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RESEARCH ARTICLE

Laryngeal mask placement in a teaching institution: analysis of difficult placements [version 1; referees: 2 approved, 1 approved with reservations]

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Abstract

Background: Laryngeal mask airway (LMA) placement is now considered a common airway management practice. Although there are many studies which focus on various airway techniques, research regarding difficult LMA placement is limited, particularly for anesthesiologist trainees. In our retrospective analysis we tried to identify predictive factors of difficult LMA placement in an academic training program.

Methods: This retrospective analysis was derived from a research airway database, where data were collected prospectively at the Memorial Hermann Hospital, Texas Medical Center, Houston, TX, USA, from 2008 to 2010. All non-obstetric adult patients presenting for elective surgery requiring general anesthesia, were enrolled in this study: anesthesiology residents primarily managed the airways. The level of difficulty, number of attempts, and type of the extraglottic device placement were retrieved.

Results: Sixty-nine unique Laryngeal Mask Airways (uLMAs) were utilized as a primary airway device. Two independent predictors for difficult LMA placement were identified: gender and neck circumference. The sensitivity for one factor is 87.5% with a specificity of 50%. However with two risk factors, the specificity increases to the level of 93% and the sensitivity is 63%.

Conclusion: In a large academic training program, besides uLMA not been used routinely, two risk factors for LMA difficulty were identified, female gender and large neck circumference. Neck circumference is increasingly being recognized as a significant predictor across the spectrum of airway management difficulties while female gender has not been previously reported as a risk factor for difficult LMA placement.

Open Peer Review

Referee Status: [?] ✓ ✓

	Invited Referees		
	1	**2**	**3**
version 1 published 29 Apr 2015	[?] report	✓ report	✓ report

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2 **Massimiliano Carassiti**, Campus Bio-Medico University of Rome Italy

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Comments (0)

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Competing interests: No competing interests were disclosed.

Introduction

Since its introduction into clinical practice in 1983[1], the laryngeal mask airway (LMA) has found a place in everyday anesthesia practice[2–4], including its use as a primary airway device in the elective or pre-hospital emergency settings, as well as a rescue airway device in either settings[5,6]. Additionally, the LMA placement has become a common airway management technique, particularly in ambulatory surgery[2,3], and is associated with shorter recovery time, earlier patient discharge and lower associated costs[7,8]. Even if the LMA is considered a very safe airway device[9] with a low incidence of complications, there may be situations where it either does not function properly or is difficult to place[10]. Importantly, the association between difficult LMA placement and increased incidence of Difficult Mask Ventilation (DMV) has been recognized[11].

Appropriate sizing is critical for correct LMA application[12], while the selection of the device type seems to play a less significant role, yet the prediction of the correct size is not easy. This can be attributed to the absence of a coherent and universal standard sizing system[13]. Most of the manufacturers suggest a weight-based size selection, however there is no consistency between weight and oropharyngeal anatomy[14].

Alternative recommendations for the selection of the appropriate size of a LMA, regarding age, height and gender, as well as anatomical landmarks, are still under investigation[15–17].

As a result, the concepts of difficult LMA placement and effective usage have prompted new research, focusing on the prediction of difficult LMA placement[18].

A simple, objective, predictive score to identify patients at risk of difficult LMA placement at the bedside does not currently exist, however to achieve such score a comprehensive airway assessment based analysis of risk identification needs to be accomplished first. Based on recorded outcomes at a major teaching hospital that utilized a comprehensive airway assessment[19] we aimed to identify predictive factors for difficult LMA placement.

