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Review Article

Diagnosis and treatment of fallopian tube obstruction: a literature review

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Abstract: 15% of couples in the world suffer from infertility, and tubal obstruction caused by inflammatory is one of the main causes. The incidence rate of this infertility has increased year by year, corresponding diagnosis and treatment methods also have a rapidly development. At present, commonly used methods are: 1. Diagnosis: Hysterosalpingography (HSG), hysterosalping-contrast sonography (HyCoSy), uterine laparoscopy; 2. Treatment: traditional drugs, Hysteroscopy and laparoscopic surgery, interventional therapy. This paper describes the relevant clinical studies of each method and their respective advantages and disadvantages, indicating that Hysterosalpingography can be used as a preliminary diagnosis of tubal obstruction. Laparoscopy can be used for further pelvic-related disease examination. Select Hysterosalpingography and interventional therapy can be used as a micro-invasive, low cost and efficient diagnosis and treatment program. In addition, patients with complex conditions should be based on specific circumstances and use a single or integrate multiple methods to achieve the purpose of diagnosis and treatment.

Keywords: Fallopian tube obstruction, diagnosis, therapies

Introduction

Fallopian tubes are an important site for the sperm-egg binding, and their normal functioning serves as a prerequisite for natural conception. Obstruction of fallopian tubes, a kind of common disease, is also one of the main causes of infertility. It is urgently hoped by such patients to unblock the obstructed fallopian tubes and restore the reproductive functions. Obstruction of fallopian tubes is mostly caused by inflammation. With increasing infection in reproductive system, especially in the "items" of infection sources, the patients troubled with obstruction of fallopian tubes also grow day by day. The infertile women caused by obstructed fallopian tubes and hydrosalpinx account for 30-40% of all the infertile population [1]. Among the factors of infection, there is general bacterial infection as well as some special pathogen infection caused by chlamydia trachomatis, ureaplasma urealyticum, mycoplasma hominis, and protozoon. Thus accurate diagnosis and optimum chosen therapy are critical for the treatment of infertility. Now the common ways of diagnosis include hysterosalpingography, hysterosalpingo contrast sonography, gynecological endoscope, serological chlamydia examination. A variety of therapies are available, which are dominated by hysteroscope, laparoscope, and interventional therapy. Other therapies available include use of traditional Chinese medicine and psychological interventional therapy. The paper gave a brief review of diagnosis and treatment of the infertility caused by obstruction of fallopian tubes, and illustrated the merits, demerits and corresponding clinical application of each therapy, respectively.

Examination and diagnosis

The tubal infertility can be diagnosed by a number of ways, including hysterosalpingography (HSG), Hysterosalpingocontrast sonography (HyCoSy), gynecological endoscopy, and serological chlamydia examination.

Hysterosalpingography (HSG)

HSG means to inject iodinated oil, a kind of high specific gravity substance, into the uterine cav-

ity through the cervix so that the lumen forms significant artificial contrast with surrounding tissues under X-ray and the physician can get to know the conditions of the uterus and fallopian tube lumen. It can not only prompt about the blockage and its location in fallopian tubes but also reveal the uterine shape. This way of examination is relative safe without significant pain and anaesthesia, thus it is a typical approach used frequently to judge the smoothness or not of the uterine cavity and fallopian tubes [2]. The diagnostic criterion of this method are: 1. Tubal patency: no resistence while injecting the contrast agent; X-ray results show normal oviduct morphology with engorged contrast agent; contrast agents are evenly distributed in the pelvic cavity after 24 h. 2. Tubal partial obstruction: some resistance while injecting contrast agent; contrast agent filled in oviduct but showed tortuous, narrow, sticky and acute sometimes; fallopian tubes may present stiff or local thickness; contrast agents are unevenly distributed in the pelvic cavity after 24 h. 3. Fallopian tube obstruction: oviducts do not develop or develop partially while injecting contrast agent; no contrast agent outflow from tubes; contrast agent do not appear or present crumby structure in pelvic. Some studies [3] evaluated the accuracy of HSG diagnosis and compared it with the laparoscopy, and found that HSG was highly sensitive in the diagnosis, useful in the preliminary examination of obstruction of fallopian tubes, and advantageous in such aspects as minor invasiveness, low cost and complication incidence. On the other hand, it is not as effective in identifying such diseases as pelvic inflammation, endometriosis, and salpingorrhexis with low value for diagnosis [4]. The aforesaid diseases can be further examined and diagnosed with laparoscopy. To sum up, HSG is convenient in operation and low in cost, so it is still widely promoted and used in the primary schools.

