FORCES APPLIED BY THE LARYNGOSCOPE BLADE ONTO THE BASE OF THE TONGUE AND THEIR RELATION WITH POSTOPERATIVE SORE THROAT

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SUMMARY: The forces applied by the laryngoscope blade onto the base of the tongue have been measured indirectly by some investigators. The relation between these forces and postoperative sore throat has not been studied previously. The aim of this study was to directly measure the forces applied by the tip of the laryngoscope blade onto the base of the tongue and its relation to incidence and severity of sore throat.

One hundred patients, 18-65 years old, all candidates for abdominal or lower limb operations under general anesthesia were selected. Maximum and mean force, laryngoscopic time and force-time product were measured using a modified macintosh laryngoscope blade during laryngoscopy. The occurrence and severity of postoperative sore throat were determined after operation using visual analogue scale. Data were analyzed statistically using t-test and Spearman's correlation coefficient.

The laryngoscopic time was 10.57 ± 1.66 seconds, the maximum force was 61.56 ± 8.07 N, the mean force and force - time product were 38.29 ± 6.74 N and 404.72 ± 71.24 N.S. respectively. There was a positive correlation between sore throat intensity, its maximum intensity maximum and mean forces.

This study showed that these forces were higher than those of previous reports. Instant forces applied by the laryngoscope blade may be a more important factor than duration of applied forces regarding the severity of postoperative sore throat.

Key Words: Laryngoscope, force, sore throat, postoperative.

INTRODUCTION

The perioperative complications of laryngoscopy and endotracheal intubation have been reviewed by many investigators (1-4). Blanc and Tremblay listed more than 30 possible acute problems associated with laryngoscopy, endotracheal intubation and extubation (2). Laryngoscopy and endotracheal intubation are known to have profound influence on circulatory parameters and intracranial pressure (5-8). Forces applied by the laryngoscope blade onto the base of the tongue are assumed to be major stimuli (9-12).

Different techniques and devices have been described to measure these forces (6, 14-18). However, none of the previous studies have directly measured the pressure applied by the laryngoscope blade onto the base of tongue.

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On the other hand, sore throat is a common postoperative complaint, occurring most often following endotracheal intubation (19). The relationship between sore throat and some factors such as tracheal tube size (20), cuff design (21), intracuff pressure (22), lubrication of the tube (23) and difficult intubation (24) have been investigated previously.

The aim of this study was to directly measure the forces applied by the tip of the laryngoscope blade onto the base of the tongue and their relation to incidence and severity of postoperative sore throat.

MATERIALS AND METHODS

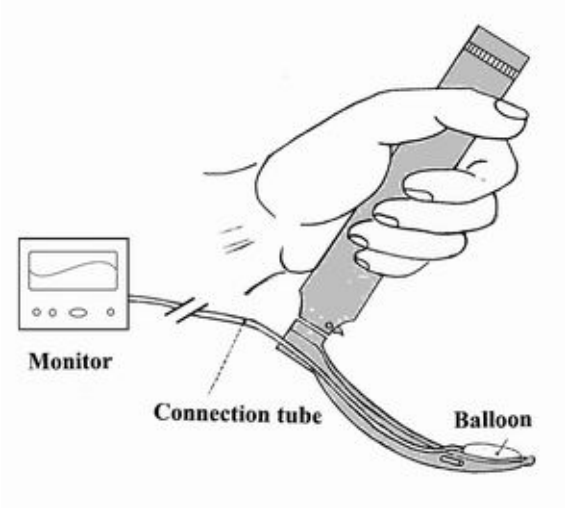
In this cross sectional descriptive study, one hundred patients, 18-65 years old, ASA I, II candidates for abdominal or lower limb operation under general anesthesia were selected. Approval of the institute ethics committee and informed consent of each subject were obtained.

Patients in whom tracheal intubation proved difficult or not achieved at first attempt, laryngoscopic time more than 15 seconds, operation time above 90 minutes, intracuff pressure exceeding 25 cm H2O and also occurrence of baking on the tracheal tube, were excluded from the study. For intubation in all patients we used high volume-low pressure cuff tracheal tubes manufactured by Supa Company (IRAN). The proper tube size in each case was selected by an anesthesiologist and tube cuffs were filled using operating room air (temperature: 22-25°C).

After pre-oxygenation, anesthesia was induced by fentanyl (1 mg/kg), atracurium (0.6 mg/kg) and sodium thiopental (5 mg/kg) and maintained with O_2, N_2O (50%) and halothane (1-1.5%) in all patients. Following induction of anesthesia and relaxation of patients, laryngoscopy was performed by the same anesthesiologist on each occasion using number 3 Macintosh laryngoscope blade. To measure pressure applied by the tip of laryngoscope blade, we attached a small non-compliant plastic balloon on the distal end of lingual surface of laryngoscope blade (Figure1). This balloon was connected to transducer of Cardiocap II monitor (Datex, Finland) using a short non-compliant tube. Before laryngoscopy, calibration was performed in each case, injecting 2.5 ml of room air in the balloon and connecting it to transducer and then zeroing the monitor.

