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[**Original Article**]

ARGON PLASMA COAGULATION FOR INTRACTABLE NASAL OBSTRUCTION OCCURRING IN PATIENTS WITH ALLERGIC RHINITIS

ERIKO OGINO-NISHIMURA, HIRO-OKI OKAMURA
and YOSHITAKA TAKIGUCHI

Department of Audiovestibular Neuroscience, Tokyo Medical and Dental University, Tokyo, Japan

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Abstract: New surgical treatment for the intractable nasal obstruction in patients with nasal allergy by using Argon Plasma Coagulator (APC) was introduced. Of patients with allergic rhinitis treated at our institute, 28 patients complaining nasal obstruction were treated APC surgery. Epithelization of the mucosa of inferior turbinate was almost completely accomplished at 4 weeks after surgery, at which time mucosal swelling was reduced, and nasal obstruction was ameliorated in all cases, though a crust and fibrin membrane adhered to the mucosa between 2 to 4 weeks after surgery, resulting in temporary exacerbation of nasal obstruction. Nasal obstruction was again aggravated in only one patient about 6 months after surgery, but such symptom could be ameliorated by re-coagulation. No bleeding and no smoke occurred in the operation. No morbidity was also noticed after operation. APC is easy to perform safely and effectively compared with another laser surgeries, and is useful for intractable nasal obstruction occurring in patients with allergic rhinitis.

Keywords: Argon Plasma Coagulator, nose allergy, new surgical treatment

INTRODUCTION

It is difficult to ameliorate nasal obstruction occurring in patients with allergic rhinitis. At present, surgical treatment of the inferior turbinate, including laser resection, is considered to be effective in the palliative improvement of nasal obstruction. Argon plasma coagulation (APC) is one of such surgical techniques, and is a new device that transmits high-frequency electric current through an ionized argon gas stream (argon plasma) into a tissue, causing inactivation, coagula-

荻野枝里子，岡村洋沖，瀧口賀隆
Correspondence to: Hiro-oki Okamura, Department of Audiovestibular Neuroscience, Tokyo Medical and Dental University, 1-5-45 Yushima, Bunkyo-ku, Tokyo 113-8519, Japan

tion, and desiccation of the tissue at a nearly uniform depth. APC has been utilized for hemostasis of wide oozy bleeding associated with endoscopic surgery in the field of gastrointestinal surgery,[1] and this technique has also been applied to surgeries in the field of otorhinolaryngology because of its beneficial nature. Because APC is easy to perform safely and effectively compared with another laser surgeries, the use of APC has gradually become a new trend as a means of superficial coagulation of the inferior turbinate. However, there are very few reports about the usefulness of APC for intractable nasal obstruction occurring in patients with allergic rhinitis. Thus, we will herein report the actual state of superficial coagulation for the inferior turbinate with APC at our institute.

PRINCIPLE OF APC

The APC consists of a high-frequency voltage generator and an argon gas supply unit (Fig. 1). Argon gas is ionized with high-frequency voltage as it is spouted out from the applicator tip, and monopolar high-frequency current flows out as sparks, from the electrode into the tissue along with the argon gas stream (Fig. 2). In other words, APC provides discharge coagulation in a non-contact manner between the electrode and the tissue. Since argon is an inactive and non-reactive substance that is readily ionized, it is possible to maintain the discharge phenomenon stably. Uniform sparks with low current density are generated because bundle-like spark paths are created within the argon gas stream, providing a shallow and uniform coagulated layer. Since argon plasma beams avoid going to the area with high impedance produced by superficial coagulation of the tissue, but rather spontaneously seek the surrounding low impedance area, it is possible to continuously

Fig. 1. Argon Plasma Coagulator equipment
The Argon Plasma Coagulator (APC) consists of a high-frequency voltage generator ICC200 (upper) and an argon gas supply unit APC300 (lower).

