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Discussion on operative skills in the embolization of hydrosalpinx by hysteroscopic placement of a microcoil

Hua-Lei Cai, BS[a], Le-Yun Pan, BS[b], Shun-Fang Wang, BS[b], Yu Tian, BS[b], Xiao-Zhu Zheng, BS[b], Yan Yang, BS[b], Kun Li, BS[c,*]

Abstract

This study aims to discuss the operative skills of hysteroscopic tubal embolization and reduce the occurrence of complications.

Ninety-four patients were divided into group A and group B. The main surgical technique in group A: when the inner sleeve is sent to the fallopian tube and no longer accessible (but no >3 cm), remove the guide wire and put into the microcoil. But in group B, there are four major surgical techniques. First, the depth at which the guide wire enters the tube was controlled at 2 cm. Second, the inner diameter of the fallopian tube must be explored to determine the type and shape of the coils. Third, saline should be used to separate the catheter. Fourth, it is to control the release speed of the coils. The superiority of the improved operation method was confirmed by comparing the surgical failure rate, incidence of complications, and cost of surgery before and after the procedure.

The reoperation rate of group A was 10% (3/30), while that of group B was 2.68% (3/112). The ectopic microcoils rate of group A was 6.67% (2/30), while that of group B was 0.89% (1/112). The microcoil damages rate of group 23.33% (7/30), while that of group B was 8.04% (9/112). All P values were $<.01$, and the difference was statistically significant.

Hysteroscopic tubal embolization is currently a new surgical procedure to block the fallopian tubes and prevent the reverse flow of fluid in the fallopian tubes into the uterine cavity. After we improved surgical techniques, the surgical failure rate, complication rate, and operation cost of fallopian tube embolization were significantly lower than before the improved method was applied. The improved techniques led to a higher success rate.

Abbreviations: HSG = hysterosalpingography, IVF = in vitro fertilization, IVF-ET = in vitro fertilization-embryo transfer, PET = polyethylene terephthalate.

Keywords: embolization of hydrosalpinx, hysteroscope, microcoil

1. Introduction

Fallopian tube obstruction is the main indication for tube babies. However, effusion in the obstructed tube affects the success rate of the test tube baby. Studies have shown that hydrosalpinx reduced the clinical pregnancy rate of in vitro fertilization-embryo transfer (IVF-ET) by 50% and natural abortion rate by 2 times. The reasons for this result mainly include the following. Water in the hydrosalpinx can return to the uterine cavity and wash the embryo away. Meanwhile, the water contains endotoxins, which is toxic to the embryos. The level of integrin $\alpha v\beta 3$ decreases, causing the endometriosis to decrease. This would affect embryo implantation.[1–4] These patients had a lower embryo implantation rate, clinical pregnancy rate, and higher abortion rate. Therefore, it is very important to treat hydrosalpinx before IVF-ET.

Therefore, a blocked fallopian tube and no fluid flow to the uterine cavity to provide a relatively good uterine environment for embryo transfer is a problem that needs to be solved before embryo transfer. In order to avoid multiple laparotomy or laparoscopic surgery, and reduce the risk of anesthesia and surgery, modern fallopian tube obstruction technology has emerged as the times require.

There are 4 ways to prevent the fallopian tube effusion from flowing into uterine cavity. These are fallopian tube embolism, tubal ligation, fallopian tube resection, and fallopian tube parasol.[5–7] A relatively less risk and more convenient and economical method is to perform fallopian tube obstruction through the uterine cavity, which can be performed under local anesthesia, thereby avoiding the risk of general anesthesia and the cost of hospitalization. The method of plugging the fallopian tube with microcoils has been reported in literature in the 1990s. The principle was that platinum microcoils are used for the mechanical embolization of the proximal end of fallopian tubes, with villi attached to the coils. This can increase the compatibility with the inner wall of the fallopian tube, mechanically block the

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[a] Department of Obstetrics and Gynecology, The Affiliated Hospital of Guizhou Medical University, [b] Department of Obstetrics and Gynecology, The Affiliated Baiyun Hospital of Guizhou Medical University, [c] Department of Surgical, The Affiliated Hospital of Guizhou Medical University, Guiyang, China.

[*] Correspondence: Kun Li, Department of Surgical, The Affiliated Hospital of Guizhou Medical University, No. 28 of Guiyi Street, Yunyan District, Guiyang 550004, China (e-mail: kunlidr@163.com).

