Sys Rev Pharm 2020; 11(3): 718 – 724
A multifaceted review journal in the field of pharmacy
E-ISSN 0976-2779 P-ISSN 0975-8453

Cold-Plasma Posterior Arytenoidochordectomy for Chronic Paralytic Laryngostenosis

Valerij Svistushkin[1], Svetlana Starostina[2], Alexey Toldanov[3]*, Liliya Selezneva[4]
[1,2,3,4]Department of Ear, Throat and Nose Diseases, N.V. Sklifosovsky Clinical Medicine Institute, I.M. Sechenov First Moscow State Medical University (Sechenov University), 6/1 Bol'shaya Pirogovskaya Str., Moscow, 119021, Russian Federation

Article History: *Submitted: 12.03.2020* *Revised: 21.04.2020* *Accepted: 26.05.2020*

ABSTRACT
The objective of the research was to study the effect of cold-plasma posterior arytenoidochordectomy in patients with chronic paralytic laryngeal stenosis. All the patients had previously undergone strumectomy followed by tracheostomy. During the research, they underwent a video laryngostroboscopic examination of the laryn and all resulted to have 2-3 mm lumen of the glottis in the posterior third. The patients were subject to the cold-plasma posterior arytenoidochordectomy. They gave their consent to be involved into the research before any procedures were applied. The majority of the patients underwent unilateral cold-plasma posterior arytenoidochordectomy. The rest underwent bilateral cold-plasma posterior arytenoidochordectomy due to the formation of granuloma and insufficient effect of the first intervention and unilateral cold-plasma posterior arytenoidochordectomy with subsequent dissection of the scar. All patients were successfully decanulated. In the long-term postoperative perio, the patients achieved the compensation of vocal function due to long-term orthophonic training and the development of a vestibuloscapular phonation mechanism. The cold-plasma posterior arytenoidochordectomy is an effective, safe, and minimally invasive surgery for the treatment of patients with paralytic laryngeal stenosis. The method is an effective substitute for a CO_2 laser and prevents gross, severe complications. It can be used in clinics as an alternative option for surgical treatment of patients with chronic paralytic stenosis of the larynx.
The median incomes for both groups were higher than the median income of Pahang state (RM 3979). The parental educational level showed 20:80 and 13:87 in percentage ratio of secondary to tertiary level for ART and NC group respectively. Regarding dental development, both ART and NC groups exhibits similar dental development rate ($p>0.05$) according to the age. Our study concluded that there is no significant difference in dental development between ART and NC children.

Keywords: Arytenoidectomy, Bilateral Laryngeal Paralysis, Coblation, Laryngeal Stenosis, Plasma, Posterior Chordectomy

Correspondence:
Alexey Toldanov
Department of Ear, Throat and Nose Diseases, N.V. Sklifosovsky Clinical Medicine Institute,
I.M. Sechenov First Moscow State Medical University
(Sechenov University), 6/1 Bol'shaya Pirogovskaya Str.,
Moscow, 119021, Russian Federation
Email: atoldanov@gmail.com

DOI: 10.31838/srp.2020.3.98

INTRODUCTION

For many decades, the motor dysfunction of the larynx, which constitutes about 29.9% of chronic diseases of the vocal apparatus, have held the limelight of otorhinolaryngologists.[1] In bilateral paralysis of the larynx with the middle position of the vocal folds, respiratory failure with an obstructive mechanism develops, which can be a direct cause of death from asphyxiation, the voice is usually not changed or changed slightly.[2] In patients with bilateral paralytic stenosis of the larynx, the risk of asphyxiation is increased due to upper respiratory tract infections, laryngeal edema, and stress.[3]

Trauma of the recurrent laryngeal nerve is a known complication of cardiothoracic interventions leading to unilateral paralysis of the vocal fold.[4] The literature provides a suggestion that in recent years, cardiothoracic surgeries have exceeded thyroid surgery in terms of the most common iatrogenic causes of recurrent laryngeal nerve injury.[4,5]

Bilateral paralytic laryngeal stenosis remains a potentially fatal condition requiring quick and accurate diagnosis.[6] Surgery is of paramount importance for patients with symptoms of respiratory failure.[7]

Despite a more than 100-year history of laryngeal surgery for bilateral laryngeal paralysis, tracheostomy still plays a huge role in treating this condition. Of course, a patient with enhancing shortness of breath and stenosis requires an immediate installation of a tracheostoma, however, at present, surgical treatment of bilateral laryngeal paralysis is moving to a combination of tracheostomy with chordoarytenoidotomy.[8] The latter began to been used for more effective surgical treatment of affected vocal folds with the basic rule of optimal preservation of the "native architecture" of the vocal part, which is crucial for maintaining the vocal function of the larynx.