Methods

Data for this retrospective analysis were derived from a database of airway assessments, management plans, and outcomes collected prospectively from August, 2008 to May, 2010 at a Level 1 academic trauma center (Memorial Hermann Hospital, Texas Medical Center, Houston, TX, USA)[11]. The study was sponsored by an educational grant from the Foundation for Anesthesia, Education and Research (FAER), and other educational funds from the Department of Anesthesiology at University of Texas Medical School at Houston. After obtaining IRB approval, (HSC-MS-07-0144) all non-obstetric adult patients presenting for elective surgery requiring general anesthesia were enrolled in this study (n=8364). All uLMA placements were carried out by anesthesiology residents. In the 'mother study', residents were randomized into two groups—an experimental group, which used a comprehensive airway assessment form[11,20] in addition to the existing anesthesia record, and a control group, which used only the existing anesthesia record. For the purpose of the present analysis, only the experiment (n=2348) group data was utilized, since the comprehensive airway assessment needed to be linked to the airway device that was utilized. We identified

110 cases-used of LMA, disposable laryngeal mask (uLMA, North America, San Diego, CA), and 69 of those as primary airway device, which we utilized for our analysis. Difficult LMA placement was defined as either inability to physically place a LMA device or inadequacy of ventilation, oxygenation, or airway protection after placement that required conversion to an alternative technique. The level of difficulty and the number of attempts of the uLMA placement were documented by the anesthesiology residents.

Statistical analysis

Sixty nine uLMA placements were completed and an analysis was performed (based on "per protocol" and not intention to treat). The mean and standard deviation were used to summarize continuous variables, and frequency (percentage) was summarized for categorical variables. A two-tailed sample t-test was applied to compare continuous variables and Chi-square or Fisher exact tests as appropriate were performed for categorical variables between patients with or without uLMA placement difficulty. Using multivariate logistic regression models, the variables associated with uLMA placement difficulty were identified. All variables with a p-value ≤0.25 in univariate analysis and variables of known biological importance (e.g., age and BMI) were entered into a full model. A backward selection method was used to identify significant independent predictors. A receiver-operating-characteristic (ROC) area under the curve was also calculated to evaluate the resulting model's predictive value, (Figure 1) as well as adjusted odds ratios and their 95% confidence intervals. Continuous variables were included after the

Figure 1. A receiver-operating-characteristic (ROC) curve evaluating the sensitivity and specificity of preoperative independent risk factors for LMA difficulty. Two independent predictors for LMA difficulty were identified using logistic regression: Female and NeckCirc of 44 or greater. The area under the curve was 0.69. The area under the curve was calculated to evaluate the resulting model's predictive value. The adjusted odds ratios and their 95% confidence interval were calc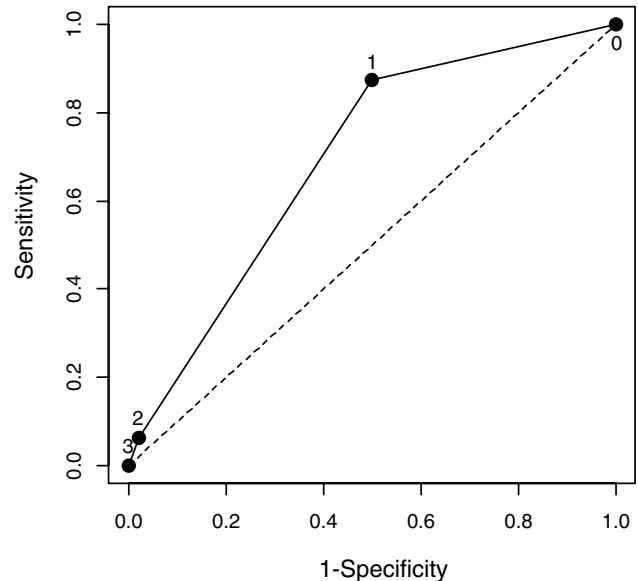ulated. Continuous variables were included after the dichotomization and the best cut-off was determined by maximizing the sum of sensitivity and specificity using the ROC curve. Analyses were conducted using SAS 9.3 (SAS Institute, Cary, NC, USA).

dichotomization and the best cut-off was determined by maximizing the sum of sensitivity and specificity using the ROC curve. Age distribution for our population was assessed by using descriptive statistics including mean, standard deviation, and median values. All statistical analyses were conducted using SAS 9.3 (SAS Institute, Cary, NC, USA). A p-value <0.05 was considered significant.

