Comparison between bronchoscopy under general anesthesia using laryngeal mask airway and local anesthesia with conscious sedation: a patient-centered and operator-centered outcome

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Background and objectives With the evolution of complex bronchoscopic procedures, search for procedures that were less painful to patients and easier for the operators to perform commenced. Conscious sedation partially achieved this target. We aimed to compare conscious sedation with general anesthesia (GA) in achieving a safer and more painless procedure.

Patients and methods Eighty patients were included: 36 (45%) were subjected to local anesthesia (LA) with midazolam and 44 (55%) to GA through laryngeal mask airway. Patients responded to a visual analogue scale (VAS) for cough, choking, dyspnea, nausea, vomiting, nasal symptoms, chest pain, and anxiety during bronchoscopy. Postbronchoscopy VAS included cough, fever, dyspnea, nausea, vomiting, nasal symptoms, and hemoptysis. Lastly, VAS for the tolerability of bronchoscopy and acceptance to repeat the procedure were answered. Operator VAS included cough, desaturations, easiness of the procedure, and success. Bronchoscopy, recovery times, the number of biopsies, and cost were recorded.

Results GA was significantly less symptomatic during bronchoscopy than LA ($P = 0.0001$). Nasal symptoms were more in LA after bronchoscopy ($P = 0.003$). Anxiety was more in LA ($P = 0.014$). The GA group found bronchoscopy to be more tolerable ($P = 0.0001$), and accepted to repeat the procedure ($P = 0.001$). The operator found that GA was associated with significantly less cough and desaturations, and was easier to perform ($P = 0.0001$). The duration of the procedure, the recovery time, the number of biopsies, and the cost were significantly higher in GA ($P = 0.0001$). Safety was equal in both groups.

Conclusion GA serves as a more peaceful procedure for the patient and the operator than LA, but at the expense of recovery time and cost. *Egypt J Broncho* 2014 8:128–137

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Keywords: bronchoscopy, general anesthesia, laryngeal mask, sedation

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Introduction

Fiberoptic bronchoscopy can be performed as an outpatient procedure under local xylocain anesthesia with or without conscious sedation. Yet, intraprocedure and postprocedure cough, sore nose, sore throat, and chest discomfort are very common symptoms [1–3]. More fundamental, and affecting the procedure outcome, possible morbidity, and even mortality, are the intraprocedural events of cough, agitation, and hypoxia, which might prematurely abrupt the procedure [4] or at least may add pressure on the operator, rendering him hasty to finish the procedure with the possibility of insufficient sampling or unsatisfactory examination. In contrast, general anesthesia (GA) is expected to totally alleviate the coughing reflex, agitation, and anxiety, in addition to compensate for any hypoxic event, which provides both the operator and, more importantly, the patient peace of mind [5]. However, it significantly increases the cost of the procedure and the postprocedural recovery time. In addition, the use of bronchoscopy through an endotracheal tube will hinder the inspection of the vocal cords and a significant portion of the trachea. Furthermore, the use of an endotracheal tube will add a burden in the mobility of the scope, and necessitates a certain tube size that can allow the passage of the scope.

It is proposed that the use of a laryngeal mask will allow the visualization of the whole respiratory tree from the vocal cords downwards, it will not interfere with the scope mobility, in addition to the previously mentioned benefits of alleviating the cough reflex and any hypoxic event. We aimed to compare conscious sedation with GA in achieving a safer and more painless procedure.

Patients and methods

A total of 80 patients underwent bronchoscopy at Mouwasat Hospital in Saudi Arabia during the period from June 2011 to January 2014. Patients were randomized into two groups. The first group (36 patients, 45%) received local anesthesia (LA) through lidocaine and the second group (44 patients, 55%) received GA through a laryngeal mask.

The patients included were able to read, understand, and sign a written consent, and were able and willing to respond to a visual analogue scale (VAS) by a maximum of 4 days after the procedure [6].

Bronchoscopy was scheduled on an elective basis for diagnostic purposes, and all participants were at least 18 years old. Patients who were unable or unwilling to fill the written consent and/or to respond to VAS within the first 4 days after the procedure, had a known allergy to lidocaine, midazolam, and/or GA, patients in whom the bronchoscopy was indicated for an emergency situation, or if the bronchoscopy was relatively or absolutely hazardous such as in patients with hypercapnic respiratory failure or with profound hypoxia (O_2 saturation below 90% with or without supplemental O_2 therapy) and patients with uncontrolled cardiac arrhythmias and/or ischemic heart diseases, pregnant women, and those who were below 18 years were excluded.

All patients in both groups were thoroughly examined clinically before the procedure. A chest radiograph and a chest computed tomography scan were performed for all patients. Patients were instructed to be fasting nothing per oral (NPO) for at least 6 h before the procedure. Blood pressure, pulse rate, peripheral O_2 saturation, and temperature were recorded before and during the procedure.

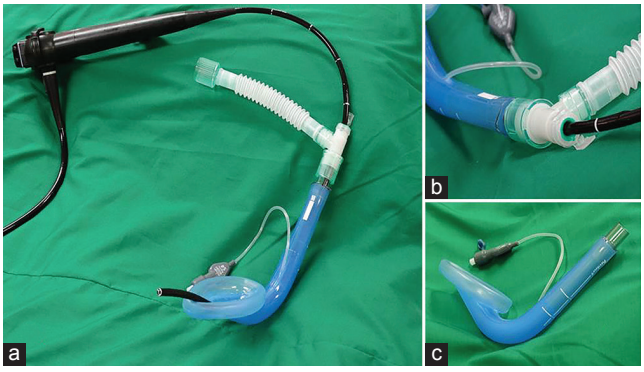
Patients in the first group (LA group) were premedicated with atropine sulfate 1 mg intramuscular injection 15 min before bronchoscopy. Bronchoscopy was performed in the endoscopy unit. LA was performed using lidocaine spray 10% (Avocaine spray 10%; Middle East Pharmaceutical Industries Co. Ltd–Avalon Pharma, Riyadh, Saudi Arabia) in the pharynx with the patient in a semisitting position. Five puffs were sprayed and the gag reflex was tested for blockage 30–60 s thereafter. Another puff was sprayed in the nose where the bronchoscopy will be introduced. All patients received supplemental O_2 4–6 l/min through nasal prongs throughout the procedure. Pulse rate, peripheral blood pressure, and O_2 saturation were also monitored throughout the procedure. Just before bronchoscopy, 1–2 mg midazolam (Hikma Pharmaceuticals, Amman, Jordan) was given intravenously, and according to the clinical progress, upon the operator's judgment, a total dose up to 10 mg was allowed to be given. After passage of the bronchoscope, the vocal cords and the tracheobronchial tree were anesthetized by 2 ml aliquots of 2% lidocaine solution (lidocaine hydrochloride injection 2%; Pharmaceutical Solutions Industry, Jeddah, Kingdom of Saudi Arabia), which was sprayed through the bronchoscopic channel by a spray-as-you-go technique [7]. Upon visualization of an endobronchial abnormality, or targeting the suspected bronchus, multiple bronchial biopsies were snatched using a reusable alligator cup with needle swing jaw biopsy forceps (FB-55CR-1; Olympus Medical Systems Corp., Tokyo, Japan). The number of biopsies was recorded. After closing the procedure, the patients were instructed to keep NPO for at least 2 h. The patients were kept under observation till stabilization and full consciousness was regained. The recovery time was recorded.

