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## SCIENTIFIC ARTICLE

# Analysis of cricoid pressure application: anaesthetic trainee doctors vs. nursing anaesthetic assistants



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### KEYWORDS

Cricoid pressure;  
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### Abstract

**Background and objective:** To evaluate the ability of anaesthetic trainee doctors compared to nursing anaesthetic assistants in identifying the cricoid cartilage, applying the appropriate cricoid pressure and producing an adequate laryngeal inlet view.

**Methods:** Eighty-five participants, 42 anaesthetic trainee doctors and 43 nursing anaesthetic assistants, were asked to complete a set of questionnaires which included the correct amount of force to be applied to the cricoid cartilage. They were then asked to identify the cricoid cartilage and apply the cricoid pressure on an upper airway manikin placed on a weighing scale, and the pressure was recorded. Subsequently they applied cricoid pressure on actual anaesthetized patients following rapid sequence induction. Details regarding the cricoid pressure application and the Cormack–Lehane classification of the laryngeal view were recorded.

**Results:** The anaesthetic trainee doctors were significantly better than the nursing anaesthetic assistants in identifying the cricoid cartilage (95.2% vs. 55.8%,  $p=0.001$ ). However, both groups were equally poor in the knowledge about the amount of cricoid pressure force required (11.9% vs. 9.3% respectively) and in the correct application of cricoid pressure (16.7% vs. 20.9% respectively). The three-finger technique was performed by 85.7% of the anaesthetic trainee doctors and 65.1% of the nursing anaesthetic assistants ( $p=0.03$ ). There were no significant differences in the Cormack–Lehane view between both groups.

**Conclusion:** The anaesthetic trainee doctors were better than the nursing anaesthetic assistants in cricoid cartilage identification but both groups were equally poor in their knowledge and application of cricoid pressure.

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**PALAVRAS-CHAVE**

Pressão cricoide;  
Residentes em  
anestesiologia;  
Assistentes de  
anestesia

## **Análise da aplicação de pressão cricoide: residentes em anestesiologia vs. enfermeiros assistentes de anestesia**

**Resumo**

*Justificativa e objetivo:* Avaliar a capacidade de residentes em anestesiologia em comparação com enfermeiros assistentes de enfermagem para identificar a cartilagem cricoide, aplicar a pressão cricoide adequada e produzir uma vista adequada da entrada da laringe.

*Métodos:* Oitenta e cinco participantes, 42 residentes em anestesiologia e 43 enfermeiros assistentes de enfermagem foram convidados a responder alguns questionários sobre a quantidade correta de força a ser aplicada na cartilagem cricoide. Os participantes deviam identificar a cartilagem cricoide e aplicar a pressão cricoide em modelos de vias aéreas superiores colocados sobre uma balança de pesagem, e a pressão era registrada. Posteriormente, os participantes aplicaram pressão cricoide em pacientes anestesiados reais após a indução de sequência rápida. Os detalhes a sobre a aplicação de pressão cricoide e a classificação de Cormack-Lehane da visibilidade da laringe foram registrados.

*Resultados:* Os residentes em anestesiologia foram significativamente melhores que os enfermeiros assistentes de enfermagem na identificação da cartilagem cricoide (95,2% vs. 55,8%,  $p = 0,001$ ). No entanto, o conhecimento de ambos os grupos era precário sobre a quantidade de força necessária para aplicar a pressão cricoide (11,9% vs. 9,3%, respectivamente) e a correta aplicação da pressão cricoide (16,7% vs. 20,9%, respectivamente). A técnica de três dedos foi realizada por 85,7% dos residentes em anestesiologia e 65,1% dos enfermeiros assistentes de enfermagem ( $p = 0,03$ ). Não houve diferença significativa entre os dois grupos em relação à classificação de Cormack-Lehane para a visão.

*Conclusão:* Os residentes em anestesiologia foram melhores que os enfermeiros assistentes de enfermagem para identificar a cartilagem cricoide, mas ambos os grupos apresentaram um conhecimento igualmente precário sobre a aplicação de pressão cricoide.

