Case Series

www.canonjm.com

CANON Journal of Medicine

DOI: 10.30477/cjm.2019.91932

Simple interrupted sutures in anastomosis of tracheal stenosis without using multiple hemostats: Introducing a new technique and review of articles

Farzad Izadi M.D.[1], Aslan Ahmadi M.D.[1], Masoud Kazemi M.D.[1], Zahra Sarafraz M.D.[1*]

[1]ENT and Head & Neck Research Center and Department, Hazrat Rasoul Akram Hospital, Iran University of Medical Science (IUMS), Tehran, Iran

*Corresponding Author: Zahra Sarafraz, ENT and Head & Neck Research Center and Department, Hazrat Rasoul Akram Hospital, Iran University of Medical Science (IUMS), Tehran, Iran
Address: , Hazrat Rasoul Akram Hospital, Iran University of Medical Science (IUMS), Tehran, Iran
Email: zahra.sarafraz@yahoo.com / Phone:

Abstract

Introduction: Tracheal stenosis may have congenital or acquired causes. Depending on the severity of the stenosis and its symptoms, the right treatment is selected. Sometimes resection of the stenotic segment and anastomosis of the two ends is the therapeutic option. There are several techniques for anastomosis.

Methods: In this article, while reviewing articles on how the sutures are used in the tracheal anastomosis, we explain the method applied in this study to use simple interrupted sutures without the use of multiple hemostats.

Results: An adapted and simplified suturing technique is described which has been successfully implemented in 30 patients.

Conclusion: End-to-end anastomosis using "simple interrupted sutures without using multiple hemostats", has minimal complexity and stress for the surgical group with similar results.

Keywords:
Tracheal stenosis;
Tracheal resection;
End-to-end anastomosis;
Tracheal suturing techniques

Introduction

Tracheal stenosis may have congenital or acquired causes. In the most common congenital type, one or more tracheal cartilages rather than incomplete rings, are completely circumferential that cause stenosis (1), while other congenital defects may also be found in the child. This congenital anomaly is often severe and the likelihood of respiratory failure increases with age.

The acquired type, which is considerably more common than the congenital one, is often due to the prolongation of the endotracheal intubation period in the intensive care units, which results in the formation of excessive connective tissue and tracheal lumen constriction and/or malacia of cartilages and their collapse.

Thermal and chemical damages and trauma of cervical trachea in motor vehicle accidents, infectious and inflammatory systemic causes, extra-esophageal reflux, additionally even tracheotomy are other causes of acquired stenosis of the trachea.

Over the past few decades the incidence of acquired stenosis has been decreasing mainly due to the use of appropriately sized portex

endotracheal tubes and high volume / low pressure cuffs.

Selection of conservative management with endoscopic measures such as laser and dilation or various open surgical procedures depend on multiple factors. These factors are the degree of stenosis, lengths and location, previous scars and amount of defect and cartilage deficiency.

Depending on the severity of the disease, the clinical symptoms may vary from only an expiratory wheezing to respiratory distress and cyanosis, and it depends on the diameter of the lumen remaining in the stenotic segment. In this case, the use of Myer-Cotton tracheal stenosis classification system is common.

Less severe cases, equivalent to the stage 1 and 2 Mayer-Cotton, do not require surgical intervention, and conservative measures are sufficient, however in cases with more severe symptoms, equivalent to the stages 3 and 4, usually a combination of all measures in step-by-step and stage-to-stage manner will lead to better results.