For patients in the second group (GA group), the procedure was carried out in the operating theater. Premedication with atropine sulfate 1 mg intramuscular was given 30 min before and midazolam 1–2 mg was given just before the procedure. Continuous monitoring of ECG, noninvasive blood pressure, and O_2 saturation were recorded. The airways were evaluated using the modified Mallampati classification [8]. Induction of anesthesia was achieved by propofol (Diprivan; AstraZeneca, London, United Kingdom) at a dose of 2 mg/kg, fentanyl 2 μg/kg, and in some patients, according to the anesthetist's discretion, a muscle relaxant, rocuronium (Esmeron; Merck Sharp & Dohme, Merck, Sharp & Dohme, New Jersy, USA) 0.6 mg/kg, was administered. A period of a few minutes of controlled positive pressure, ventilation by nitrous oxide (N_2O)/O_2 each 1.5 l/min and sevoflurane 2.0 vol% was allowed through the anesthetic machine (Dräger, Julian; Dräger Medizintechnik GmbH, Lübeck, Germany). The laryngeal mask size 5 (reusable Ambu Aura 40; Ambu, Ballerup, Denmark) was then placed, the cuff was inflated, and the cuff pressure was maintained at 60 cmH_2O with a hand pressure gauge (Ambu cuff pressure gauge; Ambu). Again, a period of a few minutes of controlled positive-pressure ventilation by N_2O/O_2 each 1.5 l/min and sevoflurane 2.0 vol% was allowed through the placed laryngeal mask to ensure proper positioning and function. A swivel connector with a perforated rubber-sealed top was then attached to the laryngeal mask (Superset double-swivel catheter mount 22F – double-flip top cap with seal – 22M/15F, 70–150 mm, sterile; Intersurgical Complete Respiratory Systems, Wokingham, UK). The anesthetic machine was mounted to the side of the swivel connector for ventilation and maintenance of anesthesia, which was achieved by sevoflurane 0–3% and O_2 100%, whereas the bronchoscope was introduced from the rubber-sealed top inlet, which prevents leakage (Fig. 1). After the procedure was accomplished, reverse of anesthesia was achieved by neostigmine 2.5 mg, with atropine sulfate 1 mg intravenously for those patients who received the muscle relaxant. The patient was transferred to the recovery room for 30–60 min, and then back to the ward according to the postanesthesia recovery score [9]. The time of recovery was recorded for each patient and compared with the LA group. Patients were kept NPO for 1–2 h after the procedure and resumed oral feeding as soon as they regained full consciousness.

The bronchoscope used in the procedure for both groups was Evis Lucera Bronchovideoscope Olympus BF type 1T260 (Olympus Medical Systems Corp.). The duration of the procedure was recorded from the start of bronchoscope introduction till the device was out.

Immediately after the procedure, the operator filled out a VAS of five points over a 10-cm scale. The concerned points were as follows: patient coughing as judged by the operator, desaturation events during the procedure, and easiness of the procedure. For the patient, VAS was recorded as soon as the patient regained full consciousness till a maximum of 4 days after the procedure [6]. The points covered were divided into two groups: the first are symptoms during the procedure, namely cough, choking, shortness of breath, nausea and/or vomiting, nasal symptoms, chest pain, anxiety just before or during the procedure, and satisfaction about the information given before the procedure. The second group of VAS were concerned about the postbronchoscopy period and included postbronchoscopy cough, fever, shortness of breath, blood-tinged sputum, nasal symptoms, nausea and/or vomiting, and lastly the overall patient evaluation of the procedure and patient acceptance to repeat the procedure if strongly indicated. VAS was plotted on a 10-cm horizontal line starting with 1 and ending with 5. The two ends represent the two extremes, with 1 indicating the most tolerable or the most satisfactory and 5 the most intolerable or unsatisfactory. Some examples for the current study are mentioned: 1, no cough at all, to 5, coughing all the time; 1, no anxiety, to 5, felt extremely anxious; 1, I found the bronchoscopy easy and tolerable, to 5, the procedure is absolutely intolerable; and 1, definitely I would repeat the procedure if indicated, to 5, I would never repeat the procedure whatever the consequences. For the operator, a similar VAS was applied as follows: 1, I noticed that the patient did not cough throughout the procedure, to 5, I found the patient coughing throughout the procedure; 1, no desaturation events emerged, to 5, desaturation events were frequent and severe; and 1, the procedure was easy and straightforward, to 5, the procedure was intricate and on the verge to be abolished. The indication for bronchoscopy was categorized to either a mass lesion or consolidation as seen in the chest radiograph and the computed tomography scan. The duration of the procedure was recorded and compared between the two groups. Likewise, the number of biopsies obtained, if ever, the cost of the procedure, and lastly the success of the procedure as indicated by grasping a definitive pathological and/or microbiological diagnosis were also compared between the two groups. Any complications regarding anesthetic methods used were recorded in both groups.

Fig. 1



The bronchoscope introduced through the rubber-sealed end of the swivel connector and passing out of the laryngeal mask. (a) Bronchoscope passing through the whole set of the laryngeal mask and swivel connector. (b) A closer view of the rubber-sealed end of the swivel connector while the bronchoscope was inserted. (c) The laryngeal mask used.

Statistical analyses

Numerical variables were expressed as mean and SD or median in case of nonparametric data. Categorical variables were expressed as frequencies and percentages. χ^2-Test and Fisher's exact test were used to examine the relationship between categorical variables. Nonparametric numerical data were compared using the Mann–Whitney *U*-test. Spearman's correlation was used to assess the correlation between the number of coughing episodes and the various VAS scores. Reliability analysis was performed to determine the correlation between patient and bronchoscopist VAS scores. A significance level of *P* value less than 0.05 was used in all tests. All statistical procedures were carried out using SPSS (version 15; SPSS Inc., Chicago, Illinois, USA) for Windows.

Results

A total of 80 patients were included in the study: 36 (45%) in the first group (LA group) and 44 (55%) in the second group (GA group). The demographic data for both groups, including age, sex, and indication for bronchoscopy, are shown in Table 1.

