77%. The incidence of these tumors is variable in other studies. Ashraf A, et al. [7] in the west reported 3.15% incidence respectively while Aziz F, et al. [18], Zahra, et al. [8] found only 1% SCSTs. Our value is comparable with that of study carried out by Tanwani A.K., et al. who documented 10.1% cases of SCST [11].

In contrast to other studies, sarcoma, which is a rare malignant SCST tumor comprises 50% of total sex cord stromal tumor. This difference may be due to variations in sample size but genetic, socio-economical and environmental factors may also be involved.

Granulosa cell tumors were the commonest SCSTs in Ashraf A, et al. study (3/4) while studies carried out by Yasmeen, et al. [16] and Ahmad, et al. [27] mentioned a variable incidence of 28.5% and 5.62% respectively.

Neoplastic lesions are more common than non-neoplastic lesions. Follicular cyst is the commonest non-neoplastic lesion. Among the neoplastic lesions, surface epithelial tumors are predominant type, followed by germ cell tumors. The commonest benign tumor is serous cyst adenoma and commonest malignant tumor is serous cystadenocarcinoma.

This study is institutional – based, therefore the results obtained may or may not reflect the actual incidence of ovarian tumors in women of this region. Therefore, multicentric study with larger sample size should be carried out.

Age distribution

All patients were females with age ranging from 17 to 73 years of age. The maximum numbers of patients were between 41-50 years of age accounting for 25% of cases.

Patients were divided into six age groups, with a difference of 10 years in each group. The commonest age group affected was from 41 to 50 years followed by age group from 31-40 and 51-60 years. This differs from the western data where it was between 50 and 70 years but correlates with other studies conducted in nearby Asian countries [19, 7].

Mean age was 42.37 years. Mean age observed in our study is lower than that observed in Ahmad Z, et al. and Malik JA, et al. studies but higher than Ashraf A, et al. [7, 12, 28].

22 out of total 51 ovarian tumors (43.6%) were found in 21- 40 years age group. Malignant tumors were far less common below 40 years. Of all malignant tumors, 70.3% (19/26) were seen above 40 years where as this was 29.69% (7/26) up to 40 years.

Out of these, surface epithelial tumors were the most common tumors occurring above 30 years. Up to 30 years 4 tumors were found, none was a surface epithelial tumor. In 1st three decades 100% malignant tumors were germ cell tumors. Most serous tumors were malignant (57.14%) whereas 42.86% were benign. However, among the malignant tumors, serous adenocarcinoma was the most common of all ovarian malignancy.

Benign serous tumors were found from 29-73 years of life. Out of these, 83.34% (1/6) were in 4th - 6th decades. Serous carcinomas were not seen up to 30 years. Most serous carcinomas

(87.5%) were seen above 40 years. Similar results were shown by Jha R, et al. [21].

Benign Mucinous tumors were found from 31-63 years of life but 75% were in 3rd-5th decade, however like serous carcinomas. Mucinous carcinomas were also not seen up to 30 years. All Mucinous carcinomas were present above 50 years.

In study of Tavassoli FA, et al. majority of benign serous tumors occur in 4th – 6th decade although they may occur in patients younger than 20 or older than 80 years [25]. Scully Robert E, et al. also found serous carcinomas to be extremely rare in the first two decades of life, average patient age for serous carcinomas being 56 years. Mucinous cystadenoma may occur at any age but are most often diagnosed in 4th – 6th decade. Mucinous cancers have mean age of 53-54 years [24].

We also found similar results. Serous carcinomas were not seen in first 3 decades of life. Average age of patient for serous carcinoma was 51.25 years. Mucinous cystadenoma was seen from 31-60 years age group, however it was more common in the 3rd decade and Mucinous cancers had mean age incidence of 55.6 years.

Germ cell tumors were seen in all age groups; however they were most frequently seen in 2nd and 4th decade (60.3 % all germ cell tumors). Most germ cell tumors (55.55%) were benign and all of these benign germ cell tumors were mature cystic teratomas occurring between 20-60 years. Rest was malignant Dysgerminoma.

