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Original Article

The Role of Three-dimensional Power Doppler for Detecting Ovarian Cancer in Adnexal Masses: A Systematic Review and Meta-analysis

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Abstract

Background and objectives: Three-dimensional power Doppler (3DPD) ultrasound has been used for assessing adnexal masses, and in this study, we aimed to perform a meta-analysis to evaluate its role in the differential diagnosis of adnexal masses.

Methods: A search for primary studies assessing the diagnostic performance of 3DPD in discriminating benign from malignant masses carried out between January 1990 and May 2023 was performed in Medline (PubMed), Scopus, and Web of Science databases with study quality evaluated using QUADAS-2.

Results: We identified 404 citations. Ultimately, 18 studies comprising 2,975 women were included, and the mean prevalence of malignant lesions was 37%. In most cases, the quality of studies was moderate. Overall, pooled sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio of 3DPD vascular tree assessment for studies including any type of mass were 77% (95% confidence interval [CI] = 52%–91%), 80% (95% CI = 37%–97%), 3.9 (95% CI = 0.7–20.9), and 0.29 (95% CI = 0.10–0.81), respectively. Heterogeneity was high for both sensitivity and specificity. Pooled sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio of 3DPD vascular tree assessment for studies including only "complex" or "suspicious" adnexal masses were 90% (95% CI = 82%–94%), 88% (95% CI = 74%–95%), 7.3 (95% CI = 3.2–16.4), and 0.12 (95% CI = 0.06–0.22), respectively. Heterogeneity was moderate for both sensitivity and specificity. We could not perform quantitative synthesis for studies estimating 3D vascular indexes.

Conclusions: The diagnostic performance of 3DPD for discriminating benign from malignant adnexal masses is good, and there is great heterogeneity in diagnostic criteria when using this technique.

Introduction

Adnexal masses are among the most frequent diagnoses in gynecological practice with almost 20% of women developing a pelvic mass in their lifetime.[1] When approaching an adnexal mass, the most feared diagnosis is ovarian cancer as it is one of the most lethal gynecologic malignancies primarily due to its late diagnosis, which can be attributed to the absence of an effective screening strategy and the lack of a symptomatic early phase. According to GLOBOCAN, in the year 2020, approximately 314,000 women were diagnosed with ovarian cancer, resulting in 207,000 deaths attributed to this disease.[2] Furthermore, ovarian cancer is the eighth most prevalent cancer in terms of both incidence and mortality among women globally.[2]

Nonetheless, the majority of adnexal masses are benign conditions and that is why proper differentiation between malignant and benign lesions is crucial for adequate treatment. The preoperative diagnosis of adnexal masses is a matter of great relevance as it determines the management of the patients according to the risk

Keywords: Ovarian neoplasms; Ultrasonography; Three-dimensional; Doppler; Transvaginal; Ovarian cancer.

Abbreviations: AUC, area under the curve; BOT, borderline tumor; CI, confidence interval; LR, likelihood ratio; QUADAS-2, Quality Assessment of Diagnostic Accuracy Studies-2; SROC, summary receiver-operating characteristics; VI, vascularization index; 3DPD, three-dimensional power Doppler.

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of malignancy in terms of selecting the optimal surgeon (gynecologist-oncologist or general gynecologist) or surgical route (minimally invasive surgery or open surgery).[3]

Various strategies have been designed to provide clinicians with an accurate tool to determine whether the tumor is benign or ovarian cancer. It has been widely demonstrated that subjective assessment by an expert ultrasound examiner is considered the gold standard approach.[4] However, when less experienced sonographers evaluate ovarian tumors, the use of IOTA simple rules or the ADNEX model yields comparable diagnostic performance.[5]

Despite significant advancements made in the field of ultrasound diagnosis for the majority of adnexal masses, this diagnostic tool still exhibits a considerable rate of false positive results, potentially resulting in a significant number of unnecessary procedures and heightened patient anxiety.[6]

Among these advancements, three-dimensional power-Doppler ultrasound was introduced into clinical practice in the late 90's.[7] Consequently, several research groups have assessed the potential role of tridimensional power Doppler ultrasound evaluation (3DPD) alongside the standard gray-scale morphologic ultrasonographic assessment of adnexal masses.

According to the literature, when using 3DPD, two different primary approaches for assessing an adnexal tumor have been proposed. One approach is based on the morphological characteristics of the tumor vascular tree and the second one evaluates the so-called three-dimensional vascular indexes, namely the vascularization index, flow index, and vascularization-flow index within the tumor.[8]

To the best of our knowledge, there is no meta-analysis analyzing the role of 3DPD in the differential diagnosis of adnexal masses. Such a meta-analysis would be valuable with potential scientific impact since it would analyze the current evidence about the role of this technique in assessing adnexal masses. In this study, we aimed to perform a systematic review and meta-analysis of 3DPD in the differential diagnosis of adnexal masses.

Methods

Search strategy

This systematic review was performed according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) recommendations (http://www.prisma-statement.org/). We did not register the protocol. Given the nature and design of this study, ethics committee approval was not required, and the study had no funding.

Three authors (AV, AC, ES) used three electronic databases (Web of Science, SCOPUS, and MEDLINE) [PubMed]) to identify potentially eligible articles that were published between January 1990 and May 2023. The search terms included the following keywords: "Ultrasound", "Ovarian", "Tumor" and "Three-dimensional", and the search was limited to English language papers. One author (AV) combined the searches from the above-mentioned databases.

Duplicated articles and non-English articles were excluded. Subsequently, citations were screened first by the titles, then by the abstracts for identifying irrelevant articles to exclude (studies not related to the topic or not primary studies). Full-text articles of the remaining citations were read for the identification of potentially eligible papers. In studies from the same research group, we assessed the dates for recruitment, and in the case of overlap, we only considered the meta-analysis as the most recent study, unless they used different 3DPD approaches in different papers.