Table 1 Demographic data for both groups showing homogenous distribution regarding age, sex, and indication of bronchoscopy

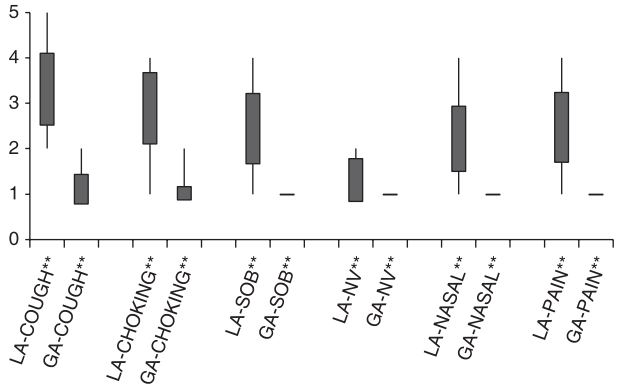
Variable	LA		GA		*P*
	Mean ± SD	Minimum–maximum	Mean ± SD	Minimum–maximum	
Age	60.92 ± 9.76	26–76	63.09 ± 8.09	40–81	0.279
Sex [*n* (%)]					
Male	32 (88.9)		36 (81.8)		0.378
Female	4 (11.1)		8 (18.2)		
Lesion [*n* (%)]					
Mass	30 (83.3)		39 (88.6)		0.531
Consolidation	6 (16.7)		5 (11.4)		

GA, general anesthesia; LA, local anesthesia.

The results of VAS for both groups are shown in Table 2.

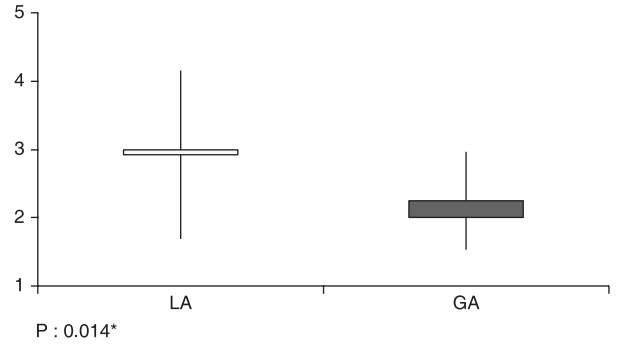
Patients in the GA group had highly significantly lesser suffering from cough, choking, shortness of breath, nausea or vomiting, and chest pain during bronchoscopy (Fig. 2). Also, GA group patients were significantly less anxious than LA group patients just before and during the procedure (Fig. 3). Both groups showed no significant difference about the acceptance of the information given before the procedure (Fig. 4). There was no significant difference between both groups regarding most of the postbronchoscopy symptoms, except for nasal symptoms, wherein the LA group complained highly significantly more than the GA group (Fig. 5). Moreover, GA patients were tolerating the procedure highly significantly better and accepted repetition if indicated compared with the LA group (Figs 6 and 7). The time spent in the procedure was highly significantly more in the GA group (22.44 ± 4.44 min for LA and 33.02 ± 3.0 min for GA; $P = 0.0001$), allowing, accordingly, highly significantly more biopsies to be obtained in the same group (4.47 ± 1.54 biopsies for LA vs. 10.75 ± 1.46 biopsies for GA; $P = 0.0001$) (Figs 8 and 9). Moreover, the cost of bronchoscopy under LA was fixed (2500 Saudi Arabian Riyal (SAR)), whereas bronchoscopy under GA costs a mean of 2912 ± 32 SAR, and the difference was highly significant ($P = 0.001$) (Fig. 10).

Fig. 2



Comparison between local anesthesia (LA) and general anesthesia (GA) regarding the visual analogue scale of symptoms during bronchoscopy. **Highly significant difference. NASAL, nasal symptoms including bleeding; NV, nausea and/or vomiting; PAIN, chest pain; SOB, shortness of breath.

Fig. 3



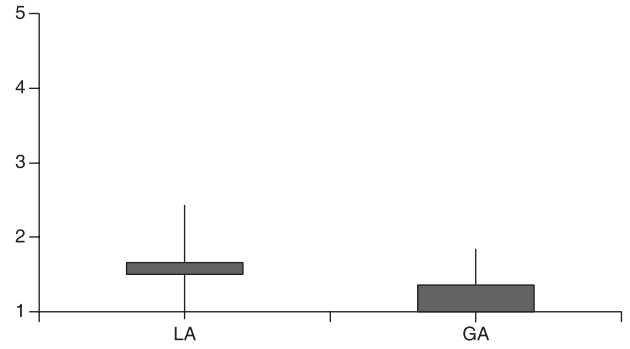
Comparison between the two groups regarding anxiety just before and during bronchoscopy ($P = 0.014$). GA, general anesthesia; LA, local anesthesia.

Table 2 Comparison between both groups regarding the visual analogue scale during or just before bronchoscopy (bronchoscopy), postbronchoscopy, and the operator visual analogue scale

Variable	LA			GA			*P*
	Mean	SD	Median	Mean	SD	Median	
Coughing (bronchoscopy)	3.31	0.79	3.00	1.11	0.32	1.00	0.0001**
Choking (bronchoscopy)	2.89	0.78	3.00	1.02	0.15	1.00	0.0001**
Shortness of breath (bronchoscopy)	2.44	0.77	2.00	1.00	0.00	1.00	0.0001**
Nausea and vomiting (bronchoscopy)	1.31	0.47	1.00	1.00	0.00	1.00	0.0001**
Nasal symptoms (bronchoscopy)	2.22	0.72	2.00	1.00	0.00	1.00	0.0001**
Chest pain (bronchoscopy)	2.47	0.77	2.00	1.00	0.00	1.00	0.0001**
Anxiety (bronchoscopy)	2.92	1.23	3.00	2.25	0.72	2.00	0.014*
Information (bronchoscopy)	1.67	0.76	1.50	1.36	0.49	1.00	0.085
Coughing postbronchoscopy	2.39	0.60	2.00	2.41	0.50	2.00	0.982
Fever postbronchoscopy	1.08	0.28	1.00	1.09	0.29	1.00	0.906
Shortness of breath postbronchoscopy	2.00	0.53	2.00	1.91	0.52	2.00	0.444
Hemoptysis postbronchoscopy	2.08	0.65	2.00	1.89	0.58	2.00	0.188
Nasal symptoms postbronchoscopy	1.36	0.54	1.00	1.07	0.25	1.00	0.003**
Nausea and vomiting postbronchoscopy	1.06	0.23	1.00	1.00	0.00	1.00	0.116
Overall tolerability of bronchoscopy	2.53	1.03	2.50	1.50	0.59	1.00	0.0001**
Acceptance of repeating bronchoscopy	2.17	1.06	2.00	1.43	0.62	1.00	0.001**
Operator perception of coughing	2.61	0.73	2.00	1.11	0.32	1.00	0.0001**
Desaturation events	1.47	0.61	1.00	1.07	0.33	1.00	0.0001**
Easiness of the procedure	1.67	0.86	1.00	1.02	0.15	1.00	0.0001**
Successfulness of the procedure	1.06	0.23	1.00	1.00	0.00	1.00	0.116

