

ACCURACY OF MULTISLICE THREE-DIMENSIONAL ULTRASONOGRAPHY IN PREDICTING SPECIFIC PATHOLOGY OF ADNEXAL MASSES

By

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ABSTRACT

Background: The MSV mode or Tomographic ultrasound imaging (TUI) allows the simultaneous showing of several longitudinal parallel views for a reference (sagittal, coronal, transverse) plane of the target, its direction and rotation, and magnitude and slice depth and length (0.5 to 5 mm) to be modified by region of interest depending on the size of the object's area of expertise.

Objective: To evaluate the diagnostic efficacy of 3D US (multi-slice view) characterizing adnexal masses for prediction of specific pathological nature.

Materials and Methods: This prospective study was carried out on 70 patients with age between 15 and 82 years, attending the outpatient clinic of Gynecological Department of Al -Azhar University Hospitals diagnosed as having adnexal mass on conventional 2D sonography. Imaging studies for diagnosis of adnexal masses, 3D US MSV (Multislice view) technique. Diagnostic work-up included an Original 2D ultrasound mass evaluation accompanied by 3D US volume assessment. All masses were evaluated by 3D US MSV.

Results: According to the color score in all ovarian masses with solid component, either pure solid or heterogeneous, 11.54% of the masses showed no vascular flow, 46.6 % had mild flow, 7.69 % with moderate flow, and 34.6 % with severe vascular flow. Ovarian masses were classified to benign and malignant by 3D US, and according to their final histopathological analysis. There was a clinical significance relationship for age with the final diagnosis. The test performance of US to detect characterizing adnexal masses as benign or malignant with sensitivity and specificity are 52% and 95.5% respectively. Obese patients with BMI more than 30 with Sensitivity and specificity for US were 52 %, 92.8 % respectively were excluded. Sensitivity of US improved from 52% to 63.6%.

Conclusion: MSV 3D US can be useful in the anatomical evaluation of adnexal masses, particularly for the identification of papillary projections in adnexal cysts. This new technique has the potential for expert consultation by sending the image volume to them to do offline analysis, even after finishing the examination with the patient.

Keywords: Multislice, Adnexal Masses, Three-Dimensional, Ultrasonography, Ovarian.

INTRODUCTION

The morphological B-mode two - dimensional (2D) sonography provides a basis for segregation between benign and malignant adnexal masses depending on

the "pattern recognition" and scoring systems (*Kurjak and Chervenak, 2017*).

3D sonographic transcends those disadvantages of existing 2D sonography, enabling a comprehensive examination of the morphological characteristics of the

examined target, without restricting the number and alignment of the scan plane (*Abbas et al., 2014*). 3D ultrasound advances allow the use of higher frequency probe to examine morphological anatomy and quantify the ovaries in diameter (*Meiburger et al., 2018*).

The multi-slice (MSV) mode and Tomographic Ultrasound Imaging (TUI) allow for simultaneous visualization of the object's reference plane, its direction and rotation, its size magnitude and its slice depth and intervals, which is 0.5 - 5 mm to be modified according to the area of expertise (*Ferrante and Paragios, 2017*).

The MSV method enables similar view of parallel slices of a region of interest. The sonographer could use a number of images to access the same volume data set using the more traditional multiplanar methodology (*Salaffi et al., 2015*). 3D ultrasound MSV provides the best of ultrasound, e.g. protection, easy processing and low cost (as compared to MRI and CT), with the benefits of 3D ultrasound (*Klibanov and Hossack, 2015*).

Many researches have analyzed the influence of 3D transvaginal sonography in adnexal mass measurement and have published conflicting findings.

The aim of this study was to evaluate the diagnostic efficacy of 3D Ultrasound (multi-slice view) characterizing adnexal masses for prediction of specific pathological nature.

PATIENTS AND METHODS

This prospective study was carried out on 70 patients with age between 15 -82 years, attending the outpatient clinic of

Gynecological Department of Al -Azhar University Hospitals diagnosed as having adnexal mass on conventional 2D sonography after approval of Al-Azhar Faculty of Medicine Ethics Committee, and a written informed consents from all participants in this research.

