

MRI in the Evaluation of Adnexal Masses with Histopathology Correlation

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A B S T R A C T

Introduction: Adnexal masses pose a diagnostic dilemma to the gynaecologist as well as radiologist because of their varied spectrum. The most important thing that needs to be determined is that whether the lesion is benign or malignant, so that the patient gets the appropriate treatment based on the pathology. Hence, the aim of the present study was to determine the accuracy of MRI in diagnosing benign and malignant adnexal lesions and its correlation with histopathological findings.

Materials and Methods: The present study was a prospective cross-sectional study which was conducted in the Department of Imaging and interventional Radiology of Meenakshi Mission Hospital and Research Centre, Madurai. Patients presented with history and clinical symptoms of adnexal tumours and patients with ultrasonography (USG) detected indeterminate adnexal masses were included in the study.

Results: In this study, the accuracy of MRI was about 93% in identifying the benign and malignant lesions. The cystic characterization of lesion was detected in majority of the subjects 60 (66.7%) with the help of MRI compared to USG, where only 30 (33.3%) of the subjects were identified. The solid lesions were also better identified with the help of MRI i.e. 19(21.1%) cases, compared to USG in which 13(14.4%) cases were only assessed.

Conclusion: In the present study, MRI was found to be highly specific (95%) and accurate (93%) in diagnosis of benign and malignant lesions.

Keywords: Magnetic Resonance Imaging, Ultrasound, Adnexal Pathologies

INTRODUCTION

Adnexa include the region within the pelvis that consists of ovary, fallopian tube, round ligament, and structures arising from associated embryologic rests. Adnexal masses are most common pathologies in women. Nearly 5% to 10% of women undergo surgery for suspicious adnexal masses and less than 25% of which prove to be malignant.¹

The most important step in management of adnexal masses is to differentiate benign and malignant masses. It is the most vital step after identification of adnexal mass and has an intense effect on the patients' management. It is more important to know the nature of the tumor before surgery in a young woman. The benign or malignant nature of a clinically diagnosed adnexal mass could not be evaluated before surgical exploration and histological examination.²

A reliable method to differentiate benign from malignant adnexal masses would allow the clinician for proper preoperative planning and proper counseling for the patient. Imaging plays an important role not only in identifying

the adnexal masses but also in identifying the origin and characterization of adnexal masses. Imaging also have significant role in differentiating benign and malignant lesions so that clinicians can plan the appropriate treatment which includes radical staging surgery for suspected ovarian malignancy, less invasive surgery for potentially benign neoplasms.³

USG is the first imaging modality for evaluation of women with suspected adnexal masses because of its widespread availability, relatively low cost, and high sensitivity in the detection of masses. However, ultrasound has its own limitations in identifying the origin of large adnexal masses and also in identifying the tissue characterization of certain adnexal masses. MR imaging has been shown to have potential in the characterization of adnexal masses.⁴

The study conducted by Yamashita et al demonstrated that MR imaging with gadolinium-based is superior to ultrasound in characterization of adnexal masses. MRI has become an important modality in the evaluation of the adnexal masses because of its multi-planar capability and best soft tissue

contrast properties. It is effective in detecting the origin of pelvic masses. The fast spin-echo sequences along with phased array coils have enabled higher resolution imaging in shortened imaging times. This resulted in improved characterization of adnexal masses, which leads to specific diagnoses of adnexal masses.⁵

Even though ultrasound features of benign adnexal masses are well established, the reported specificity of USG for the diagnosis of benignity varies from 60% to 98%. In particular, as many as 20% of adnexal lesions in premenopausal women are classified as indeterminate by using USG, even when they are interpreted in conjunction with clinical findings and CA-125 (ovarian cancer antigen) levels. MRI is considered as superior modality of investigation compared to ultrasound in detecting origin, characterization and malignant features of adnexal masses.⁶

