Optimizing Airway Surgery in COVID 19 Era

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Received: 22 October 2020 / Accepted: 14 December 2020 / Published online: 7 January 2021
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Abstract Otorhinolaryngologists, particularly dealing with airway cases, are subjected to highest risk of COVID 19 aerosolisation, self infection and transmission. Moreover, airway cases, which mostly present as emergency, cannot be deferred. Being a tertiary airway centre and having received a number of airway cases, most of them requiring prompt surgical intervention, our airway surgery and anaesthesiology team had to work in conjunction to adapt and readapt the practice over the past few months, striving to achieve effective airway surgery protocols, to minimize exposure and prevent transmission of COVID 19. To enlist the encountered airway cases during COVID 19 pandemic and to highlight the important inclusions and adaptations in executing the airway surgeries. A retrospective observational study of 7 months duration was carried out. This is a single institutional study, where the sample included the primary as well the referred airway cases. Apart from Tracheotomy, Foreign body bronchus removal, Dilatation of Laryngotracheal Stenosis (LTS) and excision of Recurrent Respiratory Papillomatosis (RRP), we also have had the experience to deal with congenital Laryngo-tracheo-oesophageal Cleft (LTOC) Type III b, Thyroid surgery to relieve tracheal compression and Bilateral Choanal Atresia repair during the last 7 months. Routine 2 weeks follow up of the patients have been favourable, as there has not been any report or clinical features of transmission of COVID 19. As the airway surgeries could be executed with the incorporation of certain change in practice and as the follow up revealed no evidence of transmission, we attempt to contribute to airway best practice guideline for maintaining the safety of patients and health professionals.

Keywords Airway surgery • Aerosols • Covid 19 • Safety • Guidelines

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Introduction

The novel corona virus disease 2019 (COVID-19) outbreak was declared a pandemic by the World Health Organisation (WHO) on 11th March, 2020. The first case of the COVID-19 pandemic in the Indian state of Assam was reported on 31 March 2020. Initially, in our region, the statistics showed a controlled number of cases. However from the latter half of May, there has been a steady rise in the number of positive cases, and currently as on 30th September, it stands at more than 89,000 confirmed cases. Such a backdrop presents unique challenges for Otorhinolaryngologists. Even more challenging is the management of airway cases. Patients with airway pathology usually seek medical attention as an emergency. The upper aerodigestive tract being the harbouring site of the virus and transmission via aerosols; airway surgeons, anaesthesiologists, and operating room (OR) personnel are subjected to high risk during any procedure. Though there are unavoidable risks and difficulties related to transmission hazard, emergent airway surgeries or procedures cannot be left unattended or deferred. For the benefit and safety of such patients and health personnel, revised safety guidelines or precautions have to be instituted. To deal with airway cases during COVID times, particularly those which require surgical intervention, there has to be an excellent co-ordination between the surgeon and anaesthesiologist as both can work in conjunction to devise adaptations to minimize aerosolisation.

As this pandemic and its challenges are unfolding and posing new tribulations, sharing of recent surgical experiences, especially in the management of airway cases, can go a long way in contributing to the best practice guidelines [3, 11]. When we initially dealt with airway cases, RT PCR test for severe acute respiratory syndrome Corona virus 2 (SARS COV 2) was available only in a few Government centres in our state. Hence because of such logistic issues, we had to strictly assume all cases to be possible positive and take necessary precautions. But eventually, with easy access to Rapid Antigen Detection Test (RADT) as well as RT PCR, even in our institute, screening for COVID 19 could be swiftly carried out.

Through this retrospective study, we are sharing our experience in dealing with airway cases during this ongoing COVID 19 pandemic; particularly pointing out that with necessary alterations in practice, we have been able to carry out the surgical interventions in concerned patients without any major glitches.

Aims and Objective

1. To enumerate the airway cases, pediatric as well as adult, which were operated in the last 7 months
2. To study the additional precautions and techniques utilized for optimizing the airway surgeries during COVID times
3. To contribute to the best practice guidelines for ensuring safety of both patients and health professionals during airway surgery in COVID times

Methodology

A single centre retrospective observational study was done from the month of March to October, 2020.

