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Case Report

An innovative application of the holmium laser: a case report of hysteroscopic holmium laser proximal fallopian tubal occlusion

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Abstract: Hysteroscopic proximal tubal occlusion is a treatment option prior to in vitro fertilization and embryo transfer (IVF-ET) in patients with a hydrosalpinx or salpingitis. The Holmium:YAG laser is well-suited for hysteroscopic procedures; however, its use in the treatment of salpingitis has not been previously reported. Here, we report a case of a 30-year-old female who presented to our hospital in 2018 after multiple failed embryo transfers. Her medical history included an induced abortion and a laparoscopic left salpingectomy performed at 12 weeks of gestation on May 4, 2010, due to bilateral tubal abscess. She was discharged following postoperative anti-inflammatory treatment. However, on May 22, 2010, she developed recurrent lower abdominal pain. Pelvic ultrasonography suggested a possible pelvic abscess. Empiric treatment with meropenem and vancomycin was ineffective, and on June 4, 2010, the patient underwent right salpingectomy and pelvic adhesiolysis. Despite multiple IVF attempts in 2017 and 2018, all transfers failed, which was considered to be due to persistent inflammation of the left tubal stump. In 2018, she underwent hysteroscopic proximal fallopian tubal occlusion using a holmium:YAG laser at the left tubal ostium, an innovative application of holmium laser. Following the procedure, she underwent successful embryo transfer and subsequently delivered a healthy infant.

Keywords: Fallopian tube transplant, inflammation, surgery, case report

Introduction

Hydrosalpinx/salpingitis can negatively impact the outcome of in vitro fertilization and embryo transfer (IVF-ET) due to factors such as mechanical obstruction of the uterus, altered endometrial receptivity and embryonic toxicity [1-3]. Treatment options for hydrosalpinx/salpingitis include laparoscopic salpingectomy, laparoscopic tubal ligation, ultrasound-guided aspiration and sclerotherapy, hysteroscopic proximal tubal occlusion (PTO) [4-7]. To address mechanical blockage of the fallopian tube, PTO is an effective option prior to IVF-ET in patients with a hydrosalpinx [8]. By placing an embolization device at the proximal end of the fallopian tube, PTO induces local aseptic inflammation and fibrosis, which leads to the proliferation of fibrous tissue and smooth muscle, ultimately resulting in complete fallopian tube obstruction. However, safety concerns related to PTO have also been raised, including implantation failure, tubal perforations, persistent pain, and systemic contact dermatitis [9, 10].

Holmium:YAG (Ho:YAG) laser is a solid-state pulsed laser with a wavelength of 2.1 microns. It can be transmitted through optical quartz fibers and used in liquid medium, making it highly suitable for hysteroscopic procedures [11]. Ho:YAG laser has a shallow penetration depth of only 0.4 mm in tissues, allowing for precise cutting with minimal damage to surrounding tissues. Studies have shown that the Ho:YAG laser is an effective, simple, and safe tool for hysteroscopic septal hysterectomies [12]. However, to date, studies on the use of Ho:YAG laser for fallopian tube occlusion are scarce, particularly in patients with salpingitis. In this case, we report a patient with salpingitis

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who underwent hysteroscopic holmium laser proximal tubal occlusion. After laser therapy, local tissue adhesion and hyperplasia resulted in tubal obstruction. Subsequently, the patient underwent successful embryo transfer and delivered a healthy infant.

Case presentation

This study was approved by Medical Technology Clinical Application and Research Ethics Committee of The First People's Hospital of Hangzhou (Approval No. IIT-20230430-0083-01).

The patient is a 30-year-old female who was admitted in November 2018 with the complaint of "discovery of uterine abnormalities for 2 days" and a history of multiple IVF-ET failures. Her medical history included an induced abortion and laparoscopic left salpingectomy performed on May 4, 2010, at 12 weeks gestation due to a bilateral tubal abscess. Following the surgery, she was discharged after postoperative anti-inflammatory treatment. On May 22, 2010, the patient experienced lower abdominal pain, and color ultrasound suggested a possible pelvic abscess. Despite treatment with meropenem and vancomycin, the inflammation was not resolved, leading to right abdominal tubal resection and pelvic adhesion separation on June 4, 2010.