Up to 30 years all malignant tumors were germ cell tumors, all other were benign. Above 30 years all germ cell tumors were benign.

Tavassoli FA, et al. says malignant germ cell tumors are most common ovarian cancers among children and adolescent females [25].

In one study, in patients under age of 21, approximately 60% ovarian tumors are germ cell

tumors, accounting for two third of ovarian cancers in 1st two decades of life. Mature cystic teratomas account for half of ovarian neoplasm that appear in 1st two decades of life. Over 80.0% mature cystic teratomas occur during the reproductive period. Immature teratomas form 10.0-20.0% of ovarian cancers occurring in 1st two decades of life [24].

In study of Hassan, et al. in 1st two decades, 49.1% tumors were germ cell tumors and of all malignancies, malignant germ cell tumors comprised 44.5%. In this study, under 21 years of age 11 ovarian tumors were seen, out of which 8 (72.7%) were germ cell tumors. Mature cystic teratoma accounted for 63.6% of all ovarian neoplasm in 1st two decades and 60.0% were seen from 21-40 years age group. Malignant germ cell tumors here comprised 100.0% of all malignancies in 1st two decades [29].

Sex cord stromal tumors were not seen below 40 years. Benign tumors most commonly occur in 40-50 years age group while the malignant counterpart in >60 years age group.

However, this study is institution based and has small sample size. So the result obtained may or may not reflect the actual histological pattern and age distribution of ovarian tumors in East Indian women. Hence, more studies with larger sample size should be observed.

Premenopausal and postmenopausal group

In our study, among the 51 patients, 29 (57%) were in the premenopausal group and 22 (43%) were in the postmenopausal group. The number of ovarian cancers in this population was 7 (24.13%) of 29 in the premenopausal group and 10 (45.45%) of 22 in the postmenopausal group.

According to Kinkel K, et al., among the 400 patients who underwent surgery, 285 (71%) were in the premenopausal group and 115 (29%) were in the postmenopausal group. The number of ovarian cancers in this population was 14 (5%) out of 285 in the premenopausal group and 42

(37%) out of 115 in the postmenopausal group [30].

Meta analysis by Kinkel K, et al. shows that out of a total of 2827 patients (1458 premenopausal women and 1369 postmenopausal women) with a diagnosis of an ovarian mass, the number of women with ovarian cancers was 149 in the premenopausal patient group and 460 in the postmenopausal patient group [30].

Symptoms:-

11.76% of our patients were asymptomatic. Symptomatically 56.86% complained of abdominal pain, 39.21% complained of abdominal distension while 11.76% complained of Weight loss and 7.8% complained of Metrorrhagia. Abdominal pain is most common symptom in nonmalignant lesion while abdominal distention is more often associated with malignant masses. 31.37% patients presented with nonspecific symptoms as nausea, vomiting etc.

Non-Malignant Masses

Hemorrhagic cyst

Total 6 cases of hemorrhagic cyst was recruited in the study out of which 2 cases showed reduction in size, so they were excluded from the study. This group comprised of 19.6% of non-neoplastic lesion recruited in the study. All presented with chief complaint of pain in abdomen. Mean age for hemorrhagic cyst was 28.5 years. All were premenopausal women between 21-44 year of age. All showed large heteroechoic well defined thin walled mass with cystic component and internal septations.

On USG and color Doppler 3 were given clear cut diagnosis of Hemorrhagic cyst. In rest of the cases, USG showed a complex adnexal SOL. The mass was quite large and its septae showed blood flow on colour Doppler with $RI > 0.4$ & $PI > 0.8$. As the age of patient was 44 years we advised CT scan which showed hypo dense thin walled cystic structure with internal septations ($< 3\text{mm}$). Diagnosis of hemorrhagic cyst was made. On laparoscopy the diagnosis was confirmed.

Endometriomas

Total 6 cases of Endometriomas were recruited in the study and comprised 19.6% of the non-neoplastic lesions. Pain in abdomen was chief complaint. One patient presented with distention of abdomen. Mean age for Endometriomas was 35 years. All are premenopausal women between 22-44 years of age.

