

# Argon Plasma Coagulation in Treatment of Post Intubation Tracheal Stenosis

Hamidreza Jabbardarjani<sup>1</sup>, Arda Kiani<sup>2</sup>, Negar Sheikhi<sup>1</sup>, Mohammad Reza Masjedi<sup>1</sup>

<sup>1</sup>Tracheal Disease Research Center, NRITLD, Masih Daneshvari Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran

<sup>2</sup>Chronic Respiratory Disease Research Center, NRITLD, Masih Daneshvari Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran

## Abstract:

**Introduction:** Acquired tracheal stenosis can be created by various malignant or benign causes. The most common cause of acquired non-malignant tracheal stenosis is endotracheal intubation, even for a short period. Argon plasma coagulation is a non-contact method of thermal hemostasis. Argon plasma coagulation can be used easily and fast and has low depth of penetration.

**Methods:** This study is single blinded. Subjects are patients with tracheal stenosis after endotracheal intubation who were selected by non-probability sampling and were studied from March 2007 to November 2009 in bronchoscopy and laser center of Masih Daneshvari Hospital, Tehran. First, for each patient, a diagnostic flexible bronchoscopy was performed to identify the type, location, and severity of the stenosis. Then, under general anesthesia, patients underwent rigid bronchoscopy. Then, with Argon plasma coagulation device (ERBE VIO 200D) the stenosis was removed as possible. After two weeks, a new PFT (pulmonary function test) was done for checking the obstructive signs.

**Results:** Of these 34 patients, 24 were asymptomatic for more than 1 year and responded to treatment(70/6%), 5 were asymptomatic for more than 10 months and less than 12 months (14/7%) and 5 did not have asymptomatic periods more than 10 months, and did not respond to treatment.

In PFT follow-ups, FEV1 in all patients who were asymptomatic for more than 10 months had a significant progress; therefore, in 27 out of 29 patients at the end of the study, FEV1 was more than 90% and 2 patients had FEV1 of 70-90%.

**Conclusion:** In fact, although the surgical treatment remains the main treatment of tracheal stenosis after intubation (PITS), if this method is not possible for any reason, APC is very useful as a safe and effective method.

**Keywords:** Argon Plasma Coagulation; Bronchoscopy; Post Intubation Tracheal Stenosis

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\*Corresponding Author: H. R. Jabbardarjani, M.D.Masih Daneshvary Hospital, Tracheal Disease Research Center,Nyavaran, Shahid Bahonar Ave, Daar Abad, Tehran, Iran, Postal code: 1955841452.Tel: +98-21-20109550; Fax: +98-21-2019550; Email: drhrjabbari@yahoo.com

## Introduction

Acquired tracheal stenosis can be created by

various malignant or benign causes. The most common cause of malignant tracheal stenosis is

tumor growth inside the lumen or its pressure from outside (1). These tumors can primarily grow in the respiratory system or resulting from the growth of adjacent tumors such as esophagus and thyroid.

The most common primary tumors involved in tracheal stenosis are adenoid cystic and squamous cell carcinoma (70-80%) (2). The most common cause of acquired non-malignant tracheal stenosis is endotracheal intubation, even for a short period (3). Tracheal stenosis after intubation was recognized for the first time in 1880 (1). Among patients with intubation history, incidence of stenosis varies from 20 to 30 percent but only 1-2 percent is symptomatic (4). Tracheal tube cuff pressure plays an important role in creating this damage (4). Stenosis can be seen in any level of trachea, from glottis to carina, but the most common location is where the tracheal tube cuff is in contact with the tracheal wall (5). In this location, blood flow decreases due to localized pressure and ischemia, and necrosis will happen (6). This ischemic injury starts at the first hours of tube placement and can cause stenosis in 3-6 weeks. This phase is associated with granulation tissue formation and fibrosis. The most common location of injury is where the mucosa lies on tracheal cartilage rings. PITS (post-intubation tracheal stenosis) increases wall thickness and decreases internal diameter of trachea. Length of stenosis typically varies between 1/5-2/5 cm (7).

