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Pressure applied by the healthcare staff on a cricoid cartilage simulator during Sellick's maneuver in rapid sequence intubation ☆, ☆

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ABSTRACT

Background: Sellick's maneuver or cricoid pressure is a strategy used to prevent bronchoaspiration during the rapid intubation sequence. Several studies have described that the force required for an adequate maneuver is of 2.5–3.5 kg. The purpose of this paper was to determine the force applied (in kilograms) on a cricoid cartilage simulator by the healthcare professionals.

Methodology: Observational cross-section trial. The participants were the healthcare professionals at the San José University Hospital in Popayán and participants at the National Congress of Anesthesiology – S.C.A.R.E. 2011, who were conveniently selected. Every participant made three attempts to apply the maneuver on the simulator.

Results: Data from 156 participants were collected. The mean global pressures applied in the first, second and third attempts were 2.70, 2.71 and 2.73 kg, respectively. Following a multivariate adjustment, males exhibited a higher force at the first attempt to do the maneuver. No association was found to other variables, such as labor experience or the training level.

Conclusions: The pressure applied by the participants in the trial during the first attempt was 2.7 kg. Most of the subjects in the trial did Sellick's maneuver applying an inadequate pressure in their first attempt. Only males exerted an overpressure in their first attempt to do the maneuver.

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Fuerza aplicada por el personal de salud sobre un simulador del cartílago cricoides durante la realización de la maniobra de Sellick en la intubación de secuencia rápida

R E S U M E N

Palabras clave:

Intubación
Cartílago cricoides
Simulación
Tráquea
Manejo de la Vía aérea

Antecedentes: La maniobra de Sellick o fuerza cricoidea es una estrategia utilizada para prevenir broncoaspiración durante la secuencia rápida de intubación. Algunos estudios han descrito que la fuerza necesaria para que la maniobra sea adecuada es de 2,5 a 3,5 kg. Este estudio tuvo como objetivo determinar cuál es la fuerza ejercida (en kilogramos) sobre un simulador del cartílago cricoides por profesionales de la salud.

Metodología: Estudio observacional de corte transversal. Los participantes fueron personal de salud del Hospital Universitario San José de Popayán y asistentes al Congreso Nacional de Anestesiología S.C.A.R.E. 2011, los cuales fueron seleccionados a conveniencia. Cada participante ejecutó 3 intentos de realización de la maniobra sobre el simulador.

Resultados: Se recolectaron datos de 156 participantes. La fuerza global media ejercida en el primer, segundo y tercer intento de realización fue de 2,70, 2,71 y 2,73 kg, respectivamente. Tras el ajuste multivariante, el género masculino presentó influencia en la mayor aplicación de fuerza en el primer intento de realización de la maniobra. No se encontró asociación con otras variables como la experiencia de trabajo o el grado de entrenamiento.

Conclusiones: La fuerza ejercida por los participantes en el estudio durante el primer intento fue de 2,7 kg. La mayoría de los sujetos en estudio realizaron la maniobra de Sellick con una fuerza inadecuada en el primer intento. Únicamente el género masculino afecta la fuerza realizada por los profesionales en el primer intento de realización de la maniobra.

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Introduction

Sellick's maneuver is the pressure applied on the cricoid cartilage for pushing the trachea and compressing the esophagus against the cervical vertebrae in an attempt to occlude gastroesophageal reflux.¹ The technique has been used widely since the sixties when it was included in the description of rapid sequence intubation.² The current recommendation for its use in the management of anesthesia in patients with a full stomach and/or during rapid sequence intubation is Classification D; there is nevertheless considerable controversy regarding its use and clinical efficacy.^{3,4} However, in view of its broad availability, little resources needed for its implementation and low risks, it is still a frequently used tool during the process of intubation.

