Chemical Ablation of Cartilagineous Tissue in Tracheal Stenosis

IRINA GABRIELA IONITA[1]*, VIOREL ZAINEA[1,2], CRISTIAN DRAGOS STEFANESCU[3], CATALINA PIETROSANU[1], MURA HAINAROSIE[1], SILVIU PITURU[1], ANDREEA RUSESCU[1], CAMELIA CRISTINA DIACONU[1,4], RAZVAN HAINAROSIE[1,2]

[1] Carol Davila University of Medicine and Pharmacy, 8 Eroii Sanitari Blvd., Bucharest, Romania

[2] Prof Dr Dorin Hociota Institute of Phonoaudiology and Functional ENT Surgery, 21 MihailCioranu Str., Bucharest, Romania

[3] Gen. Dr. Aviator Victor Anastasiu National Institute of Aeronautical and Space Medicine, 88 MirceaVulcanescu Str., Bucharest, Romania

[4] Clinical Emergency Hospital of Bucharest, Internal Medicine Clinic, 8 Calea Floreasca, 014461, Bucharest, Romania

Laryngo-tracheal stenosis represents a challenging pathology that requires multi-stage surgical approach, and a multidisciplinary team. The diagnosis is based on clinical examination, endoscopic assessment, and imagistic evaluation. Coblation is a surgical technology based on chemical ablation of the tissue, that is suitable for tracheal stenosis approach.We present our experience with coblation for the management of laryngo-tracheal stenosis, and highlight the advantages, and disadvantages of coblation for tracheal stenosis. We consider chemical ablation of the cartilaginous tissue through coblation a valuable surgical technology for the treatment of tracheal stenosis.

Keywords: tracheal stenosis, coblation

Laryngo-tracheal stenosis defines the narrowing of the airway in the larynx and/or trachea. It is a challenging pathology that requires multi-stage surgical approach, and a multidisciplinary team (ENT surgeon, thoracic surgeon, interventional bronchoscopist).

Tracheal stenosis can be congenital and acquired. The congenital ones can be membranous or cartilaginous. The acquired ones have multiple etiologies (laryngeal trauma; autoimmune diseases; inflammatory diseases – amyloidosis, sarcoidosis, vascular collagen disorders - Wegener granulomatosis; neoplasms - primary tracheal cancer, metastatic lesion), but the most common tracheal stenosis are secondary to tracheostomy and intubation [1-3].

The mechanism of stenosis formation is based on the presence of ulcerative lesions (of various causes)in thelaryngo-tracheal mucosa and cartilage. Ulceration induces an inflammatory reaction, that generates granulation and fibrous tissue formation, leading to laryngeal/tracheal scar.

The symptomatology can be scarce when is small, but the following signs, and symptoms can be present: difficulty in breathing, cyanosis, coughing, fatigue, stridor, wheezing.

The diagnosis is based on clinical examination, endoscopic assessment, and imagistic evaluation. Plane radiographs (chest radiography, linear tomogram) in antero-posterior, and lateral projection offer valuable information about the site of stenosis, its' length. Computed tomography can be performed, but has some limitation in assessing tracheal stenosis. MRI is the imagistic investigation of choice, but the high costs, and the artefacts determined by the movement of the patient represent major disadvantages.

The treatment of laryngo-tracheal stenosis is surgery. Many surgical techniques, and procedures have been developed, and many technologies have been tried in order to obtain the best long-term results. Open surgical approach with resection and anastomoses were the treatment of choice, but the development of endoscopic surgical instruments associated with modern cutting technologies (coblation, radiofrequency, laser) allowed intraluminal approach of tracheal stenosis.

Coblation is a modern surgical technology used in many surgical fields (gynecology, urology, orthopedics, ENT) for tissue ablation, tissue volume reduction, and hemostasis. It was used with success for the management of tracheal stenosis [4-7].