Surgical methods of treating laryngeal stenosis can be divided into external and internal.[9] Currently, there are more than 80 modifications of the surgical treatment of laryngeal stenosis.[10] Patients with bilateral paralytic laryngeal stenosis often undergo repeated surgical interventions, which changes stenosis from paralytic to cicatricial-paralytic.[1] The external methods used to expand the glottis are accompanied by greater surgical trauma with pain and prolonged use of a T-shaped stent in the postoperative period. All this leads to a longer postoperative rehabilitation of the patient.[11]

Median laryngotomy and laryngoscopic CO_2 laser ablation of the larynx are considered traditional methods.[12] The most minimally invasive internal approaches include posterior chordotomy using a CO_2 laser.[3] In 1972, Strong M.S., Jako G.J. were the first to use a CO_2 laser in laryngeal surgery. Along with this, intraoperative fires with burns of the tracheobronchial tree began to increase.[13] In 1984, Ossoff R.H. et al. described a CO_2 laser arythenoidectomy with bilateral paralytic laryngeal stenosis.[14] Then in 1989 Dennis D.P., Kashima H.K. presented CO_2 laser transverse posterior chordotomy.[15]

In 1993, Crumley R.L. described laryngoscopic CO_2 laser medial arytenoidectomy as a method of treating patients with bilateral paralytic laryngeal stenosis who insist on minimal risk to reduce voice quality in the dilated glottis.[16]

At present, a CO_2 laser in continuous pulsed and superimpulsed modes under suspended support microlaryngoscopy is the main method of posterior chordotomy.[17–19] Laser ablation of the posterior ½ vocal fold and the arytenoid cartilage has become the standard of care for this pathology. A significant drawback of this technique

was the excessive formation of granulations and scar tissue, which filled the lumen of the larynx, which required repeated interventions in 30-60% of patients.[20,21] The efficiency of a CO_2 laser is widely recognized, but cold plasma technique also shows many advantages as a new, alternative method in clinical practice.[3]

Recently, interest in coblation technique in otorhinolaryngology has been increasing. Despite the growing number of publications, the results of surgical treatment are contradictory. We present the data of an analytical review of the literature and our own experience on this problem.

Coblation Method

The potential use of coblation in otorhinolaryngology was first presented by the manufacturer in 2000.[22]

Coblation is a surgical method based on the use of "cold" plasma (plasma temperature 45-65°C) for treating patient tissue. Increasing current in the active zone of the electrode triggers the formation of a layer of an ionizing substance, i.e. plasma, begins. The thickness of the formed stable plasma field does not exceed 0.5-0.15 mm. The coblation method makes it possible to dissect or destroy an array of tissue without any burning effect on the surrounding anatomical structures, while coagulating the walls of the vessels. The exposure depth is from 50 to 100 nm. The plasma layer has a coagulating effect, which reduces blood loss during surgical procedures. The absence of thermal effects on the nerve endings causes minimal pain exposure.[23,24] With a decrease in local reactive phenomena, the reparative process of wound healing accelerates, and the pain syndrome decreases[25]. Plasma flow has a pronounced bactericidal effect, which allows avoiding systemic antibiotic therapy in connection with surgical intervention. The special length of the electrode handle for the larynx and the angle-adjustable blade provide easy access to any part of the larynx, which makes this method favorable for ENT operations.[26–30]

MATERIALS AND METHODS

Clinical Data

From March 2016 to March 2020, 14 patients with bilateral paralytic laryngeal stenosis underwent cold-plasma cobaltation with the Coblator II in the clinic for ENT diseases. Age range was 39-73 years, the average age was 50 years: all patients were women with bilateral paralytic stenosis of the larynx after previous strumectomy. Before surgery, 20% of patients underwent tracheostomy after 10 - 14 years, 40% - after 3 - 10 years, and 40% - immediately or after 1-3 years. Patients underwent a laryngostroboscopic examination of the larynx to assess the width of the glottis, mobility of the arytenoid cartilage, the presence of a waved mucous membrane and the condition of the larynx in general. Examination with laryngostroboscopy in all patients showed bilateral immobility of the vocal folds, which occupied a paramedian or midline position. The widest lumen of the glottis was 3-4 mm. The patients were consulted by a pulmonologist. All patients gave their written informed consent for surgery. The anthropometric and constitutional characteristics of the patients were considered - neck length, body mass index: all were of normal and asthenic physique.[11]

Surgical Method

After intubation through a tracheostomy, under general anesthesia, patients underwent direct support laryngoscopy with a laryngoscope (Karl-Storzs, Germany). Then a microscope was connected and the focus length was adjusted (Sensera S7, Karl Zeiss, Jena, Germany) to full-scale visualization of the surgical field. Coblator II (ArthroCare, USA) was set to cobalt 4 modes, which corresponds to 182.5 W. Using the plasma electrode PROcise LW + IVL ICW, the posterior third of the least mobile vocal fold was resected with the release of an elastic cone; the commissure and the anterior third remained intact. The electrode tool was connected with saline container, as well as with a suction tube to remove intraoperative blood. Next, the vocal process of the arytenoid cartilage was resected in layers to achieve adequate expansion of the glottis. Thus, a lumen of 7-8 mm was formed in the posterior third of the glottis. During exposure to the electrode, frequent "twitching" of the muscles of the larynx was noted. Intraoperative bleeding was controlled by coagulation in mode 7, which corresponded to 100 W. After careful hemostasis of the wound surface, the laryngoscope with support was removed and the operation was completed. Intraoperatively, 8 mg Dexamethasone was administered to patients. The patients were emerged from general anesthesia and transferred to the ward in a stable state.