Exclusion criteria were who did not undergo surgical removal of the adnexal mass. For each patient, medical and surgical history was evaluated, and clinical examination was performed. Routine laboratory investigations were assessed including complete blood picture, prothrombin time and activity and liver and renal function tests. Diagnostic work-up included initial 2D ultrasound mass assessment followed by 3D ultrasound volumes. The obtained volumetric data has been processed to allow for detailed explanation at all times without losing information. All masses were measured by 3D MSV ultrasound. Ultrasonographic evaluation was done using a Samsung UGEO H-60 machine (Samsung, Korea) with multi frequency (3.5 to 5) transabdominal and (5 to 7 MHz) transvaginal volumetric probes by the same sonographer (level III experience).

Laboratory investigations included specific tumor markers for each case including CA-125 in postmenopausal cases and lactate dehydrogenase, alpha-Feto protein and HCG in premenopausal cases. For each imaging modality and for combinations of ultrasound and radiologic techniques sensitivity, specificity, positive, negative predictive values, and accuracy calculated independently.

Surgical removal by laparotomy was accompanied by histopathology to

validate their existence, since the histopathological assessment was regarded as the gold standard for determining the outcome, and was categorized as benign or malignant.

Statistical analysis:

Statistical analysis was done by SPSS v20 (IBM®, Chicago, IL, USA). Normality of data (Parametric or not) was checked with Shapiro-Wilks test and histograms and all our data were normal distributed. Quantitative data were presented as mean and standard deviation

(SD) and were compared by student's t-test with ROC curve test if significant and is used to detect sensitivity and specificity. All SD were less 0.5 mean so it is not abnormal to need Mann Whitney (U) test. Qualitative data were presented as number and percent and were compared by the Chi-square (X2) test. A P value <0.05 was considered statistically significant. Sample size was calculated to achieve an alpha error of 5%, and a beta error of 2% for such data type.

RESULTS

As Regarded to demographic data showed that the age ranged from (13-77) years with mean value 40.3± 14.2 years, showed that BMI ranged from (19 - 44) Kg/m² with mean value 29.9 ± 7.0 Kg/m²,

and the number of gravidities of included patients ranged from 0-8 times with percentage between 2.86% to 31.43% (Table 1).

Table (1): Descriptive analysis of the age, BMI and analysis of gravidity in the recruited patients

Demographic data of the patients						
	Range			Mean	±	SD
Age (Years)	13	-	77	40.386	±	14.231
BMI	19	-	44	29.986	±	7.006
Gravidity						
				N	%	
	G0			8	11.43	
	G1			2	2.86	
	G2			9	12.86	
	G3			22	31.43	
	G4			20	28.57	
	G5			4	5.71	
	G8			5	7.14	
	Total			70	100.00	

BMI: Body mass index

Ovarian masses were classified according to the consistency: 62.86% masses were cystic, 12.86 % masses were

solid, 24.29 % were heterogeneous (mixed cystic and solid) and 43.18 % of cystic ovarian masses were septate (Table 2).

Table (2): Classification of the of ovarian masses in our study according the consistency and the percentage of Cystic ovarian masses with septation

Classification of the of ovarian masses.		
	N	%
Cystic ovarian masses	44	62.86
Solid ovarian masses	9	12.86
Heterogeneous ovarian masses	17	24.29
Total	70	100.00
Descriptive analysis of the percentage of septated cystic ovarian masses		
	N	%
Cystic ovarian masses without septation	25	56.82
Cystic ovarian masses with septation	19	43.18
Total	44	100.00

According to the color score in all ovarian masses with solid component, either pure solid or heterogeneous, 11.54% of the masses showed no vascular

flow, 46.6 % had mild flow, 7.69 % with moderate flow and 34.6 % with severe vascular flow (**Table 3**).

Table (3): Analysis of the color score in all ovarian masses in our study

Color score		
	N	%
No (0)	3	11.54
Mild (1)	12	46.15
Moderate (2)	2	7.69
Severe (3)	9	34.62
Total	26	100.00

(Score 0=no flow, score 1=mild flow, score 2=moderate flow, score3=severe flow).

Ovarian masses were classified to benign and malignant by 3D US and

according to their final histopathological analysis (**Table 4**).

