The reflective intubation manoeuvre increases success rate in moderately difficult direct laryngoscopy: A prospective case-control study

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Abstract: BACKGROUND: Reflective intubation is a recently described technique to facilitate tracheal intubation. OBJECTIVE: The aim of the study was to assess success rate of reflective intubation in patients undergoing tracheal intubation and to correlate its application with laryngeal visibility. DESIGN: A prospective case-control study. SETTING: Operating theatre suite of a university hospital. PATIENTS: One hundred randomly selected patients undergoing elective surgery who required tracheal intubation as part of standard anaesthesia care. INTERVENTIONS: All patients underwent an initial intubation attempt using conventional direct laryngoscopy. Successfully intubated patients formed group E (easy), and the remaining patients underwent a single reflective intubation attempt. Patients with successful reflective intubation formed group M (moderate). The remaining patients underwent tracheal intubation using a suitable alternative intubation technique (group D, difficult). MAIN OUTCOME MEASURES: Primary outcomes were the success rate and time to successful intubation. Laryngeal visibility scores, changes in arterial oxygen saturation and incidence of sore throat were secondary outcomes. RESULTS: Forty-six patients underwent successful tracheal intubation using conventional laryngoscopy (group E), 42 patients presented moderate difficulty (group M) and 12 patients required alternative intubation techniques (group D). Reflective intubation was successful in 78% of patients in the 'noneasy' subgroup, but was unsuccessful in 22%. Intubation times were 9 ± 3 (group E), 15 ± 9 (group M) and 46 ± 38 s (group D). Oxygen saturation was comparable in all patients. Sore throat occurred significantly more often in group D. CONCLUSION: Reflective intubation proved to be successful in moderately difficult intubation conditions (Cormack and Lehane classes 2 and 3a). Reflective intubation represents a very useful first-line methodological extension of direct laryngoscopic tracheal intubation.

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The Reflective Intubation manoeuvre increases success rate in moderately difficult direct laryngoscopy: a prospective case control study

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Background. Reflective Intubation (RI) is a recently described technique to facilitate tracheal intubation. The aim was to assess success rate of RI in patients undergoing tracheal intubation.

Methods. One hundred randomly selected patients undergoing elective surgery and tracheal intubation were included. All patients underwent an initial intubation attempt with conventional direct laryngoscopy. Successfully intubated patients formed group E (easy), whereas remaining patients underwent a single RI attempt. Patients with successful RI formed group M (moderate). The remaining patients were intubated with a suitable alternative intubation technique (group D, difficult). Primary parameters were success rate and time to successful intubation. Laryngeal visibility scores, SpO_2 changes and incidence of sore throat served as secondary outcome parameters and were compared among the groups.

Results. Forty-six patients formed group E, 42 patients group M and 12 patients group D. RI was successful in 46 % of all patients, while it was unsuccessful in 12 %. Intubation times were 9 ± 3s (group E), 15 ± 9s (group M) and 46 ± 38s (group D). By this ratio, RI overcame difficult laryngoscopies in 78% of the non-easy population subgroup. Oxygen saturation was comparable in all patients, whereas sore throat was noted significantly more often in group D.

Conclusions. RI proved to be successful in moderately difficult intubation conditions as in Cormack/Lehane classes 2 and 3. RI represents a very useful first line methodological extension of direct laryngoscopic intubation that neither prolongs intubation time, nor causes an increase in the incidence of a sore throat.

Abstract Word Count: 249

Key Words: airway management, intubation; laryngoscopy, intubation; intubation, difficult

Introduction

Conventional endotracheal intubation with direct laryngoscopy is the most common intubation technique in daily clinical practice. The curved Macintosh blade is widely used in this context among ordinary trained anaesthesiologists. The Cormack & Lehane (C&L) score, describing the visibility of the vocal cords or the pharynx, respectively, during direct laryngoscopy is the most commonly used tool to grade the conditions of direct laryngoscopy and endotracheal intubation. Recently the "portion of glottis opening" (POGO) score was introduced as a new classification estimating the proportion of directly visible glottis opening. Here, a C&L score of 1 represents a POGO score of 50-100%. Usually these patients can be intubated easily and straight-forward in a single attempt[1-4]. In patients with a C&L Score of 2 or a POGO Score below 50 %, respectively, facilitation of endotracheal intubation should also be possible without the need of an alternative or advanced intubation technique. In contrast, patients presenting with a C&L Score of 3 (defined as a POGO Score of 0%) are potentially difficult to intubate. In these patients, a malleable stylet bended like a hockey stick and protruding from the tube tip where applicable and/or the backward-upward-rightward-pressure (BURP) procedure might serve as feasible tools to facilitate successful endotracheal intubation in the hands of a very experienced user. In the explicitly difficult intubation setting (C&L score 4), visualizing techniques like video-laryngoscopes or video-stylets might be more promising options.[5, 6]