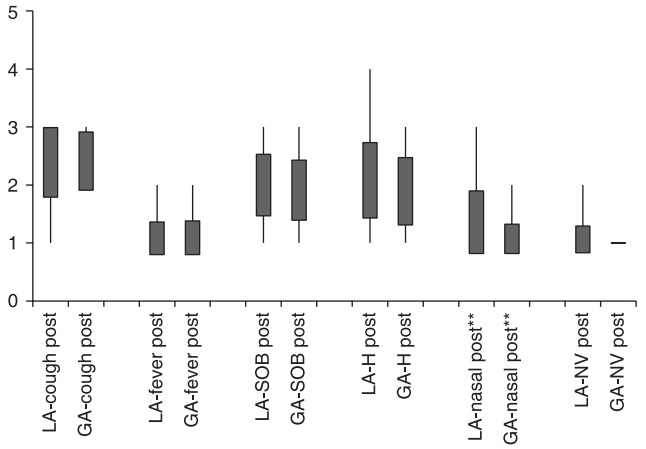
GA, general anesthesia; LA, local anesthesia; *Significant result; **Highly significant result.

Fig. 4



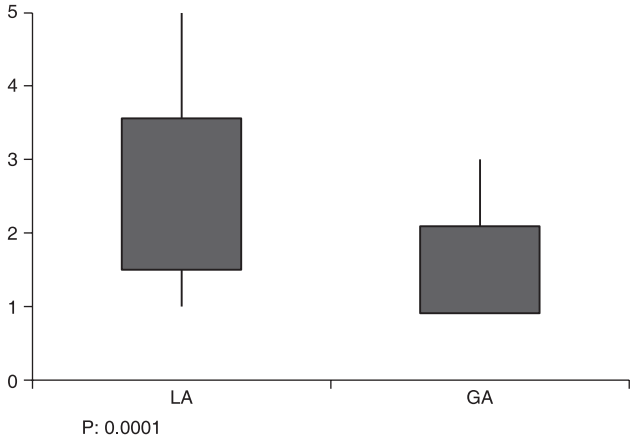
Comparison between the two groups regarding the satisfaction about the information given before bronchoscopy. GA, general anesthesia; LA, local anesthesia.

Fig. 5



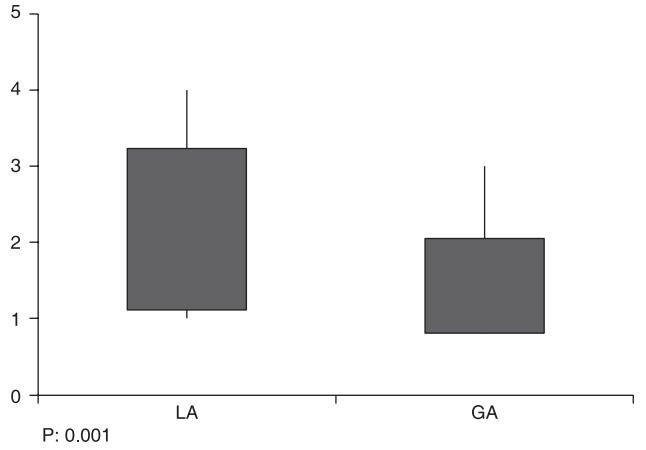
Comparison between local anesthesia (LA) and general anesthesia (GA) for postbronchoscopy symptoms; all showed no significant difference except for nasal symptoms.**Highly significant result (P = 0.003). H, blood-tinged sputum or hemoptysis; nasal, nasal symptoms including bleeding; NV, nausea and/or vomiting; post, postbronchoscopy; SOB, shortness of breath.

Fig. 6



Comparison between the two groups regarding the overall tolerability of the bronchoscopy experience (P = 0.0001). GA, general anesthesia; LA, local anesthesia.

Fig. 7



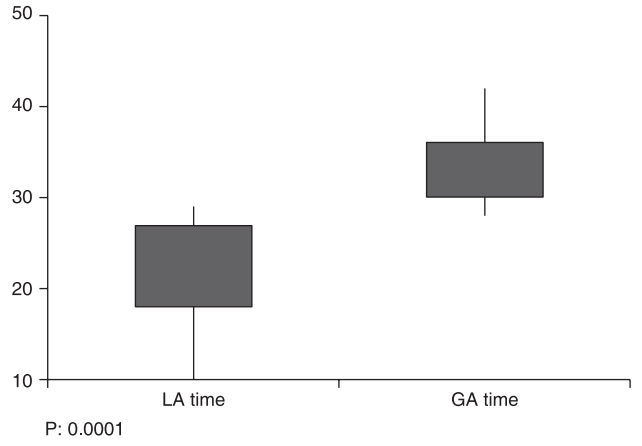
Comparison between the two groups regarding the acceptance to repeat bronchoscopy if indicated (P = 0.001). GA, general anesthesia; LA, local anesthesia.

Regarding the operator VAS, there was a highly significant difference between both groups regarding coughing as evaluated by the operator, desaturation events, and the easiness of the procedure (P = 0.0001). Nevertheless, both groups were successful in grasping a pathological and/or microbiological diagnosis with no significant difference (Fig. 11). The recovery time was highly significantly higher in the GA group compared with the LA group (27.64 ± 4.22 min for LA vs. 35.34 ± 4.75 min for GA, P = 0.001) (Fig. 12). There were no considerable complications recorded for any patient in both groups concerning anesthesia, except for desaturation events, which were more in the LA group (P = 0.0001); none was below 90%.

Discussion

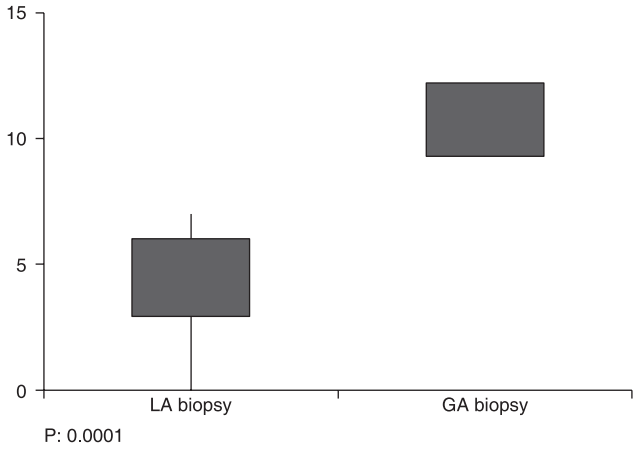
Both patients and pulmonologists desire a painless, comfortable, and peaceful bronchoscopy. Two to three decades ago, bronchoscopy seldom used to be performed without sedation[10,11], assuming there would be more complications with sedation than without [8]. Yet, with the evolution of more complex bronchoscopic procedures and techniques requiring more time, search for procedures that were less painful to patients and easier for operators to perform commenced. Moreover, other more profound studies deduced that sedation presented a less problematic procedure to patients than undergoing the procedure without sedation [12–14,15]. However, sedated patients were shown to have more hypoxia [15] and had to stay for a longer time in the hospital after accomplishing the procedure [13] than their nonsedated peers. Conscious sedation markedly improves the tolerability of bronchoscopy, and yet, it does not totally alleviate cough, choking, pain, and anxiety [7,15,16], does not

