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SCIENTIFIC ARTICLE

The influence of airway supporting maneuvers on glottis view in pediatric fiberoptic bronchoscopy

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Fiberoptic bronchoscopy;
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Abstract
Introduction: Flexible fiber optic bronchoscopy is a valuable intervention for evaluation and management of respiratory diseases in both infants, pediatric and adult patients. The aim of this study is to investigate the influence of the airway supporting maneuvers on glottis view during pediatric flexible fiberoptic bronchoscopy.
Materials and methods: In this randomized, controlled, crossover study; patients aged between 0 and 15 years who underwent flexible fiberoptic bronchoscopy procedure having American Society of Anesthesiologists I–II risk score were included. Patients having risk of difficult intubation, intubated or patients with tracheostomy, and patients with reduced neck mobility or having cautions for neck mobility were excluded from this study. After obtaining best glottic view at the neutral position, patients were positioned jaw trust with open mouth, jaw trust with teeth prottution, head tilt chin lift and triple airway maneuvers and best glottis scores were recorded.
Results: Total of 121 pediatric patients, 57 girls and 64 boys, were included in this study. Both jaw trust with open mouth and jaw trust with teeth prottution maneuvers improved the glottis view compared with neutral position ($p < 0.05$), but we did not observe any difference between jaw trust with open mouth and jaw trust with teeth prottution maneuvers ($p > 0.05$). Head tilt chin lift and triple airway maneuvers improved glottis view when compared with both jaw trust with open mouth and jaw trust with teeth prottution maneuvers and neutral position ($p < 0.05$); however we found no differences between head tilt chin lift and triple airway maneuvers ($p > 0.05$).

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Conclusion: All airway supporting maneuvers improved glottic view during pediatric flexible fiberoptic bronchoscopy; however head tilt chin lift and triple airway maneuvers were found to be the most effective maneuvers.

PALAVRAS-CHAVE
Fibrobroncoscopia;
Pediatria;
Manobras das vias aéreas;
Elevação da mandíbula;
Visibilidade da glote

A influência das manobras de suporte das vias aéreas sobre a visibilidade da glote em fibrobroncoscopia pediátrica

Resumo
Introdução: A broncofibroscopia flexível (BF) é uma valiosa intervenção para o manejo e avaliação de doenças respiratórias em pacientes tanto pediátricos quanto adultos. O objetivo deste estudo foi investigar a influência das manobras de apoio das vias aéreas sobre a visibilidade da glote durante a BF pediátrica.
Material e método: Estudo cruzado, randômico e controlado, incluindo pacientes com idades entre 0-15 anos, ASA I-II, que foram submetidos à BF. Pacientes com risco de intubação difícil, entubados ou com traqueostomia e aqueles com mobilidade reduzida do pescoço ou que exigissem cuidados para a mobilidade do pescoço foram excluídos do estudo. Depois de obter a melhor visibilidade da glote na posição neutra, os pacientes foram posicionados com elevação da mandíbula e abertura da aberta (EMBA), com elevação da mandíbula e protrusão dos dentes (EMPD), com inclinação da cabeça elevação do queixo (ICEQ) e com a tripla manobra das vias aéreas (TMVA). Os melhores escores da glote foram registrados.
Resultados: No total, 121 pacientes pediátricos foram incluídos no estudo: 57 pacientes do sexo feminino e 64 do sexo masculino. Ambos as manobras EMBA e EMPD melhoraram a visibilidade da glote em comparação com a posição neutra ($p < 0,05$), mas não observamos diferença entre as manobras EMBA e EMPD ($p > 0,05$). As manobras ICEQ e TMVA melhoraram a visibilidade da glote em comparação com as manobras EMBA e EMPD e a posição neutra ($p < 0,05$); porém, não encontramos diferenças entre a ICEQ e a TMVA ($p > 0,05$).
Conclusão: Todas as manobras de acesso às vias aéreas melhoraram a visibilidade da glote durante a BF pediátrica; porém, a inclinação da cabeça e elevação do queixo e a tripla manobra das vias aéreas foram consideradas as manobras mais eficazes.

