Brief Report

The correlation between anthropometric indices and hemodynamic changes after laryngoscopy and endotracheal intubation

Mohammadreza Safavi, Azim Honarmand, Elham Ghorbani Dasgerdi, Ghasem Mohammad Sharifi

Department of Anesthesia, Anesthesiology and Critical Care Research Center, Isfahan University of Medical Sciences, Isfahan, Iran

Abstract

Background: Cardiovascular hemodynamic changes after laryngoscopy and endotracheal intubations can cause serious complications. This study was carried out to evaluate the correlation between the anthropometric indices and hemodynamic changes after laryngoscopy and endotracheal intubation (EI).

Materials and Methods: This descriptive–analytical pilot study was carried out in 2012, in the Kashani Hospital, Isfahan, Iran. After obtaining written informed consent from 130 patients who fulfilled the inclusion criteria, they were enrolled in the study. The recorded data included were, age, weight, height, neck circumference (NC), waist-to-hip ratio (W/H ratio) and body mass index (BMI). The heart rate (HR), systolic blood pressure (SAP), diastolic blood pressure (DBP), and mean arterial blood pressure (MAP) were recorded at baseline (before injection of the anesthetic drugs), just before laryngoscopy, and one, three, five, and ten minutes after EI.

Results: The best cut-off points for BMI, NC, and W/H ratio, for prediction of significant cardiovascular changes after EI were, 26.56 kg/m^2, 38 cm, and 0.82, respectively. There was a significant correlation between BMI and HR changes in the first and fifth minutes and also in MAP in the third and fifth minutes after EI ($P < 0.05$). Moreover, there was a significant correlation between NC and MAP in the fifth minute ($P < 0.05$). The W/H ratio was significantly related to the DBP in the tenth minute and MAP in the fifth and tenth minutes ($P < 0.05$).

Conclusions: Based on the results of this study, among the anthropometric indices, the BMI, NC, and W/H ratio were significantly correlated with cardiovascular changes after laryngoscopy and tracheal intubation.

Key Words: Anthropometric indices, body mass index, endotracheal intubation, hemodynamics, index, intratracheal intubation, laryngoscopy, ratio, waist–hip

Address for correspondence:
Prof. Azim Honarmand, Department of Anesthesia, Anesthesiology and Critical Care Research Center, Isfahan University of Medical Sciences, Isfahan, Iran.
E-mail: honarmand@med.mui.ac.ir
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INTRODUCTION

Laryngoscopy and endotracheal intubation are intense stimuli that are associated with significant releases of epinephrine and other catecholamines in the plasma and consequently cardiovascular changes, such as, a rise in blood pressure and heart rate.[1-3] These changes can cause ischemic heart disease, left ventricular

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failure, arrhythmia, and intracranial hemorrhage in some patients.[4-6]

One of the predisposing factors that increase the stress of laryngoscopy and endotracheal intubation is the degree of difficult intubation. Usually, the incidence of difficult intubation in obese patients is higher.[7-9]

If there are methods that can estimate the degree of obesity, the prediction of difficult laryngoscopy and the cardiovascular changes that will follow will be possible.

There are several methods of assessing excessive body weight and obesity.[10-14] Some of these methods are body mass index (BMI), neck circumference (NC), and Waist-to-Hip (W/H) ratio.[10-14] All the above methods of measurement can simply be used as screening methods for identifying overweight and obese patients.[10-12]

Ben and colleagues[10] showed that men with NC >37 cm and women with NC >34 cm are considered as overweight. Also, in another study, Ben-Noun *et al*.[15] proved that changes in NC could accompany parallel changes in systolic blood pressure (SBP) and diastolic blood pressure (DBP).

In another study, Ben *et al*. proved that a higher NC correlates with factors of the X syndrome (such as hypertension, i.e. BP more than 140/90 mmHg, dyslipidemia, and diabetes mellitus) and augments the risk of coronary artery disease (CAD).[16]

In clinical practice, it seems that a higher NC, BMI, or W/H ratio causes more incidences of difficult intubation and consequently more cardiovascular changes after laryngoscopy and endotracheal intubation.

There are no published studies assessing the association between the above methods of obesity assessment and cardiovascular changes after laryngoscopy. Therefore, the purpose of the present study is to evaluate the correlation between the anthropometric indices of NC, BMI, and W/H ratio, with the cardiovascular changes after laryngoscopy and endotracheal intubation. Also, if there is a significant correlation between these two variables, the cut-off points for each variable can be estimated.

