



## 2D & 3D Doppler Study of Ovarian Tumors in A Tertiary Care Hospital in Chennai, Southern India

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### ABSTRACT

Ovarian tumors constitute second most common type of tumors involving the reproductive tract of women following cancer cervix in India. To discriminate the nature of ovarian lesions is of particular importance in gynecological practice. Two main problems need answers - discrimination of benign and malignant adnexal masses and choice of the appropriate surgical treatment if necessary. The aim of this study was to perform 2D and 3D power Doppler ultrasound of ovarian tumors and to compare the results with the histopathology report following surgery and thence to determine the accuracy of Doppler findings in differentiating malignant and benign ovarian tumors. This study was done at Govt. Kilpauk Medical College, a tertiary care teaching hospital in Chennai, Southern India, on all women who were posted for surgery in view of ovarian mass of size more than 5cm detected clinically. 2D and 3D grey scale ultrasound and color Doppler content of the tumor scan was done and rated subjectively by the ultrasound examiner on a visual analog scale. Vascularization index (VI), flow index (FI) and vascularization flow index (VFI) were calculated in the whole tumor and in a 5-cm<sup>3</sup> sample taken from the most vascularized area of the tumor. Logistic regression analysis was used to build models to predict malignancy. The Doppler study results were then compared with the histopathology reports following surgery. It was established that the 3D Power Doppler findings suggestive of malignancy correlated well with the histopathology of the tumors thus substantiating the fact that Doppler ultrasonography is very useful in differentiating between benign and malignant tumor in the pre-operative assessment planning period.

### LITERATURE REVIEW

#### DOPPLER ULTRASONOGRAPHY

Doppler Principle was first described by Christian Andreas Doppler in 1842. In 1955, Doppler Principle was applied to study blood flow of

organs by Shigeo Satomura and Yasuhara Nimura. An advanced variation of Color Doppler is Power Doppler<sup>24</sup> which measures the energy of a returning Doppler signal rather than analyzing the flow pattern. According to the study based on

"Folkman theory of neovascularisation", a malignant neoplasm elaborates a factor called Tumour angiogenesis factor (TAF), which stimulates rapid formation of new capillaries<sup>5</sup> that is detectable as increased flow in Doppler. Power Doppler can evaluate low-velocity blood flow and a further improvement of it is 3D power Doppler, providing imaging and measurement of blood flow in solid areas and excrescences of complex cysts<sup>25</sup>

The vascularisation indices measured are the vascularization index (VI) or blood flow (the flow index (FI)) or both (the vascularization-flow index (VFI)). VI is the ratio of color voxels to all voxels in the region of interest expressed as a percentage, and it reflects the density of vessels in the volume analyzed. FI is the sum of weighted color voxels divided by the number of all color voxels in the region of interest, and it reflects the number of blood corpuscles in the vessels of the volume. VFI is the sum of weighted color Doppler voxels divided by all voxels in the region of interest. It reflects both the density of vessels and the number of blood corpuscles flowing in the vessels of the volume.

## OVARIAN TUMORS

Malignant ovarian tumors are second leading cause of morbidity and mortality in women who die of malignancy of the reproductive tract. The various causative factors and the protective factors are discussed below:

### RISK FACTORS FOR DEVELOPMENT OF OVARIAN TUMORS –

**1. AGE:** Ovarian tumors are common in the age group of 56-60 yrs. In postmenopausal women, 30% are malignant, but in premenopausal women only 7% are malignant.

Peak age for borderline tumors is 46 yrs, hereditary ovarian tumors occur 10 yrs earlier than sporadic tumors.

**2. PARITY** – Parity is inversely related to ovarian cancer, having at least one child is protective with the reduction risk of 0.3-0.4%.

**3. INFERTILITY** – Ovulation induction with drugs increase the risk of ovarian tumors, there is increased epithelial trauma due to release of more number of follicles with use of ovulation inducers.

**4. LIFE STYLE** - It has been estimated that life style contribute to 21% of ovarian cancer.<sup>8</sup> Factors which increase the risk include:

- ✓ Smoking. It is estimated that 2% of cases may be caused by smoking.<sup>3</sup>
- ✓ Obesity. There is evidence of increased risk in postmenopausal women who are overweight.
- ✓ Lack of exercise. There is some evidence that regular physical exercise protects against some forms of ovarian cancer
- ✓ Diet rich in animal fat.

