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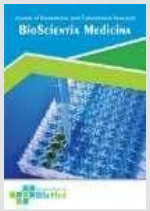

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Factors Related to the Incidence of Dysphagia in Patients Using Tracheal Cannula at Dr. Mohammad Hoesin General Hospital Palembang

Puspa Zuleika[1], Mariance[1*], Erial Bahar[2]

[1]Department of Otorhinolaryngology-Head and Neck Surgery, Faculty of Medicine, Universitas Sriwijaya /Dr. Mohammad Hoesin General Hospital, Palembang, Indonesia

[2]Department of Anatomy, Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia

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***Corresponding author:**
Mariance

E-mail address:
Mariance_zainal@yahoo.com

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A B S T R A C T

Background: The need for tracheostomy increases during the coronavirus diseases 2019 (COVID-19) pandemic. However, some studies suggest that tracheostomy causes dysphagia which can lead to other health problems such as pneumonia, choking, weight loss, malnutrition, and dehydration with serious side effects. This study aims to determine the factors associated with the incidence of dysphagia in patients using a tracheal cannula. **Methods:** This study is an observational study using a cross-sectional design. Data collection was carried out using medical record data on 58 patients who used a tracheal cannula recorded in the medical record data for the FEES examination at Dr. Mohammad Hoesin General Hospital Palembang from January 2019 to September 2021. The data were analyzed by descriptive statistics, chi-square, and multiple logistic regression. **Results:** Of 58 patients who used a tracheal cannula, it was found that 75.9% had dysphagia. The results of the comparison test showed that the factors associated with the incidence of dysphagia were gender (p=0.001), nutritional status (p=0.013), incision location (p=0.043), and primary disease (p=0.021). Factors that were not associated with the incidence of dysphagia were age (p=0.933), tracheostomy indication (p=0.741), and the type of tracheal cannula (p=1,000). Patients are male, with low and high tracheal cannula incision locations, and have a primary neurological disease. The probability or chance of dysphagia is 79.8%. **Conclusion:** Tracheostomy can cause dysphagia which is influenced by gender, location of tracheal cannula incision, and primary disease.

1. Introduction

A tracheostomy is an opening in the trachea to allow the breathing cannula to pass so that the patient can ventilate or the patient can breathe spontaneously. Tracheostomy is generally performed in intensive care unit (ICU) patients. Tracheostomy is most often indicated in patients with prolonged mechanical ventilation and the presence of upper airway obstruction. The need for tracheostomy increases during the coronavirus disease pandemic 2019 (COVID-19). The COVID-19 pandemic has led to the need for invasive ventilation, with 10% to 15% of intubated patients subsequently requiring a tracheostomy. Tracheostomy was performed in only 21 of the 196 patients (10.8%) with COVID-19.[1-4] Some studies suggest that tracheostomy causes dysphagia. Dysphagia occurs in 11% to 93% of patients after tracheostomy. In a study in Italy, as many as 557 tracheostomy patients, 187 (33.57%) of whom had dysphagia. The study in Santo Paulo reported the incidence of dysphagia as much as 16.49% in patients with tracheostomy. In a study in patients over 18 years in Spain, dysphagia occurred during tracheal cannula removal with an incidence rate of 93.4%. Tracheostomy often coexists with dysphagia because

of its anatomic location, shared pathways of the respiratory and digestive systems, and the medical complexity that necessitates the need for an artificial airway. Dysphagia in patients with a tracheal cannula occurs because of decreased sensory input, atrophy of the laryngeal muscles, and decreased subglottic air pressure. Dysphagia is the sensation of food being blocked as it travels from the mouth through the esophagus to the stomach and is considered a serious warning sign or alarm symptom. Swallowing disorders that occur in the oral, pharyngeal, and esophageal phases can cause problems with oral movements, and the swallowing process can lead to health problems such as pneumonia, choking, weight loss, malnutrition, and dehydration, with serious side effects. Impaired swallowing ability or inefficient consumption of fluids and nutrients can lead to dehydration and malnutrition. Impaired swallowing function with airway invasion can lead to aspiration pneumonia, respiratory infections, and sudden death.[1,5–8]

