

Fallopscopy—a prerequisite to the proper assessment of tubal infertility

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Objective. To review the technique and results of fallopscopy, and the classification and management of fallopian tube disease.

Data sources. *Medline* and non-*Medline* search of the relevant English literature, and personal experience.

Study selection. Studies involving the use of fallopscopy to assess tubal status were selected for review.

Data extraction. The procedure of fallopscopy and its possible problems and complications were studied. Results from fallopscopy were compared with those from conventional investigations of tubal status, and their correlation with pregnancy was evaluated.

Data synthesis. Fallopscopy gives a better assessment of tubal status than conventional methods and can also predict the subsequent pregnancy rate. By fallopscopy, the decision of the mode of therapy for subfertility can be changed in more than 60% of patients.

Conclusion. Examination of the fallopian tube using fallopscopy allows an accurate assessment of the tubal status to be made and is a prerequisite to deciding the most appropriate mode of assisted reproductive therapy.

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Key words: Fallopian tube diseases/diagnosis; Fallopian tube disease/therapy; Infertility, female

Introduction

Fallopian tube disease accounts for more than 30% of female subfertilities.¹ In the investigation of tubal infertility, the goal must be to test the function of the fallopian tubes rather than to demonstrate their patency.¹ Conventional methods used in tubal assessment, such as hysterosalpingography (HSG) or laparoscopic chromotubation, provide only indirect information about tubal patency and do not evaluate tubal mucosal status. Findings from such methods thus correlate poorly with the actual tubal status.²

Even by directly visualising the tubal mucosa using salpingoscopy, only the distal portion (ie ampulla to fimbria) of the tube can be seen.³ The proximal intramural to isthmic region has remained an unreachable zone. Distinguishing between proximal and distal tubal disease has been shown to be important, as the

outcome of treatment such as tubal surgery is related to tubal status.⁴ By the more accurate assessment of the endotubal status using transcervical fallopscopy, patients can be triaged to the most appropriate mode of therapy to maximise pregnancy rates. This review describes the pitfalls of the conventional methods of assessing tubal patency, and the technical aspects of and results from transcervical fallopscopy. The concept of a falloposcopic classification of tubal lumen disease is also discussed, and a management protocol is suggested.

Hysterosalpingography and laparoscopy correlate poorly with the actual endotubal status

In one study, 15% of all hysterosalpingograms showed evidence of uterotubal junction occlusion, despite 60% of the apparent proximal tubal occlusions having histologically normal proximal segments.² Several hypotheses have been proposed to explain this discrepancy. Both fallopian tubes may be patent and have normal mucosa; however, individual differences in their calibre or tortuosity could create a significant difference in their hydraulic resistance, thus diverting the flow of contrast agent into the tube of lower resistance. The

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presence of a polyp at the ostium or a mucous plug in the proximal tube, or spasm of the ostium can also create a false occlusion image during HSG and laparoscopic chromotubation.

False negative results are also common. Tubes that seem normal by HSG and laparoscopy can be associated with non-obstructive lesions such as abnormal endotubal vasculature or epithelial atrophy.^{5,6} Furthermore, the degree of endotubal disease has been shown not to correlate with the extent of peritoneal adhesion.⁷

Fallopscopy

Fallopscopy using the coaxial technique was first described by Kerin et al.⁵ Subsequently, Bauer et al⁸ developed a falloposcopic method that uses the linear eversion technique.

Techniques used in fallopscopy

Patient preparation

The optimal time for performing fallopscopy is during the mid-follicular phase of the menstrual cycle, because the ostium can be visualised most easily in the absence of blood and a thick endometrial lining.⁵ While previously, antibiotic prophylaxis was given, the majority of recent studies report not using antibiotics and not encountering infection after fallopscopy.^{6,7}

Various kinds of anaesthesia for fallopscopy have been described in the literature. Initially, general anaesthesia was used when suspected abnormal tubes were examined by fallopscopy, especially if concurrent laparoscopy was performed.^{7,9} Office fallopscopy under sedation, however, is gaining greater acceptance. Drug combinations such as naproxen, diazepam, and uterosacral lidocaine¹⁰; atropine sulphate and benzodiazepine⁶; and fentanyl and midazolam¹¹ have been found to be satisfactory in achieving sedation.

