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Original Article

Tracheostomy in otorhinolaryngology education and training programs: A Japanese nationwide survey ☆

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ABSTRACT

Objective: Surgical airway management is one of the most effective techniques for safe airway management. Within the training programs relating to knowledge and skills required by otorhinolaryngologists, tracheostomy and postoperative management are important items that must be fully understood by airway surgeons. We performed a nationwide survey to identify problems within tracheostomy and postoperative management in Japan in order to establish practical and safe guidelines for surgical airway management.

Methods: We conducted a questionnaire survey of the current status of tracheostomy and postoperative management at core institution of otorhinolaryngology training programs in Japan.

Results: Responses were obtained from all 101 core training institutions in Japan. Tracheostomy was performed in the operating room at 61.4% of institutions and in the ICU at 26.7%. 89.1% of them performed surgical tracheostomy (ST) in all cases. Even in the remaining 10.9%, percutaneous dilatational tracheostomy (PDT) was performed in less than 10% of cases. The primary surgeon was an otorhinolaryngology resident at 89.1% of institutions. The method of securing the tube immediately after surgery was by securing it with an attached cord at 48.5% of institutions, by suturing to the skin at 25.7%, and using a Velcro band at 24.8%. The first tube change after tracheostomy was performed on the seventh postoperative day at 81.2% of institutions. 87.1% had more than one person performing the first tube change. The tracheostomy postoperative complications within the past year were as follows: tracheostomal granulation: 89.1%; subcutaneous and/or mediastinal emphysema: 62.4%; tube stenosis: 55.4%; accidental tube removal: 50.5%; incorrect tube insertion or misplacement: 15.8%; hemorrhage from tracheal foramen requiring hemostasis in the operating room: 14.9%; pneumothorax: 4.0%; tracheo-innominate arterial fistula: 2.0%; and tracheoesophageal fistula: 1.0%. The method for educating otorhinolaryngology residents about tracheostomy was on-the-job training at 98.0% of institutions.

Conclusions: For airway management in otorhinolaryngology training programs, after learning the basics of ST, PDT should also be well understood. Furthermore, in order to create safe educational programs for intraoperative and postoperative management, it is necessary to train

Abbreviations: ST, surgical tracheostomy; PDT, percutaneous dilatational tracheostomy; ICU, intensive care unit; OR, operating room.

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otorhinolaryngologists with accurate knowledge and skills, and to strengthen collaboration with multiple professions in their leadership roles as airway surgeons.

1. Background

Surgical airway management is one of the most effective techniques for safe airway management. Although surgical tracheostomy (ST) is a basic procedure that has been used for more than 100 years [1], both surgical techniques, as well as postoperative management, directly impact life prognosis since they are performed on the airway. Indications for tracheostomy vary widely, and individual patient backgrounds are diverse. In recent years, with the widespread use of percutaneous dilatational tracheostomy (PDT), especially in Europe, as well as the increasing number of types of tracheostomy tubes, more options for techniques and tracheostomy tubes have become available [2].

Physicians licensed to practice medicine in Japan have completed 2 years of study in the essential departments (internal medicine, emergency medicine, surgery, pediatrics, obstetrics and gynecology, psychiatry, and community medicine), thus learning whole-body management, as clinical trainees, based on the clinical training system stipulated by the Ministry of Health, Labor, and Welfare. If a student majors in otorhinolaryngology in the third year, and they complete the stipulated study items and then pass the otorhinolaryngology specialist examination as a resident in the otorhinolaryngology specialist-training program stipulated for the 4-year period, they are then certified as an otorhinolaryngologist. At present, the Japanese Society of Otorhinolaryngology-Head and Neck Surgery has accredited 101 specialist-training programs, and each program has multiple affiliated institutions. Within the training programs relating to knowledge and skills required by otorhinolaryngologists, tracheostomy and postoperative management are important items that must be fully understood by airway surgeons. In Belgium [3] and France [4], guidelines have been developed for tracheotomy. The French guidelines involved the Otolaryngology Society in addition to the Intensive Care Society and the Emergency Society, in which five topics were defined: indications and contraindications for tracheotomy in intensive care, the tracheotomy techniques in intensive care, modalities of tracheotomy in intensive care, management of patients undergoing tracheotomy in intensive care, and decannulation in intensive care. care, and decannulation in intensive care. On the other hand, in Japan, there are no guidelines or stipulated policies for tracheostomy techniques or postoperative management, these being left to the discretion of each institution.

