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*Original Article*

# Bispectral index response to cricoid pressure during induction of general anesthesia

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## Abstract

**BACKGROUND:** Because the effects of cricoid pressure (CP) on BIS values have not been evaluated, this prospective study was designed to assess the BIS values after application of CP in adult patients during the routine induction of general anesthesia.

**METHODS:** We randomly allocated 70 patients (ASA-I) aged 18-64 years, listed for elective surgery into two groups of cricoid (CP) and non-cricoid (nCP). In the cricoid group, bimanual cricoid pressure was performed after the induction of anesthesia and in the nCP group, simple placement of hands without exerting pressure was performed. Arterial blood pressure, heart rate and BIS were measured and recorded immediately before and after application of cricoid pressure, before laryngoscopy and intubation and then every one minute after intubation until 4 minutes. The data were compared between and within groups using the mixed-design analysis of variance.

**RESULTS:** One minute after application of cricoid pressure and before laryngoscopy, BIS showed significantly higher value compared with the nCP group. Furthermore, one min after intubation, BIS values and arterial blood pressure increased significantly in both groups compared with the baseline values, but the increase in BIS value was more significant in CP group than nCP group. Moreover, BIS values increased significantly 2 minutes after intubation in CP group compared with nCP group.

**CONCLUSIONS:** It was concluded that the application of CP in combination with laryngoscopy and intubation increases the BIS values, which show the inadequacy of anesthesia and hypnosis during the routine induction of anesthesia.

**KEYWORDS:** Laryngoscopy, Intubation, Consciousness Monitors.

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The state of consciousness can be inferred, although not directly measured, by analysis of information on the electroencephalogram (EEG). To improve the correlation between EEG-derived indices, anesthetic drug concentrations, and clinical signs of the depth of anesthesia, several electroencephalographic EEG-based algorithms have been assessed.[1] The bispectral index score (BIS) is one of the EEG derived variables used to quantify the sedative and hypnotic effects of anesthetic drugs.[2,3] BIS monitoring shows the EEG parameter continuously from zero which shows the absence of brain activity to 95-100, which shows the awareness.[4]

Cricoid pressure is a simple method to protect the subjects from regurgitation of gastric contents during the time of intubation in full stomach patients. As far as no maneuver in clinical practice is devoid of side effects that remain true for cricoid pressure too. Since it is the first step of clinical practice of anesthesia, cricoid pressure has been considered for its efficacy, safety and its hemodynamic effects.[5] The adverse effects range from minor effects like nausea, vomiting, minimal hemodynamic alterations to severe complications like esophageal rupture, complete airway obstruction

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and fracture of the cricoid cartilage.[6] Nausea and vomiting are also associated with application of cricoid pressure, but this occurs more often when the cricoid pressure is relatively more than normal and particularly in awake subjects. The incidence of postoperative nausea and vomiting does not seem to be altered by application of cricoid pressure at the time of induction.[7]

Several studies have demonstrated an increase in BIS as well as heart rate and arterial blood pressure associated with laryngoscopy and tracheal intubation in patients receiving intravenous or inhalational anesthesia.[7-10] Saghaei et al[11] studied the effect of cricoid pressure on the presser response and showed that there were significant increases not only in systemic arterial pressure and heart rate but also in peak inspiratory pressure and also there were significant decreases in tidal volume occurred after application of cricoid pressure during the induction of anesthesia. Although the development of a relatively strong presser response after cricoid pressure application is demonstrated, the assessment of anesthetic depth in patients receiving cricoid pressure remains a challenge for anesthesiologists in order to avoid under-sedation and awareness phenomena during induction of anesthesia.

An essential goal of all anesthesiologists is to maintain an optimal level of anesthesia. No previous studies have been specifically performed to evaluate the anesthetic depth by BIS monitoring when applying cricoid pressure. Therefore, to assess the bispectral index (BIS) responses after application of cricoid pressure, we designed this study.

## Methods

We randomly allocated 70 patients (ASA-I) aged 18-64 years, scheduled for elective surgery into two groups.

Patients with no difficult mask ventilation and gas leak around the face mask were included. Patients with abnormal hemodynamic responses immediately after the drugs administration needed for anesthesia were excluded. We did not any use sedative premedication before surgery. All the patients were infused lactated ringer's solution 7 ml/kg, and electrocardiogram (ECG), non invasive blood pressure, pulse oxymetry, and capnogram monitoring were established for them in the operating room.