Giving adequate explanation to patients before fallopscopy—for example, by giving a pamphlet describing the details of the procedure—will help to alleviate anxiety and pain. The feedback from a relaxed and cooperative patient is most helpful to the operator to perform a successful falloposcopic examination.

The falloposcope

The falloposcope is a flexible high-resolution microendoscope of 0.5-mm diameter and 1.73-m length that contains a bundle of 2000 optical fibres and eight to 12 illuminating fibres. The falloposcope is capable of magnifying up to 50 times.

The coaxial technique

A flexible hysteroscope that has an outside diameter (OD) of 1.5 to 3.0 mm and that contains a single operating channel is introduced into the endometrial cavity; Ringer-lactate solution is used as a distension medium. Under video monitoring, the uterotubal ostium (UTO) is located and the tip of the hysteroscope is directed to within 3 mm of the UTO. A flexible, platinum-tipped tapered guidewire of OD 0.3 to 0.8 mm is then introduced into the UTO through the second arm of the Y-connector and is advanced into the fallopian tube until a point of resistance, increase in patient discomfort, or a distance of 15 cm is reached. A Teflon-coated catheter of OD 1.2 to 1.3 mm is introduced over the wire for a similar distance and the guidewire is withdrawn. A second Y-connector is attached to the proximal end of the catheter and the falloposcope is passed through the straight arm of the second Y-connector while Ringer-lactate solution is infused through the angled arm. After the falloposcope has been connected to a xenon light source, camera chip, and a high-resolution video monitor, the tubal lumen is visualised in a retrograde manner (ie from the fimbrial end to the isthmic region as the catheter is withdrawn).⁹

When Kerin et al performed fallopscopy using the coaxial system on 75 patients (112 tubes), there were no intra-operative or postoperative complications related to the falloposcopic procedure.⁹ However, when flexible wire cannulation or direct balloon tuboplasty procedures were attempted, there were five instances of partial and one instance of complete tubal perforation. The perforations were all small and without external bleeding, and had only minor endotubal bleeding that resolved spontaneously.⁹

The linear-everting catheter system technique

The linear-everting catheter (LEC) system (Fig 1) is an alternative to the coaxial system and is gaining



Fig 1. The linear-everting catheter system with falloposcope in situ

greater acceptance. Use of the LEC system with sedation is now usually regarded as an office procedure that does not need laparoscopy or hysteroscopy. The LEC consists of inner and outer catheter bodies (of diameters 0.8 mm and 2.8 mm, respectively) that are joined circumferentially at their distal tips by a distensible polyethylene membrane. The pressure within the enclosed space (the balloon space) is controlled by a fluid-filled syringe. The fallopiscope is advanced within the inner catheter and the membrane and introduced into the uterus. Once the ostium is identified, the outer catheter is held in position and pressure is applied to the membrane by using the fluid-filled syringe; the inner catheter is pushed forward, resulting in the linear eversion of the balloon into the fallopian tube. As a result, the fallopiscope is carried forward at twice the speed of the balloon (Fig 2). Thus, attention should be paid to the fallopiscope tip, which resides within the protective cover of the everting membrane, to avoid damaging the delicate endoscope. The balloon and fallopiscope are advanced into the fallopian tube in small increments, up to a distance of 10 cm or until resistance is encountered. Imaging of the endotubal surface is then performed in a retrograde manner using the lens-fluid interface.^{10,12}

The LEC system confers a few advantages over the coaxial system. Firstly, the eversion balloon is unrolled into the fallopian tube without exerting any shearing force between the balloon and the tubal epithelium. The everting balloon will seek the path of least resistance and negotiate any tubal tortuosity. This process greatly minimises the risk of tubal injury, which is associated with guidewire cannulation in the coaxial system. Secondly, the fallopiscope advances automatically during balloon eversion and can be moved independently to optimise visualisation. Thirdly, there is no need for any hysteroscopy or cervical dilatation, and fallopiscopy using the LEC system can be accomplished as an out-patient procedure that requires only local anaesthesia. Finally, the fallopiscope is well protected inside the balloon and is kept coaxially aligned along the tubal lumen.