Two reviewers (JLA and AV) used the following criteria for selecting the articles: Prospective and retrospective cohort primary studies that include a set of patients who underwent 2D ultrasound evaluation and 3DPD in order to assess adnexal masses for discriminating between benign and malignant lesions and surgical evaluation of ovarian tumor for histopathological diagnosis as the reference standard. We excluded those articles that were not specifically related to the issue under review and studies that did not report data about morphological criteria or vascular indexes used for the adnexal mass evaluation. Any other studies not containing the necessary data to build a contingency table were also excluded. Three of the authors (AV, AC, and ES) gathered and were blinded from each other regarding data concerning the true positives, true negatives, false positives, and false negatives of each study. Any disagreement during this process was resolved by reaching a consensus among the three authors (AC, JLA, and ES).

Qualitative synthesis

The Quality Assessment of Diagnostic Accuracy Studies-2 (QUADAS-2) was used to evaluate the risk of bias as well as concerns about the applicability of all studies included in this meta-analysis.[9] This tool comprises four areas, namely "patient selection," "index test," "reference standard," and "flow and timing." Risk of bias and concerns about applicability were analyzed and rated as low, high, or unclear for each domain except that of flow and timing. The results of the quality assessment had a descriptive purpose in order to assess the global quality of the articles analyzed and to identify any potential factors of heterogeneity. The methodological quality was assessed independently by three authors (JLA, AC, and ES) using a standard form with quality assessment criteria and a flow chart. Disagreements were resolved by reaching a consensus among all three reviewers (JLA, AC, and ES).

The evaluation of the study's quality was based on information such as study design, description of exclusion and inclusion criteria, and description of the index test and the reference standard test. For the index test, data regarding 3DPD evaluation methods was retrieved. Information on the diagnostic performance (true positives, true negatives, false positives, and false negatives) of 3DPD was also retrieved. This information was extracted separately for studies using 3DPD morphologic assessment of the tumor vascular tree and for studies using 3D vascular indexes.

Histopathological diagnosis was defined as the correct reference standard. To assess the flow-and-timing domain, we evaluated the description of the time elapsed between ultrasound examination and surgery (low risk of bias was considered when the reference standard was obtained less than 90 days after ultrasound evaluation).

Quantitative synthesis

We attempted to perform a quantitative synthesis including studies considered to be of moderate or high quality and that used comparable criteria in defining an adnexal mass as benign or malignant.

For that purpose, pooled specificity, sensitivity, and positive and negative likelihood ratio (LR) were determined using a random-effects model. As the estimation of 3D vascular indexes allows one to estimate the sensitivity and specificity of the method using three different indexes (namely vascularization index, flow index, and vascularization-flow index), we decided to use the vascularization index with the cut-off reported in each study.

Forest plots of sensitivity and specificity of all studies were calculated while heterogeneity for sensitivity and specificity was

assessed using Cochran's Q statistic and the I^2 index.[10] Summary receiver-operating characteristics (SROC) curves were plotted to illustrate the relationship between sensitivity and specificity. Publication bias was assessed according to Deek's method.[11] All analyses were performed using the MIDAS command in STATA (Stata Corporation, College Station, TX, United States) version 12.0 for Windows. Statistical significance was defined as a *P*-value of <0.05.

Results

Search results

The electronic search provided 404 citations, but after the exclusion of one hundred and forty-five duplicate records, 259 citations remained. Of these, one hundred and ninety-nine were excluded because it was clear from the title and/or abstract that they were not relevant to the review (papers not assessing diagnostic performance of 3DPD or not related to the topic).

Subsequently, the full texts of the 60 remaining articles were read. Finally, forty-three studies were excluded because they either did not assess diagnostic performance, were not related to the topic, were studied from the same group with overlapping recruiting dates, or a 2×2 table was not possible to obtain. The remaining 17 studies were ultimately included in the qualitative synthesis.[12–28]

A flowchart summarizing the literature search is shown in Figure 1.

Characteristics of the included studies

Seventeen studies reported from 2001 to 2021 were ultimately included, comprising 2,925 women with adnexal masses.[12–28] Overall, 1,086 (37.0%) women had a malignant lesion. Table 1 provides a summary of the characteristics of the studies included in the present meta-analysis.[12–28]

Study design was prospective in nine studies and retrospective in two studies.[13–15,17,19,22–26,28] In six studies, study design was not reported.[12,16,20–22,28] The series was consecutive in most studies.[15–18,21–26,28]

Six studies included any type of adnexal mass and 11 studies used 3DPD only in "complex" or "suspicious" masses on 2D gray-scale ultrasound.[12–17,19–21,23,25,27,29]

In 10 studies all 3DPD examinations were performed by the same single examiner,[12,14,16,18–21,24–26] whereas in 6 studies more than one examiner participated in the 3DPD evaluation.[13,15,17,22,23,28] In one study the number of examiners participating in the study was not reported.[27]

Nine studies used the assessment of the vascular tree as a criterion for discriminating between benign and malignant adnexal masses,[12–14,16,18–21,28] six studies used the estimation of the 3D vascular indexes,[17,22,23,25–27] and two studies assessed both approaches.[15,24]

Of those studies that used the assessment of the vascular tree as a diagnostic criterion, all reported the criteria used for considering the mass as suspicious, but the criteria were not the same for all studies (Table 1).

