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Quantitative Improvement in Laryngoscopic View by Optimal External Laryngeal Manipulation

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Study Objective: *To determine the improvement in laryngoscopic view obtained using both the Macintosh and Miller blades by applying optimal external laryngeal manipulation (OELM).*
Design: *Prospective, with each patient serving as his or her own control.*
Setting: *Inpatient operating rooms of a University Medical Center.*
Patients: *181 informed and consenting adult nonpregnant patients requiring general anesthesia and tracheal intubation. The only exclusion criteria was the need to apply cricoid pressure to prevent aspiration of gastric contents.*
Interventions: *Anesthetized, paralyzed patients underwent laryngoscopy without external laryngeal manipulation and the laryngoscopic view was graded ("A") according to visualized structures [1.0–1.9 = all (1.0) or part of the vocal cords (90% = 1.1 and 10% = 1.9); 2 = just the arytenoids; 3 = just the epiglottis; 4 = just the soft palate]. The larynx was then quickly manipulated by the thumb and index and middle fingers of the laryngoscopist's right hand in both cephalad and posterior directions over the hyoid, thyroid, and cricoid cartilages until it was determined which vector and spot produced the optimal laryngoscopic view ("B").*
Measurements and Main Results: *It was found that in every patient with a "A" greater than 1.0, OELM improved the view;* i.e., *"B" decreased relative to "A." For both the Macintosh blade patients and Miller blade patients with an "A" equal to 2, "B" decreased by one whole laryngoscopic grade in all patients. For both the Macintosh and Miller blade patients with an "A" equal to 3, "B" decreased by at least one whole laryngoscopic grade in all patients and by two laryngoscopic grades in most patients. No patient had an "A" equal to 4. The distribution of optimal-external-laryngeal-manipulation (OELM) spots for all patients was 1%, 40%, 48%, and 11% for the hyoid, high thyroid, low thyroid, and cricoid cartilages, respectively, and the distribution was not significantly different for either the Macintosh and Miller blade groups or for the "A" and "B" subgroups* (i.e., *"A" < 1.9, =2 or =3).*
Conclusions: *We conclude that OELM can improve the laryngoscopic view by at least one whole grade, that the best way to determine OELM for an individual patient is on an empirical basis by manipulation of the larynx with the laryngoscopist's right hand, and that OELM should be an instinctive and reflex response to any "A" of 2, 3, or 4.*

Keywords: Laryngoscopy; Macintosh blade; Miller blade; Management of the airway; laryngeal manipulation, external, optimal; tracheal intubation.

Introduction

Numerous authors have stated that external manipulation of the larynx during laryngoscopy can improve the laryngoscopic view.[1–8] However, these descrip-

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tions of external laryngeal manipulation vary a great deal in many important performance details, and very few actually quantitate the degree of improvement. For example, the area on the neck to manipulate the larynx has been variously described as being over the cricoid cartilage,[1,6] the thyroid cartilage,[1,7,8] or it was simply not specified[2–5] and the vector of manipulation as just posteriorly (backward),[1,3,8] just cephalad (upward),[2] both posteriorly and cephalad,[6,7] or not specified.[4,5] From a technical point of view, it is extremely difficult, if not clinically impossible, to quantitate the direction and magnitude of the manipulation vector. In addition, the person who performs external laryngeal manipulation has been an assistant [which obviously impairs hand (of the assistant)/eye (of the laryngoscopist) coordination[2,6–8]] or the person has not been specified.[1,3–5] Only two reports specify the type of laryngoscope blade used (in those cases the Macintosh blade).[2,3]

Obviously, the number of performance permutations that the above-cited literature[1–8] contains is large, and it is not exactly clear how one can achieve optimal external laryngeal manipulation (OELM) and how much benefit one can expect from the maneuver. The purpose of this investigation was to determine how to achieve optimal OELM and to quantitate the improvement in both the Macintosh and Miller laryngoscopic blade view by applying OELM.

