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Diagnostic accuracy of radiology (CT, X-ray, US) for predicting difficult intubation in adults: A meta-analysis

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A B S T R A C T

Objective: The aim of this study was to evaluate the overall accuracy of radiological measurements in prediction of difficult airway and compare the diagnostic value between the radiological measurements and the modified Mallampati score through a meta-analysis of published studies.

Methods: A comprehensive electronic search of related literature was performed in PubMed, Embase, Cochrane Library and China National Knowledge Infrastructure. Meta-DiSc 1.4 and STATA 12.0 were selected for data analysis, and QUADAS-2 tool was used to assess the quality of included studies. Difficult airway was defined as Cormack-Lehane III-IV. Data from selected studies were pooled to yield summary sensitivity, specificity, positive and negative likelihood ratios, diagnostic odds ratio, as well as summary receiver operating characteristic curve.

Results: A total of 17 studies dating up to November 2017 with 8779 individuals were enrolled in the present study. Heterogeneity existed in the non-threshold effect, but not in the threshold effect. Subgroup analyses based on radiological methods were conducted. The pooled diagnostic characteristics in the computed tomography subgroup were as follows: sensitivity 0.75 (95%CI, 0.64–0.84), specificity 0.75 (95%CI 0.68–0.81), PLR 3.19 (95%CI 1.91–5.32), NLR 0.38 (95%CI 0.23–0.64), DOR 11.74 (95% CI, 4.19–32.86) and AUC 0.8424 with Q^* index 0.7741. In the X-ray subgroup, the sensitivity was 0.78 (95%CI, 0.73–0.82), the specificity was 0.88 (95%CI, 0.87–0.89), PLR was 5.03 (95%CI, 2.44–10.37), NLR was 0.27 (95%CI, 0.22–0.33), DOR was 23.18 (95%CI, 8.81–60.95) and AUC was 0.8970 with Q^* index 0.8280. The corresponding values for the ultrasound subgroup were 0.69 (95%CI, 0.63–0.74) for sensitivity, 0.84 (95%CI, 0.82–0.85) for specificity, 6.25 (95%CI, 3.81–10.27) for PLR, 0.36 (95%CI, 0.27–0.47) for NLR, 22.26 (95%CI, 10.45–47.41) for DOR, 0.8942 for AUC with Q^* index 0.8251. The pooled sensitivity, specificity and PLR of the modified Mallampati score were 0.61 (95%CI 0.56–0.66), 0.63 (95%CI 0.61–0.64) and 2.11 (95%CI 1.71–2.61) which were significantly lower than that of radiographic methods.

Conclusions: The results indicated that the diagnostic value of CT, X-ray and US was much better than that of modified Mallampati score. Ultrasound had diagnostic indices and the area under curve similar to those of CT and X-ray in predicting difficult airway. Considering being easy, readily availability, low cost, and free from radiological hazards, it can be considered as prior diagnostic strategy in this condition.

Contents

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1. Introduction

Difficulties with airway management in relation to general anaesthesia have been a challenge for the anesthesiologist since the birth of anaesthesia. Difficult airways can cause ventilation failure, oxygen desaturation, arrhythmia, bronchoconstriction, airway injury, cardiac arrest, brain damage, or even death in anesthetic practice [1]. Thus looking for a reliable tool for precise diagnosis and prediction of difficult airway is of utmost importance, but the fact that which of these anatomical land marks and clinical factors are the best is still uncertain or is controversial [2–3].

Current bedside tests have limited and inconsistent capacity to discriminate between patients with difficult and easy intubation [4]. A standard method for evaluation of difficult laryngoscopy is using modified Mallampati score (MMS) [5,6]. However, MMS has been reported to be a good predictor by many, but was found to be of limited value by others [7]. Moreover, there is no bedside screening test has a high performance even when tests are combined [8]. It is well known that failure to estimate difficult airway in relation to anaesthesia cause severe morbidity and mortality. Unanticipated difficult intubation has been associated with unwanted patient outcomes in the operating room [1,9]. Prediction of difficult airway continue to represent a patient safety concern.