MATERIALS AND METHODS

This descriptive–analytical pilot study was performed in 2012, in the Kashani Hospital, Isfahan, Iran, after obtaining institutional approval from the Research Committee of the University and taking a written informed consent from the patients. The inclusion criteria were, patients with ASA (American Society of Anesthesiologist Physical Status) I and II, aged more than 18 years, and who had undergone surgery under general anesthesia. If there was any change in the technique of anesthesia, the patient was excluded from the study.

One-hundred and thirty consecutive patients were enrolled in the study. The recorded data were, age, sex, weight, height, neck circumference, Waist-to-Hip ratio, and body mass index (BMI). The evaluation of patients was carried out by an anesthesiologist. All measurements were recorded by a person who was unaware of the patients' NC, BMI, and Waist-to-Hip ratio.

Weight was measured using digital scales without heavy clothing. Height was measured by portable stadiometer with bare feet. Waist and Hip circumferences were measured with plastic tapes.

Waist circumference was measured at the level of the greater trochanter, midway between the lowest rib and the iliac crest, while the patient was standing, and was at the end expiration phase. NC was measured at the mid-neck height between the mid-cervical spine and the mid-anterior neck with plastic tapes. BMI was calculated by dividing the weight (kg) by height^2 (m).

After arrival of the patients to the Operating Room, routine monitoring, including electrocardiography (EKG), non-invasive BP measurement, and pulse oximetry were performed. Induction of anesthesia was done with the help of the standard techniques for general anesthesia, by using thiopental sodium 5 mg/kg, Fentanyl 2 μg/kg, and atracurium 0.6 mg/kg, for facilitating muscle relaxation. After two minutes of administration of the induction drugs, laryngoscopy and endotracheal intubation was done by an anesthesiologist.

Heart rate (HR), systolic blood pressure (SAP), diastolic blood pressure (DBP), and mean arterial blood pressure (MAP) were recorded at the baseline (before injection of anesthetic drugs), just before laryngoscopy, and one, three, five, and ten minutes after endotracheal intubation.

The grading of laryngoscopy with respect to simplicity or difficulty was assessed while the patient was fully anesthetized. Laryngoscopy was performed in the sniffing position by using a Macintosh blade No, 4 to visualize the larynx. The laryngoscopic view was classified using the Cormack and Lehane (CL) classification,[14] without external laryngeal manipulation. Difficult visualization of the larynx

(DVL) was defined as CL III or IV views on direct laryngoscopy. Easy visualization of the larynx (EVL) was defined as CL I or II views on direct laryngoscopy. Confirmation of successful intubation was by bilateral auscultation over the lung fields and capnography.

The recorded data was analyzed using the SPSS 20 software. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), Likelihood Ratio, area under curve (AUC), and cut-off point of each variable were analyzed using the Med-Cal statistical software 9.0. Correlation between the NC, BMI, W/H ratio and with HR, SAP, DAP, and MAP changes after laryngoscopy, was performed using the Pearson and Spearman correlation coefficients. p less than 0.05 was considered statistically significant.

RESULTS

One hundred and thirty patients enrolled for this study. The mean (SD) age of the patients was 35.2 (13.4) years. Eighty-seven patients (66.9%) were men and forty-three (33.1%) were women. The mean (SD) of BMI, NC, waist circumference, hip circumference, and Waist-to-Hip ratio of the patients were 26 (5.6), 39.6 (5.6), 85.1 (12.1), 101.5 (10.8), and 0.84 (0.09), respectively.

The data of hemodynamic variables from the baseline to the tenth minute after EI have been shown in Table 1. According to the Pearson's correlation coefficient test, there was a significant correlation between BMI and HR changes in the first and fifth minutes after EI ($P < 0.05$). Also, there was significant correlation between the BMI and MAP in the third and fifth minutes after EI ($P < 0.05$). There was a significant correlation between the NC and MAP in the fifth minute after EI ($P < 0.05$). The waist-to-hip ratio was significantly correlated to DBP in the tenth minute after EI ($P < 0.05$). Also, the W/H ratio had a significant correlation with the MAP in the fifth and tenth minutes after EI ($P < 0.05$).