Introduction

Flexible fiber optic bronchoscopy (FOB) is a valuable intervention for evaluation and management of respiratory diseases in both infants, pediatric and adult patients. Since its first introduction by Ikeda in 1968, fiber optic bronchoscope in clinical practice; it has been 46 years and there have also been a number of other changes in pediatric pulmonology that have consequences on bronchoscopy practice.[1] Most common indications of FOB in pediatric population are persistent radiological abnormalities, unexplained respiratory distress, and stridor. Also direct inspection in patients with suspected foreign body aspirations and broncho-alveolar lavage requirement for patients having lung infection are the other indications.

Children often require deep sedation or general anesthesia during FOB procedure.[2] Usually there is a clear airway present in awake patients however in anaesthetized patients, due to changes in upper airway structures; partial or complete obstruction makes the fiber optic advancement difficult. Reduction in muscle tone during deep sedation or anesthesia has effects on upper airway structures like soft palate, tongue base and epiglottis may be relocated to the posterior pharyngeal wall. In order to maintain clear airway in anesthetized patients, airway-supporting maneuvers may be required during fiber optic bronchoscopy. Also employment of intubating airways like Berman or Ovassapian, direct laryngoscopy, lingual traction and supraglottic airway devices (Laryngeal Mask Airway, I-Gel or Intubating Laryngeal Mask, etc.) are the alternative ways of resolving this problem.[3,4]

The effects of airway supporting maneuvers on glottis view during FOB are not studied and there is a lack of knowledge in pediatric group of patients. The aim of this study is to determine the effects of airway supporting maneuvers on glottis view during flexible FOB in pediatric patients.

Materials and methods

The study protocol was approved by the Institutional Ethical Committee of Bezmialem Vakif University. Pediatric patients between 0 and 15 years of age, having American Society

Table 1 Anterior laryngopharyngeal (LP) view 4 point Cheng et al.[5] scale.

Grade	Description
1	Full view of epiglottis, rima glottidis, corniculate cartilages and anterior commissure.
2	Tip of epiglottis and partial view of rima glottidis and corniculate cartilages are visible but anterior commissure of the cords is not visible.
3	Only tip of epiglottis and corniculate cartilages are visible but none of rima glottis seen.
4	Only floppy epiglottis seen on posterior pharynx but no visualization of rima glottidis and corniculate cartilages.

Table 2 Posterior Laryngopharyngeal view 3 point Cheng et al.[5] scale.

Grade	Description
1	Corniculate cartilages and arytenoids located upward from posterior pharynx and both base corners of rima glottidis are not visible.
2	Corniculate cartilages and arytenoids located upward from posterior pharynx and only one base side corner of rima glottidis may visible.
3	Corniculate cartilages located on posterior pharynx and arytenoid cartilages are not visible.

of Anesthesiologists (ASA) score I or II scheduled for flexible FOB between November 2013 and April 2014 included in this study. Intubated patients, patients with tracheostomy, patients requiring mechanical ventilation support, patients with difficult intubation suspect (Mallampati score 3–4, micrognathia, craniofacial abnormalities and other situations related with difficult intubation) and patients with restricted neck mobility or patients with cautions for neck mobility were excluded. Patient who had any contraindications to the drugs used in this study were excluded. In accordance with the Declaration of Helsinki, the purpose and method of the study were sufficiently explained to the parents or legal representatives of each patient. The study was conducted after obtaining informed written consent.

After usual preoperative fasting interval due to ASA Guidelines (2 h for clear fluids, 4 h for mother milk, 6 h for diary milk, formulas and other foods). An intravenous cannula inserted at the dorsum of the hand and all patients premedicated with midazolam 0.03 mg/kg and atropine 0.01 mg/kg (0.1 mg minimum). Topical anesthesia with lidocaine 10% was applied to the nasal mucosa of the nostril to facilitate FOB for at least 5 min before the interventional process. Anesthesia induction was made with propofol 1 mg/kg and ketamine hydrochloride 1 mg/kg and hypnotic drugs were utilized to provide deep sedation or general anesthesia as an adjunct to topical anesthesia for flexible fiber optic bronchoscopy. Patients were received oxygen support 5 L/min with face mask after initial hypnotic drug dose administration.

