

Intubation Failure During Gastroscopy: Incidence, Predictors and Follow-Up Findings

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ABSTRACT

Background: Intubation failure (IF) occurs when an endoscopist is unable to progress via the oropharynx into the upper oesophagus. **Aim:** To assess incidence and aetiology of IF and predictors of structural pharyngeal abnormalities in patients with IF.

Methods: All gastroscopies (n=26,130) performed in our centre, between August 2010 and August 2016 were retrospectively reviewed. Barium radiology and repeat gastroscopy findings were evaluated for structural causes of IF. Patients were categorised into 'failure to tolerate' and 'failure to progress' based on endoscopy reports.

Results: The incidence of IF was 0.95%. Rates of IF varied with endoscopist specialty (p=0.021), but not with patient age, sex or sedation dose. Among cases of IF, structural pharyngeal abnormalities were detected on barium radiology in 28.9%, consisting of cricopharyngeal hypertrophy and/or Zenker's diverticulum in 73.2%. 'Failure to progress' predicted pharyngeal pathology in 55.6%. Predictors of structural causes on barium radiology following IF included: age ≥ 65 (OR 4.0, 95% CI: 1.8-8.9, p<0.001); indication of dysphagia (OR 5.5, 95% CI: 2.5-11.8, p<0.001), and failure of endoscopic progression (OR 5.2, 95% CI: 2.3-12.0, p<0.001).

Conclusion: Patients with IF should be investigated owing to the high risk of underlying pathology, particularly if associated with age ≥ 65 , dysphagia, and failure of endoscopic progression. We propose that IF rates of <1% could be used as a quality indicator in gastroscopy.

Key words: Intubation failure – gastroscopy – pharyngeal.

Abbreviations: ASGE: Association for Gastrointestinal Endoscopy; CI: Confidence interval; CP: Cricopharyngeus; CPH: Cricopharyngeal hypertrophy; FESD: Flexible endoscopic septum division; GRS: Global rating scale; IF: Intubation failure; JAG: Joint Advisory Group for gastrointestinal endoscopy; NME: Non-medical endoscopist; OR: Odds ratio; SI: Successful intubation; ZD: Zenker's diverticulum.

INTRODUCTION

In gastroscopy, intubation failure (IF) may be defined as a situation when a trained endoscopist is unable to progress into the upper oesophagus via the oropharynx. Although this is a relatively common problem during endoscopy training, the incidence is relatively unknown. The Joint Advisory Group (JAG) mandates the auditing of intubation success across endoscopy units in the UK as a performance indicator in

gastroscopy [1]. Despite this, neither the incidence nor the aetiologies of IF have been reported in large cohort studies. Limited data arise from randomised trials, which have compared conventional gastroscopy with transnasal routes, with rates of IF ranging from 0% to 1.8% [2, 3]. In contrast, airway intubation failure has been well-studied in anaesthetics. Here, the reported incidence ranges from 0.05% electively to 1-2% in the emergency setting [4], with causes of failure summarised in an aide-memoire (Table I) [5]. Moreover, the Mallampati classification is routinely used to assess variations in oropharyngeal anatomy to gauge the difficulty of airway intubation [6]. However, for gastroscopy, little emphasis is placed on variations in oropharyngeal anatomy which may pose challenges in intubation. In clinical practice, patients are often deemed to not tolerate intubation due to factors such as anxiety, when these may be due to variations in oropharyngeal

anatomy. So far, no published studies have explored whether patients fail intubation due to anxiety, or anatomical causes.

Table I. Aide memoire for causes of failed endotracheal intubation [5]

Infections of larynx
Neck mobility abnormalities
Trismus, Teeth abnormalities (loose or protuberant tooth)/ Upper airway abnormalities (strictures or swellings)
Bull neck deformities
Ankylosing spondylitis
Trauma / Tumor
Inexperience
Oedema of upper airway
Narrowing of lower airway

Aims

Our aims of the study were as follows: to explore the incidence and aetiology of IF; to assess the predictors of IF and the predictors of pathology in patients with IF, and to perform a formal literature review into IF.

