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COMMENTARY

Can spirometry be a new tool to predict the difficult airway?

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Tracheal intubation became a popular method to deliver inhalational anesthesia in the late 1920' and in the 1930', thanks to the work of pioneers like Ralph Waters, Arthur Guedel, and Noel Gillespie in the US, and Ivan Magill in the UK [1, 2]. Among other possible techniques (such as blind intubation and tactile intubation), direct laryngoscopy emerged as the safest and most successful approach, especially following the introduction in the clinical arena of neuromuscular blocking agents in the 1940'. The use of tracheal intubation as a tool to protect the airway and to allow mechanical ventilation later spread outside of the operating rooms and diffused into the ICU and ER.

Despite its early successes, complications associated with tracheal intubation were soon identified. Among those complications was failed intubation resulting in inadequate patient ventilation and oxygenation. In a seminal paper published in 1956 [3], Cass, James, and Lines reviewed five cases of difficult intubation under direct laryngoscopy, suggesting that a few anatomical and physiological elements, identifiable through physical examination, could be utilized to predict the difficult airway. In interpreting those complicated cases, they refer to the model of direct laryngoscopy based on the alignment of the axes of the larynx, pharynx, and mouth that had been proposed by Bannister and Macbeth in 1944 [4]. According to this model, the alignment of these three axes grants the clinician a clear line of sight to direct the tracheal tube through the glottis of the patient.

Notwithstanding these initial works, morbidity and mortality related to airway management persisted. In 1990, data published from the American Society of Anesthesiologists Closed Claims Projects highlighted that complications associated with difficult airway management accounted for 17% of the airway-related claims and represented the third category of adverse respiratory events leading to trial litigation [5]. Following that, several predictive models of difficult intubation were developed, based on various parameters that could be assessed at the bedside [6, 7].

In 2005, Shiga published a very influential systematic review of bedside predictors of difficult intubation in "apparently normal patients", pointing out that a combination of Mallampati score and thyro-mental distance was the most useful screening test for a successful direct laryngoscopy intubation, even if sensitivity, specificity, and positive likelihood ratio (respectively, 36%, 87%, and 9.9) were still of "limited" clinical utility [8].

Additionally, researchers continued to investigate the mechanisms of intubation under direct laryngoscopy. One of the consequences of these studies is that the "3 axes model" by Bannister and Macbeth was disproved in the late 1990s with the use of MRI images [9]. Since then, more accurate and comprehensive models to explain the mechanics of difficult intubation have been developed [10, 11].

Currently, most international guidelines for difficult airway management [12] propose that an airway assessment should be the first step of perioperative airway management. Indeed, in many cases a simple physical exam could provide enough information to plan an individualized airway management and to minimize the chances of complications related to an unanticipated difficult intubation. Nevertheless, there is no universal agreement on which tests should be included in the assessment, and there is evidence that current preoperative screenings are still characterized by limited sensitivity and specificity [13]. In addition, recent national surveys from Denmark and the UK showed

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that, although many improvements in preoperative airway assessment, equipment and clinical training have been implemented, failing to predict difficult airways [14] and severe complications from inability to intubate the trachea [15] are still common occurrences even in advanced medical systems.

This is the landscape in which the study of Dogru and colleagues published in this issue of the Journal of Clinical Monitoring and Computing comes in [16].

The authors of this paper tried a new approach. They assessed the airway of 202 adult surgical candidates with several "traditional" bedside tests (Mallampati score, neck circumference, sterno- and thyro-mental distances, upper-lip bite test and maximum mouth opening), but also performed a preoperative spirometry. In the operating room, they used the revised Cormack-Lehane classification to grade the levels of difficult laryngoscopy they encountered. Then, they entered all of the variables considered during the preoperative evaluation in a statistical model to assess which of the variables were associated with difficult laryngoscopy, using ROC curves to measure the discriminative capability of the different tests to anticipate difficult laryngoscopy. They established that several spirometric measurements were associated with anatomical predictors of difficult laryngoscopy, and that the highest correlation was shown between the parameter forced inspiratory vital capacity (FIVC) and thyro-mental distance. In addition, they found that FIVC was a moderate predictor of difficult laryngoscopy.

The authors conclude the discussion of their results recognizing that, even if they found statistically significant relationships between the results of several pulmonary function tests and anatomical airway measures, neither FIVC nor any other parameters they assessed by spirometry appear to be clinically adequate tools to predict difficult laryngoscopy.

While the idea of utilizing spirometry as an airway assessment tool is a new and interesting one, this study poses some methodological issues that readers should consider.

First of all, the authors failed to propose a convincing mechanism underpinning the relationship between the many spirometry parameters they assessed and difficult laryngoscopy. It is true that the authors briefly mentioned in the discussion that patients with OSA may often present both a difficult airway at intubation and abnormal spirometric recordings, such as "saw-tooth" sign and altered FEF(50)/FIF(50) ratio. Still, the authors failed to collect or report the results of these specific tests in their paper. In addition, even the works by Ashraf and Krieger quoted in the reference list of their manuscript (#9 and #22) conclude that neither the saw-tooth sign nor FEF(50)/FIF(50) > 1 are useful in predicting OSA. At this point, it seems that the relationship between difficult airway prediction and spirometry that the authors have hypothesized in planning their study is built on very thin foundations.

As briefly reviewed above, bedside criteria so far proposed as predictors of difficult airway at direct laryngoscopy have all been based on theoretical models of glottis exposure and intubation's mechanics. Unfortunately, this study does not really suggest a sound hypothesis as to why FIVC can be a predictor of difficult laryngoscopy; it is therefore conceivable that the results of this investigation may represent random statistical associations among many tested parameters rather than the identification of explanatory variables.

Then, from reviewing the literature on the interpretation of spirometry measurements, it appears that FIVC—the parameter that better correlated with difficult laryngoscopy in this study –is considered in a widely cited Official Statement of the European Respiratory Society on pulmonary function tests [17] among the tests to assess flow obstruction in the extra-thoracic airway (i.e., the upper airway), but its reproducibility and interpretation are not straightforward [18]. In addition, it seems that FIVC has not been previously used in clinical studies similar to the present one by Dogru and colleagues; therefore, the approach of using FIVC to the purpose of predicting difficult laryngoscopy still needs to be validated.

In conclusion, I believe that this paper presents an interesting association between abnormal spirometric values and difficult glottis visualization at direct laryngoscopy. It certainly stimulates reflection and, possibly, new hypotheses on the physiological relationship between spirometry and airway assessment. For example, it is possible to speculate that the presence of redundant pharyngeal soft tissues in patients' upper airway may both affect FIVC at spirometry and make glottis visualization more difficult at direct laryngoscopy.

Still, it is unlikely that the results of this study will lead to direct modifications of clinical practice, for two main reasons: (1) because of the limited improvement that including FIVC in the preoperative evaluation offers in discriminating difficult airway with respect to more conventional and validated bedside tests; (2) because the implementation of spirometry as a preoperative airway assessment tool would require the routine use of an additional piece of equipment that is rarely available in preoperative anesthetic clinics.

At this moment, as it is often said, further studies are needed both to elucidate the anatomical and/or physiological relationship between abnormal spirometry and difficult airway, and to assess the predictive value of spirometry in everyday clinical practice.

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