Before the induction of anesthesia, the skin was wiped by alcohol, then three pregelled standard BIS monitor strips, two active and one ground, were placed on the forehead and mastoid portions and were connected to the BIS monitor (model A-2000, XP platform; Aspect Medical Systems, USA) and impedance test was confirmed. The impedance of every electrode was kept less than 2 K ohms. Data were collected by a co-worker who was not directly involved in patients care. The BIS is a numeric value from zero (deep sedation) to 100 (awake) derived from complex mathematical analysis of the electroencephalogram. MAP, HR and BIS were measured as baseline values before anesthesia and then anesthesia was made with IV thiopental 5 ml/kg, atracorium 0.5 mg/kg, and fentanyl 1.5 μg/kg, followed by controlled mechanical ventilation.

After induction of general anesthesia, patients were randomly divided into two groups of cricoid (CP) and placebo (nCP). In the CP group, 2 minutes after the induction of anesthesia, cricoid pressure was carried out by applying a force of approximately 4.5 kg lasting 1 minute using the palm of the left hand at the back of the neck and the thumb, index and middle fingers of the right hand to press the cricoids cartilage. The pressure was applied directly and precisely on cricoids cartilage in a backward direction against the C5 and C6 vertebra. In nCP group, hands were placed simply without exerting pressure. One minute after ending cricoid pressure, laryngoscopy and tracheal intubation were performed. In both groups, arterial blood pressure, BIS, and heart rate were measured immediately before and after making cricoid pressure, before laryngoscopy and intubation and every one minute after intubation until 4 minutes. All maneuvers in both groups were made by the same anesthesiologist and another anesthesiologist performed mask ventilation and an independent blinded co-worker recorded vital signs and BIS values.

Data were statisticaly analysed with SPSS-11.0 software (Chicago, IL., USA). All data values were expressed as mean ± SD. Repeated measures analysis of variance (within groups) and one-way analysis of variance (between groups) were use tests. Also the chi square test was used to compare sex ratios between the groups. Less than 0.05 p-values were considered significant.

This study was approved by the ethics committee of Isfahan University of Medical Sciences and all the cases signed the prepared informed consent.

## Results

Seventy patients were integrated in this study. The sex ratio, age, height and weight were not significantly different between two groups (Table 1). There was no significant difference in MAP, heart rate, and BIS values of baseline and immediately before cricoid pressure application between the two groups (Table 2).

The duration of laryngoscopy and tracheal intubation and the duration of application of cricoid pressure, as mentioned before, did not surpass one minute in any of the patients. Immediately and at one minute after the cricoid pressure application, heart rate and MAP increased significantly in CP group compared with the nCP group ($p < 0.05$) (Table 2). Consequently, one minute after applying cricoid pressure maneuver and before laryngoscopy. BIS was significantly higher in CP group. Furthermore, one minute after intubation, BIS and MAP increased significantly in both groups as compared with the baseline values, but the increase in BIS value in CP group was significantly more ($p < 0.05$) (Table 2). Moreover, BIS values at 2 minutes after intubation in CP group (61.6 ± 9.5) were significantly higher compared with nCP group (52.9 ± 9.2) ($p < 0.05$) (Table 2).

None of the patients had hypotension needing treatment, abnormal ECG, or less than 98% oxygen saturation. The postextubation sore throat incidence was not significantly different between the two groups (34% in the CP and 37% in the nCP group).

## Discussion

This study demonstrated that making of cricoid pressure may increase in hemodynamic responses and BIS values during general anesthesia. Several studies have shown that tracheal intubation is associated with increases in BIS as well as heart rate and arterial blood pressure,[9,10] but no previous study has specifically addressed the BIS effects of cricoid pressure independent of laryngoscopy and tracheal intubation.

In the present study, mean arterial pressure and heart rate increased after intubation in both groups, but the changes was greater after applying cricoid pressure. Our results were similar to the findings of Saghaei et al,[11] who showed that "the application of cricoid pressure alone, and in combination with laryngoscopy and intubation, increases the incidence of hypertensive or tachycardia episodes during the induction of anesthesia." blood pressure

**Table 1.** Comparison of basal variable between cricoid (CP) and non-cricoid (nCP) groups*

| Variables | Cricoid group (CP) | Non-cricoid group (nCP) |
|---|---|---|
| Age (year) | 39.8 ± 12.7 | 41.5 ± 14.8 |
| Gender n, (%): | | |
| Female | 16 (45.7%) | 17 (48.6%) |
| Male | 19 (54.3%) | 18 (51.4%) |
| Weight (kg) | 63 ± 10 | 64 ± 9 |
| Height (cm) | 168 ± 10 | 167 ± 8 |

