Tracheostomy Tube Exchange Failure Under General Anesthesia: A Case Report and Retrospective Analysis

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A 54-year-old man with squamous cell carcinoma of the tongue underwent bilateral cervical lymph node dissection, total tongue resection, forearm flap reconstruction, and tracheostomy. The plan was to replace the oral endotracheal tube (ETT) with a cuffed tracheostomy tube at the end of the surgical case while the patient was still under general anesthesia. No major complications were expected as the tracheal foramen was visible once surgical access was obtained. However, removal of the ETT and subsequent placement of the tracheostomy tube failed twice. Successful ventilation was not observed via capnography, and the patient's peripheral oxygen saturation (SpO_2) dropped to 70%. The anesthesiologist concluded that securing the airway through the tracheostomy would be difficult. The patient was immediately reintubated orally at which time his SpO_2 was 38%, and he was successfully resuscitated and recovered without any sequelae. This rare situation was one we had not encountered previously, so we retrospectively analyzed all tracheostomy cases performed by our department from the past 3 years. Data from 54 patients who underwent tracheostomy tube exchange after tracheostomy were aggregated from their medical records and compared with our patient. Excluding the conditions during surgery, we surmised that tracheal depth, S/H ratio, and body weight were identified as potentially significant risk factors for failed tracheal tube placement or exchange.

Key Words: Tracheostomy; Anesthesia; Airway management.

Tracheostomy is common in cases with a high risk of airway obstruction after head and neck surgery. Management of the tracheostomy tube requires frequent sputum aspiration and regular replacement/cleaning to ensure airway patency. Tracheostomy tube exchange is often safe because it is performed under spontaneous ventilation.

During the COVID-19 pandemic, it is desirable to replace the tracheostomy tube after extinguishing spontaneous ventilations to effectively prevent coughing when performing surgery under general anesthesia. However, this may lead to ventilatory insufficiency if the tracheostomy tube exchange fails. We report a case of severe hypoxemia after failed tracheostomy tube exchange performed under general anesthesia.

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CASE PRESENTATION

A 54-year-old man (height, 169 cm; weight, 95.4 kg; body mass index [BMI], 33.4 kg/m^2) underwent surgical treatment of squamous cell carcinoma of the tongue under general anesthesia. The patient's past medical history was significant for hypertension, but he denied any surgical history. Furthermore, there were no reported medications or allergies. The patient's Mallampati classification was IV, and he had a thyromental distance of 7 cm, a normal cervical range of motion, no trismus, and no evidence of airway deviation observed on a preoperative radiograph.

The patient arrived in the operating room (OR), standard anesthetic monitors were applied, and general anesthesia was induced. Using a McGRATH MAC (Covidien) video laryngoscope with a size #4 blade, the patient's airway was determined to be Cormack-Lehane grade I. The patient was orally intubated using an 8.0-mm cuffed, oral endotracheal tube (ETT). The surgery was completed, which consisted of bilateral cervical lymph node dissection, total tongue resection, and forearm flap reconstruction followed by a tracheostomy. The operative time was 19 hours and 34 minutes.

In preparation for postoperative management in the intensive care unit (ICU), the ETT was to be replaced with a cuffed, single cannula tracheostomy tube (inner diameter size: 8.0 mm) while still under general anesthesia in the OR. The tracheal foramen was clearly visible to the surgeons after the tracheostomy, so no major complications were expected. However, the surgeons' attempts to remove the ETT and replace it with the tracheostomy tube using a bougie despite neuromuscular paralysis/relaxation failed twice. Capnography waveforms failed to appear on the monitor, and the patient's pulse oximeter readings dropped to 70%.

The anesthesiologist concluded that securing the airway through the tracheostomy would be difficult and opted to immediately secure the airway via oral intubation. The patient was reintubated orally using a 7.0-mm cuffed, oral ETT with a size #12 stylette and the McGRATH MAC video laryngoscope with the size #4 blade. The patient's oxygen saturation (SpO_2) was 38% when the airway was secured. The emergent oral intubation was successful, and the patient was resuscitated and recovered without any sequelae.

A total of approximately 10 minutes passed following the first failed tracheostomy tube exchange until the successful emergent oral intubation. This event occurred in the OR after the case ended but before he was transferred to the ICU. In addition to the patient's preexisting obesity, he also had generalized edema secondary to the prolonged surgical time, which may have contributed to the failed tracheostomy tube exchange. Another peculiar finding in this case was the difficulty in replacing tracheostomy tube even a week postoperatively.

