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ผลของเครื่องมือถ่างแผลผ่าตัดต่อความดันกระเปาะลมของท่อช่วยหายใจและการเป็นอัมพาตของเส้นประสาท Recurrent Laryngeal ระหว่างการผ่าตัดหมอนรองกระดูกและเชื่อมกระดูกคอทางด้านหน้า : การศึกษาเบื้องต้น

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Effects of Retractors on Endotracheal Tube Cuff Pressure and Recurrent Laryngeal Nerve Palsy during Anterior Cervical Discectomy and Fusion: A Preliminary Study

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บทนำ: การผ่าตัดหมอนรองกระดูกและเชื่อมกระดูกคอทางด้านหน้า (anterior cervical discectomy and fusion: ACDF) ต้องอาศัยการวางเครื่องมือถ่างแผลผ่าตัดเพื่อให้เห็นกระดูกสันหลังด้านหน้าชัดเจนขึ้น ผลที่ตามมาคือผนังด้านข้างของหลอดลมและเส้นประสาท recurrent laryngeal จะถูกดันทั้งจากเครื่องมือถ่างแผล และส่วนกระเปาะลมของท่อช่วยหายใจ (endotracheal tube cuff) อาจทำให้เกิดอาการอัมพาตของเส้นประสาท recurrent laryngeal หลังการผ่าตัดได้

วัตถุประสงค์: เพื่อศึกษาผลของเครื่องมือถ่างแผลผ่าตัดต่อความดันกระเปาะลมของท่อช่วยหายใจในการผ่าตัดหมอนรองกระดูกและเชื่อมกระดูกคอทางด้านหน้าและผลของการปรับค่าความดันกระเปาะลมของท่อช่วยหายใจต่อการเกิดภาวะกลืนลำบาก ภาวะสายเสียงขยับน้อย เสียงแหบและ เจ็บคอ หลังการผ่าตัด

วิธีการศึกษา: การศึกษาแบบ prospective randomized clinical trial ในผู้ป่วยที่เข้ารับการผ่าตัดหมอนรองกระดูกและเชื่อมกระดูกคอทางด้านหน้าในโรงพยาบาลจุฬาลงกรณ์ จำนวน 24 ราย โดยแบ่งออกเป็น 4 กลุ่มกลุ่มละ 6 ราย โดยการสุ่ม ได้แก่ กลุ่ม A คือปรับค่าความดันภายในกระเปาะ

Background: The surgical retractor had been applied to visualize the anterior cervical spine during anterior cervical discectomy and fusion (ACDF). As a result, the recurrent laryngeal nerve was trapped between retractor and endotracheal tube (ETT) cuff. An increasing of ETT cuff pressure with retractor placement might produce recurrent laryngeal nerve palsy.

Objectives: The aim of the present study was to observe the effects of retractors and changes in ETT cuff pressure and to evaluate the influence of ETT cuff pressure adjustment after retractor placement on postoperative dysphagia, hoarseness and sore throat.

Methods: A prospective randomized clinical trial was undertaken with 24 patients scheduled for elective ACDF. Patients were randomized into four groups: group (A); ETT cuff pressure was adjusted and maintained at 20 mm Hg after retractor placement without N_2O anesthesia, group (B); ETT cuff pressure was not adjusted after retractor placement without N_2O anesthesia, group (C); ETT cuff pressure was adjusted and maintained at 20 mm Hg after retractor placement with N_2O anesthesia and group (D); ETT cuff pressure was not adjusted after retractor