Materials and Methods

General Preoperative and Anesthesia Induction Details

One hundred and eighty-one informed and consenting adult nonpregnant patients requiring general anesthesia and tracheal intubation participated in this University of California at San Diego institutionally approved study; the only exclusion criteria was the need to apply cricoid pressure to prevent aspiration of gastric contents. The patients were evaluated by an anesthesiologist preoperatively, and the oropharynx was classified according to structures visualized (Class I = uvula and tonsillar pillars; Class II = uvula only; Class III = base of uvula only; Class IV = just soft palate only),[9] the thyromental distance measured (in cm), and the range of motion of the head and neck determined (good, fair, poor); the evaluating anesthesiologist determined the exact method of making these measurements.[10] General anesthesia was induced intravenously (IV) with a variety of drugs (methohexital, thiopental sodium, propofol, ketamine, etomidate) and the patients paralyzed completely (as determined by a blockade monitor) by a variety of neuromuscular relaxants (succinylcholine, vecuronium, atracurium, pancuronium). After the induction of general anesthesia and paralysis, all patients were ventilated with positive pressure via a mask. Recorded data included patient age, height, weight, gender, preoperative oropharyngeal classification, thyromental distance, performance index [PI = oropharyngeal class (2.5)–thyromental distance in cm][10] range of motion of the head and neck, and any other unusual or abnormal airway findings.

Laryngoscopy and Optimal External Laryngeal Manipulation Details

Prior to the induction of general anesthesia and paralysis, all patients were placed in an optimal intubating ('sniff') position (slight flexion of the neck on the chest and severe extension of the head on the neck at the atlantooccipital joint). Laryngoscopy was performed by experienced anesthesia residents or certified registered nurse-anesthetists using either a Macintosh or Miller blade (laryngoscopist preference), first without external laryngeal manipulation and then with external laryngeal manipulation. Laryngoscopic grade was defined and quantitated according to the laryngeal structures visualized: Grade 1.0 to 1.9 = all (1.0) or part of the vocal cords (90% of vocal cords = 1.1 and 10% of vocal cords = 1.9); Grade 2 = the arytenoids only; Grade 3 = the epiglottis only; Grade 4 = the soft palate only.[11] A Grade 3 view with the Miller blade is further defined as visualization and trapping of the epiglottis but failure to visualize the arytenoids upon lifting of the Miller blade. The grade of laryngoscopic view prior to external laryngeal manipulation is referred to as "A" and the grade of laryngoscopic view with external laryngeal manipulation as "B". A Macintosh blade was used in a 106 patients and a Miller blade was used in 75 patients. There were no changes in length of blade or the position of the head and neck between laryngoscopic view "A" and "B".

The laryngoscopist held the laryngoscope in the left hand and the larynx was manipulated by the laryngoscopist's right hand. The thumb, index finger, and middle finger of the laryngoscopist's right hand quickly pressed in both a cephalad and posterior direction over the hyoid, thyroid, and cricoid cartilages until it was determined which vector and location produced the optimal laryngeal laryngoscopic view ("A"). The determination of OELM always took less than 10 seconds. If considered clinically appropriate/necessary (*e.g.*, "A" is 2 or 3) the fingers of an assistant were then used as an extension of the laryngoscopist's righthand fingers and made to reproduce optimal external laryngeal manipulation. The patient was then tracheally intubated. Data recorded included the laryngoscope blade used, laryngoscopic grade prior to external laryngeal manipulation ("A"), the laryngoscopic grade with OELM ("B"), and the location on the neck that produced OELM (hyoid, high thyroid, low thyroid, or cricoid cartilage).

Statistical Analysis

Correlation between preoperative factors and "A" was by regression analysis. Both groups of patients in whom the Macintosh and Miller blades were used were subdivided according to "A" grade as "A" greater than 1.9, "A" equals 2 and "A" equals 3. The Wilcoxon analysis was used to determine significant differences ($p < 0.05$) between "A" and the paired "B" for the three "A" laryngoscopic view blade subgroups. The Mann-Whitney U test was used to identify significant differences ($p < 0.05$) between Macintosh and Miller blade groups and the location for OELM between the various "A" subgroups (*i.e.,* unpaired data).

