Oro- and Nasogastric Tube Passage in Intubated Patients

Fiberoptic Description of Where They Go at the Laryngeal Level and How to Make Them Enter the Esophagus

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Background: Insertion of a gastric tube (GT) in anesthetized, paralyzed, and intubated patients can be difficult. The purpose of this study was to determine fiberoptically why GTs succeed or fail to enter the esophagus and, based on these findings, to determine a mechanism for converting failures into successes.

Methods: Sixty patients under general anesthesia and orotracheally intubated were studied. The larynx and hypopharynx of each patient were viewed via a fiberscope placed through the left naris. GTs were passed orally (OGT) and nasally (NGT) in all patients, and the pathway of passage or site of resistance was visualized. In cases of resistance, medially directed ipsilateral neck pressure was applied over the lateral thyrohyoid membrane (termed lateral neck pressure) to try to allow passage of the GT.

Results: All 60 patients had both an OGT and NGT passed for a total of 120 attempts. The GT passed easily on the first attempt in 92 of 120 insertions (77%) (for OGT 51/60 = 85% and for NGT 41/60 = 68%, P < 0.05). In 92% of these first-pass successes, the GT entered the hypopharynx just lateral to the arytenoid cartilages. The GT met resistance and failed to pass in 28 of 120 insertions (23%) (for OGT 9/60 = 15% and for NGT 19/60 = 32%). The sites of impaction were the piriform sinuses (13/28 = 46%), arytenoid cartilages (7/28 = 25%), and trachea (6/28 = 21%), and two OGTs did not pass the oropharynx (2/28 = 7%). Lateral neck pressure was attempted 20 times (for the piriform sinus and arytenoid cartilage impactions) with 17 successes (85%) and three failures (15%). The average distance to passage of the OGT and NGT by the arytenoid cartilage was 13.2 and 16.2 cm, respectively.

Conclusion: GTs enter the hypopharynx just lateral to the arytenoid cartilages. Consequently, the most common sites of resistance at the laryngeal level are the arytenoid cartilages and piriform sinuses. Lateral neck pressure compresses the piriform sinuses and moves the arytenoid cartilages medially, relieving 85% of these GT impactions. (Key words: Arytenoid cartilage; gastric decompression; hypopharynx; piriform sinus.)

THE insertion of a gastric tube (GT), either orally (OGT) or nasally (NGT), in an anesthetized, paralyzed, and intubated patient can be difficult. Many techniques have been proposed to aid in GT insertion including forward displacement of the larynx,1-5 use of split endotracheal tubes,4-8 immersion of the GT in ice water,9 and flexing the neck forward.10 The purpose of this study was to determine fiberoptically where OGTs and NGTs enter the hypopharynx and on what laryngeal structures the tips of OGTs and NGTs impact if they fail to enter the esophageal inlet, and, based on these findings, to determine a mechanism for converting failures into successes.

Materials and Methods

Subjects

With institutional review board approval, 60 patients scheduled for elective surgery requiring general anesthesia and endotracheal intubation were informed of the study and gave written consent to be study subjects. The subjects consisted of 34 men and 26 women aged a mean of 45 ± 16 (19-81) yr, weighing a mean of 75 ± 18 (45-127) kg, and having a height of 173 ± 10 (150-192) cm (data are mean ± SD [range]). Exclusion criteria consisted of nasal, pharyngeal, neck, esophageal, or gastric pathology of any kind, pregnancy, and age younger than 18 yr.

Anesthetic Management

Patients were placed in a "sniff" rigid laryngoscopy position, preoxygenated, intravenously premedicated with glycopyrrolate 0.3 mg; anesthetized with 1.0 mg/kg...
lidocaine, 2–3 mg/kg propofol, and 2–5 μg/kg fentanyl; and paralyzed with 0.1–0.15 mg/kg vecuronium. The patients were ventilated via mask until the train-of-four stimulus resulted in no muscular contractions. Direct laryngoscopy was then performed and the trachaea intubated with a 7.0–8.0 mm ID orotracheal tube. The endotracheal tube cuff was filled with a just seal volume (minimum volume of air to allow positive pressure ventilation with no air leak) of air, and all endotracheal tubes exited the mouth on the right side.

**Experimental Protocol**

After tracheal intubation both nares were vasoconstricted with oxymetazoline 0.05%. Patients were kept in the same the position as for tracheal intubation. One operator placed a fibroscope (either an Olympus LF-1 tracheal intubation fiberscope or Olympus BF type 30 series OES bronchofiberscope; Olympus Optical Co, Ltd, Tokyo, Japan) into the left naris of all patients and maneuvered posterior to the endotracheal tube to give a view of both sides of the larynx and hypopharynx. The fiberoptic image was continuously displayed on a television screen (Olympus OEV142 Color Video Monitor), and the image could be photographed and printed at any time (Olympus OEP Color Video Printer).