Post-Operative Period

In the postoperative period, patients were strictly prescribed vocal rest for 2 weeks to promote wound healing. Antibacterial therapy was carried out (Ceftriaxone 1 g twice a day - for 7 days); inhalation with glucocorticosteroids (Dexamethasone 4 mg and 2 ml of saline solution) - to reduce inflammation and swelling. Patients were prescribed a sparing diet on the day after surgery.

After surgical intervention, patients underwent control indirect laryngoscopy daily, and fibrolaryngoscopy and stroboscopy after 3, 7, 10 days and 3, 6 months (Figure 1).

RESULTS

All patients had moderate shortness of breath with a closed tracheostomy tube on the first day after surgery. On day 3, 7, and 10 after stroboscopy, reactive phenomena were observed, extending to the vocal folds and anterior commissure, which remitted by the 10th day. After resolving reactive phenomena in the voice section of the larynx on day 10-12, patients stayed in a hospital with a closed cannula, and then were allowed to go home. After 3 months, a smooth wound surface was visualized without granulation growth in the intervention zone: the operated voice fold was located in the abduction position and the lumen of the glottis in the posterior third was 7-8 mm. Then, each patient passed the control period in a hospital with stress tests and a closed tracheostomy tube: RR, blood pressure, heart rate for 7 days, followed by successful decanulation and plastic surgery of the skin-tracheal fistula.

We provide archival materials of our own clinical observations.

Clinical observation 1

Female patient T., 45 years old, complained of difficult natural breathing and the presence of a tracheostoma after strumectomy (2007) for nodular goiter. After 12 years, due to increasing shortness of breath, a tracheostoma was installed. In the clinic of ENT diseases of I.M. Sechenov First Moscow State Medical University she was diagnosed with bilateral paralytic laryngeal stenosis in March 2019 (Figure 1-A), for which left-sided cold-plasma posterior arytenoidochordectomy was performed; the postoperative period was unremarkable - without granulation growth in the intervention zone. After 3 months with stroboscopy, the operated vocal fold was in the abduction position, the lumen of the glottis in the posterior third was 7-8 mm (Figure 1-B). After the control period - with a hermetically sealed tracheostoma for 10 days - the patient underwent plastic surgery of skin-tracheal fistula: the wound healed by primary intention. Further, when examined after 6 months, free natural breathing was noted, subjectively - an improvement in the quality of life and a return to the profession. The patient achieved the vocal function compensation by means of a long orthophonic training and development of the vestibuloscapular phonation mechanism (Figure 1-C).

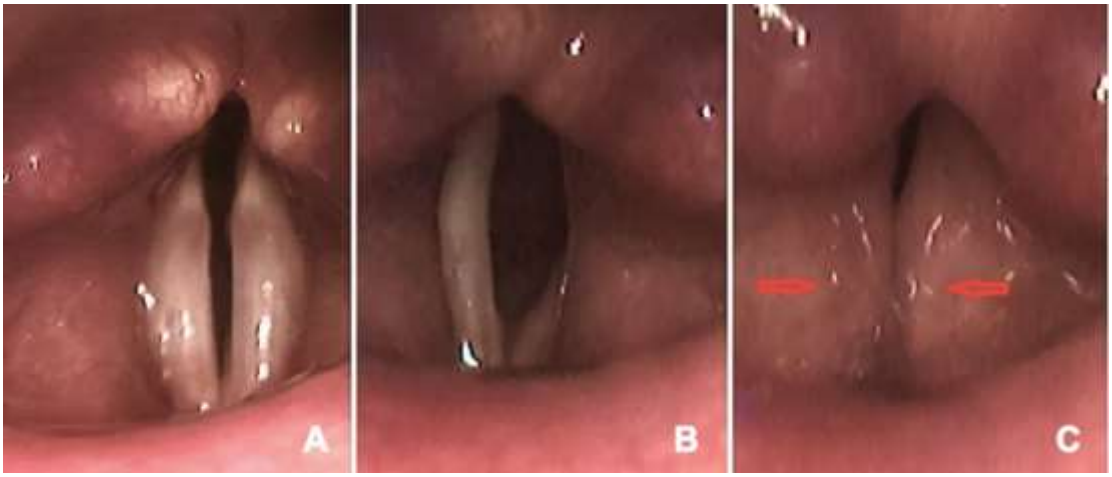

Figure 1: Endoscopic images of patient T., 45 years old: A - before surgery; B - 6 months after surgery; C - vestibuloscapular phonation mechanism (marked by arrows)

Unfortunately, not all patients had an uneventful postoperative period: let us dwell in more detail on the following clinical cases.