METHODS

Study design

We performed a single-centre retrospective cohort study of all gastroscopies performed between August 2010– August 2016 at a district general hospital. Data were retrieved from a prospectively recorded endoscopy database. We analysed all patients above 18 years with IF, defined as failure to intubate the proximal oesophagus after entering the oropharynx. Trainees' procedures were excluded. The procedures were performed by JAG-certified endoscopists using Pentax gastroscopes (EG-2990i, EG29-i10; insertion tube diameter of 9.8mm). The patients were routinely offered the choice of pharyngeal anaesthesia (lidocaine 100mg) and/or midazolam (usual dose \leq 2mg). Data were collected on the specialty of endoscopist (gastroenterologist, surgeon or non-medical (nurse) endoscopist [NME]), patient age, sex, use of pharyngeal anaesthesia and sedation. For the patients with IF, procedural data, sedation use, subsequent barium radiology were reviewed to assess for structural causes of IF. Barium radiology was reported by a dedicated gastrointestinal radiologist. Concordant pathology was defined as upper gastrointestinal pathology found on subsequent investigations, i.e. barium radiology, computed tomography (CT) and repeat gastroscopy, which related to the indication(s) of the endoscopy, e.g. dysmotility for reflux. Based on the procedural comments from endoscopy reports, each case of failed intubation was categorised by two reviewers into groups of 'failure to tolerate', based on patient's intolerance of the procedure, e.g. pulling out scope, anxiety, excessive gag, or 'failure to progress' (i.e. physically unable to progress, or endoscopist's decision to abandon intubation).

Ethics

This study was carried out according to the principles of the Declaration of Helsinki of good clinical practice. Data were collected as part of the JAG Global Rating Scale (GRS)

audit requirement; hence, Ethics Committee approval was not required, according to local regulations.

Literature review

We performed a literature search on EMBASE, MEDLINE, PubMed for relevant studies on intubation search failure using a combination of the following headings: 1) MeSH Major topics: Gastroscopy OR endoscopy OR esophagogastroduodenoscopy OR oesophagogastroduodenoscopy OR OGD; 2) MeSH terms: Intubation AND difficult OR difficulty OR fail OR failure OR failed; 3) MeSH terms: NOT tracheal; 4) Limit to English language. We expanded our search to all studies including published conference abstracts. We also included a Google Scholar search with: 1) FAIL or FAILED or FAILURE or DIFFICULT in title; 2) gastroscopy OR endoscopy OR esophagogastroduodenoscopy OR oesophagogastroduodenoscopy in title.

Statistical analysis

Statistical analyses were performed using IBM SPSS 23 (Armonk, NY). Pearson's χ^2 was used for univariable analyses of categorical data, and Wilcoxon's signed rank test for paired continuous data. The Student *t*-test was used to compare normally distributed variables and the Mann-Whitney U-test used for non-parametric comparisons. Two-tailed *p*-values were deemed statistically significant if <0.05 .

RESULTS

Incidence

In the six-year study period, 248 failed procedures for 238 patients were identified from 26,130 gastroscopies, providing an estimated incidence of 0.95% (248/26,130). In the IF group, patients had a mean age of 63.2 years (SD 16.1) and 126 (52.9%) were female. Of the 238 patients, primary indications consisted of: pain/dyspepsia (74; 31.1%), dysphagia (63; 26.5%), anaemia (28; 11.8%), bleeding (17; 7.1%), reflux (14; 5.9%), duodenal biopsy (10; 4.2%), follow-up gastroscopy (10; 4.2%), weight loss (8; 3.3%) and other (14; 5.9%). 'Failure to progress' occurred in 41 (17.2%) and 'failure to tolerate' in 197 (82.8%). Based on comments from the endoscopy report, the 'failure to tolerate' group consisted of: patient unable to tolerate – not otherwise specified (109; 55.3%), pulled scope (34; 17.3%), anxiety/agitation (30; 15.2%), non-compliance (17; 8.6%), and excessive gag (7; 3.6%). Documented reasons for failure to progress consisted of: suspected Zenker's (23; 56.1%), tight/acute upper oesophageal sphincter (5; 12.2%), pharyngeal stricture (4; 9.8%), cricopharyngeal spasm (2; 4.9%), prominent cricopharyngeus (CP) (1; 2.4%), oesophageal web (1; 2.4%), and unable to pass CP not otherwise specified (5; 12.2%).