Results

Preoperative and Anesthesia Induction Data

The patients were aged 41 ± 16 years (mean ± SD) (range 13 to 80 years), were 167 ± 9 cm in height (range 150 to 195 cm), and weighed 74 ± 16 kg (range 45 to 120 kg); 89 patients were males and 92 were females. Oropharyngeal class and the performance index were significantly related to "A" ($p = 0.0371$ and $p = 0.0351$, respectively), and the thyromental distance was not significantly related to "A" ($p > 0.1$). There was no significant difference between the Macintosh and Miller blade groups or "A" subgroups for any of these preoperative variables.

Laryngoscopy (G1 and G2) Data

Table 1 shows the essential comparison between "A" and "B." For all Macintosh and Miller blade "A" subgroups (<1.9, =2, and =3) OELM produced a significant improvement in the laryngoscopic grade. In every patient other than those who had a "A" = 1.0, the laryngoscopic grade was improved by OELM, *i.e.,* "B" decreased relative to "A". With reference to *Table 1,* the worse the laryngoscopic grade without OELM (the higher the value for "A") the greater was the improvement in laryngoscopic grade produced by OELM (change from "A" to "B" in *Table 1*). Despite the greater degree of improvement, the worse (higher) the initial value for "A" was (see increasing subgroups for "A" in *Table 1*), the worse (higher) was the final resulting value for "B."

Table 2 shows the distribution of laryngoscopic grades within the Macintosh and Miller groups. In both blade groups, there was a progressive decrease in the percentage of patients who had an "A" less than 1.9, =2, and =3. The distribution of patients within the "A" subdivisions was not significantly different between the Macintosh and Miller groups.

The distribution of patients in the "B" subgroups within both the Macintosh and Miller laryngoscope blade groups was significantly different compared with the distribution of patients in the "A" subgroups (*Table 2*). In both Macintosh and Miller blade groups, all "A" equal to 2 became "B" less than 1.9. For the 12 Macintosh blade patients with an "A" equal to 3, "B" became less than 1.9 in 11 patients and "B" equal to 2 in 1 patient. For the 5 Miller blade patients with an "A" equal to 3,"B" was less than 1.9 in 3 patients and a "B" equal to 2 in 2 patients. The distribution of patients within the "A" and "B" subgroups was not significantly different between the Macintosh and Miller laryngoscope blade groups.

Location of OELM Data

The distribution of OELM locations for all patients was 1%, 40%, 48% and 11% for the hyoid, high thyroid, low thyroid, and cricoid cartilages, respectively. Many of the laryngoscopists commented that the vector of manipulation was usually both cephalad and posterior, but sometimes it was just cephalad and sometimes it was just posterior. Occasionally, rightward pressure was additionally helpful. The distribution of OELM locations was not significantly different between Macintosh and Miller blade groups or "A" subgroups.

Discussion

This study shows that OELM improves the laryngoscopic view by at least one whole grade in patients with either a grade 2 or 3 view, and that the location to apply OELM is usually over the thyroid cartilage, occasionally over the cricoid cartilage, and rarely over the hyoid cartilage. Since the location for OELM is variable, and the amount of cephalad and posterior manipulation is also certainly variable (from patient to patient) and is clinically impossible to measure and standardize, it is only common sense that the best way to apply OELM is by a quick empirical search by the fingers of the laryngoscopist's right hand. Prior to comparing these results to previous studies and discussing the mechanism of benefit and clinical implications of this study, consideration should be given to the limitations of this study.