During laryngoscopy the pressure applied by the laryngoscope on the base or the tongue was determined by pressure-time curve displayed on monitor and printed on the graph paper (Figure 2). In each case, laryngoscopic time, surface area under the curve, maximum and mean laryngoscopic pressures were determined using pressure-time curve.

Figure 1: Attachment a small balloon on the distal end of lingual surface of Macintosh laryngoscope blade.



To measure the pressure applied by the tip of laryngoscope blade, a small non-compliant plastic balloon was attached on the distal end of lingual surface of Macintosh laryngoscope blade. This balloon was connected to transducer of monitor using a short non-compliant tube.

Laryngoscopic time (second) was determined measuring the distance between the beginning and the end of the pressure-time curve based on trace speed. The surface area under the curve was calculated by counting up the small boxes of graph paper that were located bellow the curve. The highest point of pressure - time curve was defined as maximum pressure. Mean pressure was calculated by dividing the surface area under the curve to the laryngoscopic time.

All pressure traced on the graph paper, were in mmHg unit. To change the pressure (mmHg) in to force (Newton=N), different weights (0.5 to 7 kg) were hanged at the tip of laryngoscope blade on a horizontal position on the balloon and the corresponding pressure were read on the monitor (Figure 3). The force (N) was calculated by multiplication of germ (kg) of each weight to gravity (9.8) (25) (Table1). The occurrence and severity of postoperative sore throat was determined 24 hours after operation using visual analogue scale (VAS: 0=no pain and 10=extreme pain). The severity of sore throat based on VAS was classified as mild (1-3), moderate (4-6) and severe (7-10).

Data were analyzed statistically using t-test and spearman's correlation coefficient as appropriate. Results are given as mean±standard deviation (SD) and maximum and minimum values. Statistical significance was assumed at $p < 0.05$.

Table 1: Change the pressure (mmHg) in to force (Newton=N).

Calculated force (N)	Pressure shown on the monitor	Germ of weights (kg)
4.9	16	0.5
9.8	24	1
14.7	42	1.5
19.6	61	2
24.5	90	2.5
29.4	110	3
34.3	140	3.5
39.2	160	4
44.1	175	4.5
49	195	5
53.9	210	5.5
58.8	240	6
63.7	275	6.5
68.8	295	7

The force (N) was calculated by multiplication of germ (kg) of each weight to gravity (9.8)

RESULTS

In this study 100 patients (female: 59, male: 41), 19-64 years old (mean: 36.40 ± 12.51) were examined. The mean of laryngoscopic time was 10.57 ± 1.66 seconds (range 7-14.5). The maximum and mean of forces and surface area under the curve are shown in Table 2.

Table 2: Forces applied by the laryngoscope blade onto the base of the tongue and surface area under the force-time curve.

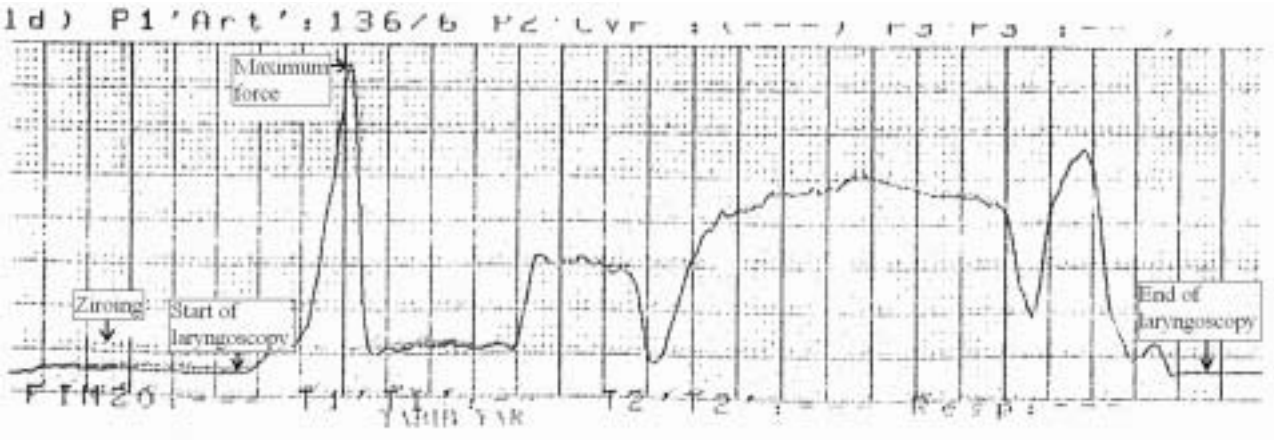
Variables	Mean ± SD	Minimum	Maximum
Maximum force (N)	61.56 ± 8.07	57	69
Mean force (N)	38.29 ± 6.74	32.66	53.90
Mean surface area (N.S)	404.72 ± 71.24	345	570

N= Newton, N.S= NewtonxSecond

The overall incidence of postoperative sore throat was 87%. The average severity of postoperative sore throat in all the patients expressed on VAS from 0 to 10 cm was 1.37 ± 0.98. The average pain intensity in patients indicating a pain level >0 was 1.57 ± 0.81. The incidence of mild and moderate sore throat in all patients were 84% and 3%, respectively. There was not any case with complaint from severe sore throat.