In the studies using the calculation of 3D vascular indexes, the methodologies employed were quite variable with one study including the whole tumor[15]; one including the whole tumor and an automated 5cc sphere of the most vascularized area of the tumor[17]; one including a manual estimation of the most vascularized area of the tumor[22]; one including two automated spheres, 1cc and 5cc, of the most vascularized area of the tumor[23]; one including an automated 5cc sphere of the most vascularized area of the tumor[24]; one including an automated 1cc sphere of the most vascularized area of the tumor[26]; another including an automated 4cc sphere of the most vascularized area of the tumor[25]; and, finally, one study did not report how estimation was performed.[27]

All studies used the histological diagnosis after surgical tumor removal as the reference standard.[12–28] Nine studies reported on the time elapsed from ultrasound evaluation to surgery.[12,15–17,19,24–26,28]

Methodological quality of included studies

QUADAS-2 assessment of the risk of bias and concerns regarding the applicability of the selected studies is shown graphically in Figure 2.

Regarding the risk of bias in the domain "patient selection", one study was not clear regarding patient inclusion criteria and eleven studies were considered as high risk because they included only selected masses for 3DPD assessment.[12–14,18–20,22–24,26–28]

Concerning the domain "index test", sixteen studies adequately described the method as well as how it was performed and interpreted.[12–26,28] One study did not describe how the 3DPD assessment was performed and was thus rated as unclear.[27]

For the domain "reference standard", all studies were considered as low risk, since it was considered they correctly identified the target condition by the reference standard.[12–28]

Regarding the domain "flow and timing", we considered nine studies low risk and the other eight unclear.[12–28] Overall, the quality of the studies was considered good.

Concerning applicability, all studies were considered low risk for all three domains "patient selection", "index test", and "reference test".

Diagnostic performance of 3DPD for discriminating between benign and malignant adnexal masses

Observing great heterogeneity in the methodologies used in the studies assessing tumor vascularization through the estimation of 3D vascular indexes, we decided not to perform a quantitative synthesis for this approach, since the results could not be compared.

Regarding the studies using the assessment of the features of the tumoral vascular tree, we observed that some studies included any type of mass while others included only "complex" or "suspicious" masses according to 2D gray-scale features. Therefore, we decided to analyze these studies separately.

Pooled sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio of 3DPD vascular tree assessment for the four studies including any type of mass, comprising 936 women, were 77% (95% confidence interval [CI] = 52%–91%), 80% (95% CI = 37%–97%), 3.9 (95% CI = 0.7–20.9), and 0.29 (95% CI = 0.10–0.81), respectively. The diagnostic odds ratio was 14.0 (95% CI = 1.0–168.0). Significant heterogeneity for sensitivity (I^2 = 95.7%, $P < 0.001$) and for specificity (I^2 = 99.1%, $P < 0.001$) was found. Forest plots for sensitivity and specificity are shown in Figure 3. Meta-regression showed that none of the co-variables assessed as year of publication, sample size, and malignancy prevalence explained the heterogeneity observed. The area under the SROC curve for diagnostic performance of 3DPD in this group of lesions was 0.84 (95% CI = 0.81–0.87) (Fig. 4). Fagan's nomogram shows that a 3DPD suspicious for malignancy in this group of lesions increases the pre-test probability from 30% to 63%; while a non-suspicious 3DPD decreases the pre-test probability from 30% to 11% (Fig. 5). We did not observe publication bias ($P = 0.63$).