Hysterosalpingocontrast sonography (HyCoSy)

HyCoSy is to inject contrast agent into the lumen so as to dilate the closed uterine cavity and fallopian tubes and form ultrasonic images. It is mainly used to diagnose the diseases concerning uterine cavity and evaluate the smoothness of the fallopian tubes. At first, the researchers at home and abroad mainly focused on two-dimensional ultrasonic imaging by combining the HyCoSy with two-dimensional ultrasonography to diagnose gynecological diseases. The contrast agent evolves from the normal saline to hydrogen peroxide, and ultrasonic contrast agents of 1st and 2nd generations, whereas the ultrasonography technology develops from the normal B-type gray-scale ultrasonic imaging to color doppler blood flow imaging, energy diagram, and all sorts of new imaging techniques so that the diagnosis becomes increasingly accurate. The limitation of two-dimensional ultrasound contrast lies in following aspects: it can't display the whole curved fallopian tube on different planes; the contrast agent can't be distinguished from the echo of intestinal canal due to high similarity; it is impossible to get the coronal section of uterus and the information about uterine diseases is limited. Three-dimensional ultrasound contrast is produced to conquer the shortcomings of two-dimensional one. With the updated contrast agent and imaging technology, 3D-HyCoSy can obtain 3D stereo images of the fallopian tubes and display three sections (namely coronal section, sagittal section, and cross section) vertical to each other at the same time, thus it can better evaluate the shape, smoothness or not, and obstructed site of the fallopian tubes [5].

Wang *et al.* [6] employed three-dimensional ultrasound contrast to diagnose 52 cases of obstructed fallopian tubes. In accordance with the CLP diagnosing criteria, the diagnosing sensitivity, specificity, positive predictive value and negative predictive value of 3D-HyCoSy were 82.4%, 88.3%, 77.9%, and 90.2%, respectively. The application of 3D ultrasound significantly raises the sensitivity and specificity of the diagnosis [7]. It is noteworthy that the three-dimensional imaging is built on the basis of two-dimensional images, so the latter's quality can directly affect the effect of the former. With narrow scope of observation, three-dimensional transvaginal ultrasound examination is inapplicable to the women pregnant for 8-10 weeks. Moreover, when the lump in the adnexa area is quite large or has complicated structure, it may intervene with the display of tubal reconstruction. The 3D HyCoSy can't well reveal the interior of the fallopian tubes, especial the diseases concerning tubal mucosa and pelvic adhesion.

Gynecological endoscopy

1. Laparoscopy is a golden criterion for the diagnosis of tubal infertility [8] with high sensitivity and specificity and ability in evaluating the abdominal cavity and other pelvic structures. LIU *et al*. [9] carried out hydrotubation and HSG towards 120 cases of tubal infertility under laparoscopy. The results revealed the sensitivity and specificity of HSG in diagnosis of tubal obstruction were 84.62% and 69%, while those of laparoscopy were 94.87% and 83%. It indicated that the laparoscopy was better in diagnosing such obstruction. But for the patients, the laparoscopy was an invasive examination demanding high cost. It is improper to be used as primary tool of diagnosis due to many factors concerning environment and conditions [10]. Some researchers insisted that the laparoscopy was more advantageous in the diagnosis of pelvic diseases [11], and it could be used in the further diagnosis in case of missed diagnosis with HSG [12, 13].

2. Hysteroscopy: one of the primary strengths of the hysteroscopy is its ability to enable the physicians to directly examine the inside of uterine cavity and make accurate judgment about the diseases, determine the organic causes within the cavity for some infertility or recurrent abortion, and remedy the shortcomings of traditional diagnosis and treatment methods. Molinas *et al*. [14] believed that it provide a direct view of the inner part of uterine cavity, the hysteroscopy can become primary tool of diagnosis for the infertility caused by obstructed aperture of fallopian tubes. Some studies [15-17] even pointed out that the combined examination of hysteroscopy with laparoscopy could improve significantly the accuracy of the diagnosis.

