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Nasogastric tube insertion in anaesthetized patients: a comprehensive review

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Abstract

Nasogastric tubes (NGT) still remain the easiest and the best way for gastrointestinal tract access. There are various indications for the insertion of a nasogastric tube in anaesthetized and critically ill patients. Although many techniques have been introduced to facilitate nasogastric tube insertion using anatomic landmarks and a group of devices, there is no consensus on a standard method. Moreover, there are different methods for the assessment of the correct placement of a nasogastric tube. In addition to these challenges in insertion and assessment methods, there are varieties of major life-threatening and minor complications to be addressed. Thus, selecting the most appropriate approach requires enough knowledge in this area, considering patient condition and clinical factors, as well as the practitioners' sufficient education and experience, along with skill in performance. This is a comprehensive review of the literature evidence on different methods for nasogastric tube insertion, on the assessment of correct placement and the evaluation of complications, in addition to an approach to the effect of education on the quality of routine practice and patients' outcome.

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Key words: nasogastric tube, insertion; nasogastric tube, complications; education

Ever since its first description by Hunter in 1790, the NGT has become one of the most common used medical devices in routine practice [1]. As the easiest and simplest way to keep the gut functional is using the gut for feeding (enteral feeding), the simplest, safest and most cost effective way for this purpose is feeding via nasogastric tube [2]. However, this quick and usually well tolerated intervention is sometimes unpleasant [3].

NGTs are used for feeding or the aspiration of gastric contents. Gastric feeding is less invasive [4] and allows the physiologic absorption of nutrients [5], stimulates the gastric phase of digestion and decreases complications such as dumping syndrome [6]. Those which are used for aspiration have a large diameter and are made from polyvinyl chloride [7]. However, those used for feeding have a smaller diameter and made from silicone or polyurethane [5].

Although gastric tube insertion is a routine practice in medicine, sometimes it can be difficult. Many methods exist for the proper placement of NGTs, such as lateral pressure on neck, fibroscopic-guided NGT insertion, endotracheal tube guided placement, a cooling tube for making it hard before use, anterior displacement of the larynx, etc. Practitioners employ their own routine techniques with different success rates in daily practice. Although an NGT is easy to insert most of the time, some patients suffer from complications after placement such as unwanted pulmonary insertion [8, 9] esophageal perforation and stenosis [10, 11] infectious complications [12] and even central nervous system complications [13]. Inserting the tip of the tube in

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the correct location is necessary for confirming its correct position [14]. Moreover, there are several methods, such as using external anatomical landmarks, in order to estimate its correct location [15, 16]. Thus, considering the best method for placement and confirmation which results in the decrease of complications is the most important goal in routine and safe practice which can be achieved with proper education and team work. This review aims to evaluate the different methods for tube insertion, confirming its correct placement, determining complications and highlighting education in patients.

This review of literature evidence was performed in September 2016 from the following databases: Pubmed, Scopus, Web of Science, Cinahl, and the Cochrane library. Key words included nasogastric tube insertion technique, complications, correct placement and education. Two researchers (AM and MN) evaluated the literature evidence in order to verify if an article was appropriated for this review.

INSERTION TECHNIQUES

Insertion of an NGT can be very challenging even for experienced anesthesiologists. The routine way for NGT insertion is its blind insertion while the patients head is in the neutral position with an approximate success rate of 40–58% [17–19]. Although common techniques for NGT insertion are lateral neck pressure, head flexion, freezing the NGT before its insertion, anterior larynx displacement, slit ETT as introducer, as well as lateral head positioning, none of them has reported high success rate [17–21] (Table 1). For the first time, Siegel *et al.* showed that a nasopharyngeally placed endotracheal tube could facilitate the insertion of a difficult nasogastric tube [55]. While there have been a few studies showing that ETT assisted gastric tube insertion, the gastric tube used in these studies were orogastric tubes [56, 57].