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ลมของท่อช่วยหายใจให้คงที่ในช่วงความดัน 20 มิลลิเมตรปรอท หลังวางเครื่องมือถ่างเปิดแผลและใช้ออกซิเจนในอากาศระหว่างการดมยาสลบ กลุ่ม B คือไม่มีการปรับค่าความดัน และใช้ออกซิเจนในอากาศระหว่างการดมยาสลบ กลุ่ม C คือปรับค่าความดันภายให้คงที่และใช้ออกซิเจนในไนตรัส ระหว่างการดมยาสลบ กลุ่ม D คือไม่มีการปรับค่าความดันและใช้ออกซิเจนในไนตรัสระหว่างการดมยาสลบ บันทึกค่าความดันกระเปาะหลอดลมของท่อช่วยหายใจและค่าความดันหลอดลมตลอดการผ่าตัด ภาวะกลืนลำบากหลังผ่าตัดประเมินโดย Bazaz dysphagia scale ที่ 24 ชั่วโมง และ 1 เดือนหลังการผ่าตัด ภาวะเสียงแหบประเมินโดย GRBAS scale และคะแนนความเจ็บคอหลังผ่าตัดประเมินโดยมาตรวัดความปวดแบบตัวเลข (numeric rating scale: NRS)

ผลการศึกษา: ผู้ป่วยทั้ง 4 กลุ่ม (24 ราย) มีความดันกระเปาะลมของท่อช่วยหายใจเพิ่มขึ้นระหว่างการใช้เครื่องมือถ่างแผลผ่าตัดอย่างนัยสำคัญทางสถิติ ไม่พบความแตกต่างกันของความดันกระเปาะหลอดลมของท่อช่วยหายใจและค่าความดันหลอดลมระหว่างกลุ่มที่ใช้และไม่ใช้ก๊าซไนตรัส พบภาวะกลืนลำบาก เสียงแหบและเจ็บคอภายหลังการผ่าตัดในผู้ป่วยทุกราย โดยกลุ่มที่ปรับค่าความดันภายในกระเปาะลมของท่อช่วยหายใจให้คงที่ในช่วงความดัน 20 มิลลิเมตรปรอท มีระดับความรุนแรงของการกลืนลำบากและภาวะเสียงแหบหลังการผ่าตัด 24 ชั่วโมงน้อยกว่าอย่างมีนัยสำคัญทางสถิติ ($p < 0.001$) อย่างไรก็ตามผู้ป่วยทุกรายให้คะแนนระดับความเจ็บคอไม่แตกต่างกัน

สรุป: การวางเครื่องมือถ่างแผลในผ่าตัดหมอนรองกระดูกและเชื่อมกระดูกคอทางด้านหน้าทำให้เกิดการเพิ่มขึ้น ของความดันกระเปาะลมของท่อช่วยหายใจ การใช้ก๊าซไนตรัสระหว่างการดมยาสลบไม่ส่งผลต่อการเพิ่มขึ้นของความดันกระเปาะลมของท่อช่วยหายใจ การปรับค่าความดันภายในกระเปาะลมท่อช่วยหายใจให้คงที่ในช่วงความดัน 20 มิลลิเมตรปรอท ระหว่างการวางเครื่องมือถ่างเปิดแผลสามารถช่วยลดระดับความรุนแรงของภาวะกลืนลำบากและเสียงแหบได้

คำสำคัญ: การผ่าตัดหมอนรองกระดูกและเชื่อมกระดูกคอทางด้านหน้า, กระเปาะลมของท่อช่วยหายใจ, เครื่องมือถ่างแผลผ่าตัด, ค่าความดัน เส้นประสาท recurrent laryngeal

placement with N_2O anesthesia. ETT cuff pressures and peak airway pressures were continuous recorded. Postoperative dysphagia (Bazaz dysphagia scale), hoarseness (GRBAS) and sore throat (NRS; 0-10) were followed up at 24 h and 1 mo.

Results: 24 ASA physical status I-III patients were evaluated. There was significantly increased in ETT cuff pressure values after retractor application when compared to the baseline values in 4 groups. There was no significant difference in changed ETT cuff pressure and peak airway pressure values between N_2O anesthesia (C, D) and without N_2O anesthesia (A, B) groups at the same period of time. Postoperative dysphagia, hoarseness and sore throat were found in all patients. The data showed significant lower of the Bazaz dysphagia scale and the severity score of hoarseness (GRBAS) in the adjustable ETT cuff pressure to maintain 20 mm Hg after retractor replacement groups (A, C) at 24 h postoperatively ($p < 0.001$). However, there was no significant difference in the NRS of sore throat among 4 groups.

