Airway Management Strategy Using Seldinger Minitracheostomy Kit to Prevent Airway Obstruction after Oral Cancer Surgery: A Retrospective Study

Kyotaro Koshika¹, Keikoku Tachibana², Tatsuki Hoshino², Reiko Terashima¹, Reina Okada², Takashi Ouchi² and Toshiya Koitabashi²

¹Department of Dental Anesthesiology, Tokyo Dental College, 2-9-18 Kanda-Misakicho, Chiyoda-ku, Tokyo 101-0061, Japan
²Department of Anesthesiology, Tokyo Dental College Ichikawa General Hospital, 5-11-13 Sugano, Ichikawa-shi, Chiba 272-8513, Japan

Received 12 February, 2021/Accepted for publication 14 June, 2021
Published Online in J-STAGE 15 November, 2021

Abstract

A minitracheostomy (MTS) is performed after surgery for oral cancer at our institution in patients who are at risk of postoperative airway obstruction. The aim of this study was to evaluate outcomes of preventive airway management with this procedure. A total of 105 patients undergoing preventive airway management with a Seldinger MTS kit after oral cancer surgery between October 2014 and March 2020 were enrolled. Information on patient characteristics, time required for the MTS, duration of tracheal cannula placement, and MTS-related complications was obtained from both the medical and anesthesia records. In addition, the numbers of postoperative instances of tracheotomy between April 2009 and September 2014 and extubation between October 2014 and March 2020 were also counted for a comparison. The time required for an MTS was 3.2 ± 2.6 min. Minor complications, including mild subcutaneous or mediastinal emphysema and bleeding, were found in 5 patients, but all recovered in a short time. The median duration of tracheal cannula placement was 2 days, with a range of from 0 to 8 days. A total of 348 oral cancer surgeries were performed between April 2009 and September 2014. Among patients undergoing these procedures, 111 underwent a tracheostomy (32%), 235 extubation (68%), and 2 sustained intubation. A total of 580 oral cancer surgeries were performed between October 2014 and March 2020. Here, 121 patients underwent a tracheostomy (21%), 105 an MTS (18%), and 354 extubation (61%). The results suggest that an MTS can be performed safely and smoothly with no significant complications. They also suggest that an MTS reduces the need for a full tracheostomy and the risk of airway obstruction after extubation. We conclude that airway management strategy with an MTS is a useful option in preventing airway obstruction following oral cancer surgery.

Key words: Minitracheostomy — Oral cancer surgery — Airway management — Airway obstruction
Introduction

Oral cancer surgery involves the upper respiratory tract as a surgical site and carries a high risk of obstruction of the upper airway. Resection of the mandible, tongue, or the floor of the mouth, in particular, carries a high risk of this, as well as upper airway edema in the pharynx and posterior tongue. For this reason, it is necessary to prevent airway obstruction following surgery. Traditionally, preventing obstruction of the upper airway has often involved sustained endotracheal intubation or tracheostomy. At our institution, obstruction is prevented by strict airway management including elective tracheostomy.

Table 1  Strategy for postoperative airway management

| Excision site                          | Score |
|---------------------------------------|-------|
| 1. Hard tissue                        |       |
| 1) Maxilla                            | 1     |
| 2) Mandible                           |       |
| Marginal mandibulectomy               | 1     |
| Segmental mandibulectomy              | 2     |
| Hemi-mandibulectomy or resection of mentum | 4     |
| 2. Soft tissue                        |       |
| 1) Tongue                             |       |
| Partial glossectomy                   | 1     |
| Hemi-glossectomy                      | 2     |
| Subtotal-total glossectomy or glossectomy including base of tongue | 5     |
| 2) Floor of mouth                     | 4     |
| 3. Neck                               |       |
| 1) Unilateral neck dissection         |       |
| Radical neck dissection               | 3     |
| Selective neck dissection             | 1     |
| If opposite neck dissection was performed previously, add following scores.  |
| Radiation of contralateral neck       | 3     |
| Resection of contralateral internal jugular vein | 3     |
| 2) Bilateral neck dissection          | 6     |