Causes of IF

One or more subsequent investigations were requested for 190 patients (79.8%). Within the IF cohort, investigations consisted of barium radiology (142; 59.7%), CT (50; 21%), repeat gastroscopy (70; 29.4%) and no further investigations (48; 20.2%). Of patients undertaking barium swallow studies ($n=142$), structural pharyngeal abnormalities were detected in 41 (28.9%) of IF cases, comprising of cricopharyngeal hypertrophy (CPH) [49%], Zenker's diverticulum (ZD)

[14.6%], pharyngeal web (12.2%), ZD with CPH (9.8%), cervical spondylosis (7.3%) and other (7.3%) (Fig. 1).

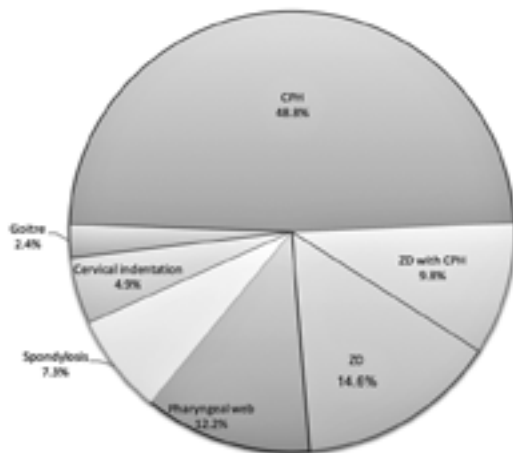


Fig. 1. Structural causes of intubation failure (n=41) detected on barium radiology. ZD: Zenker's diverticulum, CPH: cricopharyngeal hypertrophy.

Predictors of IF

The incidence of IF varied between groups ($p=0.021$), with lowest pooled rates in gastroenterologists (0.74%) compared with surgeons (1.07%) and NME (1.05%). Between the IF and successful intubation (SI) groups, there were no significant differences in mean age (63.2 for IF vs. 63.6 for SI, $p=0.77$), gender (47% male for IF vs. 49.5% male for SI, $p=0.46$) or mean midazolam dosage where administered (1.31mg for IF vs. 1.19mg for SI, $p=0.28$). Overall, 61.4% of procedures were performed with pharyngeal lidocaine (without sedation). Patients with IF were more likely to receive only pharyngeal lidocaine (65.0% vs. 61.3%, $p=0.05$) and dual premedication with pharyngeal anaesthesia and midazolam (11.9% vs. 3.7%, OR 3.56, 95% CI 2.36-5.36, $p<0.001$).

'Failure to tolerate' vs. 'Failure to progress'

Within the IF cohort, the median age of the 'failure to tolerate' group was 64 (IQR 24) vs. 73 (IQR 22) for 'failure to progress' ($p<0.001$); 86.5% of females had 'failure to tolerate' compared to 78.6% of males ($p=0.12$). There were no significant differences in the use of dual premedication ($p=0.77$), midazolam dose ($p=0.22$) or pharyngeal lidocaine ($p=0.55$) between groups. Gastroenterologists (27.3%) were more likely to report 'failure to progress' over 'failure to tolerate' than NME (12.1%) or surgeons (0%) [$p=0.002$]. Additional predictors of 'failure to progress' vs. 'failure to tolerate' included dysphagia (33.3% vs. 11.4% without dysphagia, OR 3.88, 95% CI: 1.92-7.81, $p<0.001$) and pharyngeal abnormality on barium radiology (36.1% vs. 2.0%, OR 27.70, 95% CI: 3.41-224.7, $p<0.001$).

Predictors of abnormal radiology in patients with IF

The diagnostic yield for barium radiology, CT and repeat gastroscopy were 69.0%, 54.0% and 64.3%, respectively. The diagnostic yield of pathology concordant with symptoms on further investigation for IF was 110/192 (57.3%). In patients undergoing barium radiology and repeat gastroscopy, the false

negative rate for endoscopy was 17/30 (56.7%), comprising of missed cases of pharyngeal pathology ($n=9$), dysmotility ($n=4$) and significant reflux ($n=4$). Within the IF cohort, predictors of structural causes on barium radiology included: dysphagia (OR 5.5, 95% CI: 2.5-11.8, $p<0.001$), failure to progress (OR 5.2, 95% CI: 2.3-12.0, $p<0.001$) and age ≥ 65 (OR 4.0, 95% CI: 1.8-8.9, $p<0.001$). Repeat gastroscopy was successful in 63/70 (90%) when performed by consultant endoscopists, after increasing midazolam dosage (mean increase 1.5mg, 95% CI: 1.0-2.0mg, $p<0.001$), and converting to nasogastroscopy in two cases. Overall, the positive predictive value for concordant pathology in the 'failure to progress' group was 55.6% compared to 20.3% in the 'failure to tolerate' group.