Conclusions: ETT cuff pressure significantly increased after retractor replacement during ACDF. An increasing of the cuff pressure was not affected by nitrous oxide used. Adjusting to maintain ETT cuff pressure at 20 mm Hg after applied cervical retractor reduced the severity of dysphagia and hoarseness.

Keywords: anterior cervical discectomy and fusion, endotracheal tube cuff pressure, recurrent laryngeal nerve, surgical retractor

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Introduction

Since 1990s, Anterior cervical discectomy and fusion (ACDF) has been commonly performing for management of cervical disc herniation and degenerative disc disease. The surgical retractor is applied in order to visualize the anterior cervical spine. Inserting this retractor cause compression laterally to the carotid sheath, medially to trachea and esophagus.

Consequently, the recurrent laryngeal nerve is trapped between the retractor and the endotracheal tube (ETT) cuff, might be compromised.[1]

The recurrent laryngeal nerve injury is the most common complication include dysphagia, hoarseness, sore throat and vocal fold paralysis.[2] The overall incidence of postoperative dysphagia after ACDF varies from 9.6-17.8%, hoarseness and sore throat were 3.1-11% and vocal fold paralysis was less than 2%.[3-5]

Increasing of ETT cuff pressure was seen during nitrous oxide anesthesia that caused a pressure effect on recurrent laryngeal nerve. This effect was alleviated by ETT deflation. Previous studies had shown that maintaining ETT cuff pressure between 15 and 25 mmHg could reduce endotracheal intubation-related complications in patients undergoing general anesthesia.[1] Nonetheless, there had been a few researches reported on the correlation between retractor placement and changes in ETT cuff pressure using continuous measurement. Furthermore, adjusting ETT cuff pressure after retractor placement was not usually observed.

The purpose of the present study was therefore to determine the effects of retractor and changes in ETT cuff pressure during ACDF. A secondary objective was to evaluate the influence of ETT cuff pressure adjustment after retractor placement on postoperative dysphagia, hoarseness and sore throat.

Materials & Methods

This was a prospective, randomized trial. The study was approved by the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand (IRB No. 498/58). Written informed consent was obtained from all patients who met eligibility criteria. Twenty-four patients, ASA physical status I-III, aged 20 or older who were scheduled for elective primary anterior cervical discectomy which fusion at least 1 level, were included. Patients were excluded for any one of the following: (1) pre-operative dysphagia, hoarseness or sore throat (2) pre-operative recurrent laryngeal nerve palsy (3) pre-operative short neck or airway anatomical deformity (4) body mass index > 40 (5) history of smoking (6) psychiatric problems.

Anesthesia Methods and Protocols

On the day of surgery, each eligible patient was randomly assigned into 4 groups using the randomized block designs: Group (A); ETT cuff pressure was adjusted and maintained at 20 mm Hg after retractor placement without N_2O anesthesia, Group (B); ETT cuff pressure was not adjusted after retractor placement without N_2O anesthesia, Group (C); ETT cuff pressure was adjusted and maintained at 20 mm Hg after retractor placement with N_2O anesthesia and Group (D); ETT cuff pressure was not adjusted after retractor placement with N_2O anesthesia. In the operating room, standard monitoring including noninvasive blood pressure, electrocardiogram, pulse oximeter, end tidal CO_2, temperature and esophageal stethoscope were measured. Peripheral nerve stimulator was also monitored. General anesthesia was induced with an intravenous fentanyl (0.5-1 mcg/kg), thiopental (3-5 mg/kg) or propofol (1.5-2.5 mg/kg). Tracheal intubation was performed by an experienced anesthesiologist with cis-atracurium (0.15-0.2 mg/kg) using a size 7-7.5 mm ID ETT for women and size 8-8.5 mm ID ETT for men. After endotracheal intubation, cuff pressure was manually inflated with air to a point just-to-seal at an adjustable pressure limiting valve 20 cm H_2O. All patients were in supine position with their neck slightly extended. The pilot balloon of ETT was attached to an air-filled pressure transducer for continuous cuff pressure monitoring (Figure 1). Anesthesia was maintained by 40% O_2 in N_2O or air and 1.2 MAC of desflurane, with intermittent intravenous injection of fentanyl 25 mcg/dose for analgesia and cis-atracurium 2 mg/dose for muscle relaxation. At the end of surgery, ETT was removed whenever adequate recovery of neuromuscular function was determined and spontaneous ventilation had completely recovered then transferred to the recovery room.