The cases included in the study were:
1. The adult airway cases attending the Outpatient Department (OPD) or emergency, and who required surgical intervention
2. The diagnosed paediatric airway cases warranting surgical intervention.

The success of the cases would be measured not only by the surgical outcome to relieve the airway, but also to prevent the transmission of COVID 19. So, a close follow up till 2 weeks was carried out in all the concerned patients and health personnel.

As this pandemic is recent and new perspectives are coming into light with the passing days, facing limitations of available literature to deal with varied airway cases is inevitable. Still, the ones published and accessible has been of undisputed importance, while executing the surgical interventions in airway cases as well as in drafting our study [3, 10, 12]. For searching relevant literature, we have used Google search engine. The recent articles in English, with HTML or PDF copies have been downloaded and accessed.

Result and Discussion

Being a tertiary airway centre, we had to cater to a number of airway cases in the last seven months, amongst which, most required urgent and quick surgical intervention to avoid mortality and longstanding morbidity. All the while, we were closely monitoring the COVID 19 statistics in our region, as the surgical triaging was dependant on it. The surgical triaging or categorization which we initially
followed were adopted and eventually adapted according to the changing COVID-19 trend [22].

The initial cases were the most difficult ones from a safety perspective, as screening tests were not readily accessible. Also due to scarce testing sites, the declaration of results took a longer time. Hence categorization of patients was difficult. In fact, we had to consider all cases to be possible positive while rendering necessary treatment. So a blanket cover of PPE and strict protocols had to be implemented during the early couple of months.

But gradually, with easy availability of RT-PCR as well as RADT for COVID-19, categorization became easier.

Category A patients are treated and operated in the designated isolation space, unless proven negative in RT-PCR testing (Table 1).

Category B and C patients are admitted and initially attended to in isolation and shifted to usual ward/cabin/OR after a negative COVID-19 RT-PCR (Table 1).

The airway cases with known COVID-19 positive status underwent the same categorization. For proven positive cases, provision has been made to render treatment in COVID designated isolation ward and Operation Room (OR). During the initial peak of the pandemic in our region, the cases were simply classified as surgical emergency and non-emergency. As the COVID trend peaked and plateaued at intervals, categorization had to be revised, as the semi urgent or non-urgent cases, which were earlier deferred, had to be accommodated. Triaging or categorization has been included in several centres as evident from the published literature [22, 26, 30] (Tables 2, 3).

The differences in surgical and anaesthesia techniques, most of which we followed, while managing the airway cases, during this ongoing pandemic, have been highlighted below.

**Anaesthesia [4]**

- Rapid sequence induction
- Administration of Glycopyrrolate to reduce airway secretions
- Closed circuit ventilation with Heat and Moisture Exchanger (HME) filter
- Minimisation of the use of bag and mask or Positive Pressure Ventilation (PPV)
- Use of comparatively larger size cuffed endotracheal tube
- Surgery under local anaesthesia converted to general wherever possible
- Deeper plane of anaesthesia is always preferable
- Complete neuromuscular blockade preferred
- Adequate pre-oxygenation in selected cases
- High Flow Nasal Cannula (HFNC) or scope side port oxygenation over bag and mask [10]
- Minimum attendance of health personnel during intubation
- Use of endoscope mask, wherever applicable
- Topical lignocaine instillation to the larynx and trachea after completion of procedure and prior to extubation
- Use of plastic drape barrier covering the head end to minimise spread of aerosols [25]. We have improvised the barrier with disposable plastic. However, due to limitations of surgical accessibility, we are trying to work on a reusable tenting structure to hold the disposable plastic sheet barrier [11].

There has been a re-emergence of TIVA in COVID times as preferred method of NIV [7, 10]. Though it is under discussion in our centre, its use has not been incorporated yet.