DISCUSSION

In this largest study of IF to date, our incidence of approximately 1% is comparable to the estimated 0-1.8% from small cases reported in the gastroscopy arm of clinical trials [2, 3]. Despite our literature search, we found no published studies which have correlated oesophageal intubation failure with follow-up findings. The limited data relating to gastroscopy failure have largely approached the issue from the angle of patient intolerance and discomfort. Data from Reed et al. [7], involving 3,525 gastroscopies performed by surgeons, demonstrated a 0.3% rate of incomplete examinations to the stomach, but does not report rates of IF. Qualitative research investigating the psychological aspects of 'failure to tolerate' endoscopy have identified patient apprehensions arising from feelings of vulnerability, embarrassment, fear of physical discomfort, as well as anxiety over the outcome of the investigation [8, 9].

Pre-procedural psychological anxiety is not the only predictor of intubation intolerance. Campo et al. [10] studied 509 patients undergoing unsedated gastroscopy and identified factors for poor tolerance including: first-time experience, presence of gag reflex, anxiety, young age, and female gender. The authors concluded that patients with such predictive factors may benefit more from sedation during gastroscopy. However, techniques in intubation may also affect tolerance. In a randomised trial conducted by the same group [2], nasogastric intubation using a thinner endoscope reduced the need for sedation compared with conventional gastroscopy, but routine use was restricted by the size of the working channel and image quality. The efficacy of the nasogastric scope for diagnostic and therapeutic procedures has been demonstrated in a large case series [11], with demonstrated advantages of improved patient comfort, and successful negotiation of high-grade strictures. As a high proportion of our patients were unsedated (61.4% overall) and sedation doses appear to be lower than in European centres, nasogastroscopy may be a more tolerable option for our patient group, particularly in the setting of outpatient clinics, or in patients with IF who have declined or are unsuitable for sedation, e.g. critically-ill patients. However, the literature on patients with IF due to anatomical causes remains confined to case reports which show case techniques for overcoming difficult intubation, especially in cases of ZD. These include the use of an overtube [12], guidewire [13] or catheter to facilitate passage through the upper oesophageal sphincter [14].

In our study, CPH was the most common abnormality found on the subsequent evaluation of IF. Cricopharyngeal hypertrophy is a poorly recognised entity in gastrointestinal endoscopy, with diagnosis based on visualisation of a hypertrophied CP muscle during the swallowing phase on videofluoroscopy (Fig. 2) [15], which may be more familiar to radiologists as “cricopharyngeal bar”. In a case series of 618 patients [16], CPH was observed in 10.8%, increased with age, and was associated with the obstruction of a pharyngeal bolus or cricopharyngeal indentation of the oesophagus during different phases of swallowing. On manometry, CPH has been correlated with reduced compliance and raised intrabolus pressures at the upper oesophageal sphincter [17, 18]. It is thus feasible that CPH can contribute to dysphagia and impede intubation. Cricopharyngeal hypertrophy has also been found in association with neurological disorders [16], myositis [17] and, as with our study, with ZD [16]. It has been proposed that ZD could be a consequence of CPH [15]. Zenker’s diverticulum, which occurs due to herniation of the posterior pharyngeal wall through Killian’s dehiscence [20], is thought to arise from longstanding elevations in hypopharyngeal intrabolus pressures during swallowing which occurs in conjunction with CPH [15]. However, the relationship between CPH and dysphagia has been controversial, as dysphagia is found in only 15% of patients with CPH [16]. Nevertheless, a variety of therapeutic strategies have been effective in managing



Fig. 2. Barium swallow demonstrating incipient diverticulum (solid arrow) with cricopharyngeal hypertrophy (dashed arrow).

oropharyngeal dysphagia secondary to CPH, including balloon dilatation [21, 22], myotomy [21, 22], botulinum toxin [22, 23], and flexible endoscopic septum division (FESD) in the context of ZD [24]. Hence, barium assessment of patients with oropharyngeal dysphagia and IF is necessary to facilitate treatment and reduce dysphagia-related morbidity.

