The Role of Hysteroscopy in the Assessment of Fallopian Tubal Patency: A Comprehensive Review and Meta-analysis

Die Rolle der Hysteroskopie bei der Bewertung der Eileiterdurchgängigkeit: eine umfassende Übersicht und Metaanalyse

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ABSTRACT

Hysteroscopy has been recognized as a reliable method for the evaluation of female infertility for several years. The outpatient setting is particularly convenient, as patients do not require general anesthesia and do not have to stay overnight. In recent years, more and more articles have dealt with the role of diagnostic hysteroscopy in tubal evaluation. Twenty-four articles were included in this comprehensive review and 14 of them were also included in a meta-analysis. This review provides an overview of the different techniques of hysteroscopic tubal evaluation, with a focus on perioperative changes in cul-de-sac volume, the air bubble technique ("Parryscope" technique), the Flow technique and selective hysteroscopic pertubation with methylene blue dye (SHPMBD). In pooled analyses, SHPMBD achieved the highest sensitivity for tubal patency (91.7%, 95% confidence interval, CI: 88.8–94.0), whereas the air bubble technique revealed the highest specificity of all methods (98.4, 95% CI: 95.3–99.6). Furthermore, in a meta-analysis of all methods on the assessment of single tubes, an overall sensitivity of 87.1% and an overall specificity of 79.8% (95% CI: 76.4–82.9) could be shown. In conclusion, the techniques of hysteroscopic tubal evaluation are well-tolerated, clinically relevant, and reliable.

ZUSAMMENFASSUNG

Die Hysteroskopie gilt seit mehreren Jahren als zuverlässige Methode zur Beurteilung weiblicher Infertilität. Praktischerweise kann der Eingriff ambulant erfolgen, da die Patientinnen keine Allgemeinanästhesie benötigen und nicht über Nacht im Krankenhaus bleiben müssen. In den letzten Jahren sind immer mehr Arbeiten erschienen, die sich mit der Rolle der diagnostischen Hysteroskopie zur Prüfung der Eileiterdurchgängigkeit befassen. Insgesamt hat diese umfassende Übersichtsarbeit 24 Artikel einbezogen, davon wurden 14 auch in die Metaanalyse aufgenommen. Diese Überblicksarbeit gibt eine Übersicht über die verschiedenen Techniken zur hysteroskopischen Überprüfung der Eileiterdurchgängigkeit mit besonderem Schwerpunkt auf die perioperativen Veränderungen der Flüssigkeitsmenge in der Douglas-Tasche, die Luftblasen-Technik (auch „Parryscope-Technik“ genannt), die „Flow-Technik“

und die selektive Chromopertubation. In den aggregierten Analysen zeigte die selektive Chromopertubation mit Methylenblau die höchste Sensitivität für die Eileiterdurchgängigkeit (91,7 %, 95 %-Konfidenzintervall [KI] 88,8–94,0), wohingegen die Luftblasen-Technik die höchste Spezifität aller Methoden aufwies (98,4; 95 %-KI 95,3–99,6). Darüber hinaus fand eine Metaanalyse aller Methoden zur Beurteilung einzelner Eileiter eine allgemeine Sensitivität von 87,1 % und eine allgemeine Spezifität von 79,8 % (95 %-KI 76,4–82,9). Zusammenfassend kann festgestellt werden, dass die Techniken zur hysteroskopischen Überprüfung der Eileiterdurchgängigkeit gut verträglich, klinisch relevant und zuverlässig sind.

Introduction

In women with subfertility, hysteroscopy is considered the gold standard tool for intrauterine evaluation [1, 2]. In recent years, there has also been increasing evidence for the use of hysteroscopy in the evaluation of tubal patency for infertile patients [3, 4]. Generally, hysteroscopy is an intervention with few complications and is easy to perform, even in an outpatient setting [5]. However, it is an invasive procedure and, thus, one should get the maximum possible informative output from it. If tubal patency evaluation via hysteroscopy is reliable, this information should be assessed routinely, at least in women who undergo the procedure for infertility.

Notably, several different methods of hysteroscopic tubal patency assessment have been described and all have been claimed as promising tools [4]. In detail, the following methods have been reported and evaluated: for the pre- to post hysteroscopic fluid shift in the pouch of Douglas (changes in cul-de-sac, CDS, fluid volume), the examiner conducts an ultrasound before and after the hysteroscopy to check for fluid in the pouch of Douglas. If at least one tube is open, a fluid shift will be detectable right there [6, 7, 8, 9]. For assessment of the so-called “flow” effect, the examiner observes the tubal ostia during hysteroscopy, to see whether mucus, endometrial tissue or blood clots are “flowing” towards and passing the ostia, which implies their patency [10, 11]. Another promising way is the “air bubble” or “Parryscope” technique. This involves initiating an infusion of air bubbles into the uterine cavity during hysteroscopy and observing whether these air bubbles traverse the (patent) ostia [8, 12]. Last but not least, the method of selective tubal pertubation has been reported, where a small plastic catheter is inserted through the hysteroscopy’s working channel. The tip of the catheter is placed directly at the tubal ostium and 2 to 10 ml of methylene blue dye are injected. The dye can pass through open ostia and, thus, no blue dye can be seen in the uterine cavity. Injecting the dye into occluded ostia would result in a backflow and a consecutively blue colored cavity [13].

The last review on this topic is now 6 years old and therefore outdated [3]. Vitale et al. published a more recent meta-analysis, in which all methods were lumped together and studies about perioperative changes in CDS fluid volume were excluded [4]. We aim to present the recent data in a comprehensive review and conduct a meta-analysis of the overall accuracy of the different methods to compare them with each other. Our secondary aim is to evaluate complications and pain perception in patients undergoing hysteroscopic tubal evaluation. Furthermore, we will also provide an outlook for the future in this scientific field.

Methods

A review of the literature was conducted using PubMed. The focus was on studies on hysteroscopic tubal evaluation published from 1987 to 2022. The following terms were used performing the literature research on this very specific topic: “hysteroscopy AND tubal patency”. We also searched for relevant additional studies in the reference lists of the publications found. The publications were screened by title and abstract. After reading the full text of the relevant publications, they were selected if they met the inclusion criteria. Our inclusion criteria for publications were English language, dealing with hysteroscopic tubal evaluation techniques and providing original data. Exclusion criteria were languages other than English for the comprehensive review and languages other than English, meta-analyses, reviews, commentaries, editorials, letters, and abstracts.