**Tracheotomy/Tracheostomy [5, 15, 16, 27, 29]**

- Under General Anaesthesia with complete paralysis in elective cases where orotracheal intubation is possible
- Metallic tracheostomy tubes are to be avoided to prevent mucosal injury
- A cuffed silicon (Bivona) tracheostomy set is considered to be the best of its kind during tracheotomy; subsequently the tube can be deflated and can be left unchanged for 1 month unless indicated [8]
- A relatively larger sized tube is used, to avoid frequent changing due to blockage
- Adequate pre-oxygenation prior to tracheostomy
- The skin incision should be generous to avoid unnecessary delay in the procedure
- Procedure should be as fast as possible, performed by well-trained hands
- There should be limited use of suction and electrocautery
- Holding the ventilation just before making the tracheal incision will prevent the sudden burst of aerosols
- The tracheostomy hub should be connected immediately to ventilator, preferably with a closed suction system
- Connection with Viral filter or a heat and moisture exchanger (HME) is always recommended
- Training and optimising tracheostomy tube self care at home and video-teleconsultation
- In cases where orotracheal intubation is unfavourable, TIVA or IV deep sedation with HFNC can be preferred [7]

**Foreign Body Airway Removal [2, 11, 17]**

- Use of video-endoscopy for maintaining distance
- Use of optical forces for an expeditious procedure
- Use of glass slide for blocking the vents of the bronchoscope
- Side endoscope port oxygenation
- Good communication with anaesthesiology team for avoiding unnecessary delay and minimisation of PPV
- Swift execution of the procedure when intermittent apnea technique with complete neuromuscular blockade was used as anesthesia
- TIVA or deep IV sedation is a good alternative to PPV
- Plastic drape barrier [26]

**Subglottic Tracheal Stenosis [12, 19, 24, 25]**

- Preference of repeated Coblation excision and dilatation
- Intraliesional steroid instillation
- Relook procedure with balloon dilatation, wherever applicable
- Aerosol minimalisation by closed ventilation via cuffed tracheostomy tube
- CTR and anastomosis is another surgical option, but as it was an open and tedious procedure, was not preferred.

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**Table 2 Enlisting the included studies related to the COVID 19 pandemic**

| Source | Study | Date       |
|--------|-------|------------|
| Journal of Otolaryngology-Head & Neck Surgery (Elsevier) | Recommendations from the CSO-HNS taskforce on performance of tracheotomy during the COVID-19 pandemic | February 2020 |
| JAMA Otolaryngology–Head & Neck Surgery | Surgical considerations for tracheostomy during the COVID-19 pandemic: lessons learned from the severe acute respiratory syndrome outbreak | March 2020 |
| Journal of Health Management | Personal protective equipment: challenges and strategies to combat COVID-19 in India: A narrative review | June 2020 |
| American Academy of Otolaryngology-Head and Neck Surgery (SAGE) | COVID-19 pandemic: what every otolaryngologist-head and neck surgeon needs to know for safe airway management | April 2020 |
| Indian Journal of Otolaryngology and Head & Neck Surgery | Pediatric airway surgeries in COVID 19 Era | July 2020 |
| Tr-ENT (Behbut Cevansør Otorhinolaryngology-Head and Neck Surgery Society) | ENT surgery during COVID-19 pandemic: tips for safe surgery and how to prioritize them | May 2020 |
| American Academy of Otolaryngology-Head and Neck Surgery (SAGE) | Prince AD, Cloyd BH, Hogikyan ND, Schechtman SA, Kupfer RA. Airway management for endoscopic laryngotracheal stenosis surgery during COVID-19 | May 2020 |
| The Malaysian Journal of Medical Sciences | Managing Aerodigestive Emergencies During the COVID-19 Pandemic: challenges for Healthcare Workers | May 2020 |
| Indian Journal of Anaesthesia | Difficult airway management in COVID times | May 2020 |
| International Journal of Pediatric Otorhinolaryngology | Pediatric laryngoscopy and bronchoscopy during the COVID-19 pandemic: a four-center collaborative protocol to improve safety with perioperative management strategies and creation of a surgical tent with disposable drapes | July 2020 |
| JAMA otolaryngology-Head & Neck Surgery | Safety recommendations for evaluation and surgery of the head and neck during the COVID-19 pandemic | March 2020 |
Recurrent Respiratory Papillomatosis [25]