Therefore, we performed a nationwide survey of core institutions with otorhinolaryngology-specialist training programs in Japan to generate important basic data for formulating practical and safe guidelines relating to tracheostomy for use in the future. Based on the results, we reviewed the actual status of tracheostomy and postoperative management in Japan.

2. Materials and methods

A questionnaire was sent in August 2020 to the 101 core institutions of otorhinolaryngology-specialist training programs accredited by the Japanese Society of Otorhinolaryngology-Head and Neck Surgery. The questionnaire covered the number of beds, number of full-time otorhinolaryngologists, the surgical regime for tracheostomy, surgical procedures, postoperative management, postoperative complications, and educational methods. The questions were related to tracheostomies performed on patients undergoing long-term management with intubation in the intensive care unit (ICU).

The statistical method used was Fisher's exact test, with $p < 0.05$ to indicate statistical significance. This study was performed as epidemiological research approved by the Japan Broncho-Esophagological Society (approval no. 2020-02) and the Ethics Committee at Osaka Medical and Pharmaceutical University (approval no. 45-2935).

3. Results

3.1. Numbers of beds and physicians (Table 1)

Responses were received from all 101 training program core institutions by December 2020. Of the 101 institutions, 91 are university-affiliated hospitals, and 10 are city hospitals. Four institutions had 200 to 499 beds, 49 had 500 to 799 beds, and 48 had 800 beds or more. The number of full-time otorhinolaryngologists at each program core institution was 1 to 10 at 25 institutions, 11 to 15 at 41, 16 to 20 at 26, and 21 or more at 9, with a median of 14 and a range of 5 to 32.

3.2. Surgical regime for tracheostomy (Table 2)

3.2.1. Surgery location

The locations where tracheostomy was performed were the operating room at 62 institutions (61.4%; OR group) and bedside in the ICU at 27 institutions (26.7%; ICU group). At 12 institutions (11.9%), the location was not stipulated, and decisions were made on a case-by-case basis.

3.2.2. Time from request for tracheostomy to operation

The time between the main department making a request for a tracheostomy to the otorhinolaryngology department and the procedure being performed was 0 days at 1 institution (1.0%), 1 to 2 days at 21 institutions (20.8%), 3 to 6 days at 58 institutions (57.4%), 7 to 13 days at 20 institutions (19.8%), and 14 days or longer at one institution (1.0%). At

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Table 1. Numbers of beds and physicians.

		Number of institution (%)
Type of institution	University-affiliated hospitals	91 (90.1)
	City hospitals	10 (9.9)
Numbers of beds	200-499	4 (4.0)
	500-799	49 (48.5)
	800-	48 (47.5)
Number of full-time otorhinolaryngologists	-10	25 (24.8)
	11-15	41 (40.6)
	16-20	26 (25.7)
	21-	9 (8.9)

Table 2. Surgical regime for tracheostomy.

		Number of institution (%)
Surgery location	Operating room	62 (61.4)
	ICU	27 (26.7)
	case-by-case	12 (11.9)
Time from request for tracheostomy to operation	0 days	1 (1.0)
	1 to 2 days	21 (20.8)
	3 to 6 days	58 (57.4)
	7 to 13 days	20 (19.8)
	14 days or longer	1 (1.0)
Main surgeon	Otorhinolaryngology specialists	9 (8.9)
	Otorhinolaryngology residents	90 (89.1)
	Clinical trainees	2 (2.0)

the 62 institutions in the OR group, the time from request to tracheostomy was 0 days at one institution, 1 to 2 days at 8 institutions, 3 to 6 days at 38 institutions, 7 to 13 days at 15 institutions, and no institution took 14 days or longer. On the other hand, at the 27 institutions in the ICU group, the time from request to tracheostomy was 1 to 2 days at 8 institutions, 3 to 6 days at 14 institutions, 7 to 13 days at 14 institutions, and 14 days or longer at one institution. No significant difference was found between the OR and ICU groups ($p = 0.15$).

3.2.3. Surgeons

The surgeons who performed the operations were otorhinolaryngology residents at 90 institutions (89.1%), otorhinolaryngology specialists at 9 institutions (8.9%), and clinical trainees at 2 institutions (2.0%).

3.3. Surgical procedures and postoperative management (Table 3)

3.3.1. Surgical procedures

At 90 institutions (89.1%), ST was performed on all patients, whereas at 11 institutions (10.9%), the procedure performed was sometimes ST and sometimes PDT. Among the institutions where PDT was sometimes performed, the proportion of subjects on whom PDT was performed was less than 5% at seven institutions (6.9%) and 5 to 10% at four institutions (4.0%). The tracheal opening methods in ST were an inverted U-shape at 91 institutions (90.1%), a single vertical line at 6 institutions (5.9%), a single horizontal line at 3 institutions (3.0%), and an open window at one institution (1.0%).