Table (4): Analysis of the percentage of suggested benign and malignant ovarian masses according to US diagnostic features and according histopathology

3D US provisional diagnosis		
	N	%
Benign	55	78.57
Malignant	15	21.43
Total	70	100.00
Final diagnosis by histopathological assessment.		
	N	%
Benign	45	64.29
Malignant	25	35.71
Total	70	100.00

There was clinical significance P-value: 0.02 with relationship for age

whereas BMI and parity showed no significant relationship with the final

diagnosis. Relationship between color score in ovarian masses with solid component and final histopathological diagnosis was analyzed which revealed high association between adnexal masses with high vascular flow (color score 3)

and malignancy. 45 patients (64 percent) reported benign mass and, according to their final histopathology report, 25 patients (35 percent) had malignant masses (**Figure 1**).

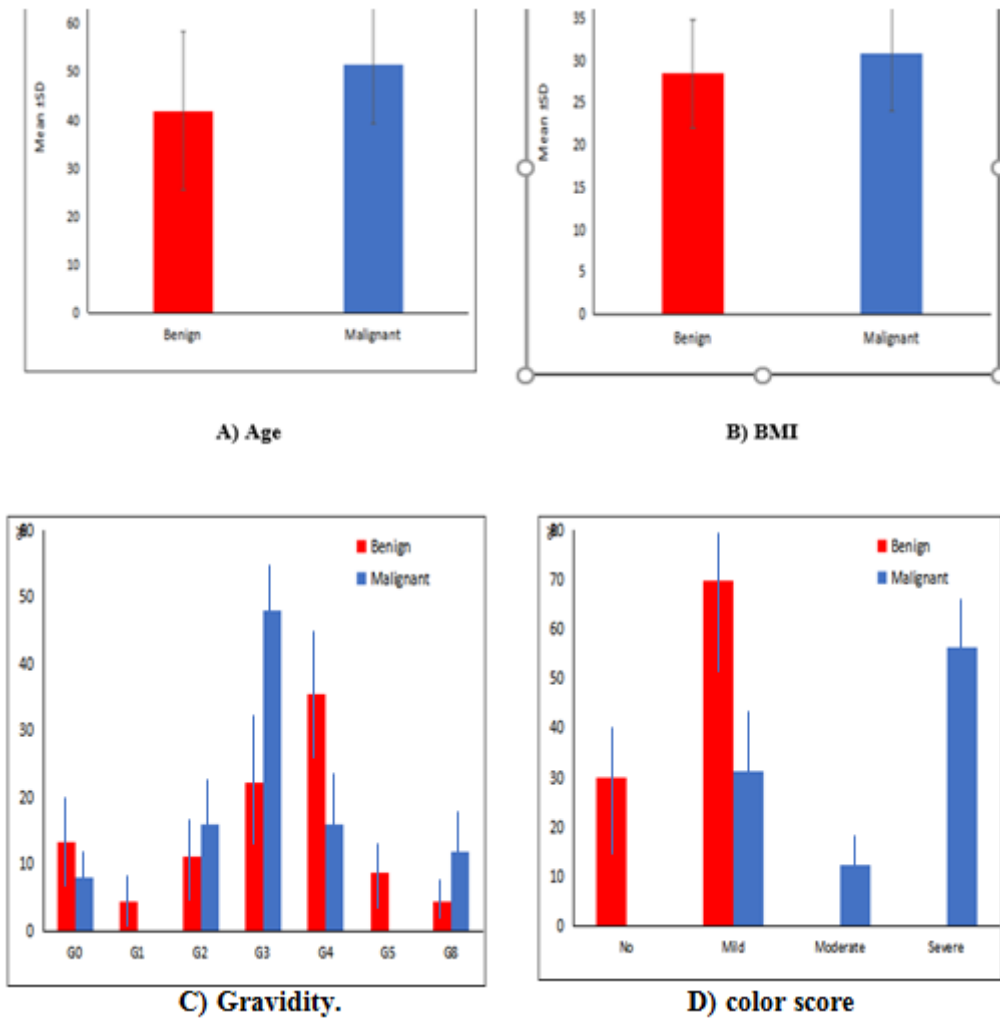


Figure (1): The relationship between some parameters and final outcome (Mean±SD)

There was no significant relationship between the final histopathological diagnosis and the largest diameter of the

masses, cystic, solid and septated lesions (**Figure 2**).