Endotracheal tube cuff pressure manipulation

ETT cuff pressure was manually inflated to 20 mm Hg in all eligible patients when finished positioning. In group A and C, the ETT cuff pressure was adjusted to maintain at 20 mm Hg during retractor placement. Air was withdrawn via pilot balloon, if ETT cuff pressure set above 20 mm Hg. In group B and D, the ETT cuff pressure adjustable was not performed.

ETT cuff pressures and peak airway pressures were continuous recorded at 5 min after endotracheal intubation (baseline; T0), just before and after 1 min after surgical retractor replacement (T1), every 5 min during surgical retractor replacement (T2), through immediately after retractor removal (T3). Before extubation, no further manipulation was performed until the ETT cuff pressure was deflated.

Baseline data

Baseline recordings include age, gender, weight, height, body mass index, ASA physical status, medical history and comorbidity, number of levels operated on, duration of operation, duration of retractor placement and total doses of cis-atracurium.

Surgical procedure

The Smith Robinson technique was used in all patients. The pathological cervical disc level was identified by C-arm fluoroscopy. A small transverse incision was on the right side of neck. The prevertebral space was approached between the carotid sheath laterally, the trachea and esophagus medially. The Cloward retractor was applied.

Postoperative measurement and assessment

All patients were followed up at 24 hour and 1 month postoperatively. The questionnaire was recorded by a blinded observer about postoperative dysphagia measured by using the Bazaz dysphagia scale, postoperative hoarseness measured by using a clinician-based voice assessment protocol; Grade, Roughness, Breathiness, Asthenia, Strain (GRBAS) and postoperative sore throat by using a numeric rating scale.

Statistical analysis

Demographic data were presented by descriptive statistics. Categorical data were presented by percentage and continuous data were presented by mean and standard deviation (SD) for all normal distribution and median, minimum, and maximum for non-normal distribution. Continuous variables were compared by ANOVA or Kruskal-Wallis test and categorical variables were compared by Fisher's exact test. Comparing cuff pressure and peak airway pressure within group was analyzed by Wilcoxon signed rank test. All statistical tests were two-tailed and performed at the 0.05 significance level.

Results

Of 24 patients evaluated, each group consisted of 6 patients. The male to female ratio within group B and D were imbalanced; there were significantly more male than female patients. However, there was no statistically significant difference in gender, age, ASA physical status, body mass index, number of levels operated on, duration of operation, duration of retractor placement and total doses of cis-atracurium among 4 groups (Table 1).

There was significantly increased in ETT cuff pressure values after retractor application when compared to the baseline values in 4 groups (group A 24.8 ± 1.7 vs 18 ± 4.5; $p = 0.043$, group B 24.3 ± 2.9 vs 19.5 ± 2.2; $p = 0.043$, group C 24.2 ± 1.5 vs 18.7 ± 2.3; $p = 0.027$, group D 24.8 ± 1.7 vs 17.8 ± 3.1mm Hg; $p = 0.027$).

Furthermore, the data showed that ETT cuff pressure values after retractor replacement were significantly higher than removal among 4 groups (group A 24.8 ± 1.7 vs 16.7 ± 1.5; $p = 0.027$, group B 24.3 ± 2.9 vs 17.3 ± 2.0; $p = 0.028$, group C 24.2 ± 1.5 vs 15.5 ± 1.4;$p = 0.027$, group D 24.8 ± 1.7 vs 17.5 ± 1.8 mm Hg; $p = 0.027$). Although, there was no significant difference in all groups when compared ETT cuff pressure baseline values with after removal ($p = 0.465, 0.336, 0.058, 1.000$, respectively) (Table 2).