Both authors manually reviewed the abstracts independently from each other. There was complete consensus regarding the relevance and the eligibility of the reviewed abstracts. Both authors also obtained full-text copies of eligible articles and extracted the relevant data, also in an independent manner. Possible inconsistencies were discussed by the reviewers. Finally, all information obtained from the selected articles was entered into a summary table. Notably all studies included in the meta-analysis were about the diagnostic accuracy of hysteroscopy for fallopian tube patency evaluation (index test) and were crossover studies, where patients served as their own controls. The reference tests were either laparoscopic chromopertubation or hysterosalpingography.

For every method, the following pooled values are provided: sensitivity, specificity, the positive predictive value (PPV) and the negative predictive value (NPV). In addition, summary receiver operating characteristic (SROC) spaces were computed.

Notably, the methodology of the selected studies was assessed by both authors using the qualitative instrument for data collection [14], where the domains “patient selection”, “index test”, reference standard” and “flow and timing” are assessed for the risk of bias (either low, unclear, or high).

Data analysis

After the studies had been selected, the following statistical parameters were extracted: true positive, true negative, false positive, and false negative; if available, they were extracted directly from the study, if not, they were calculated and arranged in 2 × 2 cross-tabs. These cross-tabs were used to calculate sensitivity, specificity, the positive predictive value (PPV) and the negative predictive value (NPV). All the analyses were done on the basis of the numbers of fallopian tubes, apart from studies about the use of perioperative changes in CDS volume, where results were related to the numbers of patients. Statistical analyses were performed with SPSS Version 28.01.0 (IBM Corp., Armonk, NY). Summary receiver operating characteristic (SROC) spaces are also provided.

Results

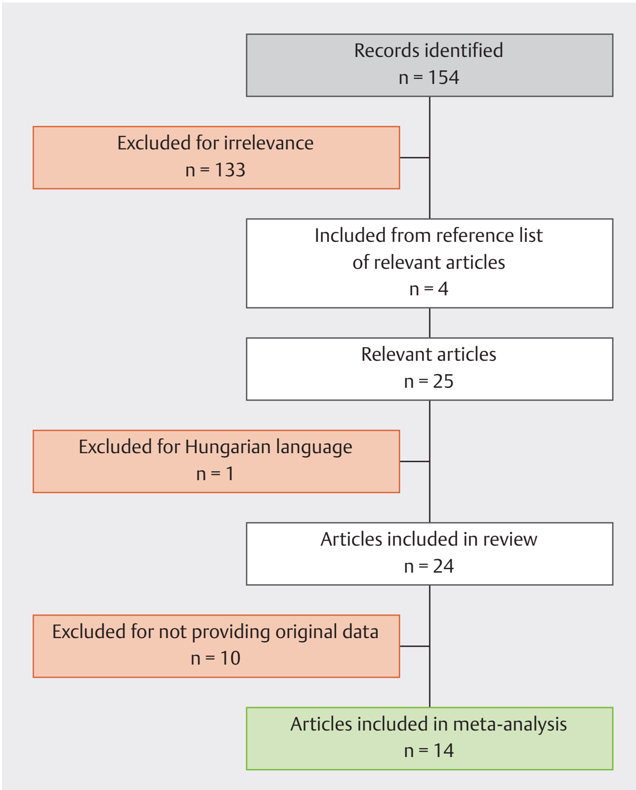
Study selection

Twenty-one relevant articles were identified through the PubMed search [3, 4, 6, 7, 8, 9, 10, 11, 12, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26] and four more through the reference lists [13, 27, 28, 29]. Of all 25 articles, one was excluded due to Hungarian language [15]. The remaining 24 articles were included in the review. However, ten of these were excluded from the meta-analysis for not providing original data [3, 4, 18, 19, 20, 21, 25, 26, 28, 29]. This resulted in 14 relevant articles for the meta-analysis [6, 7, 8, 9, 10, 11, 12, 13, 16, 17, 20, 22, 23, 24]. The flowchart is provided in ▶ **Fig. 1**. An overview of all selected articles is given in ▶ **Table 1**. Notably, in each of these studies, participants had been excluded if pregnant, had not desired future fertility, or were either premenarchal or postmenopausal.

▶**Table 1** Main characteristics of included studies.

Authors, year	Ref.	Design	Number of patients	Number of tubes	Population	Age (years)	Method	Outpatient hysteroscopy	Ref. method
Carta et al., 2017	[27]	Prospective	47	92	Infertility	34.5 ± 4.3	SHPWMBD	Yes	LC
Habibaj et al., 2012	[7]	Retrospective	56	112	Infertility	33.6 ± 4.2	CDS volume changes	Yes	LC
Hager et al., 2020	[12]	Prospective	30	60	Infertility	33.0 ± 4.8	Air bubbles	No	LC
Hager et al., 2020	[12]	Prospective	30	60	Infertility	31.9 ± 5.0	Flow technique	No	LC
Hager et al., 2021	[6]	Prospective	115	230	Patients undergoing fertility evaluation	18–44	CDS volume changes	No	LC
Lörincz et al., 2020	[15]	Prospective	61	122	Infertility	32.0 ± 4.4	Air bubbles	No	LC
Mardanian et al., 2018	[17]	Prospective	49	98	Infertility	25–38	CDS volume changes	Yes	LC
Ott et al., 2020	[11]	Prospective	72	144	Infertility	18–45	Flow technique	No	LC
Parry et al., 2017	[8]	Prospective	89	170	Infertility	32.4 ± 5.4	Air bubbles	Yes	LC
Promberger et al., 2018	[10]	Retrospective	511	998	Infertility	31.6 ± 5.8	Flow technique	No	LC
Rotshenker-Olshinka et al., 2021	[22]	Retrospective	38		Recurrent pregnancy loss, suspected fibroid or polyp, recurrent implantation failure	38 ± 5.3	CDS volume changes	Yes	HSG or HyCoSy
Roy et al., 2021	[23]	Prospective	80	160	Infertility	28.2 ± 4.0	SHPWMBD	No	LC
Shen et al., 2022	[16]	Prospective	143	286	Infertility	30.6 ± 4.3	SHPWMBD	No	HSG
Török & Major, 2012	[13]	Prospective	35	70	Infertility	33.0 ± 3.6	SHPWMBD	Yes	LC
Yildizhan et al., 2009	[9]	Prospective	56	112	Infertility	26.7 (21–38)	CDS volume changes	Yes	HSG

Abbreviations: CDS = cul-de-sac; HSG = hysterosalpingography; HyCoSy = hysterosalpingo contrast sonography; LC = laparoscopic chromopertubation; Ref. = reference; SHPWMBD = selective hysteroscopic pertubation with methylene blue dye



▶ **Fig. 1** Flowchart about study selection.

