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Comparative analysis of hysterosalpingography and laparoscopy in 143 patients with tubal infertility

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Abstract: The objective of this study is to evaluate the diagnostic and practical value of hysterosalpingography (HSG) in diagnosing tubal infertility by comparing it with laparoscopy. We analyzed 273 fallopian tubes from 143 infertility patients who underwent laparoscopic surgery at the Department of Reproductive Medicine, Affiliated Hospital of Hebei University, between December 2019 and December 2022. These patients were indicated for HSG due to suspected fallopian tube obstruction prior to and following surgery. The findings revealed that the sensitivity of HSG in diagnosing tubal patency was 55.66% (59/106), specificity was 98.80% (165/167), and coincidence rate was 82.05% (224/273). For proximal tubal obstruction diagnosis, sensitivity was recorded at 79.37% (50/63), specificity at 76.67% (161/210), and coincidence rate at 77.29% (211/273). Additionally, sensitivity for pelvic adhesiveness diagnosis stood at a mere 34.38% (33/96), with specificity being significantly higher at 85.11% (40/47) and a coincidence rate of only 51.05% (73/143). Consequently, we conclude that while HSG serves as an initial screening method for assessing fallopian tube patency, it exhibits a notable rate of missed diagnoses concerning fallopian tube pathologies and offers limited utility in identifying pelvic adhesions; conversely, laparoscopy can provide therapeutic insights into both fallopian tube lesions and pelvic conditions.

1. Introduction

Nowadays, the incidence of infertility is increasing day by day. According to statistics, the incidence of infertility is about 7%-10% [1, 2], among which infertility caused by fallopian tube factors accounts for about 25%-40% of female infertility [3,4]. Therefore, the detection method of fallopian tube function has always been the focus of clinical research. At present, the main methods used for fallopian tube examination are laparoscopy and hysterosalpingography (HSG). This study discuss and compare the value of hysterosalpingography and laparoscopy in the diagnosis of infertility caused by fallopian tube factors.

2. Data and methods

2.1. General Information

Review From December 2019 to December 2022, a total of 273 fallopian tubes were used as research objects in 143 infertility patients with normal uterine shape and no treatment who were diagnosed with tubal infertility by HSG in our hospital and required laparoscopic treatment in the Department of Reproductive Medicine, Affiliated Hospital of Hebei University. Age: 21-39 years old, average 28.24±4.54 years old; infertility history: 6-196 months, average 28.70±25.03 months; angiography: 1-4 months, average 2.58±1.09 months; blood and urine routine, coagulation function, liver and kidney function, infectious disease examination, electrocardiogram (ECG), blood and urine routine, blood coagulation function, liver and kidney function, and electrocardiogram were performed before surgery. Chest radiography and cervical cytology showed no manual range.

2.2. Detection Methods

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2.2.1. HSG

Menstruation clean for 3-7 days, acute genital tract inflammation, iodine allergy and other contraindications should be excluded before examination, and the examination should be carried out. Phloroglucinol 80mg was intramusculously injected 30 minutes before surgery to prevent false positives caused by fallopian tube spasm. During the operation, the vagina and cervix were disinfected, a liquid tube was inserted into the uterine cavity, and 1-2 mL of normal saline was injected into the air sac to plug the cervix. 20 mL of iodohyl injection was extracted with a disposable syringe and placed on the injector, and the injection speed was set at 5 mL/s. Then the Y-shaped catheter was connected to the imaging tube in a single head, and the pressure receptors of the syringe and injection pump were connected at both ends, respectively. The images were taken when 5 mL, 10 mL, 15 mL and 20 mL were injected, and the imaging results were analyzed according to the images. If the fallopian tube is smooth, the angiography can be completed. If the fallopian tube is obstructed and the water is serious, the film can be taken again 30 minutes later to observe the diffusion of the contrast agent. The patency of fallopian tube was evaluated by two radiologists.

2.2.2. Laparoscopy

The date of operation was selected 3-7 days after the patient's menstruation was cleared. STORZ laparoscopy and a set of uterine and fallopian tube were used. After the completion of general anesthesia, the patient's muscle was taken to the lithotomy position and the head was lowered to 30 degrees. After successful puncture, the first 10 mm Trocar was injected with CO2 gas to establish the pneumoperitoneum, and two 5 mm TROcars were inserted into the McGomez point on the right lower abdomen and the corresponding point on the left side of the laparoscope to directly observe the pelvic cavity and abdominal cavity of the patient. Then, a disposable liquid catheter was inserted into the vagina, and methylene blue was injected under the guidance of laparoscopy. The overflow of methylene blue at the end of the umbrella was observed, and the morphological changes, adhesion range and obstruction site of the fallopian tube were understoode.