- MLS (Micrscopic Laryngeal surgery) with video monitor display helped in maintaining some distance with the patient during the procedure
- Use of a smaller sized cuffed ET for passing through the lesion free part of glottis helped in securing the airway
- For excision of the lesion, coblator (Laryngeal wand) was used, which, apart from being a powered instrument, had the advantage of being coupled with suctioning.
- Cold steel instruments’ use for excision of laryngeal lesion is another good option during COVID times
- The use of LASER is discouraged because of the plume hazards

Bilateral Choanal Atresia Repair

- Prior orotracheal intubation and closed circuit ventilation provided a secure airway
- Endoscopic video assisted repair by posterior septal flap technique was done
- Intranasal stent was not used
- Cold steel microearsurgery instruments were used to carry out the surgical steps in the limited intranasal space
- Minimum use of drilling was incorporated
- Regular endoscopic follow up and balloon dilatation using foley’s catheter, as and when required

Table 3

| No | Age/sex | Diagnosis | Categorisation | Surgery | Anesthesia |
|----|---------|-----------|---------------|---------|------------|
| 1  | 6y/M    | Foreign body right bronchus | B          | Rigid bronchoscopy and foreign body removal | Intermittent apnea technique with full relaxation and side port oxygenation |
| 2  | 15D/F   | Type IIIb LTOC | B          | Open surgical repair of trachea and oesophagus | Tracheal intubation with endotracheal tube (ET) via low tracheotomy and closed circuit ventilation |
| 3  | 28y/M   | Subglottic tracheal stenosis (grade III) | A          | Tracheotomy followed by coblation excision, dilatation and intraloesional steroid injection | Deep IV sedation followed by closed circuit ventilation via cuffed tracheostomy tube |
| 4  | 61y/M   | Transglottic growth with stridor | B          | Tracheotomy | Deep IV sedation |
| 5  | 55y/M   | Papillary Carcinoma of thyroid with retrosternal extension and tracheal compression | B          | Total Thyroidectomy with Left sided selective neck dissection (II–V) with central compartment node clearance | Orotracheal intubation by cuffed ET and closed circuit ventilation |
| 6  | 4 yrs/M | RRP (involving anterior half of both vocal folds and anterior commissure) | B          | Video-Laryngoscopic Surgery (Coblation excision) | Orotracheal intubation by cuffed ET and closed circuit ventilation |
| 7  | 60y/M   | Multinodular goitre with tracheal compression | B          | Total thyroidectomy | Orotracheal intubation by cuffed ET and closed circuit ventilation |
| 8  | 26y/M   | Subglottic tracheal stenosis (grade IV) (prior tracheotomised) | B          | Coblation excision, dilatation and intraloesional steroid injection | Closed ventilation via cuffed tracheostomy tube |
| 9  | 3D/M    | Bilateral choanal atresia | B          | Endoscopic bilateral choanal atresia repair by septal flap technique | Orotracheal intubation by ET and closed circuit ventilation |

LTOC Type III b Repair/Thyroid or Neck Surgery

- Orotracheal intubation by cuffed ET for open Thyroid/Neck surgery
- A low tracheotomy and uncuffed ET was utilised in LTOC for an open procedure [9, 10, 14, 20, 21]
- Open and long duration of exposure demanded the best of PPE [13, 16]
- A good alternative would have been a closed endoscopic repair of the LTOC, provided the correct instrumentation was available [9, 10, 14, 20, 21]. Intermittent apnea technique or TIVA with full muscle relaxation would have been options for general anesthesia.
- Use of electrocautery in open neck surgery was limited, instead it was replaced with ties
**General Surgical Adaptations [3]**

- Use of laser and electrocautery are not recommended because of the risk of aerosolisation with plumes or fumes; Coblater and Microdebrider with incorporated suction are important alternatives
- Any surgery should be as quick as possible
- If there are two surgical options for a case, the one which is relatively of shorter duration or which causes minimal aerosol generation and exposure is preferred.