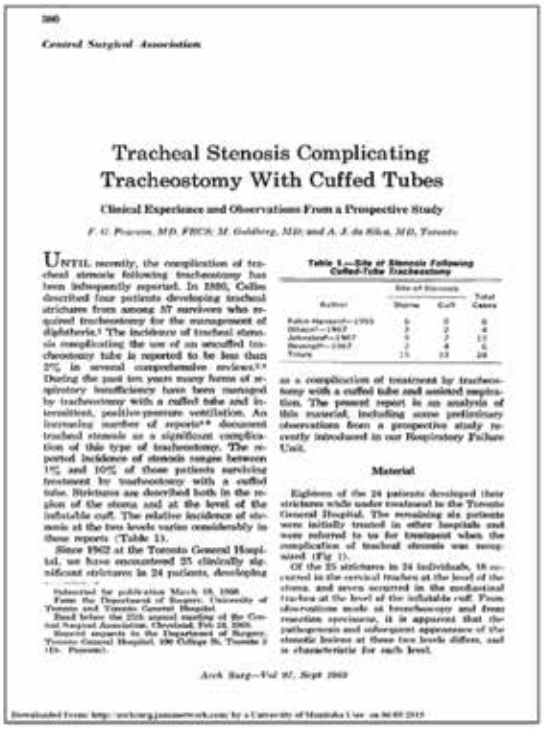
"Short segment" stenosis , which is based on the old but accepted Cantrell and Guild classifications in 1964, includes three tracheal rings(3), a tracheal resection followed by end-to-end anastomosis is the best selected procedure. Such a short segment lesions are usually due to damage from prolonged intubation, tracheal fistulas, and localized tracheal tumors that should be treated with segmental resection. These are also the common causes of tracheal stenosis.

In the "long segment" stenosis, there are surgical techniques other than simple resection/anastomosis which are beyond the current discussion.

Therefore, ultimately and classically, before performing any therapeutic treatment, a diagnostic laryngobronchoscopy, either flexible or rigid, is essential for accurate evaluation of laryngeal lumen and the health of true vocal cords and examination of tracheal mucosa and cartilages. Simple low power radiography of the neck is necessary in both lateral and antero-posterior directions. Sometimes it is necessary to use either CT scan or virtual bronchoscopy.

Case Presentation

Resection and anastomosis technique of trachea provided by F.G.Pearson et al. 1968 4)), became the basis for all subsequent surgical techniques (Fig. 1) though, gradually some modifications took place.



Tracheal Stenosis Complicating Tracheostomy With Cuffed Tubes

Clinical Experience and Observations From a Prospective Study

Figure1. Pearson et al. 1968

In this method, after skin incision and preparing the flap under the platisma, the strap muscles are opened from the midline. It is usually necessary to cut the thyroid gland from the midline to reveal the cervical trachea. The stenosis from the outer aspect of the trachea is usually seen as a dentin with lesser diameter. It matches with preoperative examinations and radiological findings, additional to the location of stenosis and the amount of resection approximation. Depending on the amount of stenosis and the use of different techniques, up to 5 cm of the trachea can be resected, which is about

half of its length (5), and it is also related to the patient's age and other conditions.

Prior to resection, with silk material and round needle, "stay sutures" are placed in the tracheal wall in the proximal and distal parts of the stenosis, which are used during the surgical procedure, especially during anastomosis, as a handle to approximate the two ends. We put these sutures in the healthy antero-lateral wall of the trachea two up and two down of the stenosis segment. The stenosis of the trachea is resected as far as we can reach the healthy cartilage rim. Do not neglect the risk of damaging the anterior wall of the esophagus. Subsequently the releasing stage begins. Releasing of trachea and Larynx is priorly preferred.

There are several techniques for releasing the distal and proximal parts of the trachea, and getting them closer to each other, from the release of larynx by cutting off suprahyoid and infrahyoid muscles, to dissection of the pulmonary ligament and other methods for "long segment" resection/anastomosis. The amount of release in the elderly is more limited due to fibrosis and calcification of the tissues, and we need several simultaneous approaches to close the two ends.

During anastomosis in classical methods, polyglactin 910 sutures containing antibacterial compounds (commercially coated Vicryl plus) is widely used to prevent the growth of various staphylococcal bacteria. Its poly-filament texture and, as a result, persistence in the tissue for up to 28 days, Vicryl plus have been identified as a suitable suture for anastomosis. The 3/0 thread is preferred with a round-tip needle.

