

# A Comparison of the Mallampati evaluation in neutral or extended cervical spine positions: a retrospective observational study of >80 000 patients

D. W. Healy\*, E. J. LaHart, E. E. Peoples, E. S. Jewell, R. J. Bettendorf Jr and S. K. Ramachandran

Department of Anaesthesiology, University of Michigan Medical School, 1H427 University Hospital Box 5048, 1500 E Medical Center Drive, Ann Arbor, MI 48109-0048, USA

\*Corresponding author. E-mail: dhealy@med.umich.edu

## Abstract

**Background:** The Mallampati examination is a standard component of an airway risk assessment. Existing evidence suggests that cervical spine extension improves the predictive power of the Mallampati examination for detecting difficult laryngoscopy and tracheal intubation, but a comparative effectiveness study has not been conducted.

**Methods:** The extended Mallampati examination (EMS) was introduced to the standard preoperative airway assessment, in addition to the standard Modified Mallampati examination (MMP). This study compared the accuracy of both Mallampati examinations on the prediction of difficult laryngoscopy, tracheal intubation, and bag mask ventilation. Univariate and adjusted analyses were performed.

**Results:** 80 801 patients with recorded MMP and EMS, and subsequent glottic view obtained during direct laryngoscopy, were examined. There was increased specificity (88.7% cf. 81.9%) but reduced sensitivity (33.3% cf. 45.7%) in the detection of difficult direct laryngoscopy with use of the EMS. The area under the receiver operating characteristic curve of each test performed in combination with other airway predictors for the models predicting difficult laryngoscopy was 0.740 (95% CI 0.731–0.753) for MMP and 0.739 (95% CI 0.729–0.752) for EMS. The area under the receiver operating characteristic curve of each test, performed in combination with other airway predictors for the models predicting difficult intubation was 0.699 (95% CI 0.688–0.711) for MMP and 0.695 (95% CI 0.683–0.707) for EMS.

**Conclusions:** This retrospective observational study demonstrates that cervical extension improves the specificity but decreases sensitivity of Mallampati examination. The Mallampati evaluation should be performed with the cervical spine in the neutral position to maximize test sensitivity.

**Key words:** glottis; laryngoscopy; physical examination; risk assessment; sensitivity and specificity

The Mallampati evaluation is a standard component of the pre-intubation airway risk assessment of surgical patients undergoing tracheal intubation. It was first proposed as a hypothesis in 1983<sup>1</sup> and its efficacy in the prediction of difficulty at laryngoscopy was demonstrated in a prospective study of 210 adult surgical patients.<sup>2</sup> The inability to see the soft palate was later

added as a 4th class<sup>3</sup> and the updated test is now referred to as the Modified Mallampati examination (MMP).

In a carefully controlled study examining multiple variables, Lewis and colleagues<sup>4</sup> found that full craniocervical extension improved the performance of the MMP examination, in the prediction of difficult laryngoscopy, when comparing receiver

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**Editor's key points**

- The Mallampati test is widely used to predict difficult tracheal intubation, but it is not known if cervical spine extension improves its predictive power.
- Predictive powers of Mallampati test with and without cervical spine extension were compared, for difficult laryngoscopy, tracheal intubation, and mask ventilation.
- Cervical extension improved the specificity but decreased the sensitivity of Mallampati test, and thus the test should be performed without cervical spine extension, to maximize the sensitivity of the test.

operating curves. Two subsequent clinical studies demonstrated that performing the MMP with the patient's cervical spine in full extension (the Extended Mallampati Score (EMS)) improved specificity without reducing sensitivity.<sup>5,6</sup> This improvement may be because craniocervical extension increases the interidental opening<sup>7</sup> (and, by inference, the palatoglossal opening<sup>5</sup>), thereby reducing the number of false positives. However, previous studies comparing the MMP and EMS lacked generalizability as they were conducted in relatively small study populations or specific patient groups (e.g. the morbidly obese). Additionally, the interdependence of other airway measures in maximizing the predictive power of the MMP or EMS has not been assessed in large, diverse populations during routine clinical care.<sup>8,9</sup> Although the MMP is a poor predictor of difficult laryngoscopy and intubation when performed as a single test,<sup>10</sup> it is routinely used in combination with other airway assessments. Therefore, given its ubiquitous use in clinical practice, maximizing the predictive power of the MMP examination is of clear relevance for patient care.