During the eighties, Wraight & Cols measured the force that should be applied over the cricoid cartilage to prevent saline reflux through a tube inside the esophagus. They estimated that the pressure required to prevent bronchoaspiration was 44 N.⁵ Some authors argue that the maneuver is only effective if applied properly. Clayton and Vanner observed that the pressure applied over the cricoid changed depending on the force applied by the operator and on the training in the execution of the maneuver. Consequently, a force of 25–35 N over the cartilage (or the equivalent weight of 2.5–3.5 kg – taking the cricoid area into account) has been used as a strategy for proper execution of the maneuver.⁶

Studies using simulators have shown that anesthesiology assistants in the first two attempts to execute the maneuver did not apply enough force; however, following a training period, the force applied was close to the recommendation.⁷

Notwithstanding the lack of clear evidence about the clinical effectiveness of Sellick's maneuver to prevent the risk of bronchoaspiration, its potential benefit may be associated to the anatomic characteristics of each particular patient, the training received by the operator in the application of force over the cricoid, the knowledge of the maneuver and/or the relationship of the esophagus, the cricoid and the cervical spine.^{8–10}

In our environment, we do not have any data available on the use of Sellick's maneuver in rapid sequence induction or on the characteristics of its use. Consequently, the objectives of this paper were: to estimate in kilograms the force applied by the various healthcare professionals over a simulator of the cricoid cartilage when executing Sellick's maneuver, to characterize the differences among them and to establish potential factor affecting the force applied.

Materials and methods

Observational, cross-section trial that included healthcare staff at the San José University Hospital, Popayán, and voluntary participants at the National Congress of Anesthesiology – S.C.A.R.E. 2011. The sample included residents of anesthesiology and other specialties throughout the country, specialists in anesthesia and in other areas, general practitioners, medical students, OR assistants, respiratory therapists and chief nurses.

Everyone agreed to participate and submitted their voluntary informed consent; the ethics committee of the San José University Hospital of Popayán approved the trial.

The researchers were in charge of recording the data in a form that included the force applied in three attempts, the name, age, gender, size, weight, length of labor experience, profession, dominant side and position at the time of doing the maneuver, in accordance with the protocol established by the group of researchers. The participants were blind to the force they applied at each attempt.

The simulation model used was a telemetry – scale Zhongshanoppel Electronics CO, Xinlongstreet-Xincun, Eastarea, Zhongshan (Kitchen Scale) used for weighing objects, that was calibrated with known weights, bought and installed on 01-04-2010 and date of commissioning 04-03-2011 (code ECRI 10-264, cost of the unit: COP\$ 95 000). The assistant of biomedical devices that works at the San José University Hospital, using a synthetic plastic fiber that simulates the consistency of the cricoid cartilage, manufactured the model of the cricoid cartilage area. A biomedical engineer supervisor, who works at the Health Department of Cauca, confirmed the calibration of the simulator in kilograms and designed a chart that verified and certified that the measurements collected from each participant were valid and within the range of variability allowed to meet quality standards (Fig. 1).

Upon approval to join the trial, Sellick's maneuver was explained to every participant and the data corresponding to the three attempts were then collected but the participant remained blind to the results recorded by the machine.

The analysis were made using a software SPSS 19.0 (IBM SPSS Statistics for Windows, Version 19.0. Armonk, NY: IBM Corp.) and R (R Development Core Team (2008). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL <http://www.R-project.org>). To summarize the quantitative variables such as age, weight, height and the force applied in kilograms, general trends and scatter measurements were used (average \pm standard deviation, median

[interquartile range], value {minimum–maximum}). Absolute and proportionate frequencies were used for the qualitative variables.

The relevant results are shown graphically using box diagrams, point charts and correlation matrixes. The level of Pearson's lineal correlation was established among three consecutive evaluations in the same participant and 95% confidence intervals were calculated for those correlations using bootstrapping. Finally, a multiple lineal regression model was developed to explore the association of co-variables in the trial with the force applied in the first attempt to execute the maneuver. A residual analysis was made to assess the adjustment of the model. A statistical alpha significance level of 0.05 was set for all the analyses.

Results

156 participants were gathered during a period of 18 months; the overall characteristics of the participants are shown in Table 1. Most of them were females (52%) and professional anesthesiologists (27%).

The median force applied in the first, second and third attempt were 2.70, 2.71 and 2.73 kg, respectively (Fig. 2).

The correlation of force applied in the three repeated evaluations was very high and it was even higher in subsequent evaluations between the first and the second $R^2=0.92$ 95% CI [0.86–0.95]. Very few outliers were found. The correlation matrix is shown in Fig. 3.