Coblation technique works by generating an electric field between an active electrod located at the tip of a radiofrequency device, and a neutral electrode with a more proximal position on the same bipolar device. The current passes through a conductive solution of electricity, such as the solution saline. This electric field interacts with the fluid, and itexcites the electrolytes and molecules in the liquid creating a high-energy field, called plasma. Plasma field contains particles energized with enough energy to break molecular bonds in soft tissues, thereby generating conditions for dissolving tissues at relatively low temperatures.Tissue ablation is obtained by chemical corrosion theplasma, not by electric means. When used in coagulation mode, localizedheating of thetissue is obtained by a greater amount of current, and by directly heating the liquidfound in contact with the tip the co-blationwand.Thegenerator can producea widerange of energy, from 100 to 500 kHz, depending on the working mode (ablation/ coagulation/hemostasis), but the tissue necrosis is minim because the temperature in the tissue remains low (between 40 and 70°C) regardless of the amount of energy produced by the generator. Another advantage of coblation (beside working at low temperature, and respecting the tissue) is a sharper ablation of the tissue with a more precise incision line.

Due to these particular aspects the coblation is a minimally invasive surgical technology – the targeted tissue is destroyed at low temperatures with practically no demage to the surrounding structures.

Taking into account the reduced effect of the coblation on the neighboring (thermal effect, electric effect) anatomic elements, this technology is a good option when operating laryngeal, and tracheal stenosis. Every surgical maneuver on the larynx, and trachea leads to a certain degree of stenosis.

* email: ionitairinag@gmail.com; Phone: 0040721241122

Cotton-Myerclassification	**Grade I**-less than 50% obstruction **Grade II**-51% to 70% obstruction **Grade III**-71% to 99% obstruction **Grade IV**-no detectable lumen or complete stenosis
McCaffreystaging system	**Stage I**-confined to the subglottisor trachea and are less than 1cm long **Stage II**-isolated to the subglottisand are greaterthen 1 cm long **Stage III**-subglottic/tracheal lesions not /involving the glottis **Stage IV**-lesions involve the glottis
Lanostaging system	**Stage I**-involve one subsite **Stage II**-involves two subsites **Stage III**-involves all three subsites (glottis, subglottis, trachea)

Table 1

Experimental part

We want to present our experience with coblation for the management of laryngo-tracheal stenosis in Prof. Dr. D. Hociota Institute of Phonoaudiology and Functional ENT Surgery. Also, we want to highlight the advantages, and disadvantages of coblation for this type of pathology.

Laryngo-tracheal stenosis determine airway reduction, that leads to respiratory failure, that imposes tracheostomy. The goal of the surgical management of tracheal stenosis is restoration of the airway without the need of tracheostomy. Multiple classifications for tracheal stenosis have been developed to predict the possibility of decannulation after surgery, but the most frequently used in daily practice are: the Cotton-Myer classification, the McCaffrey staging system, and Lano classification. Every classification addresses the stenosis from a different point of view: the Cotton-Myer classification evaluates the lumen of the trachea, the McCaffrey staging system evaluates the length of the stenosis, Lano staging system refers to the site of the stenosis (table 1).

Laryngo-tracheal stenosis can be approached either by endoscopic means, or open surgery. When choosing the surgical approach the ENT specialist has to consider the following elements: the site of stenosis, its' length, the *age* of stenosis, the etiology of stenosis (post-intubation, traumatic, systemic disease), the comorbidities of the patient, and his/her general health status. One has to have in mind that tracheal stenosis should be approached as minimally invasive as possible in terms of respecting the tracheal structures, and preserving as much healthy tissue as possible.

Due to its properties coblation is a valuable technology for the surgical management of tracheal stenosis. An important fact is that with coblationa chemical ablation of the tissue is performed, and little injury of the surrounding tissue appears. Also the temperatures generated by the coblation wand are low (40-70°C). This is extremely important because the tracheal tissue is very sensitive, and any surgical gesture can determine a certain degree of stenosis figs. 1-4).