The most important thing that needs to be determined is that whether the lesion is benign or malignant, so that the patient gets the appropriate treatment based on the pathology. Determining the benign nature of the mass will save the patient from further investigation and unnecessary surgery and malignant masses need to be identified as early as possible so that the patient gets the early and appropriate treatment.⁷

The two important modalities widely used for diagnosis of adnexal pathologies are ultrasound and magnetic resonance imaging. The advantages of ultrasound are easy availability and simplicity of the examination. However, the drawbacks include obscuration of adnexa by bowel gas, limited field of view, and its huge dependence on the skill of the radiologists. Magnetic resonance imaging with its high resolution and multi-planar imaging has the ability to characterize adnexal lesions accurately and currently the modality of choice.⁸ Hence, the aim of the present study was to determine the accuracy of MRI in diagnosis of benign and malignant adnexal lesions and to correlate with histopathological findings.

MATERIAL AND METHODS

The present study was a prospective cross-sectional study which was conducted in the Department of Imaging and interventional Radiology of Meenakshi Mission Hospital and Research Centre. The duration of the study was for a period of 22 months from January 2013 to November 2014. Patients presented with history and clinical symptoms of

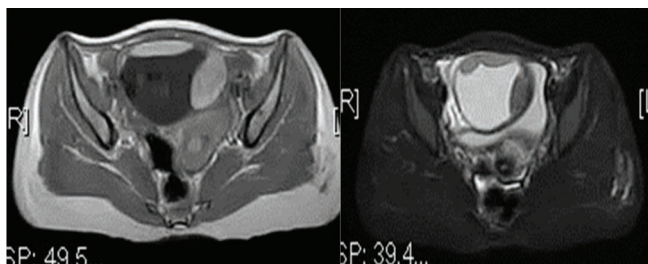


Figure-1: Shows well defined cystic lesion with hyper-intense foci similar to subcutaneous fat noted on T1 w images. T1 fat saturated images show complete suppression of hyper-intense foci suggestive of fat containing cystic lesion- Dermoid cyst.

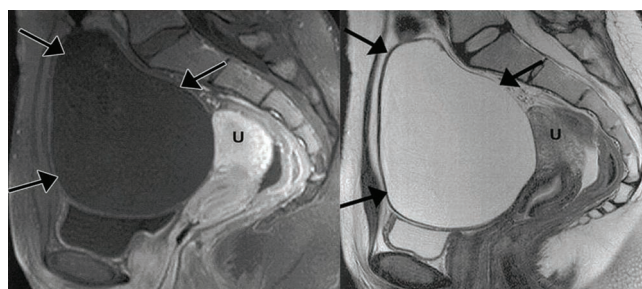


Figure-2: Shows well defined cystic lesion which is T1 hypointense and T2 hyperintense with thin wall (Arrow). – Benign tumor – Serous cystadenoma.

adnexal tumours and patients with ultrasonography detected indeterminate adnexal masses were included in the study. Patients who were not willing to undergo MRI and did not provide informed written consent were not included in the study and also patients who were claustrophobic were excluded from this study. Sensitivity, specificity, accuracy, positive predictive value and negative predictive values were calculated using the following formulae with histopathology as golden standard.

$$\text{Sensitivity} = \frac{\text{True positive}}{\text{True positive} + \text{false negative}} \times 100$$

$$\text{Specificity} = \frac{\text{True negative}}{\text{False positive} + \text{true negative}} \times 100$$

$$\text{Positive predictive value} = \frac{\text{True positive}}{\text{True positive} + \text{False positive}} \times 100$$

$$\text{Negative predictive value} = \frac{\text{True negative}}{\text{True negative} + \text{False negative}} \times 100$$

$$\text{Accuracy} = \frac{\text{True positive} + \text{True negative}}{N} \times 100$$

STATISTICAL ANALYSIS

The information collected regarding all the selected cases were recorded in a Master Chart. Data analysis was done with the help of computer using Epidemiological Information Package (EPI 2002). Using this software, range, frequencies, percentages, means and standard deviations were calculated.

