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Systematic Review and Meta-Analysis

Impact of Endotracheal Tube Cuff Pressure on Postoperative Sore Throat: A Systematic Review and Meta-Analysis

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ABSTRACT

Background: Endotracheal tube (ETT) is often necessary to achieve airway control during general anesthesia. Recent studies have showed that sore throat following endotracheal intubation is a common complaint after surgery. The objective of this systematic review and meta-analysis was to estimate whether ETT cuff pressure affects the incidence of postoperative sore throat (POST) after general anesthesia.

Methods: The following databases were searched electronically: PubMed (updated to Nov 2015), EMBASE (updated to Nov 2015), World Health Organization International Clinical Trials Registry Platform (updated to Jul 2015), Chinese BioMedical Literature Database (1978 to Oct 2015), and China National Knowledge Infrastructure (1994 to Oct 2015). Trials comparing EET cuff pressure for elective surgery were included.

Results: Three trials with a total of 609 patients were included in current analysis. Pool results from these trials showed that a lower ETT cuff pressure significantly decreased the incidence of POST at 24 hours after surgery (relative ratio [RR]=0.76, 95% confidence interval [CI] 0.61-0.95, P<0.05). However, there wasn't any difference between lower and higher cuff pressure on the incidence of POST in post-anesthesia care unit (PACU) (RR=1.00, 95% CI 0.31-3.25, P=1). A lower ETT cuff pressure was not associated with a lower incidence of postoperative hoarseness (PH) at 24 hours after surgery (RR=0.71, 95% CI 0.26-1.92, P=0.50) and in PACU (RR=1.07, 95% CI 0.59-1.93, P=0.82).

Conclusion: Our meta-analysis suggested that lower ETT cuff pressure was associated with a lower incidence of POST in patients undergoing general anesthesia at 24 hours after surgery. However, the exact effect of ETT cuff pressure on patients undergoing general anesthesia deserves further studies.

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Anesthesia is considered to be safe and stable for day surgery patients, with a low incidence of mortality and major morbidity (1). However, minor complications continue to be common and sometimes prolong the recovery time of patients and become a cause of patient dissatisfaction (2). Endotracheal tube (ETT) is often necessary to achieve airway control during general anesthesia. However, postoperative sore throat (POST) is considered as a common adverse event in patients undergoing general anesthesia with ETT. POST continues to be reported with a high frequency and can sometimes persist for several days (3). The incidence of POST ranges from 21% to 71.8% (4-6), while the incidence of postoperative hoarseness (PH) is between

40% and 50% (3, 7).

It is known that ETT cuff pressure makes a direct impact on the incidence of POST (3) and PH (8). Several studies have evaluated the effects of different ETT cuff pressures on the incidence of POST. Jaensson et al. (3) found that lower ETT cuff pressure can alleviate sore throat and discomfort in women at the post-anesthesia care unit (PACU). To our best knowledge, no previous systematic reviews or meta-analyses were conducted to define the exact role of a lower ETT cuff pressure on the incidence of POST. Therefore, we attempted to summarize the available randomized control trials (RCTs) to illustrate whether a lower ETT cuff pressure was associated with a lower incidence of POST.

MATERIALS AND METHODS

Data Sources and Searches

We searched PubMed (updated to Nov 2015), EMBASE (updated to Nov 15, 2015), World Health Organization International Clinical Trials Registry Platform (updated to Jul 2015), Chinese BioMedical Literature Database (1978 to Oct 2015), and China National Knowledge Infrastructure (1994 to Oct 2015). The medical subject heading and the appropriate corresponding keywords, "cuff pressure" AND "postoperative sore throat" were used. Studies including patients undergoing ear- nose- throat department surgeries were excluded, which may affect the accuracy of the results. We restricted the findings of the above searched with a highly sensitive search strategy recommended by the Cochrane Collaboration for identifying RCTs (9). We also checked the reference lists of RCTs and previous meta- analyses identified by the above searches to include other potential eligible trials. Finally, references from relevant articles were reviewed to identify additional studies. We followed the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analysis for reporting our results (10).

Study Selection

We identified and reviewed all studies that met the following criteria: RCTs; population: adults undergoing general anesthesia; intervention: more than one different cuff pressure of ETT; and outcome: incidence of POST.