**5. HYPERESTROGENIC STATE-** Early menarche, late menopause, failure to lactate are the other known risk factors. History of endometriosis confers a significant increased risk.

**6. GENETIC-** Familial patterns contribute to 5-10% of the ovarian tumors.<sup>8</sup>

Most tumors are associated with germ line mutations in BRCA1 mutation, smaller proportion by BRCA2 mutation. It follows autosomal dominant pattern of inheritance<sup>4</sup>. Family history of ovarian, breast, colon and endometrial cancer increases the risk of ovarian cancer.

## PROTECTIVE FACTORS

Protective factors are use of oral contraceptive pills, tubal sterilization and hysterectomy. Women who used oral contraception for 5 yrs or more have 50% reduction in the development of ovarian cancer.

## DIAGNOSIS OF OVARIAN TUMORS

### I. RADIOLOGICAL TESTS: 1. ULTRASONOGRAM

Conventional ultrasonography is widely used in diagnosis of ovarian masses by the morphological pattern of the tumors but it lacks specificity indistinguishing benign from malignant lesions. The characteristic findings of benign and

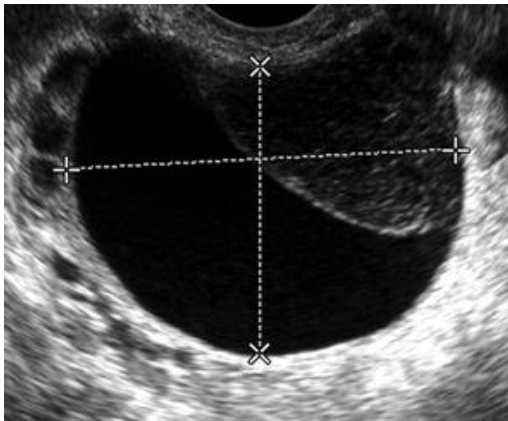
malignant ovarian tumors in Ultrasound are as follows:

### USG FEATURES OF BENIGN TUMORS

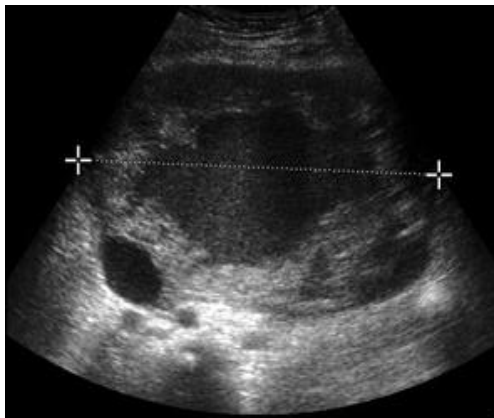
Thin wall, smooth inner wall structure and anechogenicity of the lesions are important features of benign tumours.

### THE SONOGRAPHIC FINDINGS OF MALIGNANCY

Multilocularity, complex (solid/cystic), Bilaterality, thickness of cyst wall >3mm, septal thickness >2mm, papillary excrescences, ovarian volume >10cm<sup>3</sup> presence of solid materials, metastasis, presence of ascites.



USG of - Benign ovarian cyst



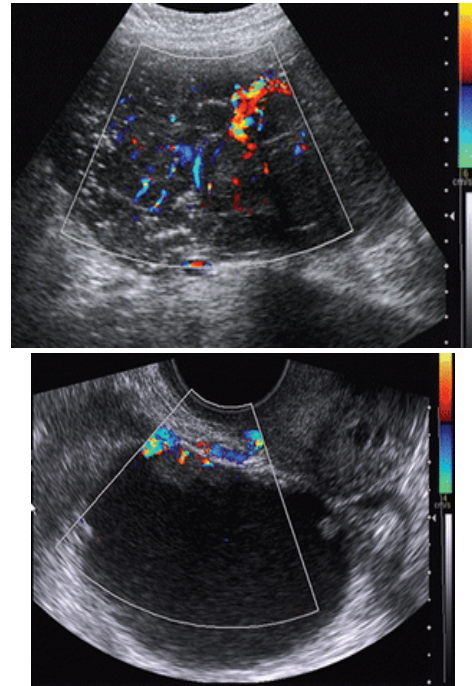
Malignant complex ovarian tumor

### (ii) DOPPLER STUDY

Malignancies often exhibit their increased flow signals not only at the periphery of a ovarian mass, but also in the central regions of the mass, and also in septations and solid areas. The neo-vascularity within the tumors is of abnormal vessels which lack smooth muscle within their

walls and containing multiple arterio-venous shunts, resulting in low-impedance flow (Pulsatility index < 1.0 ) and (Resistance Index < 0.4), a high time averaged maximum velocity (>15cm/s) and a absence of diastolic notch in such suspicious areas.

