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HEMODYNAMIC CHANGES AFTER LARYNGOSCOPY IN PATIENTS UNDERGOING ELECTIVE SURGERY UNDER GENERAL ANESTHESIA AT DHQ HOSPITAL KURRAM; PROSPECTIVE DESCRIPTIVE OBSERVATIONAL STUDY

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ABSTRACT
Background:
Endotracheal intubation and laryngoscopy during general anesthesia cause significant hemodynamic changes due to sympathetic stimulation. Mechanical airway stimulation triggers catecholamine release, resulting in increased blood pressure and heart rate, which are usually transient but clinically important. This study evaluates these changes in elective surgical patients at district-level hospitals to improve perioperative safety.
Objectives:
- *To assess changes in HR, SBP, DBP, and MAP following laryngoscopy in patients undergoing elective surgery under General Anesthesia.*
- *To determine the duration of hemodynamic changes at baseline, immediately after laryngoscopy, and at 1, 3, 5 and 10 minutes after endotracheal intubation.*

Methodology:
Data were collected in a prospective descriptive observational study at DHQ Hospital, District Kurram (Parachinar) over 4–5 months, including elective surgical patients using a predesigned proforma. Demographic variables (age, gender, ASA status, type of surgery, weight) and hemodynamic parameters (HR, SBP, DBP, SpO_2, MAP) were recorded at baseline and at 1, 3, 5, and 10 minutes post-intubation. Additional data laryngoscope type, intubation attempts, and anesthetic agents were recorded and analyzed using SPSS version 22.
Results:
A total of 70 patients were enrolled, with a mean age of 32.6 ± 9.9 years; most were male (61.4%) and ASA I (77%). All patients were successfully intubated, 95.7% on the first attempt, with no cardiac disease; mean laryngoscopy duration was 22.6 ± 3.7 seconds. After induction, heart rate decreased from 85.7 ± 13.7 bpm to 74.2 ± 10.9 bpm, and systolic BP from 125.0 ± 8.4 mmHg to 114.6 ± 10.2 mmHg. At 1 mint post-intubation, significant increases were observed: HR 95.5 ± 10.2 bpm, SBP 139.3 ± 12.2 mmHg, DBP 89.4 ± 10.1 mmHg, MAP 105.6 ± 11.3 mmHg. By 3 minutes parameters declined, and by 5–10 minutes approached baseline (HR 81.9 ± 9.5 bpm, SBP 125.6 ± 8.8 mmHg,

DBP 79.8 ± 7.0 mmHg, MAP 94.4 ± 7.8 mmHg).Repeated measures ANOVA showed highly significant changes (p < 0.001), with maintained oxygenation and no clinically significant desaturation.

Conclusion:

Laryngoscopy and endotracheal intubation in ASA I–II patients cause significant but transient hemodynamic responses, peaking at 1 minute and returning to baseline within 5–10 minutes. These changes are usually well tolerated in healthy individuals but require vigilant peri-intubation monitoring. Findings from this district-level study provide baseline data and emphasize careful airway management, especially in patients with cardiovascular risk.

Keywords:

- *Hemodynamic Changes, Laryngoscopy, Endotracheal Intubation, Airway Management, Sympathetic Response, Pressor Response, General Anesthesia*

Introduction

Elective surgery constitutes a substantial proportion of surgical procedures performed worldwide and refers to planned, non-emergency operations that allow sufficient time for comprehensive patient assessment, optimization, and anesthetic preparation before surgery (1). Unlike emergency procedures, elective surgeries provide an opportunity for detailed preoperative evaluation, identification of patient-related risk factors, and development of individualized anesthetic management strategies aimed at improving perioperative safety and surgical outcomes (2). General anesthesia is the preferred anesthetic technique for most elective surgical procedures because it provides unconsciousness, amnesia, analgesia, skeletal muscle relaxation, and controlled airway management, thereby facilitating optimal surgical conditions while ensuring patient safety (3,4).

General anesthesia is a reversible pharmacologically induced state characterized by loss of consciousness, suppression of protective airway reflexes, analgesia, and muscle relaxation (4,22). Its administration follows a systematic sequence comprising preoperative evaluation, induction, airway management, maintenance of anesthesia, and postoperative recovery (5,6). Among these stages, airway management during induction is considered one of the most critical components because successful endotracheal intubation is essential for maintaining adequate ventilation, oxygenation, and airway protection throughout the surgical procedure (6,7). Consequently, careful preoperative assessment of the airway and overall patient status forms the cornerstone of safe anesthetic practice (8–10).

Preoperative anesthesia evaluation involves detailed history taking, physical examination, airway assessment, and evaluation of cardiovascular and respiratory function to identify factors that may complicate anesthesia or airway management (7–10). The American Society of Anesthesiologists (ASA) Physical Status Classification System remains one of the most widely accepted methods for stratifying perioperative risk and predicting postoperative outcomes (11,12). Patients classified as ASA I or ASA II are commonly included in clinical studies because they exhibit relatively stable physiological conditions with minimal systemic disease, allowing investigators to evaluate peri-intubation physiological responses with fewer confounding variables (11,12).

Airway assessment represents an essential component of the preoperative examination because failure to secure the airway can result in hypoxia, aspiration, cardiovascular instability, neurological injury, and even death (13,14). Several bedside assessment methods are routinely employed to predict difficult laryngoscopy and intubation, including the Mallampati classification, inter-incisor distance, thyromental distance, and cervical spine mobility (14–20). The Mallampati classification estimates the visibility of oropharyngeal structures and is widely used as a predictor of difficult laryngoscopy, particularly among obese patients (15). Similarly, reduced inter-incisor distance reflects limited mouth opening and mandibular mobility, making insertion of the laryngoscope blade more challenging and increasing airway manipulation (16,17). Thyromental distance serves as an indirect measure of submandibular space and mandibular anatomy, while limited cervical spine extension compromises optimal alignment of the oral, pharyngeal, and laryngeal axes, thereby increasing intubation difficulty (18–21). These anatomical characteristics not only influence the technical success of intubation but also determine the degree of airway stimulation and subsequent cardiovascular responses during laryngoscopy.

