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ORIGINAL ARTICLE

Comparison of diagnostic accuracy of transvaginal ultrasound with laparoscopy in the management of patients with adnexal masses

Theodoros D. Theodoridis · Leonidas Zepiridis · Themistoklis Mikos · Grigoris F. Grimbizis · Konstantinos Dinas · Apostolos Athanasiadis · John N. Bontis

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Abstract
Purpose The aims of this study was (a) to compare the diagnostic accuracy of ultrasound examination with laparoscopic findings and both with the gold standard (histology) in the management of benign ovarian lesions, and (b) to assess the feasibility of laparoscopy in their diagnosis and management.
Methods Prospective, comparative study (Canadian Task Force Classification II-2). A total of 117 women 15–59 years old were examined at outpatient department and had transvaginal ultrasound assessment. Ninety-eight women (three postmenopausal) with 105 cystic ovarian lesions met inclusion criteria and underwent operative laparoscopy. Histology was performed in all cases.
Results Although laparoscopy showed an overall higher performance compared to transvaginal ultrasound, statistically significant difference was found only in the detection of endometriomas compared to ultrasound ($P = 0.004$ for sensitivity and $P = 0.046$ for specificity).
Conclusion Laparoscopy exhibits higher diagnostic accuracy, especially in endometriomas, compared to transvaginal scan. Laparoscopic diagnosis appears to be safe and accurate. Conservative laparoscopic management of benign adnexal masses is safe and with low morbidity.

Keywords Laparoscopy · Adnexal masses · Ovarian cysts · Transvaginal scan · Endometriomas

T. D. Theodoridis · L. Zepiridis · T. Mikos · G. F. Grimbizis · K. Dinas · A. Athanasiadis · J. N. Bontis
1st Department of Obstetrics and Gynecology, Aristotle University of Thessaloniki, Thessaloniki, Greece

T. D. Theodoridis · L. Zepiridis · T. Mikos · G. F. Grimbizis · J. N. Bontis
Endoscopy Unit, General Clinic, Thessaloniki, Greece

T. D. Theodoridis (✉)
8, Agias Theodoras Street, 54623 Thessaloniki, Greece
e-mail: theodtheo@yahoo.gr

Introduction

The application of imaging techniques in routine gynecological practice has lead to an increased detection rate of adnexal masses. However, accurate diagnosis is commonly obscured by the complexity of clinical and imaging features of these lesions. Clinician's primary goal is to rule out malignancy, as this demands immediate management in order to prevent devastating results. The risk of an ovarian tumor being malignant is estimated to be 7–13% in premenopausal and 8–45% in postmenopausal women [1]. The risk of ovarian malignancy in women undergoing laparoscopy for preoperatively benign appearing ovarian tumors ranges from 0.1 to 4.2% and increases in elder patients [2–5].

Ultrasound scan has been widely used for ovarian pathology screening. A number of scoring systems has been proposed in order to facilitate early detection of malignant ovarian lesions [6–9]. Sonographic scoring of the ovarian lesion appears to have high sensitivity (89–100%) and specificity (73–83%), moderate positive predictive value (37–46%) and excellent negative predictive value (96–100%) [6, 7].

Nevertheless, it seems that the most accurate way to detect ovarian malignancies is the combination of laparoscopic inspection of the peritoneal cavity with intraoperative biopsy [2]. The laparoscopic management of ovarian

masses is currently one of the most intriguing issues of contemporary gynecology. Until recently, the optimum approach for the management of ovarian tumors was laparotomy. The increasing experience in the use of laparoscopy during the last 15 years has altered the way of treating adnexal tumors in favor of minimally invasive techniques. Advantages of laparoscopy compared to laparotomy include shorter hospital stay, smaller percentage of postoperative adhesions, less impact on quality of life, and the overall decreased financial burden [10, 11]. Moreover, current trends indicate that ovarian lesions in young women, with or without subfertility, warrant mainly conservative management, and if operation cannot be avoided, then application of minimal invasive surgery is mandatory.