Meta-analyses of Fallopian tube patency testing using hysteroscopy

The reference test used was laparoscopic chromopertubation in 11 studies [6, 7, 8, 10, 11, 12, 13, 17, 20, 23, 24], hysterosalpingography in two studies [9, 16], and hysterosalpingography or hysterosalpingo contrast sonography in one study [22].

The Quality Assessment Tool for Diagnostic Accuracy Studies – 2 was used for the methodological assessment of the included studies, [14]. The results are presented in the Online Supplemental **Fig. S1**. Concerning the risk of bias and applicability concerns, the analysis revealed low to moderate scores for the majority of studies. In detail, eight studies had only low or unclear risk scores [6, 7, 9, 11, 12, 17, 23, 24], whereas one or two domains were assessed as having a high risk in four [8, 10, 13, 22] and two studies [16, 27], respectively. However, there were major inconsistencies in the reported results of one study [24], which are presented below.

The SROC spaces of all methods are shown in ▶ **Fig. 2**.

Perioperative changes in CDS volume

Five studies focused on changes in CDS volume and the prediction of unilateral/bilateral patency versus bilateral occlusion [6, 7, 17, 22]. While in the majority of studies laparoscopic chromopertubation was performed [6, 7, 17, 22], one study used hysterosalpingography as the reference method (Yildizan et al.) [9]. When all five studies were included in the pooled analysis, the sensitivity (90.7 %, 95 % CI: 86.4–94.0) and specificity (94.0 %, 95 % CI: 85.4–98.3) were quite similar to the pooled values without the study of Yildizan et al. (sensitivity: 89.0 %, 95 % CI: 83.8–93.0; specificity 96.6 %, 95 % CI: 88.1–99.6). Details are provided in ▶ **Fig. 3 a1** and ▶ **Fig. 3 a2**.

The air bubble technique

Three studies reported results on the diagnostic accuracy of the air bubble technique [8, 12, 24]. All studies used laparoscopic chromopertubation as the reference method. Notably, the study of Hager et al. 2020 [12] was a randomized study which compared the flow to the air bubble technique and, thus, only the 30 patients (60 fallopian tubes) where the latter was used were included in the meta-analysis about the air bubble technique.

In the study by Lörincz et al., the authors state that “the bubble method indicated that 36 (29.5 %) right-side, and 33 (27 %) left-side tubes of the total 122 tubes were occluded; the reference method revealed 57 (46.7 %) occluded Fallopian tubes.” Obviously, this indicates that hysteroscopy suggested tubal occlusion in 69 (36 + 33)/122 tubes. Since 57 tubes were occluded in laparoscopic chromopertubation, the number of falsely suspected occluded tubes was 12. This allows a conclusion to be drawn about the original cross-tab, which was not shown in the original publication (see Online Supplemental **Fig. S2**). Using these data, the sensitivity was 81.1 % (95 % CI: 68.7–89.1) and the specificity was 100.0 % (95 % CI: 92.0–100.0) for tubal patency, which differs from the values provided by the authors in their publication (73.2 % and 70.0 %, respectively) [24]. The corresponding author was contacted twice via the provided email address but did not respond.

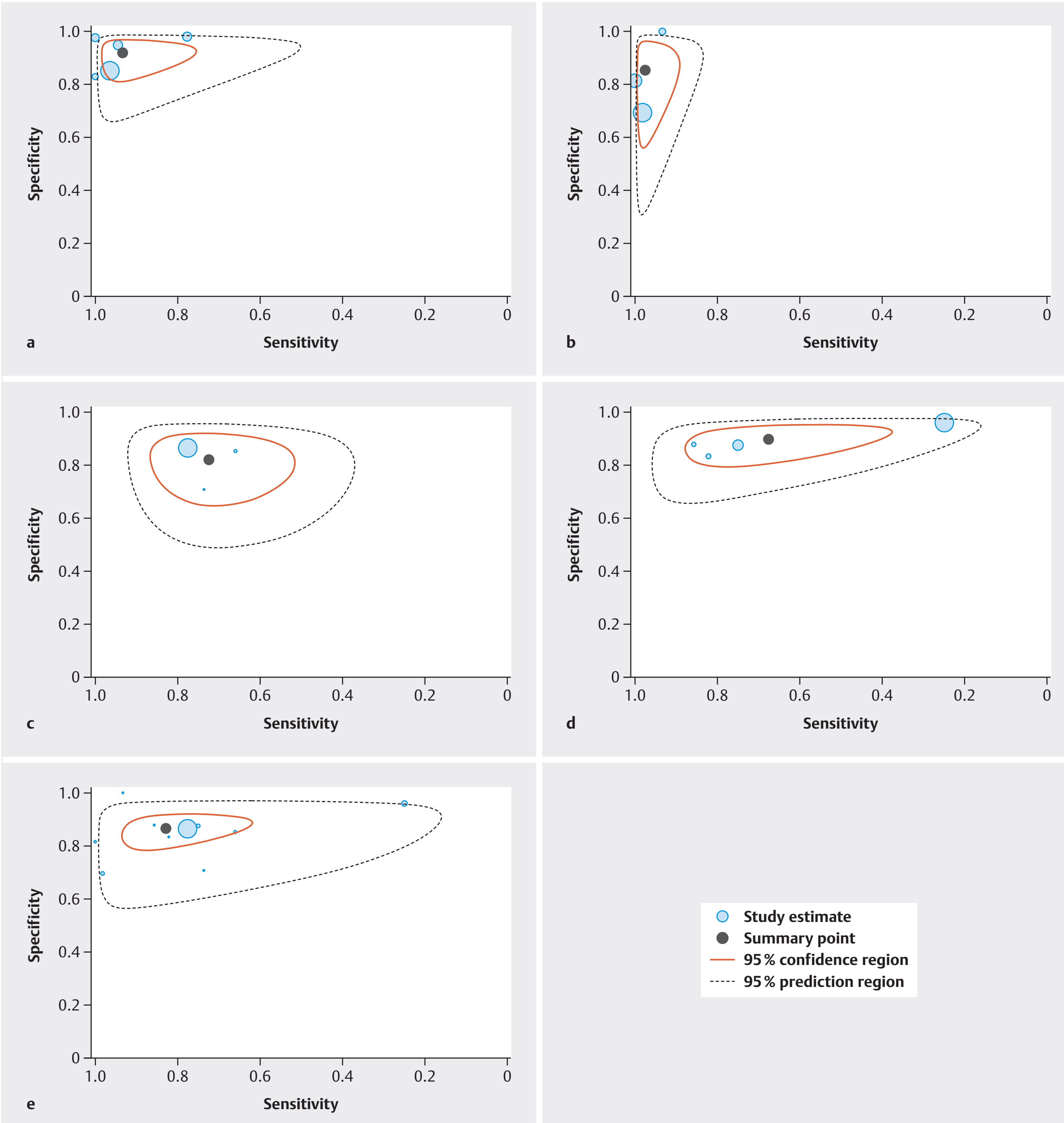
Due to the unclear situation, we performed the meta-analysis about the air bubble technique and its predictive accuracy for tubal patency twice: once with the extrapolated results of the Lörincz study (▶ **Fig. 3 b1** and ▶ **Fig. 3 b2**; pooled sensitivity: 82.2 %, 95 % CI: 75.6–87.7; pooled specificity: 98.4, 95 % CI: 95.3–99.6), and once without these results (pooled sensitivity: 82.7 %, 95 % CI: 74.0–89.4; pooled specificity: 97.6, 95 % CI: 93.2–99.5).