Results

Patient demographics are presented in Table 1 and Table 2. Of the airway evaluations performed using a comprehensive airway assessment tool 69 LMAs were utilized as a primary airway device (Table 3). Of these, 67 were successful (97.1%) and 2 were unsuccessful (2.9%), with 17 (24.6%) uLMA placements considered as

Table 1. Preoperative patient characteristics by LMADiff status.

Variables	LMADiff		p-value
	False (LMADiff=0) N=52	True (LMADiff=1) N=17	
Age (year), mean±SD <35, n (%)	48±19[1] 17 (33.3)	51±16 2 (11.8)	0.608 0.121
Male, n (%)	33 (64.7)[1]	8 (47.1)	0.198
Height (cm), mean±SD <175, n (%)	172.8±10.9[3] 23 (46.9)	169.1±8.5 12 (70.6)	0.206 0.092
Weight (kg), mean±SD	79.9±16.0	78.9±23.9	0.870
BMI (kg/m²), mean±SD <30, n (%)	26.9±5.8[1] 39 (81.3)	27.5±8.2[2] 12 (70.6)	0.744 0.493
Neck Circumference, mean±SD <44, n (%)	39.3±4.3[1] 43 (84.3)	40.0±6.6[4] 10 (62.5)	0.686 0.082
InterIncisors distance, mean±SD	4.4±0.8	4.3±1.0	0.515
Thyromental distance, mean±SD	8.9±1.5[1]	9.1±0.9[4]	0.561
Sternomental distance, mean±SD	16.2±2.4[1]	16.1±2.1[4]	0.835
Neck Mobility Grade, n (%) 1 2,3	 36 (69.2) 16 (30.8)	 13 (76.5) 4 (23.5)	0.568
Mallampati, n (%) I, II III, IV	n=51 32 (62.8) 19 (37.3)	n=17 9 (52.9) 8 (47.1)	0.474
U BiteTest A B C	 41 (78.9) 10 (19.2) 1 (1.9)	 10 (58.8) 6 (35.3) 1 (5.9)	0.245
Cervical Spine Abnormality, n (%)	3 (5.8)	2 (11.8)	0.591
NoTeeth, n (%)	7 (13.5)	4 (23.5)	0.445
Facial Hair, n (%)	11 (21.2)	4 (23.5)	1.0
Facial Trauma, n (%)	1 (1.9)	2 (11.8)	0.148
Nasal Defect, n (%)	3 (5.8)	0 (0)	NR
Neck Trauma, n (%)	2 (3.9)	0 (0)	NR
Short Neck, n (%)	1 (1.9)	2 (11.8)	0.148
Obstructive Sleep Apnea, n (%)	25 (48.1)	8 (47.1)	1.0
Thyroid, n (%)	2 (3.9)	1 (5.9)	1.0

[1]N=51; [2]N=14; [3]N=49; [4]N=16; NR: not reported due to zero cells; p-values are obtained by two sample t-test for continuous variables and Chi-square test or Fisher's exact test as appropriate for categorical variables

Table 2. Age distribution of our population.

Gender	Age	
	mean±SD	Median (min, max)
Female (N=27)	51.1±17.4	53 (18, 79)
Male (N=41)	47.3±18.1	50 (20, 80)
All population (N=68)	48.8±17.8	51.5 (18, 80)

difficult (Table 4). Multivariate logistic regression models identified two independent predictors of difficult airway: gender and neck circumference (Table 5). The risk of difficult LMA placement was significantly higher for female patients and patients with a neck circumference (≥44 cm). The model's c-statistic score is 0.69 (Table 6). When at least one of two identified risk factors as a cut-off for predicting difficult LMA placement is present, the sensitivity is 87.5% and the specificity is 50%. If we use two risk factors as a cut-off, the specificity increases to the level of 98% and sensitivity is 63% (Table 5).

Table 3. LMA size and expected outcome by LMADiff status.