Fig. 8



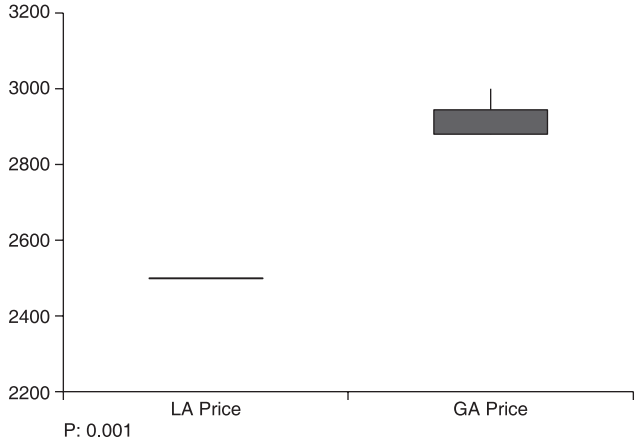
Comparison between the two groups regarding the duration of bronchoscopy (P = 0.0001). GA, general anesthesia; LA, local anesthesia.

Fig. 9



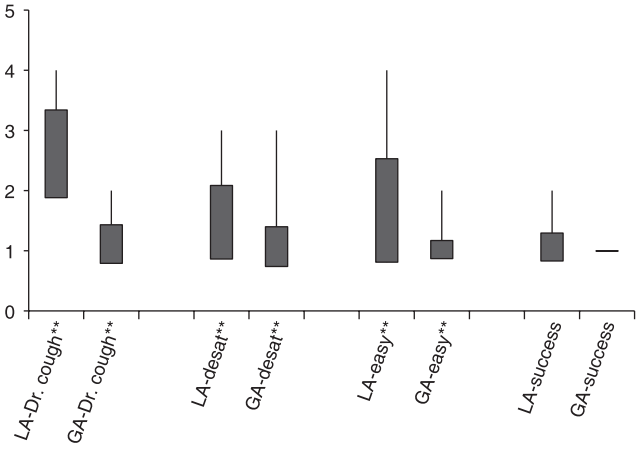
Comparison between the two groups regarding the number of biopsies snatched (P = 0.0001). GA, general anesthesia; LA, local anesthesia.

Fig. 10



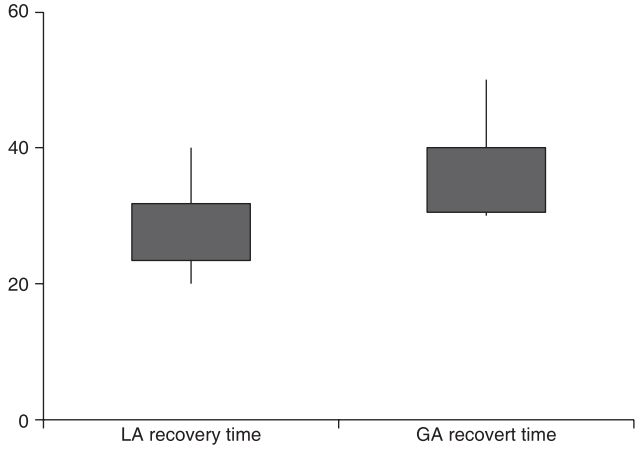
Comparison between the 2 groups regarding the cost of the procedure (P = 0.001). GA, general anesthesia; LA, local anesthesia.

Fig. 11



Comparison between local anesthesia (LA) and general anesthesia (GA) regarding the visual analogue scale for the operator. **Highly significant result. desat, desaturation events during bronchoscopy; Dr. cough, coughing events as evaluated by the operator; easy, easiness of the procedure as evaluated by the operator; and success, success of the procedure with regard to the pathological and/or microbiological diagnosis as processing of samples.

Fig. 12



Comparison between the two groups regarding the recovery time after bronchoscopy (P = 0.001). GA, general anesthesia; LA, local anesthesia.

improve patient cooperation during the procedure [12], may be associated with hypoxic events [17], and about 50% of bronchoscopy-related mortality is attributed to sedation [14].

In the current study, another step forward was aimed for a totally peaceful, painless, and easy procedure. This was achieved by deeper sedation up to total anesthesia and even muscle relaxation if required [18]. Sedatives, anesthetics, and monitoring were carried about by an anesthesiologist [19], allowing the bronchoscopist to focus on the bronchial examination. Propofol and fentanyl were used for anesthesia in bronchoscopy, which proved to be superior to midazolam in controlling patient symptoms and alleviating hypoxia [18]; yet other

studies deduce comparable desaturation events with both drugs if used by a nonanesthesiologist [20–22]. Propofol has a faster onset of action [20,22] and faster recovery [20–23]. Nevertheless, midazolam was associated with a higher carbon dioxide tension than propofol [24]. It is reported that propofol is more vulnerable to exceed the desired level of moderate (conscious) sedation [21], and is thus better monitored by an anesthesiologist [19]. Moreover, midazolam was found to induce more reduction in the mean blood pressure, the respiratory rate, and O_2 saturation in elderly patients [25]. Propofol affects O_2 saturation less significantly in elderly patients above 70 years of age [26]. In our study, the mean age of patients was 60.92 ± 9.76 years in the LA group and 63.09 ± 8.09 years in the GA group. Similarly, most of the studies included elderly patients with a mean age above 60 years [22,27,28]. In an earlier study, it was found that GA for rigid bronchoscopy was safe apart from considerable hypoxic events in 15% of the patients, which was readily reversible and was attributed to the procedure [29]. In our study, GA patients did not show significant hypoxic events in comparison with LA patients. No major interventions were performed in the current study in comparison with the work conducted by Perrin *et al*. [29], who utilized rigid bronchoscopy for endobronchial therapy. Likewise, another earlier work found that complications due to LA occurred significantly more frequently than GA in bronchoscopy, despite the old and obsolete medications used for both [30].