The flow technique

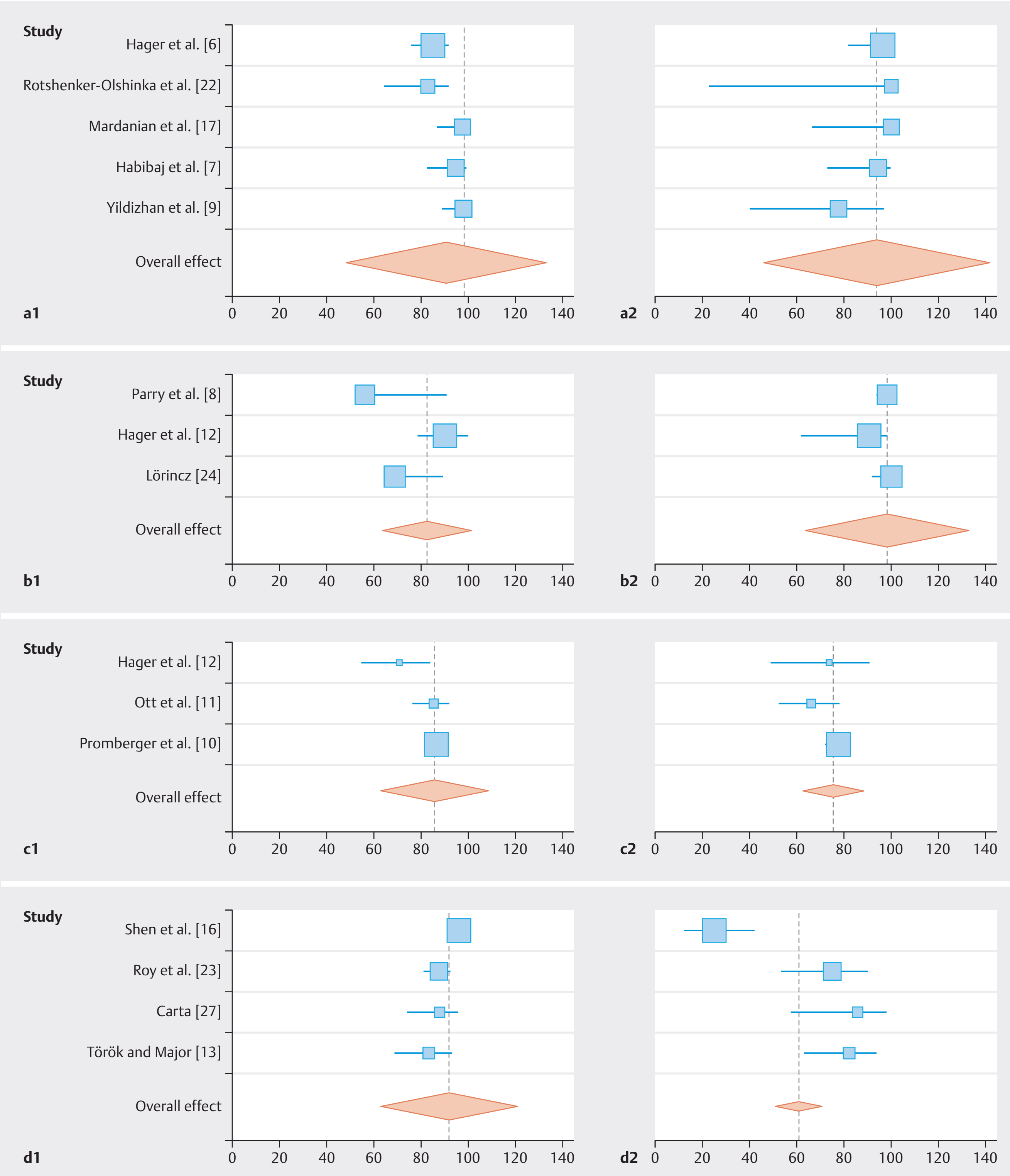
The flow technique was only reported by our own study team [10, 11, 12]. While the Quality Assessment Tool for Diagnostic Accuracy Studies– 2 revealed a higher risk of bias (Online Supplementary **Fig. S1**) for the larger retrospective study [10], this was not the case for the prospectively collected data [11, 12]. The pooled sensitivity for tubal patency was 85.6 % (95 % CI: 83.0–87.9) and the specificity was 75.5 % (70.6–80.0). ▶ **Fig. 3 c1** and ▶ **Fig. 3 c2** provide details.