The aim of this study was to compare the diagnostic accuracy of ultrasound examination with laparoscopic findings and both with the gold standard (histology) in the management of benign ovarian lesions, and to assess the feasibility of laparoscopy in their diagnosis and management.

Materials and methods

Ethical approval for this prospective, comparative study was obtained by the local ethical committee as appropriately.

A total of 117 women 15–59 years old were examined in the outpatient department of a tertiary centre (1st Department of Obstetrics and Gynecology, Aristotle University of Thessaloniki, Greece) and in an affiliated private hospital (General Clinic, Thessaloniki, Greece) from September 2001 to September 2005.

Presenting symptoms, anamnesis, clinical bimanual examination, and transvaginal ultrasound scan (TVS), were taken during the first visit in the outpatient clinic. The commonest presenting symptoms were pelvic pain, menstrual disorders, dysmenorrhoea, dyspareunia, subfertility, and routine check-up in asymptomatic women.

Inclusion criteria for this study were the presence of sonographically diagnosed cystic ovarian mass in both premenopausal and postmenopausal women. Detailed ultrasound examination (Ultramark 4 Plus Advanced Technology Laboratories, Bothell, WA, USA, and Logic 200 Q, General Electric, vaginal probe with 5 MHz frequency) was performed by experienced sonographers and Sassone score was calculated for each subject. Postmenopausal women with Sassone score > 9 were excluded from the study [6].

All subjects were rescanned 2 months after the initial visit in order to identify functional ovarian lesions. Nineteen women 19–41 years old were excluded from the study protocol as subsequent ultrasound examination did not confirm the presence of the originally identified mass (functional ovarian cysts).

Ninety-eight women (three postmenopausal) with 105 cystic ovarian lesions were finally recruited for further laparoscopic management. Body mass index ranged from 17 to 35 kg/m^2. Diameter of the ovarian masses ranged from 2.9 to 13.5 cm (Table 1).

All 98 women underwent operative CO_2 laparoscopy. Pneumoperitoneum was established with the Veress needle, except two cases with previous midline laparotomy that pneumoperitoneum was set with open laparoscopy. After trocar insertion, peritoneal fluid cytology was obtained routinely. Laparoscopic cystectomy was performed as previously described [5]. The cyst was removed by means of an endobag and was histologically examined. Suction irrigation of the peritoneal cavity and secure hemostasis concluded each laparoscopic operation.

Statistics were performed with the use of SPSS version 11.0 and Epi info for Windows Database and Statistics for Public Health Professionals [Centers for Disease Control and Prevention (CDC)]. Student's *t*-test and Fisher's exact

Table 1 Patients' age and BMI, sonographic diameter of the masses, classified according to the histological diagnosis

	n	Age (years) (mean ± SD)	BMI (kg/m^2) (mean ± SD)	Diameter (cm) (mean ± SD)
Simple cyst	32	32.4 ± 19.6	22 ± 7.0	5.07 ± 2.92
Paraovarian cyst	4	23.5 ± 16.6	27.7 ± 5.2	7.5 ± 8.16
Endometrioma	37	30.8 ± 14.6	23.3 ± 8.8	5.11 ± 3.28
Serous cystadenoma	8	32.4 ± 26.0	25.7 ± 9.6	6.04 ± 2.78
Mucinous cystadenoma	4	42.4 ± 26.0	27 ± 8.6	5.12 ± 2.5
Dermoid cyst	15	26.3 ± 7.2	22.4 ± 7.0	5.15 ± 2.24
Cystic adenofibroma	1	37	30	5.0
Corpus luteum cyst	2	31.5 ± 15.6	20.5 ± 1.4	5.75 ± 0.7
Borderline tumor	2	27.5 ± 3.0	22 ± 2.8	6 ± 1.4
Total	105	31.04 ± 18.48	23.09 ± 8.32	5.29 ± 3.26

