The factors influencing bronchoscope passing through the glottis

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Research Article

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Abstract

Background Flexible bronchoscopy is an important procedure in respiratory diseases. It is crucial whether bronchoscope can successfully pass through the glottis. The aims of the study were evaluation of differences between bronchoscope successfully passing through the glottis at one-time and repeatedly insertion at times, and analysis of various factors associated with failure of bronchoscope passing through the glottis.

Methods A retrospective analysis was performed from March 2019 to May 2019, in consecutive patients who had undergone diagnostic flexible bronchoscopy. The patients were divided into two groups according to the condition of bronchoscope passing through the glottic. Demographic and clinical information collected included age, gender, body mass index, respiratory disease, patient position, procedural time, cough and bleeding of nasal mucosa. We also recorded vital signs, including pre-, intra- and post-procedure of bronchoscope passing through the glottis.

Results 153 patients were in success group and 47 were in failure group. Success group was average 4 seconds shorter than the failure group (P = 0.001). Meanwhile, repeated passing through glottis was associated with an increase in the bleeding of nasal mucosa and cough. On the multivariate logistic regression, the neutral position and cough were the two factors associated with a higher risk of failure of passing through the glottis.

Conclusions In conclusion, successfully passage through the glottis can save procedural time and decrease the rate of cough and bleeding of nasal mucosa. Meanwhile, the neutral position and cough are two risk factors associated with failure to pass through the glottis at one time.

Introduction

Flexible bronchoscopy (FB) is a safe and increasing important procedure for diagnosis and treatment of respiratory diseases, with a low incidence of mortality and serious complications [1]. During the bronchoscopy procedure, it is crucial whether or not bronchoscope can successfully pass through the glottis at one time which can affects the following process of bronchoscopy. Various modifications of the procedure (including anesthesia methods, patient position and oxygen supplemental) have been described for improving procedural efficiency and patients' satisfaction [2-4]. Conversely, limited data are available concerning procedure predictors influencing bronchoscope passing through the glottis.

The aim of the study was therefore to evaluate differences between bronchoscope successfully passing through the glottis at one-time and repeatedly insertion at times in terms of procedural time, cough of patient, bleeding of nasal mucosa, degree of oxygen desaturation, blood pressure and heart rate. Furthermore, we also aimed to analyze various factors associated with the success of bronchoscope passing through the glottis, to be useful in increasing procedural efficiency.

Methods
A retrospective analysis was performed in the First Affiliated Hospital of Wenzhou Medical University, from March 2019 to May 2019, in consecutive patients who had undergone diagnostic flexible bronchoscopy. The exclusion criteria included patients with severe hypoxemia and organ dysfunction, massive pleural effusion, and history of pulmonary resection. All patients were provided with standard written information about the bronchoscopy procedure and informed consent was obtained from all patients. The internal review board approval was obtained by the Clinical Research Ethics Committee of the First Affiliated Hospital of Wenzhou Medical University.

Supplemental oxygen was delivered for all patients during the whole process of bronchoscopy. Routinely, vital signs, including the heart rate, blood pressure, and pulse oximeter oxygen saturation (SpO$_2$) were continuously monitored during bronchoscopy. The choice of patient position was determined by the bronchoscopist personal habit. The neutral position was defined as a supine position without a pillow and its neck was neither extended nor flexed, while the extend position was defined as a supine position with a pillow arranged under the back and its neck was slightly extended. Bronchoscopy was performed under general anesthesia and local anesthesia in our institution. Local anesthesia was installed by 10 mL of lidocaine (2%) on or through the vocal area and trachea. The patients were divided into two groups according to the condition of bronchoscope passing through the glottic. The success group was defined as one-time successfully passing through the glottic, while the failure group was defined as more than once needed. Procedural time was collected from the introduction of the bronchoscope into the patient nose to successfully passing the glottic. During the process, the endoscopic nurse performed a recording of the patient cough and bleeding of nasal mucosa. All methods were carried out in accordance with relevant guidelines and regulations.