In the classical techniques and according to the reference sources (Fig. 2) the interrupted simple sutures start from the posterior tracheal midline, and proceeds from the left and the right sides to the anterior tracheal wall, respectively. The needle tip in one edge of the trachea, moves from outside to the inside of the lumen, and on the other edge

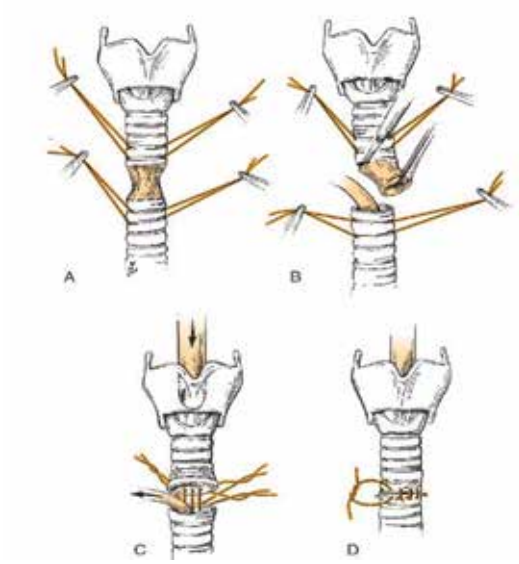


Figure 2: A, Area of stenosis. B, Resection of stenosis with intubation of trachea distally. C, Interrupted absorbable sutures placed circumferentially and reintubated from above (D). Cummings Otolaryngology Head and Neck Surgery, sixth edition, Vol.4. Elsevier Saunders. 2015;ch206:3180,Fig.8-206

moves from inside to the outside, "outside-in/inside-out technique", so that the two ends of the thread will eventually lie outside the lumen. The two ends of each suture, without being knotted, are cut at about 20 centimeters and are kept around the surgical field by the hemostat forceps. This will go on all around the trachea. Then, using two stay sutures, the two pieces are gradually tucked together and prepared threads in each side are tied with each other, one by one, and the hemostats are released to eventually complete anastomosis. All knots are located outside the lumen (Fig. 3).

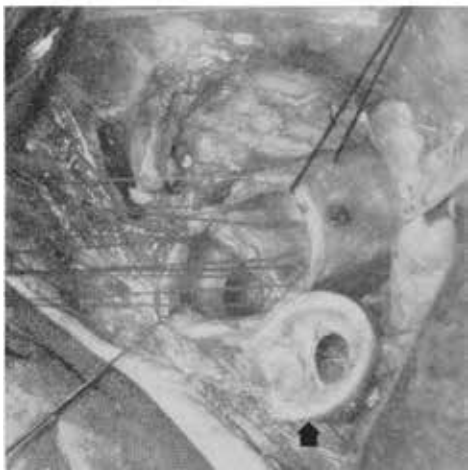


Figure 3: From the F.G.Pearson et. al study, 1968

At all these stages, complete coordination with the anesthetist is vital for changing the endotracheal tube from the distal part of the trachea to the mouth and inside the tracheal lumen. Sometimes jet ventilation is recommended, but we prefer to move the tube. The problem with classic technique is using a lot of threads and at the same time, numerous hemostats. As the patient's head is in flexion position leads to narrowing of the surgical field, there is always concern about the merging of the threads into each other and the more complexity of the anastomosis. If a thread is teared or ruptured from the tissue we have to re-suture it in a crowded field and this adds to the difficulty.

These problems require more prolong surgical timing. The surgical team demands double attention and care, in addition of the stressful nature of this surgery. Classical method of suturing increases the overall which leads to high levels of fatigue of the surgeon in end-to-end tracheal reconstruction. duration of anesthesia, the amount of medication, and the chances of complications in anesthesia and surgery which will be forced more financial costs to the public health care system.

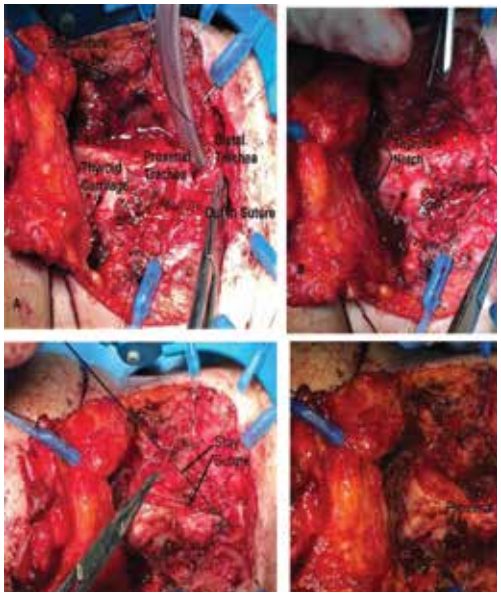


Figure 4: Adjusted method of simple interrupted sutures without using multiple hemostats (A to D)