* Values are mean ± SD

**Table 2.** Comparisons of BIS, MAP and HR before and after the application of cricoid pressure or placebo maneuver between the two groups. Data are mean ± SD

| | MAP | | HR | | BIS | |
|---|---|---|---|---|---|---|
| | **CP** | **nCP** | **CP** | **nCP** | **CP** | **nCP** |
| Base line | 103.69 ± 10.1 | 105.61 ± 13.7 | 98.5 ± 18.1 | 95.1 ± 18.8 | 95 ± 3 | 96 ± 2 |
| Immediately before CP | 98.68 ± 11.2 | 100.6 ± 14.8 | 93.5 ± 19.2 | 90 ± 19.9 | 42.8 ± 3.5 | 38.8 ± 4.6 |
| Immediately after CP | 98.25 ± 13.3* | 89.09 ± 16.2 | 96.2 ± 18.6* | 85.8 ± 17** | 42.7 ± 3.8 | 38.4 ± 5.2 |
| Before laryngoscopy and intubation | 110.74 ± 17.5*,** | 89.13 ± 17.2 | 101.2 ± 14.7* | 85.7 ± 18 | 55.7 ± 3.01* | 37.6 ± 6.9 |
| 1 min after intubation | 125.36 ± 17.5** | 117.5 ± 23.09** | 102.3 ± 17.5 | 98.8 ± 19.6 | 61.6 ± 9.5*,** | 50 ± 10.1** |
| 2 min after intubation | 114.31 ± 18.7** | 113.30 ± 19.9** | 99.5 ± 18.4 | 95.1 ± 19.3 | 61.6 ±9.5* | 52.9 ± 9.2 |
| 3 min after intubation | 103.78 ± 13.1 | 106.24 ± 18 | 93.7 ± 17.6 | 91.4 ± 18.8 | 58.5 ± 9.9 | 54.2 ± 11.7 |
| 4 min after intubation | 98.71 ± 12.7 | 97.17 ± 16.3 | 87.4 ± 16.5 | 88.5 ± 17.5 | 54.6 ± 9.8 | 53.6 ± 10.9 |

***** P < 0.05 compared with nCP group
****** P < 0.05 compared with baseline

and heart rate increase after making cricoid pressure because of stimulation of the autonomic nervous system which occurs due to compression of laryngeal and perilaryngeal structures.[5,12]

In this study, we found that application of cricoid pressure alone, after induction of anesthesia and before intubation, significantly increases BIS responses and the combination of laryngoscopy and cricoid pressure tend to further increase the BIS responses as well as the MAP and HR.

It is suggested that a reflective response to a lethal stimulus due to intubation is mediated at the sub cortical level, and it may not be linked to the BIS value. "However, peripheral noxious stimuli reaches the brain through the ascending reticular activating systems of the brainstem and may cause EEG activation".[9] So, the anesthetic effect of drugs during induction of anesthesia may be not enough to decrease the hypnotic responses.

EEG is used as an evaluation of anesthetic drug effect on the central nervous system.[13] BIS is a consequent multifocal EEG amount with a range of 0 to 100 correlated with hypnosis.

We found that BIS at one minute after application of cricoid pressure increases (not exceeding 60) in the CP group, but when following intubation, BIS values exceeded 60. This finding shows that the anesthetic depth after routine induction of general anesthesia might be insufficient to reduce the hypnotic response when the combination of cricoid pressure and intubation must be performed.

The mean value of BIS after the intubation in the studied group were higher than 60. Since during general anesthesia, BIS values between 40 and 60 are suggested as a lead for hypnotic and sedative drugs amount, it seems that the anesthetic depth was insufficient for stimulition of cricoid pressure and intubation. This was the limitation of current study.

## Conclusions

We found that the making cricoid pressure in combination with laryngoscopy and intubation may increase the BIS value, which shows the inadequacy of anesthesia and hypnosis during routine induction of anesthesia.

## Conflict of Interests

Authors have no conflict of interests.

## Authors' Contributions

SA carried out the design and prepared the manuscript. RT provided assistance in the design of the study, coordinated the study and participated in manuscript preparation. BJ participated in data collection and all of the experiments. MM provided assistance in the design of the study and analysis of the data. HS referred patients. All authors have read and approved the content of the manuscript.

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