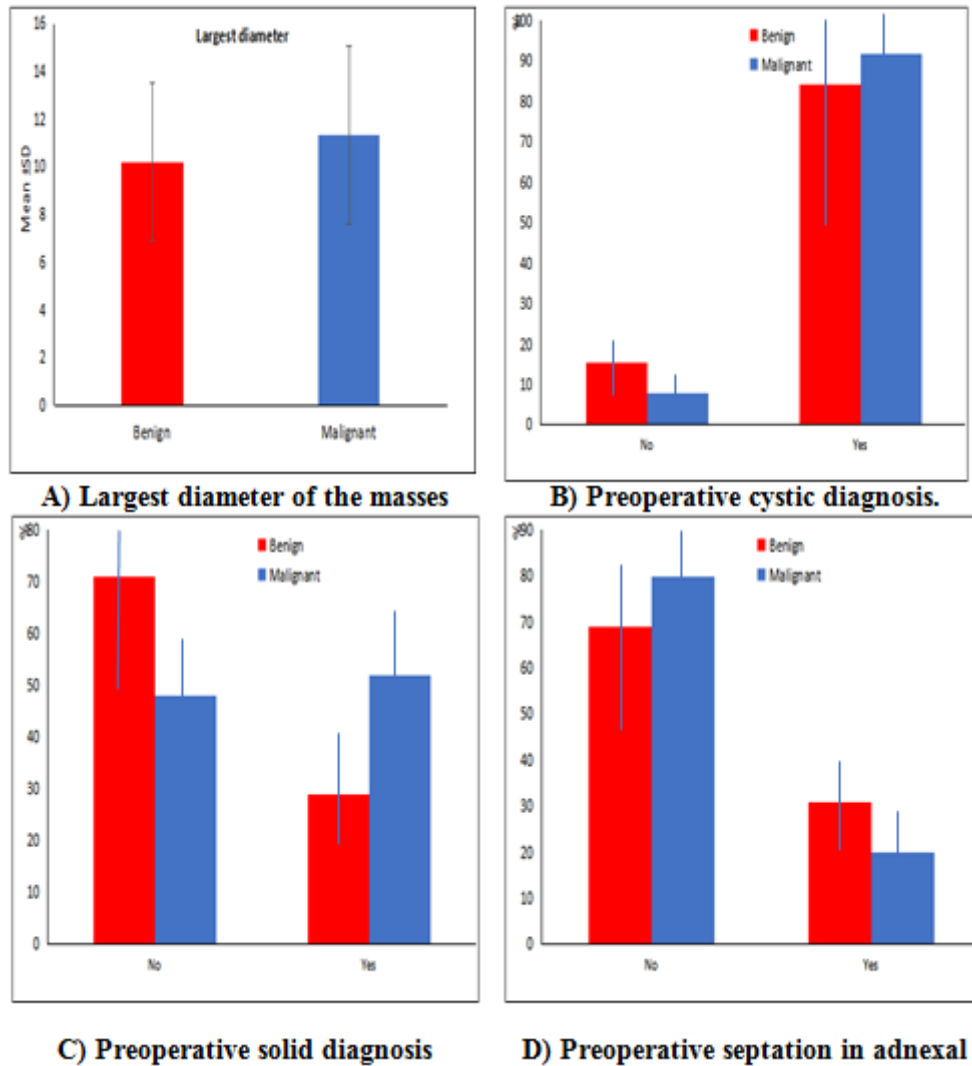


Figure (2): The relationship between some parameters and final outcome (Mean±SD).

The test performance of US to detect characterizing adnexal masses as benign or malignant with Sensitivity and

specificity are 52% and 95.5% respectively (Table 5).

Table (5): Test performance of US in prediction malignancy in all recruited patients

US Parameters	Final diagnosis					
	Benign		Malignant		Total	
	N	%	N	%	N	%
Benign	43	95.56	12	48.00	55	78.57
Malignant	2	4.44	13	52.00	15	21.43
Total	45	100.00	25	100.00	70	100.00
Roc Curve						
Sensitivity	Specificity		PPV		NPV	Accuracy
52.00	95.56		86.67		78.18	80.00

PPV: positive predictive value, NPV: negative predictive value.

We then exclude obese patients with BMI more than 30 with Sensitivity and specificity for US were 52 %, 92.8 % respectively. Sensitivity of US improved

from 52% to 63.6% by using ROC curve as we measure sensitivity and specificity not P-value (**Table 6**).

Table (6): Test performance of US in prediction malignancy in subgroup of patients with BMI less than 30

Parameter \ US	Final diagnosis					
	Benign		Malignant		Total	
	N	%	N	%	N	%
Benign	26	92.86	4	36.36	30	76.92
Malignant	2	7.14	7	63.64	9	23.08
Total	28	100.00	11	100.00	39	100.00
Roc Curve						
Sensitivity	Specificity		PPV	NPV	Accuracy	
63.64	92.86		77.78	86.67	84.62	

PPV: positive predictive value, NPV: negative predictive value.