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**Introduction**

Cricoid pressure is an external mechanical pressure applied onto the patient's cricoid cartilage during rapid sequence induction. Also known as Sellick's manoeuvre, it was introduced in 1961 to control regurgitation and aspiration of gastric content during induction of anaesthesia.<sup>1</sup> The use of cricoid pressure for prevention of pulmonary aspiration in high risk surgical patients is considered standard practice amongst the majority of anaesthesia providers.<sup>2</sup>

The routine application of cricoid pressure has been challenged with the problems of impaired laryngeal view, less effective mask ventilation and unproven benefit in reducing the incidence of aspiration or regurgitation.<sup>3</sup> The effectiveness of cricoid pressure is becoming an issue as many operators lack the appropriate knowledge about it. It has been suggested that a proper training programme is warranted to improve the cognitive knowledge and practical clinical skill of cricoid pressure application. Participants who were unable to identify the correct anatomical location of cricoid cartilage were also less likely to demonstrate cognitive knowledge concerning the correct amount of cricoid pressure to be applied.<sup>2</sup> In an observational study on African women, Fenton and Reynold found that cricoid pressure did not provide any protection against regurgitation or death in patients who underwent caesarean section.<sup>4</sup> Application of cricoid pressure resulted in significant reduction in the mean tidal

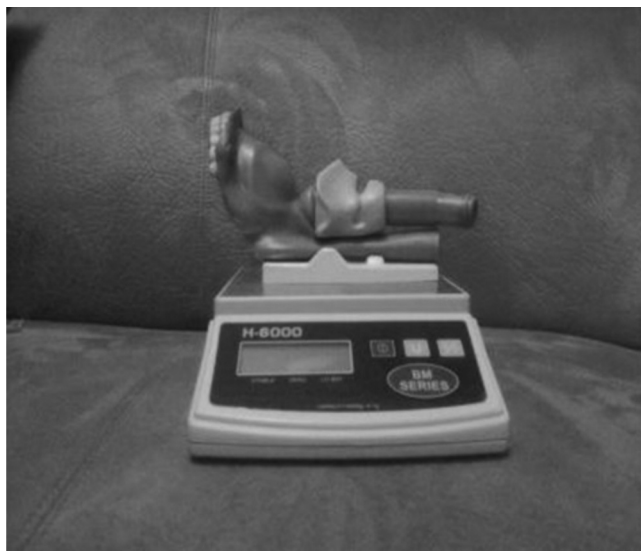
volume and upper airway obstruction in 9–18% of non-obese individuals.<sup>5</sup>

In our operating theatres, the nursing anaesthetic assistants who routinely assist in the application of the cricoid pressure are not all formally trained, but received in-house training. This study was done to determine if they were comparable with the anaesthetic trainee doctors in their ability to apply the cricoid pressure.

**Methods**

This was a prospective randomized single-blind clinical study that evaluated the ability of anaesthetic trainee doctors and nursing anaesthetic assistants in applying the cricoid pressure. Prior approval was obtained from the Research and Ethics Committee of our institution. Patients' written informed consent was also obtained before their participation.

This study consisted of two parts. In the first part, participants were asked to fill in a questionnaire which included age, gender, hand dominance, years of anaesthetic working experience and previous formal training related to the application of cricoid pressure. Then, their knowledge and demonstration of the cricoid pressure on an upper airway manikin were documented. The airway manikin with a clearly defined oropharynx, thyroid cartilage, cricoid cartilage, trachea and oesophagus was placed on weighing scale



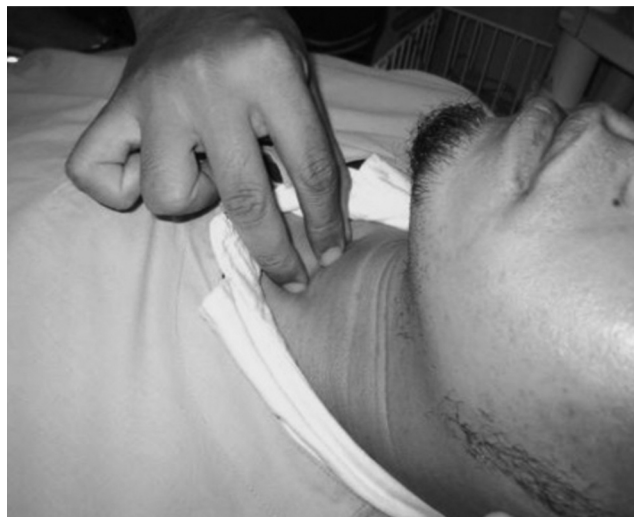
**Figure 1** Model of upper airway on weighing scale.

as shown in [Fig. 1](#). The weighing scale was calibrated with the model in place before each reading. The participants were asked to apply the cricoid pressure onto the manikin as in clinical settings and informed the investigator once the correct pressure had been applied. The anatomical site chosen by the participant, the technique performed (e.g. three-finger or two-finger) and the pressure applied were then recorded. The numerical display of the scale was only visible to the investigator.