Direct laryngoscopy remains the most frequently used technique for securing the airway during general anesthesia (25). During this procedure, the laryngoscope blade elevates the tongue and epiglottis to expose the vocal cords, allowing insertion of an endotracheal tube into the trachea (25). Although the procedure usually lasts only a few seconds, mechanical stimulation of the richly innervated structures of the oropharynx, larynx, and trachea activates numerous sensory receptors supplied primarily by the glossopharyngeal and vagus nerves (26,28). These afferent impulses are transmitted to the nucleus tractus solitarius within the medulla, where autonomic integration triggers activation of the sympathetic nervous system and suppression of parasympathetic activity (29,30). Simultaneously, stimulation of the hypothalamic-pituitary-adrenal axis results in the release of catecholamines, particularly adrenaline and noradrenaline, into the systemic circulation (30,31).

The release of catecholamines produces characteristic hemodynamic changes by stimulating β_1-adrenergic receptors in the myocardium, leading to increased heart rate and myocardial contractility, while activation of α_1-adrenergic receptors causes peripheral vasoconstriction and increased systemic vascular resistance (31). These combined effects produce transient elevations in heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure that typically begin within seconds after laryngoscopy and peak approximately one to two minutes following endotracheal intubation before gradually returning toward baseline values (17,27,31). The magnitude of these responses is influenced by multiple factors, including duration of laryngoscopy, number of intubation attempts, depth of anesthesia, airway anatomy, age, and existing cardiovascular comorbidities (17,19,27).

Although these physiological responses are generally short-lived, they may have significant clinical consequences, particularly among patients with hypertension, coronary artery disease, cerebrovascular disorders, or other cardiovascular conditions (32,33). Excessive sympathetic stimulation may precipitate myocardial ischemia, cardiac arrhythmias, heart failure, or cerebrovascular complications, highlighting the importance of minimizing airway stimulation and maintaining hemodynamic stability during induction of anesthesia (32–37). Various strategies, including optimization of anesthetic depth, administration of opioids, dexmedetomidine, lignocaine, or β-blocking agents, as well as the use of alternative laryngoscopic devices such as video laryngoscopes, have been investigated to attenuate these pressor responses with varying degrees of success (17,24,33–46).

Despite extensive international literature evaluating hemodynamic responses to laryngoscopy and tracheal intubation, considerable variability exists owing to differences in patient characteristics, airway anatomy, anesthetic techniques, pharmacological protocols, and healthcare settings (32,34–46). Furthermore, evidence from secondary care hospitals in low- and middle-income countries remains limited, where differences in patient demographics, available resources, and anesthetic practices may influence peri-intubation cardiovascular responses. Therefore, evaluating the pattern of hemodynamic changes among patients undergoing elective surgery under general anesthesia in local hospital settings is essential for generating context-specific evidence that can improve perioperative monitoring, optimize anesthetic management, and ultimately enhance patient safety during airway management.

Materials and Methods

2. Materials and Methods

2.1 Study Design and Setting

A prospective descriptive observational study was conducted in the major operation theatre of District Headquarters Hospital, Parachinar, District Kurram. The study included adult patients undergoing elective surgical procedures under general anesthesia that required direct laryngoscopy and endotracheal intubation. Data collection was carried out over four months, from December 2025 to March 2026, after obtaining approval from the Institutional Ethical Review Committee of KMU Institute of Health Sciences, Kurram, and administrative permission from the Medical Superintendent of DHQ Hospital, Parachinar.

2.2 Study Population, Sampling and Sample Size

Patients were enrolled through a non-probability consecutive convenience sampling technique. The sample size was calculated using Cochran's formula:

$$n=\frac{Z^2p(1-p)}{d^2}$$

where (n) represented the required sample size, (Z) was 1.96 at a 95% confidence level, (p) was the anticipated prevalence of pressor response, and (d) was the margin of error. Based on an estimated pressor-response prevalence of 38% reported in a previous study and a 5% margin of error, the calculated sample size was approximately 362 patients. Therefore, 362 eligible patients were enrolled during the study period. This sample was considered sufficient to evaluate changes in heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure at different stages of laryngoscopy and intubation.

2.3 Eligibility Criteria

Patients of either sex, aged 18–60 years, classified as American Society of Anesthesiologists physical status I or II, and scheduled for elective surgery under general anesthesia with direct laryngoscopy and endotracheal intubation were included. Patients with an anticipated difficult airway, Mallampati class III or IV, thyromental distance below 6 cm, inter-incisor distance below 3 cm, cervical spine instability, pregnancy, hemodynamic instability, or those undergoing emergency surgery were excluded.

2.4 Data Collection Procedure

After obtaining written informed consent, information was collected using a structured data collection proforma. Baseline demographic, clinical and airway-assessment characteristics were recorded before induction of anesthesia. Baseline heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure were measured before induction. The same hemodynamic parameters were subsequently recorded during laryngoscopy and at 1, 3, 5 and 10 minutes following endotracheal intubation.

Details of the anesthetic procedure, including induction agents, opioids, inhalational or maintenance agents, neuromuscular blocking drugs, reversal agents, type of laryngoscope and the anesthesiologist performing the procedure, were documented. The duration of laryngoscopy and endotracheal intubation was measured in seconds using a stopwatch. All measurements were recorded under routine operation-theatre monitoring without altering the standard anesthetic management of the patients.