Demographic and clinical information collected included age, gender, body mass index (BMI), related respiratory disease, patient position, the procedural time, cough and bleeding of nasal mucosa. We also recorded heart rate, blood pressure and SpO$_2$, including pre-, intra- and post-procedure of bronchoscope passing through the glottis. A decline in SpO$_2$ of more than 4% or a decline in SpO$_2$ below 90%, similarly, and a increase in heart rate and mean arterial pressure (MAP) of more than 10% were considered clinically significant when comparing pre- and intra-procedure.

**Statistical analysis**

Date analyses were performed by the IBM SPSS Statistics Version 23.0 software. Results were expressed as mean ± standard deviation (SD) or number with percentage as stated. The Chi-square test or Fisher's exact test, and Mann-Whitney U test were used for comparisons between two groups as appropriate. The statistically significant factors were further analyzed by a multivariate logistic regression analysis, which performed to assess the various factors associated with the success rate of bronchoscope passing through the glottis. Odds ratios (OR) and 95% confidence intervals (95%CI) for significant factors were calculated. A P-value of < 0.05 was considered as statistically significant.

**Results**
A total of 200 consecutive patients (132 males, 68 females; age range, 17 to 98 years; median, 57.5 years) with complete information were included in the study, with 153 patients in success group and 47 patients in failure group (Table 1). Of the 200 patients, pulmonary infection (n = 151) formed the most common clinical indications for performing bronchoscopy. The type of respiratory diseases and gender, age and BMI of patients were similar between the two groups. However, the percentage of neutral position was significantly higher in failure group in comparison to success group (76.6% vs. 39.9%; P < 0.0001). During the procedure, the cough rate of patients in success group and failure group was 81.7% (125/153) and 95.7% (45/47), with statistically difference (P = 0.018).

| Parameter                  | Success group (n = 153) | Failure group (n = 47) | P value |
|----------------------------|-------------------------|------------------------|---------|
| Gender                     |                         |                        | 0.994   |
| Male                       | 101                     | 31                     |         |
| Female                     | 52                      | 16                     |         |
| Age (year)                 | 56.9 ± 13.5             | 53.5 ± 14.4            | 0.147   |
| BMI (kg/m²)                | 0.291                   |                        |         |
| <18.5                      | 14                      | 3                      |         |
| 18.5–24.9                  | 101                     | 37                     |         |
| ≥25                        | 38                      | 7                      |         |
| Position                   | < 0.0001                |                        |         |
| Neutral                    | 61                      | 36                     |         |
| Extend                     | 92                      | 11                     |         |
| Cough                      |                         |                        | 0.018   |
| Yes                        | 125                     | 45                     |         |
| No                         | 28                      | 2                      |         |
| Pulmonary disease          |                         |                        | 0.565   |
| Non-infection              | 36                      | 13                     |         |
| infection                  | 117                     | 34                     |         |

*BMI Body mass index*
The pre-, intra- and post-procedural observations for the total population and for two groups were summarized in Table 2. Comparing of differences between the success group and failure group (Table 3) revealed that one-time successfully passing through the glottis was average 4 seconds shorter than the failure group (43.0 seconds vs. 47.2 seconds; \( P = 0.001 \)). Meanwhile, more than once attempts to pass through glottis was associated with an increase in the bleeding of nasal mucosa and cough rate (failure group vs. success group; 19.1% vs. 8.5% and 95.7% vs. 81.7%; \( P = 0.041 \) and \( P = 0.018 \), respectively). There was no significant difference between the two groups in terms of change in \( \text{SpO}_2 \), MAP and heart rate.