Then, the patient underwent IVF-ET 2-3 times between 2012 and 2013, with 4-5 eggs retrieved and 2-3 embryos transferred each time; all three attempts failed. At the time of hospitalization, the patient reported no vaginal bleeding, no abdominal pain or distension, and requested a hysteroscopic evaluation.

The patient was admitted for a gynecological examination, which revealed no abnormalities in the vulva. The vagina appeared smooth, and the cervix was normal. The uterus was positioned anteriorly, of regular size, with no tenderness on palpation, and no obvious masses were detected in the bilateral adnexa. Ultrasound examination revealed that the uterus was anteriorly tilted, with normal size and shape. The myometrium displayed heterogeneous echoes, with a nodular area approximately 1 cm in diameter, showing poorly defined boundaries and non-uniform echogenicity. Color doppler flow imaging (CDFI) suggested reduced blood flow in the myometrium. The uterine cavity line was clear, with a double-layer endometrial thickness of about 0.3 cm, and the echogenicity was not homogeneous. The right ovary was about 5.0*2.1*3.6 cm with 9-10 follicle-like structures, the largest being 1.9*0.8*1.4 cm, while the remaining follicles ranged from 0.4 to 0.9 cm. The left ovary was about 1.7*1.4*0.8 cm, with three follicle-like structures about 0.4-0.7 cm in diameter. No obvious free fluid was observed in the pelvic cavity.

Hysterosalpingography

After bilateral salpingectomy, hysterosalpingography was performed to observe the morphology of the uterine cavity and determine whether any fallopian tube remnants were present. A water-soluble contrast agent (Uvexin 3 mL) was injected. The results indicated that the uterine shape resembled a saddle, with the uterine cavity well-filled with contrast agent. A small amount of clear and translucent shadows was seen in the regions of the uterine horns on both sides. The left uterine horn was poorly visualized, and the left fallopian tube was not seen. The pelvic wall was coated with contrast agent, suggesting uterine adhesions and inflammation of the left tubal stump. Based on these findings, hysteroscopic holmium laser with proximal tubal occlusion at the left tube opening was recommended.

Preoperative and intraoperative findings

Routine preoperative examinations were basically normal. The patient underwent hysteroscopic holmium laser proximal occlusion of the left fallopian tube under intravenous general anesthesia. A prophylactic dose of cephalosporins were routinely administered 30 minutes before the operation to prevent infection. Intraoperatively, the uterine cavity appeared morphologically normal. The left tubal opening was enlarged (**Figure 1**), while the right tubal opening was normal in appearance. The endometrium showed slight congestion and minimal hemorrhage. Then, the left fallopian tube was occluded using the hysteroscopic holmium laser (**Figure 2**), and the occlusion of the fallopian tube opening post-laser treatment was confirmed (**Figure 3**).

Postoperative care and outcome

Cephalosporin + Metronidazole was administered orally to prevent postoperative infection.

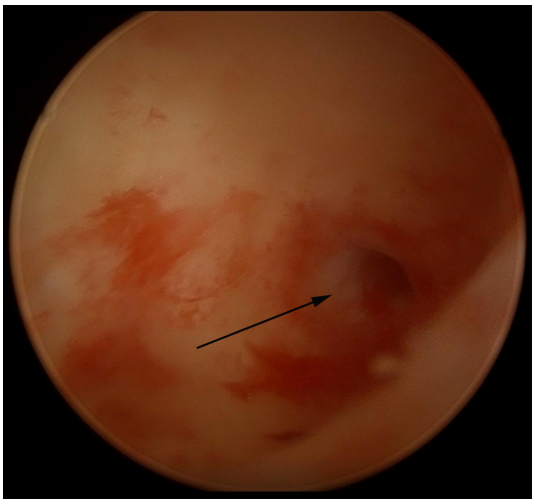

Figure 1. Hysteroscopic view showing a significant enlargement of the left fallopian tube opening; Arrow indicates opening spot.

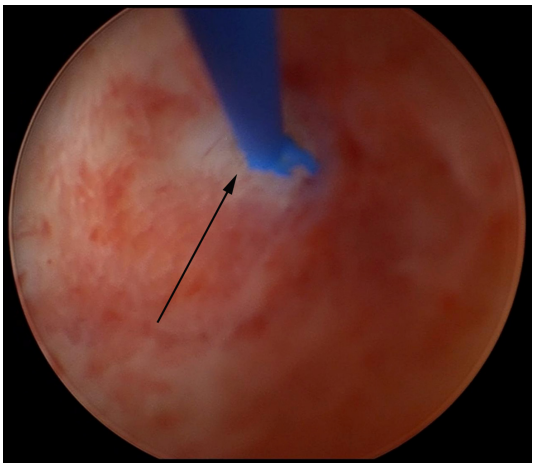

Figure 2. Occlusion of the left fallopian tube using hysteroscopic holmium laser; Arrow indicates the laser fiber during the procedure.