Data Extraction and Assessment of Study Quality

The selection of studies for inclusion in the review was performed independently by the reviewers (Hu and Xu) after using the search strategy described previously. Data were abstracted independently by Hu and Xu by using a standardized data collection form. There was no attempt to bind to the reviewers (Hu and Xu) to the authors or the results of the relevant trials. Details of study designs (i.e., date, location and sample size), patient characteristics (i.e., population gender), study design (i.e., inclusion/exclusion criteria, ETT insertion and anesthetic technique), intervention (i.e., definition of lower and higher ETT cuff pressure), surgery duration, anesthesia maintenance narcotic and main outcomes were collected. If data needed clarification or was not present in the publication, the original authors were contacted. Extracted data were entered into Microsoft Office Excel 2007 and were checked by the third author. Discrepancies were resolved by discussion, or advice was sought from a third author.

The primary outcome of the data were the incidences of POST in PACU and at 24 hours after surgery. The secondary outcomes were the incidences of PH in PACU and at 24 hours following surgery.

Statistical Analysis

Analyses were on an experiment- to- control basis. Differences were expressed as relative ratios (RRs) with 95% confidence intervals (CIs) for dichotomous outcomes. A fixed- effect model was used and a random- effects model was employed in the case of significant heterogeneity (P- value of chi- square test less than 0.10 and I^2 greater than 50%). Potential sources of heterogeneity were identified by sensitivity analyses conducted by omitting one study in each turn and investigating the influence of a single study on the overall pooled estimate. Publication bias was assessed by visually inspecting funnel plots. A P value of less than 0.05 was considered statistically significant. All statistical analyses were performed using Review Manager, version 5.0 (RevMan, The Cochrane Collaboration, Oxford, United Kingdom).

Table. Characteristics of The Included Trials.

Study	Gender	Mean age (year)	Mean cuff pressure (cm H_2O)	N_2O using	Inflated	Mean intubation duration (min)	Size of ETT	Sample size	POST in PACU	POST at 24 hours	PH in PACU	PH at 24 hours
Al-metwalli 2011	Both (female and male) (F/M=26/24)	24-47	20/25	No	Air	112.9/115.2	7.5/ 8.0	25/25	3/2	2/4	4/4	5/6
Braz 2004	Both (F/M=49/1)	33-54	20/25	66% in O_2	Air	258/270	7.5/ 8.0	25/25	2/5	2/3	11/10	10/7
Liu 2010	Both (F/M=316/193)	35-70	20/43	No	Air	162/168	7.0-7.5 / 7.5-8.0	236/273	NR	81/119	NR	8/30

ETT, endotracheal tube; POST, postoperative sore throat; PACU, post-anesthesia care unit; PH, postoperative hoarseness; NR, not reported.

RESULTS

Identification and Selection of Study

The comprehensive search yielded a total of 1448 relevant publications, and the abstracts were obtained for all citations (Figure 1). Three trials with a total of 609 patients were identified and finally included into the current analysis (11-13). The Cohen K statistic for agreement on study inclusion was 0.92.