One of the most important problems during insertion is the blind technique. In order to solve this problem, physicians attempt to insert NGT under direct visualization using a Macintosh laryngoscope or GlideScope with the assistance of Magill forceps. This could be explained by the limited space by large GlideScope blade for manipulation of a Magill forceps compared to a Macintosh laryngoscopy. Wan Ibadullah *et al.* [56] showed a higher non-significant success rate for the GlideScope compared to the Macintosh laryngoscopy. Some of the other studies have reported a shorter duration of insertion with a GlideScope compared to blind techniques [27, 58] Kavakli *et al.* [27] showed that using video laryngoscopy during NGT insertion in anaesthetized patients compared to direct laryngoscopy or blinded insertion has a high rate of correct placement with lower mucosal bleeding. Appukutty and Shroff [17] compared three different methods for NGT insertion. In two methods, they used instruments such as slit ETT and urethral guidewire compared to no instrument apart from the neck flexion and lateral pressure method. They showed that although all three ways improved the success rate, neck flexion with lateral pressure is the easiest method with a high success rate. Kirtania *et al.* [58] showed that an esophageal guidewire with anterior larynx displacement results in a high success rate compared to slit ETT and a GlideScope. They showed that esophageal guidewire guided technique with manual displacement of the larynx always resulted in the correct placement of NGT in anaesthetized patients with a low incidence of complications and shorter duration for insertion. They recommended that the lifting of tracheal cartilage could be performed in all anaesthetized patients except those who have neck mass in which the maneuver could be replaced with neck flexion. Park *et al.* [59] conducted a review study and compared the success in insertion of an NGT with i-gel and proseal LMA and showed that the success is greater with i-gel. The results of another meta analysis showed that NGT insertion was much easier and sore throat was more common with supreme LMA compared with i-gel [29].

Herring showed a new technique for NGT placement whose main difference from the standard method was a second tube measurement, with the distal tip of the tube positioned at the thoracic inlet and measured to the nostril. The NGT was advanced to this level and examined for negative pressure with a syringe. It was shown that this method could decrease bronchopulmonary complications [60]. Hernandez-Socorro *et al.* [30] showed that using ultrsonography for placement of an NGT has a high success rate after the failure of blind bedside manual method, especially in patients with severe impairment of peristaltic activity of the stomach. Kinoshita *et al.* [31] showed successful NGT insertion with an airway scope (which is a newly developed video laryngoscope consisting of a built-in monitor, camera, and disposable introducer) in a patient with cervical spine instability. Karagama [61] recommended NGT insertion with flexible fibreoptic nasoendoscope in patients where traditional methods of insertion failed.

Considering feasibility and cost effectiveness, there is growing interest in NGT insertion techniques that are not device-based. The main focus of these kinds of techniques is simplicity and decreasing complications to a minimum. Ghaemi *et al.* [32] compared nelaton catheter assisted versus standard NGT insertion and showed that nelaton group had a high success rate and shorter duration for insertion compared to the control group. Najafi [22] introduced a new method, namely the "SORT manoeuvre" for NGT placement in patients who cannot swallow. This manoeuvre is performed based on the patient's anatomy and is applicable

Table 1. Summary of current knowledge on nasogastric tube insertion, assessment of correct placement and complications