This study had several potential limitations. First, mul-

Table 1. Comparison of Laryngoscopic View Without ("A") and With ("B") Optimal External Laryngeal Manipulation

Laryngoscope Blade	"A" Subgroups	"A" (±SD)	"B" (±SD)	Change from "A" TO "B" ("A"–"B")	p-value ("A" *vs.* "B")
Macintosh	<1.9	1.4 ± 0.3	1.1 ± 0.1	0.3	0.0001
	=2	2	1.4 ± 0.3	0.6	0.0001
	=3	3	1.5 ± 0.3	1.5	0.0021
Miller	<1.9	1.3 ± 0.3	1.1 ± 0.2	0.2	0.0001
	=2	2	1.3 ± 0.3	0.7	0.0173
	=3	3	1.7 ± 0.3	1.3	0.0412

Table 2. Distribution of Patients within the Macintosh and Miller Blade Groups for "A" and "B" Subgroups

Laryngoscope Blade	"A" Subgroup	No. Patients in Laryngoscope Blade "A" Subgroup	% of Patients in Laryngoscope Blade "A" Subgroup	"B" Subgroup	No. Patients in Laryngoscope Blade "B" Subgroup*	% of Patients in Laryngoscope Blade "B" Subgroup*
	<1.9	65	61.3	<1.9	105	99
Macintosh	=2	29	27.3	=2	1	1
	=3	12	11.4	=3	0	0
	<1.9	63	84.0	<1.9	73	97
Miller	=2	7	9.3	=2	2	3
	=3	5	6.7	=3	0	0

*Distribution of patients in the "B" subgroup is significantly different ($p < 0.01$) than in the "A" subgroups for both the Macintosh and Miller blade groups.

tiple laryngoscopists participated in the study. However, all were experienced and competent with both the Macintosh and Miller blades, and variability in the data due to using multiple laryngoscopists should be slight. In addition, in terms of relevance of this study to the anesthesia community at large, use of multiple laryngoscopists can be considered a desirable feature. Second, the choice of laryngoscope blade used in a given patient was by laryngoscopist preference; it is possible that this experimental design feature could have introduced a constant error. However, the fact that the distribution of oropharyngeal class, thyromental distances, range of motion of the head and neck, and "A" findings were not significantly different between the Macintosh and Miller groups indicates that there were no systematic biases in the choice of laryngoscope blade. Third, the incidence of "A" = 3 in the Macintosh and Miller groups was 11% and 7%, respectively, which is high compared with some previous studies (2% to 3%).[12,13] However, the incidence of "A" = 3 in this study is identical to that found in a previous recent study from this institution[10] and it is very similar to other previous studies (9%).[3,6] Fourth, it is not possible to quantitate the direction and magnitude of the laryngeal manipulation vector. The laryngoscopists in this study reported that most of the time the vector was both cephalad and posterior, but on occasion it was just cephalad or just posterior and sometimes included a rightward direction. Thus, in some cases the OELM was equivalent to the "backward, upward, and to the right pressure" ("BURP") of Knill.[7]

Few previous studies have attempted to quantitate the degree of improvement in laryngoscopic view resulting from OELM. Salem *et al.*[2] found in 44 of 45 patients with an "A" of 2 to 4 that external laryngeal manipulation resulted in an improved laryngoscopic grade (one patient had no improvement and was intubated fiberoptically); however, the improvement was not quantitated for individual patients or for the group as a whole, and the location for external laryngeal manipulation was not specified. Krantz *et al.*[6] found in 98 of 102 patients with an "A" of 2 or greater, external laryngeal manipulation over the cricoid cartilage by an assistant improved the view by at least one grade. Wilson *et al.*[3] found that the incidence of an "A" of 2 could be decreased from 11% to 4% to 6% and the incidence of "A" being 3 from 9% to 1% to 5% by external laryngeal manipulation (location not specified), but it was not possible to determine what happened in individual patients. We found that in every one of 53 patients with an "A" of 2 or 3, the laryngoscopic view was improved by greater than or equal to one whole grade. Thus, although our results are consistent with previous results, more precise comparison cannot be made because of uncertainties in previous studies regarding how the external laryngeal manipulation was applied and exactly what was found.

