Journal of Clinical Anesthesia 47 (2018) 86–94

Contents lists available at ScienceDirect

Journal of Clinical Anesthesia

journal homepage: www.elsevier.com/locate/jclinane

Original Contribution

Airtraq® reduces the hemodynamic response to tracheal intubation using single-lumen tubes in adults compared with the Macintosh laryngoscope: A systematic review and meta-analysis of randomized control trials

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ARTICLE INFO

Keywords:
Airtraq
Macintosh laryngoscope
Hemodynamics
Blood pressure
Heart rate
Meta-analysis

ABSTRACT

Study objective: To investigate whether Airtraq® attenuate the hemodynamic responses to tracheal intubation using single-lumen tubes in adults as compared with the Macintosh laryngoscope.
Design: Meta-analysis.
Setting: Operating room.
Measurements: The primary outcome of this meta-analysis was to determine whether laryngoscopy using the Airtraq® reduced hemodynamic responses—heart rate (HR) and mean blood pressure (MBP)—at 60 s (s) after tracheal intubation compared to laryngoscopy with the Macintosh laryngoscope. Pooled differences in these hemodynamic responses between the two devices were expressed as weighted mean difference with 95% confidence intervals. We then conducted trial sequential analysis (TSA). The secondary outcome was to investigate whether the Airtraq® reduce the hemodynamic response at 120 s, 180 s, and 300 s after tracheal intubation compared to the Macintosh laryngoscope. We also conducted sensitivity analysis of the hemodynamic responses to tracheal intubation with the laryngoscopes using a multivariate random effects model accounting for within-study correlation of the longitudinal data.
Main results: From electronic databases, we selected 11 randomized controlled trials for studies that enrolled subjects satisfying our inclusion criteria. Compared with the Macintosh laryngoscope, the Airtraq® significantly reduced both HR and MBP at 60 s after tracheal intubation. In secondary outcome, the Airtraq® significantly reduced both HR and MBP at all measurement points, excluding HR at 300 s after tracheal intubation. TSA showed that total sample size reached the required information size for both HR and MBP. The sensitivity analysis revealed that the Airtraq® reduced both HR and MBP at all measurement points, excluding HR at 300 s after tracheal intubation.
Conclusions: The Airtraq® attenuates the hemodynamic response at 60 s after tracheal intubation compared with the Macintosh laryngoscope. (GRADE: Low) These results were supported by the sensitivity analysis. TSA suggested that the total sample size was exceeded TSA monitoring boundary both HR and MBP.

1. Introduction

Direct laryngoscopy with the Macintosh laryngoscope is still commonly performed in tracheal intubation. However, laryngoscopy and tracheal intubation might be associated with serious risk factors for myocardial infarction and stroke [1–3], such as hypertension, tachycardia, and elevated plasma catecholamines [4,5], with the mechanism underlying this excessive cardiovascular response thought to result from sympathetic activation caused by mechanical stimulation of the upper respiratory tract [6,7]. In light of this, indirect laryngoscopy has become more commonly performed for tracheal intubation since the turn of the century.

The Airtraq® indirect laryngoscope (Prodol, Meditec SA, Spain) is a single-use optical laryngoscope designed to facilitate tracheal intubation in patients with normal or difficult airways [8,9]. It has a light source and a guiding channel in which to place the tracheal tube, as

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https://doi.org/10.1016/j.jclinane.2018.03.022
Received 7 February 2018; Received in revised form 21 March 2018; Accepted 22 March 2018

well as a heating system to prevent misting of the viewfinder. Because of the special design of its optical components and curvature of the rigid blade, the Airtraq® may also reduce the hemodynamic response during tracheal intubation. The design allows intubation without having to align the anatomical axes, thus exerting less force on the oropharyngeal tissue than with the Macintosh laryngoscope. However, there is currently no consensus as to whether the Airtraq® attenuates the hemodynamic response during tracheal intubation compared with the Macintosh laryngoscope: there are several anecdotal reports show that it did so [10–12] and other studies show that it did not [13,14]. Thus, the hemodynamic response to tracheal intubation with these airway instruments remains unclear.

In this study, we performed a systematic review and meta-analysis comparing the hemodynamic response—heart rate (HR) and mean blood pressure (MBP)—to tracheal intubation using single-lumen tubes between the Airtraq® and Macintosh laryngoscopes during general anesthesia in adults to determine whether the Airtraq® attenuates the hemodynamic response.

2. Materials and methods

The manuscript was prepared in accordance with the guidelines recommended by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [15]. Before commencing this meta-analysis, we agreed on the methods of analysis, identified the inclusion and exclusion criteria to be used, and registered the study protocol with the UMIN Clinical Trials Registry (registration number: UMIN 000022199; Principal Investigator: H. Hoshijima; registration date: 3 May 2016).