Pooled sensitivity, specificity, positive likelihood ratio, and

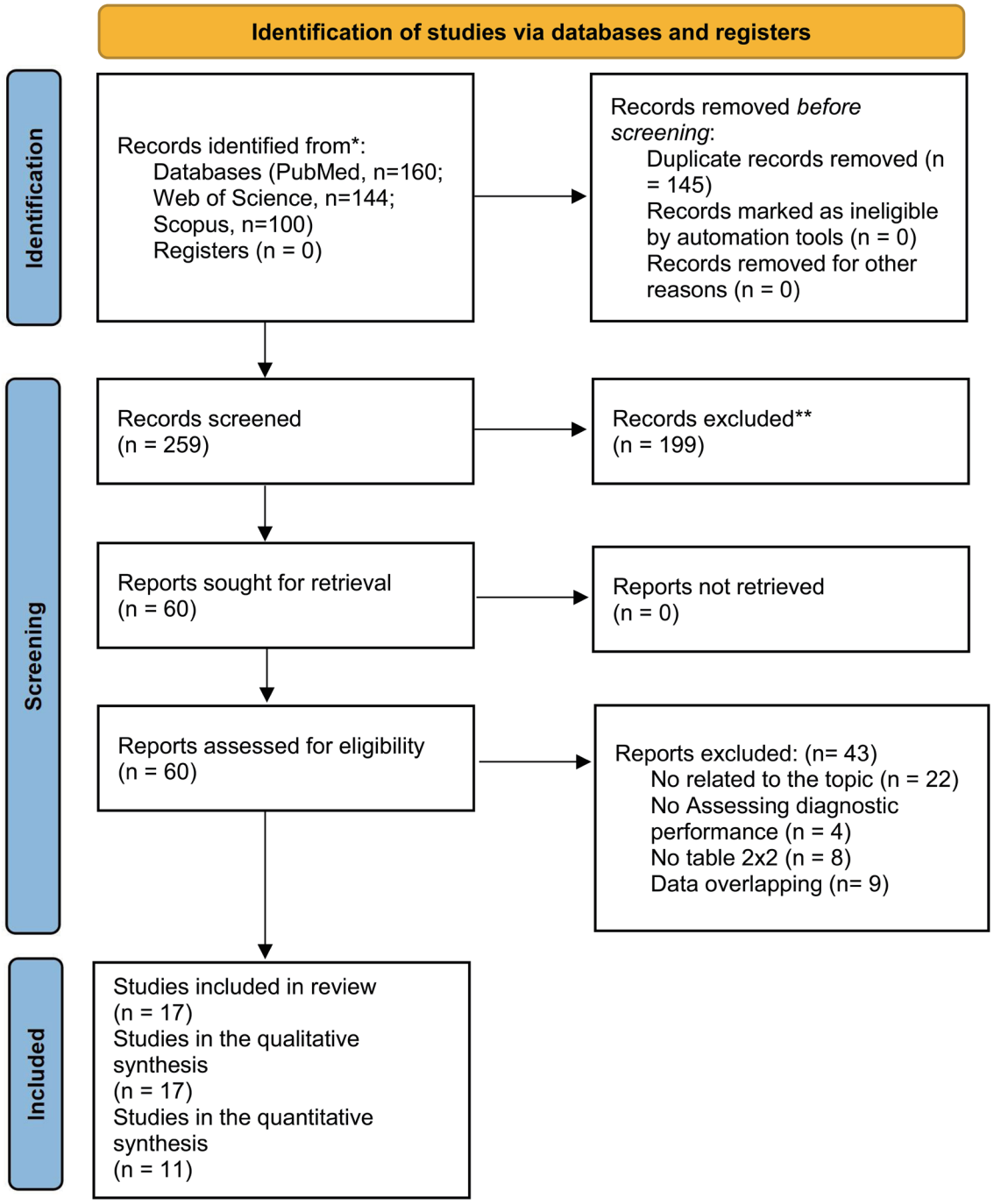

Fig. 1. Flow chart showing studies selection process. Seventeen studies were included in the qualitative synthesis and eleven of them in the quantitative synthesis.

negative likelihood ratio of 3DPD vascular tree assessment for the seven studies including only "complex" or "suspicious" adnexal masses and comprising 493 women, were 90% (95% CI = 82%–94%), 88% (95% CI = 74%–95%), 7.3 (95% CI = 3.2–16.4), and 0.12 (95% CI = 0.06–0.22), respectively. The diagnostic odds ratio was 62.0 (95% CI = 17.0–217.0). Moderate heterogeneity for sensitivity (I^2 = 54.9%, P = 0.04) and for specificity (I^2 = 75.3%, P < 0.01) was found. Forest plots for sensitivity and specificity are shown in Figure 6. The area under the SROC curve for diagnostic performance of 3DPD in this group of lesions was 0.94 (95% CI = 0.92–0.96) (Fig. 7). Fagan's nomogram shows that a 3DPD suspicious for malignancy in this group of lesions increases the pre-test probability from 45% (mean prevalence of malignancy in these studies was 45%) to 86% while a non-suspicious 3DPD decreases the pre-test probability from 45% to 9% (Fig. 8). We did not observe publication bias (P = 0.57).

Table 1. Main characteristics of the studies included in the present meta-analysis

Author	Year	Population	N patients	Patients' age (years)	Postmenopausal patients	N malignant masses (N BOT)	Study's design	Consecutive series	Number of examiners
Kurjak[12]	2001	Any mass	292	54 (37–71)*	34.9%	30 (0)	N.A.	N.A.	One
Cohen[13]	2001	Complex masses	71	22–80**	43.7%	14 (N.A.)	Prospective	N.A.	Three
Alcazar[14]	2005	Complex masses	60	48 (17–82)†	46.7%	45 (4)	Retrospective	N.A.	One
Geomini[15]	2006	Any mass	181	15–89**	42.5%	26 (11)	Prospective	Yes	Three
Sladkevicius[16]	2007	Any mass	104	N.A.	32.1%	21 (6)	N.A	Yes	One
Jokubkiene[17]	2007	Any mass	106	N.A.	41.5%	21 (6)	Prospective	Yes	Multiple
Alcazar[18]	2008	Complex masses	39	48 (22–75)†	43.6%	20 (0)	Retrospective	Yes	One
Dai[19]	2008	Complex masses	36	53 (19–91)†	66.7%	30 (5)	N.A.	N.A.	One
Chase[20]	2009	Complex masses	66	47 (18–77)*	N.A.	10 (2)	N.A.	N.A.	One
Mansour[21]	2009	Any mass	400	11–83**	N.A.	248 (0)	N.A.	Yes	One
Alcazar[22]	2009	Complex masses	143	50 (17–82)†	53.8%	113 (9)	Prospective	Yes	Two
Kudla[23]	2010	Complex masses	138	51 (18–88)†	54.3%	117 (7)	Prospective	Yes	Two
Perez-Medina[24]	2013	Complex masses	72	53 (22–86)†	59.7%	33 (8)	Prospective	Yes	One
Silvestre[25]	2015	Any mass	75	18–82**	N.A.	32 (5)	Prospective	Yes	One
Utrilla-Layna[26]	2015	Complex masses	367	46 (18–80)†	35.4%	86 (4)	Prospective	Yes	One
Smolen[27]	2016	Any mass	637	N.A.	N.A.	202 (N.A.)	N.A.	N.A.	N.A.
Sladkevicius[28]	2021	Complex masses	138	54	52.9%	38 815)	Prospective	Yes	Multiple

Author	3DPD approach	3DPD criteria for suspicion	Reference standard
Kurjak[12]	Vascular tree	Vessel architecture disorganized and complex branching pattern	Histology
Cohen[13]	Vascular tree	Presence of vessels in solid areas and/or septations	Histology
Alcazar[14]	Vascular tree	Presence of vessels in solid areas and/or septations	Histology
Geomini[15]	Vascular tree	Presence of vessels in solid areas and/or septations	Histology
	3D VI whole tumor	N.A.	
Sladkevicius[16]	Vascular tree	Vessels with abnormal branching, caliber changes, splashes and bridges.	Histology
Jokubkiene[17]	3D VI Sphere 5 cc most vascularized area	VI ≥ 10.6%	Histology
	3D VI whole tumor	VI ≥ 2.26%	
Alcazar[18]	Vascular tree	Vessels with irregular branching (>3 branches and close to 90° angulation branching), vessel caliber narrowing, microaneurysms, and vascular lakes	Histology
Dai[19]	Vascular tree	Penetrating randomly dispersed vessels with 'basket-like' irregular branching	Histology