After initial administration, patients were received continuous ketamine and propofol infusions with 6–10 mg/kg/h infusion rates. The Ramsay Sedation scale was employed to score the sedation level for all patients. The goal was to achieve a sedation level of 5 or 6 before the process. Under adequate sedation level with sufficient spontaneous ventilation with $SpO_2 > 95\%$ FOB procedure started. Patients were supine and head was neutral positioned during transnasal advancement of FOB. Following transnasal advancement with FOB, anterior and posterior laryngopharyngeal view evaluated according to 4 and 3 grade scales respectively adopted from Cheng et al.[5] study (Tables 1 and 2). After achieving of the best view of anterior or posterior glottis with neutral position, additional airway-supporting maneuvers (mentioned below) applied randomly and the best view of glottis with each maneuvers documented with video capture images.

The same bronchoscopist who had more than 10 years of experience in pediatric flexible FOB performed all procedures and an experienced anesthesiologist apart from anesthesia management who is blinded from patient positioning and airway supporting maneuvers did the evaluation of glottis view from video capture images after the FOB procedures.

The maneuvers are

1. Jaw trust with teeth protrusion maneuver (JTTP),
2. Jaw trust with opened mouth maneuver (JTOM),
3. Head tilt chin lift maneuver (HTCL),
4. Triple airway maneuver (TA).

After capturing images of anterior and posterior laryngopharyngeal view with 4 different airway supporting maneuvers, the study finalized and FOB procedure was accomplished.

Statistical analysis

Kruskal–Wallis test was used to detect differences in grades of LP tissue seen with the different airway supporting techniques. A p-value less than 0.05 was defined as statistically significant.

Results

Demographic data for all patients are shown in the Table 3. All bronchoscopies were accomplished successfully via nasal approach. In general, when compared with neutral position both four airway supporting maneuvers (JTTP, JTOM, HTCL, TA) clinically and statistically ($p < 0.05$) improved anterior and posterior laryngopharyngeal view via flexible fiber optic bronchoscopy. HTCL and TA maneuvers showed the most improved glottis view, however there were no significant difference found between JTTP–JTOM maneuvers ($p > 0.05$) and HTCL–TA maneuvers. JTTP, JTOM, HTCL, TA maneuvers

Table 3 Patient demographics.

Age	6.12 ± 4.72
Weight	22.45 ± 16.34
Sex	57 F/64 M

Table 4 Statistical analysis of glottis view scores with different maneuvers in 0–2 years of age patients ($n = 38$).

Maneuver	Score	Neutral	JTTP	JTOM	HTCL	TA
Neutral (anterior)	2.79 ± 1.01	1	0.04	0.02	0.00	0.00
JTTP (anterior)	2.32 ± 0.87	0.04	1	NS	0.00	0.00
JTOM (anterior)	2.19 ± 0.87	0.02	NS	1	0.007	0.00
HTCL (anterior)	1.40 ± 0.50	0.00	0.00	0.007	1	NS
TA (anterior)	1.29 ± 0.46	0.00	0.00	0.00	NS	1
Neutral (posterior)	2.29 ± 0.77	1	0.039	0.008	0.00	0.00
JTTP (posterior)	1.95 ± 0.70	0.039	1	NS	0.00	0.00
JTOM (posterior)	1.79 ± 0.62	0.008	NS	1	0.002	0.00
HTCL (posterior)	1.37 ± 0.54	0.00	0.00	0.002	1	NS
TA (posterior)	1.23 ± 0.43	0.00	0.00	0.00	NS	1

Values are mean ± standard deviation.
JTTP, jaw trust with teeth protrusion; JTOM, jaw trust with opened mouth; HTCL, head tilt chin lift; TA, triple airway maneuver; NS, not significant ($p > 0.05$).