n Number of cysts, *BMI* body mass index, *SD* standard deviation

Table 2 Presenting symptoms of the patients included in the study

	Pelvic pain	Menstrual disorders	Dysmenorrhoea	Dyspareunia	Subfertility	Annual visit
Simple cyst	18	8	1	2	1	15
Paraovarian cyst	3	–	–	1	–	1
Endometrioma	19	7	18	16	6	12
Serous cystadenoma	5	2	1	1	–	5
Mucinous cystadenoma	3	2	–	–	–	1
Dermoid cyst	7	2	3	5	–	9
Cystic adenofibroma	1	–	-	1	–	–
Corpus luteum cyst	2	–	2	1	–	–
Borderline tumor	1	–	–	–	–	1
Total	50 (47.6%)	21 (20.0%)	25 (23.8%)	27 (25.7%)	7 (6.7%)	44 (41.9%)

Table 3 Classification of ovarian tumors diagnosed in the patients of the study according to their age at presentation (in decades)

	<20	21–30	31–40	41–50	>50	Total
Simple cyst	2	13	12	3	2	32
Paraovarian cyst	3	–	1	–	–	4
Endometrioma	1	20	12	4	–	37
Serous cystadenoma	2	3	–	2	1	8
Mucinous cystadenoma	–	–	2	1	1	4
Dermoid cyst	3	9	2	1	–	15
Cystic adenofibroma	–	–	1	–	–	1
Corpus luteum cyst	–	1	1	–	–	2
Borderline tumor	–	2	–	–	–	2
Total	11 (10.5%)	48 (45.7%)	31 (29.5%)	11 (10.5%)	4 (3.8%)	105 (100%)

test with Yates correction were used to calculate any significant difference between numerical and nominal parameters respectively.

Results

Totally 98 women with 105 ovarian cysts were laparoscopically treated. There were 32 simple ovarian cysts (30.48%), 4 paraovarian cysts (3.81%), 37 endometriomas (35.23%), 4 mucinous cystadenomas (3.81%), 8 serous cystadenomas (7.62%), 15 dermoid cysts (14.29%), 1 cystadenofibroma (0.95%), 2 corpus luteum cysts (1.9%), and 2 borderline ovarian tumors (1.9%) (Table 1). The main presenting symptoms were pelvic pain (47.6%), dyspareunia (25.7%), dysmenorrhoea (23.8%), and menstrual disorders; 41.9% of the patients were asymptomatic presenting for their annual health visit (Table 2). Most of the patients diagnosed with ovarian tumors were 21–30 years old (45.7%) and 31–40 years old (29.5%); only four patients of this study (3.8%) were older than 50 years (Table 3). The majority of simple cysts, endometriomas, and mucinous cystadenomas, had preoperative sonographic maximum diameter 3.1–5.0 cm; the majority of paraovarian cysts, serous cystadenomas, and dermoid cysts, had preoperative sonographic maximal diameter 5.1–7.0 cm (Table 4). TVS identified correctly 30 cases of simple cysts (94%), 3 paraovarian cysts (75%), 29 endometriomas (78%), 5 serous cystadenomas (63%), 3 mucinous cystadenomas (75%), and 12 dermoid cysts (80%). Laparoscopically, were correctly diagnosed 30 cases of simple cysts (94%), 4 paraovarian cysts (100%), 37 endometriomas (100%), 6 serous cystadenomas (75%), 3 mucinous cystadenomas (75%), and 15 dermoid cysts (100%) (Table 5).