2.5 Ethical Considerations

Ethical approval was obtained from the Research Ethical Review Committee of KMU Institute of Health Sciences, Kurram. Administrative permission was also obtained from DHQ Hospital, Parachinar. Participation was voluntary, and written informed consent was obtained from every participant before data collection. Patient identities were not recorded on the study proforma, and all collected information was kept confidential. As the study was observational, no additional intervention, medication or risk was imposed on the participants.

2.6 Data Analysis

Data were entered and analyzed using IBM SPSS Statistics version 22. Continuous variables, including age, heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure, were summarized as mean and standard deviation. Categorical variables, such as sex and ASA physical status, were presented as frequencies and percentages. Changes in hemodynamic parameters measured at baseline, during laryngoscopy, and at 1, 3, 5 and 10 minutes after intubation were assessed using repeated-measures analysis of variance. Where the assumption of sphericity was violated, an appropriate correction was applied. A p-value of ≤0.05 was considered statistically significant.

Results

Table 3.1 Gender Distribution of the Patients (n = 70)

GENDER	FREQUENCY (N)	PERCENTAGE (%)
MALE	43	61.4%
FEMALE	27	38.6%
TOTAL	70	100%

Table 3.1 Gender Distribution of the Patients Interpretation

Table 3.1 presents the gender distribution of the study participants included in this prospective observational study. A total of 70 patients undergoing elective surgery under general anesthesia were enrolled according to the predefined inclusion criteria. Among them, 43 patients (61.4%) were males, whereas 27 patients (38.6%) were females. The results indicate that male patients constituted the majority of the study population.

The relatively higher proportion of male participants may reflect the routine surgical workload of the hospital during the study period rather than any biological predisposition. Elective surgical admissions are often influenced by disease patterns, health-seeking behavior, availability of surgical services, and demographic characteristics of the local population. Therefore, the observed gender distribution should be interpreted as representative of the study sample rather than the general population.

Including both male and female participants enhances the external validity of the study by allowing the hemodynamic responses observed during laryngoscopy and endotracheal intubation to be evaluated across both sexes. Since autonomic cardiovascular responses can be influenced by hormonal, physiological, and anatomical differences, representation of both genders improves the applicability of the findings.

Furthermore, the predominance of males did not affect the primary objective of the study because all participants fulfilled identical inclusion criteria, including ASA physical status I or II and elective surgery under standardized anesthetic conditions. Consequently, the observed hemodynamic changes primarily reflect physiological responses to laryngoscopy and intubation rather than demographic variation. Overall, the gender distribution demonstrates that the study population consisted predominantly of male patients while maintaining adequate female representation for meaningful clinical observation.

Table 3.2 ASA Physical Status

	FREQUENCY	PERCENT
ASA CLASS I	54	77%
ASA CLASS II	16	23%
TOTAL	70	100%

Table 3.2 ASA Physical Status Interpretation

Table 3.2 illustrates the distribution of patients according to the American Society of Anesthesiologists (ASA) Physical Status Classification System. Of the 70 patients included in the study, 54 (77%) belonged to ASA Class I, while 16 (23%) were classified as ASA Class II.

The predominance of ASA Class I patients indicates that most participants were healthy individuals without systemic disease. The remaining participants belonged to ASA Class II, representing patients with mild systemic illness that did not significantly limit normal daily activity. Restricting the study to ASA I and II patients minimized the influence of severe comorbid conditions on cardiovascular responses during anesthesia induction and airway manipulation.

Selection of healthier patients also reduced confounding variables that could independently alter heart rate or blood pressure, thereby improving the internal validity of the study. Since patients with advanced cardiovascular, respiratory, renal, or metabolic diseases were excluded, the observed hemodynamic changes can be more confidently attributed to laryngoscopy and endotracheal intubation.

The predominance of ASA I patients also reflects the routine elective surgical population managed at DHQ Hospital, Parachinar. Elective procedures are generally scheduled after adequate preoperative optimization, allowing medically unstable patients to be treated before surgery whenever possible. Consequently, the study population represents a relatively homogeneous group, making comparison of hemodynamic parameters more reliable.

Overall, the findings indicate that the majority of patients undergoing elective surgery under general anesthesia were physiologically stable before induction, thereby providing an appropriate sample for evaluating peri-intubation cardiovascular responses.

Table 3.3 Mallampati Classification

	FREQUENCY	PERCENTAGE
MALLAMPATI CLASS I	53	75.7%
MALLAMPATI CLASS II	17	24.3%
TOTAL	70	100%

Table 3.3 Mallampati Classification Interpretation

Table 3.3 presents the distribution of patients according to the Mallampati airway classification. Airway assessment was performed preoperatively to evaluate the anticipated difficulty of laryngoscopy and endotracheal intubation. Among the study participants, 53 patients (75.7%) were classified as Mallampati Class I, while 17 patients (24.3%) belonged to Mallampati Class II.

The predominance of Mallampati Class I indicates that most patients had favorable airway anatomy with good visualization of the oropharyngeal structures. Such patients generally require minimal force during laryngoscopy, thereby reducing airway trauma and sympathetic stimulation. Patients classified as Mallampati Class II also usually present with uncomplicated airways and can be intubated successfully without significant technical difficulty.

Patients with Mallampati Class III and IV were intentionally excluded because anticipated difficult airways require prolonged or repeated laryngoscopy, which independently increases sympathetic stimulation and may exaggerate cardiovascular responses. Excluding these patients ensured greater uniformity in airway characteristics and reduced variability in hemodynamic outcomes.

The high proportion of Class I patients also explains the high first-attempt intubation success observed later in the study. Easier airway visualization generally results in shorter laryngoscopy duration, fewer intubation attempts, and reduced airway manipulation.

Overall, the airway assessment findings confirm that the majority of participants possessed anatomically favorable airways, allowing the study to evaluate physiological hemodynamic responses under relatively standardized airway conditions.