Selective hysteroscopic pertubation with methylene blue dye

This technique was reported by four studies [13, 16, 23, 27]. The pooled sensitivity and specificity (▶ **Fig. 3 d1** and ▶ **Fig. 3 d2**) for tubal patency for all four studies were 91.7 % (95 % CI: 88.8–94.0) and 60.8 % (50.6–70.3), respectively. However, one study used hysterosalpingography rather than chromopertubation as the reference method [16]. When these data were excluded from the pooled analysis, a similar sensitivity was found (86.8 %, 95 % CI:



▶ **Fig. 2** Summary receiver operating characteristic (SROC) spaces of hysteroscopic techniques for tubal patency evaluation. **a** Changes in CDS volume for the prediction of unilateral/bilateral patency (per patient); **b** the air bubble technique for the evaluation of tubal patency (per single tube); **c** the flow technique for the evaluation of tubal patency (per single tube); **d** selective hysteroscopic pertubation with methylene blue dye for the evaluation of tubal patency (per single tube); and **e** all techniques listed in **b–d** combined for the evaluation of tubal patency (per single tube).



▶ **Fig. 3** Sensitivity and specificity of hysteroscopic techniques for evaluation of tubal patency. Changes in CDS volume (per patient: uni- or bilateral patency): **a1** sensitivity, **a2** specificity. The air bubble technique (per tube): **b1** sensitivity, **b2** specificity. The flow technique (per tube): **c1** sensitivity, **c2** specificity. Selective hysteroscopic pertubation with methylene blue dye (per tube): **d1** sensitivity, **d2** specificity.

81.5–90.9), but the specificity was higher (80.3 %, 95 % CI: 68.7–89.1).

Combined meta-analysis

Last but not least, all methods which dealt with the assessment of single tubes (rather than unilateral/bilateral patency versus bilateral occlusion) were included into a pooled analysis [8, 10, 11, 12, 13, 16, 23, 24, 27]. An overall sensitivity of 87.1 % was reached (85.3–88.8) together with an overall specificity of 79.8 % (95 % CI: 76.4–82.9).

An additional parameter: an unclear or "hazy" picture during hysteroscopy

It has been postulated that in case of bilateral occlusion, the hysteroscopic view would be unclear since mucus and detritus cannot be washed out [10]. It seems noteworthy that this parameter was evaluated in only one included study [11]. A hazy hysteroscopic picture was found in about 10 % of women with uni- or bilateral patency (5/51) in contrast to 71.4 % (15/21) when bilateral occlusion was found during laparoscopy ($p < 0.001$).

Factors with an impact on predictive accuracy

Only two studies evaluated possible factors associated with false-normal results. Both studies dealt with the flow technique [10, 12]. It was assumed that a false-normal result would be the most inconvenient one. When the evaluated tube was a hydrosalpinx or if there were adhesions surrounding the evaluated tube, the risk of a false-normal flow effect was increased in both studies [10, 12], while with regards to the presence of uterine myomas this was the only case in a large retrospective analysis [10].

Perceived pain

To evaluate the subjective pain perception of patients undergoing hysteroscopic tubal patency testing, we focused on studies which included women who underwent outpatient hysteroscopy without anesthesia. Three articles dealt with pain scores during and following hysteroscopy [8, 9, 27]. In the study by Carta et al. on office hysteroscopy-guided selective tubal chromopertubation, the authors used a visual analogue scale (VAS; 0, no pain; 10 worst possible pain) 30 minutes after the outpatient hysteroscopy. A range from 3 to 9 was reported, with the median VAS ranging from 6 to 8.5 according to the evaluated subpopulation. Although the authors did not report the median VAS for the whole study population, they could demonstrate that nulliparous women ($z = 1.980$; $p = 0.048$) and patients with primary infertility ($z = 2.346$; $p = 0.019$) reported significantly higher pain scores. Nevertheless, more than 95 % of patients would recommend hysteroscopy-guided selective tubal chromopertubation to a friend [27]. Parry et al. compared office hysteroscopy with the air bubble technique to hysterosalpingography with regards to pain scores. They could show that more than 90 % of patients would strongly prefer hysteroscopic assessment over hystersalpingography; more than 95 % reported maximum discomfort with hysterosalpingography and mild to no discomfort with the air bubble technique [8]. Yildizhan et al. compared hysteroscopy and sonographically measured perioperative changes in CDS volume to hysterosalpingography, with all patients reporting less pain with the hysteroscopic technique. Thirty percent of patients reported no difference in pain between hysteroscopy and hysterosalpingography. However, the other 70 % of women all reported greater pain during hysterosalpingography [9].

Complications

Three studies on hysteroscopic tubal evaluation focused on possible adverse events and reported very low complication rates [4, 9, 24, 27]. In a study about selective hysteroscopic pertubation with methylene blue dye, 8.51 % of patients showed a vasovagal syncope. Other complications which were also evaluated included abnormal bleeding, methylene allergy, uterine perforation, or pelvic inflammatory disease. However, none of these were found [27]. Two other studies, one on perioperative changes in CDS volume and one on the bubble sign, described no complications at all [9, 24]. The vasovagal reaction is described as a rare complication [4, 8]. Post-interventional infection is even rarer and was described in one of 435 patients [8]. Cervical stenosis is also a possible complication and was only described in the surgical setting [4, 8, 11, 12].

Evidence about combined methods

In the initial presentation of the air bubble technique by Parry et al., the authors combined this method with the measurement of changes in CDS fluid volume [8]. It seems reasonable to combine the methods, which evaluate every tube separately, with the sonographic measurement of changes in CDS fluid volume, which is highly predictive for the most problematic situation an infertile woman can face, namely bilateral tubal occlusion. However, Parry et al. did not provide data about the usefulness of the combination of the two techniques. In a recent secondary analysis of our study on CDS fluid volume changes [6], we demonstrated in 95 patients who had also undergone the air bubble technique that despite the high accuracy of the sonographic approach for bilateral occlusion, the air bubble technique achieved better results for the prediction of uni- or bilateral patency. Thus, the simultaneous application of both methods was suggested to be beneficial for the patient [30].

Discussion

Since 2009, an increasing body of evidence has suggested that patency of the fallopian tubes can be diagnosed with hysteroscopy with a high overall accuracy and reliability. None of the reported techniques seems to be associated with specific relevant complications. Moreover, many of the methods can be performed in the setting of an outpatient hysteroscopy.