Insertion		Diagnosis	Complications	
Anatomic	By equipment		Minor	Major
Lateral pressure on neck	Fibroscopic guided [24]	Radiology (GOLD standard) [33]	Kinking and coiling of NGT (the most common complication of NGT placement) [45]	Pulmonary insertion [8, 9]
Cooling of the tube	Endotracheal tube guided placement [25]	Auscultation of insuflated air [34]	Tube decompression or beakage	Tracheobronchial perforation, esophageal perforation and stenosis [10, 11]
Anterior displacement of larynx, lifting of thyroid cartilage	Using macintosh laryngoscope or glidescope with assistance of magill forceps [26, 27]	Ultrasonography	Nose bleed	Infectious complications [10]
Neck flexion	Uretral guidewire [25]	Nex method [14, 15]	Sinusitis [46]	And intracranial placementand central nervous system complications [48]
Lateral head positioning	I-gel [28, 29]	Under water vaccum effect [35]	Parotitis [46]	Nose erosion/ /nasal aral necrosis [49]
Anterior displacement of the mandible (and a group of older techniques) [21]	Proseal LMA [28, 29]	Aspirate colors [35]	Sore throat	Laryngeal edema with asphyxia
	Ultrasonography [30]	Ph indicator [36, 37]	Stridor [47]	Pulmonary aspiration [50]
Sort maneuver [22, 23]	Airway scope [31]	Electromagnetic device [38]		Pneumothorax [51]
	Nelaton [32]	Chemical assessment of aspirates (Ph, trypsin, bilirubin, CO_2 and pepsin) [39, 40]		Perforation of lamina cribrosa [52]
	Tube length	End tidal CO_2 monitoring [41]		Retropharyngeal abcess [47]
		Fluroscopy [42]		Stricture formation
		Endoscopy [42]		Aortoesophageal fistula [52]
		Manometer [43, 44]		Nasogastric tube syndrome [53, 54]

in anaesthetized patients. SORT is mnemonic for the four main steps of the manoeuvre, namely: sniffing position, NGT orientation, contralateral rotation, and twisting movement [23]. They recommended that the manoeuvre could also be of assistance in trans-esophageal echocardiography (TEE) probe insertion (See video at: http://atlasofscience.org/nasogastric-tube-insertion-the-simple-yet-impossible/ accessed 11 Nov 2016). Table 2 shows different RCTs concerning NGT insertion methods [62–75].

HISTORICAL REVIEW OF GASTRIC AND FEEDING TUBE INSERTION

Reports of gastric feeding go back to the 16th century with many different methods being used to deliver the feeding over the years. One of the first devices for feeding was a silver tube passed through the nostril into the nasopharynx for the feeding of tetanic patients [76]. Fabricated flexible leather catheters were introduced for the routine practice of feeding from 1646 [24]. During the late 17th century the use of hollow tubes for feeding were introduced to medicine [77]. In 1863 Kussmaul introduced a flexible orogastric tube for gastric decompression and seven years later, in 1874, Ewald *et al.* introduced a soft rubber tube for gastric insertion [acc. to 24, 77]. During the first half of the 19th century, the use of stomach tubes were introduced for the feeding of mentally ill patients [78]. During the late 19th century Rankin [79] and Morrison [80] reported feeding via a stomach tube for repetition after the intubation of patients with diphteria. Thereafter, levin tubes were introduced in 1921 which, although designed for either decompression or feeding [81], presented many complications, especially patient discomfort due to size

Table 2. A group of randomized clinical trials on nasogastric tube insertion techniques