(continued)

Table 1. *(continued)*

Author	3DPD approach	3DPD criteria for suspicion	Reference standard
Chase[20]	Vascular tree	Chaotic flow pattern. Vessel sacculation.	Histology
Mansour[21]	Vascular tree	Chaotic pattern with complex distribution and branching.	Histology
Alcazar[22]	3D VI most vascularized solid area	VI ≥ 1.556%	Histology
Kudla[23]	3D VI Sphere 1 cc most vascularized area	VI ≥ 24.015%	Histology
	3D VI Sphere 5 cc most vascularized area	VI ≥ 10.490	
Perez-Medina[24]	Vascular tree	Vessel architecture disorganized and complex branching pattern	Histology
	3D VI Sphere 5 cc most vascularized area	N.A.	
Silvestre[25]	3D VI Sphere 4 cc most vascularized area	VI ≥ 3.4%	Histology
Utrilla-Layna[26]	3D VI Sphere 1 cc most vascularized area	VI ≥ 24.015%	Histology
Smolen[27]	3D VI not otherwise specified	N.A.	Histology
Sladkevicius[28]	Vascular tree	Vessels with abnormal branching, caliber changes, splashes and bridges.	Histology

*Median with range in parentheses. †Mean with range in parentheses. **range. N.A.: data not available. BOT, borderline tumor; VI, vascularization index; 3DPD, three-dimensional power Doppler.

Discussion

Summary of evidence

In this meta-analysis, we observed that 3DPD using the assessment of the tumor vascular tree had a good diagnostic performance for discriminating benign and malignant adnexal masses. The diagnostic performance was better when this technique was used in "complex" or "suspicious" adnexal masses. We also observed great heterogeneity in the methodological approaches of studies using the estimation of 3D vascular indexes as diagnostic criteria. In addition, we observed that the quality of the studies was moderate and there was room for improvement in study design and reporting.

Strengths and limitations

Strengths: This study is the first meta-analysis to address the issue, which is a significant strength.

Limitations: The study could not perform a quantitative synthe-

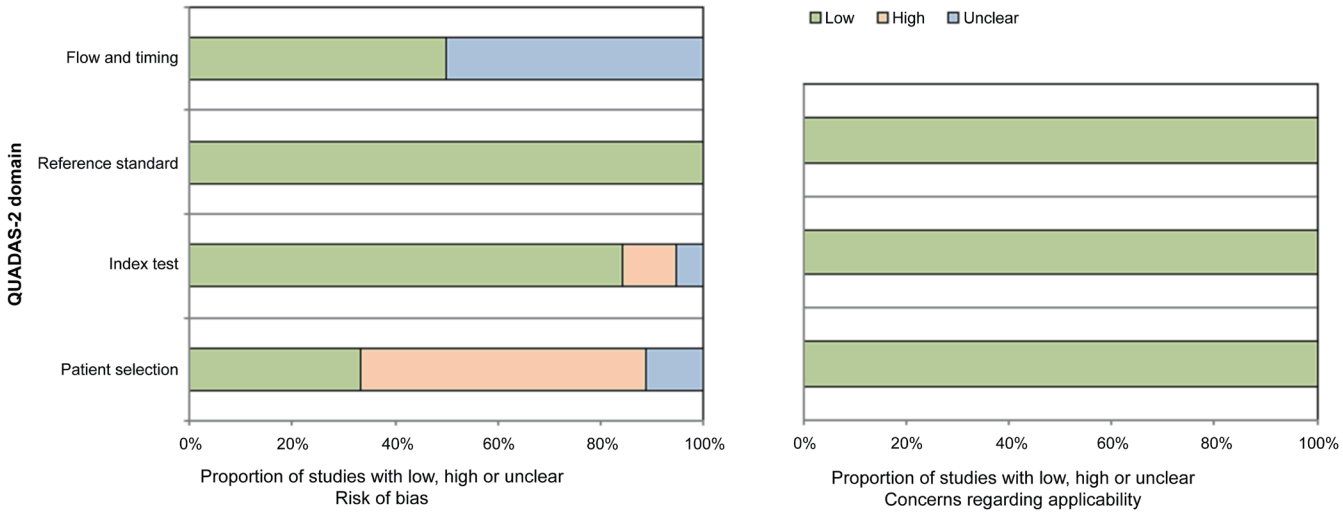

Fig. 2. Histogram plot showing quality assessment (risk of bias and concerns about applicability) for all studies included in the meta-analysis. It can be observed that a significant proportion of studies had a high risk of bias for patient selection. QUADAS-2, Quality Assessment of Diagnostic Accuracy Studies-2.