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tubal cavity, and prevent the hydrosalpinx from flowing back into the uterine cavity. Furthermore, this may also change the local microenvironment of the embolism. Moreover, the release of alkaline phosphatase from slightly mechanically necrotic tissues caused by the placement can induce helper lymphocytes to gather, fibrovascular hyperplasia, etc. This would enhance tubal obstruction. After a period of operation, aseptic inflammation, compression necrosis and partial fibrosis would occur around the coils, thereby further enhancing the effect of the embolization.[8,9] However, the operation should receive large doses of radiation, which has a certain effect on ovarian function, and the eggs cannot be taken immediately after the operation.

Rosenfield reported the first case of tubal embolization through the hysteroscopic placement of a microinsert, which was an Essure (Conceptus). The patient had a 6.5-year history of infertility. A hysterosalpingogram revealed a left hydrosalpinx. The patient was offered surgical intervention to treat the hydrosalpinx to potentially improve the chance for successful pregnancy through IVF-ET. However, the 31-year-old nulligravid woman underwent laparoscopic left oophorectomy for a persistent 6-cm complex adnexal mass, because of a body mass index of 50.5 kg/m^2. In order to avoid the previously recountered risks of general anesthesia and laparoscopy in this morbidly obese woman, the patient elected to undergo hysteroscopic placement of a microinsert. After the in vitro fertilization, the patient had a good outcome.[10] Hence, it is a reasonable method to find the opening of the fallopian tube by hysteroscopy and place a microinsert into the tubal cavity to block the fallopian tube. Compared with x-ray mediated tubal embolization, the advantage of this procedure was that it is similar to the fallopian tube intubation fluid. It can be completed under paracervical nerve block anesthesia in an outpatient clinic, without contact with radiation therapy. Furthermore, the operation has no effect on ovarian function.[10] Therefore, it is an ideal method for patients who need tubal embolus due to the test tube. However, hysteroscopic tubal embolization is not yet a mature procedure, and loss during the placement of microcoils is the most difficult event to explain. If the microcoil falls into the uterine cavity, it will be easy to remove. However, it would be difficult to remove if it enters the ventral ampulla of the fallopian tube or abdominal cavity. Therefore, we need to explore a correct placement method to eliminate such events.

2. Materials and methods

2.1. Subject investigated

This study was conducted in accordance with the declaration of Helsinki and approved by the Affiliated Hospital of Guizhou Medical University Ethics Committee and the Affiliated Baiyun Hospital of Guizhou Medical University Ethics Committee. Informed consent was given and written informed consent was obtained from all participants. From September 2012 to January 2017, 94 patients underwent hysteroscopic tubal embolization in the Affiliated Hospital of Guizhou Medical University and the Affiliated Baiyun Hospital of Guizhou Medical University.

(1) The patients were divided into 2 groups: group A (n=20), patients with no improvement in surgical technique, and 30 tubal tubes needed to be plugged; group B (n=74), patients with improved surgical skills, and 112 tubes needed to be plugged.

(2) The microcoil used was a Hilal Embolization Microcoil. This microcoil is usually used for clogging up blood vessels. It curled diameter and length is 3 mm and 1.0 cm, respectively. When it is elongated, it has a length of 3 cm. The device consists of a platinum inner coil, an outer coil made from nitinol and polyethylene terephthalate (PET, Dacron) fibers. The platinum wire has a diameter of 0.018 or 0.035 in. The catheter used was a modified Novy Cornai Cannulation Set. The microcoil was delivered through the 3-Fr operating channel of the 6.5-mm-diameter continuous-flew hysteroscopy. The optimal positioning of the microcoil would occur in the interstitial and isthmus part of the fallopian tubes. Then, 0-1 coils are immediately trailed from the tubal ostium into the endometrial cavity after placement of the microcoil. Merely 1 microcoil is placed on each side of the fallopian tube. If the B-ultrasonography does not detect a metal echo in the correct position after surgery, the placement of a second microcoil may be considered.

(3) In the present study, the experience of previous operations was summarized and the following 4 details were identified as the key techniques: the depth at which the catheter leads into the fallopian tube was controlled at a depth of 2 to 3 cm; the appropriate model and shape was selected to explore the tightness of the fallopian tube cavity; saline was used to dilate the fallopian tubes; the speed of releasing the coils was controlled. The image of uterine horn after surgery is shown in Fig. 1, and the ultrasonography after surgery is shown in Fig. 2.

(4) Statistical method: SPSS 12.0 software (IBM) was used for statistical analysis, and chi-square test was used to compare the count data.

