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Temporary tracheotomy in microvascular reconstruction in maxillofacial surgery: Benefit or threat?

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ABSTRACT

Background: Temporary tracheotomies are often used in oral microvascular flap reconstruction surgery to secure postoperative airway management and avoid emergency tracheotomies. Even when planned electively, a tracheotomy can cause severe and life-threatening complications. The aim of this study was to evaluate the complications of tracheotomies performed on oral cancer patients with microvascular flap reconstructions and differentiated patterns, which could lead to postoperative complications.
Methods: 150 patients, treated in the Department of Oral and Maxillofacial Surgery from March 2017 to August 2018, were included in this study. Patient records and perioperative data were analysed and the following specific items were evaluated: time after surgery until removal of the tracheal cannula, complications, cause and point of time of reinsertion of the cannula, anticoagulative treatment, ASA grade (American Society of Anaesthesiologists), TNM stage, and patient-specific data.
Results: 30 patients (20%) developed tracheotomy-associated complications, most commonly pneumonia (50%). There was a significant correlation between the time period until removal of the cannula and the occurrence of complications such as pneumonia and bleeding.
Conclusion: The results of our study lead us to recommend continuing to perform temporary tracheotomies in oral cancer surgery with microvascular flap reconstruction. The overall complication rate is low and postoperative airway management can be performed in a safe and controlled manner. Nevertheless, the time period for the inserted cannula should be kept as short as possible.

1. Introduction

Tracheotomy is one of the oldest methods of airway management. There are Egyptian records dating back to about 3000 BC, showing emergency tracheotomy being used to secure the airway (Heffner et al., 1986).

General anaesthesia for surgery in oral cancer patients is one of the most challenging tasks for an anaesthetist (Mishra et al., 2005). Airway management that is more or less free of complications during surgery and postoperatively is the subject of wide discussion and controversy.

According to the literature, tracheotomy is associated with reported complication rates of 8–45% (Castling et al., 1994).

Reported complications include bleeding, displacement of the cannula, obstruction of the tube, surgical emphysema, pneumothorax, tracheitis, cellulitis, pulmonary atelectasis, tracheocutaneous fistula, tracheomalacia, granulation, excessive scarring, tracheooesophageal fistula, chest infection, and failure to decannulate. There are studies showing tracheotomy to be inferior in terms of complication rate and length of hospital stay to other forms of airway management, such as overnight intubation or nasotracheal intubation (Coyle et al. 2012, 2013). Coyle et al., (2012) describe their experience with overnight intubation and claim that this method has fewer complications for patients undergoing major intraoral resection and reconstruction with a microvascular flap. In a later study, in 2013, Coyle et al., (2013) compared two units, one practicing tracheostomy, the other practicing overnight intubation. In the end, the study '*supports the discontinuation of routine tracheostomy and the adoption of a more selective practice to improve recovery*' (Coyle et al., 2013). However, tracheotomy is most commonly used in oral cancer surgery to secure breathing during the immediate postoperative period.

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We routinely perform tracheotomy in oral cancer and reconstructive surgery, when the tumor involves the floor of the mouth and/or the lateral border of the tongue, tumors of the alveolar process, advanced T-stages (T3 and T4), and, in cases of osseous free flaps, combined with intraoral soft tissue reconstruction to ensure secure airway management after surgery. The aim of this study was to demonstrate our experience with tracheotomy and its complications in 150 consecutive patients.

2. Material & methods

The study design was reviewed and approved by the ethical committee of the medical faculty of the Technische Universität München.

2.1. Patient data

From March 2017 to August 2018, 150 patients were included in the study. The patients underwent intraoral resection of oral cancer, reconstruction with microvascular free flap, and unilateral or bilateral neck dissection. We also included patients with osteoradionecrosis (ORN) of the jaw leading to microvascular reconstruction. The localisations are shown in Table 1. All of these patients received elective tracheotomy to ensure airway management. The most frequently used flaps were radial forearm flap (RFF), fibula flap (FF), and anterolateral tight flap (ALT) (Table 2). The following complications were recorded: tracheotomy-associated cervical bleeding, blockage or dislocation of the cannula, pneumonia, and failure to decannulate.