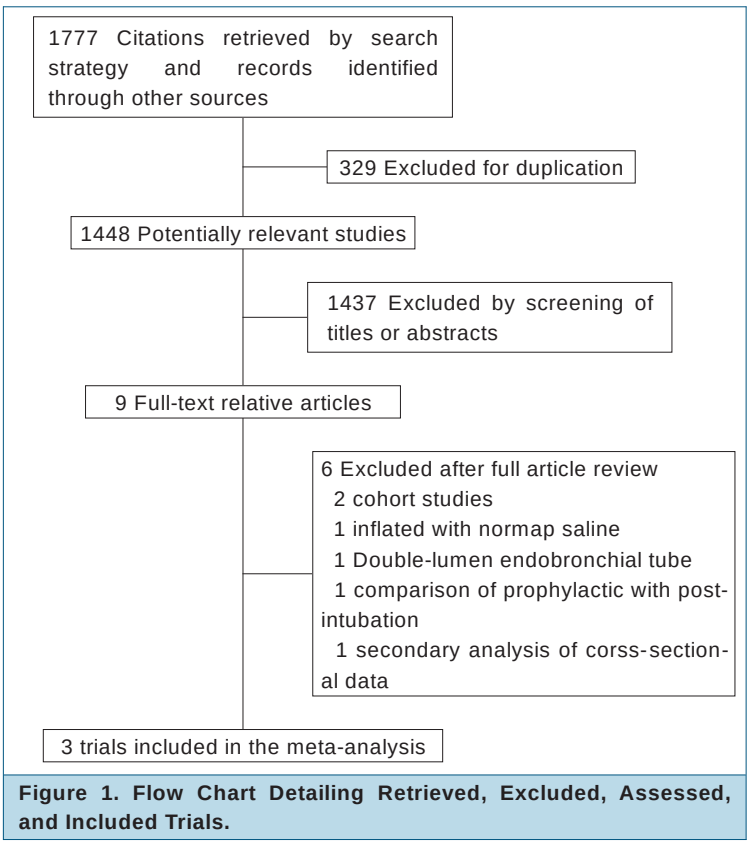

Figure 1. Flow Chart Detailing Retrieved, Excluded, Assessed, and Included Trials.

Study Characteristics and Quality

Among the three trials, two were conducted in Asian (11, 13), and one in south America (12). All trials were published in English. The age of patients ranged from 36 to 72 years old. The selected trials examined various types of general surgeries. The gender of all patients and the cuff pressure or size of ETT included in this analysis were not defined. No double lumen ETT was used in all included RCTs. Characteristics of included trials were summarized in Table.

For all selected trials, randomized sequence and allocation sequence concealment were adequately conducted. Blinded fashion was clearly stated in the adjudication of POST in two RCTs (11, 12). The numbers and reasons for withdrawal or dropout were reported in details in all trials. Nitrous oxide was not used in all included studies to avoid the cuff pressure changes except the study conducted by Braz et al., but cuff pressure monitors were used and connected to the cuff continuously in all included studies. An overview of the risk of bias was shown in Figure 2.

Primary Outcomes

Data on primary outcomes were available in three trials (n=609). A lower ETT cuff pressure could significantly reduce the incidence of POST at 24 hours after surgery (RR=0.76, 95% CI 0.61-0.95, P<0.05; P for heterogeneity=0.60, I^2=0%; Figure 3). However, a lower ETT cuff pressure didn′t show any superiority in the incidence of POST in PACU (RR=1.00, 95% CI 0.3-3.25, P=1.00; P for heterogeneity=0.51, I^2=0%; Figure 4).

Secondary Outcomes

Our analysis indicated that a lower ETT cuff pressure was not associated with a lower incidence of PH at 24 hours after surgery (RR=

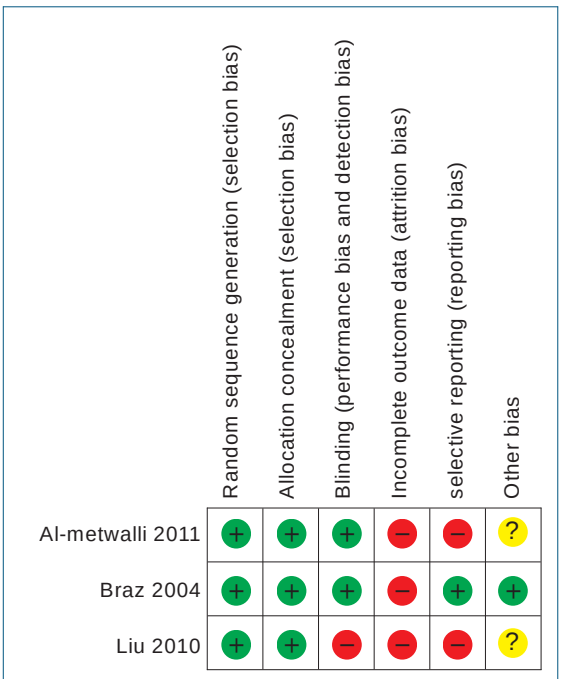

Figure 2. Risk of Bias Summary: Review Authors' Judgments About Each Risk of Bias Items for Each Included Study.

0.71, 95% CI 0.26-1.92, P=0.50; P for heterogeneity=0.02, I^2=75%; Figure 5). Our pooled analysis indicated that the ETT cuff pressure did not affect the incidence of PH in PACU (RR=1.07, 95% CI 0.59-1.93, P=0.82; P for heterogeneity=0.89, I^2=0%; Figure 6).