$$\text{Sensitivity} = \frac{\text{True positive} \times 100}{\text{True positive} + \text{false negative}} = \frac{21}{21+3} \times 100 = 88$$

$$\text{Specificity} = \frac{\text{True negative} \times 100}{\text{False positive} + \text{true negative}} = \frac{63}{63+3} \times 100 = 95$$

$$\begin{aligned} \text{Positive predictive value} &= \frac{\text{True positive} \times 100}{\text{True positive} + \text{false positive}} \\ &= \frac{21+3}{90} \times 100 = 88 \end{aligned}$$

$$\begin{aligned} \text{Negative predictive value} &= \frac{\text{True negative} \times 100}{\text{True negative} + \text{false negative}} \\ &= \frac{63}{63+3} \times 100 = 95 \end{aligned}$$

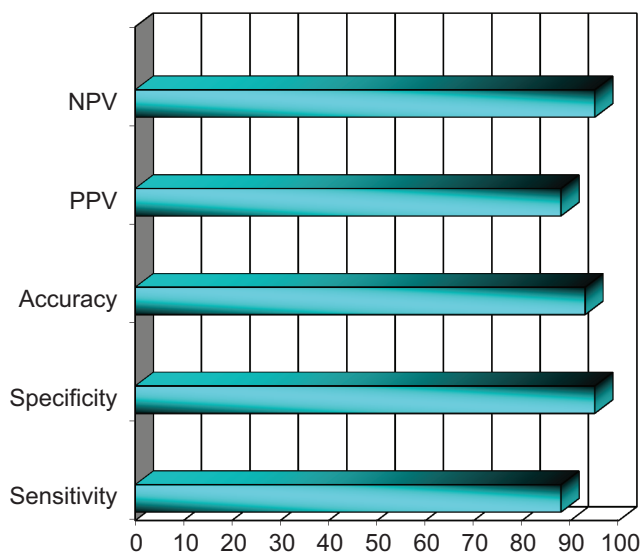
$$\begin{aligned} \text{Accuracy} &= \frac{\text{True positive} + \text{True negative} \times 100}{N} \\ &= \frac{21+63}{90} \times 100 = 93 \end{aligned}$$

RESULTS

In the present study, it was found that out of 90 subjects, majority of them were found to be from the age group 31years-40 years of age group. The mean age was found to be 35.9 years. In this study, the diameter of mass was found to be 44(48.9%) in majority of the subjects. The mean diameter of the mass was found to be 5.8 cms (Table 1 and 2).

In the present study, the origin of mass was identified with the help of MRI, it was found that 69 (76.7%) subjects had ovarian masses whereas through USG only 33(36.7%) subjects had ovarian masses. Uterine mass was detected only in 5(5.6%) subjects through USG and in 12(13.3%) subjects with MRI. About 50(55.6%) of the subjects were not identified with any mass in case of USG (Table 3).

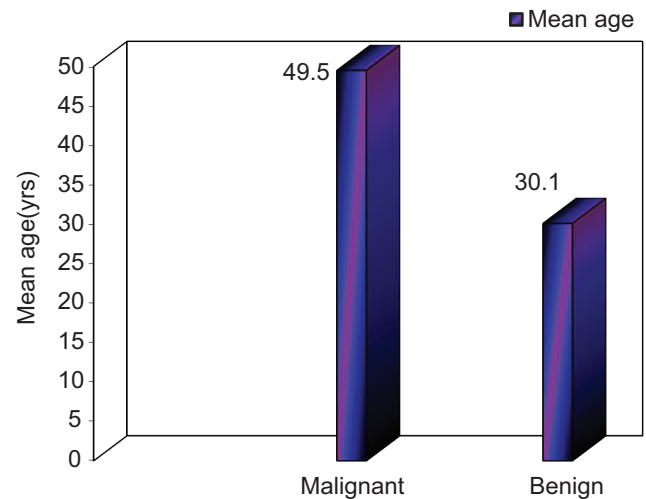
The cystic characterization of lesion was detected in majority of the subjects i.e. in 60 (66.7%) with the help of MRI than USG where only 30(33.3%) of the subjects were identified.