In the second part of the study, the participants applied cricoid pressure on actual anaesthetized patients. A total of eighty-five American Society of Anaesthesiologists (ASA) physical status I–III patients, aged 18–70 years, who underwent general anaesthesia with rapid sequence induction and endotracheal intubation were enrolled. Patients were excluded if there was anticipated difficult intubation, presence of neck abnormalities or goitre that prevented effective cricoid pressure application.

Patients were randomly assigned to two groups using random sequence computer generated numbers. In Group A, cricoid pressure was performed by anaesthetic trainee doctors with at least 3 years of anaesthetic experience. In Group B, cricoid pressure was performed by nursing anaesthetic assistants who were registered staff nurses and routinely assisted in the application of the cricoid pressure in our operating theatres. They were not all formally trained, but received on the job training.

All patients were fasted for at least 6 h and were not pre-medicated with sedatives. Standard anaesthetic monitoring of electrocardiography, non-invasive blood pressure, pulse oximetry and capnography were applied on all patients. The patient's head was placed on a head ring, with a neck flexion and head extension for intubation. Pre-oxygenation for 3 min was followed by induction of anaesthesia with intravenous fentanyl 2 µg/kg and intravenous propofol 2 mg/kg. Endotracheal intubation was facilitated with intravenous suxamethonium 2 mg/kg. Once the patient started to lose consciousness, the participants applied cricoid pressure as they normally did ([Figs. 2 and 3](#)).



**Figure 2** Three-finger technique of cricoid pressure.

The investigator recorded details on the cricoid pressure application, the laryngeal view based on Cormack–Lehane classification, cricoid pressure adjustment requirement, manipulations used and complications such as regurgitation or aspiration. Endotracheal intubation was carried out by the anaesthetist 30 s after administration of suxamethonium. Surgery was allowed to proceed after confirmation of correct placement of the endotracheal tube.

Data calculated in our pilot study of 15 participants showed that a sample size of 26 was able to detect a 57.8% difference between the two groups. Using the Power and Sample Size Calculation Version 3.0.14, the sample size required was 13 patients per arm based on an alpha value of 0.05 and a power of 80%. Thus, a total of at least 29 nursing anaesthetic assistants and anaesthetic trainee doctors were required when considering a drop-out rate of 10%.



**Figure 3** Two-finger technique of cricoid pressure.

**Table 1** Demographic data of participants. Values are expressed as mean  $\pm$  SD and number, *n* (%) as appropriate.

	Nursing anaesthetic assistants ( <i>n</i> = 43)	Anaesthetic trainee doctors ( <i>n</i> = 42)	<i>p</i>
Age (years)	28.7 $\pm$ 0.3	33.0 $\pm$ 2.6	
Hand dominance			
Right	40 (93.0)	35 (83.3)	
Left	3 (7.0)	7 (16.7)	
Gender			<0.001 <sup>a</sup>
Male	0	14 (33.3)	
Female	43 (100)	28 (66.7)	
Duration or experience in applying cricoid pressure			
<1 year	7 (16.3)	1 (2.4)	
>1 year	36 (83.7)	41 (97.6)	
Formal training on cricoid pressure application	13 (30.2)	33 (78.6)	<0.001 <sup>a</sup>

<sup>a</sup> *p* < 0.05 statistically significant.

## Statistical analysis

Data were analysed with SPSS 17.0 software (SPSS™, Chicago, IL). Chi-square test was used to compare the cognitive knowledge and actual application of cricoid pressure and unpaired Student's *t*-test for analysis of participants' age. A *p*-value of <0.05 was considered to be statistically significant.

## Results

A total of 85 participants were recruited into this study with 43 nursing anaesthetic assistants and 42 anaesthetic trainee doctors. There were no drop-outs. As shown in Table 1, the two groups were comparable with respect to the age, hand dominance and experience in applying cricoid pressure. However, the nursing anaesthetic assistants were all females and their lack of formal previous training was of statistical significance.