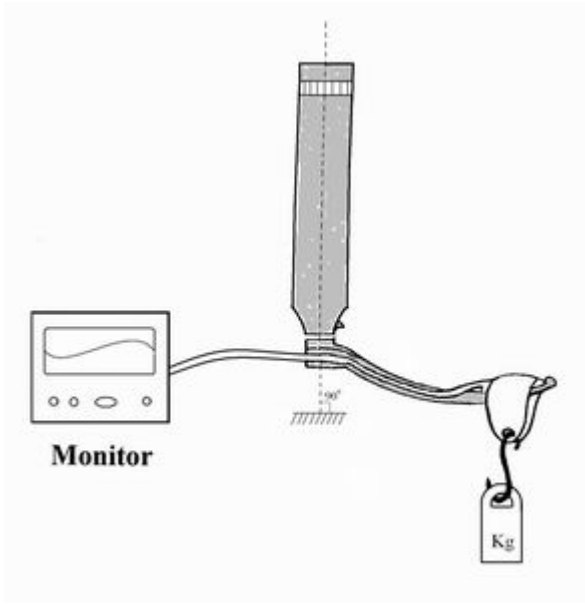
There was a positive relation between sore throat intensity and maximum (Spearman's r=0.35, P=0.001) and also mean forces (Spearman's r=0.31, P=0.004) (Figure 3).

Figure 2 : Graph paper of pressure-time curve in a typical patients.



Pressure applied by the laryngoscope on the base or the tongue was determined by pressure-time curve displayed on monitor and printed on the graph paper. Laryngoscopic time, surface area under the curve, maximum and mean laryngoscopic pressure was determined using pressure-time curve.

Figure 3: Change the pressure (mmHg) in to force (Newton=N) using different weights.



Change the pressure (mmHg) in to force (Newton=N) using different weights (0.5 to 7 kg) were hanged with a hook at the tip of laryngoscope blade on a horizontal position on the balloon and the corresponding pressure were read on the monitor. The force (N) was calculated by multiplication of germ (kg) of each weight to gravity (9.8).

The relation between sore throat intensity and the other factors such as age, sex, laryngoscopic and operation time and also surface area under the curve were not significant.

DISCUSSION

Our data showed that the mean and maximum forces applied by the tip of laryngoscope blade onto the base of the tongue during endotracheal intubation were 38.29 ± 6.74 and 61.56 ± 8.07N respectively. These values are higher than the results of previous study reported by Bucx and colleagues (20 ± 6 and 35 ± 15N) (16, 25).

This difference may be due to direct measurement of these forces and larger sample size in present study. The mean surface area under the curve (forcextime) in this study was 404±71N.S compared to the results reported by Bucx and colleagues (324 ± 194).

This difference may be due to two resons: 1. as previously mentioned the forces reported in present study were higher than the values of Bucx and colleagues report (16, 25), 2. the technique of measurement of the surface area in Bucx study was calculation mathematically but in our study was counting the small boxes.

Our incidence of postoperative sore throat of 87% is higher than that of other investigators' (19, 26). In our study 52% of all patients had number 1 pain score compared with 2.5% in Biro report (19) (1-10 expressed on a scale from 0-100). On the other hand, the average pain intensity in patients indicating a pain level >0 was 1.57 ± 0.81 (on a scale expressed from 0-10) vs. Biro reports 28±12 (on a scale expressed from 0-100). The difference between the incidence of postoperative sore throat in our study and some previous reports (19, 26) may be due to two reasons: 1. effect of age on this value; the mean age of our patients was lower than Biro report, 2. smaller sample size in our study.

The relation between laryngoscopic force and postoperative sore throat has not been studied previously. Data extracted from present study showed that there are moderate positive correlations between maximum and mean forces applied by the laryngoscope blade and severity of the sore throat (r_1= 0.35 p= 0.001, r_2= 0.31 p=0.004 respectively). These data indicate that the instant forces applied by the tip of laryngoscope blade on the tissues may be more important factors than duration of applied forces regarding the severity of post operative sore throat.

To sum up, we directly measured the forces applied by the tip of laryngoscope blade onto the base of the tongue. Results showed that these forces were higher than previous reports. Our findings also indicate that there is a positive correlation between these forces and severity of postoperative sore throat.

In conclusion this study showed that forces applied by the tip of laryngoscope blade onto the base of the tongue were higher than previous reports. Our findings also indicate that there are positive correlations between maximum and mean forces applied by the laryngoscope blade and severity of the sore throat. Instant forces applied maximally by the laryngoscope blade may be a more important factor than duration of applied forces regarding the severity of postoperative sore throat.

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