In this comprehensive review and meta-analysis, the included studies were assessed for the risk of bias using the Quality Assessment Tool for Diagnostic Accuracy Studies– 2 (see Online Supplemental **Figs. S1** and **S2**). The assessed risk of bias in the majority of the included studies was low. However, three studies did use hysterosalpingography [9, 16] or hysterosalpingography/hysterosalpingo contrast sonography [22] as the reference method rather than laparoscopic chromopertubation, which is considered the gold standard. We consider this only a minor study limitation, since we also performed pooled analyses without these data.

Nonetheless, in the pooled analysis of all methods which evaluated patency per single tube, the overall sensitivity and specificity were 87.1 % and 79.8 %, respectively. These findings are similar to those of the previous meta-analysis by Vitale et al. (sensitivity: 88 %; specificity: 85 %) [4]. This is reasonable, since all six studies included in the previous meta-analysis were also included in our study [8, 10, 11, 12, 13, 27]. However, a pooled analysis of all available techniques might not reflect the whole truth, since the overall accuracy might differ between techniques. So far, only one study has addressed this issue directly by comparing the "flow" and the "air bubble" techniques. Although both tools were found to be significantly predictive for tubal patency, the "air bubble" technique performed better (sensitivity 90.6 % versus 73.3 %, specificity 100 % versus 70.7 %) [12]. Our pooled analyses per technique revealed comparable results; in particular, the pooled specificity was higher for the "air bubble" technique (98.4 % versus 75.5 %), while similar sensitivity values were found (82.2 % versus 85.6 %, respectively; ▶ **Fig. 2**). In contrast, selective hysteroscopic pertubation with methylene blue dye revealed a pooled sensitivity of 86.8 % and a pooled specificity of 80.3 %, when only those studies were included which compared the method to laparoscopic chromopertubation. These data might suggest that the "air bubble" technique could be the most reliable approach. However, to draw final conclusions, more studies comparing different methods to one another would be necessary.

Another tool is the use of transvaginal ultrasound before and after hysteroscopy to detect changes in CDS fluid volume, which is likely increased by hysteroscopic fluid in the case of at least one open tube. However, although women with bilateral tubal patency had higher increases in CDS volume than women with one patent tube [6], this method can only reliably assess uni- or bilateral patency versus bilateral occlusion and does not allow an exact statement about a single fallopian tube. However, the method has a high pooled sensitivity of 90.7 % and a high pooled specificity of 94.0 % (▶ **Fig. 2**). Clearly, peri-hysteroscopic sonography could be easily combined with other methods, and this has been recommended for the "air bubble" technique [8]. However, only one study addressed this issue directly and revealed a high accuracy of the sonographic approach for bilateral occlusion together with better results for the prediction of uni- or bilateral patency with the "air bubble" technique [30].

None of the reported methods achieved maximum sensitivity and specificity. While this is reasonable and also applies to other methods of tubal patency evaluation like hysterosalpingography and hysterosalpingo contrast sonography [6, 9, 13, 31, 32, 33], it is clinically relevant to figure out the risk factors for an incorrect hysteroscopic assessment. From the patient's and the physician's point of view, a false-normal result could be the most unfavorable inaccurate assessment, since this might lead to a delay in necessary infertility treatment. Notably, the factors which increased the risk of a false-normal result were only evaluated for the "flow" technique. Adhesions surrounding the evaluated tube and a hydrosalpinx of the evaluated tube were the most relevant risk factors [10, 11]. The latter should be less likely for the air bubble sign since, in the original technique presented by Parry et al., the minimum time for intracavitary evaluation was ten seconds before the entry of air bubbles. This was done to allow pressure equilibration in case of a hydrosalpinx [8, 12, 26]. The aim was to prevent air bubbles from traversing the ostium of a hydrosalpinx with a peripheral occlusion. However, future studies could focus on risk factors for incorrect hysteroscopic tubal patency assessment in all techniques.

When it comes to possible complications, it must be noted that there is not much data on office hysteroscopy procedures in the literature. In hysteroscopy in general, cervical stenoses, uterine perforations, infections, and bleeding are described as possible complications [34]. When looking at the methods of hysteroscopic tubal evaluation individually, data on complications is scarce. When the Flow technique, the Parryscope technique or the technique which employs ultrasound to detect fluid in the pouch of Douglas pre- and post-hysteroscopy are used, complications are extremely rare, because the intervention is limited [6, 11, 12]. When selective chromopertubation is used to evaluate tubal patency, the complication rate could be higher, as a small catheter is inserted directly into the tubal ostia. Nevertheless, studies that have investigated this method suggest a low complication rate for this method as well [13].

For obvious reasons, the question whether the methods for hysteroscopic evaluation of tubal patency are painful is only relevant when the procedures are performed in an office setting. Notably, data are scarce. The VAS was only used in the study of Carta et al. on office hysteroscopy-guided selective tubal pertubation. Depending on the evaluated subpopulation, VAS scores from 6 to 8.5 were reported [27]. When these results are compared with the findings of a recent meta-analysis on the characteristics of the distension medium and how they affect pain during office hysteroscopy, mean VAS scores of 1–4 were found, depending on the type, pressure, and temperature of the distension medium [35]. Based on these considerations, it could be hypothesized that office hysteroscopy with selective pertubation would be more painful than office hysteroscopy alone. However, more data are needed. Notably, two observations favored hysteroscopic techniques (air bubbles and sonography for the detection of perioperative changes in CDS volume) over hysterosalpingography [8, 9]. It is likely that the methods which focus on perioperative changes in CDS volume, air bubbles or visualization of the flow effect will lead to pain which is similar to that of a normal office hysteroscopy. However, more studies are necessary, which compare hysteroscopic tubal evaluation with hysterosalpingography and hysterosalpingo contrast sonography with regards to pain scores.

All in all, the presented techniques seem promising and evidence about their accuracy is increasing. However, a few limitations need to be mentioned again [3]: some studies evaluated hysteroscopic tubal evaluation with standard diagnostic hysteroscopy rather than office hysteroscopy. It might be of relevance whether the procedure is performed under general anesthesia or not. Moreover, it could be suggested that office hysteroscopy would routinely have to be accompanied by ultrasound, since otherwise it would not be possible to obtain information about the uterine wall, hydrosalpinges, adhesions and other abnormalities [3].