At all times, we would like to stress on meticulous Doffing-Donning and hand-face hygiene for the smooth operation of the new protocols. There have been innumerable evidence based data and research on the proper use PPE. We cannot ignore the aspect of false negative RT PCR, and how it depends on several factors [17, 18]. Hence, though a pre-operative negative RT-PCR provides some amount of mental relaxation, there should be no difference in maintaining the protocols or precautions.

**Personal Protective Equipments (PPE) [3, 13, 28]**

For all the cases, the PPE used were in accordance with the guidelines issued by the Ministry of Health and Family Welfare, Directorate General of Health Sciences (Emergency Medical Relief).

**Recommendations for an Ideal Use of [6, 28]**

- Hazmat suit or proper full sleeve impermeable disposable gown with visor and foot cover over OT scrubs (we have personally used both and found them to be equally effective)
- N 95/ffp2 non valved mask
- Reusable half face respirators are found to be most effective to deal with fogging uses, especially in long surgeries [23]
- Surgical goggles
- Face shield; however face shield is non compliant during use of microscope, when seeing through eyepiece. This can be overcome by visualizing the monitor or by use video-endoscopes
- Double non powdered surgical gloves
- Proper donning and doffing of PPE and ensuring the proper execution of the sterilization chain [3].

**Follow Up [1, 6]**

As symptoms of COVID 19 infection usually manifest between 5 and 12 days of exposure, all the patients were reviewed either in person or via teleconsultation 2 weeks following surgery [1]. During the tele review, questions were put forward to inquire about any unusual health concern and the common symptoms of COVID 19 infection. In case of any doubt, RT PCR swab test for COVID 19 was advised. The health of all the healthcare staff associated with the surgeries, were also closely followed up alike. Fortunately, in all the above mentioned cases and the associated health personnel, no apparent untoward event with respect to COVID 19 transmission has been met so far [1].

**Conclusion**

Otorhinolaryngology practice has been tremendously affected because of the COVID 19 pandemic scenario, as the clinical examination and intervention involved were mostly aerosol generating procedures (AGP). In the early days, when the pandemic hit the Indian nation and extensive lockdown was imposed, a lot of patients with Otorhinolaryngology non-COVID ailments had to face the brunt. But gradually guidelines and protocols were formulated for the service of such patients who required non-delayed medical or surgical attention. We are particularly focusing on airway cases, as most of them required prompt intervention, which if failed to deliver, might result either in mortality or long standing morbidity. Our hospital, being a tertiary airway centre, and having received a good number of such cases (adult and paediatric), have been focusing on ways or adaptations to ensure safe airway surgery, to minimize the COVID 19 viral transmission and to contribute to the best practice guidelines. As the most commonly performed emergency airway surgery is tracheostomy/tracheotomy and which might be urgently required in any centre, the guidelines and adaptations have been highlighted. Some other pertinent surgical adaptations for minimizing aerosol generation include- preference of closed airway surgery over open, wherever feasible; use of cold steel instruments; limited use of coblater and microdebrider is encouraged over electrocautery and LASER. Anaesthesia adaptations are equally important as both intubation and PPV are highly AGPs; hence have been discussed. All our cases as well the associated health personnel have shown no clinical features of COVID 19 infection on follow-up. Hence we believe that with the inclusion of proper adaptations and protocols, airway surgeries can be safely optimized. Though surgical techniques’ adaptations or preference might vary and be case-specific, but the general protocols of maintaining safe practice should be diligently followed. There are several other adaptations which we are still working on. We believe that even with the dawn of vaccines in the near future, we believe the safety norms should not slackened. There is a lot to learn and absorb from this ongoing
pandemic. By sharing our experience, we are suggesting that interventions in airway cases need not be unnecessarily delayed; as by making relevant adaptations and by adhering to strict protocols, it is possible to carry out safe airway practices. It is, hereby, our humble attempt at contributing to the best airway surgical practice guidelines, not just to be implemented during this pandemic, but also can be carried forward in the post-pandemic era to ensure greater safety standards of both health personnel and patients.