Regarding accuracy in the diagnosis of benign ovarian lesions, laparoscopy performed excellent in the detection of paraovarian cysts (sensitivity 100%, specificity 100%), endometriomas (sensitivity 100%, specificity 100%), dermoid cyst (sensitivity 100%, specificity 100%), very good in the detection of simple cysts (sensitivity 94%, specificity 97%), moderately good in the detection of serous (sensitivity 75%, specificity 97%), and mucinous cystadenomas (sensitivity 75%, specificity 98%). Ultrasound was proven very good in the diagnosis of simple (sensitivity 94%, specificity 92%) and dermoid cysts (sensitivity 80%, specificity 92%), moderately good in the detection of endometriomas

Table 4 Histological findings in respect to the maximal sonographic cystic diameter in centimeter

	<3.0 cm	3.1–5.0 cm	5.1–7.0 cm	7.1–9.0 cm	>9.0 cm	Total
Simple cyst	2	14	13	2	1	32
Paraovarian cyst	–	1	2	–	1	4
Endometrioma	2	20	9	5	1	37
Serous cystadenoma	–	2	4	2	–	8
Mucinous cystadenoma	–	3	1	–	–	4
Dermoid cyst	1	6	7	1	–	15
Cystic adenofibroma	–	1	–	–	–	1
Corpus luteum cyst	–	–	2	–	–	2
Borderline tumor	–	1	1	–	–	2
Total	5 (4.7%)	48 (45.7%)	39 (37.1%)	10 (9.5%)	3 (2.9%)	105 (100%)

Table 5 Diagnostic accuracy of transvaginal ultrasound and laparoscopy in the diagnosis of benign adnexal masses

	Total	Accurate diagnosis (*n*)		Sensitivity		Specificity		PPV		NPV	
		TVS	Lap	TVS (%)	Lap (%)	TVS (%)	Lap (%)	TVS (%)	Lap (%)	TVS (%)	Lap (%)
Simple cyst	32	30	30	94	94	92	97	83	94	97	97
Paraovarian cyst	4	3	4	75	100	100	100	100	100	99	100
Endometrioma	37	29	37	78	100[a]	88	100[a]	78	100	88	100
Serous cystadenoma	8	5	6	63	75	97	97	63	67	97	98
Mucinous cystadenoma	4	3	3	75	75	95	98	38	60	99	99
Dermoid cyst	15	12	15	80	100	92	100	63	100	97	100

TVS transvaginal ultrasound, *Lap* laparoscopy, *PPV* positive predictive value, *NPV* negative predictive value

[a] Statistically significant difference

Table 6 Diagnostic accuracy of transvaginal ultrasound and laparoscopy in the detection of borderline tumors, benign tumors and endometriomas

	Borderline tumors[a]		Benign tumors		Endometriomas	
	TVS (%)	Lap (%)	TVS (%)	Lap (%)	TVS (%)	Lap (%)
Sensitivity	50	100	92	98	78	100[b]
Specificity	92	98	50	100	88	100[b]
PPV	11	50	99	100	78	100
NPV	99	100	11	50	88	100

TVS transvaginal ultrasound scan, *Lap* laparoscopy, *PPV* positive predictive value, *NPV* negative predictive value

[a] Sample size too small (two patients), not statistically significant

[b] Statistically significant difference

(sensitivity 78%, specificity 88%), paraovarian cysts (sensitivity 75%, specificity 100%), and mucinous cystadenomas (sensitivity 75%, specificity 95%), and good in the detection of serous cystadenomas (sensitivity 63%, specificity 97%) (Table 5).

Regarding accuracy in the diagnosis of borderline tumors, laparoscopy had sensitivity of 100% and specificity of 98%. Ultrasound examination had lower sensitivity (50%) and specificity (92%) in the detection of ovarian borderline tumors.

Although laparoscopy showed an overall higher performance compared to transvaginal ultrasound, statistically significant difference was found only in the detection of endometriomas compared to ultrasound ($P = 0.004$ for sensitivity and $P = 0.046$ for specificity) (Table 6).