Males executed the maneuver with an average force of 3.1 kg and females with 2.3 kg. The mean force applied by the various professionals in the trial is shown in Table 2 and Fig. 4 is a graphical representation thereof.



Fig. 1 – Stimulation model used to execute Sellick's Maneuver.
Source: The authors'.

Table 1 – Overall characteristics of the participants in the trial (n = 156).

Study variable	n (%), median [RIQ]
Age ^a	33 [28–45] {22–70}
Female ^c	81 (51.9)
Weight ^b	68 [58–78]
Height ^b	167 [160–174]
BMI ^b	24.2 [22–26.4]
Profession ^b	
Specialist in anesthesiology	42 (26.9)
Specialist in other medical-surgical areas	10 (6.4)
Resident of anesthesiology	16 (10.3)
Resident of other specialties	14 (9)
General practitioner	22 (14.1)
Medical student	14 (8.9)
Nurse	13 (8.3)
Nursing assistant	15 (9.6)
Respiratory therapists	10 (6.4)
Experience since graduation (years) ^b	7 [2–16]
Right side dominant (dominant side) ^c	146 (93.6)

Source: The authors'.

^a Data presented as median [RIQ] {range}.

^b Data presented as median (RIQ).

^c Data presented as absolute frequency (%).

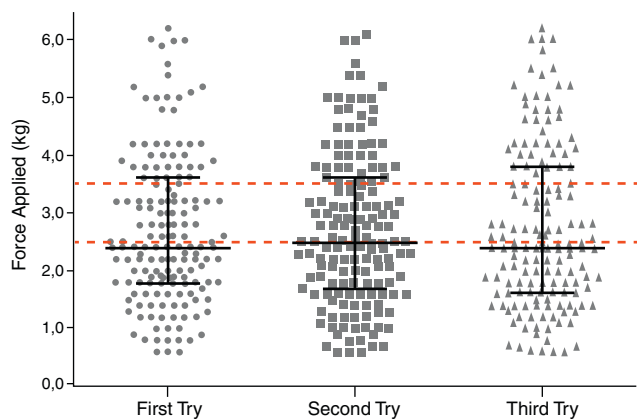


Fig. 2 – Pressure applied at the first, second and third attempt by the participants in the trial (n = 156). The lines across represent the median distribution and the ends the interquartile range. Source: The authors’.

The force applied during the first attempt to execute the maneuver showed a distribution with no evidence of abnormality (Hosmer Lemeshow $p \geq 0.05$). The multiple lineal regression analysis, β coefficients and their respective 95% confidence intervals are all shown in Table 3. The final model accomplished an R^2 of 18% (Fisher test (14, 141)=2.22, $p=0.009$) (Table 3). The residual analysis showed no evidence of abnormality or poor adjustment of the regression model.

Table 2 – Characteristics of the participants in the trial and pressure exerted over the simulator at the first attempt to execute the maneuver (n = 156).		
Variable	n (%)	Mean force \pm 1DE
Gender		
Female	81 (51.9)	2.3 \pm 1.1
Male	75 (48.1)	3.1 \pm 1.3
Profession		
Specialist in anesthesiology	42 (26.9)	3.1 \pm 1.2
Specialist in other medical-surgical areas	10 (6.4)	2.3 \pm 1.0
Resident of anesthesiology	16 (10.3)	3.2 \pm 1.5
Resident of other specialties	14 (9)	2.2 \pm 1.3
General practitioner	22 (14.1)	2.5 \pm 1.2
Medical student	14 (8.9)	2.9 \pm 0.9
Nurse	13 (8.3)	2.4 \pm 1.4
Nursing assistant	15 (9.6)	1.6 \pm 0.6
Respiratory therapists	10 (6.4)	2.8 \pm 1.4
Dominant side		
Right	146 (93.6)	2.7 \pm 1.3
Left	10 (6.4)	2.8 \pm 1.0

Source: The authors’.