On USG and Color Doppler one patient shows B/L 2 LT side and 3 on RT side mass. 3 out of 6 patients on USG show feature of endometriosis i.e. complex cystic masses with uniform low-level echogenicity. These patients were operated and on histopathology diagnosis of endometriosis was confirmed. In rest cases USG diagnosis was given as complex ovarian mass.

In one patient USG feature were suggestive of malignancy as patient age was 44 years, patient was asymptomatic and there was a complex solid cystic mass with thick septations. Its septa showed blood flow on colour Doppler with $RI > 0.4$ and $PI < 0.8$. As the age of patient was 44 years we advised CT scan which showed heterodense thin walled cystic mass with solid component with internal septations ($< 3\text{ mm}$) & internal regions of low attenuation. Diagnosis of endometrioma was made. Diagnosis was confirmed on laparoscopy.

In a 38 years old patient USG findings suggested ovarian mass with possibility of endometriosis. MRI was done and findings were consistent with endometrioma which was later confirmed on histopathology.

A 22 years old young patient presented with large heterogeneous multicystic mass of size 12 x 5 x 2 cm with internal echoes and septations in the pelvis. Septae were taking flow with $RI > 0.4$ & $PI > 0.8$ on colour Doppler. Age and above findings indicated mass was benign. CT was done to stage and characterize the tumor. On CT also it was given as complex ovarian mass. Laprotomy was done and on histopathology right sided ovarian endometrioma was confirmed.

Corpus luteal cyst

Two pre-menopausal women presented with complaint of pain in abdomen. One case was diagnosed as complex ovarian cyst and other as ruptured ectopic pregnancy (both benign). Both patients were operated and on histopathology diagnosed as a case of Corpus luteal cyst.

Theca lutein cyst

A premenopausal woman presented with complaint of pain in abdomen. On USG and color Doppler it was diagnosed as Theca lutein cyst (benign). This patient was operated and on histopathology diagnosed as a case of Theca luteal cyst.

Torsion

Two pre-menopausal women presented with complaint of pain (2 cases) and abdominal distention (1 case). One case was diagnosed as Mucinous cyst adenocarcinoma and other as ovarian cyst with torsion. Patient was diagnosed as a case of Mucinous cyst adenocarcinoma and was advised for CT scan and diagnosed as a case of Mucinous cyst adenoma. Both patients were operated and on histopathology diagnosed as a case of ovarian cyst with torsion.

Tuberculosis

A premenopausal woman of 40 year age presented with complaint of abdominal distention, weight loss and other non-specific symptom. On USG and color Doppler it was diagnosed as complex mass Immature teratoma (malignant lesion). CT scan was advised and diagnosed as a case of immature teratoma. This patient was operated and on histopathology diagnosed as a case of tuberculosis.

Benign paraovarian cyst

A premenopausal woman of 41 year age presented asymptotically. On USG and color Doppler it was diagnosed as serous cyst adenocarcinoma (malignant lesion). CT scan was advised and diagnosed as a case of serous cyst adenoma. This patient was operated and on histopathology diagnosed as a case of benign paraovarian cyst.

Sclerosing stromal tumor

A postmenopausal woman of 46 year age presented with complaint of pain abdomen and other non-specific symptoms. On USG and color Doppler it was diagnosed as fibroma (benign lesion). CT scan was advised and diagnosed as a case of as fibroma (benign lesion). This patient was operated and on histopathology diagnosed as a case of benign Sclerosing stromal tumor.

Fibroma

A postmenopausal woman of 45 year age presented with complaint of non-specific symptoms. On USG and color Doppler it was diagnosed as fibroma (benign lesion). MRI was advised and diagnosed as a case of as fibroma (benign lesion). This patient was operated and on histopathology, diagnosed as a case of fibroma (benign lesion).

Serous cyst adenoma

Total 6 cases of serous cyst adenoma were recruited in the study. This group comprised of 17.64% (6/34) of neoplastic lesions recruited in the study. 2 patients were asymptomatic while the rest presented with pain (1 case), abdominal distention (2 cases), weight loss (1 case) and other non-specific complaint in the abdomen (3 cases). Mean age for serous cyst adenoma was 54 years. All were postmenopausal women between 52-73 years of age except one who was premenopausal.