Variables	LMADiff		p-value
	False (LMADiff=0) N=52	True (LMADiff=1) N=17	
LMA Size, n (%) 3,4 5	n=27 18 (66.7) 9 (33.3)	n=7 3 (42.9) 4 (57.1)	0.387
No of Attempts 1 >1	n=29 28 (96.6) 1 (3.5)	n=4 1 (25.0) 3 (75.0)	0.003
Ideal size by weight 3,4 5	n=50 15 (30.0) 35 (70.0)	n=17 6 (35.3) 11 (64.7)	0.684
Ideal size by height 3,4 5	n=48 28 (58.3) 20 (41.7)	n=17 14 (82.4) 3 (17.7)	0.087
ExpecDMV, n (%)	6 (11.5)	3 (17.7)	0.679
ExpecDLMA, n (%)	4 (7.7)	2 (11.8)	0.631
ExpecDL, n (%)	11 (21.2)	10 (58.8)	0.003
ExpecDI, n (%)	7 (13.5)	3 (17.7)	0.699
ExpecDSA, n (%)	1 (1.9)	4 (23.5)	0.012

Expec: predicted, expected, at airway assessment; DMV: difficult mask ventilation; DLMA: difficult Laryngeal Mask Airway; DL: Difficult Laryngoscopy; DI: Difficult Intubation; DSA: Difficult Surgical Airway

Table 4. Summary statistics for LMADiff and LMASuccess.

Outcome	Frequency (percentage) N=69
LMADiff 0 1	52 (75.4) 17 (24.6)
LMASuccess 0 1	2 (2.9) 67 (97.1)

Table 5. Two independent predictors of LMA difficulty.

Predictor	β Coefficient	Standard Error	P value	Adjusted odds ratio (95% Confidence Interval)
Female	1.466	0.723	0.043	4.33 (1.05, 17.85)
Neck>=44	1.810	0.787	0.021	6.11 (1.31, 28.56)

Table 6. Diagnostic value of the cut-off for the number of risk factors in predicting a difficult mask ventilation.

Cut-off for number of risk factors	Sensitivity	Specificity	Likelihood ratio positive	Likelihood ratio negative	Positive predictive value	Negative predictive value
1	0.875	0.500	1.75	0.25	0.359	0.926
2	0.063	0.980	3.50	0.956	0.500	0.766

Likelihood ratio positive=Sensitivity/(1-Specificity)

Likelihood ratio negative=(1-Sensitivity)/Specificity

The table displays the sensitivity and specificity if we use the given value of the number of risk factors possessed by patients as a cut-off to classify LMA difficult. For example, when we use number of risk factors at 1 as a cut-off, i.e., any patients with >=1 risk factors will be classified as LMA Diff=1 and any patients with <1 risk factors will be classified as LMA Diff=0, the sensitivity will be 0.875 and specificity will be 0.500.

Discussion

In the present investigation, risk factors in 69 LMA primary airway management placements were assessed. The incidence of difficult LMA placement in our study was 24.6% and the LMA failure rate was 2.9%. Moreover, the incidence of failed LMA placement in our study is consistent with previous studies[9,13,18,21,22], ranging from 0.19 to 4.7%.

Although from a large database, the study resulted only in a few placements, which is consistent with the practice of our teaching academic center and that could give a possible explanation to the increased incidence of difficult LMA placement in our study. Beside the limited number of uLMAs utilized electively, the study provides an interesting perspective on predictive factors pertaining laryngeal mask placement: indeed, two independent risk factors were found, neck circumference ≥44 cm and female gender. A predictive score that would assist the clinician in identifying difficult LMA placement was also developed, resulting in a model with low sensitivity but specificity of 98% and a negative likelihood ratio of 95.6% (for instance, excluding difficult LMA placement in male patients with neck circumference <44 cm).

The current study supports previous findings regarding the correlation of obesity and difficult airway[23–26], since increased neck circumference is also an independent risk factor for difficult mask ventilation (DMV) and difficult intubation. The most interesting finding of this study is that female gender, rather than male gender is associated with difficult LMA placement in this study population. In contrast, Ramachandran et al. found that male gender was a predictive factor for failed LMA placement[13,18].