DISCUSSION

Imaging plays an important role in classification and positioning of adnexal masses. Ultrasound (US) is often the first imaging study to evaluate a potential ovarian laceration, as it is widely available. Morphological features that can be indicative of malignancy included thickness (> 3 mm) and wall and septa irregularity, appearance of solid areas and papillary projections, and other indications of malignant and metastatic development. In terms of vascularization, Doppler color tests revealed both the presence and location of the new blood tumor vessel: a primarily centralized blood flow is correlated with malignancies more often, while the peripheral one is more characteristic of a benign lesion (*Foti et al., 2016*). Nonetheless, certain checks are necessary unless the morphological and vascular characteristics clearly indicate a healthy lesion. *Levine et al. (2010)*. In a Consensus Statement for the Society of Ultrasound Radiologists, offered suggestions on controlling adnexal

masses. The clinical scale and existence of adnexal masses in a woman of menstrual age or of an adnexal cyst less than or equal to 1 to 3 cm and less than 5 cm in a postmenopausal women was generally benign. In characterization of adnexal mass into benign or malignant, conventional ultrasound has shown a sensitivity of 84 % and a specificity of 82 % in diagnosing cancer (*Iyer and Lee, 2010*).

Contrast enhanced ultrasound could improve the accuracy of ovarian cancer detection as *Wu et al. (2015)*, on a recent meta-analysis of ten independent studies, reported a higher diagnostic accuracy (sensitivity 89% and specificity 91%) of contrast-enhanced ultrasound in distinguishing between benign and malignant ovarian masses. When we compared these results to our own, we found that Multislice 3D Ultrasound has better specificity (96%) than conventional as well as contrast enhanced ultrasound, whereas sensitivity is lower (57%).The former meta-analysis did not determine

the accuracy of US in different BMI groups, as if we exclude obese patients, the sensitivity of US in the current study has jumped up to 71 %. The same method was used for computed tomography and magnetic resonance imaging (showing multiple slices on the same computer to compare). Magnetic resonance imaging was also used as an alternative to adnexal mass measurement (*Salem et al., 2016*). No more details from the MSV material morphology evaluation to illustrate its regular use in adnexal mass assessment. *Alcazar et al. (2013)* reported a series of 20 women (7 malignant tumors) in whom the different examiners performed both 3D US and 2D US.

They found that 3DUS was more specificity than 2DUS (92.3 % versus 38.4%) with identical sensitivity (100 %). However, this series was small and the prevalence of malignancy was high. *Alcázar et al.* reported a series of 41 women diagnosed as having complex adnexal masses on 2DUS (2013). 3DUS and 2DUS were carried out by two different examiners. Ovarian malignancy was large in prevalence (48 percent). 3DUS displayed improved than 2DUS in the test, but this discrepancy did not achieve statistically significant responsiveness (100 percent versus 90 percent) and accuracy (78 percent versus 61 percent). However, 3DUS confirmed the analytical perception of the investigator. The same group noted a second series with findings similar to the previous one (*Salaffi et al., 2015*). In a sequence of 50 masses— 33% malignant tumors—3DUS had a greater sensitivity (90% versus 81%) and specificities (84% versus 79%) than 2DUS and found both intra-observer agreement was good and

interobserver agreement were good (*Alcázar et al., 2013*). *Pascual et al. (2011)* and *Niemi (2019)* showed that different results have been observed. This is an important factor in the realistic use of this procedure. Therefore, 3DUS appears to be better than 2DUS in terms of predictive accuracy in adnexal mass malignancy predictions, but further research are necessary in order to make meaningful conclusions.

In a measurement of the effects of a 3D US multi-slice approach to adnexal mass morphology, *Abbas et al. (2014)* stated that comprehensive examination of volumes captured in a 3D ultrasound using MSV could help to better evaluate the morphology of adnexal masses particularly in the identification of papillary projections in adnexal cysts. In our research, 64 percent reported benign mass and, according to their final histopathology report, 35 percent had malignant masses. One drawback in our research was the lack of an example image, which should be shown on the same panel for accurate comparing. It might have been easier to change the mass position and orientation during the explanation of the parallel sequence if the anatomical orientation of the exact level had been implemented by slicing.