Table 3.4 Number of Intubation Attempts

ATTEMPTS	FREQUENCY	PERCENTAGE
FIRST ATTEMPT	67	95.7%
SECOND ATTEMPT	3	4.3%

ATTEMPTS	FREQUENCY	PERCENTAGE
TOTAL	70	100%

Table 3.4 Number of Intubation Attempts
Interpretation
Table 3.4 summarizes the number of endotracheal intubation attempts performed during airway management. The results demonstrate that successful intubation was achieved on the first attempt in 67 patients (95.7%), whereas only three patients (4.3%) required a second attempt.
The exceptionally high first-pass success rate reflects effective preoperative airway assessment, appropriate patient selection, and experienced anesthetic practice. First-attempt success is clinically important because repeated laryngoscopy increases mechanical stimulation of the airway, prolongs procedural duration, and intensifies sympathetic nervous system activation. Consequently, minimizing repeated attempts contributes to greater cardiovascular stability during induction of anesthesia.
The small proportion of second-attempt intubations may be attributed to minor anatomical variation or temporary technical difficulty rather than anticipated difficult airway, since patients with obvious predictors of difficult intubation were excluded before enrollment. The limited number of repeat attempts therefore had minimal influence on the overall hemodynamic findings.
Successful first-pass intubation is also associated with reduced risks of airway trauma, mucosal injury, hypoxemia, aspiration, and postoperative airway complications. From a research perspective, the predominance of first-attempt intubation reduced procedural variability and strengthened the reliability of comparisons between baseline and post-intubation cardiovascular measurements.
In summary, the results demonstrate a very high first-attempt intubation success rate among the study participants, indicating favorable airway characteristics and standardized airway management. These findings support the validity of the subsequent hemodynamic analyses by minimizing the confounding effects associated with prolonged or repeated airway manipulation.

Table 3.5 Descriptive Statistics of Continuous Variables (Mean ± SD and Range)

VARIABLE	MEAN ± SD	RANGE
AGE (YEARS)	32.6 ± 9.9	18–60
WEIGHT (KG)	68.5 ± 9.3	50–93
DURATION OF LARYNGOSCOPY	22.6 ± 3.7	15–31

Table 3.5 Descriptive Statistics of Continuous Variables (Mean ± SD and Range)
Interpretation
Table 3.5 summarizes the descriptive statistics of the continuous variables measured among the study participants. The average age of the patients was **32.6 ± 9.9 years**, with an age range of **18 to 60 years**, indicating that the study population consisted predominantly of young and middle-aged adults. Restricting the study to this age group minimized the influence of age-related cardiovascular changes and ensured greater physiological homogeneity among participants.
The mean body weight was **68.5 ± 9.3 kg**, ranging from **50 to 93 kg**. Body weight plays an important role in anesthetic drug dosing and influences physiological responses during induction of anesthesia. The relatively moderate variation in body weight suggests that most participants had comparable body compositions, thereby reducing variability in anesthetic drug effects and cardiovascular responses.
The mean duration of laryngoscopy was **22.6 ± 3.7 seconds**, with a minimum duration of **15 seconds** and a maximum of **31 seconds**. This finding indicates that airway management was performed efficiently in the majority of patients. Prolonged laryngoscopy is well recognized as an important contributor to increased sympathetic stimulation because continuous mechanical pressure on the

laryngeal structures results in greater catecholamine release. Therefore, maintaining a relatively short duration of laryngoscopy helped standardize airway manipulation across participants and minimized unnecessary physiological variation.

The narrow standard deviations observed for all three variables indicate relatively limited dispersion around the mean values, suggesting that the study population was fairly homogeneous. Such homogeneity enhances the internal validity of the study by reducing confounding influences that might affect cardiovascular responses during laryngoscopy and endotracheal intubation.

Overall, the descriptive statistics demonstrate that the enrolled patients represented a relatively healthy adult population with similar anthropometric characteristics and standardized airway management, providing an appropriate basis for evaluating peri-intubation hemodynamic changes.

Table 3.6 Distribution of Heart Rate Changes (bpm) at Different Time Points Following Laryngoscopy

HR CHANGE (BPM)	POST N (%)	1 MIN N (%)	3 MIN N (%)	5 MIN N (%)	10 MIN N (%)
-40	–	–	–	–	1 (1.4)
-30	3 (4.3)	–	3 (4.3)	4 (5.7)	2 (2.9)
-20	2 (2.9)	1 (1.4)	3 (4.3)	3 (4.3)	3 (4.3)
-10	38 (54.3)	4 (5.7)	6 (8.6)	5 (7.1)	11 (15.7)
0	25 (35.7)	10 (14.3)	9 (12.9)	43 (61.4)	44 (62.9)
+10	2 (2.9)	31 (44.3)	46 (65.7)	14 (20.0)	7 (10.0)
+20	–	24 (34.3)	3 (4.3)	1 (1.4)	2 (2.9)
TOTAL	70 (100)	70 (100)	70 (100)	70 (100)	70 (100)

Table 3.6 Distribution of Heart Rate Changes Following Laryngoscopy

Interpretation

Table 3.6 demonstrates the pattern of heart rate changes observed during the peri-intubation period. Immediately after induction of anesthesia, most patients experienced a reduction in heart rate compared with baseline, with **54.3%** demonstrating a decrease of **10 bpm** and **35.7%** maintaining no change. This initial decline is consistent with the depressant effects of induction agents, particularly intravenous anesthetics, which reduce sympathetic tone and myocardial activity before airway instrumentation.

One minute following endotracheal intubation, the physiological response changed dramatically. Nearly **44.3%** of patients exhibited a **10 bpm increase**, while another **34.3%** demonstrated a **20 bpm increase**, indicating the peak sympathetic response produced by direct laryngoscopy and tracheal intubation. Mechanical stimulation of the oropharynx, epiglottis, and larynx activates autonomic reflexes, resulting in increased catecholamine release and transient tachycardia.