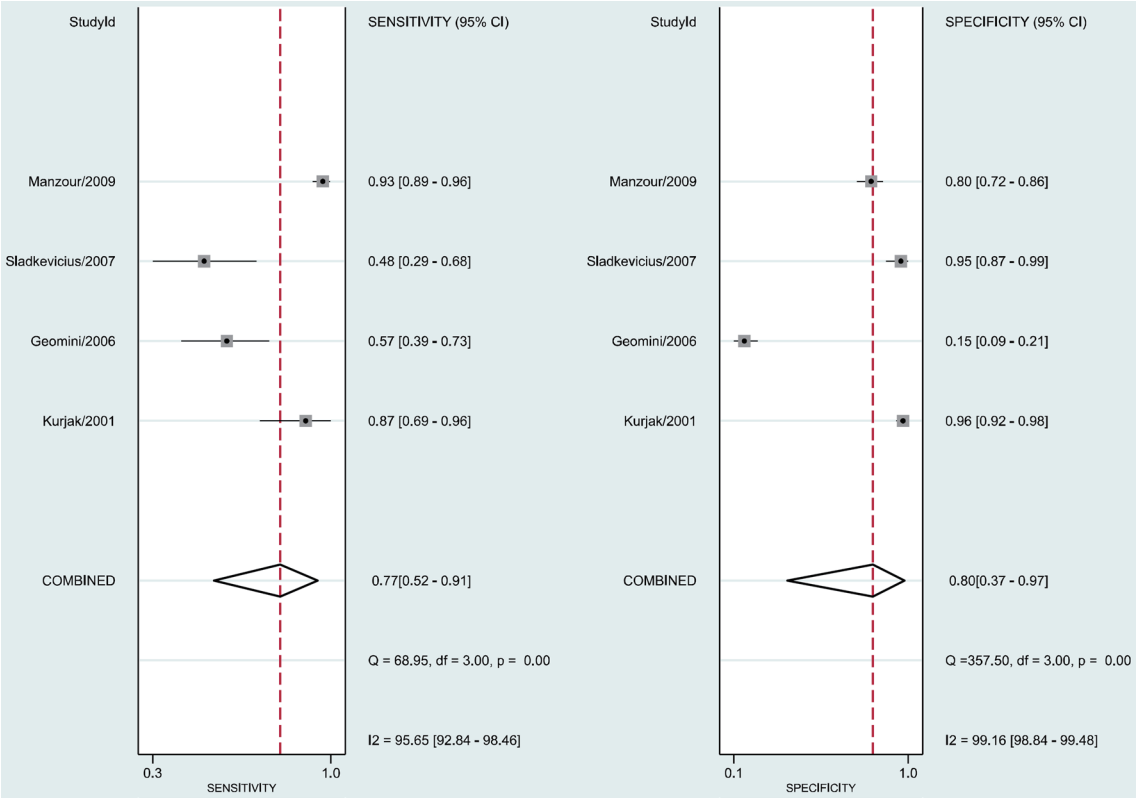

Fig. 3. Forest plot for sensitivity and specificity for 3DPD assessment of tumor vascular tree in studies including any type of mass. CI, confidence interval; 3DPD, three-dimensional power Doppler.

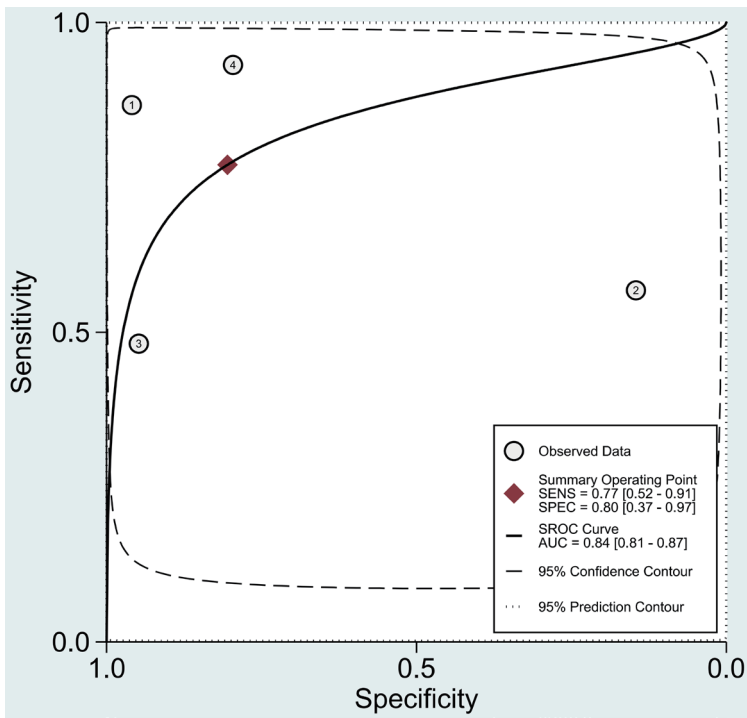

Fig. 4. SROC curve for 3DPD assessment of tumor vascular tree in studies including any type of mass. SENS, sensitivity; SPEC, specificity; SROC, summary receiver-operating characteristics; AUC, area under the curve; 3DPD, three-dimensional power Doppler.

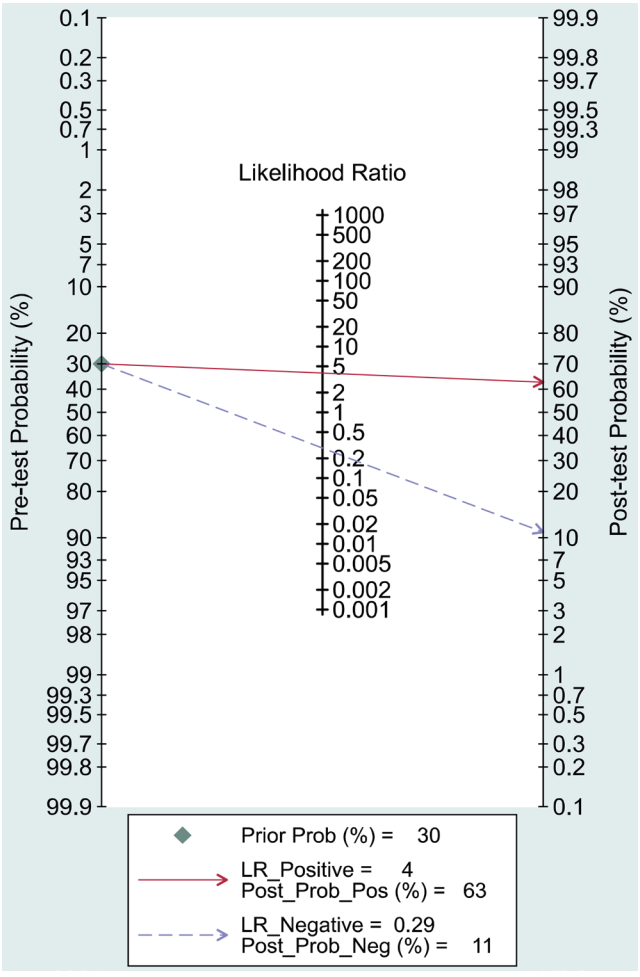

Fig. 5. Fagan nomogram for 3DPD assessment of tumor vascular tree in studies including any type of mass. LR, likelihood Ratio; 3DPD, three-dimensional power Doppler.

