神奈川歯学，57-1，17 ～ 23，2022

ORIGINAL RESEARCH

Keywords
Nasogastric tube
Pharyngeal nasogastric tube crossing
Swallowing

Relationship between pharyngeal crossing of the nasogastric tube and the side of nasal insertion

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(Received: February 18, 2022,　Accepted: March 3, 2022)

Abstract

Nasogastric tube (NGT) placement can be harmful during swallowing if the tube passes through the pyriform sinus on the opposite nostril from which it is inserted (i.e., pharyngeal NGT crossing), due to tube and epiglottic contact. We clarified whether the NGT nostril insertion side affected the frequency of pharyngeal NGT crossing. We examined test images and medical records of 118 patients who underwent NGT placement and flexible endoscopic evaluation of swallowing. The frequency of pharyngeal NGT crossing was determined by assessing patients in whom the nasal insertion side differed from the pyriform sinus passage side. We also assessed whether there was contact between the epiglottis and NGT at rest. Patient age is presented as mean ± standard deviation, and each score is presented as the median (quartile). The χ^2 test and Fisher's exact test was used. The significance level was set at $P < 0.05$. Pharyngeal NGT crossing occurred significantly less often ($P = 0.009$) when the NGT was inserted from the left nostril (14 cases; 12%) compared to the right (28 cases; 24%). Contact between the epiglottis and NGT only occurred in patients with pharyngeal NGT crossing (11 cases; 9.4%). Given that the esophagus is anatomically slightly to the left of the midline, NGTs might be more prone to passing through the left pyriform sinus. Inserting the NGT through the left nostril can reduce the frequency of pharyngeal NGT crossing, potentially preventing the harmful effects. We expect that results obtained in this study will help to determine the ideal NGT position that will have a minimal impact on swallowing function.

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Introduction

In patients who face difficulty while ingesting food, nasogastric tube (NGT) feeding is the first choice for short-term nutrition supplementation as an alternative to oral ingestion. Conventionally, however, there has been concern that the placement of an NGT might impair swallowing function, making patients more prone to aspiration. Previous studies have found that NGT placement increases laryngeal penetration, aspiration, laryngeal residue, and pharyngeal transit time in elderly people and impedes hyoid bone movement in patients with stroke, suggesting that NGT placement can lead

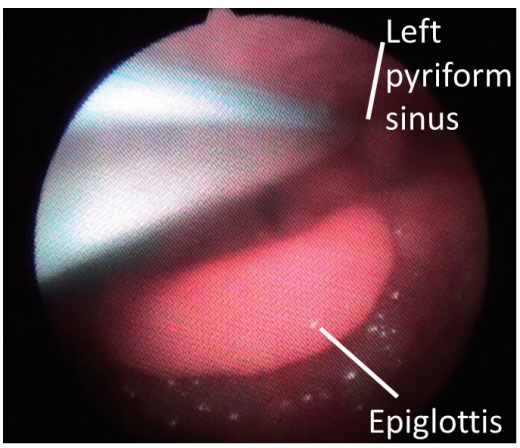

Figure 1. The nasogastric tube inserted from the right nostril enters the pyriform sinus from the left, causing tube crossing in the pharynx. The nasogastric tube is likely to touch the epiglottis during swallowing, interfering with the swallowing movement.

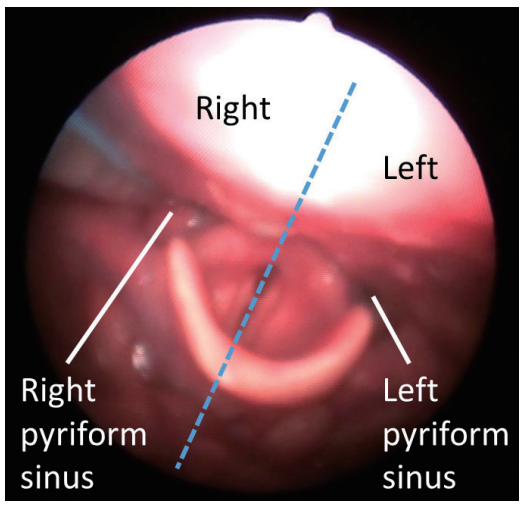

Figure 2. The pyriform sinus is a recess located between the laryngeal lumen and the thyroid cartilage lamina. The line connecting the epiglottic tubercle and interarytenoid notch was used as a midline to divide the pyriform sinus.