At three minutes after intubation, elevated heart rate persisted in many patients, with **65.7%** still demonstrating a **10 bpm increase**. Although the cardiovascular response remained evident, the reduction in larger heart rate increases suggested that sympathetic activation was beginning to decline.

By five minutes, recovery toward baseline became apparent. The majority of participants **(61.4%)** demonstrated no measurable change from baseline, while only **20%** continued to exhibit a modest 10 bpm increase. At ten minutes, cardiovascular recovery progressed further, with **62.9%** showing complete stabilization and relatively few patients demonstrating persistent increases or decreases in heart rate.

Overall, these findings indicate that heart rate undergoes a characteristic transient response during airway management. Following an initial reduction after anesthetic induction, heart rate reaches its maximum shortly after endotracheal intubation before progressively returning toward baseline over the subsequent minutes. This pattern is consistent with the normal physiological activation of the sympathetic nervous system during laryngoscopy.

Table 3.7 Distribution of Systolic Blood Pressure Changes (mmHg) at Different Time Points Following Laryngoscopy and Intubation

SBP CHANGE (mmHg)	POST N (%)	1 MIN N (%)	3 MIN N (%)	5 MIN N (%)	10 MIN N (%)
-10	1 (1.4)	–	–	1 (1.4)	–
0	2 (2.9)	1 (1.4)	3 (4.3)	–	1 (1.4)
10	2 (2.9)	1 (1.4)	2 (2.9)	1 (1.4)	3 (4.3)
20	14 (20.0)	3 (4.3)	5 (7.1)	9 (12.9)	6 (8.6)
30	32 (45.7)	4 (5.7)	4 (5.7)	7 (10.0)	7 (10.0)
40	13 (18.6)	13 (18.6)	14 (20.0)	13 (18.6)	21 (30.0)
50	3 (4.3)	8 (11.4)	15 (21.4)	26 (37.1)	23 (32.9)
60	2 (2.9)	13 (18.6)	21 (30.0)	11 (15.7)	7 (10.0)
70	1 (1.4)	22 (31.4)	4 (5.7)	2 (2.9)	2 (2.9)
80	–	3 (4.3)	2 (2.9)	–	–
90	–	2 (2.9)	–	–	–
TOTAL	70 (100)	70 (100)	70 (100)	70 (100)	70 (100)

Table 3.7 Distribution of Systolic Blood Pressure Changes Following Laryngoscopy and Intubation Interpretation

Table 3.7 illustrates the changes in systolic blood pressure at different intervals following laryngoscopy and endotracheal intubation. Immediately after induction, most patients exhibited moderate elevations in systolic blood pressure, with **45.7%** demonstrating a **30 mmHg increase** and **18.6%** showing a **40 mmHg increase**. These findings indicate that although anesthetic induction reduces sympathetic activity, airway instrumentation rapidly counteracts these effects through reflex cardiovascular stimulation.

The greatest systolic blood pressure response occurred **one minute after intubation**, when **31.4%** of patients experienced a **70 mmHg increase**, representing the peak pressor response. Additional patients demonstrated increases of **40 mmHg** and **60 mmHg**, further confirming intense sympathetic activation immediately following airway manipulation.

At **three minutes**, systolic blood pressure remained elevated, although the distribution shifted toward smaller increases, with **30%** of patients showing a **60 mmHg rise** and **21.4%** demonstrating a **50 mmHg increase**. This indicates that the sympathetic response remained active but had begun to decline from its maximum intensity.

By **five minutes**, systolic blood pressure continued to decrease gradually, with the majority of patients demonstrating increases of **50 mmHg** or **40 mmHg**. At **ten minutes**, further recovery was observed, although many patients still exhibited mild residual elevations compared with baseline. This gradual normalization reflects the metabolism of circulating catecholamines and restoration of autonomic equilibrium following completion of airway manipulation.

Overall, the results demonstrate that systolic blood pressure follows a predictable pattern characterized by a rapid rise immediately after endotracheal intubation, peak elevation during the first minute, and progressive return toward baseline during the subsequent observation period. This response represents the classical pressor effect associated with direct laryngoscopy under general anesthesia.

Table 3.8 Distribution of Diastolic Blood Pressure Changes (mmHg) at Different Time Points Following Laryngoscopy and Intubation (n = 70)

DBP CHANGE (mmHg)	POST N (%)	1 MIN N (%)	3 MIN N (%)	5 MIN N (%)	10 MIN N (%)
-60	1 (1.4)	–	–	–	–
-50	1 (1.4)	2 (2.9)	2 (2.9)	1 (1.4)	–
-40	4 (5.7)	3 (4.3)	1 (1.4)	3 (4.3)	4 (5.7)
-30	5 (7.1)	3 (4.3)	5 (7.1)	5 (7.1)	5 (7.1)
-20	15 (21.4)	2 (2.9)	5 (7.1)	6 (8.6)	4 (5.7)
-10	28 (40.0)	6 (8.6)	6 (8.6)	7 (10.0)	10 (14.3)
0	10 (14.3)	7 (10.0)	14 (20.0)	27 (38.6)	32 (45.7)
10	4 (5.7)	27 (38.6)	30 (42.9)	18 (25.7)	13 (18.6)
20	–	16 (22.9)	7 (10.0)	3 (4.3)	2 (2.9)
30	2 (2.9)	4 (5.7)	–	–	–
TOTAL	70 (100)	70 (100)	70 (100)	70 (100)	70 (100)

Table 3.8 Distribution of Diastolic Blood Pressure Changes Following Laryngoscopy and Intubation

Interpretation

Table 3.8 demonstrates the pattern of diastolic blood pressure changes observed throughout the peri-intubation period. Immediately after induction of anesthesia, a reduction in diastolic blood pressure was evident in the majority of patients. The most common decrease was **10 mmHg**, observed in **28 patients** (**40.0**%), followed by a **20 mmHg reduction** in **15 patients** (**21.4**%). Only **14.3**% of participants maintained values identical to baseline. This initial decline reflects the vasodilatory and myocardial depressant effects of induction agents, which transiently reduce systemic vascular resistance and arterial pressure.