2.3. Fallopian tube evaluation criteria

2.3.1. Diagnostic criteria for hysterosalpingography [5]

①Patency: the fallopian tube is developed throughout the whole process, and the contrast agent is misty dispersion in the pelvic cavity;

②Through and not smooth: the tubal development shows that the tubal tube is fine or distorted, and the contrast agent is clustered in the pelvic cavity;

③Proximal obstruction (interstitial or isthmic obstruction): it does not appear as interstitial obstruction, but only shows a section of isthmic obstruction;

④Distal obstruction (ampulla or umbrella end obstruction): development to the distal end, but the contrast agent is clear, the second piece of point-like development is still clear, for the umbrella end obstruction, no contrast agent shadow in the pelvic cavity.

⑤Fallopian tube and surrounding adhesion: the contrast agent flows from the end of the umbrella into the adhesive space into a bud, indicating that the fallopian tube umbrella and the surrounding tissue are adherent. Or after the contrast agent flows out of the fallopian tube, it accumulates around the fallopian tube in a sac and does not disperse.

2.3.2. Laparoscopy: diagnostic criteria[5]

① Patency: no resistance through intrauterine injection, methylene blue from the fallopian tube umbrella end quickly overflow;

② Pass and not smooth: there is resistance to the injection, gently pressurize the injection of liquid, or clamp the other side of the fallopian tube, the distal end of the fallopian tube see methylene blue overflow;

③ Distal obstruction (ampulla or umbrella obstruction) : there was little or no resistance at the beginning of the injection, and the distal fallopian tube showed dilation or salami shape under laparoscopy after pressurizing the liquid injection, and no methylene blue overflow was observed;

④ Proximal obstruction (interstitial or isthmic obstruction) : high resistance to injection or immobility, high uterine tension, blue uterine wall and corner under pressure, no methylene blue overflow in the pelvic cavity under laparoscopy, no expansion of the fallopian tubes, and large countercurrent of methylene blue fluid in the vagina.

⑤Determine the pelvic adhesion according to the relationship between pelvic organs during the operation.

2.4. Statistical methods

The main statistical indicators of diagnosis coincidence rate are sensitivity, specificity, false positive rate and false negative rate. SPSS 27 analysis software package was used to analyze and process the data. X^2 test was used in the counting data line and t test was used in the measurement data line. The difference was statistically significant if $P < 0.05$. Using the results of laparoscopy tubal fluid clearance examination as the gold standard, the diagnosis of tubal patency (including patency and obstruction) was negative, and vice versa (obstruction including proximal and distal) was positive, those without pelvic adhesion were negative, and those with pelvic adhesion were positive. Sensitivity = number of true positive/total number of sick ×100%, specificity = number of true negative/total number of disease-free ×100%, coincidence rate = (number of true positive + number of true negative)/total number of experimental ×100%

3. Results

3.1. Summary of results of laparoscopy and HSG

3.1.1. Laparoscopy and HSG fallopian tube situation

Among 143 patients, there were 273 fallopian tubes except for 13 patients who had previously undergone simple fallopian tube resection, and the results of two examination methods were obtained .(Table 1- Table 4)

Table 1: 273 results of tubal laparoscopy and HSG patency

HSG	laparoscopy		total
	Patency (positive)	Unpatency (negative)	
Patency (positive)	59	2	61
Unpatency (negative)	47	165	212
total	106	167	273

Note: In the examination of HSG, 61 fallopian tubes were found to be unobstructed; 212 fallopian tubes suggested other results; On laparoscopy, 106 fallopian tubes were unobstructed and 167 fallopian tubes showed other results. Of these, 59 fallopian tubes showed patency in both tests.

Table 2: 273 results of tubal laparoscopy and HSG obstruction

HSG	laparoscopy		total
	Smooth but not smooth (positive)	not jammed(negative)	
Smooth but not smooth (positive)	20	7	27
not jammed(negative)	12	234	246
total	32	241	273

Note: In the examination of HSG, 27 fallopian tubes were indicated to be open but not smooth; 246 fallopian tubes showed other results; At the time of laparoscopy, 32 fallopian tubes were not open and 241 fallopian tubes indicated other results. Of these, 20 fallopian tubes were indicated to be open and not smooth in both tests.