Clinical observation 2

A female patient M., 52 years old, in 2002 underwent strumectomy for nodular goiter, after which for 14 years she had signs of compensated laryngeal stenosis. In September 2016, in connection with decompensation of stenosis, she applied to the clinic of ENT diseases of I.M. Sechenov First Moscow State Medical University, where bilateral laryngeal paralysis and decompensated laryngeal stenosis were diagnosed, and a tracheostoma was urgently installed. Then, in February 2017, the patient underwent a cold-plasma posterior left arytenoidochordectomy, after which she was discharged in a satisfactory condition. After 2 months, shortness of breath and discomfort in the throat appeared; the examination revealed a granuloma of the left vocal fold, which was subsequently removed (Figure 2 –B). In May 2017, the follow-up examination revealed an insufficient lateral position of the fold in the left third of the vocal fold due to cicatricial changes, and therefore, in October 2017, right-sided arytenoidochordectomy was performed with a good functional result (Figure 2 – C).

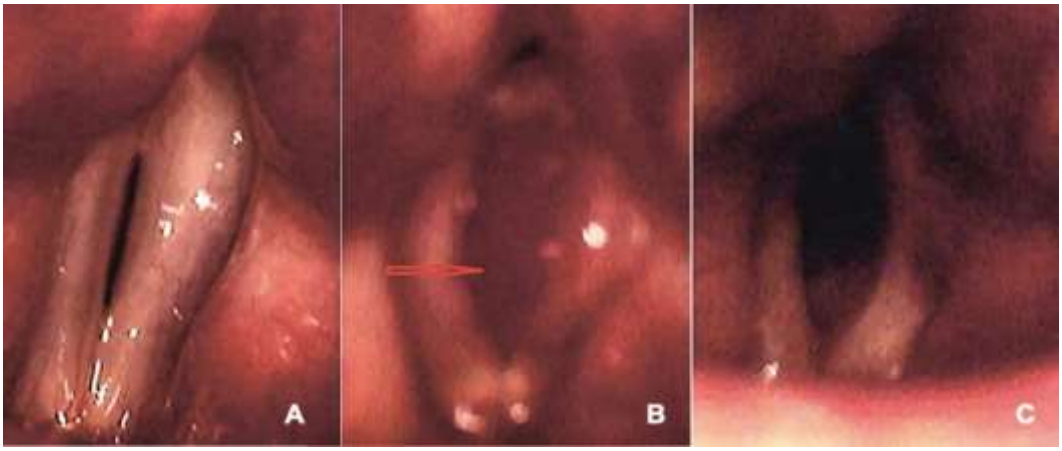

Figure 2: Endoscopic images of patient M., 52 years old: A - before surgery; B - granuloma on the left - 2 months after arytenoidochordectomy (marked by arrows); C - 6 months after arytenoidochordectomy on the right and removal of the granuloma.

Subsequently, in May 2018, after a 10-day control period, the patient was decanulated with subsequent plastic surgery of the skin-tracheal fistula; the wound healed by primary intention. In the early postoperative period, free natural breathing was noted.

Clinical observation 3

Patient S., 50 years old, noted difficult breathing after thyroidectomy for nodular goiter in March 2017. She underwent tracheostomy at the place of residence on an emergency basis in March 2018. In May 2018, in the clinic of ENT diseases of I.M. Sechenov First Moscow State Medical University, the patinet was diagnosed with bilateral laryngeal paralysis with a paramedian position of the vocal folds (Figure 3-A): a cold-plasma posterior arytenoidochordectomy was performed on the left, the postoperative period was unremarkable. However, in June 2018, the follow-up examination revealed that the right vocal fold is fixed with a scar membrane coming from the elastic cone on the right to the posterior third of the scar of the left vocal fold after the previous operation: scar thickness - 1 mm, width - 7-2 mm (Figure 3-B).