Study	Year	Technique	No of patients	Success rate
Tsai *et al.* [62]	2012	The tips of a "Rusch" intubation stylet and NGT are tied together by a slipknot and inserted	103	98.1% versus 64% (P < 0.001)
Upile *et al.* [63]	2011	Blom-Singer (16 Fr) gel caps are used to combine the distal tips of a nasendoscope and an NGT to permit intubation under direct visualization	35	Was not found to be better than NGT insertion under direct visualization with the nasendoscope alone
Chun *et al.* [64]	2009	A silicone NGT is filled with distilled water, frozen, and inserted conventionally. NGT intubation with frozen versus standard NGT was compared in patients undergoing elective general anesthesia and requiring intraoperative NGT intubation	100	Success rate of NGT intubation was 88% in the frozen NGT group versus 58% group (P = 0.001) with shorter duration
Mahajan *et al.* [65]	2009	A ureteric guide wire is modified by adding a Teflon coating to its distal tip. The modified ureteric guide wire is threaded into an NGT as a stylet to provide rigidity and support to facilitate NGT intubation	70	96%
Hung *et al.* [66]	2008	An NGT is filled with distilled water through aspiration with a feeding syringe and tapped proximally to retain the water	66	93.5% compared to 65.7% in the traditional NGT placement group (P < 0.01)
Gupta *et al.* [67]	2007	A face piece connected to a self-inflating bag is used to create positive pressure in the pharynx in order to open the upper esophageal sphincter to facilitate conventional NGT intubation	158	96% in the inflation group versus 68% in the non-inflation group (P < 0.001)
Lin *et al.* [68]	2006	an ultrathin endoscope is passed through the nose, nasopharynx, esophagus, and stomach. Then, a guidewire is fed into the stomach through the working channel of the endoscope. The endoscope is withdrawn from the patient, and an NGT is advanced over the guidewire under fluoroscopy	40	99%
Yamauchi *et al.* [69]	2005	The patient is turned to the prone Hall-frame position with the neck rotated 45° to the right. The NGT is then inserted into the nasal cavity and advanced blindly into the stomach	90	93% in the prone position and 33% in the supine position (P < 0.01)
Mahajan *et al.* [70]	2005	After introduction into the oropharynx, the orogastric tube or Murphy's eye of tube is directed into the esophagus along the lateral pharyngeal wall using a gloved left index finger	90	With a success rate of roughly 83%
Bong *et al.* [71]	2004	Placing the patient's head in the (right) lateral position instead of the traditional neutral position	30	80% in the right lateral group versus 40% in the neutral group
Ozer *et al.* [72]	1999	Lateral neck pressure compresses the piriform sinuses and moves the arytenoid cartilages medially	28	85%
Parris [73]	1989	The "reverse Sellick maneuver," or anterior displacement of the cricoid cartilage	30	75–80%
Perel *et al.* [74]	1985	NGT intubations were performed successfully with the use of a finger or a laryngoscope with a Magill forceps	100	70%
Cohen *et al.* [75]	1963	NGT is inserted through the nose and mouth where its tip is grasped with a Magill forceps under laryngoscopic visualization. The NGT is retracted from the mouth until approximately 3 inches remain from the nares. Then, an esophageal stethoscope is threaded through a slit endotracheal tube and passed either blindly or under laryngoscopic visualization into the esophagus until maximal heart sounds are heard. The stethoscope is then exchanged for an NGT through the slit endotracheal tube	118	100%

and stiffness of the tubes which facilitated their passage. While their usage continued till 1960s, the new generation of these tube are smaller in diameter and softer than the previous ones and checking the gastric residual volume is easier with them [82].

COMPLICATIONS

Insertion of an NGT is one of the invasive routine procedures in operating rooms, emergency departments and intensive care units. Proper selection of size, assessment of correct position and the method of fixing are some of the easiest methods to prevent complications [46]. Complications may be minor such as nose bleeds, sinusitis, tube decompression or breakage, kinking and coiling of the NGT (the most common complication of NGT placement) or may be major such as nose erosion, esophageal or tracheobronchial perforation, laryngeal oedema with asphyxia, pulmonary aspiration, pneumothorax and intracranial placement [45, 51, 83]. Studies have shown that neck flexion with lateral pressure and lifting of thyroid cartilage has the highest success rate without using other instruments in anaesthetized patients. Although they have indicated that these complications could decrease with neck flexion and lifting of the thyroid cartilage, this manoeuvre should be performed gently in order to prevent the occurrence of carotid sinus reflex. Nasal ala necrosis and cleft deformity is a rare complication especially in small children [48]. Moon *et al.* [49] indicated that guidewire-aided NGT insertion could result in serious pulmonary and esophageal complications. Inkpin reported an unusual case of inspiratory stridor in recovery during general anaesthesia due to direct trauma of the airway upon NGT insertion [50]. Parotitis, perforation of lamina cribrosa and retropharyngeal abscess are other complications related to NGT [47, 84]. Moreover, there have been some reports about the stricture formation, aortho-esophageal fistula and submucosal passage [52]. Brousseau *et al.* [53] reported a rare but life threatening complication of NGT which is characterised by bilateral vocal cord paralysis and supraglottic oedema following NGT insertion. The syndrome was first described by Soferman [54] in 1990 as a triad of nasogastric intubation, throat pain and bilateral vocal cord paralysis. In critically ill patients admitted to an ICU, staying there for some time and undergoing enteral feedings, there are some complications of NGT feedings such as aspiration pneumonia, skin irritation, tube dislodgment, dumping syndrome all of which are different from NGT complications in anaesthetized patients [85].