Table 1 Comparison of Demographic Data Between Four Groups

Data	Group				P value
	A	B	C	D	
Gender					0.793
Male	3	5	3	4	
Female	3	1	3	2	
Age	52±14	56±20	61±14	57±12	0.750
ASA physical status					1.000
1	3	2	2	3	
2	2	3	3	3	
3	1	1	1	0	
BMI	24.9±3.0	24.6±3.9	26.0±5.0	25.7±5.2	0.992
Number of intervertebral levels operated					0.878
1	5	5	6	4	
2	1	1	0	2	
Total of cis-atracurium (mg)	14.3±1.5	13.7±2.3	17.0±3.3	13.5±1.2	0.095
Duration of operation(min)	147.5	140	187.5	130	0.243
	(115, 195)	(125, 180)	(120, 210)	(120, 165)	
Duration of retractor application(min)	50	58.5	87.5	57.5	0.473
	(30, 105)	(37, 104)	(35, 115)	(30, 85)	

Data are expressed as number, ratio, or mean±SD and * P < 0.05

Table 2 Endotracheal cuff pressure at various stages of ACDF operation

Parameters	Stages	Groups			
		A	B	C	D
Cuff pressure (mm Hg)	Baseline : T0	18 ± 4.5 (12-23)	19.5 ± 2.2 (16-22)	18.7 ± 2.3 (15-21)	17.8 ± 3.1 (15-22)
	Before application of retractor : T1	21.3 ± 2.1 (19-25)	21.3 ± 2.0 (20-25)	20.8 ± 0.8 (20-22)	20.5 ± 2.1 (17-23)
		(p = 0.207)	(p = 0.066)	(p = 0.066)	(p = 0.026)
	During application of retractor : T2	24.8 ± 1.7 (23-28)	24.3 ± 2.9 (22-30)	24.2 ± 1.5 (22-26)	24.8 ± 1.7 (23-28)
		(p = 0.043)*	(p = 0.043)*	(p = 0.027)*	(p = 0.027)*
	After removal of retractor : T3	16.7 ± 1.5 (15-18)	17.3 ± 2.0 (16-21)	15.5 ± 1.4 (13-17)	17.5 ± 1.8 (15-20)
		(p = 0.465)	(p = 0.336)	(p = 0.058)	(p = 1.000)

Data are expressed as mean±SD , range and * P < 0.05

The changes of peak airway pressure values in all groups showed no statistical significant between baseline and after retractor application (group A 20.3 ± 3.3 vs 20.7 ± 3.3;p = 0.157, group B 19.5 ± 3.3 vs 19.8 ± 3.1; p = 0.317, group C 20.0 ± 4.5 vs 20.5 ± 4.4;p = 0.083, group D 20.5 ± 4.0 vs 20.8 ± 4.1 cm H2O; p = 0.157). Moreover, there was a similar when compared baseline values with after retractor removal values, and also after retractor placement with after removal values (Table 3).

There was no significant difference in changed ETT cuff pressure and peak airway pressure values between N_2O anesthesia (C, D) and without N_2O anesthesia (A, B) groups at the same time period (T0, T1, T2, and T3) (Table 4). (Figure 1)