Sensitivity Analysis and Publication Bias

Tests for heterogeneity identified the trial by Braz (2004) et al. with outlying results. Exclusion of this trial resolved the heterogeneity, but did not change the results (not presented). For the results of POST in PACU and at 24 hours after surgery, there was no evidence of significant publication bias by inspection of the funnel plot (not presented).

DISCUSSION

To our best knowledge, this is the first meta-analysis of studies to evaluate the effect of different cuff pressures of ETT on the incidence of POST. Our meta-analysis suggested that a lower ETT cuff pressure could significantly reduce the incidence of POST at 24 hours after surgery.

POST is one of the most common complaints of patients after endotracheal extubation (6). The symptom was so common that many patients and anesthesia staff believed that it was a natural consequence of endotracheal intubation. POST was at its peak in the early postoperative period, 2 to 6 hours after extubation (3, 14), but the incidence decreased rapidly with time. The underlying causes of POST include mechanical pressure by the cuff or tube. We had found in a systematic review and meta-analysis that smaller size of ETT could reduce the incidence of POST (15). It′ s known that ETT with larger size can exert higher pressure at the tube mucosal interface and lead to a greater area of muscle trauma (16). The movement of cuff and tube in the trachea when positioning and manipulation of goiter during surgery are also responsible for POST. It is recommended that the ETT cuff pressure should be between 15 and 25 cm H_2O (17). The potential mechanism lies on that excessive cuff pressure can cause damage to tracheal mucosa by direct trauma and reduction of blood flow (18). When the pressure reaches 30 cm H_2O, blood flow can be reduced considerably (19).

It is also not clear what the effect of perioperative monitoring of the cuff pressure is on the patients′ perceived pain or injury to their tracheal mucosa. Up to now, anesthesia staff have suggested that in short procedures that last only a few hours, most clinicians give little attention to operative cuff pressure.

Another factor which was thought to be associated with an increased risk of POST was the experience of the anesthesia personnel (20). However, this factor has not been shown to increase the risk of POST in previous studies (6, 21, 22). It seems that relying on experience in calculation of the pressure by pilot balloon palpation is not sufficiently reliable (23). The volume of cuff inflation should preferably not be fixed. To allow effective ventilation, the cuff should be inflated until it prevents an air leak. Furthermore, it is likely that training on a manikin simulator during the early phase of employment may improve the technique and thereby reduce the risk of POST.

POST is largely self-limiting and most interventions only result in a minor reduction in the severity of symptoms, in hence, avoiding excessive cuff pressure has the most favourable pro-

Study or Subgroup	low pressure Events	Total	high pressure Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Al-metwalli 2011	2	25	4	25	3.4%	0.50(0.10, 2.49)
Braz 2004	2	25	5	25	4.2%	0.40(0.09, 1.87)
Liu 2010	81	236	119	273	92.5%	0.79(0.63, 0.98)
Total (95% CI)		286		323	100%	0.76(0.61, 0.95)
Total events	85		128			

Heterogeneity: Chi^2=1.02, df=2(P=0.60); I^2=0%
Test for overall effect; Z=2.44 (P=0.01)

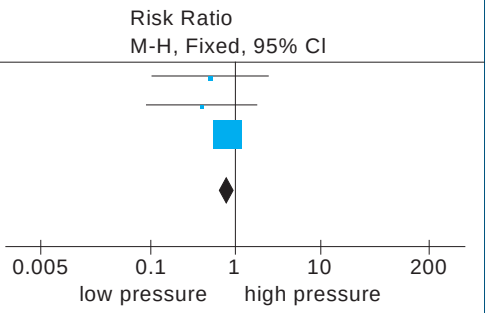

Figure 3. Forest Plot of POST at 24 Hours after Surgery.