Patients with mild stenosis may be asymptomatic initially, but in case of becoming symptomatic, shortness of breath, stridor, or wheezing in exhalation occur (7).

Trachea stenosis is divided into two types: simple and complex. The simple type, itself, is divided into the following groups; web-like: it consists of a crescent web that is located in the trachea and causes shortness of breath; the fibrotic band: the bands of fibrosis from one side to the other side that cause deviation and narrowing of the trachea; granulation: tissue granulation that occurs because of a reaction to the tracheal tube.

In the complex type, the most important issue is the destruction of tracheal cartilage, in which intra-tracheal clean-up will not solve the problem. In these patients, when open surgery is not possible, stenting can be helpful for a while.

To date, surgical removal of the damaged area (resection) and connecting the healthy ends together

(end to end anastomosis) was the only way to cure tracheal stenosis (8-9). Nowadays, interventional bronchoscopy methods such as dilatation with rigid bronchoscope, balloon dilatation, electrocautery, laser, and argon plasma coagulation are introduced as basic treatment with proven successful outcomes.

Argon plasma coagulation is a non-contact method of thermal hemostasis, and can be used easily and fast with low depth of penetration. This technology uses argon gas to produce thermal energy around the probe. A high voltage sparks at the tip of the probe causing the argon gas to ionize. The ionized gas goes to the closest tissue and provides thermal energy. This temperature evaporates the liquid inside and outside the cell and breaks cellular proteins, which cause destructive and coagulative effects on the tissue. Depth and rate of the tissue destruction depends on the voltage of the device and duration of the treatment. With a power of 40-120W, and a duration below 2 seconds, the penetration depth will be less than 5 mm. Argon plasma coagulation is applied for periods of one to three seconds. If the voltage of the device, or its duration rises, the penetration and tissue damage will be greater.

The probe diameter is 1/5-2/3 mm and its length is 220 cm. The tip should be at a proper distance from the end of the bronchoscope; thus, the first black line on the probe can be seen during the procedure; otherwise, it causes damage to the bronchoscope (10).

## Methods

Subjects are patients with tracheal stenosis after endotracheal intubation who were selected by non-probability sampling and were studied from March 2007 to November 2009 in bronchoscopy and laser center of Masih Daneshvari Hospital in Tehran. Inclusion criteria were symptomatic tracheal stenosis after intubation. Patients with contraindications for bronchoscopy, or high risk to cardiac condition, or history of radiotherapy in previous months were excluded.

Patients' information were collected and investigated. All patients underwent preoperative investigation including physical exam, chest X-ray, CT-scan, a 6-minute walk, and PFT (pulmonary function test).

First, for each patient a diagnostic flexible

bronchoscopy was performed to identify the type, location, and severity of the stenosis. Then, under general anesthesia, patients underwent rigid bronchoscopy. Argon plasma coagulation device (ERBE VIO 200D) was then used to remove the stenosis as much as possible. After two weeks, a new PFT was done for checking the obstructive signs. If the individuals were asymptomatic for one year, they were considered cured and if symptoms were seen, they were retreated by argon plasma coagulation.

Before argon plasma coagulation, all potential risks were explained for the patients with enough information about this method which was available to them. Collected data were analyzed using statistical software SPSS17.

## Results

A total of 34 patients were evaluated. Their mean age was 30.52± 14.84 (range, 12 to 74) years. Eight were female (23.5%) and 26 (76.5%) were male. Types of stenosis observed by flexible bronchoscopy are depicted in Table 1.

The most common site for stenosis was upper trachea in 13 (38.2%) patients. Other places included subglottic (12 patients, 35.3%), mid trachea (7 patients, 20.6%) and distal trachea (2 patients, 5.9%). There was no statistical association between location of stenosis and response to the treatment (P>0.05). Number of the treatment sessions ranged between 1-8, and most patients were under treatment for 1-4 sessions.

Of these 34 patients, 24 were asymptomatic for more than 1 year, and responded to treatment (70.6%); 5 were asymptomatic for more than 10 months and less than 12 months (14.7%); and 5 did not have asymptomatic periods more than 10 months with no response to the treatment (Table2).