to impaired swallowing function[1,2]. Meanwhile, other studies have found that NGT placement does not alter the pharyngeal transit time during swallowing in patients with stroke[3]. Further, it has been reported that the presence or absence of an NGT does not influence the incidence of aspiration and that there is no change in the risk of aspiration when swallowing a small amount of liquid with or without an NGT, suggesting that NGT placement has no effect on swallowing function[4,5]. Differences in NGT size have also been reported to affect swallowing function and the resulting sense of discomfort[6].

The precise effects of NGT placement on swallowing function remain inconclusive. The reason for the discrepancy in findings across studies may be related to the position of the NGT passing through the pharynx and larynx. Dziewas et al. showed that NGTs have no effect on swallowing function if positioned correctly, whereas malpositioned NGTs cause worsening of dysphagia in patients with stroke[7]. Fujishima et al. reported that when an NGT is passed obliquely through the pharyngeal region, the tube touches the epiglottis during swallowing, with adverse implications[8]. However, only a few reports have addressed the cause of NGT mispositioning in the pharynx and larynx that renders swallowing difficult.

The esophagus is positioned between the trachea anteriorly and the cervical spine posteriorly. Due to this anatomical feature, a recess, labeled the pyriform sinus, exists on both sides of the entrance of the esophagus, despite its structure consisting of a single tube. Thus, while placing an NGT, if the tube is advanced through the pyriform sinus on the opposite side of the nostril through which it is inserted, it will end up crossing the pharynx obliquely (Figure 1). The NGT, which is positioned over the larynx and trachea, crosses the bolus transport path, which can cause a foreign body sensation, inhibit epiglottic inversion, increase the risk of aspiration, and decrease the saliva swallowing frequency at rest, leading to harmful effects on swallowing function[8]. However, no study has comparatively examined NGT crossing according to the severity of the swallowing disorder in patients.

The present study aimed to examine the frequency of the crossing of the NGT across the midline of the pharynx (hereafter referred to as pharyngeal NGT crossing) in patients, to examine the differences by side (left vs. right), and to examine if the frequency of pharyngeal NGT crossing is affected by whether the NGT is inserted from the left nostril or the right nostril. We expect that the results obtained in this study will help to determine the ideal NGT position that will have a minimal impact on swallowing function.

Materials and Methods

Patients

We examined 118 patients with signs of dysphagia admitted to the National Hospital Organization at Taka-

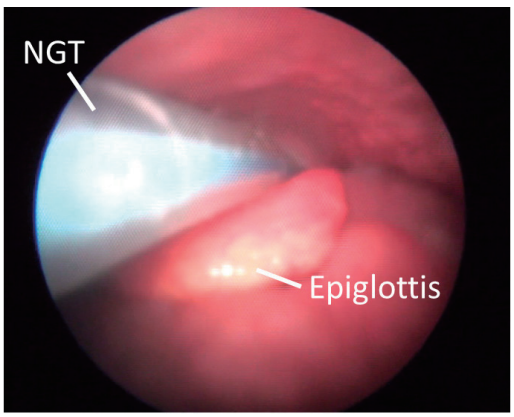

Figure 3. The nasogastric tube is in contact with the epiglottis at rest, resulting in constant discomfort. As epiglottic inversion is also inhibited during swallowing, the risk of aspiration increases. NGT, nasogastric tube.