One could argue that many subfertile/infertile women with a normal uterine cavity and patent tubes are found to have intraabdominal abnormalities, first and foremost endometriosis. This seems relevant, given the increased prevalence of endometriosis in subfertile women compared to women of proven fertility [36]. As precision medicine and tailored treatment are coming into more general use, individual approaches should be found for every patient [37]. Although the evidence suggests that operative laparoscopy increases the rates of naturally conceived intrauterine pregnancies, at least in women with minimal and mild endometriosis [38], surgery should only be indicated with great caution and recurrent surgery should be avoided [37]. Thus, a combination of transvaginal ultrasound and outpatient hysteroscopy might be relevant diagnostic tools for some women. However, given these considerations and since chromopertubation can be performed during laparoscopy, the hysteroscopic evaluation of fallopian tube patency should be restricted to women who only undergo office hysteroscopy. We do not believe that this technique will replace laparoscopy. In conclusion, in view of the high sensitivity and specificity of the hysteroscopic techniques for tubal patency evaluation, these methods are more than promising. However, until they are considered standard tools, their relevance lies in maximizing the informative output of diagnostic hysteroscopy, especially for women with in-/subfertility who do not undergo concomitant laparoscopy.

Supplemental Figures

Supplemental Fig. S1. Assessment of risk of bias using the qualitative instrument for data collection (Quality Assessment Tool for Diagnostic Accuracy Studies– 2 [14]).

Supplemental Fig. S2. Extrapolated cross-tab of the prediction of tubal patency using the hysteroscopic air bubble technique. The provided numbers of occluded tubes for hysteroscopy and laparoscopy allowed us to re-calculate the numbers of patent tubes (steps 1 and 2, respectively). After that, calculation of the false-abnormal hysteroscopic results was possible (step 3), which allowed us to fill in the rest of the cross-tab.

* Data provided in the Results Section of reference [24].

Conflict of Interest

Advisory Board of Exeltis (MH, JO) and Lenus (JO); Research subsidies of trackle (MH), Bionorica (MH, JO), Lenus (JO); Lecture fees from Gedeon Richter (JO), Exeltis (JO), Lenus Pharma (JO).

References

[1] Campo R, Meier R, Dhont N et al. Implementation of hysteroscopy in an infertility clinic: The one-stop uterine diagnosis and treatment. Facts Views Vis Obgyn 2014; 6: 235–239

[2] Parry JP, Isaacson KB. Hysteroscopy and why macroscopic uterine factors matter for fertility. Fertil Steril 2019; 112: 203–210. DOI: 10.1016/j.fertnstert.2019.06.031

[3] Hager M, Simek IM, Promberger R et al. The Role of Diagnostic Hysteroscopy in the Evaluation of Fallopian Tube Patency: a Short Review. Geburtshilfe Frauenheilkd 2019; 79: 483–486. DOI: 10.1055/a-0826-1326

[4] Vitale SG, Carugno J, Riemma G et al. Hysteroscopy for Assessing Fallopian Tubal Obstruction: A Systematic Review and Diagnostic Test Accuracy Meta-analysis. J Minim Invasive Gynecol 2021; 28: 769–778. DOI: 10.1016/j.jmig.2020.11.013

[5] Siristatidis C, Chrelias C, Salamalekis G et al. Office hysteroscopy: current trends and potential applications: a critical review. Arch Gynecol Obstet 2010; 282: 383–388. DOI: 10.1007/s00404-010-1437-x

[6] Hager M, Ott J, Göbl C et al. Detection of hysteroscopic fluid in the pouch of Douglas: a prospective cohort study about the predictability of bilateral tubal occlusion. Arch Gynecol Obstet 2021; 304: 1073–1080. DOI: 10.1007/s00404-021-05993-0

[7] Habibaj J, Kosova H, Bilali S et al. Comparison between transvaginal sonography after diagnostic hysteroscopy and laparoscopic chromopertubation for the assessment of tubal patency in infertile women. J Clin Ultrasound 2012; 40: 68–73. DOI: 10.1002/jcu.20883

[8] Parry JP, Riche D, Aldred J et al. Proximal Tubal Patency Demonstrated Through Air Infusion During Flexible Office Hysteroscopy Is Predictive of Whole Tubal Patency. J Minim Invasive Gynecol 2017; 24: 646–652. DOI: 10.1016/j.jmig.2017.02.010

[9] Yildizhan B, Durmusoglu F, Uygur M et al. A new technique for the diagnosis of fallopian tube patency by using hysteroscopy with ultrasound compared with hysterosalpingography in infertile women. Arch Gynecol Obstet 2009; 280: 543–547. DOI: 10.1007/s00404-009-0953-z

[10] Promberger R, Simek IM, Nouri K et al. Accuracy of Tubal Patency Assessment in Diagnostic Hysteroscopy Compared with Laparoscopy in Infertile Women: A Retrospective Cohort Study. J Minim Invasive Gynecol 2018; 25: 794–799. DOI: 10.1016/j.jmig.2017.11.020

[11] Ott J, Hager M, Nouri K et al. Assessment of Tubal Patency: A Prospective Comparison of Diagnostic Hysteroscopy and Laparoscopic Chromopertubation. J Minim Invasive Gynecol 2020; 27: 135–140. DOI: 10.1016/j.jmig.2019.03.006

[12] Hager M, Ott J, Holzer I et al. Hysteroscopic Assessment of Tubal Patency: A Randomized Comparison between the Flow and Parryscope Techniques. J Minim Invasive Gynecol 2020; 27: 1552–1557.e1. DOI: 10.1016/j.jmig.2020.01.014

[13] Török P, Major T. Accuracy of assessment of tubal patency with selective pertubation at office hysteroscopy compared with laparoscopy in infertile women. J Minim Invasive Gynecol 2012; 19: 627–630. DOI: 10.1016/j.jmig.2012.03.016

[14] Whiting PF, Rutjes AW, Westwood ME et al. QUADAS-2: a revised tool for the quality assessment of diagnostic accuracy studies. Ann Intern Med 2011; 155: 529–536. DOI: 10.7326/0003-4819-155-8-201110180-00009

[15] Lőrincz J, Jakab A, Török P. A petevezeték-átjárhatóság vizsgálómódszereinek összehasonlító elemzése [Comparison of current methods of tubal patency assessment]. Orv Hetil 2017; 158: 324–330. DOI: 10.1556/650.2017.30653