Table 3: 273 results of tubal laparoscopy and HSG proximal obstruction

HSG	laparoscopy		total
	Proximal obstruction (positive)	Non-proximal obstruction (negative)	
Proximal obstruction (positive)	50	49	99
Non-proximal obstruction (negative)	13	161	174
total	63	210	273

Note: On HSG examination, 99 fallopian tubes indicated proximal obstruction; 147 fallopian tubes suggested other results; At laparoscopy, 63 fallopian tubes showed proximal obstruction and 210 fallopian tubes indicated other results. Fifty of these fallopian tubes showed proximal obstruction in both modalities.

Table 4: 273 results of tubal laparoscopy and HSG proximal obstruction

HSG	laparoscopy		total
	Distalobstruction (positive)	Non-distal obstruction (negative)	
Distalobstruction (positive)	68	18	86
Non-distal obstruction (negative)	4	183	187
total	72	201	273

Note: On HSG examination, 86 fallopian tubes indicated distal obstruction; 187 fallopian tubes suggested other results; At laparoscopy, there were 72 fallopian tubes with distal obstruction and 201 fallopian tubes with other results. Of these, 68 fallopian tubes showed distal obstruction in both modalities.

3.1.2. Laparoscopic and HSG pelvic conditions are shown in Table 5.

Table 5: Comparison of the results of HSG and laparoscopic pelvic examination in 143 patients

HSG	laparoscopy		total
	Pelvic adhesion (positive)	No pelvic adhesion (negative)	
Pelvic adhesion (positive)	33	7	40
No pelvic adhesion (negative)	63	40	103
total	96	47	143

Note: In the examination of HSG, 40 patients were suggested to have different degrees of pelvic adhesions. There was no obvious pelvic adhesion in 103 patients. There were 96 patients with different degrees of pelvic adhesions and 143 patients without pelvic adhesions under laparoscopy. Pelvic adhesions of different degrees were detected in 33 patients by both methods.

3.1.3. Study on other pelvic conditions under laparoscopy

Among the 143 patients, 46 cases of pelvic endometriosis, 15 cases of ovarian endometriosis (10.49%), 2 cases of pelvic tuberculosis (1.40%), and 1 case of borderline serous tumor (0.70%) were found under laparoscopy.

3.2. Compared with the results of laparoscopy, the diagnosis coincidence rate of the fallopian tube and pelvic cavity was analyzed as follows

3.2.1. Coincidence rate of tubal patency diagnosis

Among 273 fallopian tubes, 106 fallopian tubes were patency and 167 were non-patency. The diagnostic sensitivity was 55.66% (59/106), the specificity was 98.80%(165/167), and the false positive rate was 1.2% (2/167). The false negative rate was 44.34% (47/106) and the coincidence rate was 82.05% (224/273).

3.2.2. Diagnosis coincidence rate of fallopian tube obstruction

Among the 273 fallopian tubes, 32 fallopian tubes were open but not open, 241 fallopian tubes

were not open but not open. The diagnostic sensitivity was 62.50 % (20/32), the specificity was 97.10%(234/241), the false positive rate was 2.90% (7/241), and the false negative rate was 3.75% (12/32). The coincidence rate was 93.04% (254/273).

3.2.3. Coincidence rate of diagnosis of proximal tubal obstruction

Among the 273 fallopian tubes, 63 fallopian tubes were proximal blocked and 210 were non-proximal blocked under laparoscopy. The diagnostic sensitivity was 79.37% (50/63), the specificity was 76.67 % (161/210), the false positive rate was 23.33% (49/210), and the false negative rate was 20.63% (13/63). The compliance rate was 77.29% (211/273).

3.2.4. Coincidence rate of diagnosis of distal fallopian tube obstruction

Among the 273 fallopian tubes, 72 were distal obstruction and 201 were non-distal obstruction. The diagnostic sensitivity was 94.44 % (68/72), the specificity 91.04 % (183/201), the false positive rate was 8.96% (18/201), and the false negative rate was 5.56% (4/72). The coincidence rate was 91.94% (251/273).

3.2.5. Coincidence rate of pelvic adhesion diagnosis

There were 96 patients with pelvic adhesion and 47 patients without pelvic adhesion. The diagnostic sensitivity was 34.38 % (33/96), the specificity 85.11 % (40/47), the false positive rate 14.89% (7/47), and the false negative rate 65.63% (63/96). The coincidence rate was 51.05% (73/143).