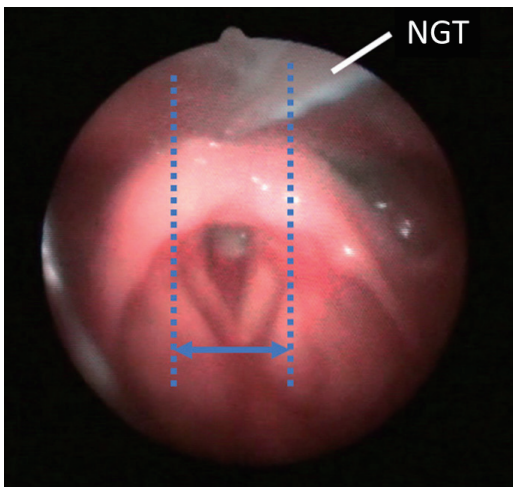

Figure 4. The position of the nasogastric tube passing through the entrance of the esophagus. Nasogastric tube positioning along the midline was dependent on whether the tube was within the range of the vocal cords at rest. NGT, nasogastric tube.

saki General Medical Center between March 2014 and September 2015 who underwent flexible endoscopic evaluation of swallowing (FEES) and NGT placement[9]. Of these, one patient was excluded since his test images revealed NGT coiling in the pharynx. Further, patients were excluded when the side of nasal passage and the pyriform sinus passage could not be determined due to image distortion.

Examination methods

Clinical records of these patients with NGTs who underwent FEES were examined to collect information on sex, primary disease, and age at the time of the initial evaluation. Using recorded FEES images, the side of nasal insertion, the side of pyriform sinus passage, contact between the epiglottis and NGT at rest, and the position of NGT placement were examined. To determine whether the NGT was advanced through the pyriform sinus on the left or right side, we defined the right side of a straight line connecting the interarytenoid notch and the epiglottic tubercle as the right pyriform sinus, and the left side of this line as the left pyriform sinus (Figure 2). The cases with and without NGT crossing were determined based on whether the NGT passed through the nostril and pyriform sinus on the different sides or on the same side (Figure 2), respectively, and the presence and absence of NGT crossing by the side of nasal insertion was examined. The contact between the epiglottis and NGT was examined by assessing whether the NGT touched the epiglottis at rest (Figure 3). We also assessed the position of the NGT as "midline" or "non-midline" according to whether the NGT passed near the midline of the entrance of the esophagus or not (Figure 4). The Functional Oral Intake Scale (FOIS) was assessed using medical records[10].

This retrospective study was conducted in compliance with the Declaration of Helsinki and was approved by the Kanagawa Dental University Research Ethics Review Committee (approval number: 451), and the Clinical Research Ethical Review Board of the National Hospital Organization at Takasaki General Medical Center (approval number: H29-8).

Statistical analysis

Statistical analysis was performed using SPSS Statistics version 26 (IBM Japan Ltd., Tokyo, Japan). Patient age is presented as mean ± standard deviation, and each score is presented as the median (quartile). A binomial test was used to assess the side of nasal insertion and pyriform sinus passage. The χ^2 test was used to assess differences in the frequency of pharyngeal NGT crossing by the side of nasal insertion (left vs. right), contact between the epiglottis and NGT at rest, and the position of the NGT (i.e., whether the NGT was passed through the midline of the entrance of the esophagus or not). However, if there were cells with expectation values < 5 in the cross-tabulation table, Fisher's exact test was used. The significance level was set at $P < 0.05$.

Table 1 Patient characteristics

Patients		N	%
Sex	Male	67	57.3
	Female	50	42.7
Average age		77.7±12.4	yo
Primary disease		N	%
Central nervous system diseases		33	28.2
Respiratory diseases		23	19.7
Neuromuscular diseases		21	17.9
Digestive diseases		11	9.4
Circulatory diseases		10	8.5
Musculoskeletal disorders		6	5.1
Spinal cord injury		4	3.4
Other *		9	7.7

N: number of patients, %: percentage of total patients in the study, yo: years old
*Includes myocardial infarction, heart failure, post-esophageal cancer surgery, post-colorectal cancer surgery, spinal cord injury, disuse atrophy, and malignant lymphomas.