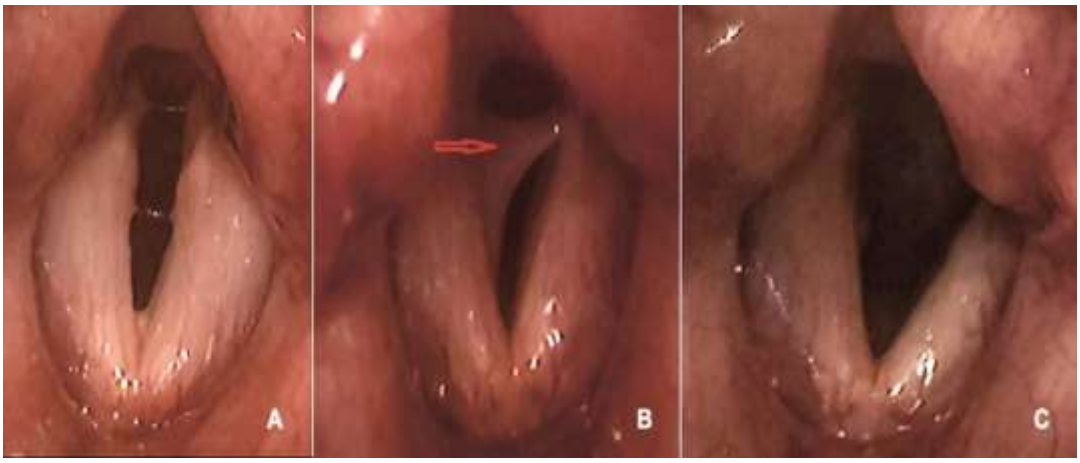

Figure 3: Endoscopic images of patient S., 50 years old: A - before surgery; B - 2 months after surgery, a scar is visualized (marked by arrows); C - 6 months after scar removal.

It was decided to use the Surgitron radio wave scalpel to dissect scar tissue in the thinnest place - closer to the left vocal fold, and lay the residual fragment with a flap on a preformed bed on the upper surface of the right vocal fold. Intraoperatively after the dissection of the scar, a discrepancy of the vocal folds was noted, a laryngeal lumen of about 8-9 mm was formed in the posterior sections. Subjectively, immediately after the operation, the patient reported improved breathing with a closed tracheostoma. After 6 months with laryngostroboscopy, the lumen of the glottis has not changed (Figure 3-C). After a 10-day control period, the patient was decanulated, followed by plastic surgery of the cutaneous-tracheal fistula; the wound healed by primary intention. In the early and late postoperative periods, free natural breathing was noted.

DISCUSSION

The main advantages of coblation are minimal trauma to the surrounding tissues, the resecting convenience of the structures of the vocal fold and the arytenoid cartilage with one electrode tool, the ability to perform complete hemostasis at one time, and the early postoperative period less complicated for the patient. Removing the vocal process of the arytenoid cartilage increases the area of the glottis,

while the remaining front part of the fold makes it possible to maintain a socially acceptable voice function. The least trauma to the surrounding tissue during surgery ensures the preservation of the protective function in the field operation period.

In 2014, Chan L.S. et al. described 10 adult patients (from 24 to 50 years old) who underwent coblation resection for laryngeal stenosis with good outcomes. They described coblation as an attractive adjuvant method for endoscopic treatment of laryngotracheal stenosis. Its efficiency and safety are similar to other modern treatment methods with additional advantages: lower ablation temperature, excellent hemostasis, reduced collateral tissue damage, short procedures and reduced risk of inflammation in the airways. Experience has shown a single coblation intervention to be effective even in patients with severe stenosis.[31]

In 2016, Fastenberg, J. H. and colleagues published one of the first in the literature report on a pilot study on the use of coblation for laryngeal stenosis in children. Six cases with various pathologies were presented, including complex stenosis of the larynx, paralysis of the vocal folds and suprastomal granuloma. Coblation has been used to perform a wide range of procedures, including scar removal, granulation, arythenoidectomy, and posterior chorectomy. All patients showed a good result without serious complications in the preoperative and postoperative periods.[32]

In 2015, Googe B, Nida A., and Schweinfurth J. presented an observation of a 77-year-old woman who underwent cobalt arytenoidectomy: after 8 months, the patient was decanulated with good results and intact voice function.[33]

In 2018, Benninger M. S. et al., presented a broader study: 15 patients underwent coblation chordectomy, of which 13 were women with an average age of 57 years. The authors note that all patients showed improved breathing immediately after the procedure and during observation. Healing time also turned out to be faster compared to procedures using a CO_2 laser. In particular, most patients experienced no symptoms such as shortness of breath (71%) and stridor (83%). Patients who underwent coblation chordotomy may experience a clinically significant improvement in their overall quality of life and voice function.[6] Professor Zhang Q.F. et al., (Dalian Central Hospital) reported 29 patients who were successfully decanulated 1 week after surgery: postoperative pain was minor and good long-term results were noted.[34] The authors' data are consistent with the results of our observations.

In the clinic of ENT diseases of I.M. Sechenov First Moscow State Medical University (Sechenov University) from March 2016 to the present, cold-plasma posterior arytenoidochordectomy is performed using Coblator II in patients with bilateral paralytic laryngeal stenosis. All patients subjectively noted an improvement in breathing on day with a closed tracheostoma; after 3-6 months everyone underwent successful decanulation with plastic surgery of the cutaneous-tracheal fistula. Lately, the operated vocal fold was in the abduction position and the lumen of the glottis in the posterior third was 7-8 mm. Compensation of vocal function in the long-term postoperative period was achieved by patients due to long-term orthophonic training and the development of a vestibuloscapular phonation mechanism.