According to the Cormack and Lehane grading scale, 90 (69.2 %) patients were grade 1, 32 (24.6 %) patients were grade 2, seven (5.4 %) patients were grade 3, and one (0.8 %) patient was grade 4. According to these results, laryngoscopy was considered easy in 122 (93.8 %) patients and difficult in eight (6.2 %) patients.

The best cut-off points for BMI, NC, and W/H ratio, for prediction of significant cardiovascular changes after EI were 26.56 kg/m^2, 38 cm, and 0.82, respectively. The best cut-off points for BMI, for prediction of significant HR changes in the first and fifth minutes after EI, compared with the basal value were, 23.1 kg/m^2 and 28.4 kg/m^2, respectively. The best cut-off point for BMI in prediction of significant MAP in the third minute after EI, compared with basal value was, 26.2 kg/m^2.

In Figures 1-8, the AUC for BMI, NC, and W/H ratio, for prediction of significant hemodynamic changes after EI has been shown. The sensitivity, specificity, PPV, and NPV in the cut-off points for BMI, NC, and W/H ratio in the prediction of significant cardiovascular changes after EI have been shown in Table 2.

DISCUSSION

The cardiovascular changes during laryngoscopy are due to sympathetic stimulation and can lead to lethal complications.These complications include heart rate changes, BP changes, arrhythmia, and ST segment changes.[17]

The general purpose of this study was to determine the diagnostic value of obesity indices in the prediction of cardiovascular changes after laryngoscopy and tracheal intubation in the patient candidate for surgery, under general anesthesia.

The correlation of BMI and NC with difficult intubation has been shown in previous studies.[9-11]. On the other hand different studies have shown that hemodynamic changes during laryngoscopy and tracheal intubation are more common in obese patients.[12-15]

Table 2: Hemodynamic changes at different time intervals after laryngoscopy compared with the basal value

Variable	First minute	Third minute	Fifth minute	Tenth minute	*P* value
HR (beat/min)	0.005±0.11	0.004±0.12	−0.02±0.16	−0.05±0.17	0.0001
SBP (mmHg)	−0.06±19.7	−0.05±17.2	−0.1±21.3	−1.37±13.4	0.0001
DBP (mmHg)	−0.03±14.2	−0.01±17.2	−0.05±15.3	−0.08±13.2	0.001
MAP (mmHg)	−0.05±17	−0.03±19.4	−0.06±17.5	−0.09±12.9	0.001

HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MAP: Mean arterial pressure

Table 1: Hemodynamic parameters from basal to 10 minutes after laryngoscopy and endotracheal intubation

Variable	Basal	Before laryngoscopy	First minute	Third minute	Fifth minute	Tenth minute	*P* value
HR (beat/min)	89.9±14.7	88.2±14	88.6±14.8	89±15.6	86.6±14.7	83.1±12.6	0.001
SBP (mmHg)	133.5±18.2	132.1±17.5	126.2±19.7	127.1±23.5	122.1±21.3	118.4±13.4	0.0001
DBP (mmHg)	80.9±13.8	77.7±11.4	75.6±14.2	77.3±17.2	73.9±15.3	70.8±13.2	0.001
MAP (mmHg)	98.1±11.1	95.9±13.6	91.1±17	93±19.4	90.2±17.5	86.4±12.9	0.001

HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MAP: Mean arterial pressure, *P* value <0.05 was signification with correlation test

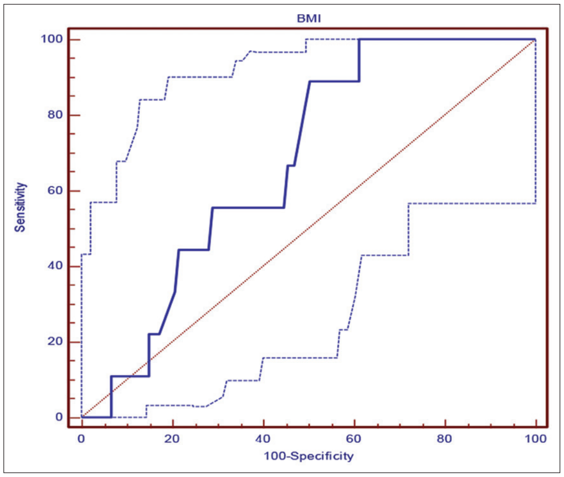

Figure 1: Area under curve (0.674) for BMI at cut-off point for prediction of heart rate changes in the first minute after laryngoscopy. BMI = Body mass index, NC = Neck circumference, W/H ratio = Waist-to-hip ratio