In geriatric patients, it is reported that age, history of aspiration, pneumonia and heart attack, neurological diseases, and the presence of tracheal canoules are risk factors for dysphagia. In individuals with tetraplegia, it was reported that age, gender, and tracheal canndules were identified as statistically significant risk factors for dysphagia. Meanwhile, based on male gender is a significant risk factor in dysphagia that develops into aspiration pneumonia. In patients taking tracheal candules, dysphagia occurs due to the presence of swallowing dysfunction caused in part by the candules and secondary muscle weakness due to the post-critical phase. Schefold et al. stated that the indication of tracheostomy is also associated with dysphagia, in which patients with the neurological disease have an increased risk of developing dysphagia. In addition, clinically, patients with prolonged mechanical ventilation and tracheostomy are at greater risk for dysphagia. Scoretz et al. reported that the use of a passy muir valve to close the system with a deflated cuff restores airflow through the upper airway, which improves sensation, taste and smell, pressure, and overall swallowing function. Kim et al. investigated the incidence of dysphagia in patients with brain injury with the result that a number of dysphagia symptoms improved after decannulation.[9–13] The relationship between tracheostomy and dysphagia is related to the effect of the tracheal cannula on cuff pressure, namely muscle atrophy and atrophy of nerve endings in the glottic and subglottic regions. Disruption of the airways through the glottis, and loss of pressure in the subglottic region, directly affect the cough reflex, laryngeal adduction, and glottic closure reflex. Restoration of the airways through the glottis can be accomplished with the use of penetrating. Thus the use of cannula Penetration is also associated with dysphagia. The placement of the tracheal cannula is not in the normal position causing injury to surrounding structures such as the esophagus, and esophageal motility disorders are the cause of dysphagia. Ideally, a tracheostomy is performed between the second and third tracheal rings. Patients with dysphagia are at risk for aspiration pneumonia, malnutrition, and impaired quality of life. Swallowing complaints that occur in the oral, pharyngeal, and esophageal phases can cause problems with oral movements, and the swallowing process can lead to health problems such as pneumonia, choking, weight loss, malnutrition, and dehydration, with serious side effects.[1.5–8.14] Efforts to explore the factors that influence the incidence of dysphagia in patients using a tracheal cannula are very important to be explored in order to minimize complications from dysphagia and improve the quality of life of patients using a tracheal cannula.

2. Methods

This study is an observational study using a cross-sectional design with the aim of knowing the factors associated with the incidence of dysphagia in patients using a tracheal cannula at Dr. Mohammad Hoesin General Hospital Palembang. This study uses secondary data from the Medical Record Installation of Dr. Mohammad Hoesin General Hospital Palembang. A total of 58 research subjects participated in this

study, where research subjects had inclusion criteria, namely having complete medical record data. This study aims to explore the role of age, sex, nutritional status, primary disease, indications for tracheostomy, type of fenestrated/non-fenestrated tracheal cannula, and location of tracheal incision on the incidence of dysphagia.

Univariate analysis was carried out on the data on the basic characteristics of the research subjects. This univariate analysis aims to describe the research sample. Descriptive analysis in the form of numerical data and categorical data. Numerical data will be presented in the form of mean values and standard deviations, while categorical data will be presented in the form of graphs or tables of frequency distribution, proportion or percentage, and narrative. Bivariate data analysis with dysphagia, each of which is a categorical variable using the Chi-Square test. Data from statistical analysis results are displayed in tables, graphs, and textual. Processing of the resulting data will be assisted with SPSS software for windows version 23.0. Multivariate analysis was conducted to analyze the relationship between many independent variables and a dependent variable. For categorical data, logistic regression is used, while for numerical data, linear regression is used. This multivariate analysis aims to determine the factors associated with dysphagia in patients using a tracheal cannula.

3. Results

Most research subjects were in the age group > 46 years (70.7%), with the mean age being 52.19±19.86 years. In this study, most of the research subjects were male (63.8%). Most of the subjects had poor nutritional status (55.2%) and had the primary disease in the form of neurological disease (58.6%). Based on the indications for tracheostomy, most of the subjects had indications due to prolonged intubation (56.9%), the location of the tracheal incision was in the middle (56.9%), and the type of cannula used was fenestrated (79.3%). The incidence of dysphagia in tracheostomy patients was 75.9%.