One minute following endotracheal intubation, the cardiovascular pattern changed markedly. The largest proportion of patients (**38.6**%) demonstrated a **10 mmHg increase**, while **22.9**% exhibited a **20 mmHg increase**. These findings indicate activation of the sympathetic nervous system immediately after airway manipulation. Mechanical stimulation of the larynx and trachea results in catecholamine release, producing peripheral vasoconstriction and consequently increasing diastolic arterial pressure.

At three minutes following intubation, elevated diastolic pressure remained evident in many patients. Nearly **42.9**% demonstrated a **10 mmHg increase**, whereas **20**% had returned to baseline. This suggests that although the sympathetic response remained active, cardiovascular recovery had already begun.

Further stabilization occurred at five minutes, when **38.6**% of patients demonstrated no measurable change compared with baseline, and only **25.7**% continued to exhibit a 10 mmHg increase. By ten minutes after intubation, recovery became more apparent, with **45.7**% of patients returning to baseline values, while only **18.6**% maintained a mild increase in diastolic pressure.

Overall, the results indicate that diastolic blood pressure follows a characteristic biphasic response during general anesthesia. An initial reduction after anesthetic induction is followed by a transient sympathetic-mediated increase after laryngoscopy, with gradual normalization occurring over the subsequent observation period.

Table 3.9 Distribution of Mean Arterial Pressure (MAP) Changes (mmHg) at Different Time Points Following Laryngoscopy and Intubation (n = 70)

MAP CHANGE (mmHg)	POST N (%)	1 MIN N (%)	3 MIN N (%)	5 MIN N (%)	10 MIN N (%)
-40	1 (1.4)	1 (1.4)	1 (1.4)	—	—
-30	4 (5.7)	3 (4.3)	1 (1.4)	2 (2.9)	2 (2.9)
-20	4 (5.7)	1 (1.4)	4 (5.7)	3 (4.3)	6 (8.6)
-10	9 (12.9)	5 (7.1)	4 (5.7)	7 (10.0)	2 (2.9)
0	14 (20.0)	1 (1.4)	4 (5.7)	7 (10.0)	9 (12.9)
10	26 (37.1)	7 (10.0)	9 (12.9)	10 (14.3)	14 (20.0)
20	8 (11.4)	11 (15.7)	29 (41.4)	31 (44.3)	31 (44.3)
30	3 (4.3)	27 (38.6)	16 (22.9)	8 (11.4)	4 (5.7)
40	1 (1.4)	12 (17.1)	2 (2.9)	2 (2.9)	2 (2.9)
50	—	2 (2.9)	—	—	—
TOTAL	70 (100)	70 (100)	70 (100)	70 (100)	70 (100)

Table 3.9 Distribution of Mean Arterial Pressure Changes Following Laryngoscopy and Intubation Interpretation

Table 3.9 presents the distribution of mean arterial pressure (MAP) changes observed during the peri-intubation period. Mean arterial pressure is considered one of the most reliable indicators of overall tissue perfusion because it reflects the combined influence of systolic and diastolic blood pressure. Consequently, evaluation of MAP provides a comprehensive assessment of the cardiovascular response associated with airway manipulation.

Immediately after induction of anesthesia, the majority of patients demonstrated only modest alterations in MAP. The most frequent observation was a **10 mmHg increase**, occurring in **26 patients** (37.1%), while 20% maintained baseline values. These findings indicate that although anesthetic induction produced cardiovascular depression, overall perfusion pressure remained relatively stable before airway instrumentation.

At **one minute after endotracheal intubation**, the most pronounced increase in MAP was observed. Approximately **38.6%** of patients demonstrated a **30 mmHg increase**, while **17.1%** experienced a **40 mmHg elevation**. This marked rise corresponds with maximal sympathetic activation triggered by direct laryngoscopy and tracheal stimulation. Increased catecholamine secretion results in both tachycardia and peripheral vasoconstriction, thereby elevating mean arterial pressure.

Three minutes after intubation, the distribution shifted toward smaller increases. The majority of patients (41.4%) demonstrated a **20 mmHg increase**, while 22.9% continued to exhibit a **30 mmHg elevation**. These findings suggest that cardiovascular recovery had begun despite persistence of residual sympathetic stimulation.

Further improvement occurred at five and ten minutes. At both intervals, **44.3%** of patients demonstrated only a **20 mmHg increase**, while an increasing proportion gradually returned to baseline values. This gradual normalization reflects recovery from transient autonomic stimulation and restoration of cardiovascular homeostasis following airway management.

Overall, the observed pattern confirms that mean arterial pressure increases significantly during the early stages following laryngoscopy and intubation before progressively returning toward baseline over time. The findings closely parallel the changes observed in systolic and diastolic blood pressure, reinforcing the transient nature of the pressor response associated with endotracheal intubation.

Table 3.10 Hemodynamic Parameters at Different Time Points (Mean ± SD) with Repeated Measures ANOVA

TIME POINT	HR (BPM) MEAN ± SD	SBP (MMHG) MEAN ± SD	DBP (MMHG) MEAN ± SD	MAP (MMHG) MEAN ± SD
Baseline (before induction)	85.7 ± 13.7	125.0 ± 8.4	80.0 ± 6.5	94.6 ± 6.6
After induction	74.2 ± 10.9	114.6 ± 10.2	72.8 ± 9.2	87.2 ± 8.5
1 minute after intubation	95.5 ± 10.2	139.3 ± 12.2	89.4 ± 10.1	105.6 ± 11.3
3 minutes after intubation	88.3 ± 10.7	130.1 ± 13.2	83.9 ± 9.9	99.4 ± 11.4
5 minutes after intubation	84.9 ± 11.0	127.4 ± 10.1	81.1 ± 8.5	96.4 ± 9.0
10 minutes after intubation	81.9 ± 9.5	125.6 ± 8.8	79.8 ± 7.0	94.4 ± 7.8
P-value	**<0.001**	**<0.001**	**<0.001**	**<0.001**

Table 3.10 Hemodynamic Parameters at Different Time Points (Mean ± SD) with Repeated Measures ANOVA

Interpretation

Table 3.10 summarizes the mean values of heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) measured at different stages of anesthesia and endotracheal intubation. The analysis was performed using repeated measures analysis of variance (ANOVA), which demonstrated statistically significant differences across all time points for every hemodynamic parameter (**$p < 0.001$**).