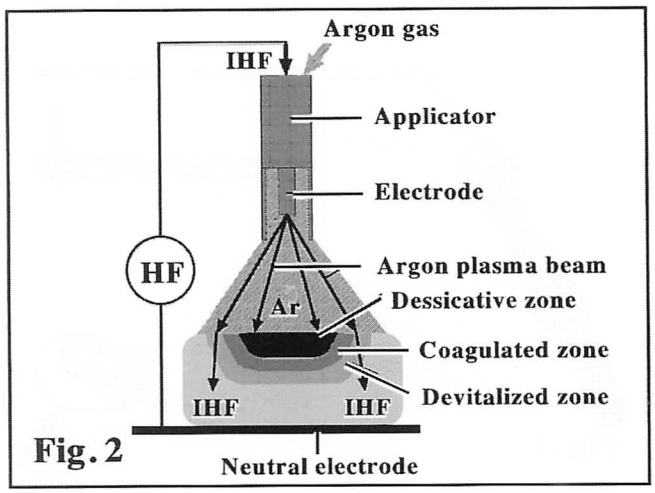

Fig. 2. Principles of Argon Plasma Coagulator
Argon gas is ionized with high-frequency voltage (HF) as it is spouted out from the applicator tip, and monopolar high-frequency current flows out as sparks, from the electrode into the tissue along with the argon gas stream (Ar). Since argon is an inactive and non-reactive substance that is readily ionized, it is possible to maintain the discharge phenomenon stably. Uniform sparks with low current density are generated because bundle-like spark paths are created within the argon gas stream, providing a shallow and uniform coagulated layer. Since argon plasma beams avoid going to the area with high impedance produced by superficial coagulation of the tissue, but rather spontaneously seek the surrounding low impedance area, it is possible to continuously coagulate a wide tissue surface at a limited penetration depth. IHF : electrical current

coagulate a wide tissue surface at a limited penetration depth. APC has effects of making the tissue dry, coagulated, and inactivated, but not evaporated, unlike laser surgeries.

METHODS AND SUBJECTS

Of patients with allergic rhinitis treated at our institute for their chief complaint of nasal obstruction, 28 patients who showed no improvement of symptoms with drug therapy, or for whom drug therapy could not be indicated due to their systemic disorders underwent superficial coagulation of the inferior turbinate with APC. Devices used included a high-frequency voltage generator (ICC200) and an argon gas supply unit (APC300) (ERBE Company), and an applicator for intranasal surgery (direct radiation ; 90-degree side radiation), as shown in Fig. 3. The coagulator was set at monopolar energy of 30 W and an argon gas flow rate of 0.8 l/min. The applicator tip was covered with protector to prevent argon plasma beams from running in the direction of side radiation and in the opposite direction, avoiding damage on the mucosa of the nasal septum as well as other regions. Surface anesthesia with 4% lidocaine and epinephrine diluted at 1 : 5,000 was preoperatively

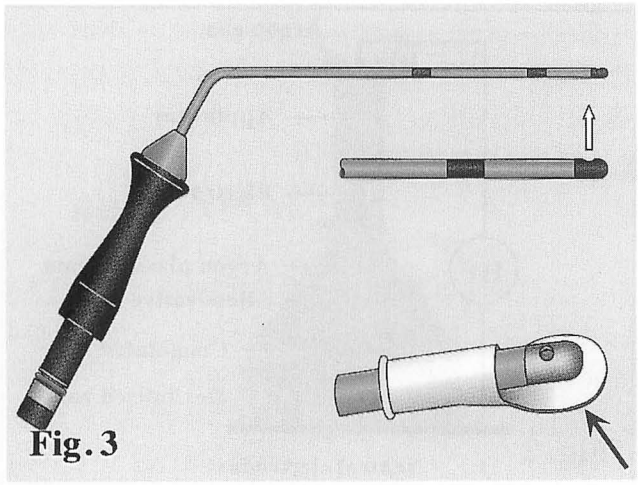

Fig. 3. Applicator
The flexible and light applicators with 90-degree side radiation (white arrow). The applicator tip was covered with silicon protector (black arrow) to prevent argon plasma beams from running in the direction of side radiation and in the opposite direction.

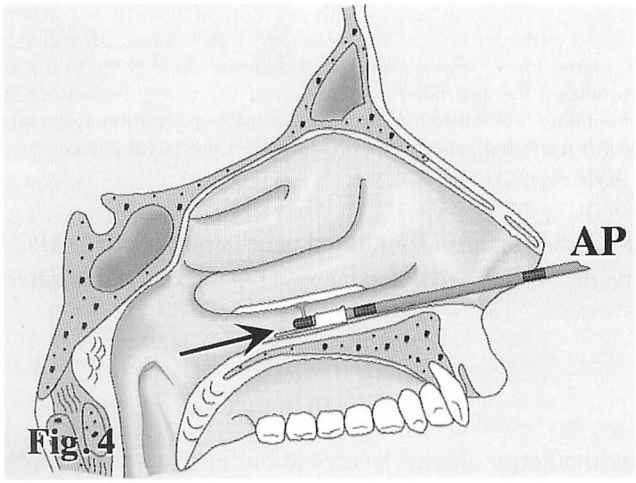

Fig. 4. Application technique
The inferior turbinate was coagulated from its posterior margin to the front (arrow), through lateral and inferior planes into the end. AP: applicator

administered to reduce intraoperative pain.