CONCLUSION

In morphological evaluation of adnexal masses, 3D ultrasound MSV is particularly useful for identification of papillary projections in adnexal cysts. This new technique has the potential for expert consultation by sending the image volume to them to do offline analysis, even after finishing the examination with the patient.

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دقة الموجات فوق الصوتية ثلاثية الأبعاد متعددة الشرائح في التنبؤ بالباثولوجي الدقيق لأجسام في ملحقات الرحم

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خلفية البحث: يسمح وضع عرض الصور المتعددة الشرائح أو التصوير الشعاعي بالموجات فوق الصوتية بعرض عدد من العروض المتزامنة بين التسلسل الزمني لمستوى مرجعي (مستوى مستعرض، سهمي، تاجي) لجسم ما، واتجاه الصورة ودورانها، وحجم التكبير وعمق الشريحة والفترة الفاصلة (من ٠.٥ إلى ٥ مم) يمكن تعديلها وفقا لمنطقة الاهتمام.

الهدف من البحث: تقييم الفعالية التشخيصية للموجات فوق الصوتية ثلاثية الأبعاد (المنظر متعدد الشرائح) في التنبؤ بالباثولوجي الدقيق لأجسام في ملحقات الرحم.

المرضى وطرق البحث: أجريت هذه الدراسة على ٧٠ مريضا تتراوح أعمارهن بين ١٥ و ٨٢ عاما، وحضرن العيادة الخارجية لقسم الأمراض النسائية في مستشفيات جامعة الأزهر الذين تم تشخيصهن بأنهن مصابات بورم في ملحقات الرحم في التصوير السوني التقليدي ثنائي الأبعاد. دراسات التصوير لتشخيص الحالات، تقنية رصد الموجات فوق الصوتية (عرض الشرائح المتعددة): وتم إجراء تقييم أولي بالموجات فوق الصوتية ثنائية الأبعاد للورم متبوعا بعمل الموجات فوق الصوتية ثلاثية الأبعاد. وتم إجراء التشخيص النهائي من خلال التحليل الباثولوجي للأورام بعد إجراء إستئصال جراحي والحالات التي تخضع لإجراء إستئصال جراحي للورم تم استبعادهن من التحليل الاحصائي.

نتائج البحث: وفقا لنقاط اللون في جميع اورام المبيض ذات المكونات الصلبة، سواء كانت صلبة أو غير متجانسة، ظهر ١١.٥٤ في المائة من الحالات تدفق دموي عالي، و ٤٦.٦ في المائة كان تدفقها بسيطا، و ٧.٦٩ في المائة مع التدفق المعتدل و ٣٤.٦ في المائة مع التدفق الأوعائي الشديد. مع مقارنة اورام المبيض التي صنفت إلى حميدة وخبثية مبدئيا من قبل الأشعة ثلاثية الأبعاد ووفقا لآخر

تحليل باثولوجي، كان هناك علاقة إيجابية ذات أهمية سريرية للعمر مع التشخيص النهائي. وكان الأداء التجريبي بجهاز الموجات فوق الصوتية للكشف عن وصف الحالات بأنها حميدة أو خبيثة ذات حساسية وخصوصية ٥٢٪ و ٩٥،٥٪ على التوالي. وبعد استبعاد المريضاات ذوات البدانة بزياده معامل كتلة الجسم اكثر من ٣٠، زادت حساسية وخصوصية الاشعه التلفزيونيه وكانت ٥٢٪، ٩٢،٨٪ على التوالي لتصبح ٥٢٪ و ٦٣،٦٪ على التوالي.

الإستنتاج: يمكن ان تكون الموجات فوق الصوتية ثلاثية الأبعاد متعدد الشرائح مفيدة في التقييم الشكلي لأجسام ملحقات الرحم وخاصة في الكشف عن الزوائد الحليمية في الأكياس الملحقة. لذلك يمكن أن تضيف فائدة للمرضى الذين يعانون من الأكياس المشبوهة خاصة في النساء بعد انقطاع الطمث. هذا قد يغير إختيار القرار الأمثل لتقييم هذه الأكياس في هؤلاء المرضى.

الكلمات الدالة : الموجات فوق الصوتية – ثلاثية الأبعاد – أجسام فى ملحقات الرحم متعددة الشرائح .