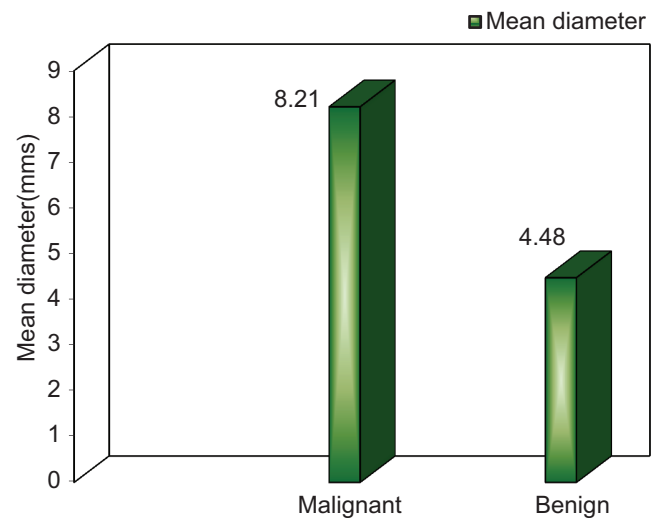
Graph-1: Shows the distribution of data based on efficacy of MRI among the study Subjects

The solid lesions were also better identified with the help of MRI i.e. 19 (21.1%) whereas in USG about 13(14.4%) solid lesions were only assessed. About 46(51.2%) subjects were not identified with the help of USG (Table 4).

The final diagnosis showed that about 24(26.7%) subjects were found to be with malignancy and about 66(73.3%) of the subjects with benign lesions. Through HPE, about 19 (21.1%) of the lesions were found to be serous cystadenoma



Graph-2: Shows the distribution of data based on mean age and malignancy among the study subjects



Graph-3: Shows the distribution of data based on mean diameter and malignancy among the study subjects

Age Group	Cases	
	No	%
Upto 30 years	33	36.7
31 – 40 years	33	36.7
41 – 50 years	11	12.2
Above 50 years	13	14.4
Total	90	100
Range	21-60 years	
Mean	35.9 years	
SD	11.0 years	

Table-1: Shows the distribution of data based on age group among the study subjects

Diameter of Mass (Cm)	Cases	
	No	%
4	44	48.9
5	22	24.4
6	2	2.2
7	5	5.6
8	5	5.6
9	5	5.6
10	3	3.3
11	2	2.2
12	2	2.2
Total	90	100
Range	4-12 cms	
Mean	5.48 cms	
SD	2.16 cms	

Table-2: Shows the distribution of data based on diameter of mass among the study subjects

Origin of Mass	Identified as per			
	USG		MRI	
	No.	%	No.	%
Uterine	5	5.6	12	13.3
Ovarian	33	36.7	69	76.7
Extra uterine/extra ovarian	2	2.2	9	10.0
Not identified	50	55.6	-	-
Total	90	100	90	100

Table-3: Shows the distribution of data based on origin of mass as per USG and MRI among the study subjects

Characterization of Lesion	Identified as per			
	USG		MRI	
	No.	%	No.	%
Solid	13	14.4	19	21.1
Cystic	30	33.3	60	66.7
Mixed	1	1.1	11	12.2
Not identified	46	51.2	-	-
Total	90	100	90	100

Table-4: Shows the distribution of data based on characterization of lesion as per USG and MRI among the study subjects

Final diagnosis	Cases (n = 90)	
	No	%
Malignant	24	26.7
Benign	66	73.3
Total	90	100

Table-5: Shows the distribution of data based on final diagnosis among the study subjects

followed by haemorrhage cysts in 17(18.9%) and fibroids in 12(13.3%). Through MRI, about 19(21.1%) of the lesions such as haemorrhage cysts and serous cystadenoma were found to be detected and fibroids in 12(13.3%) subjects (Table 5 and 6).