Patient-related variables used were age, gender, location of the tumor, microvascular flap, American Society of Anaesthesiologists (ASA) grade, alcohol and smoking history, basic diseases, previous radio- or chemotherapy, and anticoagulative medication (Table 3).

As relevant basic diseases, hypertension, bronchial asthma, chronic obstructive pulmonary disease (COPD), chronic bronchitis, coronary heart disease (CHD), and sleep apnoea were also recorded. Recorded outcomes included duration of stay in intensive care unit (ICU), duration of the cannula in situ, and total length of hospital stay.

Table 1
Localisation ($n = 150$).

Site	n (%)
Lateral tongue	28 (18.7)
Floor of mouth	39 (26)
Gum of lower jaw	27 (18)
Gum of upper jaw	4 (2.7)
Buccal mucosa	8 (5.3)
Retro molar lower jaw	7 (4.7)
Retro molar upper jaw	4 (2.7)
Palate	12 (8)
ORN	26 (17.3)

ORN = osteoradionecrosis of the lower jaw.

Table 2
Microvascular reconstruction ($n = 150$).

	n (%)
RFF	78 (52)
+ plate	14 (9.3)
ALT	12 (8)
+ plate	4 (2.7)
Fibula	37 (24.7)
Others	5 (3.3)

RFF = radial forearm flap, ALT = anterolateral thigh flap.

2.2. Statistical analysis

Data were analysed using the Statistical Package for the Social Sciences (IBM SPSS Statistics, Version 23, Armonk, USA). Chi-square tests and non-parametric Mann–Whitney U-tests were used. Probabilities less than 0.05 were accepted as significant.

3. Results

The male to female ratio was 1.8:1, with a median age of 63.8 years. Eight different tumor locations were recorded, the most common being floor of the mouth (26%), tongue (18.7%), and gum of the lower jaw (18%). 26 patients (17.3%) were treated for osteoradionecrosis of the lower jaw (Table 1).

Out of 150 patients, 22 were diagnosed with a recurrence of their primary cancer. For reconstruction the radial forearm flap (RFF) was most frequently used (78.52%); other approaches involved a combination of RFF and plate, fibula and anterolateral tight flap (ALT). RFF with plate was mostly used on patients with osteoradionecrosis (ORN) (Table 2).

After surgery, all patients ($n = 150$) spent the first postoperative night under ongoing sedation in the operation recovery room, with 10.8% staying for a second night, before they returned to the maxillofacial ward. 18 patients had to be sent to ICU again during their stay because of a critical medical condition: seven patients as a result of pneumonia with respiratory insufficiency, six due to postoperative delirium, three with pulmonary embolism (PE), one because of sepsis, and one with cardiac failure. The length of stay in ICU for these 18 patients ranged from 5 to 66 days, with a median of 18.11 days. Intravenous ampicillin/sulbactam was administered prophylactically three times a day until the tenth postoperative day.

After returning to the maxillofacial ward, 76.7% ($n = 115$) of the patients were decannulated within the first 6 days, with a recorded range of 2–56 days. Surgical closure of the tracheotomy site was not performed. The patient with the longest stay of 56 days suffered from pneumonia with respiratory failure shortly after the surgery, so he could not be decannulated. The chest X-ray showed pleural effusion during the third week after surgery. When there was no improvement the effusion was drained through a pleuracentesis and the antibiotic therapy was switched from ampicillin/sulbactam to ceftriaxone. During this time the patient was ventilated via the cannula. After 56 days he was safely decannulated in a stable general condition.

In seven cases (4.7%) the cannula had to be reinserted as a result of pneumonia with respiratory failure, bleeding, necrosis of the flap, failure to decannulate, and respiratory failure after PE. Details are shown in Table 4. Reinsertion of the cannula, however, had no significant impact on the length of the hospital stay.

The length of hospitalisation ranged from 8 to 72 days with a mean of 19.83 days. As expected, a significant difference was observed in the extent of hospitalisation: patients with complications linked to postoperative tracheotomy stayed significantly longer at the hospital after surgery (29 ± 13.5 vs 16.8 ± 8.3 days) ($p < 0.01$).