Age distribution of our population was considered as a cause for this difference. Indeed, age distribution of our female population could be associated with an increased proportion of postmenopausal women. Previous studies have demonstrated that the prevalence and severity of Obstructive Sleep Apnea (OSA) is increased in postmenopausal women, as compared to pre-menauposal women, which may be related to functional changes[27]. However, history of OSA was not an independent predictive factor in our population. This can be attributed to the retrospective nature of our study, where OSA assessment was assessed only by patient history. Of interest, a recent but unpublished study has highlighted that the female gender was a predictor for difficult LMA placement in a study population of more than 400 patients, where LMA placement was performed by a single skilled clinician[28].

Of the other airway variables that were evaluated in our study, none was identified as an independent predictor of LMA failure: this finding differs from that of Ramachandran et al., who recognized the absence of teeth as an independent predictor of LMA failure, and the differences could be attributed to population included in the two studies, particularly the limited number of outcomes of our study, possible underutilization of the LMA as a primary airway device, as compared to other airway devices, the increased incidence of difficult LMA placements in our population, and the placements by trainees. Discussing the limitations of the present investigation, it is necessary to mention the retrospective nature as well the stepwise selection that may contribute to bias the study, and the subjective nature of the definition of difficult LMA placement. Additionally, we assumed that all anesthesiology residents had similar educational skills based on a previous study[19], which also could have affected our findings.

In conclusion, two risk factors for LMA placement difficulty were identified: female gender and large neck circumference. Considering the airway as an entity, neck circumference is being increasingly recognized as a significant predictive factor for difficulty with airway management, especially when it is considered across the spectrum of difficulties.

Data availability

Data have been obtained from databases at the Memorial Hermann Hospital, Texas Medical Center, Houston, IRB approval HSC-MS-07-0144. The author can support applications to the Institutional Board to make the data accessible upon individual request. Please forward your requests to Davide *Cattano*.

Author contributions

Katsiampoura Anastasia D: data analysis, data interpretation, manuscript preparation

Cai Chunyan: data analysis, data interpretation, manuscript preparation

Killoran Peter V: study design, data acquisition, data interpretation, manuscript preparation

Corso Ruggero M: manuscript preparation, data interpretation

Hagberg Carin A: study design, study monitoring, manuscript preparation

Cattano Davide: study design, data acquisition, data interpretation, manuscript preparation

Competing interests

Grant information

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Open Peer Review

Current Referee Status: ❓ ✅ ✅

Version 1

Referee Report 08 September 2015

doi:10.5256/f1000research.6882.r9937

Massimo Micaglio

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I read with interest this investigation and I wish to thank the Authors for the request of my review.

With this retrospective study they aimed to identify a simple, objective list of predictive factors for difficult laryngeal mask airway placement. As they underlined, at present such a list is not available.

The topic is up-to-date, remarkable and well represents a growing body of research on EGA.

Because LMA placement was performed by residents, some well known factors contributing to difficult placement of a LMA (type of anesthesia induction, dose of hypnotic agents, proper "waiting time" before LMA insertion, NMBA usage or not, etc.), could have been considered. But some limitations of the study are correctly stated by authors.

The conclusions that large neck circumference and female gender were independently associated with difficult LMA placement definitely provide data potentially useful to clinicians.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Competing Interests: I have been paid by Teleflex for lecturing and I am involved in teaching for courses supported by educational grants from Teleflex. Teleflex is the provider of the unique Laryngeal Mask Airways utilized in the study.

Referee Report 23 June 2015

doi:10.5256/f1000research.6882.r8512

Massimiliano Carassiti

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The major limitation of the study is the small sample size and that the degree of experience of the operators is not classified.

The study identifies the circumference of the neck and the female gender as independent risk factors for the positioning of the LMA. The "female risk" is in contrast to the study of Ramachandran *et al.*, which had a larger sample size and included the experience of operators, and this must be stressed more effectively in discussion

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Competing Interests: No competing interests were disclosed.