The introduction of three-dimensional (3D) power Doppler ultrasound has opened up the possibility of objectively assessing vascularization in a whole organ or tumor. Vessels with low-velocity blood flow can be imaged using 3DDoppler.



### 3D Doppler findings in Ovarian malignant tumor

Signals from various areas within the tumor are determined and the lowest PI and RI are considered for data analysis. Furthermore, the area distribution of visualized vessels in the adnexal masses was also categorized and recorded as in the center of the mass, in the septum, in the papillae, at peri-tumor areas. Malignant neoplasm Offer low resistance to blood flow due to presence of aberrant tumor vessels. Cut off values used by most of researches are: RI < 0.4 PI < 1

(iii) CT SCAN & MRI SCAN: Imaging of the ovarian tumors is best done with the help of a Computerized Tomography either plain or with use of contrast and by a Magnetic Resonance Imaging Scan. They prove to be useful in also

assessing the presence of lymph node enlargement and other metastasis.

## II. BIOCHEMICAL TESTING: TUMOR MARKERS

Tumor markers are useful in identification of benign and malignant tumors. The various tumor markers commonly used are-

CA125 – more than 35U/ml is of significance

CEA- more than 5ng/ml is significant in the absence of smoking history

Beta HCG and AFP are elevated in germ cell tumors and endodermal sinus tumors. AFP more than 10,000ng/ml or betaHCG more than 50,000 mIU/ml in the initial evaluation mean poor prognosis of the ovarian tumor.

The major disadvantage in the use of tumor markers as a diagnostic tool is the occurrence of false positivity in benign conditions like tuberculosis, endometriosis, benign liver tumors etc.

## STUDY DETAILS

- Sample size -75
- Duration of study- January 2015 – December 2016 ( 2 Years)
- Study design- Prospective observational study

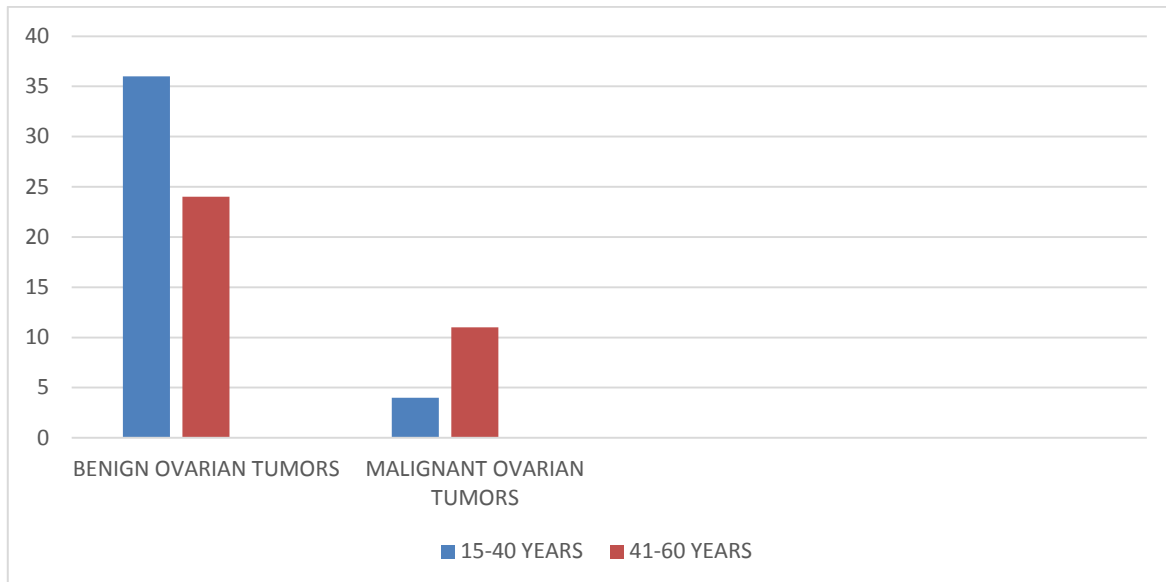
- **Observations made are tabulated as follows:**