A total complication rate of 20% ($n = 30$) was recorded. Complications are shown in Table 5. The most common complication was pneumonia ($n = 15$; 10%). Significant risk factors for pneumonia were determined as age ($p < 0.05$), COPD ($p = 0.015$), chronic bronchitis ($p = 0.001$), alcohol abuse ($p = 0.0041$), ASA grade of 3 ($p = 0.031$), and length of the period of the cannula in situ ($p = 0.00014$). Out of the 15 patients with pneumonia, eight had to be transferred to ICU for treatment. All cases were treated successfully with antibiotics: two patients were treated with ampicillin/sulbactam, two had to be switched to piperacillin/tazobactam, two were switched to cephalosporins, one patient was

Table 3
Patient data ($n = 150$).

Mean age (years)	63.89
Range (years)	35–89
	n (%)
Sex	
Male	98 (65.3)
Female	52 (34.7)
Smoker	
Yes	77 (51.3)
No	73 (48.7)
Alcohol	
Yes	54 (36)
No	96 (64)
ASA-grade	
I	2 (1.3)
II	90 (60)
III	57 (38)
IV	1 (0.7)
Previous radiotherapy	
Yes	44 (29.3)
No	106 (70.7)

ASA = American Society of Anaesthesiologists.

treated with vancomycin, and one patient was diagnosed with herpes simplex pneumonia and treated with aciclovir.

It was shown that patients with pneumonia had an average hospital stay of 33.92 days, which was significantly higher than patients without pneumonia (18.32 days) ($p < 0.001$).

Another complication was failure to decannulate ($n = 7$; 4.7%). Pneumonia ($p = 0.003$) was shown to be a significant risk factor (Table 6).

Out of 150 patients, two (1.3%) had a second operation due to bleeding at the tracheotomy site.

Other risk factors for tracheotomy-associated complications were anticoagulation medication with acetylsalicylic acid ($p = 0.03$). 37 patients (24.7%) were medicated with acetylsalicylic acid, of which 24 (16%) patients had complications: 17 (11.3%) patients had to return to surgery, two (1.3%) patients had postoperative bleeding, and five (3.3%) patients had pneumonia. The average length of stay for these patients was also significantly higher (23 ± 11 vs 17.2 ± 9.8 days) ($p = 0.002$). The two patients with postoperative bleeding at the tracheotomy site stayed 31 and 36 days, respectively, while the five patients with pneumonia stayed 23–72 days, at an average of 19.83 days.

To be able to identify comorbidities, we included hypertension (59 patients, 39.3%), asthmatic disease (eight patients, 5.3%), COPD (14 patients, 9.3%), CHD (26 patients, 17.3%), chronic bronchitis (six patients, 4%), and sleep apnoea (five patients, 3.3%). The only significant association could be shown between COPD, chronic bronchitis, and pneumonia ($p < 0.05$).

Table 5
Tracheotomy-associated complications.

Type of complication	*n* (%)
Bleeding at tracheotomy site	4 (2.7)
Dislocation of cannula[a]	1 (0.7)
Pulmonary atelectasis	1 (0.7)
Pneumonia	15 (10)
Respiratory failure	5 (3.3)
Failure to decannulate	7 (4.7)

[a] Dislocation of the cannula on the ward — the cannula was reinserted immediately without any harm to the patient.

4. Discussion

Oncology patients should be treated according to guidelines and standards whenever possible to guarantee high-quality treatment. This begins with the decision on required therapy and ends in tumor aftercare (Bissinger et al., 2017). Patients with oral cancer surgery require special attention when it comes to airway management, not only because of postoperative swelling, but also because of the risk to aspirate.

Elective tracheotomy is the most widely used approach for airway management (Marsh et al., 2009), though there have been studies arguing that the complications outweigh the benefits of this technique. These studies present alternatives to tracheotomy, such as overnight intubation or nasotracheal intubation (Coyle et al., 2012; Nikhar et al., 2017). Nevertheless, as long-term airway management may be vital, elective tracheotomy is definitely recommended in high-risk patients (Anehosur et al., 2017). According to Waldron et al. (Waldron et al., 1990), 60.5% of emergency tracheotomies have been conducted due to oral tumors, which suggests special attention needs to be paid in such cases.