Results from fallopiscopy

In most studies, fallopiscopy has been performed mainly in patients with hysterosalpingographic or laparoscopic evidence of endotubal disease. The success rate of cannulation by fallopiscopy in 'abnormal' tubes of these patients is more than 90% in the majority of recent studies.¹²⁻¹⁴ The poor correlation between findings from HSG or laparoscopy and those from fallopiscopy is well documented. Both false-positive and false-negative rates of HSG are approximately

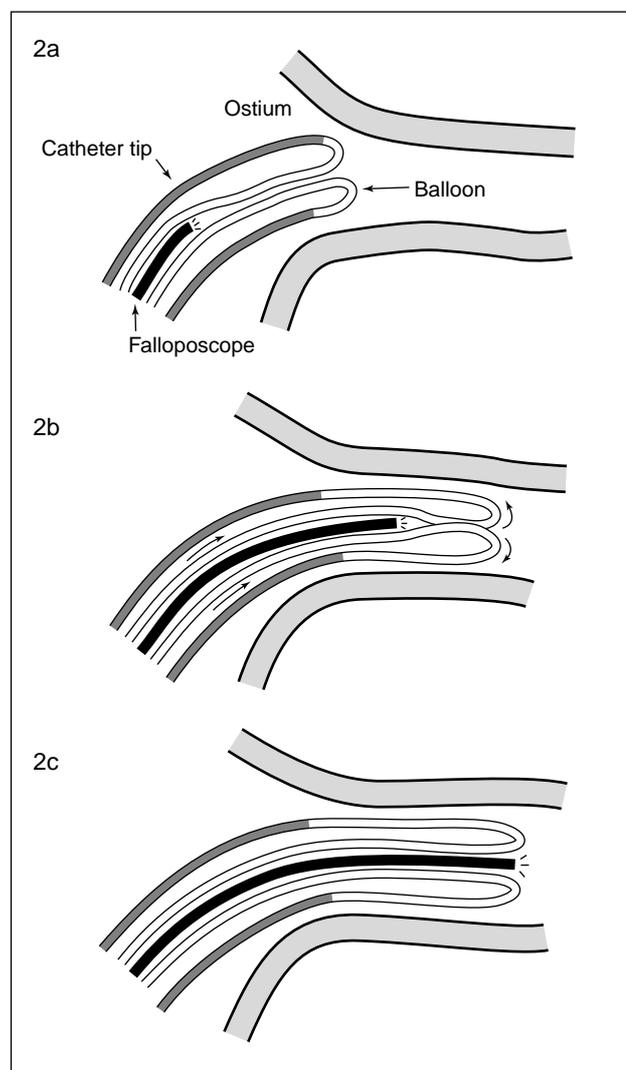


Fig 2. Mechanism of eversion with the linear-everting catheter system

(2a) balloon is pressurised; (2b) inner body is advanced and balloon carries fallopiscope forward; (2c) complete eversion: fallopiscope reaches tip of balloon

40%.² Venezia et al⁶ studied 10 patients with hysterosalpingographic and laparoscopic evidence of endotubal disease and eight patients with normal HSG results; a total of 31 fallopian tubes were examined. Fallopiscopy identified 17 normal, healthy tubes, seven of which had been diagnosed by HSG as being blocked. In contrast, fallopiscopy showed evidence of mild to moderate endotubal damage in four tubes that appeared normal when HSG was used and severe epithelial damage in one tube that appeared to be mildly stenosed on the hysterosalpingogram. Overall, agreement of fallopiscopy results with those from HSG was obtained in only 19 (61%) of the 31 tubes.⁶

In addition, Kerin et al⁹ examined 112 'diseased' tubes in 75 patients. Fallopiscopy showed 52 (46%) tubes to be normal, 33 (29%) tubes to have mild to moderate disease, and 27 (24%) tubes to have severe

to obstructive disease. Follow-up showed that within 1 year of the procedure, six (21%) of the 28 women in whom at least one tube was normal had conceived and two (9%) of the 22 who had mild to moderate disease had conceived, while none of the 16 patients with severe endotubal disease had. Thus, severe tubal disease, as identified by fallopscopy, carries a poor prognosis for pregnancy.⁹

Complications of fallopscopy

Fallopscopy is usually completed within 30 minutes; the duration depends on the experience and skill of the operator. Six instances of minor tubal perforation among the 122 'diseased tubes' in 75 patients (ie a perforation frequency of 4.9% per tube and 8% per patient) have been detected by the coaxial system using guidewire cannulation.⁹ No other major complications have been reported. Thus, fallopscopy can be considered a safe and atraumatic procedure, particularly when the LEC system is used.