ASSESSMENT OF CORRECT PLACEMENT

NGTs may be misplaced initially during insertion or after its placement with or without symptoms. Thus, diagnosis of the correct placement of an NGT is very important for safe practice. Correct placement of an NGT depends on the appropriate location of the catheter tip and the proper depth of the inserted tube. As displacement of tubes occurs in almost 3% of operating rooms up to 40% in critically ill paediatric patients, verification of correct NGT at initial placement, before the administration of drugs, any enteral feeding, as well as every shift is recommended [86, 87]. One casual factor for tube misplacement is the fact that based on NPSA guidelines, the length is measured from nose to ear to xiphisternum (NEX). However, this seems to be incorrect and it is recommended to measure in the opposite direction from the xiphisternum to ear to nose (XEN) and then add 10 cm which reaches the mid-stomach region in most patients [14, 15]. Thus, it is recommended that the NEX and Hanson methods should no longer be taught in nursing programs or used in practice by nurses.

Although radiology is the gold standard for the evaluation of correct NGT placement, x-ray is associated with a delay in starting feeding, excess x-ray usage and with misinterpretation, especially in the following situations: low degree of expertise of the interpreter, degrees of radiopacity of the tubes used, low x-ray quality, an absence of patient history and an inability to visualize key anatomy [33]. The auscultation of insufflated air which will not always cause a whooshing sound or bubbles from tubes under water, the vacuum effect or aspirate colours are all methods which have since been discarded [34]. Some studies suggest methods which use a pH indicator instead of the litmus test. The implementation of a new strategy for confirming correct tube placement requires good nursing education, compliance and multidisciplinary team work. Windle *et al.* [88] used an electromagnetic imaging system in order to assess the correct placement of NGTs and showed that this method has some advantages, especially in confirming the post-pyloric placement of an NGT even at the early stage of implementation.

The chemical assessment of aspirates consists of examining pH, trypsin, bilirubin, CO_2 and pepsin. Although the pH of aspirates has gained more attention compared to other values, it has some drawbacks in patients receiving acid suppressant drugs or continuous enteral feeding [89, 90]. Gilbertson [36] demonstrated that a gastric aspirate pH less than 5 is a safe, reliable and practical cut off level in paediatric patients. A pH less than 4 has a predictive value for gastric placement [91, 92] while $5 < pH < 6$ should be evaluated for bronchial or esophageal placement [37, 93] and $pH > 6$ should be considered as small bowel placement [94]. Perform the successful aspiration of secretions is one of the most important problems for this method of evaluation.

Araujo-Preza *et al.* [39] showed that end tidal CO_2 monitoring is a safe, easy and cost effective method for confirming the correct placement of a NGT and one may omit radiography with the use of capnometry. Burns *et al.* [40] compared capnographic evaluation with colorimetric CO_2 detection for correct NGT placement and concluded that colorimetric device is as accurate as capnography in this regard. A recent systematic review showed level 2b evidence for colorimetric capnography in detection of the gastric placement of an NGT. They mentioned two concerns, the first was a few trails with low sample size while the second concerned the fact that colorimetric capnography is not originally used with the NGT but is connected to it after placement. Therefore, as there are different practices concerning this method, it may not be considered a standard procedure in the clinical setting Tho *et al.* *[*34] showed that the use of colorimetry is not an accurate method for the detection of appropriate NGT placement in general ward patients.