3.3.2. Tube-fixing method

The method of securing the tube immediately after surgery was by securing it with an attached cord at 49 institutions (48.5%), by suturing to the skin at 26 institutions (25.7%), and using a Velcro band at 25 institutions (24.8%), with one institution not responding to the question.

3.3.3. First postoperative tracheostomy tube change

The first postoperative tracheostomy tube change was performed on the 7th day after surgery at 82 institutions (81.2%), the 14th day at six institutions (5.9%), the 6th day or earlier at seven institutions (6.9%), the 11th day at three institutions (3.0%), and the 14th day or later at one institution (1.0%). The personnel who performed the first tube change were two or more physicians at 58 institutions (57.4%), a physician and a nurse at 30 institutions (29.7%), and multiple people at 88 institutions (87.1%). On the other hand, it was performed by a single physician at 13 institutions (12.9%), and no institution had it performed by nurses alone.

3.3.4. Second and subsequent tracheostomy tube changes and tube management

Management of tracheal tubes after the second and subsequent tube change was passed to physicians at the main department at 80 institutions (79.2%). On the other hand, at 17 institutions (16.8%), management was performed continuously by otorhinolaryngologists, and at one institution (1.0%) by a nurse.

3.4. Postoperative complications (Table 4)

The tracheostomy postoperative complications within the past year were as follows and in decreasing order of the num-

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Table 3. Surgical procedures and postoperative management.

		Number of institution (%)
Surgical procedures	0%	90 (89.1)
(PDT)	0< <5%	7 (6.9)
	5≦ <10%	4 (4.0)
Tracheal opening methods in ST	Inverted U-shape	91 (90.1)
	Single vertical line	6 (5.9)
	Single horizontal line	3 (3.0)
	Open window	1 (1.0)
Tube-fixing method	Secure with an attached cord	49 (48.5)
	Suture to the skin	26 (25.7)
	Use of Velcro band	25 (24.8)
	no respond	1 (1.0)
First postoperative tracheostomy tube change	7th day	82 (81.2)
	14th day	6 (5.9)
	6th day or earlier	7 (6.9)
	11th day	3 (3.0)
	14th day or later	1 (1.0)
Personnel who performed the first tube change	Two or more physicians	58 (57.4)
	A physician and a nurse	30 (29.7)
	Single physician	13 (12.9)
Second and subsequent tracheostomy tube management	Physicians at the main department	80 (79.2)
	Otorhinolaryngologists	17 (16.8)
	Nurse	1 (1.0)
	case-by-case	3 (3.0)

Table 4. Postoperative complications.

Complications	Number of institution (%)
Tracheostomal granulation	90 (89.1)
Subcutaneous and/or mediastinal emphysema	63 (62.3)
Tube stenosis	56 (55.4)
Accidental tube removal	51 (50.5)
Incorrect tube insertion or misplacement	16 (15.8)
Hemorrhage from tracheal foramen	15 (14.9)
Pneumothorax	4 (4.0)
Tracheo-innominate arterial fistula	2 (2.0)
Tracheoesophageal fistula	1 (1.0)

ber of institutions where they were seen: tracheostomal granulation: 90 (89.1%); subcutaneous and/or mediastinal emphysema: 63 (62.4%); tube stenosis: 56 (55.4%); accidental tube removal: 51 (50.5%); incorrect tube insertion or misplacement: 16 (15.8%); hemorrhage from tracheal foramen requiring hemostasis in the operating room: 15 (14.9%); pneumothorax: 4 (4.0%); tracheo-innominate arterial fistula: 2 (2.0%); and tracheoesophageal fistula: 1 (1.0%).

3.5. Educational methods (Table 5)

The method for educating otorhinolaryngology residents about tracheostomy was on-the-job training at 99 institutions (98.0%). At 36 institutions (35.6%), senior doctors conducted lectures; 11 institutions (10.9%) used DVDs or Internet videos for teaching; 8 institutions (7.9%) had created original videos; and 8 institutions (7.9%) used simulators.

Table 5. Educational methods.