Availability of Data and Materials All patients’ data for the article has been derived from the archived information of the concerned cases.

Compliance with Ethical Standards

Conflict of interest There are no conflicts of interest.

Ethics Approval Institutional ethical committee clearance has been obtained with adherence to the “The Declaration of Helsinki”.

Patient’s Consent The authors certify that they have obtained all appropriate patient consent forms. In the forms, the patient(s) has/have given her/his consent for her/his/their images or other clinical information to be reported in the journal.

References

1. Backer JA, Klinkenberg D, Wallinga J (2020) Incubation period of 2019 novel coronavirus (2019-nCoV) infections among travellers from Wuhan, China, 20–28 January 2020. Eurosurveillance 25(5):2000062
2. Bajwa SJ, Kurdi M, Strumpoulis K (2020) Difficult airway management in COVID-19 cases. Indian J Anaesth 64(14):116
3. Balakrishnan K, Schechtman S, Hogikyan ND, Teoh AY, McGrath B, Brenner MJ (2020) COVID-19 pandemic: what every otolaryngologist–head and neck surgeon needs to know for safe airway management. Otolaryngology-Head Neck Surg 164(1):97–104
4. Brewster DJ, Chirome NC, Do TB, Fraser K, Groombridge CJ, Higgs A, Humar MJ, Leeuwenburg TJ, McGoughlin S, Newman FG, Nickson CP (2020) Consensus statement: Safe Airway Society principles of airway management and tracheal intubation specific to the COVID-19 adult patient group. Med J Aust 16:16
5. Chao TN, Braslow BM, Martin ND, Chalian AA, Atkins J, Haas AR, Rassekh CH (2020) Tracheotomy in ventilated patients with COVID-19. Ann Surg 272:e30–e32
6. Cheung JC, Ho LT, Cheng JV, Cham EY, Lam KN (2020) Staff safety during emergency airway management for COVID-19 in Hong Kong. Lancet Respir Med 20:30084–9. https://doi.org/10.1016/S2213-2600
7. Chokshi T, Channasappara S, Vergheese DC, Bajwa SJ, Gupta B, Mehdirdatta L (2020) Re-emergence of TIVA in COVID times. Indian J Anaesth 64(14):125
8. Cooper JD, Todd TR, Pearson FG (1981) Use of the silicone tracheal T-tube for the management of complex tracheal injuries. J Thorac Cardiovasc Surg 82(4):559–568
9. Donahoe PK, Gee PE (1984) Complete laryngotracheoesophageal cleft: management and repair. J Pediatr Surg 19(2):143–148
10. Ferrari LR, Zurakowski D, Solari J, Ravbar R (2013) Laryngeal cleft repair: the anesthetic perspective. Pediatr Anesth 23(4):334–341
11. Francom CR, Javia L, Wolter NE, Lee GS, Wine T, Morrissey T, Papsin BC, Peyton JM, Matava CT, Volk MS, Prager JD (2020) Pediatric laryngoscopy and bronchoscopy during the COVID-19 pandemic: a four-center collaborative protocol to improve safety with perioperative management strategies and creation of a surgical tent with disposable drapes. Int J Pediatr Otorhinolaryngol 134:110059
12. Gervasio CF, Averono G, Robiolo L, Bertoletti M, Colagio U, De Co L, Bertone F (2020) Tracheal stenosis after tracheostomy for mechanical ventilation in COVID-19 pneumonia—a report of 2 cases from Northern Italy. Am J Case Rep 21:e926731–e926741
13. Givi B, Schiff BA, Chinn SB, Clayburgh D, Iyer NG, Jalili S, Moore MG, Nathan CA, Oroloff LA, O’Neill JP, Parker N, Zender C, Morris LGT, Davies I (2020) Safety recommendations for evaluation and surgery of the head and neck during the COVID-19 pandemic. JAMA Otolaryngol Head Neck Surg 146(6):579–584