Another risk factor mentioned in the literature is the location of the tumor: posterior tongue, floor of the mouth, and anterior mandible present special risks for postoperative airway management, so in these cases tracheotomy is highly recommended (Shaw et al., 1974). Furthermore, with the complication rate twice as high in emergency tracheotomy as in elective tracheotomy, the aim should be to convert emergency situations into elective ones (Mehta and Chamyal, 1999). There are different approaches in the form of scoring systems to defining a high-risk patient and determining the best form of treatment. Gupta et al., (2016) have developed the Clinical Assessment Scoring System for Tracheostomy (CASST), which includes criteria such as previous radiation, bulky flap, age, and bilateral neck dissection. This scoring system aims to predefine a high-risk group of patients. Cameron et al., (2009) have also defined a scoring system for assessing the need for tracheotomy; in this system, comorbidities have to be closely surveyed. However, predicting the need for tracheotomy is still a

Table 4
Reinsertion of cannula ($n = 8$).

Gender	Localisation	Complication[a]	TKRe[c]	TkReEx[d]	Comorbidities
Male	Tongue	Pneumonia	9	13	CHD[e]
Male	ORN[b]	Pneumonia	13	22	–
Male	ORN	Bleeding	7	10	Bronchitis
Male	Gum of the lower jaw	Bleeding	2	2	–
Male	Floor of the mouth	Necrosis of the flap	8	10	CHD
Female	ORN	Microvascular revision of the flap	14	Failure to decannulate	Hypertension
Female	Buccal mucosa	Microvascular revision of the flap	8	10	Hypertension
Female	Floor of the mouth	Microvascular revision of the flap	8	10	Hypertension

[a] Complication leading to reinsertion of the cannula.
[b] ORN = osteoradionecrosis of the lower jaw.
[c] TkRe = number of days postoperatively the cannula was reinserted.
[d] TkReEx = number of days before the reinserted cannula was removed.
[e] CHD = coronary heart disease.

Table 6
Failure to decannulate ($n = 7$).

Gender	Localisation	Complications[a]	Relevant diseases
Male	ORN[b]	Intraoral healing disturbances	COPD[g], CHD[h]
Male	Fm[c]	Pneumonia, resp. Failure[d]	Hypertension, CHD
Male	Fm	Delir.[e], PE[f], resp. Failure	COPD
Female	ORN	Resp. Failure	Hypertension, COPD
Female	Fm	Delir., pneumonia	Hypertension, CHD
Male	Fm	Resp. Failure after sepsis	–
Male	ORN	Resp. Failure after pleural effusion	–

[a] Complications associated with the failure to decannulate.
[b] ORN = osteoradionecrosis of the lower jaw.
[c] Fm = floor of the mouth.
[d] Resp. Failure = respiratory failure.
[e] Delir. = postoperative delirium.
[f] PE = pulmonary embolism.
[g] COPD = chronic obstructive pulmonary disease.
[h] CHD = coronary heart disease.

difficult task in the individual patient, and scoring systems do not always convince those in clinical practice (Lee et al., 2015; Schmutz et al., 2018). Unlike other studies, we did not find a significant association between tracheotomy-linked complications and male gender or risk factors such as nicotine abuse or previous radiation therapy (Nikhar et al., 2017). The main risk factors we identified were age, alcohol abuse, pulmonal comorbidities as COPD and chronic bronchitis, ASA grade III, and a long duration of cannula in situ. In the literature, significant pulmonal comorbidities were shown to be COPD and chronic bronchitis (Xu et al., 2017). Reported complication rates associated with tracheotomy in the literature vary considerably, with a range of 8–45% (Castling et al., 1994; Halfpenny and McGurk, 2000). The most common complication is pneumonia, followed by bleeding and emphysema (Freburg-Hoffmeister et al., 2017; Mehta and Chamyal, 1999). Our study recorded a total airway management complication rate in oral cancer surgeries of 20%. This included cases of pneumonia, bleeding, pulmonary atelectasis, respiratory failure, dislocation of the cannula, and failure to decannulate.