Reconstruction

| 1. Free flap                          | 2     |
| 2. Pedicled flap                      | 2     |
| 3. Metal plate for reconstruction of mandible | 1     |

Other issues for consideration

1. Patient: age, activities of daily living, BMI, medical history, etc
2. Surgery: extent of resection, operation time, massive bleeding, hard edema, etc

Strategy of airway management

Total score  1  Extubation
2-3  Minitracheostomy or extubation
4-5  Tracheostomy, prolonged intubation, or minitracheostomy
more than 6  Tracheostomy
in high-risk patients. The application of this procedure is selected based on an index on which a high score indicates that a tracheostomy is required\(^5\). We have also encountered postoperative airway obstruction in patients with a low score on this index following tongue cancer excision, however\(^10\). Therefore, from October 2014 onwards, a new modified index was adopted at our hospital, which allows for the addition of a minitracheostomy (MTS) between extubation and tracheostomy. It has been reported that MTS is less invasive than tracheostomy, and mechanical ventilation can be performed via an MTS tube in case of upper airway obstruction\(^15\).

Table 1 shows the new index used at our institution. Scores are awarded based on the type of surgical procedure used to determine the most appropriate method of airway management. According to this new index, MTS should be performed after oral cancer surgery in patients at risk for postoperative airway obstruction. To our knowledge, no clinical study to date has investigated outcomes with this procedure following oral cancer surgery. The purpose of the present study was to evaluate outcomes with MTS in preventing airway obstruction following surgery for oral cancer.

**Materials and Methods**

The protocol of this study was approved by the Institutional Research Board of the Tokyo Dental College Ichikawa General Hospital (approval number: 16-38). Patients who underwent preventive airway management using a Seldinger MTS kit (Portex\textsuperscript{®} Mini-Trach\textsuperscript{®} II Seldinger kit, Smiths Medical Japan, Tokyo) (Fig. 1) after oral cancer surgery between October 2014 and March 2020 were enrolled. Information on patient characteristics (including age, sex, height, weight, body mass index [BMI], type of surgical procedure, operation time, and bleeding volume), the time required for the MTS procedure (from skin incision to completion of tracheal cannulation), MTS-related complications, duration of tracheal cannula placement, and total score to determine strategy for postoperative airway management (Table 1) was retrospectively obtained from both the medical and anesthesia records. Patient information was anonymized prior to analysis. The numbers of tracheotomies performed between April 2009 and September 2014 and extubations between October 2014 and March 2020 after oral cancer surgery were determined for a comparison.

The results are expressed as the mean ± SD. The total score for postoperative airway management and duration of tracheal cannula placement is expressed as the median (range,
minimum—maximum values). All surgeons performing an MTS at our institution are required to undergo prior training using an MTS kit before applying this procedure in a clinical setting.

Results

A total of 105 patients (67 men, 38 women) who underwent an MTS after oral cancer surgery were included in the analysis. Table 2 shows the patient characteristics. The most common surgical procedure was unilateral neck dissection, which was performed in 49 patients (47%), followed by tumor resection with unilateral neck dissection, which was performed in 36 (34%). The success rate of MTS was 100%. The time required for the MTS was 3.2 ± 2.6 min. No particularly notable complications were observed during the procedure. Minor complications, including mild subcutaneous or mediastinal emphysema and bleeding, were found in 5 patients, but all recovered within a short time (Table 3). The duration of tracheal cannula placement was 2 days (range, 0–8 days). The total postoperative airway management score was 3 points (range, 1–8 points). Of the 348 oral cancer surgeries performed between April 2009 and September 2014, 111 involved a tracheostomy (32%), 235 extubation (68%), and 2 sustained intubation. A total of 580 oral cancer surgeries were performed between October 2014 and March 2020. Of these, 121 involved tracheostomy (21%), 105 an MTS (18%), and 354 extubation (61%).