Serological chlamydia examination

The physiological functional disorders concerning fallopian tubes or tubal infertility are mostly caused by tubal mucositis and perisalpingitis after appearance of all sorts of pelvic infections. Now some studies have proved [18] that the tubal infertility is related to chlamydia trachomatis (CT). Li Yuhua *et al*. [19] conducted relevant lab examinations in two groups [CT-DNA, UU-DNA, antibody to heat shock protein 60 (C-HSp60), IL-6, IFN-γ and bacterial culture], recorded the positive rates of all the test indicators of research objects, sorted out the data through statistical approaches, and analyzed the relation between the tubal infertility and some reproductive tract inflammatory factors and pathogens. Their results revealed the positive indicators in observation group were significantly higher than those in control group, and positive rates of C-HSp60, IL-6 and IFN-γ for patients suffering from tubal infertility grew obviously and could be used as serological indicators for clinical screening of tubal infertility. Such examination can provide a new approach for the clinical diagnosis of tubal infertility.

Therapies

Tubal recanalization under assistance of endoscopy

Tubal obstruction therapy under assistance of hysteroscopy-laparoscopy: The cause of disease can be determined under the direct view with hysteroscopy-laparoscopy so as to perform following procedures on the basis of the determined cause: salpingolysis, oophorocystectomy, hysteromyoma, polycystic ovary drilling operation, intrapelvic abnormality reductive surgery, pelvic adhesiolysis, tubal fimbrioplasty and neostomy. Proximal intubation, pressurization and hydrotubation under hysteroscopy can be performed for the middle and proximal obstruction, needle electrode separation for intrauterine adhesion, and loop electro-surgical excisional procedure, bipolar vaporization, or scissor cutting for uterine malformation.

Tube recanalization under assistance of hysteroscopy: The patient took misoprostol orally 1 h before taking the operative treatment. After normal sterilization and anaesthesia, the uterus was distended, hysteroscopy was inserted into the uterus and then into the fallopian tube to reach the interstitial portion with adjustment of the ostium. Mixed solution of normal saline, gentamicin, dexamethasone and methylene blue was injected into the catheter. Attention was paid to the return of recanalization liquid. F Yang [20] divided 60 patients of tubal infertility into two groups, and performed normal intubation recanalization and intubation recanalization under assistance of hysteroscopy on them. According to the results, the successful rate of incubation recanalization under hysteroscopy was 93.3% (28/30) while that in case of traditional incubation recanalization was 67.7%

(20/30), and significant difference could be detected between them. It indicates that the treatment of tubal obstruction with incubation recanalization under assistance of hysteroscopy can obtain good clinical effect.

Tube recanalization under assistance of laparoscopy: The patients accept normal disinfection in the vulva before the operation. Aseptic towel should be spread and the anaesthesia adopts intratracheal inhalation. The patient is asked to adopt lithotomy position, and cut is formed below the navel as entrance for laparoscopy. A small cut of 5 mm is also created in front of crista iliaca. The operation assistants prepare all the apparatus and instruments required for the operation, and the uterine and tubal recanalization is carried out. The selection of operation plan depends on the conditions of the patients in order to ensure the specificity and scientificity of the operation. After the operation, normal anti-inflammation is exerted and preventive measures against fallopian tube adhesion should be taken. The concrete operation procedures as well as the type and way of operation vary with the patients. In general case, the operations include tubal fimbriae dilation, tubal end anastomosis, mass release, and salpingostomy. Wang *et al*. [21] recanalized the obstructed fallopian tubes of 63 patients under the assistance of laparoscopy. After the treatment, the smoothness rate of the patients achieved 49.2%, and no negative effect or complication was found after the operation. The prognosis was satisfactory. The laparoscopy is proven to have good clinical effect and few intraoperative complications in treating tubal infertility, thus it can be effective to clinical practice.