Adequate preoperative airway planning, including specific techniques and equipment tailored to each specific patient, can play an important role in decreasing the risks associated with difficult airway management. Imaging techniques, such as computed tomography (CT), magnetic resonance imaging (MRI), X-ray and ultrasound (US), display the anatomical features of the upper airways well and have been recommended for evaluation of difficult airway [10–13]. However, there was a large variability regarding the results and sample sizes of these studies. For instance, the specificity in the report of Di et al. [14] was only 0.5, whereas specificity was 0.97 in the study of Naguib et al. [10]. Thus, the real value of radiology in diagnosing difficult airway is uncertain. Moreover, the findings of present reports were based on the results of individual clinical trials, and the literature lacks a pooled and robust appraisal of all the evidence for the diagnostic accuracy of radiological measurements. Meta-analysis of the diagnostic efficiency are rigorous approaches for examining and synthesizing the evidence in the evaluation of the diagnostic and screening test [15]. Therefore, we conduct this meta-analysis to determine the relationship between radiology and difficult airway to precisely estimate the diagnostic accuracy of the radiological methods.

2. Materials and methods

2.1. Search strategy

This meta-analysis was conducted according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) statement and methods [16]. A comprehensive retrieval in PubMed, Embase, Cochrane Library, and China National Knowledge Infrastructure (CNKI) was carried out to search relevant articles that evaluate the diagnostic value of radiology (CT, MRI, X-ray, US) for predicting difficult airway dating from 1991 up to November 2017. We used the terms "difficult airway" OR "difficult intubation" OR "difficult laryngoscopy" as text words combined with "computed tomography", "magnetic resonance imaging" OR "MRI", "radiography" OR "X-ray" OR "radiology", "ultrasound" OR "sonography" OR "ultrasonography", respectively. In addition, content experts were contacted, and bibliographies of the relevant studies were reviewed to identify additional references. All analyses of this systemic review were based on previous published studies, so no ethical approval and patient consent are required. The search results were collated and deduplicated in Endnote X7 (Thomson Reuters, NY).

2.2. Study selection

Two authors (C.J. and Q.N.) independently screened the abstracts of articles shortlisted by the initial search. The same authors reviewed the full texts to identify studies that met the inclusion criteria. Any disagreement over study selection was resolved with a consensus with the other author (W.-R.C.).

In the meta-analysis, studies were considered eligible if they met all of the following criteria: (1) its purpose was to assess or explore the diagnostic accuracy of CT, MRI, X-ray, US, MMS for difficult airway; (2) population: adult patients undergoing surgery under general anaesthesia; unpregnant; American Society of Anesthesiologists (ASA) score I-III; (3) study provided sufficient data to calculate true positive (TP), false positive (FP), true negative (TN), and false negative (FN); (4) no language restriction was indicated. Meanwhile, studies were excluded based on the following criteria: (1) duplicate publications; (2) insufficient data to construct a two-by-two table; (3) reviews, editorials, conference abstracts and case reports; (4) trials that did not report on specific outcomes; and (5) lack of access to full text. Abstract books of conference proceedings were hand searched to identify potentially eligible studies published only in abstract form. Authors of trial reports published only as abstracts were contacted and asked to contribute full datasets or completed papers. The bibliographies of all identified relevant studies were used to perform a recursive search of the literature.

MMS was specified according to the visibility of pharyngeal structures with the patient in an upright sitting position, head in neutral position, mouth wide open, and tongue protruding to its maximum without phonation [6]. Class I is visualization of the hard palate, soft palate, fauces, uvula, and pillars. Class II is visualization of the hard palate, soft palate, fauces, and base of uvula. Class III is visualization of the hard palate and soft palate. Class IV is visualization of only the hard palate.

The Cormack-Lehane classification is a grading system commonly used to describe laryngeal view during direct laryngoscopy. First published in 1984, it has since then become the gold standard for airway classification in clinical practice and in airway-related research [17–21]. Classification of laryngoscopic views was based on the method described by Cormack and Lehane [22]. Grade I is full view of the glottis. Grade II is partial view of the glottis or arytenoids. Grade III is only epiglottis seen. Grade IV is neither glottis nor epiglottis visible. Grade I and II are categorized as easy laryngoscopy. Grade III or IV are categorized as difficult laryngoscopy.