The inferior turbinate was coagulated from its posterior margin to the front (Fig. 4), through lateral and inferior planes into the end, as if the applicator was gently rubbing the mucosa. The anterior end was particularly carefully coagulated (Fig. 5). It was somewhat difficult to perform surgical manipulation in the presence of sputum deviation, as with laser surgeries. Emitting smoke or bleeding was minimum during surgery, requiring no aspiration. Surgery required only a very

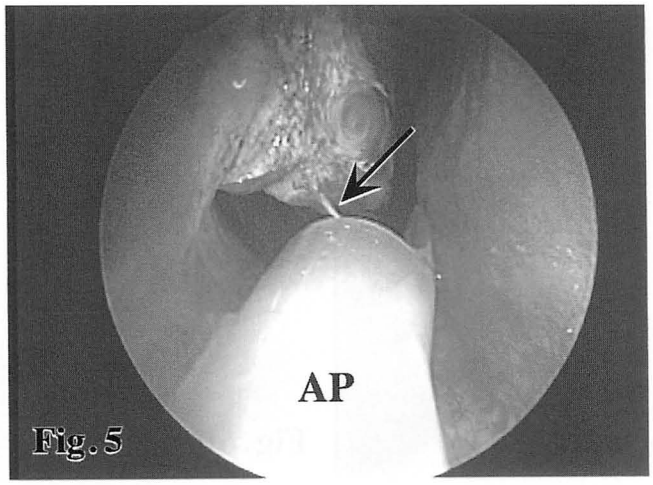

Fig. 5. Operation for the inferior turbinate by APC
Monopolar high-frequency current flows out as sparks from the electrode into the tissue along with the argon gas stream (arrow). Note that APC needs no adhesion between the electrode and the tissue. AP : applicator

short time, taking about 10 minutes for both right and left inferior turbinates.

RESULTS

Fig. 6a shows a postoperative state of the inferior turbinate. A crust and fibrin membrane adhered to the mucosa between 2 to 4 weeks after surgery, resulting in temporary exacerbation of nasal obstruction. However, epithelization of the mucosa of inferior turbinate was almost completely accomplished at 4 weeks after surgery (Fig. 6b), at which time mucosal swelling was reduced, and nasal obstruction was ameliorated in all cases. No bleeding occurred postoperatively in any case. Nasal obstruction was again aggravated in one patient about 6 months after surgery, but such symptom could be ameliorated by re-coagulation.

DISCUSSION

Coagulation and desiccation of the inferior turbinate, mainly with laser surgery, has been performed as a therapeutic modality because it is considered effective for nasal obstruction for which drug therapy is considered relatively ineffective, compared with other symptoms of allergic rhinitis. APC which has already been utilized for hemostasis of wide oozy bleeding associated with endoscopic surgery in the field of gastrointestinal surgery in recent years.[1] It has also been applied to otorhinolaryngologic surgeries, because particular attention has been paid to its beneficial nature to cause inactivation, coagulation, and dryness of the tissue at a nearly uniform depth.[2,3] Because APC is particularly easy to perform safely, the use of

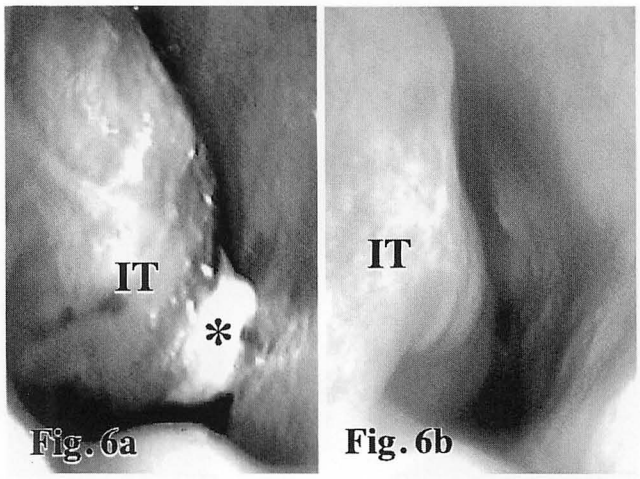

Fig. 6. The postoperative states of inferior turbinate after APC surgery
Fig. 6a and 6b show the states of inferior turbinate (IT) at 2 and 4 weeks after APC surgery, respectively. A crust and fibrin membrane (*) adhered to the mucosa between 2 to 4 weeks after surgery (6a). Epithelization of the mucosa of inferior turbinate was almost completely accomplished at 4 weeks after surgery (Fig. 6b).