3. Results

We use chi-square test to process the data. The age of patients in group A was 22 to 44 years old, and that in group B was 24 to 45 years old. There was no statistically significant difference in the age between the 2 groups ($P > .05$). The reoperation rate of group

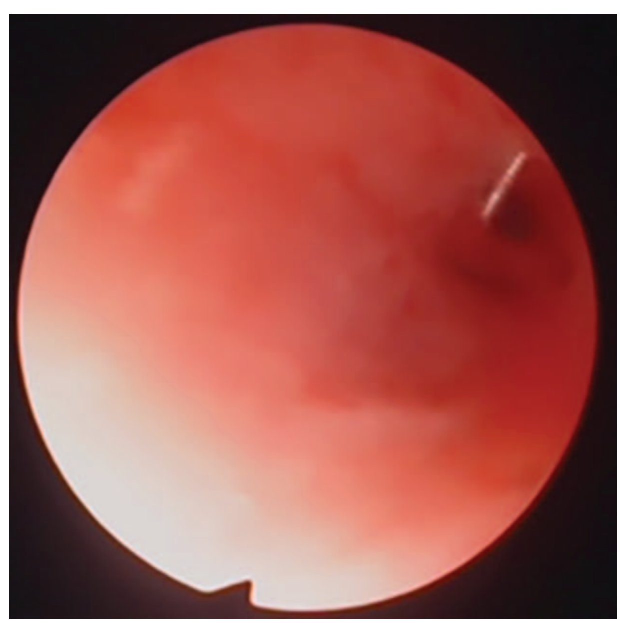

Figure 1. The image of uterine horn after surgery.

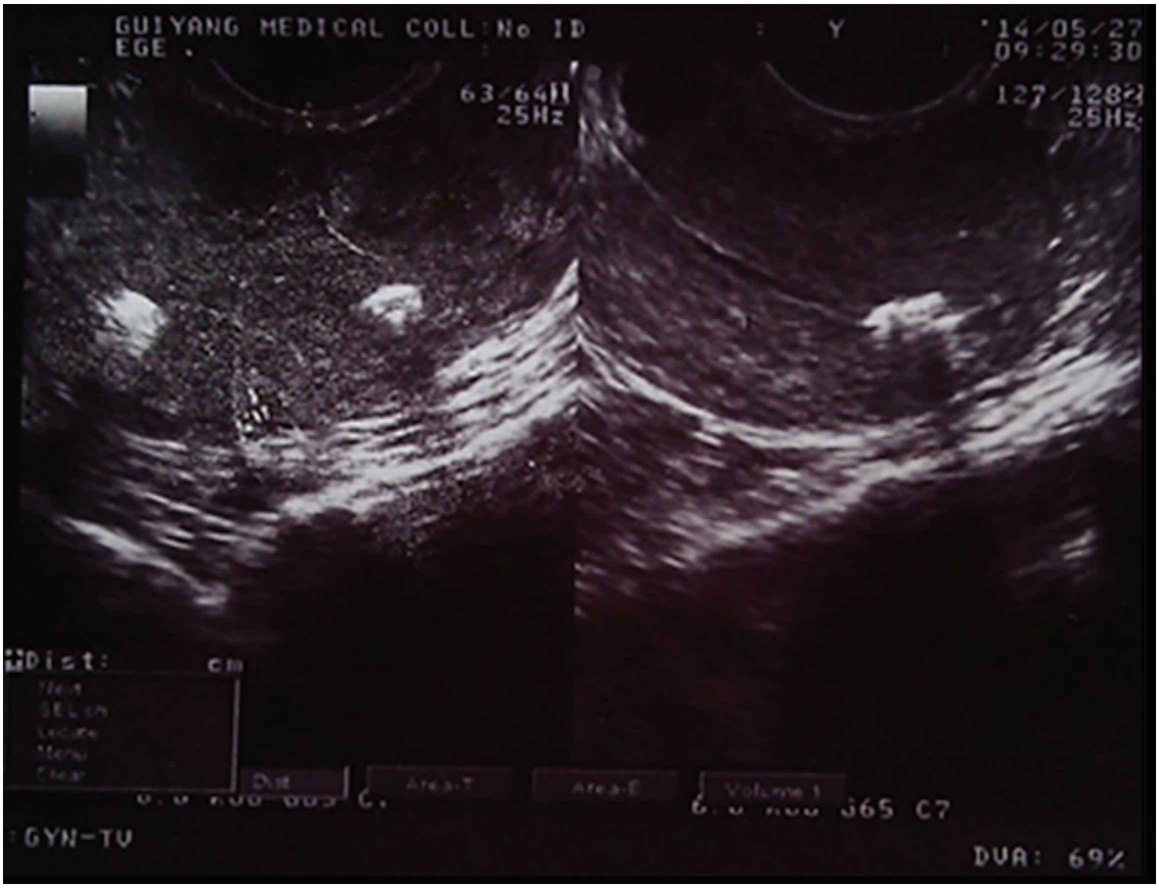

Figure 2. The ultrasonography after surgery.