Discussion

Despite several disadvantages, tracheostomy and sustained intubation have remained
useful strategies for airway management in patients at high risk for postoperative airway obstruction. Sustained tracheal intubation requires sedation and/or mechanical ventilation, which can lead to complications, such as ventilator-associated pneumonia and/or postoperative delirium. Moreover, it may cause verbal communication difficulties and can be uncomfortable for conscious patients. On the other hand, a tracheostomy is a major invasive procedure that may also cause complications, such as infection, intratracheal or subcutaneous bleeding, injury of the brachiocephalic artery or esophagus, surgical emphysema, pneumothorax, and pneumomediastinum. Moreover, tracheostomy leads to temporary voicelessness, which is stressful for patients and causes impairment of swallowing function due to restriction of the elevation movement of the larynx during swallowing. In addition, cosmetic disadvantages can occur after the removal of the tracheostomy cannula. There are several reports regarding severe complications and occasional death with tracheostomy. Therefore, surgeons may hesitate to use these airway management strategies as they are highly invasive. Extubation without performing these procedures may result in postoperative obstruction of the upper airway, however. Therefore, the present study investigated outcomes in patients who had undergone an MTS immediately after extubation. The results revealed that the procedure time was short (3.2 ± 2.6 min), and that there were no major complications. This suggests that MTS offers a useful option in preventive airway management after oral cancer surgery. The amount of practice required for successful performance of an MTS has been reported. One earlier study found that 96% of participants were able to perform the procedure on a mannequin within 40 sec after 5 successive completions, demonstrating the importance of training in advance. In the present study, the MTS was performed within a short time, even though the patients were moving and coughing. This suggests that not only advanced practice, but also instruction from an expert assisting with the procedure is important. The success rate for placement of the MTS cannula observed in the present study (100%) was in line with that seen in earlier studies (96–100%).

In addition, the results of the present study suggest another useful feature of MTS. The rate of tracheostomy after the introduction of MTS decreased from 32% to 21%. Similarly, the rate of extubation decreased from 68% to 61%. These results indicate that a portion of the patients underwent MTS instead of tracheostomy or extubation. This suggests that MTS should be prioritized between extubation and tracheostomy in postoperative airway management, as this may reduce the number of tracheostomies required and the risk of airway obstruction after extubation.

The current policy at our hospital is to assign a numerical score to determine risk of postoperative airway obstruction and use this figure as a guide to choosing the most appropriate method of postoperative airway management. The median score for operations in which a MTS was performed was 3 as the most frequently performed procedure in this study was unilateral neck dissection. Generally, the patient is extubated following this procedure, but cases of upper airway obstruction have been reported. Therefore, an MTS is often performed at our hospital to reduce this risk. The minimum score is 1, and according to hospital policy, this corresponds to extubation. However, the policy also states that other factors, such as age, activities of daily living, BMI score, medical history, the extent of resection, operation time, massive bleeding, and hard edema must be taken into consideration, and these factors are not allocated scores. Therefore, the decision on which method to use to secure the airway cannot be made based on the score alone. Prophylactic airway management may be necessary, even if the score is low. On the other hand, the maximum score is 8, and according to the index, this corresponds to a tracheostomy. In the present study, the wide range of scores observed (from 1 to 8) meant that, ultimately, the choice for postoperative airway management was made based on the surgeon’s or
Koshika K et al.

anesthesiologist’s experience. A number of clinical scoring systems have been proposed for the selection of postoperative airway management.\textsuperscript{4,6,7,11,12,19} The optimal postoperative airway management strategy remains controversial, however. We believe that an MTS offers a safer and less invasive option. In the future, it may be necessary to establish the criteria for selecting postoperative airway management strategies including MTS.

An MTS involves the placement of an indwelling plastic cannula with an internal diameter of 4.0 mm through the cricothyroid membrane into the distal trachea.\textsuperscript{22} Clinically, it is performed with the aim of aspirating sputum \textit{via} the tracheal cannula\textsuperscript{3}. As ventilation can also be performed \textit{via} the cannula, it is also used to secure the airway in emergency cases of upper airway obstruction.\textsuperscript{1} Because the diameter of the tracheal cannula is only 4 mm, however, this technique provides poor ventilation compared with tracheal intubation or tracheostomy. Frequent suction is required because the lumen can be occluded by secretions. An MTS is therefore only a temporary measure for establishing an open airway, and it cannot be used for prolonged periods, such as with conventional tracheostomy for ventilation.\textsuperscript{1} A definitive airway must be established using other techniques, and using an MTS cannula for ventilation or oxygenation can provide time for performing these other techniques.\textsuperscript{1} In fact, in one of the present patients who underwent marginal mandibulectomy and MTS for mandibular gingival carcinoma, ventilation \textit{via} the prophylactically inserted 4-mm tracheal cannula enabled the tracheostomy to be performed without difficulty when the patient developed postoperative upper airway obstruction.\textsuperscript{17} In addition, scarring after decannulation is unobtrusive, and this may also contribute to the acceptability of this technique by both patients and medical staff.