Next, in the first 30 subjects, a second operator placed a room-temperature, lubricated, 18-French, Argyle Salem Sump tube (Sherwood Medical, St. Louis, MO) orally by...
entering the mouth to the left of the endotracheal tube. After observations were made, the OGT was removed and the GT was placed through the right naris. This order was reversed for the second 30 patients. All GTs were marked at 15 and 20 cm from the distal end. When the OGT or NGT came into view on the monitor, the following observations were made:

1. If the GT (OGT or NGT) passed easily into the esophagus on the first attempt, the relationship of the GT to the larynx was documented (picture taken) and the depth of insertion to arytenoid cartilage was noted.

Successful placement of the GT was confirmed by aspiration of gastric contents in all subjects.

2. If the GT (OGT or NGT) met resistance on the first pass, so that the GT buckled, it was considered a failure of GT passage and it was documented (picture taken) upon what structure at the laryngeal level the tip of the GT impacted.

3. If the GT failed to pass on the first attempt because of a laryngeal obstruction, the GT was pulled back 1 cm and external medially directed pressure was applied to the ipsilateral lateral neck by one to three fingers at the level and lateral border of the thyrohyoid mem-

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Fig. 3. Photograph of fiberoptic image and schematic diagram of photograph of typical example of gastric tube impacting on arytenoid cartilage.

Fig. 4. Photograph of fiberoptic image and schematic diagram of photograph of typical example of gastric tube entering the trachea.
Statistical Analysis

Specific events (e.g., OGT and NGT success and failure and site of impaction) are described by the absolute number of occurrences and the percentage incidence, and comparison of frequency of specific events for differences was by chi-square analysis for two independent groups with level of significance set at $P < 0.05$.

Results

All 60 patients had both OGT and NGT insertion attempted for a total of 120 GT attempts. The GT passed easily on the first attempt in 92 (77%) of 120 insertions. There was a difference ($P < 0.05$) in first-attempt success between OGTs (51/60 = 85%) and NGTs (41/60 = 68%). There was no difference ($P > 0.05$) between incidence of success if the OGT or NGT was passed first or second (i.e., success in the first 30 patients compared with the second 30 patients). In 92% of the first-pass successes, the GT entered the hypopharynx just lateral to the arytenoid cartilage (fig. 1), and in 8% of the first-pass successes the GT entered the hypopharynx in the posterior midline.

The GT met resistance and failed to pass on the first attempt in 28 (23%) of 120 insertions (OGT first-attempt failure 9/60 = 15%; NGT first-attempt failure 19/60 = 32%; $P < 0.05$). Of the 28 failures, the GT impacted in the piriform sinus 13 times (46%) (fig. 2), on the arytenoid cartilages seven times (25%) (fig. 3), and entered the trachea six times (21%) (fig. 4); two OGTs (7%) could not pass the oropharynx. All GTs that entered the trachea slipped past the endotracheal tube cuff without difficulty. Figure 5 summarizes where all GTs passed or impacted.

If the GT impacted in the piriform sinus ($n = 13$) or on the arytenoid cartilage ($n = 7$), lateral neck pressure was attempted to allow passage into the esophagus. Lateral neck pressure caused collapse of the ipsilateral piriform sinus and slight medial movement of the ipsilateral arytenoid cartilage (fig. 6). Lateral neck pressure was attempted 20 times, with 17 successes (85%) and three failures (15%).

If the GT entered the trachea ($n = 6$ attempts) or could not pass the oropharynx ($n = 2$ attempts), lateral neck pressure was not attempted. Consequently, there were eight attempts that required multiple passes and the aid of a Macintosh laryngoscope to pass the GT.

The average distance to the point of passage by the arytenoid cartilage for OGT was 13.2 ± 1.3 cm and for NGT was 16.2 ± 1.2 cm (mean ± SD).

Discussion

We found that GTs enter the hypopharynx just lateral to the arytenoid cartilages, and that the most common sites of impaction are adjacent to this point of entry, namely the ipsilateral piriform sinus and arytenoid cartilage. Furthermore, we found that lateral neck pressure converted 85% of these failures into successes. Before discussing the implications of these findings, consideration should be given to the limitations of our methodology.

First, there were some suboptimal views of the hypopharynx and larynx secondary to secretions. However, we were always able to visualize the point of GT entry into the hypopharynx. All impactions were signaled by obvious resistance and buckling of the GT. It was sometimes difficult to clearly see the exact site of impaction if the GT impacted against the lateral wall of the piriform sinus (i.e., the lateral pharyngeal wall). We considered these impactions to be in the piriform sinus.