3.2.6. Study on the coincidence rate of each type of diagnosis

As can be seen from the diagnostic coincidence rates of different types of diseases in Table 6, angiography has a high diagnostic coincidence rate for distal fallopian tube obstruction, with satisfactory sensitivity and specificity, and is not easy to misdiagnose. The specificity of diagnosis of tubal patency and obstruction is high, and it is not easy to misdiagnose, but the sensitivity is low, and it is easy to miss diagnosis. The sensitivity of diagnosis of proximal fallopian tube obstruction is high, which is not easy to miss, but the specificity is low and easy to misdiagnose. However, both sensitivity and specificity are low in the diagnosis of pelvic adhesion, and the diagnostic value is limited.

Table 6: Diagnostic coincidence rate of different types of diseases (%)

index	sensitivity	specificity	Agreement rate
patency	55.66	98.80	82.05
Pass but not smooth	62.50	97.10	93.04
Proximal obstruction	79.37	76.67	77.29
Distal obstruction	94.44	91.04	91.94
Pelvic adhesions	34.38	84.11	51.05

4. Discuss

According to statistics, the incidence of infertility is gradually increasing under the influence of various factors, among which tubal infertility accounts for about 25-35% of female infertility [1], and is one of the most important causes of female infertility. Choosing the appropriate method to examine the fallopian tubes and pelvic cavity is very important in the diagnosis and treatment of

infertility.

HSG is the preferred method for diagnosing tubal patency. Its advantages are that HSG is convenient and inexpensive. It can detect proximal and distal tubal obstruction, display tuberous salpingitis in the isthm, understand the details of the tubal tube, and evaluate the inflammation around the tubal tube. A 2014 meta-analysis (sample size 4,221 cases) reported sensitivity and specificity as high as 94% and 92% [6]. If HSG indicates that the fallopian tube is patency, then the possibility of fallopian tube obstruction is small [7], which is consistent with the results of this comparative test. The sensitivity and specificity of the diagnosis of distal fallopian tube obstruction are very high, reaching 94.44% and 91.04% in this study, that is, if HSG indicates distal fallopian tube obstruction or hydrops, there is little possibility of no fallopian tube lesions. However, the disadvantage of HSG is that it has low sensitivity and specificity in the diagnosis of proximal fallopian tube obstruction. This study and a retrospective study found that only a few cases obtained consistent results during laparoscopic exploration of patients diagnosed with HSG as proximal fallopian tube obstruction [8]. Another prospective study also found that HSG suggested that patients with proximal obstruction of the fallopian tube received HSG again, and 60% of the cases showed fallopian tube patency [9], which may be due to false positives caused by mucus plugs, tissue debris blockage, or uterine fallopian mouth spasm, so it is necessary to exclude such factors as much as possible before HSG. In addition, although HSG can understand the inflammation around the fallopian tube and the situation of pelvic adhesion, its sensitivity and specificity are not high, only 34.38% and 84.11% in this study, which shows that HSG has certain defects in the diagnosis of pelvic adhesion, and its diagnostic value is not high. In addition, for patients who are not suitable for HSG, HSG is not suitable for the diagnosis of pelvic adhesion. For example, abnormal thyroid function [10], etc., other more suitable methods should be selected as appropriate to examine the fallopian tubes.

Laparoscopy is the most accurate method to evaluate fallopian tube patency at present, but it is not the first choice because of the complicated operation and high cost. However, laparoscopy can confirm suspected tubal lesions and play a therapeutic role in them. Therefore, for infertility patients with reproductive system lesions, laparoscopy can be directly selected as an examination method [11]. However, studies have found that laparoscopic diagnosis also has a false positive rate of about 3% [12], which may be related to intraoperative anesthesia leading to cervical opening relaxation, fluid outflow from the cervical opening, and insufficient intrauterine pressure. Hysteroscopic intubation can effectively solve this problem [13]. In addition, due to its complex operation, high risk factor, long hospital stay, high cost, and other characteristics, laparoscopy can be used as a solution. Laparoscopy can only be used as a second-line diagnosis of tubal infertility.

To sum up, the correct selection of examination methods can not only improve the accuracy of disease diagnosis, bring convenience to clinical work, improve the cure rate, but also reduce the cost and treatment cycle of patients. Both the European Society of Human Reproduction and Embryology and the Chinese Medical Doctor Association suggest that for infertile women without obvious pelvic inflammatory disease and endometriosis, HSG should be used as the preferred screening method to evaluate the patency of the fallopian tube [4, 14], while laparoscopy should be used as a diagnosis and treatment method for patients with suspected pelvic inflammatory disease, salpingitis or internal abnormalities, or unexplained infertility [4,15].In addition, HSG has a certain rate of missed diagnosis, so when the patient's HSG results indicate that the fallopian tube is patency but still not pregnant after one year, laparoscopy should be performed in time to confirm the diagnosis and be treated if necessary.

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