Mean hospitalization was 0.98 ± 0.95 days (0–3 days). Oophorectomy was performed in eight cases: a case with a borderline tumor, two cases with mucinous cystadenomas, two cases with serous cystadenomas, and three cases with simple ovarian cysts. Conversion to laparotomy was

decided in two cases (2/98): in the first case endometriosis stage IV with bilateral endometriomas and extended pelvic adhesions (frozen pelvis) was intraoperatively encountered, and decision for laparotomy was decided upon the high risk of bowel damage that the laparoscopic approach involved; in the second case there were preoperative indications of highly suspicious for malignancy ovarian tumor (TVS showed intracystic vegetations and septa), and during laparoscopy external cystic vegetations were recognized (histology confirmed borderline ovarian tumor). There were four intra- and postoperative complications: a case of subcutaneous emphysema, one case of postoperative shoulder pain, one case of large bowel serosa laceration [the lesion was detected and sutured with 3/0 polyglycolic acid suture (Vicryl, Ethicon) laparoscopically], one case of urinary tract infection.

The age of women with borderline tumors was not statistically different compared to the age of women with any other ovarian lesion. Dermoid cysts presented in women of younger age compared to simple cysts ($P = 0.024$), endometriomas ($P = 0.003$), and mucinous cystadenomas ($P = 0.000$). Mucinous cystadenomas presented in elder women compared to endometriomas ($P = 0.009$).

Seven women presented with bilateral ovarian tumors. Bilateral endometriomas were found in three of them, bilateral simple ovarian cysts in one, and combination of endometrioma with simple cyst, mucinous cystadenoma with simple cyst and borderline tumor with simple cyst in three different subjects.

Discussion

Despite the recent advances in the imaging technology, the current clinical use of transvaginal sonography with or without the aid of color Doppler, combined with the serum markers is not always adequate to distinguish between benign, borderline, and malignant ovarian tumors [12]. The occurrence of borderline (low malignant potential) ovarian masses is 10–20% of all ovarian epithelial tumors and is mainly diagnosed in young women [13]. More importantly, it has been described that in preoperatively selected patients with adnexal cystic masses without sonographic evidence of thick septa, internal wall papillae, or solid components, the rate of laparoscopically discovered adnexal cysts with intracystic papillary projections was 5% of which 14% were borderline tumors [14].

In our series, the diagnostic accuracy of laparoscopy in the identification of ovarian lesions was higher compared to ultrasound examination. In the diagnosis of borderline ovarian tumors laparoscopy had excellent sensitivity and specificity (100 and 98% respectively), with positive predictive value 50% and negative predictive value 100%. Laparoscopy set the diagnosis correctly in all the cases of endometriomas, dermoid cysts, and paraovarian cysts in our series. Laparoscopy was less accurate in the description of the nature of serous and mucinous cystadenomas, although the lower sensitivity laparoscopy exhibits in these cases is mostly unimportant, because it does not alter the conservative surgical approach that consists of ovarian cystectomy in such cases.

Generally, our results suggest that sensitivity and specificity of the laparoscopic diagnosis of benign and borderline ovarian lesions are rather superior compared to the ultrasound approach (Table 6). Laparoscopic diagnosis of endometriomas was statistically more accurate compared to the sonographic examination of these lesions ($P = 0.004$ for the sensitivity and $P = 0.046$ for the specificity in the comparison of these methods). Due to the small sample size (one case of cystic adenoma, two cases of corpus luteum cysts, four cases of paraovarian cysts, and four cases of serous cystadenomas), there is no statistical difference in the diagnostic performance of laparoscopy compared to ultrasound in certain types of benign ovarian lesions. There is also no statistical difference in laparoscopic compared to the sonographic evaluation in simple ovarian cysts (both methods appear to have 94% sensitivity in the diagnosis of simple cysts).

