



Original Article

Hemodynamic Response to Laryngoscopy and Endotracheal Intubation in Hypertensive and Normotensive Patients: A Comparative Observational Study

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Received: 10-07-2025

Accepted: 08-08-2025

Available online: 12-08-2025

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Medical and Pharmaceutical Research

ABSTRACT

Background: Laryngoscopy and endotracheal intubation produce a transient sympathetic response characterized by tachycardia and elevation of arterial pressure. This response is usually tolerated by healthy individuals, but it is clinically important in patients with hypertension because of reduced cardiovascular reserve and higher risk of perioperative instability.

Objectives: To compare the hemodynamic response to laryngoscopy and endotracheal intubation between hypertensive and normotensive adult patients undergoing elective surgery under general anaesthesia.

Methods: This comparative observational study was conducted at Gandhi Medical College, Secunderabad, Telangana, India, from December 2022 to November 2023. A total of 100 patients were included, with 50 hypertensive and 50 normotensive patients. Heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure were recorded at baseline, before laryngoscopy, and at 1, 3, 5, and 10 minutes after intubation. Intergroup comparisons were performed using appropriate statistical tests, and $p < 0.05$ was considered statistically significant.

Results: The groups were comparable for age, sex, body mass index, duration of laryngoscopy, and duration of surgery. Hypertensive patients showed significantly higher post-intubation heart rate and blood pressure values. The peak response was observed at 1 minute after intubation. At this time point, heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure were higher in hypertensive patients than in normotensive patients. Maximum increases in all hemodynamic parameters were also significantly greater in the hypertensive group.

Conclusion: Hypertensive patients demonstrated a stronger tachycardic and pressor response to laryngoscopy and endotracheal intubation than normotensive patients. Careful preoperative assessment, adequate depth of anaesthesia, and close early post-intubation monitoring are essential in hypertensive patients.

Keywords: Hemodynamic response; Hypertension; Laryngoscopy; Endotracheal intubation; General anaesthesia; Mean arterial pressure.

INTRODUCTION

Laryngoscopy and endotracheal intubation are routine components of general anaesthesia, but they are also among the most intense noxious stimuli encountered during induction. Mechanical stimulation of the larynx, pharynx, epipharynx, and trachea activates autonomic reflex pathways and produces sympathetic discharge, with a measurable rise in heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure [1,2]. Although these changes are usually transient, their magnitude and duration vary according to patient factors, depth of anaesthesia, airway manipulation, duration of laryngoscopy, and associated cardiovascular disease [3-5].

The cardiovascular response to intubation has been described for several decades. Classic studies demonstrated acute hypertension during induction and intubation even in normotensive individuals, while later work confirmed that catecholamine release contributes to the pressor response [3,6-8]. The response generally peaks immediately or within the first minute after intubation and then gradually declines over the next several minutes. In healthy adults, this short sympathetic surge is often clinically acceptable. In contrast, exaggerated increases in heart rate and blood pressure can increase myocardial oxygen demand and rate-pressure product, thereby creating avoidable risk in susceptible patients.

Hypertensive patients deserve special attention during airway instrumentation. Chronic hypertension is associated with altered vascular reactivity, increased systemic vascular resistance, and impaired baroreceptor buffering. As a result, similar airway stimulation can produce a greater pressor response when compared with normotensive patients. Previous studies comparing airway devices and intubation methods in hypertensive patients reported higher heart rate and arterial pressure responses following tracheal intubation than after less stimulating supraglottic airway techniques [9-11]. Pharmacological approaches such as opioids, beta-blockers, lignocaine, alpha-2 agonists, and vasodilators have been evaluated to attenuate this response, but response prediction remains important for routine clinical planning [12-14].

In resource-constrained and high-volume surgical settings, continuous recognition of post-intubation hemodynamic variation is essential because many patients present with treated or undiagnosed hypertension. Direct comparison of hypertensive and normotensive patients using standard peri-intubation measurements provides practical information for anaesthesiologists. The present study was conducted to compare the hemodynamic response to laryngoscopy and endotracheal intubation in hypertensive and normotensive patients undergoing elective surgery under general anaesthesia. The primary objective was to compare changes in heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure at baseline, before laryngoscopy, and at 1, 3, 5, and 10 minutes after intubation between the two groups.