Complications of MTS include bleeding, local hematoma, hoarseness, obstructive subglottic granuloma, subcutaneous emphysema, misplacement of the guidewire, pneumothorax, positioning problems, delayed healing, subglottic stenosis, ventilatory difficulties, and esophageal damage.\textsuperscript{1,3,16,21} In the present study, subcutaneous or mediastinal emphysema or bleeding occurred in 5/105 patients (5%). The reported complication rates for MTS were 5–10%\textsuperscript{3}, and the rate observed in the present study was similarly low. We believe two factors to have contributed to this finding. First, the present patients underwent MTS after preparation in the operating room. Second, the surgeons had received prior instruction from an expert to ensure the safety of the procedure. This was a retrospective study based on medical and anesthesia records, however, so it is possible that very mild complications may not have been recorded. Future prospective studies are required with regard to this issue.

Some of the medical records accessed in the present study described difficulty in non-verbal communication or the need for written conversation in tracheotomy patients. Being unable to convey thoughts or feelings postoperatively is a major source of distress for the patient, and can lead to a sense of isolation, anxiety, and fear. At the same time, being unable to understand the patient’s requests can also be a source of serious stress for medical staff. This issue can be avoided by using an MTS, as the patient will still be able to talk while the cannula is in place. An MTS performed as prophylactic airway establishment may also be helpful in terms of quality of life while the patient remains hospitalized.

Thus, an MTS offers many advantages. It can be performed safely and smoothly with no significant complications. It can provide ventilation through a cannula in cases of upper airway obstruction, and the patient can still speak and will feel only little discomfort, even when the cannula is inserted, and almost no scars are left after cannula removal. The MTS cannula has a small diameter of only 4.0 mm, however, and does not have a cuff; therefore, the decision regarding patients for whom an MTS is indicated must be made with caution.
Conclusion

The results of this study demonstrated that the MTS was performed safely and smoothly with no significant complications in the present patients. The time required for the procedure was as short as 3.2 ± 2.6 min, and minor complications were noted in only 5 patients. We believe that prior training with the MTS kit and assistance by an expert instructor contributed to the results. These findings suggest that an MTS reduces the need for a tracheostomy and the risk of airway obstruction after extubation. Taken together, these results indicate that an MTS offers a useful option in preventing airway obstruction following oral cancer surgery.

Acknowledgements

The authors declare no conflict of interest associated with this manuscript.