Methods	Number of institution (%)
On-the-job training	99 (98.0%)
Senior doctors conduct lectures	36 (35.6%)
DVDs or Internet videos	11 (10.9%)
Original videos	8 (7.9%)
Simulators	8 (7.9%)

4. Discussion

In 2018, approximately 30,000 tracheostomies were performed in Japan [5], with otorhinolaryngologists performing approximately 9,000 of these [6]. Tracheostomy is one of the basic surgical procedures to be mastered in the otorhinolaryngology specialist training program, and the training program stipulates that each resident must have experience with at least five cases. In terms of the surgeon's length of experience, at 89.1% of institutions, the procedure was performed by an otorhinolaryngology resident, whereas at 2.0%, it was performed by a clinical trainee. On the other hand, 8.9% of institutions had an otorhinolaryngology specialist perform the procedure because, although tracheostomy is a basic procedure, it is recognized as a high-risk procedure in some cases.

Tracheostomy is a medical procedure that directly affects life prognosis, so educational methods are extremely important. It has been reported that educating physicians and nurses thoroughly about anatomy and basic care relating to tracheostomy reduces intraoperative and postoperative complications while also giving them confidence in medical treatment of the patient [7,8]. For example, a cuff pressure of 20 to 30 cm H_2O and humidification have been reported to reduce the rate of ventilator-associated pneumonia [9,10], and changing the tracheostomy tubes every 2 weeks reduces the rate of tracheal granulation [11].

Tracheostomy-related education is focused on on-the-job training at most Japanese medical institutions. However, 35.6% of the institutions provide surgical instruction by

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means of lectures, and few use surgery videos or DVDs, create their own surgery videos, or use simulations for instructions. In recent years, various studies have been performed on the methods and effectiveness of medical skill training. In particular, surgical simulation using cadavers, for example, is recommended for learning surgical procedures [12,13], and the importance of cadaver-based training has also been reported for PDT [14]. In the future, further enhancing the educational methods by implementing surgical simulation using cadavers and other simulations for ST will be preferable.

In recent years, PDT has become widely recognized [15]. In Europe in particular, PDT is in frequent use at ICUs [16–18]. According to a report on 429 institutions in 59 countries by the European Society of Intensive Care Medicine [2], ST is performed in 19.8% of cases in Europe and 36.4% outside Europe, and otorhinolaryngologists tend to perform ST at ICUs for high-risk cases for which PDT is difficult. In the present study, 89.1% of the institutions performed ST on all patients, and 10.9% of the institutions performed PDT on some patients; however, at institutions performing PDT, the proportion of patients who underwent PDT was 10% or less. This study showed that otorhinolaryngologists in Japan recognize the basic tracheostomy technique to be ST, and the penetration of PDT remains low.

The location of tracheostomy, that is, whether it should be performed at the ICU or in the operating room, is frequently reviewed [17–20]. When performed in the ICU, the patient does not need to be moved, but the environment and personnel are not conducive to performing the procedure at the bedside in the ICU. On the other hand, when tracheostomy is performed in the operating room, it is easier to obtain the cooperation of anesthesiologists and personnel accustomed to responding to sudden changes. However, the disadvantages are the risk of transferring the patient to the operating room if he/she is in poor general condition and the time needed to secure the operating room and personnel [21]. According to the above report from the European Society of Intensive Care Medicine [2], PDT is performed almost exclusively in the ICU, whereas ST is performed in the operating room in 59.1% of cases. In the present study, the OR group was 61.4%, and the ICU group was 26.7%, which is approximately the same ratio. Furthermore, there was no significant difference in the time from request for tracheostomy to operation between each group. Therefore, when an otorhinolaryngologist performs a tracheostomy, it is suggested that the time from request to surgery be determined by the wish of the otorhinolaryngologist (the primary surgeon) and/or the anesthesiologist rather than by the location of the procedure itself.