Although combination approaches such as auscultation and pH, pH and tube length or pH and colour have some advantages, they cannot replace radiography for the assessment of correct NGT placement. While fluroscopy and endoscopy have the advantage of direct visualization, they are both are costly, risky and time-consuming [42]. There are a few studies evaluating the use of manometer to aid correct NGT placement and which showed a positive pressure reading when the NGT was correctly placed in stomach [43, 44]. They also showed that for confirmation of gastric placement, the auscultation technique had a sensitivity of 100% and a specificity of 79.3%. In contrast, the manometer technique had a sensitivity of 100% and a specificity of 100% in the discrimination of gastric placement from airway placement of NG tubes. Metheny and Stewart evaluated bilirubin for differentiating the small bowel and stomach and showed that the sensitivity of bilirubin at a level of < 5 mg dL^{-1} in predicting gastric placement was 96% with specificity of 88% [95].

A recent systematic review demonstrated that there is insufficient evidence to detect the optimal cut off value for correct tube placement. Thus, based on the low level of evidence, the implementation of a practical guideline for biochemical assessment of aspirates is not recommended [96]. So, for assessing correct placement of the tube aspiaration of secretion and evaluation of pH and external length of tube is basic procedures. If one is unable to approve the correct placement after these evaluations, a chest x-ray is necessary. A radiologic assessment is also necessary for critically ill patients and patients with swallowing problems [52, 86]. Powers *et al.* [38] showed that use of an electromagnetic device could help one to assess correct NGT placement at the bedside. They demonstrated that there is a high percentage of agreement between this method and radiologic evaluation with no complications. In a review by Rahimi *et al.* [97], it was shown that no single bedside method has been shown to be reliable for the continuous assessment of correct NGT placement and using more than one method is necessary. Table 1 shows a summary of different diagnostic methods for the correct placement of an NGT.

EDUCATION

The early identification of the potential risk for patient harm is a great way to avoid complications associated with NGTs. The first step is possessing updated knowledge, as well as good observation and monitoring of the patients. Therefore, we need to implement educational programs for medical workers to reach this point. Several studies have shown that educational training for nurses is a simple and cost-effective means for decreasing complications and improving outcomes. The implementation of nursing education policy as a vehicle for achieving a better balance between the qualifications of nurses and national health care needs could result in great return on investment. Choi *et al.* [98] in their study proposed a reality--based training simulation of tube insertion to facilitate NGT placement and showed that this system provides a new educational tool in order to enhance conventional NGT placement. The same group, in another study, explained a method for developing a computerized NGT placement training method for clinical education [99] Reisenberg *et al.* [100] used a modified Delphi method to create a checklist for education and the assessment of NGT insertion and showed that using a validated checklist could decrease costs and complications while increasing the quality of health care. Binstadt *et al.* [101] used a simulation-based module for integration in emergency departments. They showed that this module of education could help healthcare workers perform any necessary intervention which is expected to be expert and that their ability reached the optimal level of performance in terms of management and decision making. Finally, youtube.com could provide many advantages in terms of technical simplification, increased audience and education. As a forum for continuous medical education, youtube.com could increase the relationship between educators and learners and could consequently improve their quality of work and lead to fewer complications [102].

CONCLUSIONS

Although various methods have been introduced so far to facilitate NGT insertion, none of them is routinely used and may not be part of mainstream knowledge. In conclusion, there is no single method that cost-effectively confirms gastric position in all conditions and avoids complications. Thus, we should perform priority-based practice to conduct the best way. A shift from the traditional to the more discerning recent methods is well worth one's while, in view of the increasing complexity of patients being dealt with.

We should consider individualized characteristics (anatomic landmarks, weight, height, BMI, neck mobility, etc), close monitoring of complications, gentle and atraumatic insertion and, finally, educational programs for medical workers to establish a standard method.

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