The correct cricoid pressure was taken to be either 30 or 40 N. Only 9.3% of nursing anaesthetic assistants and 11.9% of anaesthetic trainee doctors gave the correct answer as shown in Table 2. Both groups were also comparable

in applying the correct pressure with only 20.9% of nursing anaesthetic assistants and 16.7% of anaesthetic trainee doctors doing it correctly. The anaesthetic trainee doctors were significantly better in identifying the cricoid cartilage (*p* = 0.001) with 95.2% identifying it correctly compared to 55.8% nursing anaesthetic assistants. A majority of the participants performed the three-finger technique of cricoid pressure application, 85.7% of the anaesthetic trainee doctors compared to 65.1% of nursing anaesthetic assistants (*p* = 0.03).

Table 3 shows there was no significant difference in the Cormack-Lehane views during the initial application of cricoid pressure in both groups. Most of the patients were intubated with a single attempt, 97.7% and 92.9% respectively. There was no aspiration or regurgitation seen in both groups.

## Discussion

The correct application of cricoid pressure is important to be effective in preventing pulmonary aspiration and avoiding complications such as oesophageal injury or difficult intubation due to impairment of the laryngeal view. Technically, it

**Table 2** Analysis of cricoid pressure on airway manikin. Values expressed as number, *n* (%) as appropriate.

	Nursing anaesthetic assistants ( <i>n</i> = 43)	Anaesthetic trainee doctors ( <i>n</i> = 42)	<i>p</i>
Correctly stated cricoid pressure	4 (9.3)	5 (11.9)	0.70
Correct application of cricoid pressure	9 (20.9)	7 (16.7)	0.62
Correct identification of cricoid cartilage	24 (55.8)	40 (95.2)	0.001 <sup>a</sup>
Hand that applies cricoid pressure			0.72
Right	39 (90.7)	39 (92.9)	
Left	4 (9.3)	3 (7.1)	
Technique			0.03 <sup>a</sup>
Three-finger	28 (65.1)	36 (85.7)	
Two-Finger	15 (34.9)	6 (14.3)	

<sup>a</sup> *p* < 0.05 statistically significant.

**Table 3** The impact of cricoid pressure on laryngeal view. Values are expressed as number, *n* (%) as appropriate.

	Nursing anaesthetic assistants ( <i>n</i> = 43)	Anaesthetic trainee doctors ( <i>n</i> = 42)	<i>p</i>
<i>Cormack-Lehane score at first attempt</i>			0.27
I	27 (62.8)	31 (73.8)	
II	14 (32.6)	11 (26.2)	
III	2 (4.7)	0	
<i>Number of attempts at intubation</i>			0.29
1	42 (97.7)	39 (92.9)	
2	1 (2.3)	3 (7.1)	

is simply the application of backward pressure on the cricoid cartilage, just inferior to the thyroid cartilage, to occlude the oesophagus.<sup>6</sup> This manoeuvre promotes safe anaesthesia but requires trained or experienced personnel and considerations of the anatomical features, physiological effects, technique and pressure requirements and its effect on the ease of intubation.

Our study revealed there was significant knowledge deficit in the identification of the cricoid cartilage which is essential for correct cricoid pressure application. The majority of our anaesthetic trainee doctors (95.2%) were able to identify, but only 55.8% of the nursing anaesthetic assistants were able to do so. Low identification results by nursing anaesthetic assistants were also reported in other studies at 55.6% and 24.0%.<sup>2,7</sup> The application of cricoid pressure onto the wrong anatomical structure can potentially lead to complications such as trauma, distortion of the airway or difficulty with bag mask ventilation.<sup>4</sup> Poor cricoid cartilage identification by our nursing anaesthetic assistants can be attributed to the low percentage of formal training received on cricoid pressure application (30.2%). As such, formal coaching of the nurses to include the anatomical relationships pertaining to the cricoid cartilage should be emphasized.

Our nursing anaesthetic assistants and anaesthetic trainee doctors showed comparably low values for correctly stating (9.3% vs. 11.9% respectively) and applying (20.9% vs. 16.7% respectively) the required pressure. The generally substandard level of knowledge with regard to cricoid pressure are similarly reported in several other studies whereby only 5.0–17.8% of the subjects (perioperative nurses or anaesthetic trainees) were able to correctly state the correct amount of cricoid pressure.<sup>2,8–10</sup> These studies show that there is still inadequate basic knowledge and skills in cricoid pressure application by both the anaesthetic trainees and assistants.