The aim of the current study was to compare the performance of the MMP and EMS in the prediction of difficult direct laryngoscopy and tracheal intubation, through a retrospective analysis of anaesthetic records in an unselected general surgical population. We hypothesized that the EMS would be superior to the MMP in the prediction of difficult laryngoscopy and tracheal intubation.

**Methods**

University of Michigan Institutional Review Board approval was obtained for this study. The study and reporting adhered to the STROBE standards for observational studies.<sup>11</sup> Signed patient consent was waived, as no patient care interventions were involved in the conduct of the study, and all patient identifiers were removed. Based on an *a priori* hypothesis, the standard airway assessment at the University of Michigan Health System was changed to include the EMS. The data for this prospective observational study were extracted from a single centre electronic database of patient health records, that has previously been used for multiple studies related to airway outcomes.<sup>6,12–21</sup> There have been more than 30 000 patients added since the most recent study that used this single centre dataset.<sup>13</sup>

**Patient population**

We included all adult (>18 yr) patients undergoing general anaesthesia with a documented preoperative airway examination comprising both the Modified Mallampati Score (the MMP) and an extended Mallampati score (the EMS), in combination with a documented glottic view obtained at direct laryngoscopy (Cormack and Lehane grade) and a binary difficult intubation rating.<sup>22</sup> We excluded all patients without a documented intraoperative

view or presence of an existing airway and patients in which intubation was performed by alternative means (video or fiberoptic laryngoscopy). We encountered additional exclusions during our secondary analysis because of missing mask ventilation values.

**Data collection**

To test the hypothesis that the EMS was a better predictor of difficult laryngoscopy and tracheal intubation than the MMP, the EMS was added to our institution's formal airway assessment in October 2006 and its performance was assessed after eight yr of use. The study had Institutional Review Board approval before the additional data element was added in 2006. Data were acquired from the Anaesthesia Information Management System (Centricity TM, General Electric Healthcare, Waukesha, WI) of the University of Michigan. The anaesthesia provider completes this component of the Electronic Health Record, as part of the routine preoperative history and physical examination process. The correct method of preoperative airway examination is taught by didactic lectures in the first two yr of anaesthesia residency and by bedside supervision and demonstration. Furthermore, instructions for performing the test are included in the electronic record, which consists of individual data elements describing multiple clinical aspects through discrete, predefined pick list selections, with the possibility of additional free data entry. When data were unclear or missing, patients were identified and individual charts reviewed, to ensure correct interpretation of the data elements retrieved. We assessed the following data elements of the preoperative airway assessment, considered predictors of difficult laryngoscopy and/or difficult intubation: anaesthesia provider estimates of the Mallampati 3 or 4 in the neutral cervical spine position (MMP), Mallampati 3 or 4 at full neck extension (EMS), limited mouth opening (estimated <3 cm), reduced thyromental distance (estimated <6 cm), limited cervical spine extension (bedside impression), limited jaw protrusion (based on the inability to protrude the mandibular incisors to meet or extend past the maxillary incisors or gums), the subjective impression of thickened neck anatomy, and the presence of neck radiation changes. These variables have been described as predictors of airway outcomes in multiple previous studies.<sup>6,12,13,19,20</sup> We collected the following additional information from the electronic health record: age, weight, height, calculated BMI, sex.

**Outcomes**

The primary outcome was the presence of a class 3 or 4 Cormack and Lehane view at direct laryngoscopy, using either Macintosh or Miller blade.<sup>22</sup> Additional outcomes included the presence of difficult tracheal intubation, and difficult and impossible bag mask ventilation. Difficult tracheal intubation was defined as 3 or more attempts at tracheal intubation. Bag mask ventilation was graded according to a four point scale.<sup>12,13,18,23</sup> Grade 3 mask ventilation, defined as mask ventilation that is inadequate to maintain oxygenation, unstable mask ventilation, or mask ventilation requiring two providers. Grade 4 mask ventilation is defined as impossible mask ventilation noted by absence of end-tidal carbon dioxide measurement and lack of perceptible chest wall movement during positive pressure ventilation attempts, despite the use of airway adjuncts and additional personnel. All three outcomes are documented in the electronic anaesthetic record, using specific pick list choices that permit dichotomous outcome designation when they occur. Floating

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