14. Griffith CL, Liversedge TF (2015) Laryngeal clefts. BJA Educ 15(5):237–241
15. Heyd CP, Desiato VM, Nguyen SA, O’Rourke AK, Clemmens CS, Awad MI, Worley ML, Day TA (2020) Tracheostomy protocols during COVID-19 pandemic. Head Neck. https://doi.org/10.1002/hed.26192
16. Kligerman MP, Vukkadala N, Tsang RK, Sunwoo JB, Hollinger FC, Chan JY, Damrose EJ, Kearney A, Starmer HM (2020) Managing head and neck cancer patients with tracheostomy or laryngectomy during the COVID-19 pandemic. Head Neck 42(6):1209–1213
17. Krishnamoorthy M, Nasir MS, Mohamad I (2020) Managing aerodigestive emergencies during the COVID-19 pandemic: challenges for healthcare workers. Malays J Med Sci MJMS 27(3):153
18. Kucirka LM, Lauer SA, Laeyendecker O, Boon D, Lessler J (2020) Variation in false-negative rate of reverse transcriptase polymerase chain reaction–based SARS-CoV-2 tests by time since exposure. Ann Intern Med 173(4):262–267
19. Lucchi M, Ambrogi M, Aprel V, Ribechini A, Fontanini G (2020) Laryngotracheal resection for a post-tracheotomy stenosis in a patient with coronavirus disease 2019 (COVID-19). JTCVS Tech 4:360–364
20. Monnier P (2011) Laryngeal and tracheal clefts. Pediatric airway surgery. Springer, Berlin, Heidelberg, pp 147–156
21. Myer CM III, Holmes DK, Cotton RT, Jackson RK (1990) Laryngeal and laryngotracheoesophageal clefts: role of early surgical repair. Ann Otol Rhinol Laryngol 99(2):98–104
22. Ohanian OS, Ces K, Aydemir L, Çelik M, Keles Türel MN (2020) ENT surgery during COVID-19 pandemic: tips for safe surgery and how to prioritize them. Tr-ENT 30(Supp 1):41–51
23. Patel B, Hardman JC, Yang W, Robson A, Putnam G, George A, Paleri V (2020) Reusable respirators as personal protective equipment during ENT surgery. J Laryngol Otol 111:1–3
24. Prince AD, Cloyd BH, Hogikyan ND, Schechtman SA, Kupfer RA (2020) Airway management for endoscopic laryngotracheal stenosis surgery during COVID-19. Otolaryngology-Head Neck Surg 162:194599820927002
25. Rachmanidou A, Modaill P (2011) Coblation resection of laryngotracheal stenosis surgery during COVID-19. Otolaryngology-Head Neck Surg 145(5):e826741
26. Raman EV, Shivnani D (2020) Pediatric airway surgeries in COVID 19 era. J Otolaryngol Head Neck Surg 27:1–4
27. Sommer DD, Paller J (2020) Laryngectomy during the COVID-19 pandemic. Head Neck. https://doi.org/10.1002/hed.26192
28. Tewfik MA, Fung K, Cote D, Gupta M, Sme N, Brown TF (2020) Recommendations from the CSO-HNS taskforce on performance
of tracheotomy during the COVID-19 pandemic. J Otolaryngol-Head Neck Surg 49:1–4
28. Sharma N, Hasan Z, Velayudhan A, Emil MA, Mangal DK, Gupta SD (2020) Personal protective equipment: challenges and strategies to combat COVID-19 in India: a narrative review. J Health Manag 22(2):157–68
29. Tay JK, Khoo ML, Loh WS (2020) Surgical considerations for tracheostomy during the COVID-19 pandemic: lessons learned from the severe acute respiratory syndrome outbreak. JAMA Otolaryngol Head Neck Surg 146(6):517–518
30. Wee LE, Fua TP, Chua YY, Ho AF, Sim XY, Conceicao EP, Venkatachalam I, Tan KB, Tan BH (2020) Containing COVID-19 in the emergency department: the role of improved case detection and segregation of suspect cases. Acad Emerg Med 27(5):379–387

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