APC as a means of superficial coagulation of the inferior turbinate has gradually become a new trend in the treatment of allergic rhinitis. Thus, we have also performed superficial coagulation of the inferior turbinate with APC in the outpatient setting, to ameliorate intractable nasal obstruction in patients with allergic rhinitis.

Since discharge coagulation, requiring no contact between the electrode and the tissue, is characteristic of coagulation of the inferior turbinate with APC, it is possible to reduce the risk of bleeding, etc. occurring frequently with contact coagulation when the electrode is detached from the tissue (Table 1). More, since argon plasma beams avoid going to the coagulated area, but spontaneously seek the surrounding area, it is also possible to continuously and diffusely coagulate a wide

Table 1. Characteristics of coagulation of the inferior turbinate with argon plasma coagulation

(1)	No adhesion between the electrode and the tissue due to non-contact coagulation.
(2)	Able to diffusely irradiate the tissue.
(3)	No invasion to a deep tissue (practically no carbonization of the tissue) because of a limited tissue penetration depth.
(4)	Emitting smoke is very small, because of no tissue evaporation.
(5)	Easy to coagulate the posterior margin of inferior turbinate through the use of various types of applicator.
(6)	Useful as a day surgery because of a very small amount of bleeding.
(7)	No need of protective glasses which every laser surgery essentially requires.

tissue surface at a shallow depth of about 2 mm. APC has effects of making the tissue dry, coagulated, and inactivated, but not evaporated, unlike lasers. Although local temperature may reach 600 (C when a laser applicator is in contact with the tissue, it does not exceed 100 (C with APC, possibly resulting in less damage on the deep tissue and less formation of postoperative edema, crusts, or fibrin membrane. As for beneficial aspects of APC in relation to manipulation, coagulation of the posterior margin of inferior turbinate can be easily performed if a flexible and light applicator is used because it is possible to make side radiation ; a very small amount of smoke is emitted because of no tissue evaporation, requiring neither aspiration, nor to wear protective glasses. These characteristics are thought to be very advantageous over laser surgeries.

As for problems, it was somewhat difficult to treat patients with septum deviation, as with laser surgeries. Although we have so far encountered no operable cases with APC, even a patient with severe deviated septum can be treated with a bent flexible applicator or a very small applicator is used. Several patients complained of tooth numbness, which was thought to occur probably because some current leaked into the interdental space, but this problem can be solved by biting a piece of gauze during surgery. Other than turbinates, especial case should be given not to mistakenly radiate the salpingopharyngeal orifice.

Nasal obstruction was often exacerbated during a postoperative period of about 2 weeks due to edema and crusts in the coagulated mucosa, but this symptom was dramatically improved in all cases, compared with its preoperative state, as edema and the amount of crust were decreased. Although nasal discharge and sneezing could not be controlled with coagulation and desiccation, as a general rule, concomitant use of an anti-allergic drug is effective for these symptoms, and disturbances of activities of daily life are usually diminished significantly because of amelioration of nasal obstruction. As for long-term effectiveness, Bergler et al. reported that nasal obstruction was still improved in 83% at 12 months after surgery.[5] One of our patients reported re-aggravation of symptoms at postoperative month 6, but re-coagulation ameliorated the symptoms.

Macroscopical appearances of the mucosa in the inferior turbinate after coagulation became the same as those seen before surgery at 4 weeks after surgery. Fukazawa et al.[4] investigated histological changes in the mucosa of inferior turbinate after surgery, and they observed that the mucosal surface was covered with non-ciliated cuboidal epithelium at postoperative month 3, showing fibrosis of the lamina propria mucosae and a decrease in nasal glands. By contrast, it was reported that the mucosal epithelium returned to the same ciliated epithelium as that seen before surgery at 3 months after surgery, and no differences were observed between pre- and post-operative results of mucus ciliary function test.[5] Although regeneration of epithelium was also observed at 3 months after surgery in a histological study following laser coagulation and desiccation of the inferior turbinate,[6,7] the degree of postoperative mucosal injuries is known to differ according

to the depth of coagulation and desiccation, inherent to each laser.[8] Therefore, because APC produces only shallow tissue invasion, the epithelium easily regenerates after APC, compared with laser surgeries, indicating that APC is a surgical therapy gentle to the epithelium.

CONCLUSION

Coagulation of the inferior turbinate with APC was performed for intractable nasal obstruction in patients with allergic rhinitis. The results of APC demonstrated that APC is equally effective, but safer and easier to perform, compared with another laser surgeries, indicating that APC can be actively utilized in the outpatient setting.

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