sis for studies using the estimation of the 3D vascular indexes due to methodological differences among the studies. The quantitative synthesis for studies using the assessment of the tumor vascular tree was based on a limited number of studies and a small sample size, requiring caution in interpreting the results. The study did not compare 3DPD with 2D Color Doppler, which might affect the generalizability of the results. As high heterogeneity was observed among the studies, the results should be considered with caution.

Interpretation of the results in the clinical context

Adnexal masses are a common clinical problem in gynecological practice, and correct differential diagnosis is essential for adequate management. Currently, there is evidence that 2D gray-scale and color Doppler assessment of the adnexal masses, either by subjective examiner impression or using different classification systems, such as the IOTA Simple Rules, or predictive logistic models, such as the IOTA ADNEX model, are the best approach for discriminating between benign and malignant lesions.[3,29]

A meta-analysis showed that pooled sensitivity and specificity for the examiner's subjective assessment was 90–94% and 85–94%, respectively.[4] At least, three meta-analyses showed that pooled sensitivity and specificity for IOTA Simple Rules was 93–95% and 77–82%, respectively.[4,30,31] Moreover, a recent meta-analysis observed that pooled sensitivity and specificity for the IOTA ADNEX model were 94% and 78%, respectively.[32]

In this context, the question is whether 3DPD adds diagnostic capacity to the ultrasound assessment of adnexal masses. According to our results, it seems that 3DPD does not add diagnostic information to current 2D ultrasound-based approaches for the differential diagnosis of adnexal masses, even in the selected populations. In addition, 3D ultrasound is not as widely available as 2D ultrasound. Furthermore, specific software is needed for assessing 3DPD findings in adnexal masses.

Future research agenda

Despite the limitations observed and the apparent lack of benefit using 3DPD, it is our impression that better-designed prospective studies using vascular tree 3DPD as a diagnostic approach to adnexal masses are needed. These could include artificial intelligence approaches and a focus on indeterminate adnexal masses, particularly those with solid components, that are the most difficult to assess even for expert examiners or even where logistic models do not help.[6,33]

On the other hand, prospective studies are needed to determine the ideal approach and which 3D vascular indices cut-offs should be used; clearly, a consensus about methodology and diagnostic criteria is needed.

Conclusion

In conclusion, in this meta-analysis, we have observed that 3DPD using the assessment of the tumor vascular tree featured a good diagnostic performance in discriminating between benign and malignant adnexal masses, and the diagnostic performance is better when this technique is used in "complex" or "suspicious" adnexal masses. Despite this, 3DPD does not add diagnostic information to current 2D ultrasound-based approaches for the differential diagnosis of adnexal masses. However, further major research is needed particularly to determine for which adnexal masses it could be useful and what criteria should be used.

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Conflict of interest

The authors have no conflict of interest related to this publication.

Author contributions

Study concept and design (JLA), acquisition of data (ES, AV, AC), analysis and interpretation of data (JLA, ES, AC), drafting of the manuscript (ES), critical revision of the manuscript for important intellectual content (JLA, AC, AV) administrative, technical, or material support (ES), and study supervision (JLA). All authors have made a significant contribution to this study and have ap-