Ultrasound showed that the diameter of uterine interstitial fibroid was 1 cm. There were no postoperative complications. After laser therapy, local tissue adhesion and hyperplasia resulted in tubal obstruction. The patient subsequently became pregnant and delivered a live baby.

Discussion

In this case, repeated embryo transplantation failed after salpingectomy for a tubal abscess, which was considered to be related to inflammation of the tubal stump. Laparoscopic salpingectomy and tubal ligation are common treatment choices for hydrosalpinx/salpingitis [11]. However, in this case, the bilateral fallopian tubes were moved, and the lesion was located in the remnant interstitial portion of the tube. As a result, tubal ligation was ineffective. Furthermore, the patient underwent two surgeries for pelvic abscess, with significant adhesions observed during the second operation. Repeated laparoscopic or open surgery is not a viable option, as it would not only be technically challenging but also carry a high risk of intestinal injury.

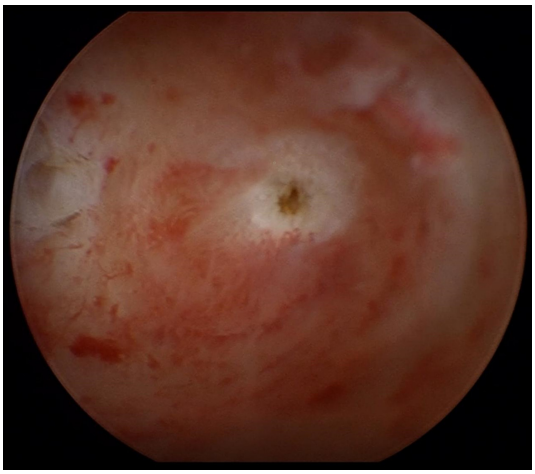

Figure 3. The left fallopian tube opening after hysteroscopic holmium laser occlusion; Arrow indicates the site of occlusion.

Compared with a single-stage procedure, the laser can reduce thermal radiation damage to the muscle layer [13]. In monopolar electrosurgery, the current flows through various tissues outside the surgeon's visual control and then returns to the generator, posing a risk of thermal injury to distant tissues [14]. In addition, peripheral nerve irritation, including to the obturator nerve, may lead to severe obturator spasm and damage to surrounding structures [15]. Also, the use of hypotonic, electrolyte-free solutions such as glycine or sorbitol during monopolar electrosurgical hysteroscopy carries a risk of fluid overload and hyponatremia [16].

Ho:YAG lasers are widely used in various surgical specialties, particularly in urology, orthopedics, and dentistry [17, 18]. Ho:YAG lasers can be transmitted through a 400 micron quartz fiber that passes through the 5fr working chan-

nel of a 5 mm BETTOCHI surgical sheath [11], eliminating the need for cervical dilatation. The pulsed Ho:YAG laser is a promising tool for hysteroscopic surgery due to its cutting precision, reduced charring effect, good hemostasis, and ease of handling. Compared to Nd:YAG and semiconductor lasers, holmium lasers cause less tissue damage in a water environment and less local damage after surgery [19]. The treatment is simple and easy to perform with little risk.

Compared with PTO, the Ho:YAG laser avoids foreign body placement and eliminates the risk of embolus migration. Moreover, the procedure is performed at the opening of the fallopian tube, leading to more effective obstruction than at other sites. However, a limitation of this case is that as the patient had undergone multiple surgeries, and the condition had recurred, leading to the use of the innovative holmium laser for treatment. While there are fewer references for its clinical application in patients diagnosed with hydrosalpinx for the first time, the surgical success observed in this case, coupled with favorable intraoperative and postoperative outcomes, supports the recommendation of holmium laser treatment for broader clinical use due to its advantages of causing less tissue damage postoperatively.

Conclusion

In conclusion, this protocol is worthy of widespread application in patients with a hydrosalpinx requiring tubal preconditioning before IVF-ET.

Disclosure of conflict of interest

None.

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