In our study, GA patients did not receive local airway anesthesia. LA by lidocaine, despite its proven safety in most studies [31,32], is not devoid of complications. Topical lidocaine was associated with increasing incidence of laryngomalacia in a set of pediatric patients [33]. Several studies deduced that lidocaine inhalation can lead to bronchoconstriction [34,35], and so, some authors suggested the addition of salbutamol inhalation to lidocaine to overcome this drawback [36]. The plasma lidocaine concentration exceeded the toxic level in 20% of the patients in one study [37]. An older retrospective investigation reported incidences of dizziness, tachycardia, nausea, and vomiting due to topical anesthesia in patients undergoing bronchoscopy [30]. We also reported a highly significant increase in shortness of breath, nausea, and vomiting in the LA group compared with the GA group.

In this work, we virtually compared the principle of proceduralist-administered sedation applied in the LA group with anesthesiologist-administered sedation in the GA group [38]. Despite the fact that proceduralist-administered sedation is found to be equally safe [16,20–24,27,39] and less costly [40], we were looking for a more peaceful and comfortable procedure for both the patient and the bronchoscopist. We also did not encounter any sedation-related and/or anesthesia-related complications in any included patients in both groups, and we found that GA was highly significantly costlier than LA. Nevertheless, the GA group showed highly significantly lesser symptoms than the LA group.

In our study, we utilized a laryngeal mask for bronchoscopy and ventilation. Laryngeal mask airway was first used in anesthesia about 30 years ago and proved effective in allowing spontaneous and controlled ventilation, decreased the incidence of sore throat, and was useful in surgeries in which airway difficulties may be expected [41]. It was used thereafter for fiberoptic bronchoscopy under GA as it allows clear visualization of the larynx and vocal cords and the whole length of the trachea [42] in contrast to the traditional endotracheal tube. Moreover, it has a wider lumen, allowing the passage of both the scope and air with less increment of airway pressure [43]. The laryngeal mask was used and proved safe and effective in pediatric patients [44], even allowing passage of larger scopes for more fundamental interventions in these patients [45]. Similarly, laryngeal mask airway was used in adults for bronchoscopy with excellent safety and effectiveness [42,43,46].

The current study showed that GA was highly significantly associated with fewer symptoms such as cough, choking, shortness of breath, nausea and vomiting, nasal symptoms, and chest pain than LA with conscious sedation by midazolam. Despite the fact that sedation significantly reduced symptoms during bronchoscopy [11,15], patients still suffer cough. In a recent investigation, Grendelmeier *et al*. [27] found that both patient and operator VAS for cough recorded a median score of 2–3 out of 5 with propofol given either as a bolus or an infusion for conscious sedation. Likewise, in our work, the median VAS for cough was 3 in the LA group with sedation, but it showed nearly total alleviation of cough in the GA group, with a median VAS of 1. Propofol was found to be superior to midazolam in controlling cough during conscious sedation in bronchoscopy [21,23]; yet it frequently exceeds the safe level of sedation when performed by a nonanesthesiologist [19,21]. Even with the addition of hydrocodone, cough was found to improve only slightly, with the median value of VAS decreasing from 4 for propofol alone to 3 for propofol plus hydrocodone (P = 0.025) [16]. Similarly, addition of hydrocodone to midazolam caused only a slight improvement in patients' VAS for cough (P = 0.043) [47]. Our results showed a highly significant difference between LA with

sedation and GA with regard to all symptoms during bronchoscopy including cough ($P = 0.0001$). Similarly, a mixture of O_2 and N_2O was found to control cough, discomfort, and pain during bronchoscopy better than oxygen plus nitrogen [48]. Postbronchoscopy symptoms were similar for both groups in our study except for nasal symptoms as we did not introduce the bronchoscope through the nose in GA in contrast to LA. The improved symptom control in GA in the current work was reflected by the higher tolerability of the procedure in the GA group compared with the LA group. Moreover, patients subjected to GA were highly significantly more accepting to repeat bronchoscopy than those who received LA. Symptoms during bronchoscope insertion were associated with lesser acceptance to repeat bronchoscopy in one study [6].

In our study, we found that patients who received LA and sedation were significantly more anxious before and during bronchoscopy than patients subjected to GA. In a recent study, it was found that propofol-based sedation was associated with less anxiety and symptoms than midazolam-based sedation [49]. Some authors tried to introduce music [50] or provide nature sights and sounds [51] for patients undergoing bronchoscopy to alleviate anxiety without significant results.

It is well known that bronchoscopy is associated with decreased oxygenation and blood O_2 saturation, especially if associated with bronchoalveolar lavage [52,53]. With conscious sedation, it was found that desaturation events are similar with the use of either midazolam or propofol [20,23]. Desaturation events during bronchoscopy, in combination with tachycardia, may result in myocardial ischemia, especially in protracted bronchoscopic procedures [54]. Positive-pressure ventilation was used to overcome more hypoxia in bronchoscopy in hypoxemic patients [55]. Mechanical ventilation with laryngeal mask airway was found to be effective in alleviating hypoxia during diagnostic or therapeutic bronchoscopic procedures [43,56]. In the current investigation, desaturation events were highly significantly lesser in patients with GA than in those under LA with moderate sedation ($P = 0.0001$), even with a prolonged duration of bronchoscopy in the GA group.

The present investigation shows that the bronchoscopy time was highly significantly longer in the GA group than in the LA group. Cough, discomfort, pain, and, more importantly, desaturation may force the bronchoscopist to be hasty in completing the procedure. Conscious sedation was found to decrease the procedure time [27,57]. Recently, Grendelmeier *et al*. [27] found that patients under propofol infusion had a slightly more prolonged bronchoscopy than those who received propofol bolus. In contrast, other investigators found that deep sedation led to a shorter time to accomplish bronchoscopy than moderate sedation [58]. Similarly, other authors found no difference in the procedure length between those who received N_2O and those who received O_2 with nitrogen [48]. This discrepancy may be explained by the number of biopsies snatched, which was highly significantly more in the GA group in our investigation than in the LA group. Another reason is that the procedures conducted in the two patients under LA required only bronchoalveolar lavage, which is expected to require less time than bronchial biopsies. Likewise, deep sedation was found to allow more biopsies than moderate sedation [48].

Despite the more rapid clearance of propofol compared with midazolam [23], in our study, patients under GA consumed more recovery time than those under LA. The recovery time did not increase on increasing the induction dose of propofol in one study [59]. The recovery time was significantly shorter in conscious anesthesia for propofol than for midazolam [20,23]. Nevertheless, when GA for different interventions was compared with conscious sedation, those receiving GA consumed more time for recovery [60,61].

In conclusion, GA with laryngeal mask airway provides an almost totally peaceful procedure for both the patient and bronchoscopist, allowing time for meticulous examination and intrabronchial procedures. The only drawbacks are the prolonged recovery time and the increased cost.

Acknowledgements

Conflicts of interest

None declared.

References

1 Diette GB, White P Jr, Terry P, Jenckes M, Wise RA, Rubin HR. Quality assessment through patient self-report of symptoms prefiberoptic and postfiberoptic bronchoscopy. *Chest* 1998; **114**:1446–1453.