Study or Subgroup	low pressure Events	Total	high pressure Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Al-metwalli 2011	3	25	2	25	40.0%	1.50(0.27, 8.22)
Braz 2004	2	25	3	25	60.0%	0.67(0.12, 3.65)
Total (95% CI)		50		50	100%	1.00(0.31, 3.25)
Total events	5		5			

Heterogeneity: Chi^2=0.44, df=1(P=0.51); I^2=0%
Test for overall effect; Z=0.00 (P=1.00)

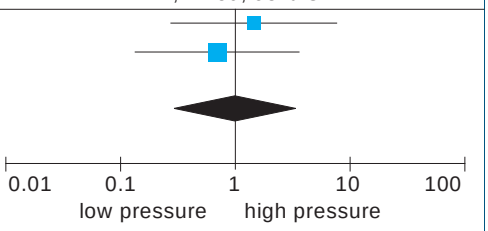

Figure 4. Forest Plot of Comparison of POST in PACU.

Study or Subgroup	low pressure Events	Total	high pressure Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Al-metwalli 2011	5	25	6	25	29.8%	0.83(0.29, 2.38)
Braz 2004	10	25	7	25	34.8%	1.43(0.65, 3.15)
Liu 2010	8	236	30	273	35.4%	0.31(0.14, 0.66)
Total (95% CI)		286		323	100%	0.71(0.26, 1.92)
Total events	23		46			

Heterogeneity: Tau^2=0.58; Chi^2=8.12, df=2(P=0.02); I^2=75%
Test for overall effect; Z=0.68 (P=0.50)

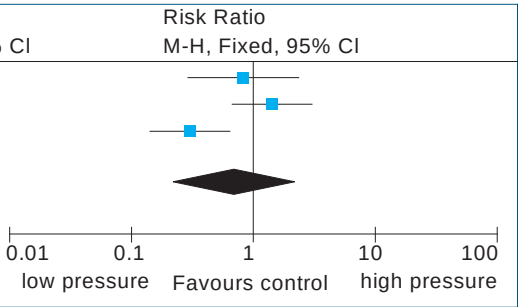

Figure 5. Forest Plot of Comparison of PH at 24 Hours after Surgery.

Study or Subgroup	low pressure Events	Total	high pressure Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Al-metwalli 2011	4	25	4	25	28.6%	1.00(0.28, 3.56)
Braz 2004	11	25	10	25	71.4%	1.10(0.57, 2.11)
Total (95% CI)		50		50	100%	1.07(0.59, 1.93)
Total events	15		14			

Heterogeneity: Chi^2=0.02, df=1(P=0.89); I^2=0%
Test for overall effect; Z=0.23 (P=0.82)

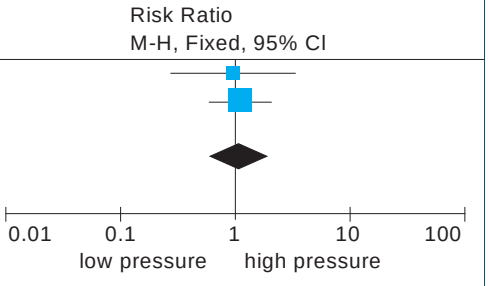

Figure 6. Forest Plot of Comparison of PH in PACU.

file in adults (18).

The incidence of hoarseness was similar in the present meta- analysis. It may suggest that this symptom was not associated with the cuff pressure. Hoarseness results from edema of the vocal cords or mechanical injury to the glottic area (13). Therefore, the avoidance of forcible intubation may be shown to reduce the incidence of hoarseness (24). In a study with patients undergoing anterior cervical spine surgery included, dysphagia was not related to the cuff pressure, but rather to the duration of neck retraction, whereas increased cuff pressure during neck retraction influenced the incidence of

POST (25).

There were several limitations in the present study. First, the geographic regions only covered Asia (China and Kingdom of Saudi Arabia) and South America (Brazil). Therefore, our results might limit its generalizability to other regions or races. Secondly, the wide CIs may suggest that there was considerable heterogeneity among the included trials. The target population also varied greatly. The adopted definitions of POST differed from 1 hour to 24 hours or even to 96 hours. Finally, most patients from all included studies were female. Whether the results of our current meta-analysis was applicable to male patients was unknown.

CONCLUSION

Our meta-analysis suggested that a lower ETT cuff pressure could reduce the incidence of POST at 24 hours after surgery in patients undergoing general anesthesia. However, the wide CIs suggested that beneficial or harmful effects cannot be ruled out for all outcomes. Further studies with rigorous design and adequate samples were needed to clarify the effect of different ETT cuff pressure on the occurrence of POST in different populations in future.

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All authors declare there were no conflict of interest in the work.

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