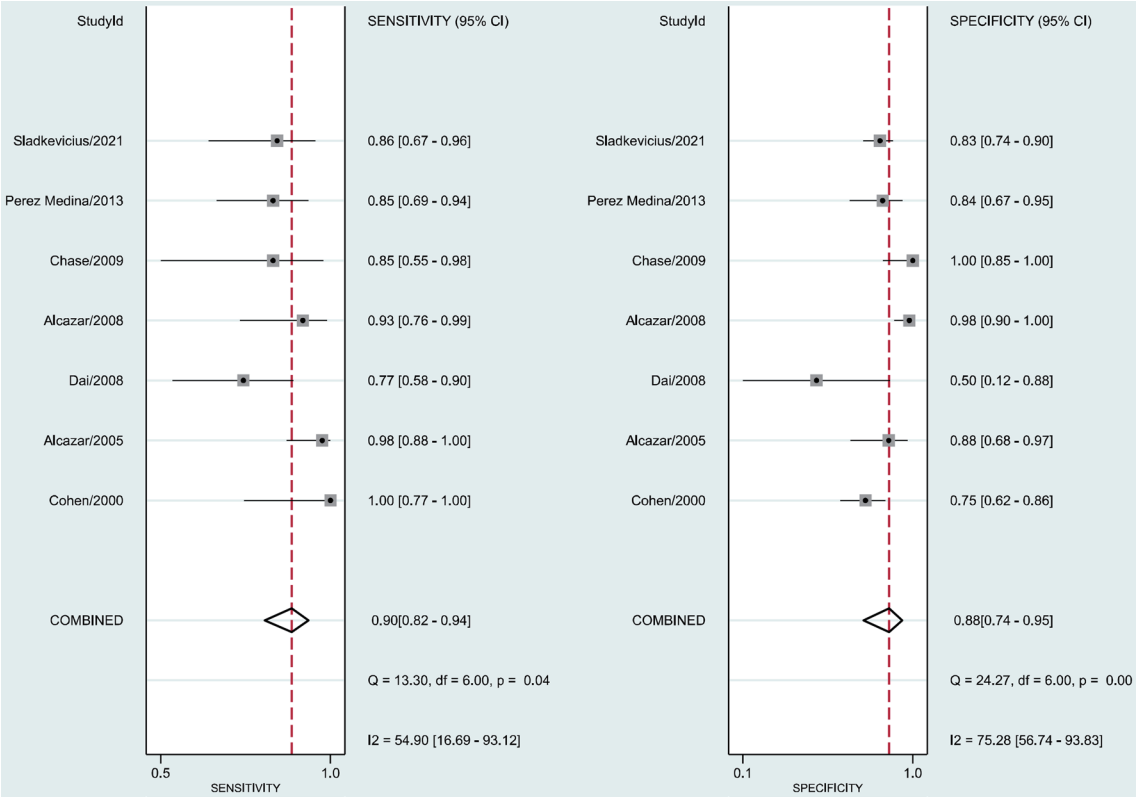

Fig. 6. Forest plot for sensitivity and specificity for 3DPD assessment of tumor vascular tree in studies including only "complex" or "suspicious" adnexal masses. CI, confidence interval; 3DPD, three-dimensional power Doppler.

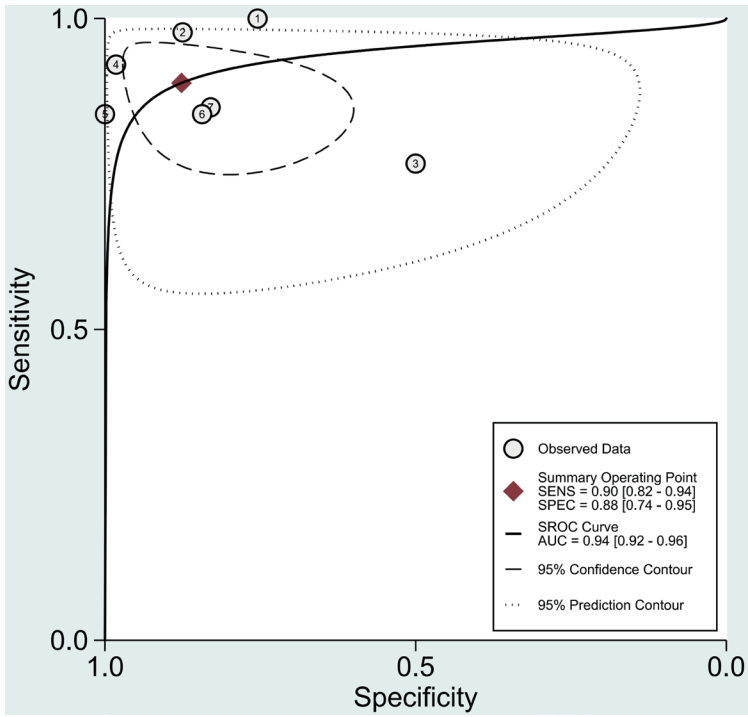

Fig. 7. SROC curve for 3DPD assessment of tumor vascular tree in studies including only "complex" or "suspicious" adnexal masses. SENS, sensitivity; SPEC, specificity; SROC, summary receiver-operating characteristics; AUC, area under the curve; 3DPD, three-dimensional power Doppler.

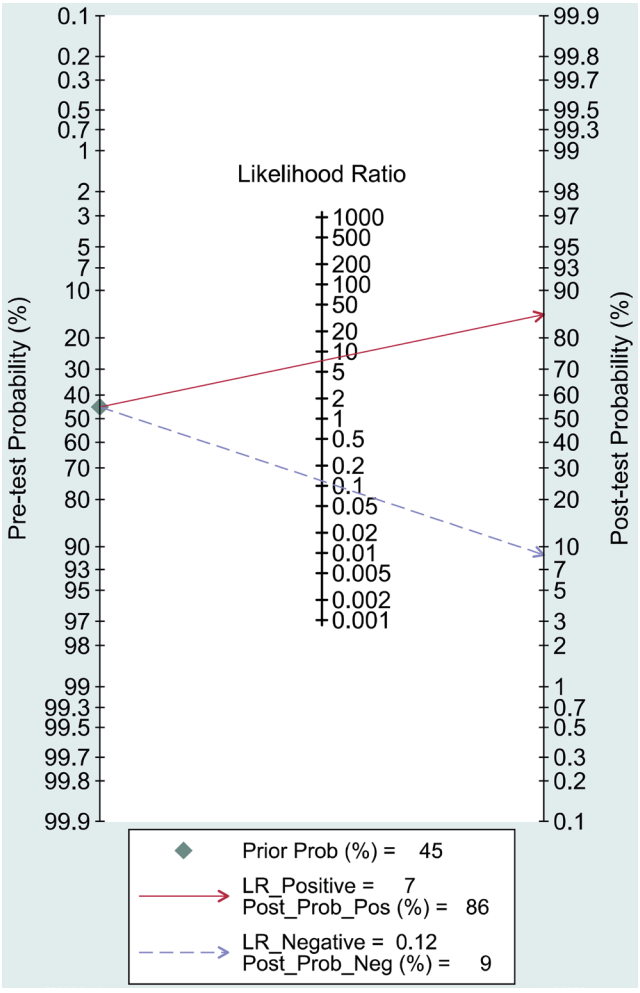

Fig. 8. Fagan nomogram for 3DPD assessment of tumor vascular tree in studies including only "complex" or "suspicious" adnexal masses. LR, likelihood Ratio; 3DPD, three-dimensional power Doppler.

proved the final manuscript. All authors read and approved the final version of the manuscript.

Data sharing statement

Data are available upon reasonable request.

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