A common way to cope with a moderately difficult laryngeal view (e.g. C&L 2 or POGO below 50%) is to elevate the tip of the tracheal tube. The elevated tip of the tube facilitates an improved vie of the glottic opening, which is normally covered by the epiglottis. An intubation technique which would limit the number of intubation

attempts as well as the duration of laryngoscopy while significantly increasing the success rate seems to be desirable. In this context Reflective Intubation (RI), a simple auxiliary technique to manually modify the endotracheal tube's shape during the ongoing laryngoscopy was recently described[13]. Important advantages of this particular technique are that the on-going intubation attempt does not have to be interrupted and there are no additional intubation attempts necessary.

RI facilitates successful intubation with a specific move of the hand holding the tracheal tube (usually the right hand): A gentle pressure is applied by the middle finger of the right hand to the shaft of the tube about 2 cm above the upper dental ridge (or the upper gums in edentulous patients) using the latter as a hypomochlion (Figure 1).

Insert Fig. 1 close to here

This manoeuvre causes an upward bending of the tube's distal segment. This way, both ends of the tube approach each other – similar to a reflection in water or a mirror, which gave rise to the name to the procedure. Based on the then-induced change of the curvature of the tube, one should be able to increase direct visualization of the glottis/pharynx (graded by C&L Score), thus significantly alleviating endotracheal intubation. We therefore investigated the overall success rate of the RI technique in a prospective case control study.

Methods

Ethical approval for this study (Ethical Committee N° KEK-StV-Nr. 50/13) was obtained from the Ethical Committee of the Kanton Zurich, Switzerland (Chairperson Prof P. Meier-Abt) on 29 October 2013. One hundred patients undergoing elective surgery with mandatory use of tracheal intubation were enrolled in this study. The inclusion was performed according to the availability of suitable patients, who also provided written informed consent during the pre-operative visit of the anaesthesiologist on the day before surgery. Exclusion criteria were age under 18 and ASA class III or above. Gender, age, height, weight and Mallampati score were collected and documented during the pre-operative visit as well.

On the day of surgery, patients were treated in accordance with local clinical guidelines. Endotracheal intubation and related measurements were performed exclusively by the two authors of this article, who are both familiar with the RI technique and are also well prepared to cope with unexpected airway difficulties of all kinds. All patients received 7.5 mg midazolam orally for premedication. General anaesthesia was induced with propofol 1.5 mg/kg, fentanyl 3 µg/kg and the non-depolarizing muscle relaxants rocuronium 0.6 mg/kg or atracurium 0.2 mg/kg. General anaesthesia was maintained with sevoflurane administrated per inhalation or propofol 6-8 mg/kg guided by clinical surrogate parameters. Complete neuromuscular blockade was confirmed by absence of palpable twitches in response to supra-maximal train-of-four stimulation of the ulnar nerve at the wrist before the first intubation attempt. All patients were obligatory intubated in the supine position. The intubation procedure was commenced and performed according to a designated flow chart (Figure 2).

Insert Fig. 2 close to here

First, direct laryngoscopy was performed and C&L grade as well as POGO percentage was assessed. Endotracheal intubation using a regular tracheal tube (no stylet inserted) was attempted. Successfully intubated patients formed the "Easy Intubation" group (group E). The remaining patients ("non-easy" subgroup) underwent an additional intubation attempt using RI, without interrupting the initial laryngoscopy. Patients successfully intubated with RI formed the "Moderately Difficult Intubation" group (group M). Finally, patients in which the airway could not be secured with the RI technique were categorized as the "Difficult Intubation" group (group D). These patients underwent endotracheal intubation using an alternative technique, including the insertion of a malleable stylet, supraglottic airway, flexible fiberoptic or the SensaScope video-stylet. In some cases the application of the BURP external manoeuvre on the larynx[14] was successful as well. Time to intubation was noted and defined as the time between the insertion of the laryngoscope into the mouth and the verification/declaration that the endotracheal tube was in proper final position.