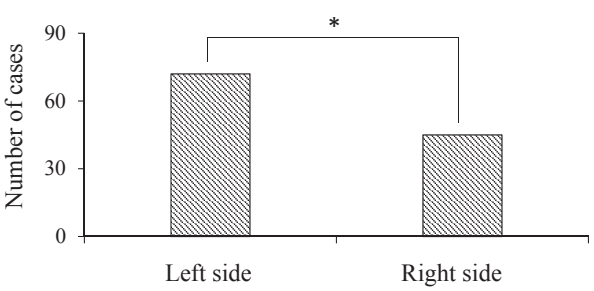

Figure 5. Side of passage through the pyriform sinus. Regardless of the side of nasal insertion, nasogastric tubes were found to pass through the left pyriform sinus more frequently compared to the right side ($P = 0.013$). * indicates statistical significance.

Results

Clinical characteristics of patients

Table 1 presents the number of patients and their primary disease. Patients with systemic diseases included: 33 with central nervous system diseases, 23 with respiratory diseases, 21 with neuromuscular diseases, and 40 with other diseases (mean age: 77.7 ± 12.4 years; 67 males and 50 females). Central nervous system diseases included cerebral infarction, cerebral hemorrhage, subarachnoid hemorrhage, hypoxic encephalopathy, and encephalitis; respiratory diseases included aspiration pneumonia, pulmonary embolism, and post-lung cancer surgery; neuromuscular diseases included Parkinson's disease, multiple system atrophy, dementia, and myasthenia gravis; and other diseases included myocardial infarction, heart failure, post-esophageal cancer surgery, post-colorectal cancer surgery, spinal cord injury, disuse atrophy, and malignant lymphomas. The median [quartile range] FOIS score was 1[1-3].

Side of nasal insertion and pyriform sinus passage

With respect to the side of nasal insertion, 59 (50.4%) patients had the NGT inserted from the right nostril, whereas 58 (49.6%) patients had the NGT inserted from the left nostril ($P = 0.926$).

With respect to the side of pyriform sinus passage, 45 (38.5%) patients had the NGT advanced through the pyriform sinus on the right side, and 72 (61.5%) patients had it advanced on the left side ($P = 0.013$; Figure 5).

Relationship between NGT crossing and the side of nasal insertion

Table 2 presents the number and proportion of patients with or without NGT crossing according to the side of nasal insertion. NGT crossing was observed in 42 of the 117 (35.9%) patients. Of these, 28 (23.9%) patients had the NGT inserted from the right nostril and 14 (12.0%) had it inserted from the left nostril. The frequency at which NGT crossing occurred was significantly lower with NGT insertion from the left nostril than the right ($P = 0.009$).

Relationship between NGT crossing and contact between the epiglottis and NGT at rest

The contact between the epiglottis and NGT at rest was observed in 11 (9.4%) patients with NGT crossing and 0 patients without NGT crossing, and the difference between the two was significant ($P < 0.001$; Table 3).

Table 2 Frequency of nasogastric tube crossing according to the side of nasal insertion

Side of insertion	With NGT crossing	Without NGT crossing	Total
Right nostril	28 (23.9%)	31 (26.5%)	59 (50.4%)
Left nostril	14 (12.0%)	44 (37.6%)	58 (49.6%)
Total	42 (35.9%)	75 (64.1%)	117 (100.0%)

NGT, nasogastric tube
The frequency at which NGT crossing occurred was significantly lower with NGT insertion from the left nostril than the right ($P = 0.009$).