Table 1. Characteristics of research subjects

Variable	N	%	$\underline{Mean} \pm SD$
Age			52.19 ± 19.86
6-11 years	3	5.2	
12-25 years	4	6.9	
26-45 years	10	17.2	
> 45 years	41	70.7	
Gender			
Female	21	36.2	
Male	37	63.8	
Nutritional status			
Malnutrition	32	55.2	
Good nutrition	6	10.3	
Overnutrition	20	34.5	
Indications of tracheostomy			
SJNA	25	43.1	
Prolonged intubation	33	56.9	
Incision location			
Low	10	17.2	
Middle	33	56.9	
High	15	25.9	
Primary diseases			
Non-neurological	24	41.1	
Neurological	34	58.6	
Cannula type			
Fenestrated	46	79.3	
Non-fenestrated	12	20, 7	
Dysphagia			
Yes	44	75.9	
No	14	24.1	

Table 2 shows the relationship between study variables, where age, tracheostomy indication, and type of tracheal cannula do not have a significant relationship with the incidence of dysphagia. Meanwhile, gender, nutritional status, incision location, and primary disease had a significant relationship with the incidence of dysphagia.

Table 2. Bivariate analysis of study variables

Age	**Dysphagia**				**Total**		**P-value**	**OR(CI95%)**
	Yes		**No**					
	n	**%**	**n**	**%**	**N**	**%**		
6-11 years	2	66.7	1	33.3	3	100.0	0.933[a]	N/A[b]
12-25 years	3	75.0	1	25.0	4	100.0		
26-45 years	7	70.0	3	30.0	10	100.0		
> 45 years	32	78.0	9	22.0	41	100.0		
Gender	**Dysphagia**				**Total**		**P-value**	**OR (CI95%)**
	Yes		**No**					
	N	**%**	**n**	**%**	**n**	**%**		
Female	10	47.6	11	52.4	21	100.0	0.001[a]	12.5 (2.9 -53.6)
Male	34	91.9	3	8.1	37	100.0		
Nutritional status	**Dysphagia**				**Total**		**P value**	**OR(CI95%)**
	Yes		**No**					
	n	**%**	**n**	**%**	**N**	**%**		
Malnutrition	28	87,5	4	12.5	32	100.0	0.013[a]	N/A[b]
Good nutrition	14	70.0	6	30, 0	20	100.0		
Overnutrition	2	33.3	4	66.7	6	100.0		
Indications for Tracheostomy	**Dysphagia**				**Total**		**P-value**	**OR (CI95%)**
	Yes		**No**					
	N	**%**	**n**	**%**	**n**	**%**		
SJNA Prolonged	20	80.0	5	20.0	25	100.0	0.741[a]	0.7
intubation	24	72,7	9	27.3	33	100.0		(0.2-2.3)
Location of Incision	**Dysphagia**				**Total**		**P value**	**OR (CI95%)**
	Yes		**No**					
	n	**%**	**n**	**%**	**N**	**%**		
Low	9	90.0	1	10.0	10	100.0	0.043[a]	N/A[b]
Middle	21	63.6	12	36.4	33	100.0		
High	14	93.3	1	6.7	15	100.0		
Primary disease	**dysphagia**				**Total**		**P-value**	**OR (CI95%)**
	Yes		**No**					
	n	**%**	**n**	**%**	**N**	**%**		
Non-neurological	14	58.2	10	41.7	24	100.0	0.021[a]	5.4
Neurological	30	88.2	4	11.8	34	100.0		(1.4-20.1)
Cannula type Tracheal	**Dysphagia**				**Total**		**P-value**	**OR (CI95%)**
	Yes		**No**					
	N	**%**	**N**	**%**	**n**	**%**		
Fenestrated	35	76.1	11	23.9	46	100.0	1,000[a]	1.1
Non-fenestrated	9	75.0	3	25.0	12	100.0		(0.2-4.6)

Table 3. Multivariate analysis of various factors associated with dysphagia in patients using a tracheal cannula

Factors	**Coefficient (B)**	**P-value**	**OR**	**95% CI**
Gender	2.925	0.002	18,626	1.950-177.918
Location of tracheal incision	1.890	0.019	6.618	0.211 -207,478
Primary disease	3,633	0.000	37,830	3,167-451,860
Constant	-7.074	-	-	-