Discussion

The force required for the adequate execution of Sellick’s maneuver ranges from 2.5 to 3.5 kg.⁶ This trial showed that

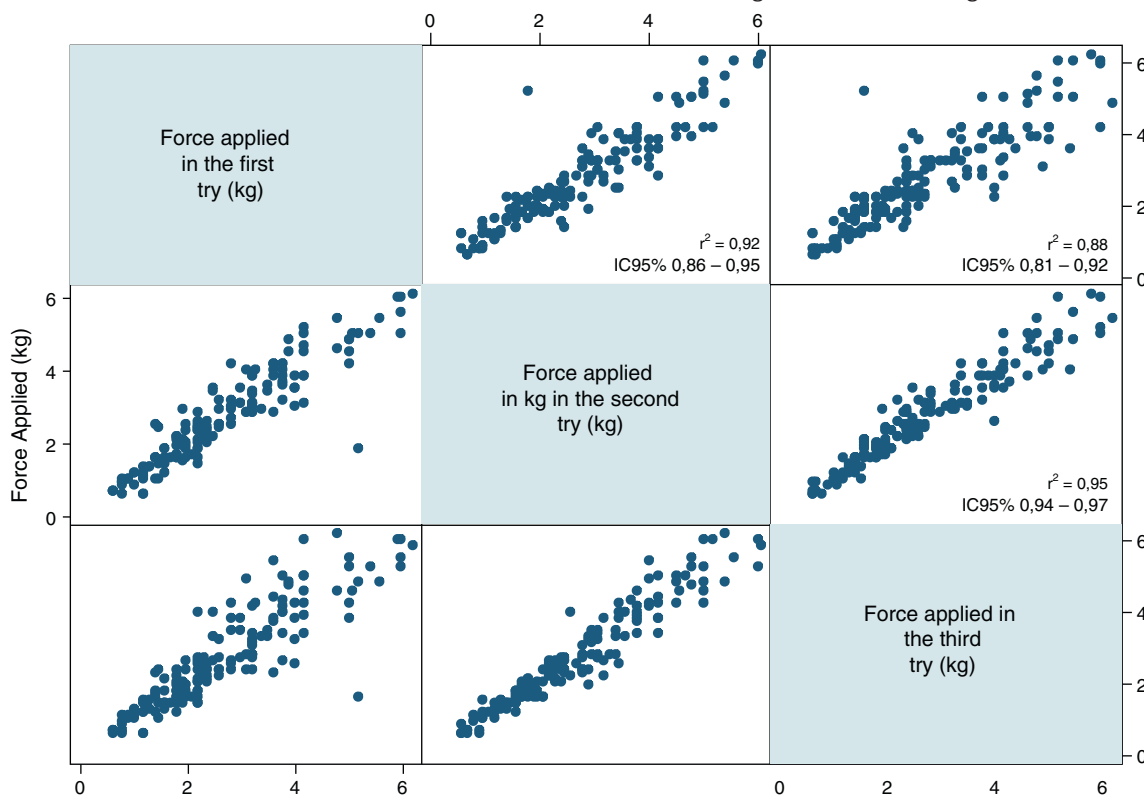


Fig. 3 – Correction matrix for the force applied by the participants over the simulator in the three attempts (n = 156). Source: The authors’.