Although most of our anaesthetic trainee doctors have attended previous courses related to cricoid pressure application, they were not better than the nursing assistants at performing it. Factors that have been proposed by several authors for the poor performance included lack of formalized or standardized training, infrequency of training and lack of clinical guidelines.<sup>11–13</sup> In our institution, the anaesthetic trainee doctors are responsible for managing the airway including the intubation process. Therefore, they rarely have the opportunity to practice applying the cricoid

pressure adequately. This could be one of the reasons as to their poor performance in applying the cricoid pressure despite having sound knowledge to correctly recognize and identify the cricoid cartilage as was similarly described by Brisson and Brisson in 2010.<sup>14</sup>

In 2006, Patten utilized the Knowles theory in an effort to educate nurses about correct application of cricoid pressure and succeeded in increasing the knowledge and skill from a pre-test result of 3.5% to a post-test result of 68.6%.<sup>15</sup> Kopka and Crawford proposed an effective biofeedback trainer based on key features of regular, simple and inexpensive training which was able to effectively train anaesthetic personnel in the correct application of cricoid pressure.<sup>16</sup> Thus, apart from regular training, the quality of the training remains an important aspect of successful education programmes.

The majority of the participants in our study are right hand dominant. As the predominant position for the assistant applying the cricoid pressure is to stand on the patient's right side, hand dominance is logically deemed to be an important factor for the application of cricoid pressure. Cook et al. demonstrated that when cricoid pressure was applied with the left hand, the average mean force was less by 5–12 N.<sup>17</sup> On the contrary, Schmidt and Akeson concluded that there was no significant difference in the ability to apply and maintain force with either hand.<sup>18</sup> Cook et al. also showed that nursing anaesthetic assistants applied a much lower force than is classically taught and were able to maintain the force with either hand for a sustained period.<sup>17</sup> Thus, left hand application is acceptable when clinically indicated, but it may have a lower margin for error than when applied with the right hand.<sup>17</sup> Beavers et al. demonstrated no correlation in hand dominance and actual application of cricoid pressure amongst perioperative nurses and suggested that the best hand choice for effective and sustainable cricoid pressure application would be the hand with the greater strength and dexterity.<sup>2</sup>

When patients become unconscious, pressure on the cricoid cartilage should be increased to 3–4 kg or 30–40 N. The aspiration of gastric contents can be avoided by giving a total of 4 kg or 40 N pressure.<sup>7–10</sup> Studies have reported that only 10–31% of participants applied the correct amount of cricoid pressure.<sup>7,9,10</sup> This is disconcerting because inadequate pressure application may result in an unoccluded oesophagus rendering patients at risk for regurgitation and aspiration. Overzealous application on the other hand may



result in airway management difficulties and inadvertent patient injuries.

Most of our participants used the three-finger technique during cricoid pressure application. Wraight et al. suggested that the three-finger technique is less likely to cause lateral displacement which could hinder the glottis view during laryngoscopy.<sup>19</sup> Other common methods using thumb and index finger or thumb, index finger and middle finger or extended thenar web have been described.<sup>1,19</sup> As a result of the variety of methods postulated in cricoid pressure application, some techniques contributed to 25% ineffective performance according to Brisson and Brisson.<sup>14</sup> The currently available resources are conflicting and there are no airway training focusing on cricoid pressure application.<sup>14</sup>

This study was limited by the lack of real-time monitoring during application of cricoid pressure on actual patients. The amount of pressure applied on the airway manikin and on the real patients may differ as the sensation felt is not the same, with the patients' tissue consistency being softer than the stiff rubbery material of the airway manikin.

Our institution's nursing anaesthetic assistants are skewed towards the female gender. This could be another limitation to the study. In Sweden, a similar study revealed that the inadequate comprehension on the practice of cricoid pressure application remained prevalent despite not reporting any gender difference.<sup>18</sup>

In conclusion, the anaesthetic trainee doctors were more proficient in the identification of cricoid cartilage but both the anaesthetic trainee doctors and the nursing anaesthetic assistants were equally poor in their application of the cricoid pressure. Strategies to ensure safe and effective cricoid pressure application should be improved to ensure good patient outcome.

### Conflicts of interest

The authors declare no conflicts of interest.

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