On USG and Color Doppler one patient showed B/L, 2 LT side and 3 on RT side mass. 3 out of 6 patients on USG showed features of serous cyst adenoma. These patients were advised for CT scan and all 3 were diagnosed as a case of serous cyst adenoma. These cases were operated and on histopathology diagnosis of serous cyst adenoma was confirmed. In rest cases in which USG had given diagnosis of serous cyst adenocarcinoma, CT was advised in 2 cases and MRI in one case. These cases on CT and MRI showed features of serous cyst adenoma which was later confirmed by histopathology.

2. Mucinous cystadenoma:-

Total 4 cases of Mucinous cyst adenoma were recruited in the study. This group comprised of 11.76 % (4/34) of neoplastic lesions recruited in study. None of the patient was asymptomatic and all presented with pain (3 cases), abdominal distention (3 cases), weight loss (1case) and other non-specific complaints in the abdomen (1 case). Mean age for serous cyst adenoma was 54 years. Two are premenopausal women between 31-40 years of age and 2 were postmenopausal between 48-63 years of age.

On USG and Color Doppler 3 out of 4 patients showed feature of Mucinous cyst adenoma. These patients were advised CT scan and all 3 were diagnosed as a case of serous cyst adenoma. These cases were operated and on histopathology diagnosis of Mucinous cyst adenoma was confirmed. In rest of the cases that USG had diagnosed as Mucinous cyst adenocarcinoma, MRI was advised. MRI also showed features of Mucinous cyst adenocarcinoma which was later proved as Mucinous cyst adenoma on histopathology.

Mature teratoma (Dermoid cyst):-

Total of 5 cases of mature teratomas (Dermoid cyst) were recruited in the study. This group comprised of 14.70 % (5/34) of neoplastic lesions recruited in the study. Two patients were asymptomatic while the rest presented with pain (2 cases) and other non-specific complaints in the abdomen (2 cases). Mean age for mature teratomas (Dermoid cyst) was 51.8 years. Two were premenopausal women between 30-31 years of age and 3 were postmenopausal between 44-60 years of age.

On USG and Color Doppler 5 out of 5 patients showed features of mature teratomas (Dermoid cyst). Three patients were advised CT scan and all 3 were diagnosed as mature teratomas (Dermoid cyst). In remaining 2 cases, MRI was advised. MRI also showed features of mature teratomas (Dermoid cyst) in both the cases. These cases were operated and on histopathology diagnosis of mature teratomas (Dermoid cyst) was confirmed.

Malignant Masses

Serous cyst adenocarcinoma

Total 8 cases of serous cyst adenocarcinoma were recruited in the study. This group comprised of maximum no of cases (23.52% (8/34)) of neoplastic lesion recruited in the study. Only one patient was asymptomatic while the rest presented with pain (3 cases), abdominal distention (7 case) and weight loss (1 case). Mean age for serous cyst adenocarcinoma was 51.12 years. Three were premenopausal women between 31-45 years of age and rests 5 were postmenopausal between 50-66 years of age.

On USG and Color Doppler one patient showed 5 LT side and 3 mass on RT side. 5 out of 8 patients on USG showed features of serous cyst adenocarcinoma. All these patients were advised CT scan. 3 were diagnosed as cases of serous cyst adenocarcinoma while two were diagnosed as cases of serous cyst adenoma.

These cases were operated and on histopathology, diagnosis of all cases was confirmed as serous cyst adenocarcinoma. i.e. two out of 5 cases on CT were wrongly diagnosed as benign lesion.

In rest of the 3 cases that USG had diagnosed as Mucinous cyst adenoma, tubo-ovarian mass (both benign) and one malignant ovarian mass, MRI was advised. All these 3 cases showed features of serous cyst adenocarcinoma which was later confirmed by histopathology.