Table 5 Statistical analysis of glottis view scores with different maneuvers in 2–6 years of age patients ($n = 38$).

Maneuver	Score	Neutral	JTTP	JTOM	HTCL	TA
Neutral (anterior)	2.50 ± 0.83	1	0.005	0.00	0.00	0.00
JTTP (anterior)	2.00 ± 0.73	0.005	1	NS	0.00	0.00
JTOM (anterior)	1.71 ± 0.70	0.00	NS	1	0.007	0.00
HTCL (anterior)	1.31 ± 0.47	0.00	0.00	0.007	1	NS
TA (anterior)	1.13 ± 0.34	0.00	0.00	0.00	NS	1
Neutral (posterior)	2.13 ± 0.70	1	0.026	0.00	0.00	0.00
JTTP (posterior)	1.78 ± 0.58	0.026	1	0.048	0.00	0.00
JTOM (posterior)	1.53 ± 0.56	0.00	0.048	1	0.03	0.00
HTCL (posterior)	1.26 ± 0.45	0.00	0.00	0.03	1	0.034
TA (posterior)	1.08 ± 0.27	0.00	0.00	0.00	0.034	1

Values are mean ± standard deviation.
JTTP, jaw trust with teeth protrusion; JTOM, jaw trust with opened mouth; HTCL, head tilt chin lift; TA, triple airway maneuver; NS, not significant ($p > 0.05$).

resulted respectively more improvement in posterior glottis view during FOB in 2–6 years of age group ($p > 0.05$). Statistical analysis of the view of anterior and posterior laryngopharyngeal tissues showed at the Tables 4–6.

In 0–2 years of age group; at anterior LP view scores both four airway supporting maneuvers (JTTP, JTOM, HTCL, TA) clinically and statistically ($p < 0.05$) improved anterior and posterior laryngopharyngeal view via flexible fiberoptic bronchoscopy when compared with neutral position. However there were no significant difference found between JTTP and JTOM maneuvers ($p > 0.05$). HTCL and TA maneuvers showed statistically significant difference when

Table 6 Statistical analysis of glottis view scores with different maneuvers in 6–15 years of age patients ($n = 45$).

Maneuver	Score	Neutral	JTTP	JTOM	HTCL	TA
Neutral (anterior)	2.47 ± 0.90	1	0.015	0.009	0.00	0.00
JTTP (anterior)	2.00 ± 0.83	0.015	1	NS	0.00	0.00
JTOM (anterior)	1.93 ± 0.75	0.009	NS	1	0.00	0.00
HTCL (anterior)	1.22 ± 0.42	0.00	0.00	0.00	1	NS
TA (anterior)	1.11 ± 0.31	0.00	0.00	0.00	NS	1
Neutral (posterior)	2.11 ± 0.65	1	0.01	0.001	0.00	0.00
JTTP (posterior)	1.76 ± 0.60	0.01	1	NS	0.00	0.00
JTOM (posterior)	1.62 ± 0.61	0.001	NS	1	0.00	0.00
HTCL (posterior)	1.13 ± 0.34	0.00	0.00	0.00	1	NS
TA (posterior)	1.02 ± 0.15	0.00	0.00	0.00	NS	1

Values are mean ± standard deviation.
JTTP, jaw trust with teeth protrusion; JTOM, jaw trust with opened mouth; HTCL, head tilt chin lift; TA, triple airway maneuver; NS, not significant ($p > 0.05$).

compared with both JTTP and JTOM ($p < 0.05$) but there were no significant difference found between HTCL and TA maneuvers ($p > 0.05$).

In 2–6 years of age group; at anterior LP scores showed similar results like general score. All airway maneuvers clinically and statistically improved at posterior LP view scores. In contrast with general results; JTTP and JTOM, HTCL and TA scores showed statistically significant results respectively.

In 6–15 years of age group; statistical analysis of both anterior and posterior LP view scores were similar with general results and 0–2 years of age group.

Discussion

According to our study, compared to the neutral position, all airway-supporting maneuvers (JTTP, JTOM, HTCL and TA) improved both anterior and posterior view of glottis during FOB in all pediatric age groups. The best maneuvers to improve both anterior and posterior glottis view in all age groups are HTCL and TA.