In the initial PFTs, in 22 patients (64.7%) FEV1 was between 50-70% and 12 patients had FEV1 less than 50%. The initial FEV1 had no

Table 1. type of stenosis

Type of stenosis	Frequency	Percentage
Fib	13	38.2
Web	16	47.1
Fib+Web	2	5.9
Granulation	3	8.8
Total	34	100.0

Table 2. response to the treatment

Response to treatment	Frequency	Percentage
Yes	24	70.6
No	5	14.7
>10 m, <12 m	5	14.7
Total	34	100.0

correlation with other factors examined in this study including the location of stenosis or type of narrowing (P>0.05).

In the PFT follow-ups, FEV1 in all patients who were asymptomatic for more than 10 months had a significant progress; thus, in 27 out of 29 patients, FEV1 was more than 90% and 2 patients had FEV1 70-90% at the end of the study. The rate of change in FEV1 had no statistically significant correlation with the type of stenosis, or its location, or demographic factors (p>0.05).

## Discussion

In this study, the effect of argon plasma coagulation as a treatment method for tracheal stenosis was studied. A total of 83% of the patients responded to this method and were; therefore, asymptomatic for more than 10 months. Also, patients showed obvious improvement and increase in PFT and FEV1. Thus, it is concluded that argon plasma coagulation is a safe method with few side effects for the treatment of tracheal stenosis in patients who are not surgical candidates.

Tracheal stenosis is an important complication of tracheal intubation, because it can easily end in the patient's death (11). To date, this complication has been treated by surgical resection and anastomosis (8).

In a study by Simpson et al, 60 patients with tracheal stenosis were treated by bronchoscopic methods. This study concluded that bronchoscopic techniques alone, are not useful in severe tracheal stenosis, especially in case of wide tracheal stenosis, or tracheal cartilage damage; so, surgical resection of damaged area in extensive stenosis seems more useful (13). But in some patients, surgical treatment is not possible, or acceptable. Several

bronchoscopic methods are performed to treat and control the symptoms and signs in these patients.

In 1999, Bricchet and colleagues suggested that Nd YAG laser and stent can be used as the first step of treatment (14). In other studies.. methods

like balloon dilatation, stent and argon plasma coagulation had been reported to be useful as well (13 &15).

Recently, argon plasma coagulation as a method for treatment of benign tracheal stenosis has been used frequently used (14,16,17,18, &19).

Morice and colleagues announced that the argon plasma coagulation causes heat and tissue destruction. When the level of electrical conductivity of the tissue is low, argon looks for a tissue with less electrical resistance, so it reduces the penetration depth. Thus, this method causes uniform coagulation and prevents airway perforation (20).

In our study, performed in a 32-month period, patients with tracheal stenosis after intubation underwent fiberoptic bronchoscopy and dilatation by argon plasma coagulation. Argon plasma coagulation helps us to treat tracheal stenosis with contraindications for surgery with a low potency of side effects.

In a study by Wang and colleagues, argon plasma coagulation was performed in 32 patients with tracheal stenosis, and showed a significant improvement in stenosis severity. This article concluded that accompaniment of argon plasma coagulation and stent is useful for controlling complex stenosis in carina (12).

Our patients were controlled by symptoms and PFT (FEV1). Argon plasma coagulation was used for dilatation of tracheal stenosis. There was no significant relationship between the risk factor evaluated such as age, sex, site and type of stenosis, and response to the treatment. Among the patients, 5 had not responded to treatment during the study time and were candidates for other bronchoscopic, or surgical treatments. These patients had no special risk factors against patients with a good response.

Argon plasma coagulation can be used in many aspects. It can even be used for evacuation of foreign bodies from the bronchial tracts (21). In a study by Yang, et al, argon plasma coagulation was found to be with 100 % success in the treatment of bronchial carcinoma, and helpful in tracheal stenosis caused by tumoral tissues (16).

## Conclusion

In fact, although the surgical treatment remains

the main treatment of tracheal stenosis after intubation (PITS), if this method is not possible for any reason, argon plasma coagulation as a safe and effective method is very useful.

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