A was 10% (3/30), while that of group B was 2.68% (3/112). The $P<.01$. The ectopic microcoils rate of group A was 6.67% (2/30), while that of group B was 0.89% (1/112), $P<.01$. The microcoil damages rate of group 23.33% (7/30), while that of group B was 8.04% (9/112), $P<.01$. All P values were <.01, and the difference was statistically significant (Table 1).

4. Discussion

Fallopian tube obstruction is the main indication for making a test-tube baby. However, the obstruction of fallopian tube effusion cells of the embryo lead to scour and toxic effects that affect in vitro fertilization (IVF) outcomes. This thereby blocks the fallopian tube, and stops the tubal fluid flow to the uterus and embryo transfers due to the intrauterine environment. This is a problem that needs to be solved before embryo transfer. In order to avoid multiple open abdomen or laparoscopic surgery, and reduce the risk of anesthesia and surgery, modern fallopian tube obstruction technology has come into being. Tubal embolization is a technique for the treatment of hydrosalpinx before IVF-ET, which aims to block the fallopian tube quickly and conveniently, in order to avoid the scouring and toxicity of the tubal effusion on IVF embryos, and improve the success rate of IVF-ET. Rosenfield used Essure to obstruct the fallopian tube, allowing the patient to give birth through IVF-ET. Ensure is a device for laparoscopic sterilization. The device was placed near the end of the fallopian tube under the guidance of hysteroscopy.[11] In addition, Essure can be used to treat hydrosalpinx IVF patients.[12–14] However, it is still in the research stage, and is not a standard use for operations.

Therefore, the investigators attempted to intubate the fallopian tube through hysteroscopy and place microcoils. This surgical approach had no radiation, and was more intuitive. However, since this technology is rare, there was not enough clinical experience both here and abroad. The present study conducted a retrospective analysis of these cases in our hospital since it was launched in 2012. The patients were divided into 2 groups, and the time to improve the surgical technique was the node. The number of reoperations (representing the surgical failure rate) of patients, the number of abnormal microcoil cases (representing surgical complications), and the number of damaged microcoils (representing the cost of operation) were compared after improving the technique, and it was found that the surgical failure rate, complications, and surgical costs were all reduced. The difference was statistically significant. Hence, it was considered that the surgical improvement is effective. In order

Table 1

Comparison of reoperation, microcoils ectopic, microcoil damage between the 2 groups.

Group	Reoperations	Ectopic microCoils	microCoil damages
A (n=30)	3	2	7
B (n=112)	3	1	9
P	<.01	<.01	<.01

Statistical treatment: chi-square test, $P<.01$.

to summarize the improvement of the surgical technique, 4 important points were considered. First, there was a need to understand the correct placement of the microcoils, in order to determine the length of the tube entering the fallopian tube. The interstitial part of the normal fallopian tube was 0.5 to 1.0 mm in diameter and 1 cm in length, while the isthmic part was 1 to 2 mm in diameter and 2 to 3 cm in length, which is the narrowest segment in the fallopian tube. Hence, the best place for tubal embolization is from the interstitial part to the isthmus. A 3-cm long microcoil was used, and the length of which is the same as that of the interstitial part of the fallopian tube and the isthmus of the fallopian tube. The improved technique was to place the tip of the coil exactly 2 cm from the opening of the fallopian tube, in order to allow the coil to be curled short after it is released. Subsequently, the coil will eventually be placed in the middle of the interstitial part of the fallopian tube, the isthmus. This requirement was achieved by limiting the depth at which the guide wire enters the fallopian tube. The depth at which the guide wire enters the tube was controlled at 2 cm, and the shallowest case was 1.8 cm.