*Tested by logistic regression backward LR

The equation obtained is:

Y = -7.074 + 2.925*(X1) + 1.890*(X2) + 3.633*(X3)

Y = 1,374

Information: Y = Dysphagia; X1 = Gender; X2 = Location of incision; X3 = Primary disease; Then put into the probability formula

P = 1/(1+EXP(-Y))

P = 1/(1+EXP(-1.374))

P = 0.798

Based on these calculations, by entering the three factors, the probability of dysphagia is 79.8%. That is, if the subject is male, with a high tracheal cannula incision location, and has a primary neurological disease, the probability or chance of dysphagia is 79.8%.

4. Discussion

In this study, age was not associated with dysphagia in patients undergoing tracheostomy. This is as reported by a study that stated that age had no significant effect on the incidence of dysphagia with a tracheostomy. Dysphagia can also occur in pediatric patients undergoing tracheostomy. Swallowing problems were found in 70.5% of pediatric patients who underwent tracheostomy. Children with a tracheostomy often have difficulty swallowing. The tracheal cannula binds to the larynx and prevents the elevation of the larynx. A tracheal cannula has the potential to desensitize the larynx and cause an ineffective cough mechanism since it is not possible to establish positive subglottic pressure with the tracheal tube open. The absence of positive subglottic pressure during swallowing increases the risk of penetration and aspiration. In general, the mechanisms described in the adult population also apply to pediatric patients, even in a much larger population than the adult population.[15-17]

The male gender is a significant risk factor for dysphagia that develops into aspiration pneumonia. The results of dysphagia examination using FEES showed that most of the dysphagia occurred in men, as much as 65.6%. This is because men have more comorbidities, and women have a longer life expectancy than men. In addition, women have greater neck muscle resistance and greater hyoid bone, and better displacement of the larynx when swallowing. Even with increasing age, muscle strength remains the same.[18]

Poor nutritional status is considered a cause and effect of dysphagia due to inadequate oral intake. However, different results were reported in a study that stated that in elderly patients undergoing tracheostomy, no statistical difference was observed between the dysphagic and Body Mass Index groups. Dysphagia is found in 40 to 65% of individuals over 60 years of age and does not correlate with underweight people. The small sample size may be the cause of the lack of correlation between swallowing disorders in tracheostomy patients and Body Mass Index. In this study, it was shown that there was a relationship between nutritional status and the incidence of dysphagia in tracheostomy patients because the sample of this study was in the age range of both children and the elderly and was not only carried out in the elderly.[19]

Prolonged intubation can cause changes in the laryngeal mucosa which in turn can cause the vocal cords to become edematous, desensitize the larynx and pharynx and eliminate their response to foreign bodies entering the airways, resulting in aspiration. Intrinsic and extrinsic muscles that are not used can cause muscle atrophy, resulting in weakness and stiffness of all striated muscles, including those in the larynx and pharynx. Impaired swallowing is due in part to the cannula and muscle weakness secondary to muscle atrophy. A large body of evidence is emerging, reporting the risk of dysphagia associated with intubation and ventilation. Thus, there is no correlation between indications for tracheostomy and dysphagia because indications for prolonged intubation and SJNA can both pose a risk of dysphagia.[20,21]

A tracheal cannula should ideally be placed between the second and third tracheal rings because it is the most widely used method because it is