Mucinous cyst adenocarcinoma:-

Total 4 cases of Mucinous cyst adenoma were recruited in the study. This group comprised of 11.76 % (4/34) of neoplastic lesion recruited in the study. None of the patients was asymptomatic and all presented with pain (1 case), abdominal distention (3 cases), weight loss (2case) and other non-specific complaints in the abdomen (1 case). Mean age for Mucinous cyst adenocarcinoma was 55.66 years. All were postmenopausal between 55-57 years of age.

On USG and Color Doppler 3 out of 3 patients showed features of Mucinous cyst adenocarcinoma. Two patients were advised CT scan and both were diagnosed as Mucinous cyst adenocarcinoma. These cases were operated and on histopathology diagnosis of Mucinous cyst adenocarcinoma was confirmed. In the remaining cases MRI was advised. MRI also showed features of Mucinous cyst adenocarcinoma which was later confirmed as Mucinous cyst adenoma on histopathology.

Dysgerminoma:-

Total 4 cases of Dysgerminoma were recruited in the study. This group comprised of 11.76 % (4/34) of neoplastic lesion recruited in the study. Two patients presented with pain, two with abdominal distention, and other non-specific complaints in the abdomen (1 case). Mean age for mature teratomas (Dermoid cyst) was 19 years. All were premenopausal females between 17-22 years of age.

On USG and Color Doppler 4 out of 4 patients showed features of Dysgerminoma. Three patients were advised CT scan and all 3 were diagnosed as Dysgerminoma. In the remaining cases, MRI was advised. MRI also showed features of Dysgerminoma. These cases were operated and on histopathology diagnosis of Dysgerminoma was confirmed.

Sarcoma:-

Total 2 cases of Sarcoma were finally diagnosed in study. Two patients presented with pain abdomen and other non-specific symptoms. Mean age for Sarcoma was 65 years. All were postmenopausal females between 61-69 years of age.

On USG and Color Doppler both patients showed features of complex ovarian mass (malignant). These patients were advised CT scan and both were diagnosed as a case of complex ovarian mass (malignant). These cases were operated and on histopathology diagnosis of Sarcoma was confirmed.

Huber S, et al. states that ultrasound correctly characterized malignant and benign tumors in 89%. The site of the primary tumor was correctly diagnosed in 90% of cases by ultrasound. For US, the positive predictive value was 85%, the negative predictive value 73%. In differentiation of non-advanced disease from advanced malignancy, US showed a false-positive rate of 0.416 and false-negative rate of 0.258 respectively [35].

One study shows the sensitivity of morphologic analysis with ultrasound in predicting malignancy in ovarian tumors has been shown between 85% to 97%, whereas its specificity ranges from 56% to 95% [7].

The resistive index (RI) and pulsatility index (PI) have been used in the evaluation of ovarian masses because of the expected low impedance and high diastolic blood flow seen in blood vessels supplying the malignant tumor. Typically, an RI less than 0.4 to 0.8 and a PI <1 are considered to be suggestive of malignancy. However, due to operator dependence and overlap of these indices between malignant and benign lesions (such as in pelvic inflammatory disease and endometriosis), the usefulness of color and pulsed Doppler is limited [37].

Our results are comparable to previously published international literature. A meta-analysis conducted by Kinkel, et al. described that CT shows sensitivity and specificity of 81% and 87% respectively when used for indeterminate masses seen on ultrasound [30]. Similarly, Liu, et al. reported that PET/CT scan shows a sensitivity of 87% and specificity of 100% for differentiating benign from malignant ovarian cancers [40]. Tsili, et al. also described in their study that MDCT can categorize adnexal masses into benign and malignant in up to 93% and 89% of the cases respectively [39]. Mubarak, et al. found 97% sensitivity, 91% specificity, and an accuracy of 96% in the differentiation of benign and malignant ovarian masses, while PPV and NPV were 97% and 91%, respectively. Our study reported a sensitivity and specificity of

83.33% and 77.7%, respectively [41]. Low sensitivity and specificity are expected as our CT is single slice (Somatom).

According to Huber S, et al., MRI correctly characterized malignant and benign tumors in 89% of cases. The site of the primary tumor was correctly diagnosed in 94% of cases by MRI. The positive predictive value & negative predictive value was 92% and 89% for MRI. In differentiation of non-advanced disease from advanced malignancy, MRI showed a false-positive rate of 0.125 and false-negative rate of 0.032 respectively [37].