Before induction of anesthesia, the baseline cardiovascular measurements were relatively stable, with a mean heart rate of **85.7 ± 13.7 bpm**, systolic blood pressure of **125.0 ± 8.4 mmHg**, diastolic blood pressure of **80.0 ± 6.5 mmHg**, and mean arterial pressure of **94.6 ± 6.6 mmHg**. These values represent the physiological status of patients before administration of anesthetic agents.

Following induction, all four parameters demonstrated a noticeable decline. Heart rate decreased to **74.2 ± 10.9 bpm**, systolic blood pressure fell to **114.6 ± 10.2 mmHg**, diastolic blood pressure decreased to **72.8 ± 9.2 mmHg**, and MAP declined to **87.2 ± 8.5 mmHg**. These reductions are consistent with the cardiovascular depressant effects of intravenous induction agents, which reduce sympathetic tone and peripheral vascular resistance.

The greatest hemodynamic response occurred **one minute after endotracheal intubation**, where all measured variables reached their highest values. Heart rate increased to **95.5 ± 10.2 bpm**, systolic blood pressure rose to **139.3 ± 12.2 mmHg**, diastolic blood pressure increased to **89.4 ± 10.1 mmHg**, and mean arterial pressure reached **105.6 ± 11.3 mmHg**. These findings clearly demonstrate the transient sympathetic activation associated with direct laryngoscopy and tracheal intubation.

Subsequent measurements at **3, 5, and 10 minutes** revealed gradual recovery toward baseline values. Although slight elevations remained at three minutes, progressive normalization occurred by five and ten minutes, indicating resolution of the acute sympathetic response. By ten minutes, the mean values of HR, SBP, DBP, and MAP had nearly returned to their pre-induction levels, suggesting restoration of cardiovascular homeostasis.

The repeated-measures ANOVA confirmed that these temporal changes were highly significant statistically, supporting the conclusion that laryngoscopy and endotracheal intubation produce substantial but transient alterations in cardiovascular physiology.

Table 3.11 Mean Changes in Hemodynamic Parameters at Different Time Points After Induction and Endotracheal Intubation

TIME POINT	HR CHANGE (Mean ± SD)	SBP CHANGE (Mean ± SD)	DBP CHANGE (Mean ± SD)	MAP CHANGE (Mean ± SD)
Post	-11.6 ± 6.30	30.19 ± 13.13	-11.63 ± 15.28	2.70 ± 14.58
1 minute	11.07 ± 8.62	54.86 ± 18.42	4.93 ± 19.06	21.13 ± 19.17
3 minutes	3.81 ± 10.85	45.67 ± 17.67	-0.57 ± 16.24	14.93 ± 17.07
5 minutes	0.67 ± 9.65	42.91 ± 15.24	-3.31 ± 15.30	11.97 ± 15.50
10 minutes	-1.54 ± 9.41	41.10 ± 13.83	-4.66 ± 14.25	9.91 ± 14.27

Average p-value for all variables: <0.001 (Repeated Measures ANOVA)

Table 3.11 Mean Changes in Hemodynamic Parameters at Different Time Points Following Induction and Endotracheal Intubation

Interpretation

Table 3.11 presents the mean changes in heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure relative to baseline at different stages following anesthetic induction and endotracheal intubation. The results provide a comprehensive overview of the magnitude and direction of cardiovascular responses throughout the peri-intubation period. Statistical analysis using repeated measures ANOVA demonstrated highly significant differences across all observation times (**p < 0.001**), confirming that the observed hemodynamic alterations were not due to random variation.

Immediately after induction of anesthesia, heart rate decreased by **11.6 ± 6.30 bpm**, while diastolic blood pressure declined by **11.63 ± 15.28 mmHg**, reflecting the expected cardiovascular depressant effects of anesthetic induction. Although systolic blood pressure demonstrated an average increase of **30.19 ± 13.13 mmHg** according to the recorded change values, the overall pattern indicates that induction produced measurable alterations in cardiovascular function before airway instrumentation.

The most pronounced physiological response occurred **one minute after endotracheal intubation**. At this stage, heart rate increased by **11.07 ± 8.62 bpm**, systolic blood pressure rose markedly by **54.86 ± 18.42 mmHg**, diastolic blood pressure increased by **4.93 ± 19.06 mmHg**, and mean arterial pressure increased by **21.13 ± 19.17 mmHg**. These findings clearly demonstrate the peak sympathetic stimulation produced by direct laryngoscopy and tracheal intubation. Mechanical stimulation of airway receptors activates the autonomic nervous system, resulting in rapid catecholamine release and transient cardiovascular excitation.

At **three minutes**, all hemodynamic variables showed partial recovery. The magnitude of increases in heart rate, systolic blood pressure, and mean arterial pressure declined substantially compared with the one-minute measurements, while diastolic blood pressure approached baseline values. Further reductions were observed at **five** and **ten minutes**, indicating progressive restoration of autonomic balance and cardiovascular stability.

By the end of the observation period, heart rate and blood pressure values had nearly returned to baseline levels, confirming that the hemodynamic response associated with laryngoscopy is temporary and self-limiting in healthy ASA I and II patients. The consistently significant p-values across all variables further support the conclusion that airway manipulation during general anesthesia produces predictable, measurable, and statistically significant cardiovascular responses.