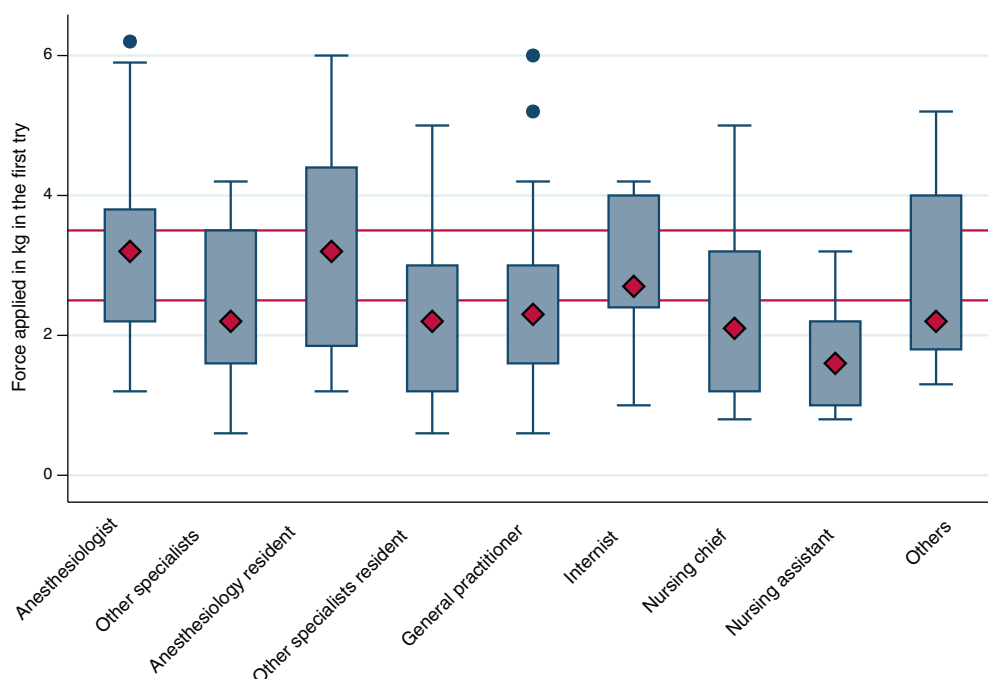


Fig. 4 – Box diagram representing the distribution of force by the participants in the trial (n = 156). The ends of the boxes represent the RIQ and the diamonds the means of each distribution.
Source: The authors’.

Table 3 – Multiple linear regression model outcome studied: force applied at the first attempt (kg) (n = 156).

Independent variables	Coef. β	p	CI 95%
Age	-0.14	0.658	-0.07 to 0.04
Male	0.62	0.049	0.00 to 1.25
Weight	0.005	0.677	-0.01 to 0.03
Height	-0.009	0.654	-0.05 to 0.03
<i>Profession*</i>			
Specialist in other medical-surgical areas	-0.95	0.051	-1.91 to 0.002
Resident of Anesthesiology	-0.14	0.732	-1.00 to 0.707
Resident of other specialties	-0.91	0.041	-1.79 to -0.038
General practitioner	-0.69	0.062	-1.42 to 0.035
Medical student	-0.28	0.550	-1.22 to 0.65
Nurse (a)	-0.46	0.301	-1.35 to 0.42
Nurse assistant	-1.37	0.003	-2.2 to -0.48
Respiratory therapists	-0.43	0.417	-1.5 to 0.62
Experience since graduation (years)	0.007	0.816	-0.05 to 0.07
Right side dominant (dominant side)	0.101	0.816	-0.75 to 0.96

Source: The authors’.

* Reference category (dummy variable): anesthesiologist.

as opposed to other participants, most anesthesiologists and anesthesiology residents apply higher levels of force at their first attempt. However, most of the subjects studied apply inadequate force and this fact has been confirmed

by various trials around the world.^{11,12} Research done with simulation devices have indicated that anesthesiology assistants and nursing staff require a short training period to be able to apply a level of force close to the recommendation that may be replicated afterwards.⁷ These findings point to an opportunity to educate healthcare staff in anesthesia maneuvers.

It is interesting – though not unexpected – that the pressure applied at each attempt is highly correlated, and even more in subsequent evaluations. Generally speaking, other participants applied less pressure in their first attempt as compared to anesthesiologists, many of which were outside the recommended range. Thus, the regression model shows that residents from other specialties, other medical specialists, general practitioners and nursing assistants, exert far less pressure in their first attempt as compared to anesthesiologists.

When exploring the influence of other variables, only males showed a significant association with higher force at their first attempt. However, no evidence could be found with regards to an association with the professional experience, age, anthropometric characteristics or the dominant side.

Since this was an observational trial its validity could be affected by potential biases. The method for recruiting the participants, the fact that they were blinded to the force applied over the simulator and the logistic characteristics of each individual evaluation, may have introduced selection or information biases, respectively. These potential pitfalls should be taken into consideration when evaluating the applicability or generalization of the results to other populations.

Conclusions

The force applied by the participants in the trial at their first attempt was 2.7 kg. Most of the participants in the trial executed Sellick's maneuver with inadequate force at their first attempt. Only males have an impact on the force applied by professionals in their first attempt to do the maneuver.

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Conflict of interests

The authors have no disclosures to make.

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