The true positive were found to be 21, false positive were found to be 3 followed by true negative which were found to be 63 and false negative to be 3. Out of 24 malignant lesions,

Final diagnosis	As per			
	HPE		MRI	
	No.	%	No.	%
Fibroids	12	13.3	12	13.3
Broad ligament hematoma	2	2.2	2	2.2
Hemorrhagic cysts	17	18.9	19	21.1
Serous cystadenoma	19	21.1	19	21.1
Torsion ovary	2	2.2	2	2.2
Mucinous cystadenoma	3	3.3	3	3.3
Broad ligament fibroid	1	1.1	1	1.1
Para ovarian cysts	2	2.2	2	2.2
Hydrosalpinx	2	2.2	2	2.2
Fibroma	1	1.1	1	1.1
Dermoid	1	1.1	1	1.1
Peritoneal inclusion cysts	1	1.1	1	1.1
Endometriotic cysts	3	3.3	1	1.1
Benign Total	66	73.3	66	73.3
Serous cystadeno carcinoma	8	8.9	10	11.1
Mucinous cystadeno carcinoma	7	7.8	7	7.8
Papillary carcinoma	4	4.4	3	3.3
Chorio carcinoma	1	1.1	1	1.1
Embryonal cell carcinoma	1	1.1	-	-
Metastatic ovarian carcinoma	1	1.1	1	1.1
Endometrioid carcinoma	1	1.1	1	1.1
Steroid cell tumours	1	1.1	1	1.1
Malignant Total	24	26.7	24	26.7
Total	90	100	90	100

Table-6: Shows the distribution of data based on final diagnosis as per HPE and MRI among the study subjects

Malignancy as per MRI	As per HPE results			
	Malignant		Benign	
	No.	%	No.	%
Malignant (24)	21	87.5	3	12.5
Benign (66)	3	4.5	63	95.5

Table-7: Shows the distribution of data based on comparison of malignancy results as per HPE and MRI findings among the study subjects

21 lesions turn out to be malignant lesions in histopathology and 3 adnexal lesions which were thought are malignant in MRI turn out to be benign lesions in histopathology.

Out of the 66 benign lesions identified by MRI, about 63 lesions turned to be benign in histopathology and about 3 lesions were identified as malignant which were diagnosed as benign in MRI (Table 7). In this study, the accuracy of MRI was about 93% in identifying the benign and malignant lesions (Graph 1).

The efficacy of MRI showed 88% sensitivity, 95% specificity, 88% positive predictive value, 95% negative predictive value and 93% accuracy. The relationship between age and malignancy was found to be highly significant at p value 0.001. The mean malignant score was found to be 49.5±9.1 and benign was found to be 30.1±6.5. The relationship between diameter and malignancy was also found to be statistically significant at p value 0.001. The mean score in malignancy was found to be 8.21±2.32 and benign mean score was found to be 4.48±0.86 (Graph 2 and 3).

DISCUSSION

In the present study, about 90 patients detected with adnexal masses were diagnosed with the help of ultrasonography and MR imaging. In this study, evaluation was done to assess the accuracy of MR imaging in identifying the benign and malignant lesions and to find out the correlation of the MR imaging findings with histopathology which is considered as gold standard. Also, the efficacy of ultrasound with MRI in determining the origin and characterization of lesion was compared in the present study. It was found that ultrasound was able to identify origin of adnexal masses in 44% cases, which includes uterine (5.6%), ovarian (36%) and extra-uterine-ovarian (2%) of the subjects whereas, MRI was able to detect origin in correctly in all the cases. That is, nearly in about 55% of the masses ultrasound was not able to identify the origin.⁹

In current study, the large size of the masses, obese body habitus, faeces and fluid filled bowel loops were the important factors which affected the identification of origin of adnexal lesions in USG, whereas MRI was able to overcome these negative factors and correctly identified the origin of lesions in all the cases.