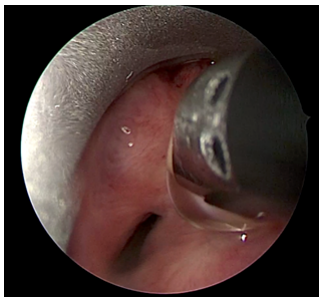

Fig. 1. Tracheal stenosis - aspect at the beginning of the surgery

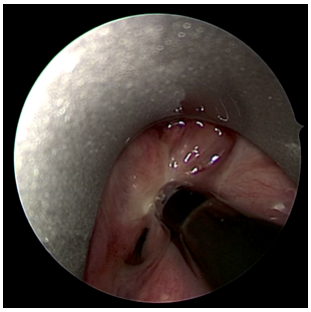

Fig. 2. Tracheal stenosis - intraoperative palpation with the coblation wand

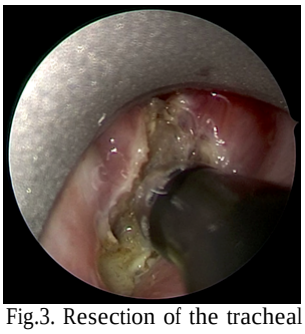

Fig.3. Resection of the tracheal stenosis with coblation

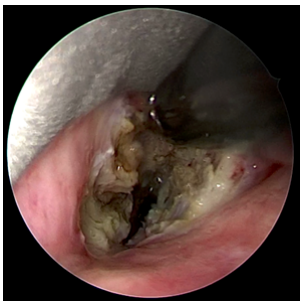

Fig.4. Resection of the tracheal stenosis with coblation -there is practically no bleeding during resection

Another advantages of coblation are: the diminished bleeding, and the possibility to perform both resection, and hemostatis with the same wand. Another positive aspect is that the coblation wand does not produce smoke. This is a valuable asset during endoscopic surgery when a clear image on the screen is mandatory. When using coblation the bleeding is small, the surgical field is clean, the surgicalgestures are more accurate, therefore the duration of the surgery can be shorter (figs. 5-7).

Fig. 5. Montgomery T-tube

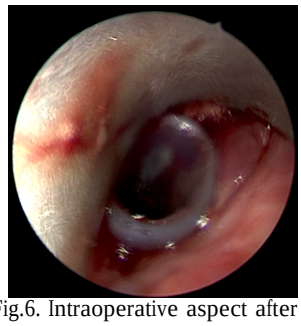

Fig.6. Intraoperative aspect after the insertion of the Montgomery T tube

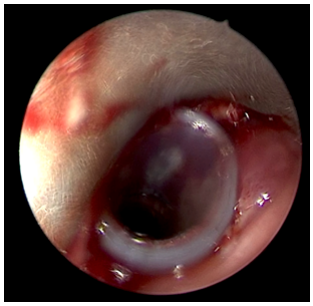

Fig.7. The final position of the Montgomery T-tube at the end of the surgery

The technique of coblation has some disadvantages: it is not efficient if important bleeding occurs; it is expensive (the wands are disposable).

Results and discussions

The surgical treatment of tracheal stenosis can be performed either via open/external approach, or by endoscopic means (bronchoscopy). The following options of treatment are the most common: resection and reconstruction (end-to-end anastomosis/ tracheoplasty), laser surgery, dilatation(balloon), stent. Tracheal stenosis are difficult to treat, and there are cases when more of the abovementioned surgical procedures are tried, but the stenosis reappears. The treatment should be individualized and the comorbidities of the patient should be carefully addressed. The tracheostomy is mandatory when collapse of the airway is present or is highly probable. Tracheostomy saves the life of the patient, and provides the necessary time for treatment of the comorbidities in safe conditions for the patient [8, 9].

Different cutting technologies can be applied during surgery: cold instruments, coblation, argon plasma, laser. All have their positive, and negative aspects. The less traumatic the ablation technology for the tracheal anatomic structures (cartilage, mucosa), the better.

In our opinion coblation can be used with success for the ablation of the stenotic tissue and cartilage of the trachea. The chemical ablation of the tissue is extremely important due to the minimum lesion of the tissue, and the lack of secondary necrosis.

The treatment of tracheal stenosis is not standardized. Although there are authors who consider resection of the stenosis with reconstruction of the trachea the optimum surgical treatment with the best long-term result, others consider it controversial because of the high risk of recurrence [10]. There are authors that state the rate of reccurence is higher for endoscopic surgery of tracheal stenosis [11].

Conclusions

The surgical management of tracheal stenosis is a challenging, and requires delicate surgical gestures with minimally invasive surgical technologies. The treatment has multiple stages, requires numerous surgeries, and good results are very hard to obtain. Chemical ablation of the cartilaginous tissue, is less traumatic, and promotes favorable healing patterns due to the low temperatures generated by the coblation wand, and to the minimal damage of the neighboring tissue. The coblation is easy to use, safe, and, in certain situations, shortens the time of surgery.

We consider chemical ablation of the cartilaginous tissue through coblation a valuable surgical technology for the treatment of tracheal stenosis. It has multiple advantages that certify its use in this type of pathology, but in our opinion long-term studies are necessary to assess the impact of coblation on tracheal structures, and its' benefits compared to other surgical technologies.

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