**TABLE I:** Table of age-distribution of Benign and Malignant Ovarian Tumors:

	BENIGN OVARIAN TUMORS (n=60)	MALIGNANT OVARIAN TUMORS (n=15)
AGE GROUP		
15-40 YEARS	36	4
41-60 YEARS	24	11
2DOPPLER FINDINGS		
RI	0.75	0.44
PI	1.71	0.79
3D POWER DOPPLER FINDINGS median (range), %		
VI	1.29 (0.06-29.08)	5.8(0.45-26.30)
FI	27.6 ± 3.99	34.7 ± 6.01
VFI	0.48 (0.01–10.66)	1.99 (0.10–10.89)

- Inclusion criteria –Women clinically detected with adnexal mass of size more than 5cm and were posted for a laparotomy
- Exclusion criteria – Cysts of size less than 5cm, any anechoic unilocular cyst that resolves on follow up and endometriotic cysts.
- Procedure – A commercially available 5-MHz Combison 530 ultrasound system was used to perform three-dimensional power Doppler sonography transvaginally. Having calculated the volume and vascular indices of the whole tumor, a 5-cm<sup>3</sup> spherical sample volume was selected. The results of the ultrasound examinations and those of subjective estimation of the risk of malignancy were compared with those of histological examination of the respective surgical specimens. Staging of malignant tumors was done by the attending physician in accordance with the classification system recommended by the International Federation of Gynecology and Obstetrics.





**Figure 1** – Figure showing the age wise distribution of Benign and Malignant ovarian Tumors

**TABLE II** – Table showing the Positive 2D & 3D Doppler findings and their Sensitivity and Specificity in Malignant Vs Benign Ovarian Tumors

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**TABLE III:** Table showing the Analysis of diagnostic capacity of the 2D and 3D Doppler tests

	3D Doppler	2D Doppler
Sensitivity	93.33%	90.28%
Specificity	93.33%	87.78%
Positive predictive value	77.78%	76.18%
Negative Predictive Value	98.25%	96.25%
Diagnostic Accuracy	93.33%	90.28%

**DISCUSSION**

Every suspicious ovarian mass needs a sonography by an expert which can first use all the techniques and the different parameters to discriminate benign and malignant tumors. Secondly, after control if necessary, he can propose the patient for appropriate surgical treatment. The reliability of 2D and 3D Doppler findings of benign and malignant tumors is shown in Table 3. The 2D ultrasound findings differed significantly between benign and malignant

tumors, the only exceptions being the presence of papillary projections, the presence of shadowing, thickness of septa, and bilaterality. The 3D power Doppler flow index with the best diagnostic performance was the Vascularisation Index (VI) in a 5-cm<sup>3</sup> sample taken from the most vascularized area of the tumor. Three-dimensional power Doppler imaging better defines the morphological and vascular characteristics of ovarian lesions. Even though malignancies were correctly identified by both 2D and 3D imaging,

the specificity significantly improved with the addition of 3D power Doppler. This improves diagnostic accuracy will promote better patient care by helping the surgeon to be able to separate complex benign masses from ovarian cancer, thereby facilitating quick and appropriate management of the ovarian tumor patient avoiding unnecessary inconvenience to both the patient and the operating surgeon. The study thus substantiates the fact that use of 3D Doppler study would help in exact diagnosis of malignant ovarian tumors which is of utmost importance to decrease the mortality and morbidity of patients. The study also revealed the fact that malignant ovarian tumors are more common in the postmenopausal age group compared to other age groups.

## CONCLUSION

This study concludes that color Doppler especially 3D Doppler has more sensitivity and specificity in diagnosing malignant ovarian tumors when compared to other diagnostic modalities.

The study also reveals that benign ovarian tumors are most common in 15-40 yrs and malignant tumors are most common in 41-60 yrs. Epithelial tumors were the most common type that occurred in the patients of our study.

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