We believed that the cause of the problems encountered in this case was related to anatomical and surgical factors as this was a rare situation that we had not encountered previously. Therefore, we considered that the risk factors related to this complication could be examined by comparing the present case with past tracheostomy cases. We analyzed general trends and information related to intubation involving 54 patients who received a tracheostomy tube and compared those averages with the findings from this case. Tracheostomy tube exchange was performed successfully without any problems in all 54 of those cases.

The Kagoshima University Hospital Review Board approved this retrospective study (number: 210013EKI). Furthermore, written informed consent was obtained from the patient to publish this case report and the accompanying images.

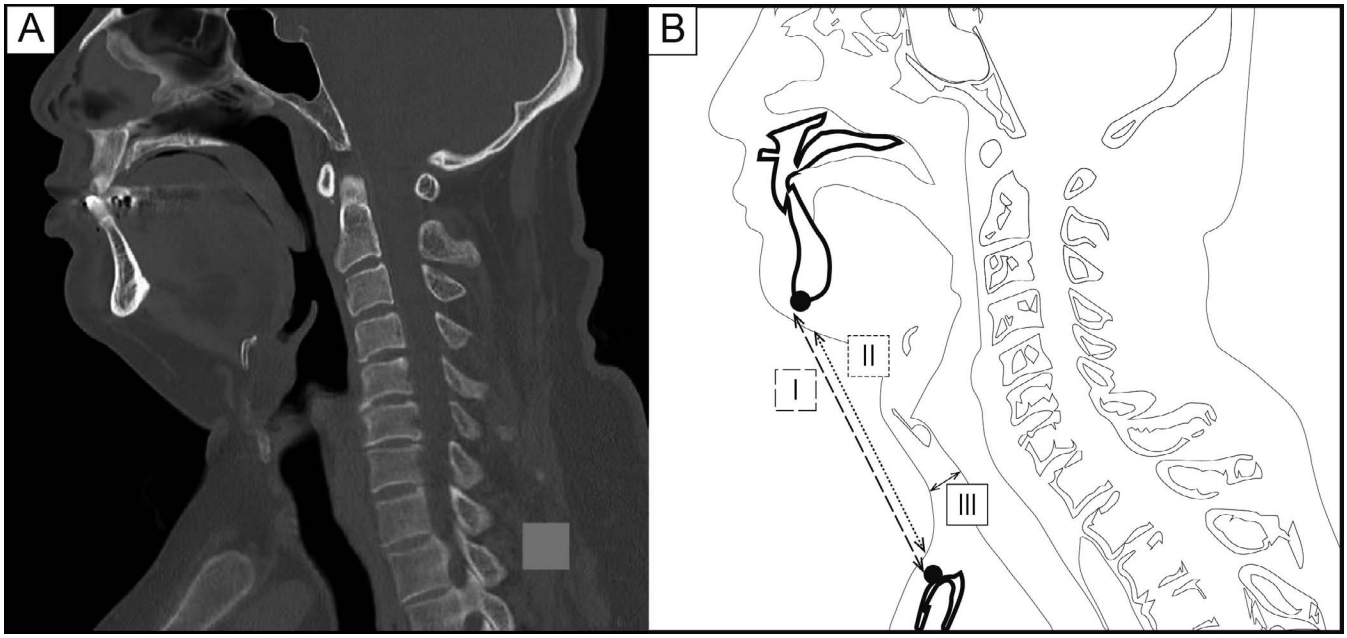
DISCUSSION

All analyses were performed using ORIGIN 2016, version 9.3 (OriginLab Corporation). We analyzed the preoperative sagittal midline computed tomography (CT) images of our patient, which revealed a thick and short neck (Figure, A) with a large amount of soft tissue. For the purposes of our retrospective analysis, we identified several radiographic landmarks: 1) the distance from the mandibular mentum to the sternal notch (I); 2) the part of the "I" line segment that was not occupied by soft tissues (II); and the distance from the trachea (corresponding to the second tracheal cartilage) to the skin (III). Our analysis included the following 2 factors: III (Figure, B); and the percentage of II/I (Figure, B). We designated the percentage ratio of I:II as the soft tissue/hard tissue ratio (S/H ratio) because we assumed that the working space for tracheostomy tube exchange might be affected by the amount of soft tissue surrounding this space.