The tube recanalization under combined hysteroscopy with laparoscopy: Li Hongmei [22] divided 80 patients suffering from tubal infertility into two groups. About half of the patients in each group was of secondary infertility. Two groups accepted tube recanalization with hysteroscopy and its combination with laparoscopy, respectively. The test results revealed that the successful recanalization rate in the hysteroscopy group was 55%, significantly lower than that of hysteroscopy-laparoscopy group (85%). In the group of hysteroscopy in combination with laparoscopy, the recanalization rate among 21 secondary infertility patients was 85.71% which was significantly higher than that (27.78%) among the 19 primary infertile patients in the group of hysteroscopy. The recanalization rates was no significant difference between 18 secondary infertile patients in the hysteroscopy group and the 22 primary infertile patients in the group of hysteroscopy in combination with laparoscopy, which meant the treatment effect of hydrotubation under hysteroscopy in combination with laparoscopy was significantly better than that of hysteroscopy alone. The means of combined technology was especially effective for the secondary infertile patients.

Wire-guided tube recanalization under combination of hysteroscopy with laparoscopy: The operation takes lithotomy position and tracheal intubation is performed under general anaesthesia. Laparoscope is inserted into the body to detect the shape, size, and location of the pelvic cavity, uterus and ovary and find out whether the fallopian tubes have adhesion or distortion. Corresponding operative procedures are performed, such as separation of the pelvic adhesion (if any), and restoration of the organs within the pelvic cavity to the normal shapes as much as possible. The patients displaying fimbriae adhesion and dropsy should accept plastic surgery or neostomy; those having mesosalpinx cyst should accept enucleation; those having focus of endometriosis should accept electrocoagulation on the focus or enucleation of chocolate cyst. The hysteroscopy is inserted to observe the thickness and color of the endometrium as well as the shape of uterine cavity. Oviduct catheter is placed through the ostium of fallopian tubes under hysteroscopy, and mixed solution of methylene blue with normal saline is injected through the catheter as indicator so that the physician can get information about the obstruction of fallopian tubes and the detailed location through the indicator under laparoscopy monitoring. In case of great resistance or partial enlarged fallopian tube, it indicates existence of tubal obstruction. Tube recanalization is performed by inserting the RF guide wire into the oviduct catheter and propelling it from the near end to the remote end of fallopian tubes in order to dredge the adhesion in interstitial portion, isthmus and ampullary region of the fallopian tubes. The guide wire is inserted until it reaches the fimbriae of the fallopian tubes. After that, the wire should be retreated, and diluted solution of methylene blue is again injected. Under the laparoscopy,

when the diluted solution of methylene blue is found to flow out from the fimbriae end, it means the fallopian tubes are successfully recanalized, but the solution should be injected still to prevent possible adhesion. In their studies, Hou *et al*. [23] implemented tubal intubation with hysteroscopy under the guidance of laparoscopy on 650 patients suffering from unilateral or bilateral proximal tubal obstruction. As revealed by the results, successful tubal incubation can significantly improve the pregnant rate, and the patients with unilateral tubal obstruction are mostly possible to get pregnant after successful incubation. It means the women with proximal tubal obstruction can consider accepting the hysteroscopy intubation under guidance of laparoscopy as a substitute plan for the assisted reproductive technology.

Interventional treatment

Interventional treatment is a minimally invasive approach for treating the obstruction of fallopian tubes by combining radiological apparatus with imaging equipment to realize intervention. The way of diagnosis is to adopt selective salpingography, and the treatment methods include tube recanalization and drug perfusion within fallopian tube lumen. The traditional per-X ray salpingography serves only as a means of detection that can find sites of adhesion and obstruction but can't exert treatment. By contrast, the selective salpingography increases the static pressure of liquid within fallopian tubes, and conquers the pain caused by excessive expansion of the uterine cavity and pseudo-positive factors of sphincter spasm, while the recanalization makes use of the dilation of the guide wire to separate the adhesion within fallopian tubes and restores unblocked fallopian tubes through the pushing static force of the liquid. Meanwhile, it can also facilitate the identification of the obstruction causes so as to achieve diagnosis and treatment at the same time. To perform salpingography is to use digital subtraction angiography and apply oviduct interventional recanalization apparatus under the monitoring with imaging equipment and place the catheter at the fallopian tube lumen for injection of contrast agent. If development fails at the far end of fallopian tubes, it is proven that the near end gets obstructed, and further tube recanalization should be performed. The tube recanalization is to place the catheter at the ostium of the obstructed fallopian tube, and insert guide wire into the catheter to separate the adhesion. After a successful recanalization, anti-inflammatory drug should be injected to treat the salpingitis and anti-adhesion medicine to consolidate the effect of therapy.