### Table 2

The pre-, intra- and post-procedural observations for patients

|                        | All patients | Success group | Failure group |
|------------------------|--------------|---------------|---------------|
| N                      | 200          | 153           | 47            |
| Pre-procedure          |              |               |               |
| \(-\text{SpO}_2\)^a (%)| 99.6 ± 1.0   | 99.6 ± 0.9    | 99.6 ± 1.1    |
| \(-\text{MAP}^b\) (mmHg)| 103.3 ± 15.4 | 103.0 ± 15.0  | 104.3 ± 16.6  |
| -heart rate (/min)     | 79.1 ± 14.0  | 79.7 ± 13.8   | 77.0 ± 14.3   |
| Intra-procedure        |              |               |               |
| \(-\text{SpO}_2\) (%)  | 99.9 ± 0.5   | 99.8 ± 0.6    | 99.9 ± 0.3    |
| \(-\text{MAP}\) (mmHg) | 92.3 ± 13.2  | 92.1 ± 13.7   | 92.9 ± 11.5   |
| -heart rate (/min)     | 76.4 ± 13.2  | 76.7 ± 13.4   | 75.3 ± 12.6   |
| Post-procedure         |              |               |               |
| \(-\text{SpO}_2\) (%)  | 99.7 ± 0.8   | 99.7 ± 0.8    | 99.7 ± 0.6    |
| \(-\text{MAP}\) (mmHg) | 98.3 ± 13.4  | 98.3 ± 12.9   | 98.4 ± 14.8   |
| -heart rate (/min)     | 78.4 ± 13.1  | 79.0 ± 12.9   | 76.5 ± 13.6   |

a: pulse oximeter oxygen saturation; b: mean arterial pressure
Table 3
Statistical results of the success group and failure group

|                                | Success group (n = 153) | Failure group (n = 47) | P value |
|--------------------------------|-------------------------|------------------------|---------|
| Procedural time (second)       | 43.0 ± 9.6              | 47.2 ± 10.3            | < 0.0001|
| Bleeding of nasal mucosa (%)   | 13 (8.5)                | 9 (19.1)               | 0.041   |
| Cough (%)                      | 125 (81.7)              | 45 (95.7)              | 0.018   |
| A decline in SpO₂ᵃ (%)         | 1 (0.7)                 | 0 (0)                  | > 0.999 |
| Increase in MAPᵇ (%)           | 7 (4.6)                 | 4 (8.5)                | 0.503   |
| Increase in heart rateᶜ (%)    | 15 (9.8)                | 6 (12.8)               | 0.759   |

ᵃ: pulse oximeter oxygen saturation; ᵇ: mean arterial pressure; ᶜ: the number of a decline in SpO₂ of more than 4% or a decline in SpO₂ below 90%; a increase in heart rate and MAP of more than 10% when comparing pre- and intra-procedure.

On the multivariate logistic regression, the neutral position of patient [OR(95% CI), 4.746 (2.228–10.110)] and cough [OR (95% CI), 4.525 (1.005–20.380)] were the two factors associated with a higher risk of failure of passing through the glottis (Table 4).

Table 4
Multivariate logistic regression of factors associated with unsuccessfully passing through glottic at one time

| Factor       | P         | ORᵃ   | 95% CIᵇ lower | 95% CIᵇ upper |
|--------------|-----------|-------|---------------|---------------|
| Neutral position | < 0.0001 | 4.746 | 2.228         | 10.110        |
| Cough        | 0.049     | 4.525 | 1.005         | 20.380        |

ᵃ: Odds ratios; ᵇ: 95% confidence intervals

Comment

Flexible bronchoscopy is a common and well-tolerated diagnostic procedure in respiratory diseases. However, it can cause some distasteful effects such as cough, smother and anxiety for patients, especially during the processing of bronchoscope passing through the vocal area. The factors that affect patient satisfaction with bronchoscopy can be divided into patient characteristic, process or procedure factors, and operative experience of bronchoscopist [1,5]. A questionnaire to assess patient satisfaction
with FB conducted under conscious sedation, found that male gender, shorter examination time, excellent bronchoscopist quality and less discomfort from coughing, pharyngeal pain and swallowing were associated with greater patient satisfaction [6]. During bronchoscopy, the patients have a more intense reaction when bronchoscope passes through the glottis and then some even need to repeatedly insert the bronchoscope. Therefore, it is essential to master the ability of successfully passing through the glottic.