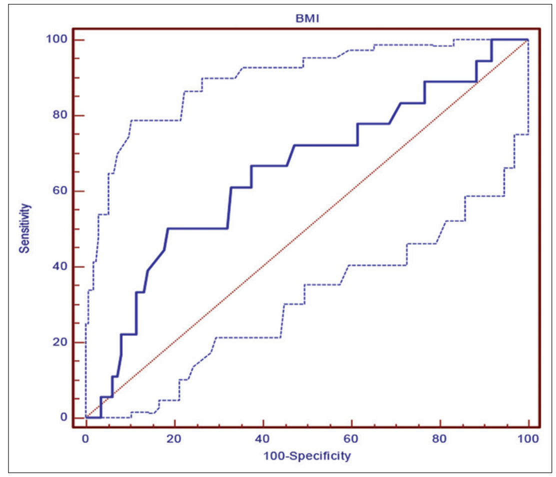

Figure 2: Area under curve (0.647) for BMI at cut-off point for prediction of heart rate changes in the fifth minute after laryngoscopy. BMI = Body mass index, NC = Neck circumference, W/H ratio = Waist-to-hip ratio

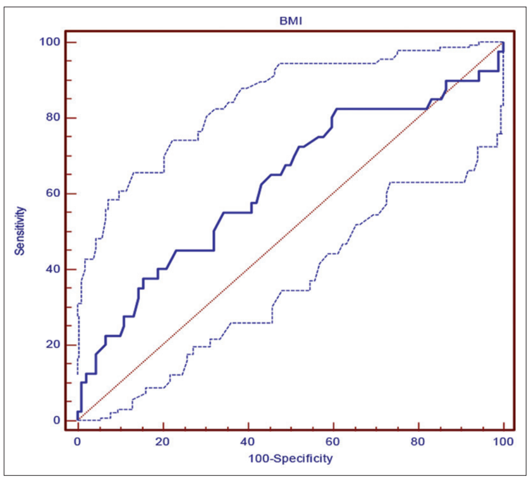

Figure 3: Area under curve (0.624) for BMI at cutoff point for prediction of mean arterial blood pressure changes in the third minute after laryngoscopy. BMI = Body mass index, NC = Neck circumference, W/H ratio = Waist-to-hip ratio

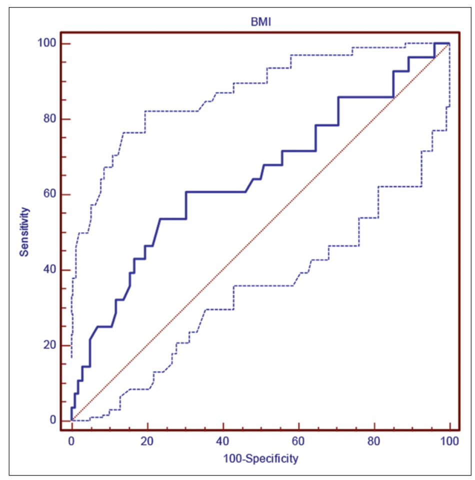

Figure 4: Area under curve (0.644) for BMI at cut-off point for prediction of mean arterial blood pressure changes in the fifth minute after laryngoscopy. BMI = Body mass index, NC = Neck circumference, W/H ratio = Waist-to-hip ratio

According to the results of the present study, there was a significant correlation between MAP and HR changes with BMI, after EI. The patients with higher BMI probably had a greater incidence of difficult intubation. The higher the degree of difficulty in laryngoscopy, the more was the sympathetic stimulation and consequently the degree of hemodynamic changes was higher.

The best cut-off point for BMI to predict hemodynamic changes after EI was 26.2, with sensitivity, specificity, PPV, and NPV values of 60.7, 69.6, 35.4, and 86.6%, respectively. These data showed that the most valuable diagnostic index for BMI, to predict hemodynamic changes after EI, was NPV, which meant that a patient with BMI less than 26.2 would not suffer from significant cardiovascular changes after laryngoscopy, with a possibility of 86.6%.