In a clinical study [24], 116 cases of tubal obstruction were randomly divided into experimental group and control group to accept interventional tube recanalization therapy under imaging of digital subtraction angiography (DSA). The patients in the experimental group accepted tube perfusion with ozone water while those in control group with normal anti-inflammatory and adhesion medicines. As revealed by the experimental result, the successful recanalization rate, pregnant rate and recurrence rate were 93.1% (54/58), 79.3% (46/58), and 5.2% (3/58), respectively for the experimental group, and 91.4% (53/58), 60.3% (35/58) and 17.2% (10/58) respectively for the control group. An analysis prompted about no statistical difference in respect of the successful recanalization rate between two groups, and lower pregnant rate and recurrence rate in the experimental group. The experiment indicates that the interventional drug perfusion in treatment of tubal obstruction can effectively raise the post-operation pregnant rate, and the perfusion of fallopian tubes with ozone can substitute the traditional anti-inflammatory and adhesion medicines.

Assisted treatment with traditional Chinese medicine (TCM)

Although the treatment of tubal obstruction by combining hysteroscopy with laparoscopy can improve the uterine pregnancy rate, it is susceptible to recurrence of adhesion and obstruction after the operation. Some researchers [25-27] found that the use of TCM can activate blood circulation, dissipate stasis, and dredge collaterals during or after the tube recanalization, which can obtain better effect of tube recanalization treatment, effectively reduce the re-obstruction rate and improve the intrapelvic environment, consolidate the operating effect, and raise the pregnant rate. In the opinions of TCM, the infertility caused by tubal obstruction can be mainly attributed to the accumulation of damp toxin, Qi-stagnation and blood stasis, and obstructed veins. It is thus believed in TCM that the mission of tubal obstruction treatment

is to activate the blood circulation, dissipate the stasis and dredge the collaterals [28]. Chen G Y *et al*. [25] performed guide-wire dredging treatment under combination of hysteroscopy with laparoscopy on 89 patients with obstructed fallopian tubes in their study, and it was found that 164 fallopian tubes of 84 patients were successfully recanalized. Those 84 patients were randomly and equally divided into two groups, namely Group A and B, after the operation. Each group was composed of 42 patients. The patients in Group A accepted TCM orally in combination with Kangfu Xiaoyan Suppository butt plug after the operation for three courses of treatment (10 d per course), whereas the patients in Group B received no special treatment. The follow-up one year later indicated that among the 86 patients who had successful tube recanalization, 22 in Group A and 12 in Group B realized intrauterine pregnancy with total intrauterine pregnant rate reaching 39.53% (34/86), and the difference in respect of intrauterine pregnant rate between two groups was significant, but that in tubal pregnancy was insignificant. In addition, those failing to get pregnant 1 year after the operation accepted HSG. The examination prompted about 19.5% of re-obstruction rate in Group A and 39.3% in Group B. The difference between two groups was significant. This proves that the combination with TCM after hysteroscopy-laparoscopy combined operation can improve the intrauterine pregnant rate and the assisted TCM therapy after tube recanalization has certain reference value for treatment.