2 Mori K, Saito Y, Suga Y, Takahashi T, Yokoi K, Miyazawa N, *et al.* A study of pharyngeal symptoms caused by bronchofiberscopy. *Jpn J Clin Oncol* 1993; **23**:162–165.

3 Poi PJ, Chuah SY, Srinivas P, Liam CK. Common fears of patients undergoing bronchoscopy. *Eur Respir J* 1998; **11**:1147–1149.

4 Facciolongo N, Patelli M, Gasparini S, Lazzari Agli L, Salio M, Simonassi C, *et al.* Incidence of complications in bronchoscopy. Multicentre prospective study of 20,986 bronchoscopies. *Monaldi Arch Chest Dis* 2009; **71**:8–14.

5 Gasparini S. It is time for patients to undergo bronchoscopy without discomfort. *Eur Respir J* 2011; **38**:507–509.

6 Lechtzin N, Rubin HR, Peter W, Jenckes M, Diette GB. Patient satisfaction with bronchoscopy. *Am J Respir Crit Care Med* 2002; **166**:1326–1331.

7 Hadzri HM, Azarisman SMS, Fauzi ARM, Roslan H, Roslina AM, Adina ATN, *et al.* Can a bronchoscopist reliably assess a patient's experience of bronchoscopy? *JRSM Short Rep* 2010; **1**:35–42.

8 Samsoon GL, Young JR. Difficult tracheal intubation: a retrospective study. *Anaesthesia* 1987; **42**:487–490.

9 Chung F, Vincent WS, Ghan VWS, Ong D. A post-anesthetic discharge scoring system for home readiness after ambulatory surgery. *J Clin Anesth* 1995; **7**:500–506.

10 Pearce SJ. Fibreoptic bronchoscopy: is sedation necessary? *BMJ* 1980; **281**:779–780.

11 Hatton MQF, Allen MB, Vathenen AS. Does sedation help in fibreoptic bronchoscopy? *BMJ* 1994; **309**:1206–1207.

12 Maltais F, Laberge F, Laviolette M. A randomized, double-blind, placebo controlled study of lorazepam as premedication for bronchoscopy. *Chest* 1996; **109**:1195–1198.

13 Maguire G, Rubinfeld AR. Patients prefer sedation for fibreoptic bronchoscopy. *Respirology* 1998; **3**:81–85.

14 Putinati S, Ballerin L, Corbetta L, Trevisani L, Potena A. Patient satisfaction with conscious sedation for bronchoscopy. *Chest* 1999; **115**:1437–1440.

15 Ni YL, Lo YL, Lin TY, Fang YF, Kuo HP. Conscious sedation reduces patient discomfort and improves satisfaction in flexible bronchoscopy. *Chang Gung Med J* 2010; **33**:443–452.

16 Schlatter L, Pflimlin E, Fehrke B, Meyer A, Tamm M, Stolz D. Propofol versus propofol plus hydrocodone for flexible bronchoscopy: a randomized study. *Eur Respir J* 2011; **38**:529–537.

17 Lim HJ, Cho YJ, Park JS, Yoon H, Lee J-H, Lee CT, *et al.* Predictors of hypoxemia developed during fiberoptic bronchoscopy under monitored anesthesia care. *Chest* 2012; **142**:915A.

18 Wahidi MM, Jain P, Jantz M, Lee P, Mackensen GB, Barbour SY, *et al.* American college of chest physicians consensus statement on the use of topical anesthesia, analgesia, and sedation during flexible bronchoscopy in adult patients. *Chest* 2011; **140**:1342–1350.

19 American Society of Anesthesiologists Task Force on Sedation and Analgesia by Non-anesthesiologists. Practice guidelines for sedation and analgesia by non-anesthesiologists. *Anesthesiology* 2002; **96**:1004–1017.

20 Clarkson K, Power CK, Oconnell F, Pathmakanthan S, Burke CM. A comparative evaluation of propofol and midazolam as sedative agents in fiberoptic bronchoscopy. *Chest* 1993; **104**:1029–1031.

21 Crawford M, Pollock J, Anderson K, Glavin RJ, Macintyre D, Vernon D. Comparison of midazolam with propofol for sedation in outpatient bronchoscopy. *Br J Anaesth* 1993; **70**:419–422.

22 Stolz D, Kurer G, Meyer A, Chhajed PN, Pflimlin E, Strobel W, *et al.* Propofol versus combined sedation in flexible bronchoscopy: a randomised non-inferiority trial. *Eur Respir J* 2009; **34**:1024–1030.

23 Clark G, Licker M, Younossian AB, Soccal PM, Frey JG, Rochat T, *et al.* Titrated sedation with propofol or midazolam for flexible bronchoscopy: a randomized trial. *Eur Respir J* 2009; **34**:1277–1283.

24 Carmi U, Kramer MR, Zemtzov D, Rosengarten D, Fruchter O. Propofol safety in bronchoscopy: prospective randomized trial using transcutaneous carbon dioxide tension monitoring. *Respiration* 2011; **82**:515–521.

25 Sun GC, Hsu MC, Chia YY, Chen PY, Shaw FZ. Effects of age and gender on intravenous midazolam premedication: a randomized double-blind study. *Br J Anaesth* 2008; **101**:632–639.

26 Heuss LT, Schnieper P, Drewe J, Pflimlin E, Beglinger C. Conscious sedation with propofol in elderly patients: a prospective evaluation. *Aliment Pharmacol Ther* 2003; **17**:1493–1501.

27 Grendelmeier P, Tamm M, Pflimlin E, Stolz D. Propofol sedation for flexible bronchoscopy: a randomised, noninferiority trial. *Eur Respir J* 2014; **43**:591–601.

28 Ernst A, Simoff M, Ost D, Michaud G, Chandra D, Herth FJF. A multicenter, prospective, advanced diagnostic bronchoscopy outcomes registry. *Chest* 2010; **138**:165–170.

29 Perrin G, Colt HG, Martin C, Mak MA, Dumon JF, Gouin F. Safety of interventional rigid bronchoscopy using intravenous anesthesia and spontaneous assisted ventilation a prospective study. *Chest* 1992; **102**:1526–1530.

30 Lukomsky GI, Ovchinnikov AA, Bilal A. Complications of bronchoscopy. Comparison of rigid bronchoscopy under general anesthesia and flexible fiberoptic bronchoscopy under topical anesthesia. *Chest* 1981; **79**:316–321.

31 Keane D, McNicholas WT. Comparison of nebulized and sprayed topical anaesthesia for fibreoptic bronchoscopy. *Eur Respir J* 1992; **5**:1123–1125.

32 Berger R, McConnell JW, Phillips B, Overman TL. Safety and efficacy of using high-dose topical and nebulized anesthesia to obtain endobronchial cultures. *Chest* 1989; **95**:299–303.