We did not find any lethal complications due to dislocation of the cannula, as described in other studies (Goldenberg et al., 2000; Haspel et al., 2012); nor did we have any cases of emphysema, tracheitis, or pneumothorax.

The 4.6% of patients affected by failure of decannulation were released into outpatient care with their cannula still in situ. This matter is not discussed in the literature. In our opinion, this could also be seen as severe complication, with adverse effects for the patient. Dependent on the localisation of the tumor, there can be dyspnoea caused by swelling during radiotherapy, which could lead to problems in airway management and the need for tracheotomy (Langerman et al., 2012). In cases of advanced T-stages, positive lymph nodes, or incomplete resection, radiotherapy is the next step of treatment, according to the German oncology guidelines for oral cancer (Wolff et al., 2012), and it can sometimes be useful to retain the tracheotomy to ensure a safely manageable airway (Leiser et al., 2017). None of our patients needed to retain the cannula during radiotherapy.

The time period until removal of the cannula was recorded to have a median duration of 5.63 days. This seems to be shorter than found in other studies: Hammarfjord et al., (2015) reported a median duration of 7 days, and Coyle et al., (2012) a median duration of 11.3 days. The patients benefit from a time-appropriate, early removal of the cannula, allowing them to receive logopedics and, further, to start to swallow and speak. This is an important psychological factor for the patients. The removal of the cannula improves mobility and thus helps to avoid complications associated with immobility, such as pneumonia and thrombosis (Coyle et al., 2013).

Since there were only seven cases of recannulation in our study, we could not draw correlations between recannulation and complication rate or duration of hospital stay.

The duration of hospitalisation after oral cancer surgery is discussed in many studies and often used as an argument against tracheotomy, because longer hospitalisation leads to higher costs (Siddiqui et al., 2016). In our study, the median length of hospital stay was 15 ± 10.6 days, ranging from 8 to 72 days. According to Castling et al (Castling et al., 1994), patients with tracheotomy-associated complications spent longer periods in ICU (4 days vs 2 days) and, in addition, had a longer overall hospital stay of 25 days, compared with an average of 14 days for all patients. As expected, we observed similar results regarding hospitalisation: patients with postoperative tracheotomy-associated complications stayed significantly longer in hospital.

One might draw the conclusion that complications in tracheotomy patients are generally more severe because the airway is affected, and therefore require longer hospitalisation. Pneumonia is a common and well-known postoperative complication in oral cancer patients, with tracheotomy as a major risk factor, as studies have shown (Li et al., 2016; Ong et al., 2004; Xu et al., 2017). We also noticed pneumonia to be the most frequent complication; in our opinion pneumonia can be seen as a complication promoted by both tracheostomy and a prolonged period of the cannula in situ. Additionally, pneumonia has an impact on length of hospitalisation, being a leading cause of ICU stay (McDevitt et al., 2016).

5. Conclusion

Our study looked at patients with tracheotomy-associated complications. In order to reduce tracheotomy-associated cases, which lead to a longer hospitalisation and higher costs, particular attention should be paid to patients with risk factors, and the cannula in situ period should be kept as short as possible, to avoid severe complications. This is possible through detailed extraction from patient records and determination of unknown pathognomonic findings (for example, via radiography of the patient's chest). Additionally, it is important to question the indication of tracheotomy for every patient on an individual basis. In cases of extraoral approaches for reconstruction of the jaw with minimal or lack of intraoral soft tissue reconstruction, and for tumors of the palate and buccal mucosa, tracheotomy need not be considered because the airway is protected. This would reduce the incidence of complications, while maintaining a secure and easily manageable postoperative airway.

The limitation of our study is its retrospective nature. The main benefit is highlighting the over-indication for tracheotomy in oral and

reconstructive surgery for the above-mentioned localisations, which offers the possibility of carrying out further comparative studies.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jcms.2019.01.017.

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