Application of microwave ablation at a frequency of 2.45 GHz to the uterus: Present and future

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Abstract

Microwave endometrial ablation at 2.45 GHz using a thin, curved microwave applicator for organic menorrhagia was developed more than 10 years ago. Since then, the number of patients who undergo this treatment has been gradually increasing. Additionally, various clinical applications of microwave ablation to gynecologic lesions, including direct microwave ablation therapy for myoma and adenomyosis, is occasionally conducted. Other techniques include transcervical microwave myolysis for uterine myomas and transcervical microwave adenomyolysis for uterine adenomyosis combined with microwave endometrial ablation. Necrosis followed by shrinkage of myomas and adenomyosis after microwave ablation therapy has been observed in a pilot study. Microwave endometrial ablation as an alternative to hysterectomy appears to be a logical choice for treating noninvasive endometrial cancer and atypical endometrial hyperplasia when the patient is a poor surgical candidate.

Key words: microwave endometrial ablation, myolysis, menorrhagia, myoma, adenomyosis

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**Introduction**

Before the introduction of microwave endometrial ablation (MEA) at a frequency of 9.2 GHz for treating menorrhagia, microwaves were not frequently utilized in gynecologic practice. Since then, thousands of patients have undergone MEA. Presently, global endometrial ablation (GEA), including MEA, without hysteroscopic resection or coagulation of the endometrium, is more widely used than hysteroscopic ablation (EA). Kanaoka et al. developed MEA at 2.45 GHz using a thin, curved microwave applicator for treating organic menorrhagia in a distorted or enlarged uterine cavity. This paper describes the present status of MEA at 2.45 GHz and novel application of the microwave ablation technique for treating uterine myoma and adenomyosis.

A new versatile, alternative to hysterectomy for treating menorrhagia in Japan

Hysterectomy for functional menorrhagia seems as an over-surgery at least in part. Since hysteroscopic resection or coagulation of the endometrium is a low-invasive alternative to hysterectomy, many women with functional menorrhagia undergo this procedure. From a medical economical perspective, the National Health Service in the United Kingdom determined that EA may serve to reduce the economic burden imposed by hysterectomy procedures. The cost was compared between endometrial ablation and hysterectomy, and it was concluded that endometrial ablation was cheaper than hysterectomy for at least the first 1 year after treatment. Thus, a number of hysteroscopic EAs were performed.

Hysteroscopic EA requires clinicians to have the skill of hysteroscopic resection or coagulation, which is obtained through training. Additionally, hysteroscopic EA may cause water intoxication, bleeding, and uterine perforation during operation. Therefore, various apparatuses specifically used for EA without hysteroscopic surgery were developed, making EA easier to perform and safer for patients. EA without hysteroscopic resection or coagulation is referred to as the second generation EA or GEA.

A prospective randomized study was conducted to compare MEA at 9.2 GHz and hysteroscopic EA. Hysterectomy rate was found to be significantly lower and the rate of satisfaction was significantly higher after MEA than after hysteroscopic EA at 10 years after treatment. In this comparative study, inclusion criteria were menorrhagic women who did not wish to retain child bearing potential with the uterine size equivalent to 10 weeks of pregnancy or less; however, the existence of a submucous myoma or adenomyosis was not considered. Thus, the study was performed primarily in patients with functional menorrhagia. GEA using various power sources other than microwaves is also indicated for treating menorrhagia in a uterus without distortion or enlargement of the cavity, suggesting that GEA is primarily indicated for functional menorrhagia. Hydrothermal ablation (HTA) is exceptionally suitable for treating the endometrium lining the cavity containing a small submucous myoma. However, organic menorrhagia in a cavity containing a large submucous myoma is a contraindication. Therefore, HTA as an alternative to hysterectomy for organic menorrhagia is insufficient.

In Japan, functional menorrhagia is primarily treated using medication. Combined estrogen-progestin drugs or antifibrinolytic drugs covered by Japanese health insurance are effective for treating functional menorrhagia. Additionally, oral contraceptives and the levonorgestrel intrauterine system (LNG-IUS) developed for contraception are also used to treat functional menorrhagia, although they are not covered by health insurance. Hysterectomy is selected only when conservative treatment is unsatisfactory or when there is a contraindication for medication. However, laparoscopic hysterectomy as well as abdominal hysterectomy is popularly indicated for patients with an enlarged uterus with myomas or adenomyosis. Therefore, a novel alternative to hysterectomy in Japan should be versatile such that it can be used for treating organic menorrhagia caused by considerably large myomas or adenomyosis; the procedure should also be minimally invasive, safe, cheap, and easy to perform, for widespread adoption as an alternative to hysterectomy. The alternative should also be useful for treating menorrhagia caused by a large submucous myoma that is beyond the capability of hysteroscopic myomectomy due to the size or location. Hysterectomy for menorrhagia is paid in part by health insurance, while treatment using a novel method is funded by the patient. Therefore, an alternative treatment should have significant advantages over
hysterectomy to increase value to the patient. Thus, the author developed MEA at 2.45 GHz using a thin, curved applicator as an alternative to hysterectomy for treating organic menorrhagia.