Discussion

Among the infertile women, 30-40% of them are caused by diseases concerning fallopian tubes. The tubal diseases serve as a common factor inducing female infertility and pose a task for the infertility treatment. The pathogenesis is quite complicated, including inflammation in fallopian tubes, oviduct tuberculosis, endometriosis, post-operation pelvic damage and adhesion, and congenital aplasia. Among them, the non-specific salpingitis is the most common cause for the obstruction of fallopian tubes, accounting for one third of the tubal infertility. There are many diagnostic methods about tubal patency, including imageological diagnosis (HSG and HyCoSy), and hysteroscopy and laparoscopy diagnosis. Endoscopy examination can visually observe the condition of tubal mucosa, but more for the assessment of surgical prognosis and adjustment of treatment programs. Laparoscopic is the most reliable method of examination. But, because of the invasive and expensive, it is most used as a means of treatment. HSG is the main diagnostic method of tubal obstruction infertility. And it can prove to be therapeutic at times [29]. However, HSG means producing a continuous pressure which was used to make the contrast agent filled into uterine cavity. This condition may induce patients with poor comfort, and even produce pain. HyCoSy is also based on similar principle in HSG, so there are also similar shortcomings. Selective salpingography (SSG), which can be used as diagnostic and therapeutic method, greatly make up for the shortcomings of HSG. But in terms of the operability of the device, experienced doctors who can make a quick, accurate and painless operation are needed. The therapies in early stage such as hydrotubation have such advantageous as simple equipment, convenient operation, and low cost, but they are also troubled with high misdiagnosis rate. They can't determine the site of the tubal obstruction or its severity and property, and they may cause massive hemorrhage with tubal rupture in case of ectopic pregnancy. The appearance of the hysteroscopy-laparoscopy and salpingography enables the physicians to make a comprehensive evaluation of the conditions of fallopian tubes, uterine cavity and pelvic cavity. The examination with laparoscopy can evaluate the structure of fallopian tubes and relationship between fallopian tubes and other tissues and organs, accurately separate the tubal adhesion and pelvic adhesion, restore the shapes and activities of fallopian tubes, and diagnose such diseases as endometriosis in pelvic cavity, and raise the pregnant rate among secondary infertile patients when used concurrently [22]. When it is prompted that the fallopian tubes are obstructed in hydrotubation under hysteroscopy, guide wire recanalization can be directly carried out with monitoring of laparoscopy, which harvests good treatment effect in respect of proximal tubal diseases [30-36]. As for the distal obstruction of fallopian tubes, some researchers [37-39] pointed out the assisted laparoscopy therapy is of satisfactory clinical value in treating the patients with light to moderate distal tubal obstruction; the post-treatment pregnancy or not is related to the severity of tubal diseases; and early diagnosis and treatment are

Table 1. Advantages and disadvantages of diagnosis methods in fallopian tube obstruction

Methods	Characteristic	Advantages	Disadvantages
Hysterosalpingography (HSG)	Radiography (x-ray)	Most commonly used, low cost	Limited disease diagnosis, x ray radiation
Hysterosalpingocontrast sonography (3D-HyCoSy)	Ultrasonography	No Radiation, few side effects, diagnosis accuracy	Patients suffer pain observation effect are susceptible to Interferent difficult operation for doctor
Gynecological endoscopy	Hysteroscopy/Laparoscope	Gold standard	Invasive, high cost
Serological chlamydia examination	FQ-PCR*	-/-	Potential methods

*FQ-PCR(Fluorescence Quantitative-Polymerase Chain Reaction).

Table 2. Advantages and disadvantages of treatment methods in fallopian tube obstruction

Methods	Characteristic	Advantages	Disadvantages
Tubal recanalization under assistance of endoscopy	Hysteroscopy/Laparoscopy	Comprehensive and accurate treatment	Invasive, high cost
Interventional treatment	Integrated diagnosis and treatment	Non-invasive,low cost, Integrated diagnosis and treatment	x ray radiation
Medical treatment	Drugs	Auxiliary treatment method	Independent employment effect is not good

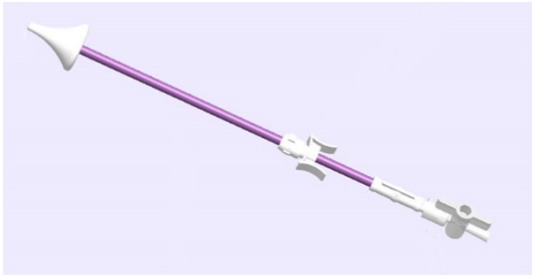

Figure 1. Hydrotubation for HSG, a new type of apparatus for HSG.

more effective. In general, the use of hysteroscopy-laparoscopy can greatly help with the treatment of tubal obstruction, but it is not promoted in the application due to expensive price. The interventional treatment with salpingography and tubal recanalization causes little surgical injury when compared with the combination of hysteroscopy with laparoscopy, but it produces X-ray radiation [24].