As our results suggest, the feasibility of laparoscopic diagnosis is apparent in the management of benign ovarian tumors. This is in agreement with modern literature, as even laparoscopic management of borderline ovarian tumors is feasible and safe when oncological surgical principles are respected [15, 16]. In a series of 819 women treated laparoscopically for ovarian tumors, laparoscopy had 100% sensitivity in the detection of malignant lesions compared to histology, with negative and positive predictive values 41.3 and 100% respectively [3]. Guidelines for surgical management of these lesions are similar to those of ovarian malignancy and include laparotomy with peritoneal washing, hysterectomy and bilateral salpingoophorectomy, and multiple peritoneal biopsies [17]. The laparoscopic staging in women treated for borderline ovarian tumors is comparable to the laparotomic one [18]. Independently of the high suspicion an adnexal mass may appear in the sonographic investigation, an attempt for laparoscopic diagnosis is valuable for a number of reasons: (a) in cases of non-neoplastic but post-inflammatory lesions, laparotomy is avoided with certain benefits for the patient, (b) in cases of diagnosis of ovarian cancer, initial minimally invasive approach allows midline laparotomy for as per protocol management of the lesions, and (c) in cases of ovarian cancer laparoscopic magnification provides the chance to detect microscopic metastatic lesion in the peritoneum, especially in upper abdomen and

subdiaphragmatically [19]. On the other hand, drawbacks of laparoscopic management of adnexal masses include: (a) the possible non-detection of a malignant lesion or the possibility of not converting to laparotomy, especially in cases where operation takes place in day-surgery units, or by inexperienced surgeons, (b) the rupture of the ovarian cyst and the intraperitoneal spillage of the contents (possibly malignant) of the tumor, and (c) the port-site metastasis and the intraperitoneal transfer of the malignant cells [16, 19].

In our series, TVS's diagnostic performance in the investigation of borderline ovarian tumors was quite satisfactory (sensitivity 50%, specificity 92%, positive predictive value 11%, and negative predictive value 99%). Compared to laparoscopic diagnosis, however, the performance of TVS is slightly poorer, but not statistically significant different, probably due to the small sample size ($n = 2$). As mentioned above, endometriomas were less accurately detected with ultrasound. In the sonographic investigation of the rest of the benign ovarian lesions studied (simple cysts, cystadenomas, dermoid cysts, paraovarian cysts), no statistical difference was found compared to laparoscopy.

The use of color Doppler in the investigation of ovarian tumors has been extensively studied, and specific predictive for malignancy values for pulsatility index (PI < 1.0) and resistance index (RI < 0.4) have been proposed [20]. Nevertheless, PI and RI cut off values for benign, borderline, and malignant ovarian tumors described by various researchers are in the same range [21]. This lack of sensitivity makes color Doppler a technique of limited value in the investigation of ovarian lesions [22]. Main reason of the poor distinctive ability of color Doppler is that in cases of ovarian malignancies there is non specific neovascularization. In accordance to this, in a prospective study where clinical examination, TVS, serum markers, and color Doppler, were evaluated in the preoperative investigation of ovarian tumors, the size of the lesion and the TVS morphologic features were the best predictive markers for malignancy in the premenopausal women, and the morphology and CA-125 for the postmenopausal women [22]. The role of other advanced imaging modalities like magnetic resonance imaging (MRI), computed tomography (CT), and positron emission tomography (PET) in the diagnosis of borderline or malignant ovarian tumors is still under debate. Contrast enhanced MRI appears to have 85–95% sensitivity and 87–96% specificity in the diagnosis of ovarian malignancies [23]. Nevertheless, according to Stratton et al., MRI has lower diagnostic accuracy compared to laparoscopy in the detection of endometriomas [24]. CT and PET do not appear to offer more information compared to the ultrasound scan [25].

Conclusion

In conclusion, this study demonstrates the feasibility of laparoscopic diagnosis in the investigation of benign and borderline ovarian tumors and the higher diagnostic accuracy, especially in endometriomas, of laparoscopy, compared to transvaginal scan, especially in endometriomas. Laparoscopic diagnosis appears to be safe and accurate. Conservative laparoscopic management of benign adnexal masses is safe and with low morbidity.

Conflict of interest statement None.

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