Table 3 Frequency of contact between the epiglottis and nasogastric tube at rest according to the presence and absence of nasogastric tube crossing

NGT contact with the epiglottis	With NGT crossing	Without NGT crossing	Total
Present	11 (9.4%)	0 (0.0%)	11 (9.4%)
Absent	31 (26.5%)	75 (64.1%)	106 (90.6%)
Total	42 (35.9%)	75 (64.1%)	117 (100.0%)

NGT, nasogastric tube
The contact between the epiglottis and NGT at rest was observed significantly more patients with NGT crossing than those without NGT crossing ($P < 0.001$)

Table 4 Nasogastric tube position (midline/non-midline) according to the presence and absence of nasogastric tube crossing

Position of the NGT	Without NGT crossing	With NGT crossing	Total
Midline	0 (0.0%)	10 (8.5%)	10 (8.5%)
Non-midline	75 (64.1%)	32 (27.4%)	107 (91.5%)
Total	75 (64.1%)	42 (35.9%)	117 (100.0%)

NGT: nasogastric tube
The proportion of patients with a "midline" NGT position was significantly higher among patients with NGT crossing compared to those without NGT crossing ($P < 0.001$).

Position of the NGT at the entrance of the esophagus

In 10 (8.5%) patients, the NGT was positioned along the midline of the entrance of the esophagus; in all these cases, NGT crossing was noted. On the other hand, among patients in whom the NGT was not positioned along the midline, NGT crossing was noted in 32 patients (27.4%), but not in the remaining 75. Thus, the proportion of patients with a "midline" NGT position was significantly higher among patients with NGT crossing compared to those without NGT crossing ($P < 0.001$; Table 4).

Discussion

The following three findings were observed in this study: (1) pharyngeal NGT crossing occurred significantly less frequently when the NGT was inserted through the left nasal cavity as opposed to the right, (2) all cases showing epiglottis NGT contact at rest involved pharyngeal NGT crossing, and (3) all cases with midline NGT involved pharyngeal NGT crossing.

Causes of pharyngeal NGT crossing

We found the frequency of pharyngeal NGT crossing to be higher when the NGT was inserted from the right nostril as compared to the left nostril. The cause of this may be that NGTs are prone to enter the pyriform sinus on the left side. In the present study, NGTs were found to pass through the pyriform sinus on the left side at a significantly higher frequency compared to the right side, regardless of the side of nasal insertion. This could be explained by anatomical factors. Schmalfuss et al. studied computed tomography and magnetic resonance imaging scans and found that the cervical esophagus was located on the left side of the trunk in healthy adults[11]. Halber et al. also reported that the esophagus is located more towards the left side at the height of the carina (tracheal bifurcation)[12]. Moreover, Seta et al. reported that, due to anatomical factors related to the cervical esophagus, swallowed food that passes through

the entrance of the esophagus tends to transit through the pyriform sinus on the left side[13]. Since NGTs are advanced through the cervical esophagus (which is curved to the left) after passing through the entrance of the esophagus, chances are high that they are positioned more toward the left side at the origin of the esophagus (i.e., near the pyriform sinus). In other words, regardless of whether the insertion is made into the left or right nostril, NGTs are more likely to enter the pyriform sinus on the left side. For this reason, the risk of tube crossing in the pharyngeal area increases when NGTs are inserted through the right nostril. Therefore, our findings suggest that the incidence of pharyngeal NGT crossing can be reduced by inserting NGTs through the left nostril.

Effects of NGTs according to placement position

In the present study, the contact between the epiglottis and NGT at rest was observed in some patients with NGT crossing (11/117; 9.4%), but not in those without NGT crossing. If an NGT touches the epiglottis even at rest, the movement of the epiglottis is likely to be hindered during swallowing, and the risk of laryngeal penetration or aspiration increases. Therefore, avoiding NGT crossing may also help to avoid contact between the epiglottis and NGT at rest. According to a previous study, rates of improvement in epiglottic inversion and pharyngeal residue were higher after NGT removal in cases where NGT crossing was observed, as compared to those without NGT crossing[14]. These findings suggest that NGT crossing inhibits epiglottic inversion, resulting in increased pharyngeal residue.

In the present study, the frequency of "midline" NGT placement was 8.5% (10 patients), similar to that reported by a previous study in which 8% of the cases showed midline NGT placement[7]. All of the 10 patients with midline NGT placement in our study had NGT crossing. In cases with NGT crossing, the NGT is often positioned along the midline of the esophageal entrance. Under these conditions, the risk of aspiration potentially increases, as boluses of food or saliva swallowed during oral intake, direct training, or saliva swallowing could flow into the trachea along the tube. Thus, by avoiding NGT crossing, midline placement of an NGT may also be avoided.