Author Response (*Member of the F1000 Faculty* and *F1000Research Advisory Board Member*) 24 Jun 2015
Davide Cattano, Department of Anesthesiology, The University of Texas Medical School at Houston, USA

We want to thank Dr Carassiti comments. The experience of the operators is definitely important and a major factor determining the success of a device or technique. In the specific case of the current investigation, which was derived retrospectively from a larger database, all airway manipulation/management were carried out by trainees (CA-1-CA3) with a minimum experience of six month (meaning the CA1 class was enrolled only after their first 6 months of training were elapsed), and one to one supervised by an attending anesthesiologist, which ultimately was responsible. We believe the point raised are extremely important, yet relying on the fact that tailoring for every single case to the experience based, would require a significant larger sample. While we evaluated the cases by experience of the operators, in general, we did not find any skewed distribution, yet a case by case was not deemed important, because of the number of cases. As we mentioned in our discussion the results have to be carefully considered observationally, with the possibility of selection bias due to the nature of the "mother" study to start with, to the limited number of cases, that would include a selected group of individuals (half of the residents, because they were assigned to a full airway assessment on multiple testing), yet not for any particular reason, different. Ramachandran *et al.*, accessed a single institution, residency program database, were, otherwise, it is reasonable to think the majority of EGA placements occurred by experienced staff. Yet the sample is much larger to question our findings. An interesting hypothesis, based on both studies, is that a differential complexity is determined by oro-pharyngeal anatomy vs laryngeal structures and neck morphology. That may explain that in males, a larger LMA would have chosen based on weight, while oropharyngeal or laryngeal structures would not accommodate for instance a size 5. In our overweight/obese population that may also explain why females patients (maybe largely selected for LMA because not as "morbidly obese", or accidentally clustered in our sample) resulted in more failures in our cohort.
It is a great opportunity, as suggested by Dr Vannucci, to identify new frontiers of EAD research.

Competing Interests: None

Referee Report 12 May 2015

doi:10.5256/f1000research.6882.r8514

Andrea Vannucci
Department of Anesthesiology, Washington University in St. Louis, St. Louis, MO, USA

I wish to thank the authors very much for the opportunity to review this interesting investigation of theirs.

In this retrospective study, the authors correlated a set of prospectively collected data including a comprehensive assessment of upper airway and neck anatomy and function to the event "*difficult laryngeal mask (LMA) placement*" in 2,348 adult patients. Those patients, who underwent elective, non-obstetric procedures, received an LMA Unique™ as the primary device to control the airway during their surgery.
LMA placement was generally performed by anesthesiology residents.

Difficult LMA placement was defined as "*… either inability to physically place a LMA device or inadequacy of ventilation, oxygenation, or airway protection after placement that required conversion to an alternative technique.*"

The authors identified 69 patients that met their criteria for "difficult LMA placement".

By logistic regression analysis, they came to the conclusion that neck circumference larger than 44 inches and female sex were independently associated with difficult LMA placement.

The hypothesis of the study that a comprehensive preoperative assessment of the airway may help predicting difficulties at the placement of an LMA is an interesting one, certainly worth of an exploration.

The main issue I see in the abstract, title, methods and conclusion of the study is an ambiguous definition of "difficult LMA placement" that likely includes two separate entities: a) failure to position an LMA (2 cases in the study, as per results presented in Table 4); and b) failure of the LMA during the use (15 cases, again as per Table 4 after removing the two above mentioned failures).

If my above interpretation of the study premises is correct, it is unlikely we can understand the causes of intraoperative failure of the LMA if intraoperative factors are not explored.

In particular, I believe that it would be important to consider what procedures the patients were undergoing when the LMA failure was detected, how much after the induction of the anesthesia and the start of the surgery the failure occurred, and other intraoperative and anesthetic factors like position of the operating table (flat, Trendelemburg, reverse Trendelemburg, etc.), the type of anesthesia (inhalational, intravenous, balanced technique, etc.), and so on.

In fact, intra-operative factors may have had a more relevant role in determining the intra-operative failure of the LMA than the baseline patient anatomical characteristics.