Also, our data showed that NC and W/H ratio was significantly correlated to the MAP and DAP changes after laryngoscopy. With an increase in the NC and W/H ratios, laryngoscopy was more difficult and accordingly the stress of laryngoscopy and sympathetic stimulation was more.

The best cut-off point for NC to predict hemodynamic changes after EI was 38 cm, with sensitivity, specificity, PPV, and NPV values of 5.71, 40.2, 28.2, and 91.1%, respectively. These data showed that the most valuable diagnostic index for NC to predict hemodynamic changes after EI was NPV, which meant

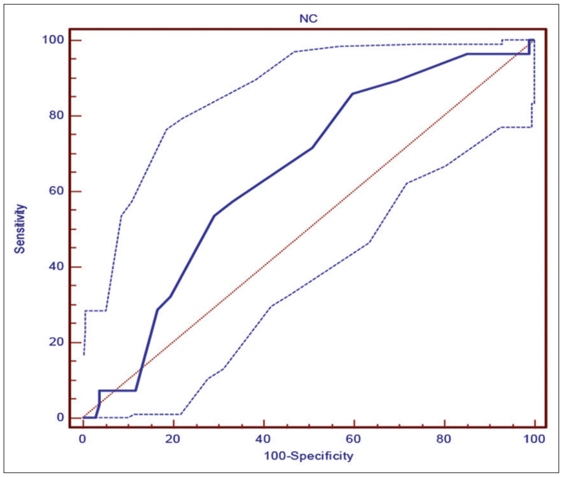

Figure 5: Area under curve (0.644) for NC at cut-off point for prediction of mean arterial blood pressure changes in the fifth minute after laryngoscopy. BMI = Body mass index, NC = Neck circumference, W/H ratio = Waist to hip ratio

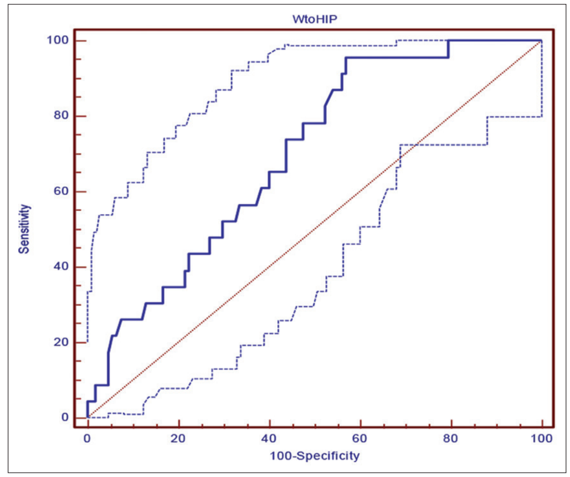

Figure 6: Area under curve (0.696) for W/H ratio at cut-off point for prediction of diastolic blood pressure changes in the tenth minute after laryngoscopy. BMI = Body mass index, NC = Neck circumference, W/H ratio = Waist-to-hip ratio

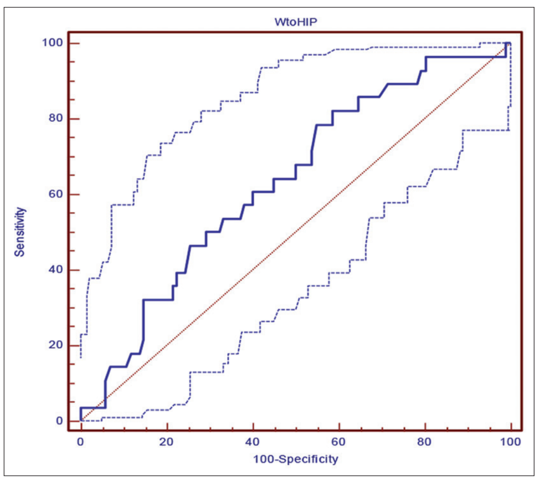

Figure 7: Area under curve (0.631) for W/H ratio at cut-off point for prediction of mean arterial blood pressure changes in the fifth minute after laryngoscopy. BMI = Body mass index, NC = Neck circumference, W/H ratio = Waist-to-hip ratio