To identify the origin of large/ pedunculated fibroid was also difficult in ultrasound.¹⁰ In our study, total 13 cases (14%) were identified as fibroids. Ultrasound was able to identify origin of masses i.e. fibroids in only 5 cases where as MRI was able to identify the origin of all fibroids, out of which one fibroid was diagnosed as broad ligament fibroid (extrauterine), rest of the fibroids were identified as originating from uterus.

This study showed that accurate tissue characterization, the second essential component of characterizing an adnexal mass, was poor for USG and excellent for MRI. Ultrasound was able to characterize the adnexal masses in 48% of cases (14.4% solid, 33.3% cystic, 1.1% mixed) whereas MRI was able to characterize adnexal masses in all the cases (21.1% solid, 66.7% cystic, 12.2% mixed). Our study showed wide spectrum of masses with solid, cystic and mixed intense lesions. Our study revealed that presence of solid component in cystic lesion is not always an indication of malignancy. For example, in cystic teratoma, the presence of solid components in cystic lesion indicates fat containing lesion. Unenhanced T1 and T2 -weighted imaging is important for accurate tissue characterization. Lipid and blood are easily detected and differentiated on T1-weighted imaging with and without fat suppression.

The demonstration of fat requires both standard and fat-suppressed T1-weighted imaging, because the latter helps to differentiate fat from blood products as a cause of the high T1 signal intensity. T2-weighted imaging helps to identify the relatively low signal intensity of endometriomas, reflecting blood degradation products from repeated cyclical bleeding or the very low signal intensity of fibrous tissue in a fibrous tumor of the ovary (i.e., Brenner tumor, ovarian fibroma, fibrothecoma).

In this study, by using the above mentioned sequences we correctly characterized 22 masses (3 endometriotic cysts, 1 dermoid, 17 haemorrhagic cysts and 1 fibroma). It was revealed that out of 90 adnexal masses, 66 (73%) of adnexal

masses were identified as benign and 24(26%) of adnexal was identified as malignant lesions. Histopathological examination was done in all the cases. Out of 24 malignant lesions, 21 lesions turn out to be malignant lesions in histopathology and 3 adnexal lesions which were thought are malignant in MRI turn out to be benign lesions in histopathology.¹¹

Out of 66 benign lesions identified by MRI, 63 lesions turned to be benign in histopathology and 3 lesions were identified as malignant which were diagnosed as benign in MRI. In our study the accuracy of MRI was 93% in identifying the benign and malignant lesions. These results were similar to the study conducted by Komatsu T et al in evaluating adnexal masses (benign/ malignant) by MRI and correlating with histopathology. Also, a similar study was done by Scoult LM et al which highlighted that benign lesions are most common in age groups between 20- 40 years and malignant lesions are most common between 40- 60 years.^{12,13,14}

Our study revealed that mean age of the patients with malignant lesions was 49 years and mean age of the patient with benign lesions were 30 years. The mean age of the patients with adnexal masses in our study was 35 years (Range 21-60 years). In a study done by Saroja et al described that the adnexal masses which were more than 5cm were suspicious of malignancy. In our study nearly 24 adnexal lesions were identified as more than 5 cm which were diagnosed as malignant lesions in MRI. The mean size of the adnexal lesions in our study was 5 cm (range 4- 12 cms).¹⁵

The limitation of this study was, as contrast was not used for evaluating the suspicious malignant lesions. But in a study done by Hricak et al found that there was no significant difference in the rate of detection of benign and malignant lesions between non-enhanced and contrast-enhanced images.¹⁶

CONCLUSION

The multi-planar and better soft tissue contrast imaging of MRI makes it superior imaging modality than ultrasound in evaluating adnexal masses. The ability of MRI in evaluation of adnexal masses in accurately determining the origin of a mass and characterizing its solid, haemorrhagic, fatty, and fibrous content may avoid unnecessary surgeries or significantly contribute to the preoperative planning of a sonography to detect indeterminate mass. Hence, this study showed that MRI was highly specific (95%) and accurate (93%) in diagnosing benign and malignant lesions which will help in future for gynecological oncologist in proper management of the patient.