Microwave endometrial ablation at 2.45 GHz

Before the first report regarding MEA at 9.2 GHz was published, a microwave tissue coagulator that generates microwaves at 2.45 GHz had been used by Japanese surgeons when coagulating thermally unresectable hepatocellular carcinomas. A few patients with ectopic pregnancy underwent laparoscopic surgery using the microwave tissue coagulator in the pilot study. However, Japanese gynecologists stopped utilizing microwaves at 2.45 GHz until MEA at 9.2 GHz was reported. A microwave tissue coagulator was used to thermally coagulate the endometrium of a Japanese woman with menorrhagia due to aplastic anemia. A thin microwave applicator 1.6 mm in diameter was introduced into a normal-sized uterine cavity. In the pilot study, microwaves were irradiated to the endometrium in 5 women. Menorrhagia was cured in all patients. It was concluded that MEA at 2.45 GHz was effective for treating menorrhagia in a uterine cavity of normal size. To apply MEA at 2.45 GHz to a uterus with an enlarged cavity, which is distorted by myomas or adenomyosis, a curved microwave applicator 4 mm in diameter was developed. The new curved applicator enabled irradiation with microwaves to the endometrium at the cornus, fundus, and the distal surface of the submucous myoma protruding into the cavity. After MEA using the curved applicator, total or partial necrosis extending from the directly necrotized area of the submucous myoma was observed (Fig. 1), followed by shrinkage of the myoma in addition to improvement of menorrhagia. The number of patients that undergo MEA at 2.45 GHz is gradually increasing in Japan.

MEA is also effective for emergent hemostasis. MEA can be used to stop uterine bleeding more easily and rapidly than hysterectomy or uterine artery embolization.

Microwave myolysis

A submucous myoma with a large protruding ratio that is small in size shrinks following MEA. However, a submucosal myoma with a small protruding ratio or large size does not shrink following MEA. Even when menorrhagia is cured by MEA, a growing myoma may cause hysterectomy or second MEA before menopause. Myolysis simultaneously performed with MEA may reduce the amount of therapy required after MEA, and some papers have reported that laparoscopic myolysis combined with hysteroscopic EA reduces the need for hysterectomy before menopause. Next, transcervical microwave myolysis (TCMM) using a microwave applicator with the sharp end inserted and fixed in the myoma assisted by transcervical ultrasonic guidance was developed. TCMM was performed following MEA in a submucous myoma more than 5 cm in size. After 5-10 min of continuous microwave irradiation, delayed necrosis in the area extending from the directly necrotized area around the applicator tip in a myoma was induced; with this procedure, the myometrium

Figure 1 Contrast-enhanced T1-weighted MRI of a uterus enlarged by a submucous myoma occupying the uterine cavity 4 weeks after MEA.

The uterine lining and a half of the submucous myoma is depicted as an avascular area.

(cited from reference 13)
adjacent to the myoma remains intact (Fig. 2). Menstrual bleeding decreased and the necrotized area shrank 3 months after the operation. Although the short-term result was satisfactory, longer observation is needed to evaluate the usefulness of simultaneous MEA and TCMM use.

Microwave adenomyolysis

Adenomyosis is a tumor-like condition common in women aged 30 to 50 years. Adenomyosis causes dysmenorrhea and menorrhagia in addition to enlargement of the uterus. Resection of the adenomyotic lesion is not widely performed as myomectomy for uterine myomas in women who wish to become pregnant. Rollerball EA is not effective for deep adenomyosis. When the duration of microwaves irradiated from an applicator tip in the uterine cavity is increased to treat deep adenomyosis, it fails to necrotize adenomyosis deeper than 10 mm from the cavity lining. Some patients become amenorrheic after MEA and continue to develop dysmenorrhea. Therefore, hysterectomy is presently the standard surgical treatment for adenomyosis. Analogous to TCMM, transcervical microwave adenomyolysis (TCMAM) combined with MEA is feasible. Deep adenomyosis may be treatable by combining TCMAM with MEA. Thus, we performed a pilot study of MEA with TCMAM (unpublished results).

Adenomyotic tissue is fragile in comparison with normal myometrium and myoma. It is more easily penetrated by a thin microwave applicator than myoma. After MEA was completed, a 4mm microwave applicator was transcrivically introduced into the uterine cavity and inserted into the adenomyotic lesion assisted by transabdominal ultrasonic guidance. Based on the lesion size, microwaves at 40 W were continuously irradiated for 100 to 200 s. Four weeks after operation, contrast-enhanced MRI revealed that a de novo avascular area of 18-27 mm in thickness was located near the cavity (Fig. 3). Both menorrhagia and dysmenorrhea improved, and the necrotized area shrank in 3 months after the operation. Although the short-term results were satisfactory, longer obser-
viation is needed to evaluate the effectiveness of simultaneous MEA and TCMAM use.

MEA for Endometrial Malignancy

A malignant endometrial lesion is a contraindication of MEA. However, treatment of a minimally invasive endometrial neoplasm is feasible. A paper published in the United Kingdom reported the case of an elderly woman with corpus cancer who was treated using MEA at 9.2 GHz. The author reported that MEA at 2.45 GHz was successfully used to treat complex endometrial hyperplasia with atypia in a young woman with various complications. In 2010, Owaki and colleagues reported at the annual meeting of Japan Society of Obstetrics and Gynecology the successful treatment of corpus cancer in an elderly woman using MEA at 9.2 GHz. Indication of MEA for treating a superficial endometrial neoplasm in a poor surgical candidate is likely a rational choice; however, clinical trials are needed to confirm this.

Conclusions

MEA at 2.45 GHz is an alternative to hysterectomy for treating menorrhagia in an enlarged or distorted cavity. A large submucous myoma or adenomyosis causing menorrhagia may be treated using simultaneous MEA and TCMAM in the future.

References

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