The study is ongoing and there is no data on comparing this method with other surgical methods. Therefore, there is a need for larger-scale studies with observational data in the remote postoperative period. In the future, we hope to conduct such a study and provide evidence-based statistical comparative data on the value of the method for patients with chronic paralytic laryngeal stenosis in need of surgical treatment.

CONCLUSION

The coblation method is extremely useful and relevant in the surgery of patients with bilateral laryngeal paralysis, however, it also has a number of limitations. For example, an electrode tip is expensive and suitable for single use only, which makes this method inaccessible to a number of patients and clinics. Nevertheless, an improvement in the quality of life associated with this technique and an understanding of the advantages of this method make it likely that a greater number of operating otolaryngologists and their patients will choose this new technology.

Cold-plasma posterior arytenoidochordectomy - effective, safe, and minimally invasive surgery for the treatment of patients with paralytic laryngeal stenosis. The method is an effective and efficient substitute for a CO_2 laser and prevents gross, severe complications. It can be used in clinics as an alternative option for surgical treatment of patients with chronic paralytic stenosis of the larynx.

HIGHLIGHTS

1. With bilateral laryngeal paralysis, the least traumatic intervention is advisable.
2. The main task is to restore breathing and preserve the larynx mucosa and voice function.
3. Coblation is extremely relevant in the surgery of patients with bilateral laryngeal paralysis.
4. In our clinic, 14 operated patients had a good functional outcome.
5. Cold-plasma posterior arytenoidochordectomy is an effective and minimally invasive operation with a short rehabilitation period.

COMPLIANCE WITH ETHICAL STANDARDS

Local ethics committee Sechenov University (05-17 from 14.06.2017).

CONFLICT OF INTERESTS

There were no reports of potential conflicts of interest related to this article.

NOTES

Authors' contributions: Study concept and design: A.T., S.S., V.M., L.S. Collection and processing of material: A.T. Statistical data processing: A.T., S.S. Text writing: A.T., S.S. Editing: V.M., S.S.