Effects of NGT on swallowing function

Pryor et al. investigated the effects of NGTs on swallowing function in older, healthy adults through videofluorographic swallowing studies and examined changes in aspiration, laryngeal penetration, and pharyngeal transit time[1]. They reported that the placement of an NGT, even if small in diameter, can significantly increase aspiration, laryngeal penetration, and pharyngeal residue in the pyriform sinus and epiglottic vallecula and that large-diameter NGTs can significantly increase pharyngeal transit time[1]. Kwak et al. performed ultrasound examinations in patients with stroke who underwent NGT placement and found that hyoid bone movement significantly increased upon NGT removal compared to when the NGT was in place, suggesting that NGT placement disrupts the movement of the hyoid bone[2].

On the other hand, a number of reports have found no apparent harmful effects of NGTs on swallowing function. Huggins et al. examined swallowing of liquid barium on command in 10 young volunteers who had no issues with swallowing function and observed no significant changes due to NGT placement in bolus transit and clearance or airway protection, although swallowing took longer[15]. Leder et al. performed a videoendoscopic swallowing study in 1260 patients who developed dysphagia due to a variety of factors[4]. They compared the aspiration status between patients with and without an NGT and found no significant differences[4]. In a study involving 147 patients with dysphagia, Kim et al. found no significant changes in the severity of aspiration or laryngeal penetration, which were examined as possible effects of NGT placement on swallowing 1 ml of fluid[5]. However, none of these studies took into account the differences in the course of NGT passage; thus, there is a possibility that the harmful effects of inappropriately positioned NGTs could have been masked by results obtained with appropriately placed NGTs.

Inappropriate placement of NGTs encompasses not only pharyngeal NGT crossing, but also "NGT coiling." In the present study, one case of pharyngeal NGT coiling was confirmed. A previous study reported that 5 (5.0%) of 100 examined patients had NGT coiling in the pharynx[7]. In those cases, laryngeal penetration and aspiration were noted, and swallowing function was clearly impaired; however, these symptoms improved upon NGT removal. Since the inappropriate placement of NGTs cannot be determined by external observation, imaging modalities, such as endoscopy and fluorography, are required for investigation.

Limitations

This study involved a retrospective examination of medical records and image analysis, and assessment of pharyngeal sensation or motor paralysis of the tongue was not performed. Moreover, while NGT size has been reported to affect swallowing function, we did not examine our data in relation to tube diameter due to a lack of detailed records regarding individual tube size[6].

Furthermore, although a previous study reported on changes in tube placement position depending on the method of insertion used, no calibration (e.g., standardization of the NGT placement method) was performed in the present study[16,17]. Thus, there is a possibility that the insertion method may have affected the present findings. In order to demonstrate the risk of NGT crossing, swallowing evaluations must be repeated in patients with NGT crossing after re-inserting the NGT without crossing. Notably, no re-insertion was performed in patients with NGT crossing in the present study.

In the future, we plan to comparatively assess patients with and without NGT crossing using the same insertion method and a fixed tube diameter. In addition to the FOIS, the assessment will include subjective evaluations of swallowing difficulty, pharyngeal residue, and the penetration-aspiration scale. Moreover, the sample size needs to be increased to perform comparisons according to the disease.

Conclusions

In conclusion, the frequency of pharyngeal NGT crossing was lower when NGTs were inserted through the left nostril. By avoiding pharyngeal NGT crossing, discomfort during swallowing, pharyngeal residue, laryngeal penetration, and the risk of aspiration can be reduced.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgments

The authors thank Dr. Motoaki Inagawa, Department of Oral and Maxillofacial Surgery, and the doctors and co-medical staff of the Nutrition Support Team (NST) of the National Hospital Organization at Takasaki General Medical Center.

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