There are two possible mechanisms contributing to the benefit of OELM. First, OELM may simply push the larynx into the line of vision allowed by the Macintosh and Miller laryngoscope blades. This push, whether due to cephalad, posterior, or both cephalad and posterior movement, places the laryngeal inlet in a more posterior position relative to the tongue and epiglottis. This explanation is similar to that proposed by Salem, *et al.*[2] Krantz *et al.*[6] and Knill.[7] Indeed, the view has been expressed that laryngoscopy displaces the larynx anteriorly and to the left and with "BURP" "the right hand corrects what the left hand is overdoing."[14] Second, with a Macintosh blade, optimal OELM may increase the traction of the laryngoscope blade on the hyoepiglottic ligament, thereby lifting the epiglottis out of the line of vision.

The clinical implications of this study are obvious. Optimal external laryngeal manipulation can best be produced empirically by the laryngoscopist's right hand and under the circumstances of this study will highly likely improve the view of the larynx. Consequently, in all cases of difficult laryngoscopy, OELM should be used, and the definition of a best attempt at laryngoscopy must include the application of OELM.[15,16] This maneuver should be taught to every trainee in anesthesia and practiced by all trained anesthesiologists so that OELM is an inherent part of laryngoscopy and therefore will be an instinctive and reflex corrective response to a poor laryngoscopic view.[16]

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References

1. Latto IP: Management of difficult intubation. In: Latto IP, Rosen M (eds): *Difficulties in Tracheal Intubation.* London: Bailliere Tindall, 1985:99–103.
2. Salem MR, Heyman HJ, Mahdi M: Facilitation of tracheal intubation by cephalad displacement of the larynx-rediscovered. *J Clin Anesth* 1994;6:167–8.
3. Wilson ME, Spiegelhalter D, Robertson JA, Lesser P: Predicting difficult intubation. *Br J Anaesth* 1988;61:211–6.
4. Stone DJ, Gal TJ: Airway management. In: Miller RD (ed): *Anesthesia 3d ed.* New York: Churchill Livingstone, 1990:1265–92.
5. Collins VJ: *Principles of Anesthesiology, 3d ed.* Philadelphia: Lea and Febiger, 1992:518–59.
6. Krantz MA, Poulos JG, Chaouki K, Adamek P: The laryngeal lift: a method to facilitate endotracheal intubation. *J Clin Anesth* 1993; 5:297–301.
7. Knill RL. Difficult Laryngoscopy made easy with a "BURP." *Can J Anaesth* 1993;40:279–82.
8. McIntyre JW: The difficult tracheal intubation. *Can J Anaesth* 1987;34:204–13.
9. Samsoon GL, Young JR: Difficult tracheal intubation: a retrospective study. *Anaesthesia* 1987;42:487–90.
10. Lewis M, Keramati S, Benumof JL, Berry CC: What is the best way to determine oropharyngeal classification and mandibular space length to predict difficult laryngoscopy? *Anesthesiology* 1994;81: 69–75.
11. Cormack RS, Lehane J: Difficult tracheal intubation in obstetrics. *Anaesthesia* 1984;39:1105–11.
12. Williams KN, Carli F, Cormack RS: Unexpected difficult laryngoscopy: a prospective survey in routine general surgery. *Br J Anaesth* 1991;66:38–44.
13. Carli F, Williams KN, Cormack RS. Difficult laryngoscopy. *Br J Anaesth* 1992;68:117–8.
14. Relle A. More on "BURP" [Letter]. *Can J Anaesth* 1994;41:74.
15. Benumof JL: Management of the difficult airway: with special emphasis on awake tracheal intubation. *Anesthesiology* 1991;75: 1087–110.
16. Benumof JL. Difficult laryngoscopy: obtaining the best view. *Can J Anaesth* 1994;41(5 P + 1):361–5.