REFERENCES

1. Kirasirova EA, Piminidi OK, Lafutkina NV, Mamedov RF, Rezakov RA, Kuzina EA. The diagnostics and treatment of bilateral paralysis of the larynx. Her Otorhinolaryngol [Internet]. 2017 [cited 2020 Apr 18]; 82(4): 77. Available from: http://www.mediasphera.ru/issues/vestnik-otorinolaringologii/2017/4/downloads/ru/1004246682017041077
2. Uskov AE. Surgical rehabilitation of patients with bilateral paralytic stenosis of the larynx. Her Otorhinolaryngol. 1998; 4: 58–61.
3. Hu Y, Cheng L, Liu B, Ming H, Tian A, Ma M. The assistance of coblation in arytenoidectomy for vocal cord paralysis. Acta Otolaryngol (Stockh) [Internet]. 2019 Jan 2 [cited 2020 Apr 18]; 139(1): 90–3. Available from: https: //www.tandfonline.com/doi/full/10.1080/00016489.2018.1542160
4. Rosenthal LHS, Benninger MS, Deeb RH. Vocal fold immobility: A longitudinal analysis of etiology over 20 years: The laryngoscope [Internet]. 2007 Oct [cited 2020 Apr 18]; 117(10): 1864–70. Available from: http://content.wkhealth.com/linkback/openurl?sid=WKPTLP: landingpage&an=00005537-200710000-00029
5. Spataro EA, Grindler DJ, Paniello RC. Etiology and time to presentation of unilateral vocal fold paralysis. Otolaryngol Neck Surg [Internet]. 2014 Aug [cited 2020 Apr 18]; 151(2): 286–93. Available from: http://journals.sagepub.com/doi/10.1177/0194599814531733
6. Benninger MS, Xiao R, Osborne K, Bryson PC. Outcomes following cordotomy by coblation for bilateral vocal fold immobility. JAMA Otolaryngol Neck Surg [Internet]. 2018 Feb 1 [cited 2020 Apr 18]; 144(2): 149. Available from: http://archotol.jamanetwork.com/article.aspx?doi=10.1001/jamaoto.2017.2553
7. Benninger MS, Gillen JB, Altaian JS. Changing etiology of vocal fold immobility. The Laryngoscope [Internet]. 1998 Sep [cited 2020 Apr 18]; 108(9): 1346–50. Available from: http://doi.wiley.com/10.1097/00005537-199809000-00016
8. Jackson C. Ventriculocordectomy: A new operation for the cure of goitrous paralytic laryngeal stenosis. Arch Surg [Internet]. 1922 Mar 1 [cited 2020 Apr 18]; 4(2): 257. Available from: http://archsurg.jamanetwork.com/article.aspx?doi=10.1001/archsurg.1922.01110110003001
9. Özdemir S, Tuncer Ü, Tarkan Ö, Kara K, Sürmelioglu Ö. Carbon dioxide laser endoscopic posterior cordotomy technique for bilateral abductor vocal cord paralysis: A 15-year experience. JAMA Otolaryngol Neck Surg [Internet]. 2013 Apr 1 [cited 2020 Apr 18]; 139(4): 401. Available from: http://archotol.jamanetwork.com/article.aspx?doi=10.1001/jamaoto.2013.41
10. Tsurikov VP, Ivanov SV. Mastering the methods of surgical treatment of patients with paralytic stenosis of the larynx. Her Otorhinolaryngol. 1998; 4: 56–7.
11. Starostina SV. The constitutional approach to the choice of the surgical strategy for the treatment of chronic post-traumatic laryngeal stenoses. Vestn Otorinolaringol [Internet]. 2017 [cited 2020 Apr 18]; 82(1): 20. Available from: http://www.mediasphera.ru/issues/vestnik-otorinolaringologii/2017/1/downloads/ru/1004246682016011020
12. Gorphe P, Hartl D, Primov-Fever A, Hans S, Crevier-Buchman L, Brasnu D. Endoscopic laser medial arytenoidectomy for treatment of bilateral vocal fold paralysis. Eur Arch Otorhinolaryngol [Internet]. 2013 May [cited 2020 Apr 18]; 270(5): 1701–5. Available from: http://link.springer.com/10.1007/s00405-013-2414-3
13. Strong MS, Jako GJ. Laser surgery in the larynx early clinical experience with continuous CO_2 laser. Ann Otol Rhinol Laryngol [Internet]. 1972 Dec [cited 2020 Apr 18]; 81(6): 791–8. Available from: http://journals.sagepub.com/doi/10.1177/000348947208100606
14. Ossoff RH, Sisson GA, Moselle HI, Duncavage JA, Andrews PE, Mcmillan WG. Endoscopic laser arytenoidectomy for the treatment of bilateral vocal cord paralysis: The Laryngoscope [Internet]. 1984 Oct [cited 2020 Apr 18]; 94(10): 1293???1297. Available from: http://doi.wiley.com/10.1288/00005537-198410000-00006
15. Dennis DP, Kashima H. Carbon dioxide laser posterior cordectomy for treatment of bilateral vocal cord paralysis. Ann Otol Rhinol Laryngol [Internet]. 1989 Dec [cited 2020 Apr 18]; 98(12): 930–4. Available from: http://journals.sagepub.com/doi/10.1177/000348948909801203
16. Crumley RL. Endoscopic laser medial arytenoidectomy for airway management in bilateral laryngeal paralysis. Ann Otol Rhinol Laryngol [Internet]. 1993 Feb [cited 2020 Apr 18]; 102(2): 81–4. Available from: http://journals.sagepub.com/doi/10.1177/000348949310200201
17. Kashima HK. Bilateral vocal fold motion impairment: Pathophysiology and management by transverse cordotomy. Ann Otol Rhinol Laryngol [Internet]. 1991 Sep [cited 2020 Apr 18]; 100(9): 717–21. Available from: http://journals.sagepub.com/doi/10.1177/000348949110000905
18. Asik MB, Karasimav O, Birkent H, Merati AL, Gerek M, Yildiz Y. Impact of unilateral carbon dioxide laser posterior transverse cordotomy on vocal and aerodynamic parameters in bilateral vocal fold paralysis. J Laryngol Otol [Internet]. 2016 Apr [cited 2020 Apr 18]; 130(4): 373–9. Available from: https: //www.cambridge.org/core/product/identifier/S0022215116000700/type/journal_article