Our study does have limitations. First, due to its retrospective nature, not all patients with IF underwent subsequent investigations; those who did may have had investigations to evaluate the primary endoscopic indication rather than for IF, which may affect the validity of our findings. Second, the arbitrary groupings of IF into ‘failure to tolerate’ and ‘failure to progress’ potentially generates bias, although we have subsequently correlated this distinction with significantly increased likelihood of structural pharyngeal abnormalities. We acknowledge that patients may have a combination of both factors, which may be impossible to separate, even with the presence of a neutral study investigator in the context of a prospective study. In patients who had further gastroscopy after IF, intubation was successful in a significant proportion (90%), albeit under an experienced specialist endoscopist, and with greater sedation doses. Therefore, intubation success may have been influenced by endoscopist experience (e.g. lifetime procedural counts), which was not addressed within our study. Third, the study was meant to be an exploratory analysis of the IF cohort. As such, the data collection variables for the SI group was limited to demographics and premedication use, and had not included physical or psychological patient co-morbidities, alcohol use, smoking, patient anxiety or comfort scores, which we suspect may also influence success of intubation. Although we have reported on some univariate predictors of IF, this was not a dedicated case-control analysis. Larger numbers of IF may have allowed for multivariable analysis.

Despite our limitations, our analysis of 26,130 gastroscopies over 6 years is the largest studied real-world IF dataset. Our results do have practical implications, as patients with IF have high rates of underlying structural pharyngeal pathology, with 73.2% comprising of ZD and/or CPH on subsequent investigation, which may be amenable to treatment. Our data suggest that barium swallow is effective at detecting non-structural pathology in cases of IF, such as dysmotility and reflux. Furthermore, the high rates of intubation success on subsequent attempts, albeit with higher doses of sedation, is reassuring.

For future research, there may be a role for a prospective study involving the pre-endoscopic assessment of the oropharyngeal cavity using the Mallampati score, and correlating this with intubation failure or discomfort scores. In anaesthetics, a Mallampati score of III or IV was associated with difficult tracheal intubation (OR 5.89, 95%CI 4.74-7.32) [25], but this has not been validated in endoscopy. We hypothesise that higher Mallampati scores, in addition to factors outlined in the aide memoire (Table I), may predispose to IF, and in these circumstances, nasogastroscopy may be a preferable approach in the first instance. However, more data are required before these recommendations can be made.

For future practice, we recommend for endoscopists to document reasons for IF and into groupings of ‘failure to tolerate’ and ‘failure to progress’, as this affects subsequent

management and pathological yield. 'Failure to tolerate' may be overcome by addressing patient factors such as allaying anxieties, increasing sedation, use of general anaesthesia, and nasogastroscopy, whereas 'failure to progress' may benefit from nasogastroscopy, or endoscopic adjuncts such as cap-assisted intubation or catheter guidance. If intubation failure persists, the patient should undergo barium assessment and/or further attempts with greater sedation under the most experienced endoscopist available. Our data may have relevance for the quality assurance of gastroscopy. Although the JAG states that intubation success is an auditable outcome [1], no current key performance indicator exists. The Association for Gastrointestinal Endoscopy (ASGE) does not specifically mention IF [26], but states that complete examinations should be achieved in >98% of gastroscopies. Based on our data, and that from Reed et al. [7], we propose that an IF rate of <1% is a realistic and auditable quality metric in gastroscopy.

CONCLUSION

The incidence of IF approaches 1%, with structural pharyngeal abnormalities found in 28.9% of patients undergoing further investigation. Patients with IF should be investigated further owing to the high risk of underlying pathology, particularly if associated with age ≥ 65 , dysphagia, and failure of endoscopic progression. Older age, dysphagia and abnormality on barium radiology correlated with 'failure to progress' compared to 'failure to tolerate' intubation. This distinction may inform strategies for overcoming IF, such as use of nasogastroscopy or increasing sedation. The diagnostic yield of barium radiology is comparable to repeat gastroscopy in the context of IF, and may be more helpful in evaluating pharyngeal and functional pathology. Intubation failure rates of <1% may be considered as an auditable metric for the quality assurance of gastroscopy.

Conflicts of interest: Authors declare no conflict of interests for this study.

Authors' contribution: K.S. performed data analysis and originally drafted the manuscript. J.L. performed the data collection and literature review, and co-wrote the discussion. N.C.F. provided informatics support, analytical oversight and significantly enhanced the manuscript. C.J.J.M. provided critical review and concept of the paper. S.I. designed and supervised the study, and is the study guarantor. All authors read and approved the manuscript.

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