Classification of fallopian tube luminal disease

Comparison of the falloposcopic findings and appearance of each segment of the normal fallopian tubes of eight patients⁵ with the corresponding features of abnormal tubes has led to a scoring system for tubal lumen disease,⁹ which is currently the most commonly used. In the classification system, each of the four segments of the fallopian tube (intramural, isthmic, ampulla, and fimbria) are assessed according to the following five parameters: patency (patent, stenosed, or obstructed); epithelium (normal, atrophic, or flat and featureless); vascularity (normal, intermediate, or pale); adhesion (none, thin, or thick); and dilatation (none, minimal, or hydrosalpinx). The scores 1, 2, or 3 assigned to the three options for each parameter reflect normal findings, mild to moderate abnormalities, and severe abnormalities, respectively. The total scores of each tube are then added; a total score of 20 reflects normality, 21 to 30 means mild to moderate disease, and a total score of >30 signifies severe disease (Box).

Despite its popularity, the classification system has its shortcomings. Firstly, a score cannot be given if the tube cannot be cannulated along its full length. If a patient has a history of tubal surgery and re-anastomosis, then part of the tube may be missing and a score cannot be given. Secondly, the transition from one segment of the tube to another can be difficult to distinguish, especially if tubal damage is present. Thus, an individual description of all four segments may not give reproducible findings and scores. A more practical classification method may be to divide the tube into proximal and distal portions, and to assess them

individually according to the length of tube reached. Finally, vascularity and epithelial status describe the same parameter.

Management of fallopian tubal luminal disease

If pseudo-proximal tubal occlusion by a mucous plug or debris is confirmed, the occlusion can usually be dislodged by passage of the falloposcope or by aquadissection. A mild to moderate adhesion or a stenosis may be divided by balloon dilatation techniques.¹⁵ In the case of dense fibrotic obstruction, either in vitro fertilisation or tubal resection followed by microsurgical anastomosis should be considered. In the case of gross hydrosalpinx with extensive endotubal damage, further surgical intervention may prove useless and the patient should consider in vitro fertilisation.^{7,10}

The overall result and pregnancy rate after reconstructive surgery for tubal blockage is disappointing.^{16,17} The microsurgical approach and laparoscopic route have been advocated¹⁸; however, the results remain unsatisfactory. It has been suggested that the selection criteria for tubal surgery rather than the surgical technique determines the success of the outcome.¹⁸

Boer-Meisel et al¹⁸ graded tubal damage according to the following five criteria: the extent of the adhesions, nature of the adhesions, diameter of the hydrosalpinx, macroscopic condition of the endosalpinx, and thickness of the tubal wall. Using these criteria, patients are classified into three prognostic groups: good, intermediate, and poor. For the good prognostic group, the chances of intrauterine and term pregnancy after tubal surgery have been reported to be 77% and 59%, respectively; the pregnancy rates for the intermediate and poor prognostic groups have been reported to be 16% and 3%, respectively.¹⁸

Winston and Magara¹⁷ have classified the hydrosalpinx into four stages: a thin-walled hydrosalpinx with little or no fibrosis (stage I); a thick-walled hydrosalpinx with good mucosa (stage II); a thick-walled hydrosalpinx with marked mucosal damage, or a thick fibrous adhesion (stage III); and a tubo-ovarian mass or fibrosis, or an adherent hydrosalpinx with incarcerated ovary and/or isthmic damage (stage IV). Pregnancy rates after tubal surgery have been reported to be 39% for stage I disease, 20% for stage II disease, and as low as 9% and 6% for stage III and IV disease, respectively.¹⁷

Thus, tubal surgery is warranted only in patients with mild to moderate tubal disease; for those with severe disease, in vitro fertilisation offers a better

Falloposcopic classification and localisation of tubal lumen disease

Name:
 ID No.:
 Age:
 G: P: A: Ectopic:
 Significant History:
 HSG: Laparoscopy: Laparotomy:
 LMP:
 Date:

Site of disease	RIGHT TUBE				LEFT TUBE			
	intramural	isthmic	ampullary	fimbrial	intramural	isthmic	ampullary	fimbrial
PATENCY								
Patency 1								
Stenosis 2								
Fibrotic obstruction ... 3								
EPITHELIUM								
Normal 1								
Pale, atrophic 2								
Flat, featureless 3								
VASCULARITY								
Normal 1								
Intermediate 2								
Poor pallor 3								
ADHESIONS								
None 1								
Thin, weblike 2								
Thick 3								
DILATATION								
None 1								
Minimal 2								
Hydrosalpinx 3								
*OTHER 2-3								
Cumulative Score								
TOTAL SCORE	RIGHT TUBE: (Normal = 20)				LEFT TUBE: (Normal = 20)			

A cumulative score for each tube of: 20 = Normal tubal lumen; >20 but <30 = Moderate endotubal disease; >30 = Severe endotubal disease
 *Mucus plugs or tubal debris, endotubal polyps, endometriosis, salpingitis isthmica nodosa, inflammatory, infective, neoplastic conditions, and absent tubal segments are each assigned a score of 2 to 3 depending on the significance of the lesion

Treatment performed:
 Prognosis for conception:
 Recommended follow-up treatment:
 Surgeon:

chance of achieving an intrauterine pregnancy. Previously, the endosalpinx status could be assessed only during operation. Using fallopscopy, however, a more accurate assessment of the tubal status can be made before subjecting the patient to tubal surgery, and this information will help to decide the optimal mode of treatment.¹⁹ Fallopscopic findings can lead to a change in patient management in more than 60% of cases.^{6,14,20}

Potential therapeutic applications of fallopscopy

The direct visualisation and identification of each segment of the fallopian tube allows the non-incisional transfer of gametes or embryos into the ampulla region

during assisted reproductive procedures.²¹ In selected patients who have tubal occlusion, pregnancies have been achieved after tubal recanalisation using fallopscopic tuboplasty.²² In addition, direct instillation of methotrexate or an alternative medication during tubal pregnancy can be performed.

Conclusion

Conventional methods that use HSG or laparoscopy to assess tubal infertility are inadequate due to their high rate of both false positive and false negative results. Fallopscopy allows the direct visualisation of

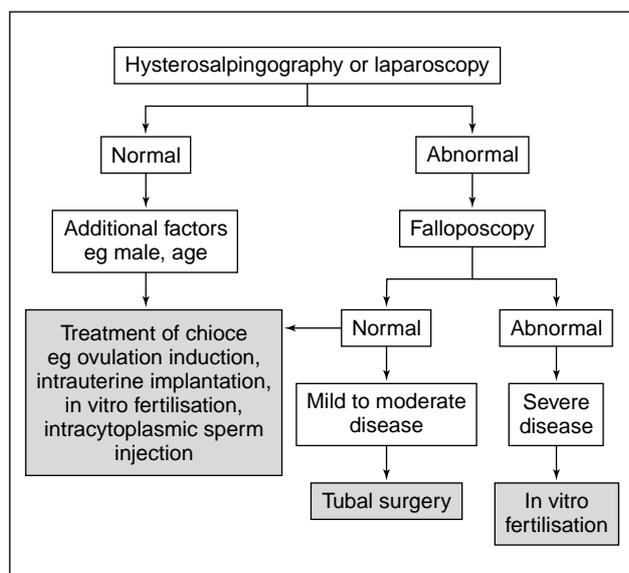


Fig 3. Flow chart describing the investigation and management of tuboperitoneal disease in subfertility patients

the endosalpinx and can diagnose and correct pseudo-tubal occlusion; the method can also detect non-obstructive tubal disease. The increased accuracy of the tubal assessment helps in the allocation of patients to the most appropriate treatment (Fig 3).

The development of the LEC system has enabled fallopscopy to be performed as an office procedure under sedation. The technique is safe and atraumatic, but is still in its infancy; thus, this approach is only employed in very few infertility centres and has not been introduced in Hong Kong. By giving operators the appropriate training, the use of fallopscopy can be increased; pregnancy rates could thereby be improved and the cost and time spent on unnecessary surgical intervention or assisted reproductive procedures could be reduced.

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