19. Laccourreye O, Escovar M-IP, Gerhardt J, Hans S, Biacabe B, Brasnu D. CO 2 Laser endoscopic posterior partial transverse cordotomy for bilateral paralysis of the vocal fold. The Laryngoscope [Internet]. 1999 Mar [cited 2020 Apr 18]; 109(3): 415–8. Available from: http://doi.wiley.com/10.1097/00005537-199903000-00014
20. Wassermann K, Mathen F, Eckel HE. Concurrent Glottic and Tracheal Stenoses: Bilateral vocal fold motion impairment: Pathophysiology and management by transverse cordotomy. Ann Otol Rhinol Laryngol [Internet]. 2001 Apr [cited 2020 Apr 18]; 110(4): 349–55. Available from: http://journals.sagepub.com/doi/10.1177/000348940111000411
21. Reker U, Rudert H. Modified posteriore Dennis and Kashima cordectomy in treatment of bilateral recurrent nerve paralysis. Laryngo-Rhino-Otol [Internet]. 1998 Apr [cited 2020 Apr 18]; 77(04): 213–8. Available from: http://www.thieme-connect.de/DOI/DOI?10.1055/s-2007-996963
22. Woloszko J, Gilbride C. Coblation technology: plasma-mediated ablation for otolaryngology applications. In: Anderson RR, Bartels KE, Bass LS, Garrett CG, Gregory KW, Kollias N, et al., editors. San Jose, CA; 2000 [cited 2020 Apr 18]. p. 306. Available from: http://proceedings.spiedigitallibrary.org/proceeding.aspx?doi=10.1117/12.386267
23. Stalder KR, Woloszko J, Brown IG, Smith CD. Repetitive plasma discharges in saline solutions. Appl Phys Lett [Internet]. 2001 Dec 31 [cited 2020 Apr 18]; 79(27): 4503–5. Available from: http://aip.scitation.org/doi/10.1063/1.1429752
24. Woloszko J, Stalder KR, Brown IG. Plasma characteristics of repetitively-pulsed electrical discharges in saline solutions used for surgical procedures. IEEE Trans Plasma Sci [Internet]. 2002 Jun [cited 2020 Apr 18]; 30(3): 1376–83. Available from: http://ieeexplore.ieee.org/document/1158301/
25. Chandran D, Woods C, Ullah S, Ooi E, Athanasiadis T. A comparative study of voice outcomes and complication rates in patients undergoing injection laryngoplasty performed under local versus general anaesthesia: an Adelaide voice specialist's experience. J Laryngol Otol [Internet]. 2017 Jan [cited 2020 Apr 18]; 131(S1): S41-6. Available from: https: //www.cambridge.org/core/product/identifier/S0022215116009221/type/journal_article
26. Roy S, Reyes S, Smith LP. Bipolar radiofrequency plasma ablation (Coblation) of lymphatic malformations of the tongue. Int J Pediatr Otorhinolaryngol [Internet]. 2009 Feb [cited 2020 Apr 18]; 73(2): 289–93. Available from: https: //linkinghub.elsevier.com/retrieve/pii/S0165587608005375
27. Leuin S, Cunningham M, Volk MS, Hartnick C. Transhyoid approach to excision of recurrent vallecular pseudocysts. The Laryngoscope [Internet]. 2008 Jan [cited 2020 Apr 18]; 118(1): 124–7. Available from: http://doi.wiley.com/10.1097/MLG.0b013e31814b8db7
28. Prasad KC, Ranjan RK, Agarwal S, Prasad SC, Bhat J. Congenital laryngeal saccular cyst: Report of a case in an infant. Ear Nose Throat J [Internet]. 2006 Jan [cited 2020 Apr 18]; 85(1): 49–51. Available from: http://journals.sagepub.com/doi/10.1177/014556130608500115
29. Derkay CS, Wiatrak B. Recurrent respiratory papillomatosis: A review. The Laryngoscope [Internet]. 2008 Jul [cited 2020 Apr 18]; 118(7): 1236–47. Available from: http://doi.wiley.com/10.1097/MLG.0b013e31816a7135
30. Zhou C, Sun B, Wang F, Dai Z, Han Z, Han J, et al. Coblation plus photodynamic therapy (PDT) for the treatment of juvenile onset laryngeal papillomatosis: case reports. World J Surg Oncol [Internet]. 2014 [cited 2020 Apr 18]; 12(1): 275. Available from: http://wjso.biomedcentral.com/articles/10.1186/1477-7819-12-275
31. Chan CL, Frauenfelder CA, Foreman A, Athanasiadis T, Ooi E, Carney AS. Surgical management of airway stenosis by radiofrequency coblation. J Laryngol Otol [Internet]. 2015 Jan [cited 2020 Apr 18]; 129(S1): S21–6. Available from: https: //www.cambridge.org/core/product/identifier/S0022215114002783/type/journal_article
32. Fastenberg JH, Roy S, Smith LP. Coblation-assisted management of pediatric airway stenosis. Int J Pediatr Otorhinolaryngol [Internet]. 2016 Aug [cited 2020 Apr 18]; 87: 213–8. Available from: https: //linkinghub.elsevier.com/retrieve/pii/S0165587616301768
33. Googe B, Nida A, Schweinfurth J. Coblator arytenoidectomy in the treatment of bilateral vocal cord paralysis. Case Rep Otolaryngol [Internet]. 2015 [cited 2020 Apr 18]; 2015: 1–3. Available from: http://www.hindawi.com/journals/criot/2015/487280/
34. Zhang Q-F, Zhang J-J, Zhang Y, She C-P, Ma L. Endoscopic coblation assisted arytenoidectomy in the treatment of bilateral vocal cord paralysis. Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi. 2013 Jul; 48(7): 589–91.