USG and Color Doppler are more sensitive (88.23%) than CT (83.33%)/ MRI (80.0%) and specificity (76.47%) is less than CT (77.77%)/ MRI (83.33%). Our study views that USG and Color Doppler are complimentary to CT/MRI. 1st line modality of choice is USG followed by CT/MRI, preferably MRI, for combined effect of increasing the specificity, PPV and accuracy of diagnosing ovarian masses.

Incidental adnexal masses are common in both pre- and postmenopausal women, with the vast majority being benign. Ultrasound is the study of choice for primary evaluation of adnexal masses, and MRI and CT are useful for further workup and to define extent of disease. Lesions that are indeterminate on ultrasound can often be characterized with greater specificity by contrast-enhanced MRI as definitively benign. Symptomatic ovarian cancer that has spread out of the ovary often presents on CT, and it should be distinguished by the radiologist from a metastatic colon, or gastric or pancreatic cancer. CT is also the preferred technique in the pretreatment evaluation of ovarian cancer, to define the extent of disease, and to assess the likelihood of optimal surgical cytoreduction [37].

In a prospective study of women with suspected adnexal masses, both Doppler ultrasound and MRI were highly sensitive for identifying malignant lesions (ultrasound 100%, MRI 96.6%), but the specificity of MRI was

significantly greater (ultrasound 39.5%, MRI 83.7%). Therefore, women who clinically have a low risk of malignancy but have indeterminate lesions on ultrasound are the ones most likely to benefit from MRI [44].

MRI was superior in diagnosis of malignant ovarian masses though US, too, performed well at lesion detection and characterization. With regard to tumor staging MRI is emerging as a problem-solving modality and may allow more appropriate clinical decisions to be made in selected patients with complex adnexal disease [36].

Conclusion

Thus we conclude that nonmalignant tumors are more common than malignant tumors. Surface epithelial tumors are most common class of tumors, benign surface epithelial tumors being most common benign tumors and malignant surface epithelial tumors being most common malignant tumors. Considering individual tumors, serous cystadenoma is the most common ovarian tumor overall as well as most common benign tumor whereas serous cystadenocarcinoma is most common malignancy.

Malignant ovarian tumors are more common above 40 years. Germ cell tumors are seen in all age groups and are most common tumor up to 30 years.

In conclusion, Ultrasound is a simple, non-invasive, non-ionizing, low cost, easily available, reproducible, time saving tool for evaluation of ovarian masses. It should be the first investigation to be done in young/middle age females or pregnant women where CT is not advisable. It is useful in detecting & differentiating benign lesion from malignant lesion and detecting the malignant lesion at an early stage. Its sensitivity for detection of cystic masses is very high so it has a definite role in differentiation of cystic from solid masses of the ovary & eliminating the need for further expansive procedures including CT/MRI.

Ultrasonography (US) is accepted as the primary imaging modality in the evaluation of an ovarian mass. The use of US in the detection of a suspected ovarian mass and in its differentiation from a uterine mass has been well established. Because US depict the mass, characterization of the mass is typically performed during the same examination. Thus, de facto, US becomes the main triage method prior to treatment.

Color Doppler imaging serves as an adjunct to conventional sonography in differentiating between malignant and benign ovarian mass. Centrally located flow, flow along septations, and flow within papillary excrescences also suggest malignancy. Findings suggesting a benign mass are (I) Peripheral flow is more consistent with a benign neoplasm. (II) Hemorrhage in a mass is highly suggestive of a benign mass or cyst. (III) Resistance of blood flow in and around adnexal masses is a sensitive method for detecting ovarian cancer and that benign lesions can be differentiated from malignant ovarian masses on the basis of the resistive index (RI).

The role of preoperative CT in identifying patients who are potential candidates for optimal debulking surgery is extremely important.

Magnetic resonance (MR) imaging can provide additional information on soft tissue composition of adnexal masses based on specific tissue relaxation times and allows multiplanar imaging at larger field of view to define the origin and extent of pelvic pathology.

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