Multiple meta-analyses and systematic reviews comparing ST and PDT have shown no significant differences in perioperative mortality or morbidity [15,22,23]. On the other hand, the report about the risk of death due to PDT in approximately 1 in 600 patients cannot be ignored [24]. Therefore, it is essential to strictly adhere to the indications and contraindications for PDT [25]. When there is uncertainty about using the tracheostomy technique, otorhinolaryngologists, experts in neck surgery, are often asked to make the decision. Accordingly, otorhinolaryngologists must also have actual experience with PDT, have thorough knowledge of the indications, contraindications, techniques, and risks of both ST and PDT, and liaise effectively with physicians in other departments in the role of giving instructions. Simon et al. [24] reported that the principal causes of death in 71 patients with fatal complications of PDT were hemorrhage, followed by airway complications, tracheal perforation, and pneumothorax. Of deaths due to airway complications, 52.4% were due to accidental tube removal, and 33.3% due to obstruction of airways or incorrect insertion or misplacement at the time of tube change. In the present study, the most frequent adverse event was tracheostomal granulation, followed by subcutaneous and mediastinal emphysema, tube obstruction, and accidental tube removal, and these four events were found to have occurred in at least 50% of institutions. Incorrect insertion and misplacement of tubes, which occurred at 15.8% of institutions, presents a risk of leading to subcutaneous or mediastinal emphysema and even to cardiac arrest. In this study, the first postoperative tube change was performed within 1 week at 88.1% of institutions, and it was performed by more than one person at 87.1% of institutions. According to a report about US otorhinolaryngology-training programs, 43.4% of 46 programs experienced a lost airway, and there had been a fatality in 15.2% [26]. According to that report, in all programs the first tube change was made within 1 week, but 53% of residents reported that direct supervision was always provided for the first change. In Japan, incorrect insertion or placement at the first tube change is recognized as a serious incident that can occur in management of tracheostomy patients, and a system has therefore been established for the first tube change, involving instruction, and performance by multiple persons. This is considered one of the reasons for the relatively low rate of incorrect insertion and placement in the present study. This low rate may be influenced by the analysis of deaths related to dislocation or misplacement of a tracheostomy tube in the early post-tracheostomy period from the Japan Medical Safety Research Organization [27]. Furthermore, in the present study it was shown that most institutions used ST, with the trachea treated under clear vision, with 90.1% of institutions choosing to use an inverted U-shaped incision of the trachea with suturing to the skin below. The widespread use of this surgical option may also be a factor in preventing incorrect insertion and placement at the time of postoperative tube change in Japan. On the other hand, it was also shown that, at the second and subsequent tube changes, management of the tracheostomy foramen was left to a physician in the main department at 79.2% of institutions. White et al. [28] reported that the rate of accidental tube removal was reduced from 0.42 to 0.27% by improved education about postoperative management and an improved management organization. In Japan, education of non-otorhinolaryngologists is considered important for the continued safe management of tracheostomy patients. In US based otorhinolaryngology training programs, the tube was sutured to the skin postoperatively in 93% of cases to prevent accidental tube removal [26]. In the present study, at 48.5% of institutions, an attached cord was used to secure the tube, and at only 25.7% was the tube sutured to the skin. As accidental tube removal can

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be life threatening, there is scope for further investigation of immobilization methods to ensure safety. Tracheo-innominate arterial fistulas and tracheoesophageal fistulas are also serious complications, but they were reported at only two and one institutions, respectively. These complications occur in patients with long-term tracheostomy tube placement. It is possible that the estimates may be relatively small, because this study only evaluated core institutions with specialist training programs, which are acute care hospitals.

5. Conclusions

The overwhelming majority of tracheostomies performed in Japan are ST, and the surgeons are otorhinolaryngology residents at most institutions, with education being focused on on-the-job training in the operating room. Further training by surgical simulation will be required in the future. PDT has not been incorporated into otorhinolaryngology specialist training programs in Japan, and the implementation of PDT is currently limited. It is expected that PDT will be widely used in Japan in the future. For safe performance, it is considered that otorhinolaryngologists should learn the basics of tracheostomy based on the ST and then deepen their understanding in relation to PDT. Otolaryngologists also have the role and responsibility to educate all physicians and healthcare professionals who manage tracheostomies on the knowledge and techniques of tracheostomy and its postoperative management. In the future, it is necessary to create educational programs for intraoperative and postoperative management to train otolaryngologists with accurate knowledge and skills and to strengthen collaboration with multiple professions in their leadership roles as airway surgeons.

Statement of ethics

The protocol for this human study was approved by the Ethics Committee of the Osaka Medical and Pharmaceutical University, Takatsuki, Japan (Approval number: 45-2935), as per the Helsinki Declaration of 1975, which was revised in 1983. Written informed consent was obtained from the patient for the publication of this case report and the accompanying images. This study was performed as epidemiological research approved by the Japan Broncho-Esophagological Society (approval no. 2020-02).

Consent for publication

Not applicable.

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Authors' contributions

MH, contributed to the design of the report, collected data, and drafted the manuscript. KS contributed substantially to the design of the report, and drafted or provided critical revision of the article. KT, MH, and HH contributed to the analysis and interpretation of the data. RK approved the final version of the manuscript.

Declaration of Competing Interest

The authors have no conflicts of interest to declare.

Data availability

All data generated or analyzed during this study are included in this article." Further inquiries can be directed to the corresponding author.

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