relatively safe. Placement of the tracheal cannula in a high position can cause injury to surround structures, the possibility of greater exposure to the vocal cords, and laryngeal stenosis can occur. It is indicated for patients with laryngeal malignancies and with laryngectomy, while low-lying tracheostomy is rarely performed because the area has a lot of large blood vessels, so that dangerous if it is cut at the incision, the cannula is too deep, the tip of the cannula can pass through the carina and injure causing laceration of the bifurcation wall, and in cannula with a balloon, the balloon can fold around the stoma. Abnormalities of esophageal motility are a cause of dysphagia because peripheral sensory nerves cause the onset of the swallowing response. Impaired swallowing function can be caused by impaired coordination and contraction of pharyngeal muscles or changes in esophageal sphincter pressure so that the ability to push is reduced. This process is mostly carried out by the maxillary nerve branch of the trigeminal nerve (cranial nerve V), a pharyngeal branch of the glossopharyngeal nerve (cranial nerve IX), and two of the branches of the vagus nerve (cranial nerve X), the pharyngeal branch, and the superior laryngeal nerve. Impaired pharyngolaryngeal sensitivity to physical or chemical stimuli is a component of swallowing dysfunction and increases the risk of aspiration in the elderly and patients with neurologic disease. Difficulty swallowing and tracheostomy related to impaired swallowing reflex after tracheostomy. Impaired reflexes cause food and fluid to enter the larynx and cause aspiration. Swallowing dysfunction is caused by desensitization of the larynx or fixation of the larynx by tracheostomy. The tracheal cannula applies pressure to the esophagus, thereby changing the function of swallowing. Tracheostomy also causes a reduction in the elevation and anterior displacement of the larynx, which impairs the relaxation of the hypopharyngeal sphincter. Briefly explain that causes of tracheal cannula aspiration include abnormal anterior-superior movement of the larynx, decreased subglottic pressure, impaired laryngeal closure reflex, and altered stages of oral, pharyngeal, and esophageal swallowing.[22,23]

Impaired pharyngolaryngeal sensitivity to physical or chemical stimuli is a component of swallowing dysfunction and increases the risk of aspiration in the elderly and patients with neurologic disease. Patients with neurological disorders have a higher risk of aspiration because of the greater frequency of swallowing. Patients with neurological disorders will have decreased sensitivity to some stimuli, leading to a high prevalence of silent aspiration or unnoticed aspiration. Stroke, parkinson's disease, multiple sclerosis, Alzheimer's disease, and some motor neuron disorders (amyotrophic lateral sclerosis, progressive bulbar palsy, and pseudobulbar palsy) can cause neurogenic dysphagia, whose manifestations depend on the location of the dysphagia. Meanwhile, patients with non-neurological diseases, namely head and neck cancer patients showed that the presence of a tracheotomy or tracheostomy tube did not increase the incidence of aspiration. Dysphagia and aspiration that occur in patients with tracheostomy are caused by a critical illness requiring a tracheostomy.[24]

The reflexive closure of the vocal cords occurs primarily as a result of intrinsic contraction of the laryngeal muscles. Primary reflex closure is produced by a rapid contraction of the thyroarytenoid in response to stimulation of the superior laryngeal nerve. Closure of the larynx that is not well coordinated can cause cessation of breathing or swallowing apnea, and airway closure must occur so that food/fluid from the oropharynx into the pharynx and esophagus. When laryngeal sensitivity is normal, aspiration of food or fluids usually produces a cough response. This response can help clear any material that is aspirated out of the airway and into the pharynx or oral cavity to be expelled or swallowed. The use of a fenestrated tracheal cannula is often inappropriate and thus does not function properly. The commercially available tracheal cannula can significantly increase the resistance to flow through the upper airway if the fenestrated is not positioned properly. The fenestrated cannula should be used with care and only for certain reasons because of the

potential risk of abrasion and granulation formation if positioned poorly. The fenestrated cannula may have 1 or 2 holes on the curved side of the outside of the cannula tube. This opening allows air to pass through the cannula into the vocal cords when the cannula stoma is closed by the patient's finger, and as a result, sound can be produced. In addition, the patient can still feel that he is breathing through his nose, and this opening also reduces the risk of granulation tissue formation. The fenestrated cannula can be useful in patients with medialization of the vocal cords and vocal cord paresis, where air cannot be inhaled in the usual way and requires a tracheostomy. If clinically indicated, a number of measures are performed (deflating the balloon cannula and use of a speech valve to support laryngeal function or sensation and to increase expectoration), which some guidelines suggest avoiding. To reduce the potential for infection. Thus, the absence of a significant relationship between the type of cannula and the incidence of dysphagia may be due to the use of a fenestrated cannula that is not done properly and correctly so that it does not provide results as it functions by increasing the sensitivity of the larynx which can prevent dysphagia.[25]

5. Conclusion

Tracheostomy can cause dysphagia which is influenced by gender, location of tracheal cannula incision, and primary disease.

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