During the whole procedure, oxygenation was continuously monitored via pulse-oximetry. Any changes in peripheral oxygen saturation (SpO_2) during the intubation procedure were documented. If SpO_2 was below 90%, intubation procedure was interrupted and manual hand-bag-ventilation was initiated. Finally, a suitable alternative technique for securing the airway was applied.

After surgery, all patients were transferred to the post-anaesthesia care unit (PACU) and closely monitored by the PACU staff for at least two hours, which represents standard of care at our institution. Before being discharged, all patients were asked about newly occurred sore throat and examined for dental damage. To our knowledge,

no data is available about the success rate of RI. Based on this fact and assuming the high feasibility of the proposed study, we decided to include 100 patients and to observe during the trial whether this sample size leads to results that can be statistically analyzed. Therefore, no prior power analysis was performed.

Statistical analysis

The results were analysed with the SPSS statistics software (Version 21, IBM SPSS Statistics, USA). Descriptive statistics are presented as mean ± standard deviation for continuous variables, as counts for categorical variables and as percentages where appropriate. The Chi^2 test was used to compare categorical variables among the groups. For analysis between the groups a one-way analysis of variance (ANOVA) or the Kruskal-Willis test was applied to compare parametric and nonparametric data, respectively. A p-value <0.05 was considered to be statistically significant.

Results

One hundred patients (69 females and 31 males) were included in this prospective case control study. The uneven gender distribution resulted from the fact that a major part of the investigation had been conducted in the gynaecological operation theatre. Overall, 48 patients had a Mallampati score of 1, 43 patients a score of 2, 8 patients a score of 3, and 1 patient a score of 4 (Table 1). The overall POGO score of all patients was 50 ± 35%. 46 patients could easily be intubated during the first attempt (group E). From the remaining 54 patients, 42 were intubated successfully using the RI technique (group M). Twelve patients had to be intubated with additional intubation techniques, these patients formed group D (Figure 2).

The resulting 3 post hoc intubation difficulty groups were different in size but not significantly different by biometric values (Table 2). Further differences were found in laryngeal visibility (C&L and POGO scores), time to intubation, as well as in the Mallampati score predicting laryngeal view. Peripheral oxygen saturation did almost not alter in all patients and never reached critical values (SpO_2 mean 98 ± 2; min 90; max 100). The postoperative incidence of sore throat revealed a significantly higher incidence in the patients of group D who had to undergo three or more intubation attempts ($p<0.01$). No dental damage was reported in any patient.

Discussion

Epidemiological data of our study population, like distribution of Mallampati Scores[15, 16] and best possible view on the glottis during laryngoscopy[1, 3], are comparable to those of previous reports. We therefore conclude that our results might be representative for a standard population of patients undergoing elective surgery.

Nearly half of all patients in our study (42 %) could easily be intubated without the need of an additional aid or technique. At first glance, this number might seem to be rather low. However, it should again be emphasized that absolutely no additional aid or facilitating technique, e.g. BURP, was applied during the initial intubation attempt in our study patients, otherwise the success rate would probably have been much higher. Although BURP might be a simple manoeuvre, anaesthesiologists must be aware that it still represents an “invasive” procedure and might therefore not only provoke clinical concerns but sometimes even distort laryngeal view.[17, 18] The overall success rate of our initial intubation attempt (including non-invasive and RI) was close to 90 %, which is comparable with previous publications. In the clinical setting,

unexpected difficulties during laryngoscopy occur in 5.8% of all patients and poor glottis visualisation is estimated to be encountered in 1-9 % of intubation attempts[16, 19]. We therefore conclude that the availability of RI as well as of other alternative intubation methods and aids is crucial, since more than half of the patients in our study needed a modified approach after a straight forward insertion of the tracheal tube during the first attempt proved to be unsuccessful.

The fact that there were no significant alterations in oxygenation (as assessed by continuous measurement of SpO_2) clearly showed that a staged and stepwise approach of alternating the actually applied intubation technique – as carried out in the current study in accordance with our flow chart (Figure 2) - is absolutely suitable in the daily clinical practice and routine.