2.1. Inclusion and exclusion criteria

Our search encompassed all trials that compared measures associated with oral intubation between use of the Airtraq® and use of the Macintosh laryngoscope for direct laryngoscopy among adult patients. We excluded studies that described these measures without the associated hemodynamic changes of HR and MBP.

2.1.1. Search strategy

We conducted a comprehensive search of the literature using PubMed, the Cochrane Central Register of Controlled Trials, EMBASE, and Scopus. Our strategy, which combined free text and Medical Subject Headings (MeSH) terms, was devised for the PubMed search as follows: (airtraq[All Fields] OR macintosh[All Fields]) AND (“haemodynamic”[All Fields] OR “hemodynamics”[MeSH Terms] OR “hemodynamics”[All Fields] OR “hemodynamic”[All Fields]). In addition, we manually searched references listed in the reports and reviews identified. No restrictions regarding the language of the article or publication type were imposed, and the most recent search was performed in December 2017.

2.2. Selection of included studies

2.2.1. Data extraction

Two authors (HH and MK) independently scanned the title and abstract of each of the included trials. The full-text versions of the candidate trials were evaluated to ascertain whether they met the inclusion criteria. Each author independently assessed all trials that satisfied the inclusion criteria, using standardized data collection forms. Disagreements were resolved through discussion. Where there were suspected discrepancies in the data, we contacted the relevant authors directly. The primary outcome of this meta-analysis was to determine whether the Airtraq® and the Macintosh laryngoscope reduce the hemodynamic responses at 60 s (s) after tracheal intubation. To evaluate the hemodynamic changes after tracheal intubation, we compared HR and MBP values. The secondary outcome was to investigate whether the Airtraq® reduce the hemodynamic response at 120 s, 180 s, and 300 s after tracheal intubation compared to the Macintosh laryngoscope.

2.3. Critical appraisal of study quality

2.3.1. Risk of bias assessment

We also projected the risks of bias in the methodology of the included trials for sequence generation, allocation concealment, blinding of participants, incomplete outcome data, selective outcome reporting, and other potential threats to validity [16].

2.3.2. Quality of evidence assessment

We applied the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach [17] with GRADEpro software (version 3.6 for Windows; available from http://ims.cochrane.org/revman/gradepro) to assess the quality of evidence of the main outcomes. The quality of evidence was further evaluated based on the presence/absence of limitations in study design, inconsistency, indirectness, imprecision of the results, and publication bias. The quality of evidence for the main outcomes was graded as very low, low, moderate, or high.

2.4. Data synthesis and analysis

Statistical analysis was performed using Review Manager software (ver. 5.2, Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark). The pooled differences of the hemodynamic changes to tracheal intubation between the Airtraq® indirect laryngoscope and the Macintosh direct laryngoscope were expressed as weighted mean difference (WMD) with 95% confidence intervals (CIs). We used random effect models to estimate the effect sizes. We also tested homogeneity of the effect size across trials by using the Cochran Q statistic and the I^2 statistic, which are indicative of the percentage of variability due to heterogeneity rather than sampling error [18]. A p value < 0.10 and an I^2 value exceeding 50% indicated heterogeneity, thus helping to avoid false-negative results and the inclusion of such results in the meta-analysis.

We performed the sensitivity analysis of the hemodynamic responses to tracheal intubation of the Airtraq® and Macintosh laryngoscopes using a multivariate random effects model accounting for within-study correlation of the longitudinal data. In this model, the study number was set as a random effect; device and time point were set as fixed effects. We used the “metaphor” package in the R statistical computing language for the sensitivity analysis [19,20]. Moreover, we analysed intubation time as a subgroup analysis.

We then conducted trial sequential analysis (TSA) to assess sensitivity; this analysis is vital to conduct as it can prevent type I error due to multiple testing of the effect in the meta-analysis [21–26]. First, we calculated the required sample size (i.e., required information size). We set the risk of type I errors at 5% and risk of type II errors at 10%. Success rate, intubation time, and glottic visualization in the control group were based on those in the randomized controlled trials (RCTs) with a low risk of bias. A minimum clinically meaningful a mean difference of 10 beats per minute for HR and 5 mm Hg for MBP were used for the TSA. The alpha spending boundaries of the meta-analysis (i.e., monitoring boundaries of the TSA) and adjusted CIs were also calculated. The cumulative Z-curve of the meta-analysis was plotted to see whether trial sequential monitoring boundaries were crossed for assessing type I and type II error and the need for further trials [25]. TSA was performed using TSA viewer (version 0.9.5.9 beta; www.ctu.dk/tsa).

The validity of meta-analyses can often be limited by publication bias because studies showing no significant difference frequently remain unpublished. Consequently, to evaluate the potential for publication bias, we constructed a funnel plot by plotting RR values against associated standard errors [27] and applied Begg's test to assess the