METHODOLOGY

Study design and setting

This comparative observational study was conducted in the Department of Anaesthesiology at Gandhi Medical College, Secunderabad, Telangana, India, from December 2022 to November 2023. The study included adult patients scheduled for elective surgical procedures under general anaesthesia requiring direct laryngoscopy and endotracheal intubation. Institutional ethics committee approval and written informed consent were obtained before enrolment.

Study population

A total of 100 patients were included and divided into two equal groups: 50 hypertensive patients and 50 normotensive patients. Hypertensive patients were those with a documented diagnosis of hypertension or regular antihypertensive medication with acceptable preoperative blood pressure for elective surgery. Normotensive patients had no known history of hypertension and had normal preoperative blood pressure. Adult patients of either sex with ASA physical status I or II were considered eligible. Patients with uncontrolled hypertension, coronary artery disease, arrhythmia, anticipated difficult airway, emergency surgery, pregnancy, significant renal or hepatic dysfunction, and requirement of more than one intubation attempt were excluded to reduce confounding.

Anaesthetic procedure and data collection

All patients underwent routine preanaesthetic evaluation. Baseline heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure were recorded in the operating room before induction. Standard monitoring included electrocardiography, non-invasive blood pressure, pulse oximetry, and end-tidal carbon dioxide. Anaesthesia was induced according to institutional practice using standard intravenous induction agents and muscle relaxant. After adequate mask ventilation and neuromuscular relaxation, direct laryngoscopy and oral endotracheal intubation were performed by an experienced anaesthesiologist. Laryngoscopy duration was recorded in seconds. Hemodynamic variables were recorded before laryngoscopy and at 1, 3, 5, and 10 minutes after intubation. These time points were selected because previous studies have shown that the maximal pressor response is usually observed immediately after intubation and during the early post-intubation period [5,8,10,11].

Outcome measures

The primary outcome was the difference in hemodynamic response between hypertensive and normotensive patients after laryngoscopy and endotracheal intubation. Heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure were assessed at all predefined time points. The maximum increase in each parameter was calculated using the difference between the pre-laryngoscopy value and the 1-minute post-intubation value, as the highest response was expected during this interval based on earlier physiological observations [3,6,8].

Statistical analysis

Data were entered into a spreadsheet and analysed using standard statistical methods. Continuous variables were expressed as mean \pm standard deviation, while categorical variables were expressed as frequency and percentage. Intergroup comparison of continuous variables was performed using the independent samples t-test. Categorical variables

were compared using the chi-square test or Fisher exact test when appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 100 patients were included in the study, with 50 hypertensive patients and 50 normotensive patients. The mean age was slightly higher in the hypertensive group compared with the normotensive group. Both groups were comparable with respect to sex distribution, body mass index, duration of laryngoscopy, and duration of surgery. ASA physical status II was more common among hypertensive patients (Table 1).

Table 1. Baseline characteristics of the study participants

Variable	Hypertensive group (n=50)	Normotensive group (n=50)	p-value
Age, years	48.9 ± 10.2	45.7 ± 9.8	0.114
Male	29 (58.0%)	27 (54.0%)	0.688
Female	21 (42.0%)	23 (46.0%)	0.688
BMI, kg/m ²	25.8 ± 3.4	24.9 ± 3.2	0.178
ASA I	14 (28.0%)	34 (68.0%)	<0.001
ASA II	36 (72.0%)	16 (32.0%)	<0.001
Duration of laryngoscopy, seconds	17.2 ± 4.3	16.8 ± 4.1	0.635
Duration of surgery, minutes	92.4 ± 31.5	89.7 ± 29.8	0.660

Values are expressed as mean ± SD or frequency (%).

Heart rate increased in both groups following laryngoscopy and endotracheal intubation. The maximum rise was observed at 1 minute after intubation. The hypertensive group showed significantly higher heart rate values at 1, 3, 5, and 10 minutes after intubation compared with the normotensive group (Table 2).