The TCM therapy does obtain some effect in treating the tubal obstruction-induced infertility [40-42], but it has its own shortcomings, such as the lack of uniform differentiation criteria and effect evaluating standards in the clinical studies or quantitative classification of the severity of tubal obstruction. On the other hand, this disease requires long-term treatment, but the TCM administration is not convenient. The acting mechanism of TCM remains unclear so that the therapeutic effect is limited with lack of specificity in the clinical treatment. Nevertheless, relevant clinical studies reveal [25-27] the assisted use of TCM after the combined operation of hysteroscopy with laparoscopy can prevent recurrence of adhesion after the tubal recanalization so as to improve the therapeutic effect. In addition, the psychological factors of the patients also matter [43], which means psychological intervention can help with the treatment of tubal obstruction [44].

To sum up, we summarized the diagnosis and treatment methods of tubal obstruction. We simply described the advantages and disadvantages in **Tables 1** and **2**. In diagnosis aspect, HSG is one of the most commonly used methods for the diagnosis of fallopian tube obstruction. The cost is small and micro-invasive, but there are some uncontrollable factors in the application of HSG. These factors can cause the patient's discomfort and the inaccuracy of the diagnosis. There are two main types of instruments for HSG in the market: 1. The invasive type: balloon catheter, which are the currently main used instrument; 2. Minimally invasive type: hydrotubation for HSG, a new type of apparatus for HSG (**Figure 1**). Through the expansion of the cervix, the balloon catheter was placed into the uterine cavities. Then we can complete the injection of contrastagent through outside mouth of the Balloon catheter. Contrast agent goes into the uterine cavity through catheter, then we can judge the fallopian tube and uterine cavity conditions with X-ray. However, because of balloon inflatable

Table 3. the comparation between Hydrotubation for HSG and balloon catheter

Clinical application	Hydrotubation for HSG (minimally invasive)	Balloon catheter (invasive)
Operation time	3-5 minutes	10-20 minutes
Operator visibility	Wide range of operator visibility	Narror operator visibility in uterus
Number of operators	1	2
Degree of difficulty	Operator do not need training	Operators need training
Pain sensation of Subject	Very little pain	Obvious pain
Application Range	Can be used in different hunman	Can not be used in Uterine abnormality or deformity, cervix flabby, et al.
Security	Not entering the cervix, high safety performance	Entering the cervix, low safety performance

compression on uterus, the uterine morphology and problems might be partially obscured. Sometimes the inside catheter tip leans against the cornua uteri. This condition may obstruct the opening of the fallopian tube, causing the fallopian tube obstruction illusion. Because its invasion on uterine cavity, this method belongs to invasive operation. Another method, the hydrotubation for HSG, only need to put the catheter into the vagina and place at the outside of the cervix. Then the conditions of uterus and fallopian tube can be examined by injecting contrast agent with X-ray. So, we defined this method as a minimally invasive type due to keeping out the cervix. **Table 3** compares two methods and indicates that the minimally invasive hydrotubation for HSG should gradually replace the invasive balloon catheter. HyCoSy developed rapidly in recent years. With better imaging technique (from 2D to 3D imaging), diagnostic results are more accurate, but the observation area of ultrasound diagnosis has some limitations, and observation effect are susceptible to Interferent. In the treatment aspect, hysteroscopy-laparoscopy produces significant effect on the treatment of tubal obstruction-induced infertility when used either separately or in combination. Guide-wire recanalization and later assisted medicine therapy can be adopted in view of the conditions of patients in order to ameliorate the therapeutic effect and prevent relapse. But this method is invasive and expensive, needs a long recovery period for patients. Moreover, the interventional treatment of tubal obstruction (SSG + fallopian tube recanalization) is also significantly effective. Being minimally invasive, such treatment can greatly relieve the patients' pain and cut down the operation time. But this method needs experienced interventional doctors to ensure fast and painless treatment. Compared with other methods, interventional therapy can be defined as a combinative methods in diagnosis and treatment. It can be commonly used as a tubal obstruction diagnosis and treatment methods. Howerver, because the equipment for this methods is not yet perfect, doctors require expert operation. Therefore, in the future, in order to make this method more simple, feedback device of pressure and angle controller should be added. So that, Even if the doctor who do not familiar with the operation can easily find the fallopian tube mouth, and then quickly and accurately operate diagnosis and treatment.

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Disclosure of conflict of interest

None.

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