This additional information could provide more insight on the mechanisms of LMA failure and could also facilitate a comparison of the results of this study with the ones obtained by Dr. Ramachandran and colleagues at the University of Michigan.

Therefore, my advice to the authors is to add as much information as they can retrieve in their database on intraoperative factors that may have had a role in determining LMA failure.

Besides this significant limitation, the study approaches the problem of "LMA failure" (either initial failure to position or later failure during surgery) from an interesting perspective and provides some new and

interesting data that can be of interest to many clinicians.

A few additional questions:
- Table 1: last row title "Thyroid". What do the authors mean here?

- Table 3: Can the authors provide the specific references for each of the categories: "ExpecDMV", "ExpecDLMA", "ExpecDL", "ExpecDI", "ExpecDSA"?

- Methods: did the authors retrieve (part of) their data from an electronic or a paper anesthetic records? This information could be reported in the methods section.

- Discussion, page 6. Can the authors further clarify the following point (in particular what they intend by "stepwise selection" and how this relates to the bias of the study) "Discussing the limitations of the present investigation, it is necessary to mention the retrospective nature as well the stepwise selection that may contribute to bias the study, and the subjective nature of the definition of difficult LMA placement."?

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Competing Interests: No competing interests were disclosed.

Author Response (*Member of the F1000 Faculty* and *F1000Research Advisory Board Member*) 12 May 2015
Davide Cattano, Department of Anesthesiology, The University of Texas Medical School at Houston, USA

We are very grateful to Dr Vannucci for his timely and well thought review. We appreciate the opportunity to respond to some of his comments and clarify few of the work's points.

The study we extracted the LMA information was designed to evaluate the prediction of the difficult airway (ref 19). It was based on a paper-based evaluation form that contained all 11 of the predictive factors the ASA and other professional societies recommended (based on the practice management guidelines from 2003) as well as others. As airway management progressed during the study, different airway options populated our database (paper form collected), including LMA placements. We agree that anatomy is not the only factor contributing to difficult or failed placement of an EAD (proper relaxation, proper technique) and others may related to anatomy though, like sizing (see in the tables the estimation of used size versus optimal size). Other than placement, other factors contributes to overall failure of an EAD, which aim to be a ventilation conduit and patent airway assistance. So ventilatory mechanical and non mechanical issues can arise. Dr Vannucci correctly suggest that such factors (intraoperative) would be of great interest. Because of the scope and information available we limited to the factors contributing to the difficulty or failure of initial positioning and ventilation. The anesthesiologist attending decided and reported whether or not the LMA was satisfactory and the assessment of success (yes, no, i.e. failed) and easiness (yes, no, i.e. difficult and easy). So of the 69 placements, 17 were considered difficult, but not failed, and of the 17 also 2 were considered ultimately a failure (that is the meaning of the 2 separate tables). Expected DMV, DI etc, are based on the preoperative definition of the airway assessment, meaning the airway evaluation resulted in a predicted difficult bag mask ventilation, difficult laryngoscopy, difficult intubation etc. They not necessarily meant a difficult

airway, but the predictive portion. The Thyroid in the first table was the comment of resident evaluation or acknowledging a patient condition significant for "thyroid pathology" (could have been goiter as well as clinical diagnosis of hyper or hypothyroidism, aspecifically).

Last, the stepwise regression was performed by our statistician taking into account the primary univariate and multivariate analysis. Considering the small sample we acknowledged that study limitations need to be taken into account when interpreting the results.

In conclusion the current results propose that there may be unrecognized anatomical factors, maybe related to sizing methods, which the authors are also evaluating in other investigations (13, 17). However Dr Vannucci's points pertaining the value of post placement onset ventilation and seal failures are in need of further exploration.

Competing Interests: No competing interests were disclosed.

Referee Response 12 May 2015

Andrea Vannucci, Washington University in St. Louis, USA

Thank you to the authors for the clarifications and additional information they provided. I am fine with their response.

Competing Interests: No competing interests were disclosed.