Table 2. Comparison of heart rate between hypertensive and normotensive patients

Time point	Hypertensive group (n=50)	Normotensive group (n=50)	p-value
Baseline	78.6 ± 10.1	76.9 ± 9.4	0.383
Before laryngoscopy	74.8 ± 9.5	73.2 ± 8.8	0.383
1 minute after intubation	101.6 ± 12.8	91.7 ± 11.4	<0.001
3 minutes after intubation	94.8 ± 11.9	84.6 ± 10.8	<0.001
5 minutes after intubation	87.9 ± 10.7	79.2 ± 9.6	<0.001
10 minutes after intubation	80.8 ± 9.8	76.4 ± 8.9	0.021

Values are expressed as mean ± SD; heart rate measured in beats/min.

Systolic and diastolic blood pressure were higher in hypertensive patients at baseline and remained significantly higher throughout the post-intubation period. In both groups, blood pressure decreased after induction before laryngoscopy and then increased sharply after intubation. The highest systolic and diastolic blood pressure values were recorded at 1 minute after endotracheal intubation (Table 3).

Table 3. Comparison of systolic and diastolic blood pressure between hypertensive and normotensive patients

Parameter / Time point	Hypertensive group (n=50)	Normotensive group (n=50)	p-value
Systolic blood pressure, mmHg			
Baseline	139.8 ± 12.4	124.6 ± 10.8	<0.001
Before laryngoscopy	122.6 ± 13.5	108.4 ± 11.2	<0.001
1 minute after intubation	166.4 ± 18.6	143.8 ± 15.2	<0.001
3 minutes after intubation	154.2 ± 17.4	132.6 ± 13.8	<0.001
5 minutes after intubation	143.6 ± 15.9	124.8 ± 12.7	<0.001
10 minutes after intubation	134.2 ± 13.8	119.6 ± 11.5	<0.001
Diastolic blood pressure, mmHg			
Baseline	86.8 ± 8.5	78.4 ± 7.6	<0.001
Before laryngoscopy	76.4 ± 8.2	68.2 ± 7.4	<0.001
1 minute after intubation	99.2 ± 10.8	86.6 ± 9.7	<0.001
3 minutes after intubation	93.4 ± 9.9	80.8 ± 8.8	<0.001
5 minutes after intubation	87.6 ± 9.2	75.4 ± 8.1	<0.001
10 minutes after intubation	82.2 ± 8.7	72.6 ± 7.8	<0.001

Values are expressed as mean ± SD.

Mean arterial pressure increased significantly after laryngoscopy and intubation, with a stronger response in hypertensive patients. The maximum rise in all hemodynamic parameters was observed at 1 minute after intubation. The mean increase in heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure was significantly greater in hypertensive patients compared with normotensive patients (Table 4).

Table 4. Mean arterial pressure and maximum hemodynamic change after intubation

Parameter	Hypertensive group (n=50)	Normotensive group (n=50)	p-value
Mean arterial pressure, mmHg			
Baseline	104.5 ± 9.2	93.8 ± 8.3	<0.001
Before laryngoscopy	91.8 ± 9.6	81.6 ± 8.4	<0.001
1 minute after intubation	121.6 ± 12.9	105.7 ± 11.1	<0.001
3 minutes after intubation	113.7 ± 11.8	98.1 ± 10.2	<0.001
5 minutes after intubation	106.3 ± 10.9	91.9 ± 9.4	<0.001
10 minutes after intubation	99.5 ± 9.8	88.3 ± 8.7	<0.001
Maximum increase after intubation			
Increase in heart rate, beats/min	26.8 ± 8.6	18.5 ± 7.9	<0.001
Increase in systolic blood pressure, mmHg	43.8 ± 13.4	35.4 ± 11.8	0.001
Increase in diastolic blood pressure, mmHg	22.8 ± 8.7	18.4 ± 7.6	0.008
Increase in mean arterial pressure, mmHg	29.8 ± 9.6	24.1 ± 8.9	0.003

Values are expressed as mean ± SD.

Overall, hypertensive patients demonstrated a greater hemodynamic response to laryngoscopy and endotracheal intubation compared with normotensive patients. The peak response occurred at 1 minute after intubation, followed by a gradual decline toward baseline over the next 10 minutes.