Table 3 Peak airway pressure at various stages of ACDF operation

Parameters	Stages	Groups			
		A	B	C	D
Peak airway pressure ($cm H_2O$)	Baseline : T0	20.3 ± 3.3 (16-26)	19.5 ± 3.3 (16-24)	20.0 ± 4.5 (16-27)	20.5 ± 4.0 (15-27)
	Before application of retractor : T1	20.7 ± 3.3 (16-26) (p = 0.157)	19.5 ± 3.3 (16-24) (p = 1.000)	20.2 ± 4.4 (16-27) (p = 0.317)	20.5 ± 4.0 (15-27) (p = 1.000)
	During application of retractor : T2	20.7 ± 3.3 (16-26) (p = 0.157)	19.8 ± 3.1 (16-24) (p = 0.317)	20.5 ± 4.4 (16-27) (p = 0.083)	20.8 ± 4.1 (15-27) (p = 0.157)
	After removal of retractor : T3	20.3 ± 3.3 (16-26) (p = 1.000)	19.7 ± 3.1 (17-24) (p = 0.564)	20.5 ± 4.4 (16-27) (p = 0.083)	20.7 ± 3.6 (15-26) (p = 0.564)

Data are expressed as mean±SD , range and * P < 0.05

Table 4 Peak airway pressure at various stages of ACDF operation

Parameters	Techniques of anesthesia	Stages			
		Baseline : T0	Before application of retractor : T1	During application of retractor : T2	After removal of retractor : T3
Cuff pressure (mm Hg)	Without N_2O (A,B)	18.3 ± 3.5 (12-23)	21.3 ± 1.9 (19-25)	24.6 ± 2.3 (22-30)	17.0 ± 1.7 (15-21)
	N_2O (C,D)	18.3 ± 2.6 (15-22)	20.7 ± 1.5 (17-23)	24.5 ± 1.6 (22-28)	16.5 ± 1.8 (13-20)
P value		0.630	0.630	0.630	0.630
Peak airway pressure ($cm H_2O$)	Without N_2O (A,B)	19.9 ± 3.2 (16-26)	20.1 ± 3.2 (16-26)	20.3 ± 3.1 (16-26)	20.0 ± 3.1 (16-26)
	N_2O (C,D)	20.3 ± 4.0 (15-27)	20.3 ± 4.0 (15-27)	20.7 ± 4.1 (15-27)	20.6 ± 3.8 (15-27)
P value		0.932	0.932	0.932	0.932