Flexible FOB via nasal approach under deep sedation or general anesthesia in pediatric group of patients is widely practiced technique. During deep sedation or general anesthesia, loss or reduction of muscle tone in upper laryngopharyngeal structures results posterior displacement of tongue, soft palate and epiglottis is the main reason for airway obstruction and limited visibility during FOB, as FOB relies on a clear airspace around bronchoscope's tip. This study was aimed to determine the effects of four different airway supporting maneuvers on glottis view and to find the best position for patient's head and neck for a clear airway during FOB.

Durga et al.[4] showed that jaw trust combined with lingual traction results a clear airway passage for orotracheal fiberoptic intubation. Unfortunately Durga et al. found that jaw trust or lingual traction fail to produce full clear airway when used alone. Lifting the epiglottis from posterior pharyngeal wall is the major factor for improving the view of anterior laryngopharyngeal structures. Cheng et al.[5] showed that JTTP, JTOM, HTCL and TA improves the view of anterior laryngopharyngeal tissues respectively. Our findings partially support Cheng et al. study. We found that both four maneuvers improved anterior view however we didn't found any differences between JTOM and JTTP and similarly there were no difference found between HTCL and TA maneuvers in our study except for posterior glottis view 2–6 years of age group. In Cheng et al. study as they used muscle relaxants and their patients were not spontaneously breathing their results were less improved compared with our results. Difference between the age groups in two studies is another factor for comparison. In a crossover study Stacey et al.[3] compared direct laryngoscopy and jaw trust to aid Fiberoptic intubation. They found that direct laryngoscopy produced better clear airway passage when compared with jaw trust maneuver. Unfortunately they compared only two methods to assess their effects on Fiberoptic view. It is possible to find different results if other maneuvers that we used were also employed in their study. Our study based on spontaneous ventilating patients and the depth of anesthesia might be inadequate for laryngoscopy. Deep sedation with propofol and ketamine is commonly used in clinical practice for the propose of hypnosis and analgesia for pediatric bronchoscopic procedures.[6] Our findings showed that the major factors, that has influence on the anterior displacement of the epiglottis from posterior pharyngeal wall are anterior movement of mandibula and head tilt positioning.

Recent study by Abramson et al.[7] assessed age related changes of the upper airway by 3-dimentional computed tomography. They found that upper airway parameters such as volume, surface area, length, mean cross-sectional area were increased in concordance with the increase in age. However they were found no difference regarding to sex in airway parameters. Kim et al.[8] found that there were proportional difference between children older than 12 months of age and children younger than 12 months of age regarding ultrasound measurements of subglottic diameter and empirical formula for endotracheal tube fitting.

Vialet et al.[9] found that slight head extension narrows the angle delta and improves alignment of the line of vision of the glottis and laryngeal axis. This data support our findings that positions including head extension like HTCL and TA are likely to improve glottis view weather in bronchoscopy or other imaging modalities.

Meier et al.[10] showed that chin lift and jaw trust maneuvers combined with continuous positive airway pressure (CPAP) improve the glottic opening via flexible nasal laryngoscopy and decrease stridor in spontaneously breathing, anesthetized children. However Bruppacher et al.[11] showed that jaw trust has a superior effect to improve airway patency and ventilation in children undergoing adenoidectomy when compared with chin lift and CPAP.

Reber et al.[12] investigated Jaw trust, Chin lift and combination of this maneuvers with CPAP in 24 children having adenotonsillar hypertrophy. Similarly with our study chin lift combined with CPAP showed the most efficient combination to reduce the stridor and improve the glottis score when compared with jaw trust alone or combination with CPAP.

In conclusion, airway-supporting maneuvers improves glottis view during FOB. Head tilt chin lift and Triple airway maneuvers were found to be the most efficient maneuver for both anterior and posterior glottis view during pediatric Fiberoptic bronchoscopy.

Conflicts of interest

The authors declare no conflicts of interest.

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