DISCUSSION

The present comparative observational study demonstrated that hypertensive patients had a more pronounced hemodynamic response to laryngoscopy and endotracheal intubation than normotensive patients. Heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure increased in both groups after intubation, but the magnitude of rise was consistently greater in the hypertensive group. The maximum response occurred at 1 minute after intubation, followed by progressive reduction at 3, 5, and 10 minutes. This temporal pattern agrees with classic physiological observations that airway stimulation produces an early sympathetic surge during laryngoscopy and tracheal tube placement [1,3,5].

The rise in heart rate after intubation reflects sympathetic activation and reduced vagal predominance during airway stimulation. Shribman et al. demonstrated that laryngoscopy and intubation are associated with significant cardiovascular and catecholamine responses, with heart rate rise being particularly linked to tracheal intubation [8]. Similar catecholamine-related mechanisms were reported by Russell et al. and Derbyshire et al., who showed increased plasma catecholamine concentrations during intubation [6,7]. In the present study, the hypertensive group had a mean heart rate of 101.6 ± 12.8 beats/min at 1 minute after intubation, compared with 91.7 ± 11.4 beats/min in the normotensive group, indicating a stronger chronotropic response in patients with hypertension.

The pressor response was also more marked in hypertensive patients. At 1 minute after intubation, systolic blood pressure, diastolic blood pressure, and mean arterial pressure were significantly higher in hypertensive patients than normotensive patients. These findings are consistent with Prys-Roberts et al., who described substantial hemodynamic consequences of induction and intubation in hypertensive patients [4]. Fujii et al. reported greater circulatory responses after tracheal intubation than after laryngeal mask airway insertion in both normotensive and hypertensive patients, with greater heart rate changes among hypertensives [9]. Kihara et al. and Sener et al. also emphasized that airway device selection and tracheal intubation technique influence the magnitude of hemodynamic response in hypertensive patients [10,11].

The clinical importance of these findings lies in perioperative risk reduction. A transient rise in blood pressure and heart rate is not benign in all patients, particularly when hypertension coexists with left ventricular hypertrophy, cerebrovascular disease, or occult coronary artery disease. Increased heart rate and arterial pressure raise myocardial oxygen demand and can precipitate ischemia in vulnerable patients. Kanchi et al. observed that conventional laryngoscopy elicits a hemodynamic response associated with increased heart rate and blood pressure in coronary artery disease patients [13]. These observations support careful titration of anaesthetic depth, minimisation of laryngoscopy duration, continuation of appropriate antihypertensive therapy, and preparedness to use attenuation strategies in selected high-risk cases.

Various pharmacological measures have been evaluated to reduce the intubation response, including opioids, beta-blockers, lignocaine, dexmedetomidine, and other agents [12,14]. However, the present study did not compare attenuation drugs; instead, it highlights that hypertensive status itself is an important determinant of response intensity under routine clinical conditions. The comparable duration of laryngoscopy and surgery between the two groups strengthens the interpretation that the observed differences were primarily related to baseline cardiovascular status rather than airway manipulation time. These findings reinforce the need for vigilant early post-intubation monitoring in hypertensive patients.

Limitations

This study had certain limitations. The sample size was limited to 100 patients from a single tertiary care centre, which restricts wider external application. Catecholamine levels, depth of anaesthesia monitoring, and antihypertensive drug stratification were not included. Only short-term hemodynamic changes up to 10 minutes after intubation were assessed, difficult airway cases were excluded, and postoperative cardiac outcomes were not recorded.

CONCLUSION

Hypertensive patients showed a significantly greater hemodynamic response to laryngoscopy and endotracheal intubation than normotensive patients. The peak rise in heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure occurred at 1 minute after intubation and then gradually declined over 10 minutes. Although both groups demonstrated transient sympathetic activation, the response was clinically stronger among hypertensive patients. These findings support careful preoperative optimization, adequate depth of anaesthesia, gentle and timely laryngoscopy, and close monitoring during the early post-intubation period. Hypertensive status should be considered an important predictor of exaggerated pressor response during airway instrumentation, especially in surgical patients requiring general anaesthesia and individualized anaesthetic care throughout induction.

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