Data are expressed as mean±SD , range and * P < 0.05

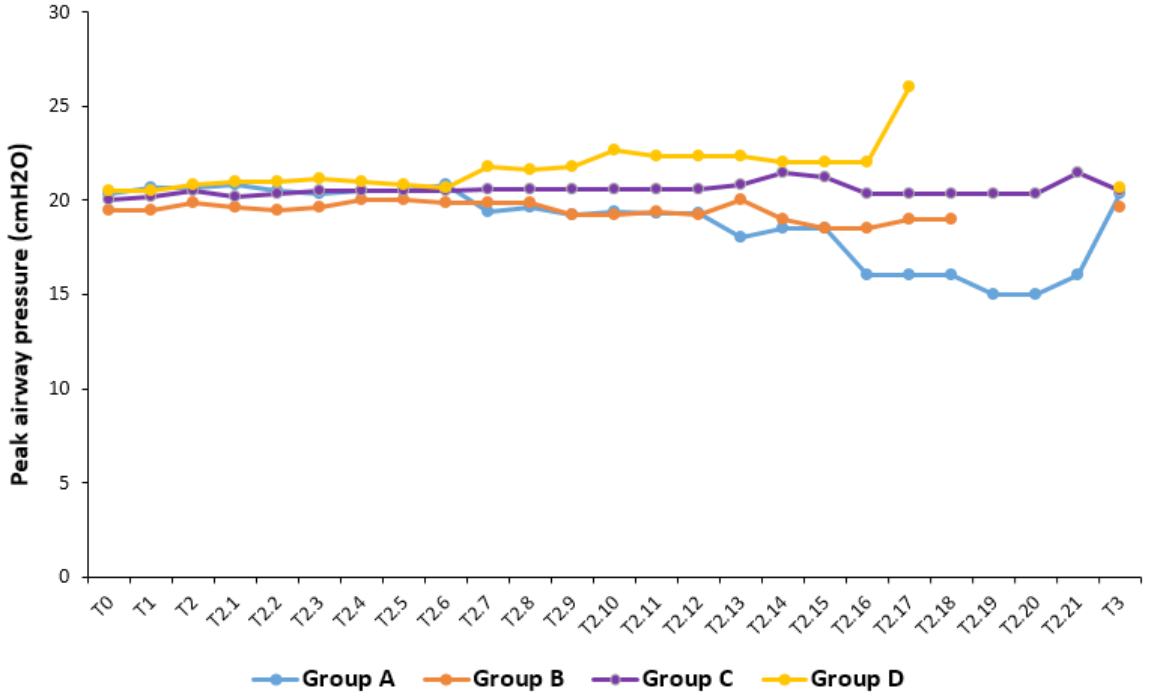

Figure 1 Peak airway pressure at various stages of ACDF operation

Table 5 Severity of postoperative dysphagia, hoarseness and sore throat

Parameters	Follow-up	Severity	Groups				P value
			A	B	C	D	
Bazaz dysphagia scale	24 h	none	0	0	0	0	<0.001
		mild	6	0	6	0	
		moderate	0	0	0	1	
		severe	0	6	0	5	
	1mo	none	4	1	5	3	0.97
		mild	2	3	1	1	
		moderate	0	1	0	1	
		severe	0	1	0	1	
Score of hoarseness (GRBAS)	24 h	normal	0	0	0	0	<0.001
		slight	6	0	6	0	
		medium	0	6	0	6	
		high	0	0	0	0	
Numeric rating scale of sore throat	24 h	1 to 10	5 (5, 6)	5 (3, 6)	5 (3, 8)	5 (5, 6)	0.56

Data are expressed as number and * P < 0.05

Postoperative dysphagia, hoarseness and sore throat were found in all patients. The severity score of dysphagia (the Bazaz dysphagia scale) at 24 h varied from 1-3 whereas 0-2 at 1 month postoperatively. The data showed a significant lower in the Bazaz dysphagia scale in adjustable ETT cuff pressure to maintain 20 mm Hg after retractor replacement groups (A, C) at 24 h postoperatively ($p < 0.001$). The severity score of hoarseness (GRBAS) at 24 h was about 1-2, and also was statistically significant lower score in group A, C than B, D ($p < 0.001$). Nevertheless, there was no significant difference in the numeric rating scale of sore throat among 4 groups (NRS 5-10/10) (Table 5).

Discussion

The surgical retractor was placed in the soft tissue of neck during anterior cervical discectomy and fusion (ACDF) to approach the anterior cervical spine. The objective of this study was to determine the effect of retractor and changes in ETT cuff pressure during ACDF. As well as to evaluate the influence of ETT cuff pressure adjustment after retractor placement on postoperative dysphagia, hoarseness and sore throat.

From the results of this study showed that ETT cuff pressure significantly increased after retractor replacement during anterior cervical discectomy and fusion in all groups (Table 2). In addition, the ETT cuff pressure in six patients increased from baseline values of 18-20 mm Hg to 38 mm Hg. This outcome was correlated to previous studies. In Rakesh Garg et al. showed that the cuff pressure increased to 48 mm Hg from 10-12 mm Hg of baseline values.[6] Kim SW et al. found that the cuff pressure increased from 20 mm Hg (baseline) to 32 mm Hg.[7] As well as, Apfelbaum and colleagues in a cadaveric study illustrated raised in ETT cuff pressure from 15 to 52 mm Hg after retractor application.[5]

Recent study demonstrated that the peak airway pressure increased but not clinically significant after retraction.[6] Possibly, the effect from surrounding tissue pressured on endotracheal tube. Nevertheless, in the present study, there was no significant difference in the peak airway pressure during placement of retractor.