The main cardiac bronchoscopy complications are arrhythmias and myocardial ischemia, clinically manifest in the increasing of blood pressure and heart rate [7]. Hypoxemia, resulting from respiratory depression by sedative drugs using and worsening on passage through the vocal cords, is also common during bronchoscopy. The majority of desaturations are transient and do not require specific intervention. In addition, oxygen desaturation is associated with an increase in cardiac workload with elevations of blood pressure and heart rate. Atrial arrhythmias occur at widely differing stages of the procedure, and ventricular arrhythmias occur mainly on passage through the vocal cords. In our study, 78.5% patients underwent bronchoscope passing through the glottis successfully at one time. There was no instance of severe complications among 200 patients. Moreover, we did not find significant cardiac complications and hypoxemia differences in the 2 groups during bronchoscope passing through vocal cords. However, one-time success passing showed statistically significantly decrease in the procedural time, and the probability of bleeding in nasal mucosa and cough of patients.

Laryngeal exposure has been classically regarded as a key factor in bronchoscope passing through glottis. Therefore, the proper positioning of a patient before bronchoscopy is a critical step. During laryngoscopy and intubation, the sniffing and simple extension positions are considered as the optimal patient positions to attain adequate visualization of the entire vocal area [8,9]. Bronchoscopy is typically performed either in the supine or the semi-recumbent or sitting posture, mainly depended on the bronchoscopist habit in different institutions [10]. Various studies have investigated the influence of posture on the oxygen desaturation and patient satisfaction. Van Zwam et al. showed the sitting position was associated with oxygen desaturation with a relative risk of 2.46 compared to the supine position, whereas patient comfort showed no difference [3]. However, a prospective study by Meghjee S.P et al. described there was no significant difference on oxygen desaturation between supine and semi-recumbent position [11]. In our study, the supine positions were divided into neutrality and extension depending on with or without pillow. The extend supine position was more beneficial to successfully passing through glottis when compared to neutral supine position during bronchoscopy.

Cough has been found to be reliably associated with the level of patient discomfort during bronchoscopy [12]. With the development of painless technology, patients and physicians usually prefer sedation for bronchoscopy to reduce discomfort [4]. The anesthesia methods used for bronchoscopy mainly include general and local anesthesia. Lidocaine is the most commonly used for local anesthesia which applied via the bronchoscope working channel. Antoniades N et al. found that local lidocaine administered to the larynx and tracheobronchial tree significantly decreased cough frequency and reduced the requirement for sedative drugs in a randomized controlled trial [13]. A recent study reported that the patients who was given 1% tetracaine injection pure liquid as local anesthesia had better glottis opening, mild cough
response and better tolerance, and the bronchoscope was easier to pass through the glottis [14]. In our
study, cough was a higher risk factor of bronchoscope failing to pass through the glottis. The difficulty of
passage process would be increased when patient coughing. Conversely, successful passage through the
glottis could reduce irritation on the vocal cords and decrease the occurrence of cough. Therefore, it is
crucial to adopt appropriate local anesthesia in vocal area during bronchoscopy for further study.

In conclusion, flexible bronchoscopy is a safe diagnostic procedure in respiratory diseases. Successfully
passage through the glottis can save procedural time and decrease the rate of cough and bleeding of
nasal mucosa during bronchoscopy. Meanwhile, the neutral position of patient and cough are two risk
factors associated with failure to pass through the glottis at one time.

Declarations

Ethics approval and consent to participate: All patients were provided with standard written information
about the bronchoscopic procedure and informed consent was obtained from all patients. All methods
were carried in accordance with relevant guidelines and regulations. The internal review board approval
was obtained by the Clinical Research Ethics Committee of the First Affiliated Hospital of Wenzhou
Medical University.

Consent for publication: Not applicable.

Availability of data and materials: The datasets used and/or analysed during the current study are
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Competing interests: The authors declare that they have no competing interests.

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XHJ designed the trial and analyzed data; XRJ and MFH performed the trial. All authors read and
approved the final manuscript.

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