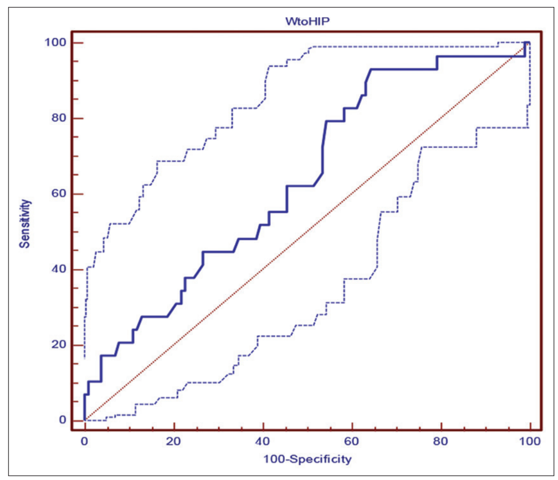

Figure 8: Area under curve (0.636) for W/H ratio at cut-off point for prediction of mean arterial blood pressure changes in the tenth minute after laryngoscopy. BMI = Body mass index, NC = Neck circumference, W/H ratio = Waist-to-hip ratio

that a patient with NC less than 38 cm would not suffer from significant cardiovascular changes after laryngoscopy, with a possibility of 91.1 %.

Waist-to-Hip ratio was another anthropometric index with a cut-off point of 0.79, and sensitivity, specificity, PPV, and NPV of 93.1, 35.6, 29.3, and 94.7%, respectively, which was investigated in our study. Like BMI and NC, the most valuable diagnostic index for W/H ratio, to predict hemodynamic changes after EI, was NPV, which meant that a patient with a W/H ratio less than 0.79 would not suffer from significant cardiovascular changes after EI, with a possibility of 94.7% [Table 3].

This is the first study to investigate the correlation of three anthropometric indices (neck circumference, body mass index, and waist-to-hip ratio) with cardiovascular changes after laryngoscopy and endotracheal intubation. The correlation was significant in some time intervals after laryngoscopy. In fact, our study was a pilot study. If there was a larger sample size, probably the correlation in other time intervals would be significant also.

In the study, the simple bedside criteria were evaluated to predict the intensity of hemodynamic changes after laryngoscopy and tracheal intubation. By using the results of this study one can predict the cardiovascular complications after laryngoscopy and endotracheal intubation and prepare the equipments for cardiopulmonary resuscitation. Further study is needed to document the results of our study.

Table 3: Sensitivity, specificity, PPV, NPV, positive and negative LR of BMI, NC, and W/H ratio for prediction of hemodynamic changes after laryngoscopy and endotracheal intubation

Variable	Change in hemodynamic	Criterion	Sensitivity	95% CI	Specificity	95% CI	+LR	−LR	PPV	NPV
BMI (kg/m^2)	Change in HR one minute	≤26.5625	100.00	66.2-100.0	38.84	30.1-48.1	1.64	0.00	10.8	100.0
	Change in HR five minutes	≤23.1481	50.00	26.1-73.9	81.25	72.8-88.0	2.67	0.62	30.0	91.0
	Change in MAP three minutes	>28.4055	37.50	22.7-54.2	84.44	75.3-91.2	2.41	0.74	51.7	75.2
	Change in MAP five minutes	>26.1719	60.71	40.6-78.5	69.61	59.7-78.3	2.00	0.56	35.4	86.6
NC (cm)	Change in MAP five minutes	>38	85.71	67.3-95.9	40.20	30.6-50.4	1.43	0.36	28.2	91.1
WAIST/HIP ratio	Change in DBP ten minutes	>0.816	95.65	78.0-99.3	42.99	33.5-52.9	1.68	0.10	26.5	97.9
	Change in MAP five minutes	>0.8318	78.57	59.0-91.7	45.10	35.2-55.3	1.43	0.48	28.2	88.5
	Change in MAP ten minutes	>0.7955	93.10	77.2-99.0	35.64	26.4-45.8	1.45	0.19	29.3	94.7

BMI: Body mass index kg/m^2, NC: Neck circumference cm, CI: Confidence interval, LR: Likelihood ratio, PPV: Positive predictive value, NPV: Negative predictive value, HR: Heart rate, MAP: Mean arterial blood pressure

CONCLUSION

According to the results of this study, BMI, NC, and Waist-to-Hip ratio could be considered as valuable factors that correlated with significant cardiovascular changes after laryngoscopy and tracheal intubation.

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