Second, the inner diameter of the fallopian tube must be explored to determine the type and shape of the coils, and avoid the early fall off of the coils. The 3Fr catheter can pass through the narrowest part of the fallopian tube in some patients, but it has a certain sense of closeness, which needs to be realized in practice. After severe hydrosalpinx, the interstitial part and isthmus of the fallopian tube were also thickened and dilated, and the inner diameter was allowed to reach approximately ≥2 mm. When the inner diameter of the fallopian tube is thicker or the water is enlarged,[15] the 3Fr catheter can easily and smoothly enter the ampulla through the isthmus of the fallopian tube. Caution must be given in distinguishing it from the perforation of the fallopian tube, because the tube is delicate. It is easy for a tube with a metal guide wire to break through the fallopian tube, both of which cause the coil to be lost into the broad ampulla of the fallopian tube or abdominal cavity (it is not easy to remove the microcoil). If the microcoil falls into the abdominal cavity or the ampulla of the fallopian tube, it does not induce a bad effect. However, it would always worry the patient, causing psychological stress. Hence, it is important to explore the thickness and direction of the fallopian tube during surgery.

It is often difficult to explore the cavities of the fallopian tube. These difficulties are mostly the conglutination of the lumen, and sometimes the distortion of the fallopian tube. No matter what the circumstances, do not use the guide wire to force the separation, because this kind of operation would most likely cause tubal perforation. Saline should be used to separate the catheter, and follow up with the lead wire, which gradually sends the catheter where it is needed.

The last point is to control the release speed of the coils, in order to allow the coils to have time to curl. This is one of the key factors that prevent the coils from easily falling off. The diameter of the coil wire used was generally 0.46 mm or 0.89 mm, which is less than or equal to the inner diameter of the fallopian tube. When the coil metal wire is curled up, it forms a 3-mm coil, which blocks the fallopian tube. This is also the main reason for keeping the coil position early after the surgery. If the coil is released too fast and the coil cannot be curled up, it will present in the fallopian tube in a rather straight and thin state, and allow it to easily to fall off under the action of fallopian tube peristalsis, especially when the fallopian tube is thicker.

Through the improvement of the above techniques, damage to the coils and catheters was obviously reduced during the operations, which was statistically. Due to the improvement of the above techniques, none of the coils entered the abdominal cavity, or the whereabouts of the coils remained unknown. A review of 5 studies revealed that the microcoil discharge rate was between 0.4% and 3%.[16] The microcoil discharge rate in the present data was 0.02%. But, most of the current studies used microcoil is Essure, it is mainly used for sterilization. The microcoil that we use is Hilal Embolization Microcoil, it's smaller than Essure, we want it to have little effect on the embryo of IVF.

The effectively of the hysteroscopic tubal embolization requires hysterosalpingography (HSG) to be confirmed. There was a metal echo near the horn of the uterus by B-ultrasound, which confirms that the position of the coil is basically correct. Figure 2 shows the ultrasonic signs of microcoils in the bilateral uterine horn. However, it cannot be confirmed whether the fallopian tube remains unobstructed. HSG revealed the occlusion of the fallopian tube after Essure.[17] Since patients are often eager to undergo IVF-ET, HSG cannot be used as a routine reexamination. This is often performed only after clinical doubts on the effectiveness of the fallopian tube embolization. Figure 3 presents 1 year after fallopian tube embolization. Multiple unsuccessful embryo transfer was determined by HSG, which clearly revealed that the coils were outside the angle of the uterus and partially curly, and the fallopian tubes had no emerge at all.

Hysteroscopic tubal embolization is a new method for preconditioning hydrosalpinx. Compared with the traditional method, the operation is safe, simple, and economical, and has a good application prospect.[18] The most important factor for the proper placement of bilateral microinsertion devices is to fully observe the opening of the fallopian tube.[19] Through the improvement of surgical techniques, such as the use of a catheter guide wire into the fallopian tube at a depth of 2 to 3 cm, the selection of the appropriate model and shape to exploring the

Figure 3. One year after fallopian tube embolization.

tightness of fallopian tube cavity, the use of saline to dilate the fallopian tubes, and controlling the speed of releasing the microcoil, the failure rate, complications, and operation cost were reduced. Exploring the correct operation method would be helpful for the popularization and development of this technique.

Author contributions

Conceptualization: Hualei Cai, Kun Li.
Data curation: Leyun Pan, Shunfang Wang.
Formal analysis: Leyun Pan, Shunfang Wang.
Methodology: Yu Tian.
Resources: Xiaozhu Zheng, Yan Yang.
Software: Yu Tian.
Supervision: Kun Li.
Writing – original draft: Hualei Cai, Kun Li.
Writing – review & editing: Hualei Cai, Kun Li.

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