Second, it is possible that during the initial pass of the GT some warming and softening of the GT occurred that could have affected the result of the subsequent pass of the GT. However, there was no statistically significant

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Fig. 6. Photograph of fiberoptic image and schematic diagram of larynx and hypopharynx without (A) and with (B) lateral neck pressure at the level of the thyrohyoid membrane. Lateral neck pressure causes collapse of the ipsilateral piriform sinus and medial movement of the ipsilateral arytenoid cartilage.

difference in success or failure between first and second GT passes for both OGTs and NGTs. In addition, the GT warming and softening consideration was minimized by promptly removing the GT after the first pass, and the GT operator did not find any change in the rigidity of the GT (to bending or palpation) after the first pass.

Third, we estimate that our depth measurements were accurate by \( \pm 1 \) cm. Two sources contributed to this error. First, there was some imprecision in depth perception and knowing exactly when the tip of the GT passed the arytenoid cartilages; we estimate this error to be \( \pm 0.5 \) cm. Second, we think that there was a \( \pm 0.5 \) cm error in reading the external markings.

We found that GTs entered the hypopharynx just lateral to the arytenoid cartilage 92% of the time. Our 8% incidence of GT entry into the hypopharynx in the posterior midline is similar to the 6% incidence found by Friedman et al.\(^{11}\) Our findings do not provide an explanation as to why there was a slightly but statistically significantly higher success rate with OGTs than NGTs. Our 5% incidence of GTs entering the trachea was higher than those previously reported (0.5-4.0%).\(^{12-14}\)

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This may be because all our patients were tracheally intubated and because of differences in endpoint detection. Understanding where GTs naturally pass by the larynx into the hypopharynx readily explains where GTs commonly impact at the laryngeal level and suggests how to remedy the obstruction.

We found the most common sites of impaction to be the piriform sinuses and arytenoid cartilages. This is different from previous literature, which reports that failures may be caused by the endotracheal tube itself, the base of the patient's tongue, or the cuff of the endotracheal tube bulging back on the esophagus.\(^2\)\(^3\)\(^4\)\(^6\)\(^7\)

In the vast majority of patients (98%) there was no difficulty passing the GT to the laryngeal level on the first attempt, and once the GT passed alongside of the arytenoid cartilage we met no further obstructions. This suggests that once the arytenoid cartilage is passed, and a just seal volume of air is put into the endotracheal tube cuff, GT passage should be successful (excluding distal esophageal or gastroesophageal junction stenoses or hiatus hernia).

The average distance from the incisors to the point of laryngeal passage was 13.2 cm, and from the nares it was 16.2 cm. The distance from incisor to arytenoid of 13.2 cm agrees very well with the recently reported distance from incisor to vocal cord of 14.8 cm.\(^17\) Knowing the depth of insertion to the point of success or failure allows the operator to know, by external markings, when to expect impaction or passage at the laryngeal level.

Lateral neck pressure converted piriform sinus and arytenoid cartilage impactions to successful passes 85% of the time. The effect of lateral neck pressure is to compress the piriform sinus and move the arytenoid cartilage medially. Collapse of the piriform sinus eliminates this recess as a potential space of impaction and funnels a laterally oriented GT toward the usual entry point into the hypopharynx, which is just lateral to the arytenoid cartilage. Movement of the arytenoid cartilage medially causes a GT impacted on the arytenoid cartilage to occupy a position that is just lateral to the arytenoid cartilage, thereby allowing the GT to enter the hypopharynx in the usual position. We theorize that any maneuver that results in lateral neck pressure (as defined in this study), such as anterior displacement of the thyroid cartilage by picking up the lateral thyroid cartilage wings, will accomplish these two endpoints (closure of the piriform sinus and medial movement of the arytenoid cartilage). Consequently, it is not surprising that similar success rates have been reported with anterior displacement of the thyroid cartilage as we found with lateral neck pressure in our study.\(^2\)\(^3\)\(^5\)

Our findings suggest that one mechanism of success of anterior displacement of the thyroid cartilage (by trying to lift the lateral borders of the thyroid cartilage) is the effect of the maneuver on the piriform sinuses and arytenoid cartilages.

In clinical practice, the laryngeal laterality of the GT is not known. Consequently, unless there is a clinical contraindication, our findings suggest that if resistance is met at approximately 13 cm for an OGT and at approximately 16 cm for an NGT, then application of bilateral neck pressure is a logical first choice maneuver in order to convert the failure into a success.

In summary, this study shows that in intubated patients, GTs enter the hypopharynx just lateral to the arytenoid cartilages. Consequently, we found the most common sites of resistance to passage of a GT at the laryngeal level to be the piriform sinuses and arytenoid cartilages. Lateral neck pressure compresses the piriform sinuses and moves the arytenoid cartilages medially, thus relieving 85% of these obstructions. We suggest that any maneuver that results in these two endpoints will aid in GT placement.

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References