We retrospectively analyzed all tracheostomy cases performed by the oral surgery department at Kagoshima University within the past 3 years. A total of 54 patients underwent tracheostomy tube exchange after tracheostomy, and data including findings from CT images of all included patients were aggregated from their medical records. We hypothesized that several anatomical and physical factors might influence the success of tracheostomy tube exchange: age, height, weight, BMI, operation time, anesthesia time, infusion volume, blood transfusion volume, urine volume, bleeding volume, in-out balance, tracheal depth, and S/H ratio. For the patient presented in this case report, the factors identified as being 3+ standard deviations (SD) from the mean included body weight, operation time, anesthesia time, tracheal depth, and S/H ratio. These factors may be associated with tracheostomy tube exchange failure. In the current case, tracheostomy tube exchange was difficult even at 1 week postoperatively. Excluding the conditions at the time of surgery, we surmised that tracheal depth, S/H ratio, and body weight were significant risk factors for this patient. However, due to the small number of participants included in this limited analysis, the predictive value of using 3+ deviations from the SD may be questioned as a valid metric without further research (Table). We could not confirm all thyromental distances from the analyzed patients' past reports. Therefore, we excluded thyromental distance from this study.

Tracheostomy tube exchange is a routine medical procedure. However, complications, such as tension pneumothorax, hypoxia, and mediastinal emphysema, have been reported.[1–5] Some studies have discussed the optimal timing for tube exchange.[6–8] Few studies have

Figure. Radiographic Imaging and Landmarks Used for Analysis.



(A) The sagittal midline computed tomography image from this case report. (B) The radiographic landmarks I, II, and III. The S/H ratio was the percentage ratio of "II" to "I." S/H ratio, soft tissue/hard tissue ratio; I, distance from the mandibular mentum to the sternal notch; II, part of the "I" line segment not occupied by soft tissues; III, depth of the trachea.

examined the patient-related risk factors that could affect this procedure.[4,5] We suspect that the difficulty of tracheostomy tube exchange can be anticipated based on anatomical findings, such as tracheal depth and S/H ratio. Determining risk factors for tube exchange may help enable safe insertion of a tracheostomy tube and reduce the likelihood of failure. However, it is beyond the scope of this study to determine the risk ratio associated with each factor. Moreover, it is necessary to collect and analyze additional data on such rare complications. Future studies should include the collection of accurate data to promote further investigation

Table. Analysis of Anatomic and Surgical Factors.

		Aggregate data (n = 54)			
	Case report patient	*Mean*	*1 SD*	*2 SD*	*3 SD*
Age, y	54	69.8	± 10.9	± 21.8	± 32.7
Height, cm	169.8	161.0	± 8.6	± 17.1	± 25.7
Weight, kg	95.4*	57.5	± 11.5	± 23.0	± 34.4
BMI, kg/m^2	33.1	22.0	± 3.2	± 6.4	± 9.7
Operation time, min	1174*	753.6	± 128.9	± 257.7	± 386.6
Anesthesia time, min	1304*	856.8	± 133.0	± 265.9	± 398.9
Infusion volume, mL	5770	4370.0	± 151.8	± 2303.6	± 3455.3
Blood transfusion volume, mL	0	120.0	± 249.3	± 498.7	± 748.0
Urine volume, mL	1250	1957.8	± 964.2	± 1928.4	± 2892.6
Bleeding volume, mL	500	384.8	± 314.0	± 628.0	± 941.9
In-out balance, mL	4020	2009.0	± 775.7	± 1551.3	± 2327.0
Tracheal depth, mm	43.45*	11.63	± 5.05	± 10.09	± 15.14
S/H ratio, %	47.4*	77.9	± 6.6	± 13.2	± 19.7

* Identifies patient factors 3+ SD from aggregate mean. BMI, body mass index.

Aggregate data obtained from 54 patients who underwent successful tracheostomy tube placement/exchange. Factors for this patient identified as being 3+ standard deviations (SD) from the aggregate mean were body weight, operation time, anesthesia time, tracheal depth, and soft tissue/hard tissue ratio (S/H ratio).

and precise analysis of this issue, including data related to intubation.

CONCLUSION

We experienced a case of severe hypoxemia during failed tracheostomy tube placement under general anesthesia. We retrospectively analyzed previous tracheostomy cases that were successfully performed and compared the data to this case to identify potential risk factors for this complication. We surmised that tracheal depth, S/H ratio, and body weight were significant risk factors that led to the failed tracheostomy tube placement.

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