[16] Shen H, Lu Y, Su R et al. Fertility Improvement of Hysteroscopy with Chromopertubation in the Management of Infertile Women with Hysterosalpingography Evidence of Abnormal Tubal Patency: A Prospective Comparative Study. Int J Womens Health 2022; 14: 1613–1619. DOI: 10.2147/IJWH.S386746

[17] Mardanian F, Rouholamin S, Nazemi M. Evaluation of Efficacy of Transvaginal Sonography with Hysteroscopy for Assessment of Tubal Patency in Infertile Women Regarding Diagnostic Laparoscopy. Adv Biomed Res 2018; 25: 101. DOI: 10.4103/abr.abr_71_17

[18] Shokeir T. Regarding "Accuracy of Tubal Patency Assessment during Diagnostic Hysteroscopy Compared with Laparoscopy in Infertile Women: A Retrospective Cohort Study". J Minim Invasive Gynecol 2018; 25: 542. DOI: 10.1016/j.jmig.2017.12.024

[19] Devine K, Dolitsky S, Ludwin I et al. Modern assessment of the uterine cavity and fallopian tubes in the era of high-efficacy assisted reproductive technology. Fertil Steril 2022; 118: 19–28. DOI: 10.1016/j.fertnstert.2022.05.020

[20] La Sala GB, Sacchetti F, Degl'Incerti-Tocci F et al. Complementary use of hysterosalpingography, hysteroscopy and laparoscopy in 100 infertile patients: results and comparison of their diagnostic accuracy. Acta Eur Fertil 1987; 18: 369–374

[21] Roma Dalfó A, Ubeda B, Ubeda A et al. Diagnostic value of hysterosalpingography in the detection of intrauterine abnormalities: a comparison with hysteroscopy. AJR Am J Roentgenol 2004; 183: 1405–1409. DOI: 10.2214/ajr.183.5.1831405

[22] Rotshenker-Olshinka K, Volodarsky-Perel A, Steiner N et al. Transvaginal Sonography Post-Office Hysteroscopy as a Screening Tool for Tubal Patency: A Reliable and Feasible Technique in an Outpatient Setting. J Obstet Gynaecol Can 2021; 43: 978–983. DOI: 10.1016/j.jogc.2021.05.007

[23] Roy KK, Gajapathy SR, Rai R et al. Assessment of Tubal Patency with Selective Chromopertubation at Office Hysteroscopy versus Modified Minilaparoscopy in Infertile Women. Gynecol Minim Invasive Ther 2021; 10: 159–165. DOI: 10.4103/GMIT.GMIT_95_20

[24] Lörincz J, Molnár S, Herman T et al. Predictive value of bubble sign for tubal patency during office hysteroscopy. Eur J Obstet Gynecol Reprod Biol 2020; 253: 58–60. DOI: 10.1016/j.ejogrb.2020.07.048

[25] Panda SR, Kalpana B. The Diagnostic Value of Hysterosalpingography and Hysterolaparoscopy for Evaluating Uterine Cavity and Tubal Patency in Infertile Patients. Cureus 2021; 13: e12526. DOI: 10.7759/cureus.12526

[26] Parry JP, Riche D, Rushing J et al. Performing the Parryscope technique gently for office tubal patency assessment. Fertil Steril 2017; 108: 718. DOI: 10.1016/j.fertnstert.2017.07.1159

[27] Carta G, Palermo P, Pasquale C et al. Office hysteroscopic-guided selective tubal chromopertubation: acceptability, feasibility and diagnostic accuracy of this new diagnostic non-invasive technique in infertile women. Hum Fertil (Camb) 2018; 21: 106–111. DOI: 10.1080/14647273.2017.1384856

[28] Aldred J, Riche DM, May W et al. Air infused saline for predicting tubal patency with flexible office hysteroscopy is correlated with post-hysteroscopy changes in cul-de-sac fluid volume. Fertil Steril 2016; 106: e220

[29] Török P. A novel method of selective chromopertubation at office hysteroscopy. J Gynecol Res Obstet 2016; 2: 31–32

[30] Ott J, Boegl MS, Hager M. Does detection of hysteroscopic fluid in the pouch of Douglas increase the accuracy of the hysteroscopic bubble technique for bilateral Fallopian tube occlusion? A retrospective cohort study. GREM 2024; 5: 55–59. DOI: 10.53260/grem.2450110

[31] Ludwin I, Ludwin A, Wiechec M et al. Accuracy of hysterosalpingo-foam sonography in comparison to hysterosalpingo-contrast sonography with air/saline and to laparoscopy with dye. Hum Reprod 2017; 32: 758–769. DOI: 10.1093/humrep/dex013

[32] Lo Monte G, Capobianco G, Piva I et al. Hysterosalpingo contrast sonography (HyCoSy): let's make the point! Arch Gynecol Obstet 2015; 291: 19–30. DOI: 10.1007/s00404-014-3465-4

[33] Alcázar JL, Martinez-Astorquiza Corral T, Orozco R et al. Three-Dimensional Hysterosalpingo-Contrast-Sonography for the Assessment of Tubal Patency in Women with Infertility: A Systematic Review with Meta-Analysis. Gynecol Obstet Invest 2016; 81: 289–295. DOI: 10.1159/000443955

[34] Cholkeri-Singh A, Sasaki KJ. Hysteroscopy safety. Curr Opin Obstet Gynecol 2016; 28: 250–254. DOI: 10.1097/GCO.0000000000000289

[35] De Silva PM, Stevenson H, Smith PP et al. A Systematic Review of the Effect of Type, Pressure, and Temperature of the Distension Medium on Pain During Office Hysteroscopy. J Minim Invasive Gynecol 2021; 28: 1148–1159.e2. DOI: 10.1016/j.jmig.2021.01.003

[36] D'Hooghe TM, Debrock S, Hill JA et al. Endometriosis and subfertility: is the relationship resolved? Semin Reprod Med 2003; 21: 243–254. DOI: 10.1055/s-2003-41330

[37] Bonavina G, Taylor HS. Endometriosis-associated infertility: From pathophysiology to tailored treatment. Front Endocrinol (Lausanne) 2022; 13: 1020827. DOI: 10.3389/fendo.2022.1020827

[38] Seifer BJ, Su D, Taylor HS. Circulating miRNAs in murine experimental endometriosis. Reprod Sci 2017; 24: 376–381. DOI: 10.1177/1933719116667228