During nitrous oxide (N_2O) anesthesia, it had been reported that N_2O diffusion into the ETT cuff pressure leading to increased cuff pressure and might cause morbidity.[8,9] However, nitrous oxide had several advantages such as analgesic effects, potential to reduce awareness, allow for rapid and reliable changes in depth of anesthesia.[10] Until now, there was no any

previous study using N_2O anesthesia during ACDF operation. To prove the effect of N_2O on the ETT cuff pressure, we compared N_2O anesthesia groups (C, D) with not using N_2O anesthesia groups (A, B) (Table 4). The result showed that there was no significant difference in changed ETT cuff pressure values between groups at the same time period. This might cause by a slightly expansion of N_2O in cuff pressure and a proportional of cuff pressure over time exposure.[11] Thereby, the present study suggested the use of N_2O anesthesia in anterior cervical discectomy and fusion (ACDF).

With retractor application, this study postulated that ETT cuff pressure increased. Possibly, rising in cuff pressure, as well as the retractor itself, might be caused a direct effect to compress the tracheal wall mucosa and recurrent laryngeal nerve. Clinical symptoms included dysphagia, hoarseness and sore throat that were most obvious 24 hour postoperatively. The incidence of vocal cord palsy was about 2.7-3.2%.[6,12] Previous studies reported that controlled ETT cuff pressure could reduce this iatrogenic trauma to recurrent laryngeal nerve and then decreased complications.[2,4,13,14] It had been reported that a reduction of the ETT cuff pressure below 20 mm Hg during retractor insertion reduced the damage to recurrent laryngeal nerve.[4] As a result from our study, postoperative dysphagia, hoarseness and sore throat were observed in all patients. However, severity of postoperative dysphagia at 24 h and hoarseness were lower score in an adjustable the ETT cuff pressure to maintain 20 mm Hg after retractor replacement group (A, C) than controlled groups (B, D) ($p < 0.001$). But the numeric rating scale of sore throat was similar in all groups. Moreover, we found that the severity of symptoms was temporary and recovery within 1-3 months postoperatively.

Recurrent laryngeal nerve injury was the most commonly reported ACDF-related complications.[15] The incidence was varied from 15-94%.[16] Normal tracheal venous and lymphatic pressure are 12 mm Hg and 3-5 mm Hg; respectively.[17] It had been reported that over-inflation of ETT cuff pressure would produce high pressure on the tracheal wall disturbed perfusion of tracheal mucosa and resulted in tracheal mucosa ischemia when cuff pressure exceeded 30 mm Hg. Thus, an appropriate ETT cuff pressure would decrease complications. At present, the ETT cuff pressure was recommended to maintain with in 15-25 mm Hg providing an adequate seal to prevent aspiration and air leak, without compromising tracheal mucosa perfusion.[18]

Jianhui Lui, et al. illustrated that the severity of tracheal mucosa, examined by using fiberoptic bronchoscopy, was correlated to a high ETT cuff pressure.[12] Indicating that routine ETT cuff measurement after endotracheal intubation event during brief operation had been recommended as a method to reduce postoperative tracheal morbidity.[19,20] However, it did not usually used in practical. Nowadays, there was no standards for frequency and method of cuff pressure monitoring. In our study, we used a continuous monitoring of ETT cuff pressure due to feasible, accurate and also could be manner safely.

There were limitations of this study. First, the present study is a pilot design, therefore it is limited by the small sample size. Second, the parameters for postoperative evaluation, include the Bazaz dysphagia scale, a clinician-based voice assessment protocol; Grade, Roughness, Breathiness, Asthenia, Strain (GRBAS) and a numeric rating scale, are subjective. Third, a recall bias may occur during follow up patient's symptoms (dysphagia, hoarseness and sore throat) at 1 month postoperatively because patients might recall past exposure better or worse than the reality.

Conclusion

The placement of surgical retractor during anterior cervical discectomy and fusion results in rising of endotracheal tube cuff pressure from the baseline cuff pressure. To manipulate and maintain the ETT cuff pressure at 20 mm Hg, after cervical retractor was applied, reduced the severity of dysphagia and hoarseness when compared with a nonadjustable cuff

pressure. Nitrous oxide was not caused increased cuff pressure however; further study with more sample size is required.

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