Adjusted method applied in this study is to use simple interrupted sutures without the use of multiple hemostats (Fig. 4A to D). This technique was used in 30 cases of children and adults in whom tracheal resection and anastomosis were indicated. In each case, after explaining the condition of the tracheal disease and the necessity of its correction and alternate and parallel therapies and the results and possible complications of each one, written informed consent from the patient or his fellows, in cases where the patient was a child, was obtained

After the standard resection, anastomosis begins while the anesthetic tube is located in the distal part of the trachea. Four stay sutures were being used, which the two ends of the trachea are brought together by the surgeon's assistant and the repair begins from the posterior wall of the trachea. The same 0/3 Vicryl-plus thread is used. On the other hand by passing each needle from the tracheal wall, the knot is settled outside the lumen. The same thread and needle is used for the next interrupted suture on the right or the left side for several times until the two ends of the trachea eventually come together and the anastomosis repair is totally completed. To strengthen the anastomosis, the stay sutures are also tied together from both sides of the anastomosis (Fig. 4C).

Discussion

In this method, the overall operation time is 60 minutes, less than the classic method of anastomosis with multiple hemostat forceps. The overall time of anesthesia and side effects along with costs are reduced.

Finally, in postoperative follow up, the surgical results of patients with the technique of "simple interrupted sutures without using multiple hemostats" did not differ from the classic methods with multiple hemostats and our patients have followed all the post-op stages as other patients, and the results are similar. In reviewing the medical literatures of laryngology, several suture techniques for the anastomosis of the trachea have

been introduced. They can be categorized as following:

• Simple interrupted suture technique:

It was introduced for the first time by Froster et al. in France in 6) 1958). Afterwards, Grillo introduced fourteen patients with tracheal stenosis. They were operated and sutured similar to the Froster's method. But in this study 0/2 or 0/3 catgut threads, or a stainless steel wire number 35 were used. In either case, they reported excellent results in ten patients (5). From that time forward, Pearson and his colleagues published a report from the Toronto Hospital in Canada in 4) 1968) describing 25 patients with details such as the age and location and symptoms of stenosis, and the duration of intubation, etc. which was operated by the Fosters' method and developed good results. This article is based on the "segmental resection and end-to-end anastomosis technique of the trachea" to date.

• Simple continuous suture technique:

Kutlu et al. in 1999 reported the results of one hundred cases of "tracheobronchial sleeve resection" in Britain (7), in which the continuous suture technique was used to repair the mucous membrane with a double needle/non-absorbable thread (polypropylene = Prolene/3 zero). At the end, four additional sutures, with Prolene/ zero, took the whole thickness of the trachea and completed the anastomosis. Although the majority of these patients were malignant tumor cases and %12 complications reported, the final conclusion of the authors was that the continuous suture technique achieved results comparable to that of the simple interrupted suture technique for the resection/anastomosis of the trachea.

Bayram and his colleagues from Turkey in 2007 published their research results for comparing the classic interrupted suture method with continuous simple suture method in two groups of ten adult dogs (8). In both groups, 0/4 Vicryl threads were used. The average time of suturing in the interrupted group was 15.2 minutes and in the continuous group was 9.6 minutes. Histopathologic tests one month after anastomosis did not show any difference in the tissue repair of the two groups.

Aigner et al. from Austria, in a same study in lung transplantation, published in 2003, found similar results (9) and suggested the use of continuous suture technique as a standard method.

• Knotless Barbed Suture:

In 2012, the Laryngoscope published an article by Carrie M. Bush and his colleagues. In this publication "V-Loc" were used, which is the knotless thread of Ethicon as a continuous suture for anastomosis of the fresh trachea of the human cadaver (10). The results of its tensile strength were evaluated with laboratory instruments and the results were similar to the conventional use of Vicryl, while the satisfaction of surgeons was higher. Although, this method cannot be performed everywhere due to the high expenses.

Andreas Kirschbaum et al., In 2016, in a laboratory study, using 45 fresh pig's trachea after cutting the trachea from the left main bronchus, divided them into three equal groups and repaired with interrupted method in one group, a continuous method in the other group, and a combination of continuous sutures in the posterior and interrupted at the anterior wall in the last group. Underwater sealed anastomosis was investigated under laboratory conditions in non-tensile and tensile conditions. The final result was that, in the absence of tensile forces, the type of suture does not effect the resistance of the site of anastomosis, however if the anastomosis is carried out under tensile conditions, for example, in a resection of more than four centimeters, then the interrupted suture technique is much more reliable and recommended (11).