References

1) Ala-Kokko TI, Kylönen M, Nuutinen L (1996) Management of upper airway obstruction using a Seldinger minitracheotomy kit. Acta Anaesthesiol Scand 40:385–388.
2) Alberti PW (1984) Tracheostomy versus intubation: a 19th century controversy. Annals Otol Rhinol Laryngol 93:333–337.
3) Beach L, Denchey L, Lee A (2013) The efficacy of minitracheostomy for the management of sputum retention: A systematic review. Physiotherapy 99:271–277.
4) Cameron M, Corner A, Diba A, Hankins M (2009) Development of a tracheostomy scoring system to guide airway management after major head and neck surgery. Int J Oral Maxillofac Surg 38:846–849.
5) Fukushima K, Ichinohe T, Kitahata H, Shimada A, Niwa H, Miyawaki T (2019) Shikamasuigaku 8th ed., pp.408–411, Ishiyaku Publishers, Tokyo. (in Japanese)
6) Gupta K, Manendik D, Patel D, Patel P, Shah B, Vijay DG, Kothari JM, Toprani RB, Patel KD (2016) Clinical assessment scoring system for tracheostomy (CASST) criterion: Objective criteria to predict pre-operatively the need for a tracheostomy in head and neck malignancies. J Craniomaxillofac Surg 44:1310–1313.
7) Halfpenny W, McGurk M (2000) Analysis of tracheostomy-associated morbidity after operations for head and neck cancer. Br J Oral Max Surg 38:509–512.
8) Mohamedbhai H, Ali S, Dimasi I, Kalavrezos N (2018) TRACHY score: A simple and effective guide to management of the airway in head and neck cancer. Br J Oral Maxillofac Surg 56: 709–714.
9) Meier J, Wunschel M, Angermann A, Ertl T, Metterlein T, Klingelhöffer G, Reichert TE, Ritzka M (2019) Influence of early elective tracheostomy on the incidence of postoperative complications in patients undergoing head and neck surgery. BMC Anesthesiol 19: 43.
10) Koshika K, Sazuka S, Nishizawa S, Serita R, Koitabashi T (2014) A case of postoperative tongue bleeding after partial glossectomy. Nihonshikamasuigakkaizashi 42:216–217. (in Japanese)
11) Lee HJ, Kim JW, Choi SY, Kim CS, Kwon TG, Paeng JY (2015) The evaluation of a scoring system in airway management after oral cancer surgery. Maxillofac Plast Reconstr Surg 37: 19.
12) Leiser Y, Barak M, Ghantous Y, Yehudai N, Abu El-Naaj I (2017) Indications for elective tracheostomy in reconstructive surgery in patients with oral cancer. J Craniofac Surg 28: e18–e22.
13) Mehta AK, Singh VK (1999) Minitracheostomy in ventilatory insufficiency. Med J Armed Forces India 55:217–219.
14) Mishra S, Bhatnagar S, Jha RR, Singhal AK (2005) Airway management of patients undergoing oral cancer surgery: a retrospective study. Eur J Anaesthesiol 22:510–514.
15) Nomori H, Horio H, Suemasu K (2001) Pressure-controlled ventilation via a minitracheostomy tube: experimental study using mechanical lung model. Surg Today 31: 780–784.
16) Ohtsuka T, Nomori H, Watanabe K, Kaji M, Naruke T, Suemasu K (2006) Obstructive subglottic granuloma after removal of a minitracheostomy Tube. Ann Thorac Cardiovasc Surg 12:265–266.
17) Okada R, Seki H, Tachibana K, Koshika K, Ouchi T (2021) The usefulness of prophylactic placement of minitracheostomy: A case of postsurgical upper airway obstruction. Masui 70. (in Japanese) (in press)
18) Sakatoku Y, Fukaya M, Miyata K, Itatsu K, Nagino M (2017) Clinical value of a prophylactic minitracheostomy after esophagectomy:
analysis in patients at high risk for postoperative pulmonary complications. BMC Surg 17:120.

19) Schmutz A, Dieterich R, Kalbhenn J, Voss P, Loop T, Heinrich S (2018) Protocol based evaluation for feasibility of extubation compared to clinical scoring systems after major oral cancer surgery safely reduces the need for tracheostomy: a retrospective cohort study. BMC Anesthesiol 18:43.

20) Uemura T, Yamazato M, Fukuda T, Sugahara K (2012) A case of upper respiratory tract obstruction after endotracheal extubation of the patient with radical neck dissection. Nihonshikamasuigakkaizasshi 40:52–53. (in Japanese)

21) Wong DT, Prabhu AJ, Coloma M, Imasogie N, Chung FF (2003) What is the minimum training required for successful cricothyroidotomy?: A study in mannequins. Anesthesiology 98:349–353.

22) Wright CD (2003) Minitracheostomy. Clin Chest Med 24:431.

Correspondence:
Dr. Kyotaro Koshika
Department of Dental Anesthesiology,
Tokyo Dental College,
2-9-18 Kanda-Misakicho, Chiyoda-ku,
Tokyo 101-0061, Japan
E-mail: koshikakyotarou@tdc.ac.jp