The finding that 46% of all patients revealed easy intubation conditions is appeasing. However, we should still be concerned about the remaining 54% present, in particular those 12% of the total study population (and 22% of the non-easy subgroup), who were rated as “Difficult” (group D). The majority of the patients who were not termed as “Easy” revealed just a moderate difficulty level and could be intubated by the use of simple means such as the RI technique. Thus, RI seems to be an appropriate method in cases of limited glottis visibility, i.e. C&L 2 or 3a or POGO score less than 50% (but still higher than 0%). The differentiation between the C&L categories of 3a vs. 3b is defined as follows: In 3a the epiglottis can be lifted with the laryngoscope blade from the posterior pharyngeal wall (thus creating an access to the glottis), while in 3b the epiglottis cannot be elevated at all. This is an important discrimination, since any technique based on bending the tracheal tube (including the RI) might be successful in C&L 3a but is very likely to fail in a setting with a C&L 3b. Therefore, C&L 3b requires the (immediate) use of different, more sophisticated equipment

along with a higher degree of airway management skills by the anaesthesiologist in charge.

The results of our study confirm the fact that the application of RI as a first line variation of the initial intubation technique should be advocated, as it not only feasible and leads to more successful intubations within the first attempt but it also doesn't require any additional instruments to be involved and can instantly and easily be applied during the initial intubation attempt. It is solely based on an additional move exerted by the intubating person, without the necessity to interrupt the on-going laryngoscopy. Not only does RI reduce the time to intubation (by avoiding the involvement of additional equipment that has to be procured and prepared for use), it also applies less strain and tension onto the temporomandibular joints as well as the patient's teeth as is the case when multiple laryngoscopy attempts are conducted until the airway is finally secured[11, 12]. In our study, RI was able to overcome encountered difficult laryngoscopies (in the non-easy subgroup representing 54% of the total study population) in 78%. Therefore, RI apparently seems to be an excellent, feasible and simple technique as a first line measure in unexpected difficult laryngoscopies/intubations. It should be noted that in laryngoscopies presenting a C&L of 3b or higher, RI does not seem to be suitable, and that in these cases other means of tracheal intubation should be considered and applied immediately.

A certain limitation of this investigation represents the fact that all intubations were performed by two experienced anaesthetists. This circumstance had on the one hand the benefit of having constant conditions; on the other hand the obtained results cannot represent the skills level of a mixed user population comprising a certain portion of novices. (2003 Mulcaster JT1, Mills J, Hung OR, MacQuarrie K, Law JA, Pytka S, Imrie D, Field C.; 2014 Nilsson PM1, Russell L, Ringsted C, Hertz P, Konge

L.) Therefore, further investigations of RI with a larger number of cases as well as with a more diverse user population is recommended in order to understand better the full potential of RI.

Conclusions

The RI technique seems to be an appropriate, non-invasive and promising method for patients with moderately increased C&L score and/or a decreased POGO score, respectively, and might therefore be considered to be integrated into our daily clinical practice and teaching of airway management.

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Authors' contributions

P.B. has initially developed the RI technique and has set up the study protocol. K.R. has performed the dialog with the Ethical Committee and has provided the statistical analysis. Both authors contributed equally in collecting the data and writing the manuscript. Final manuscript preparation and submission was done by P.B.

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Key Messages

- Reflective Intubation (RI) is a simple, non-invasive and expedient facilitating technique for moderately severe difficult laryngoscopy.

- We found the proportion of non-easy cases to be 54 from 100, of which 78% could be intubated by RI in a first attempt.

- The best efficiency of RI was found in patients with a Cormack/Lehane classification 2 of laryngeal view and a positive POGO score of < 50%.

Figure titles and legends

Figure 1

Illustration of the Reflective Intubation technique

Left side: before RI activation the right hand holds the tracheal tube in the usual way; the middle finger (a) is not yet active. Right side: RI is activated and the tracheal tube has an elevated tip (d). This happens because the middle finger (a) exerts a slight pressure on the tube shaft (b) against the dental row (c).

Figure 2

Workflow

Workflow of the study starting with the 100 included patients and depicting the decision making after success or failure of the successive intubation attempts. The three resulting “post hoc” study groups are represented by the upper boxes. The ciphers in the circles indicate the number (and percentage) of the involved patients.