M. Behrend & J. Klempnauer, in a paper in 2001, compared the interrupted and continuous suture technique with polyglactin thread, and continuous suturing with polydioxanone thread in three sheep groups and concluded that all three methods are appropriate for tracheal anastomosis, although the suture technique is more important than the thread matrix material (12).

The advantage of modified method is that less suture threads are needed. A maximum of three threads is used. The field of surgery is not crowded and is free of multiple and extra-added hemostat clamps, therefore the surgeon progresses in a relaxed state without confusion. If the thread is torn or separated from the tissue, the new suture is restored to the right place, at the same time. One scrub nurse is enough to help the surgeon and there is no mistake or confusion to find and knot the suture threads.

Conclusion

End-to-end anastomosis using "simple interrupted sutures without using multiple hemostats", with minimal complexity and stress for the surgical group and with conventional and familiar instruments, results in outcomes similar to the old classical and the new recent anastomosis methods. It can be used as an alternative method everywhere and with the usual facilities of a general hospital.

Authors' Contributions

All authors equally contributed to the manuscript. All authors approved the final version of the manuscript.

Conflict of Interest Disclosures

There are no conflicts of interest in terms of the present manuscript.

Ethical approval/Consideration

A written informed consent was taken from patients and their guardians. Their information was kept confidential. No cost posed to the participants for their participation in this study.

References

1. Alessandro de Alarcon, et al. Laryngotracheal Stenosis-Definitions and Pathogenesis. Sataloff's Comprehensive Textbook of Otolaryngology Head & Neck Surgery, Vol.4 Laryngology. Jaypee Brothers Medical Publishers (P) Ltd. 2016;ch8-68:844
2. Marc Nelson, et al. Pediatric Tracheal Anomalies. Cummings Otolaryngology Head and Neck Surgery, sixth edition, Vol.4. Elsevier Saunders. 2015;ch82-206:3171
3. Marc Nelson, et al. Pediatric Tracheal Anomalies. Cummings Otolaryngology Head and Neck Surgery, sixth edition, Vol.4. Elsevier Saunders. 2015;ch206:3176
4. Pearson F.G. et al. Tracheal Stenosis Complicating
5. Tracheostomy with Cuffed Tubes Clinical Experience and Observations From a Prospective Study. Arch Surg Vol.97 Sept 1968
6. Grillo H.C. 1984
7. Forster, E., Molé, L., and Fromes, R. Sténose trachéale annulaire serrée après trachéotomie. Résection du segment sténosé. Anastomose bout a bout. Guérison Mém Acad Chir. –188 :84 ;1958 193
8. Kutlu CA and Goldstraw P. Tracheobronchial sleeve resection with the use of a continuous anastomosis: results of one hundred consecutive cases. J Thorac Cardiovasc Surg –1112 :117 ;1999 1117.
9. Bayram AS, Erol MM, Salci H, Ozyigit O, Gorgul S and Gebitekin C. Basic interrupted versus continuous suturing techniques in bronchial anastomosis following sleeve lobectomy in dogs. Eur J Cardiothorac Surg 854–32:852 ;2007
10. Aigner C, Jaksch P, Seebacher G, Neuhauser P, Marta G, Wisser W, et al. Single running suture—the new standard technique for bronchial anastomoses in lung transplantation. Eur J Cardiothorac Surg 493–488 :23 ;2003.
11. Carrie M. Bush et. Al. New Technology Applications: Knotless Barbed Suture for Tracheal Resection Anastomosis. Laryngoscope, 2012 ,1066–122:1062
12. Kirschbaum A. et. al. Initial Resistance of Carina Anastomoses with Increasing Tensile Stress: An ex vivo Model Comparing Different Suture

Techniques. Eur Surg Res 26–58:20;2017
13. Behrend M. & Klempnauer J. Influence of Suture Material and Technique on End-to-End Reconstruction in Tracheal Surgery: An Experimental Study in Sheep. Eur Surg Res 216–33:210;2001