33 Nielson DW, Ku PL, Egger M. Topical lidocaine exaggerates laryngomalacia during flexible bronchoscopy. *Am J Respir Crit Care Med* 2000; **161**:147–151.

34 McAlpine LG, Thomson NC. Lidocaine-induced bronchoconstriction in asthmatic patients. *Chest* 1989; **96**:1012–1015.

35 Chen WY, Chai H. Effects of inhaled lidocaine on exercise induced asthma. *Respiration* 1987; **51**:91–97.

36 Groeben H, Silvanus MS, Beste M, Peters J. Combined lidocaine and salbutamol inhalation for airway anesthesia markedly protects against reflex bronchoconstriction. *Chest* 2000; **18**:509–515.

37 Sucena M, Cachapuz I, Lombardia E, Magalhães A, Tiago Guimarães J. Plasma concentration of lidocaine during bronchoscopy. *Rev Port Pneumol* 2004; **10**:287–296.

38 Jose RJ, Shaefi S, Navani N. Sedation for flexible bronchoscopy: current and emerging evidence. *Eur Respir Rev* 2013; **22**:106–116.

39 Dang D, Robinson PC, Winnicki S, Jersmann HPA. The safety of flexible fibreoptic bronchoscopy and proceduralist-administered sedation: a tertiary referral centre experience. *Int Med J* 2012; **42**:300–305.

40 Hassan C, Rex DK, Cooper GS, Benamouzig R. Endoscopist-directed propofol administration versus anesthesiologist assistance for colorectal cancer screening: a cost-effectiveness analysis. *Endoscopy* 2012; **44**:456–464.

41 Brain AIJ, McGhee ID, Miatier EJ, Thomas A, Abu-Saael MAW, Bushman JA. The laryngeal mask airway. *Anaesthesia* 1985; **40**:356–361.

42 McNamee CJ, Meyns B, Pagliero KM. Flexible bronchoscopy via the laryngeal mask: a new technique. *Thorax* 1991; **46**:141–142.

43 Wang T, Zhang J, Wang J, Dang BW, Xu M, Pei YH, *et al.* Interventional bronchoscopy with the use of mechanical ventilation by larynx mask or tracheal intubation under general anesthesia. *Zhonghua Jie He He Hu Xi Za Zhi* 2011; **34**:739–742.

44 Naguib ML, Streetman DS, Clifton S, Nasr SZ. Use of laryngeal mask airway in flexible bronchoscopy in infants and children. *Pediatr Pulmonol* 2005; **39**:56–63.

45 Tunkel DE, Fisher QA. Pediatric flexible fiberoptic bronchoscopy through the laryngeal mask airway. *Arch Otolaryngol Head Neck Surg* 1996; **122**:1364–1367.

46 Douadi Y, Bentayeb H, Malinowski S, Hoguet E, Lecuyer E, Boutemy M, *et al.* Anaesthesia for bronchial echoendoscopy: experience with the laryngeal mask. *Rev Mal Respir* 2010; **27**:37–41.

47 Stolz D, Chhajed PN, Leuppi JD, Brutsche M, Pflimlin E, Tamm M. Cough suppression during flexible bronchoscopy using combined sedation with midazolam and hydrocodone: a randomised, double blind, placebo controlled trial. *Thorax* 2004; **59**:773–776.

48 Atassi K, Mangiapan G, Fuhrman C, Lasry S, Onody P, Housset B. Prefixed equimolar nitrous oxide and oxygen mixture reduces discomfort during flexible bronchoscopy in adult patients. A randomized, controlled, double-blind trial. *Chest* 2005; **128**:863–868.

49 Ferrando J, Fernández-Navamuel I, Clemente CC, Vila P, Flandes J, Andreo F, *et al.* Tolerance of the endobronchial ultrasound (EBUS) using five different sedation models. *Chest* 2014; **145**:492A.

50 Colt HG, Powers A, Shanks TG. Effect of music on state anxiety scores in patients undergoing fiberoptic bronchoscopy. *Chest* 1999; **116**:819–824.

51 Diette GB, Lechtzin N, Haponik E, Devrotes A, Rubin HR. Distraction therapy with nature sights and sounds reduces pain during flexible bronchoscopy. A complementary approach to routine analgesia. *Chest* 2003; **123**:941–948.

52 Cole P, Turton C, Lanyon H, Collins J. Bronchoalveolar lavage for the preparation of free lung cells: technique and complications. *Br J Dis Chest* 1980; **74**:273–278.

53 Williams TJ, Bowie PE. Midazolam sedation to produce complete amnesia for bronchoscopy: 2 years' experience at a district general hospital. *Respir Med* 1999; **93**:361–365.

54 Matot I, Kramer MR, Glantz L, Drenger B, Cotev S. Myocardial ischemia in sedated patients undergoing fiberoptic bronchoscopy. *Chest* 1997; **112**:1454–1458.

55 Maître B, Jaber S, Maggiore SM, Bergot E, Richard JC, Bakthiari H, *et al.* Continuous positive airway pressure during fiberoptic bronchoscopy in hypoxemic patients. A randomized double-blind study using a new device. *Am J Respir Crit Care Med* 2000; **162**:1063–1067.

56 Veres J, Slavei K, Errhalt P, Seyr M, Ihra G. The Veres adapter: clinical experience with a new device for jet ventilation via a laryngeal mask airway during flexible bronchoscopy. *Anesth Analg* 2011; **112**:597–600.

57 Grendelmeier P, Kurer G, Pflimlin E, Tamm M, Stolz D. Feasibility and safety of propofol sedation in flexible bronchoscopy. *Swiss Med Wkly* 2011; **141**:w13248.

58 Yarmus LB, Akulian JA, Gilbert C, Mathai SC, Sathiyamoorthy S, Sahetya S, *et al.* Comparison of moderate versus deep sedation for endobronchial ultrasound transbronchial needle aspiration. *Ann Am Thorac Soc* 2013; **10**:121–126.

59 Lin TY, Lo YL, Hsieh CH, Ni YL, Wang TY, Lin HC, *et al.* The potential regimen of target-controlled infusion of propofol in flexible bronchoscopy sedation: a randomized controlled trial. *PLoS One* 2013; **8**:e62744.

60 VanNatta ME, Rex DK. Propofol alone titrated to deep sedation versus propofol in combination with opioids and/or benzodiazepines and titrated to moderate sedation for colonoscopy. *Am J Gastroenterol* 2006; **101**:2209–2217.

61 Rudner R, Jalowiecki P, Kawecki P, Gonciarz M, Mularczyk A, Petelenz M. Conscious analgesia/sedation with remifentanil and propofol versus total intravenous anesthesia with fentanyl, midazolam, and propofol for outpatient colonoscopy. *Gastrointest Endosc* 2003; **57**:657–663.