REFERENCES

1. Smorgick N, Maymon R. Assessment of adnexal masses using ultrasound: a practical review. *Int J Womens Health*. 2014; 6(1): 857-863.
2. Funt SA, Hann LE. Detection and characterization of adnexal masses. *Radiol Clin North Am*. 2002; 40(3): 591-608.
3. Thurnher S, Hodler J, Baer S, Marincek B, von Schulthess GK. Gadolinium-DOTA enhanced MR imaging of adnexal tumours. *J Comput Assist Tomogr*

- 1990;14(4):939–949.
4. Aruna K, Sumana C. Diagnosis of Adnexal Masses – Using Ultrasound and Magnetic Resonance Imaging for Proper Management. *Asian Pac. J. Health Sci.* 2016; 3 (4):279-284.
 5. Yamashita Y, Hatanaka Y, Torashima M, Takahashi M, Miyazaki K, Okamura H. Characterization of sonographically indeterminate ovarian tumours with MR imaging: a logistic regression analysis. *Acta Radiol* 1997; 38(6):572- 577.
 6. Dodge JE, Covens AL, Lacchetti C, et al. Preoperative identification of a suspicious adnexal mass: a systematic review and meta-analysis. *Gynecol Oncol.* 2012; 126(1):157–167.
 7. Madan R, Narula MK, Chitra R, Bajaj P. Sonomorphological and color doppler flow imaging evaluation of adnexal masses. *Indian J Radiol Imaging.* 2004; 14(2): 365-72.
 8. Timmerman D, Bourne TH, Tailor A, et al. A comparison of methods for preoperative discrimination between malignant and benign adnexal masses: the development of a new logistic regression model. *Am J Obstet Gynecol* 1999; 181(1):57–65.
 9. Valentin L, Hagen B, Tingulstad S, Eik-Nes S. Comparison of “pattern recognition” and logistic regression models for discrimination between benign and malignant pelvic masses: a prospective cross validation. *Ultrasound Obstet Gynecol* 2001;18(4):357–365.
 10. Padhani AR, Husband JE. Dynamic contrast enhanced MRI studies using ECF agents. *Clin Radiol* 2001; 56(2):607–620.
 11. Mol BW, Boll D, De Kanter M, et al. Distinguishing the benign and malignant adnexal mass: an external validation of prognostic models. *Gynecol Oncol* 2001;80(1):162–167
 12. Sohaib SA, Mills TD, Sahdev A, et al. The role of magnetic resonance imaging and ultrasound in patients with adnexal masses. *Clin Radiol.* 2005; 60(3): 340–8.
 13. Komatsu T, Konishi I, Mandai M, et al. Adnexal masses: transvaginal US and gadolinium-enhanced MR imaging assessment of intra-tumoral structure. *Radiology* 1996; 198(1):109–115.
 14. Scoutt LM, McCarthy SM, Lange R, Bourque A, Schwartz PE. MR evaluation of clinically suspected adnexal masses. *J Comput Assist Tomogr.* 1994; 18(3):609–618.
 15. Saroja Adusumilli et al. MRI of sonographically indeterminate adnexal masses. *American Journal of Roentgenology* 2006; 187(3):732-740.
 16. Hricak H, Chen M, Coakley FV, Kinkel K, Yu K, Sica G, et al. Complex adnexal masses: detection and characterization with MR imaging – multivariate analysis. *Radiology* 2000; 214(1): 39–46.

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