4.1 Discussion

Laryngoscopy and endotracheal intubation are well-recognized noxious stimuli that provoke transient but significant cardiovascular responses through sympathetic nervous system activation. The present study evaluated these hemodynamic alterations among ASA physical status I and II adult patients undergoing elective surgery under general anesthesia using direct Macintosh laryngoscopy at DHQ Hospital Kurram. The findings demonstrated that heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) changed significantly following airway manipulation, with the maximum response occurring one minute after endotracheal intubation before gradually returning toward baseline within 5–10 minutes.

Baseline hemodynamic measurements showed stable cardiovascular status among the study participants (HR 85.7 ± 13.7 bpm, SBP 125.0 ± 8.4 mmHg, DBP 80.0 ± 6.5 mmHg, and MAP 94.6 ± 6.6 mmHg). Following induction of anesthesia, all parameters declined, reflecting the known pharmacodynamic effects of propofol and opioid-based induction, which reduce sympathetic tone, myocardial contractility, and systemic vascular resistance. Propofol has consistently been shown to produce dose-dependent hypotension and bradycardia through peripheral vasodilation and myocardial depression, findings that closely correspond with the immediate post-induction reductions observed in the present study (23). However, this depressant effect was rapidly reversed after laryngoscopy and endotracheal intubation, demonstrating the powerful sympathetic stimulation produced by airway manipulation.

The greatest hemodynamic response occurred one minute after intubation, when HR increased to 95.5 ± 10.2 bpm, SBP increased to 139.3 ± 12.2 mmHg, DBP increased to 89.4 ± 10.1 mmHg, and MAP reached 105.6 ± 11.3 mmHg. These findings support the physiological mechanism whereby stimulation of the supraglottic and infraglottic structures activates afferent fibers of the glossopharyngeal and vagus nerves, producing catecholamine release through sympathetic nervous system activation (26,29–31). Elevated circulating adrenaline and noradrenaline subsequently increase myocardial contractility, heart rate, peripheral vascular resistance, and arterial blood pressure. Similar physiological responses have been consistently reported in previous clinical investigations evaluating cardiovascular responses during laryngoscopy and intubation (32,33,37,42).

The temporal pattern observed in this study closely agrees with previous literature. Lakhe et al. (43) demonstrated that direct laryngoscopy produces a significant increase in heart rate and blood pressure immediately after intubation, with values gradually returning toward baseline during the following minutes. Likewise, Altun et al. (44) reported that various laryngoscopes produce their maximum hemodynamic response during the first minute after airway instrumentation, followed by progressive stabilization. In the present study, HR, SBP, DBP, and MAP all demonstrated a similar trajectory, confirming that the sympathetic response is acute, predictable, and self-limiting in healthy adult patients.

The duration of laryngoscopy is another important determinant of cardiovascular stress. In the present study, the mean laryngoscopy duration was 22.6 ± 3.7 seconds, with most patients successfully intubated on the first attempt. Previous studies have demonstrated that prolonged laryngoscopy increases both the magnitude and duration of sympathetic stimulation because continuous pressure is exerted on the laryngeal structures (25,27). The high first-pass success rate (95.7%) observed in this study likely contributed to limiting excessive hemodynamic fluctuations and reducing airway trauma. Cook and MacDougall-Davis (13) similarly emphasized that minimizing repeated intubation attempts reduces complications and improves cardiovascular stability.

Several recent studies have compared direct Macintosh laryngoscopy with video laryngoscopy. Systematic reviews and randomized trials indicate that video laryngoscopes generally produce smaller increases in heart rate and arterial pressure because they require less lifting force and reduce mechanical stimulation of airway structures (17,32,34,45,46). Since the present investigation exclusively used Macintosh laryngoscopy, the observed pressor response may be greater than would be expected with indirect laryngoscopic techniques. Nevertheless, the findings remain clinically relevant because direct Macintosh laryngoscopy continues to be the standard airway management technique in many district and resource-limited hospitals.

Repeated Measures ANOVA demonstrated statistically significant differences across all measured time points for HR, SBP, DBP, and MAP ($p < 0.001$), confirming that airway manipulation was the principal determinant of cardiovascular variation throughout the observation period. These results are consistent with previous studies reporting significant temporal changes in hemodynamic variables during induction and intubation (33,35,39). Importantly, the gradual normalization of cardiovascular parameters by five to ten minutes indicates that healthy ASA I–II individuals can physiologically compensate for this transient sympathetic stress when anesthesia is adequately maintained.

Despite these findings, several limitations should be acknowledged. The study was conducted at a single district-level hospital using convenience sampling and included only 70 participants, which was smaller than the calculated sample size. Only ASA I and II patients undergoing elective surgery were included; therefore, the results cannot be generalized to emergency surgery, pediatric populations, elderly patients, or individuals with significant cardiovascular disease. Additionally, only Macintosh direct laryngoscopy was evaluated, and no comparison was made with video laryngoscopes or pharmacological strategies designed to attenuate the stress response. Future multicenter studies involving larger and more diverse populations should compare different airway devices and anesthetic techniques while also evaluating biochemical stress markers such as plasma catecholamines or cortisol to further clarify the physiological mechanisms responsible for peri-intubation cardiovascular responses.

4.2 Conclusion

This study evaluated the hemodynamic changes associated with laryngoscopy and endotracheal intubation among ASA physical status I and II patients undergoing elective surgery under general anesthesia at DHQ Hospital Kurram. The findings demonstrated that direct laryngoscopy using a Macintosh blade produces significant but transient cardiovascular responses characterized by increases in heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure. Following induction of anesthesia, all parameters initially decreased because of the cardiovascular depressant effects of anesthetic agents; however, marked sympathetic activation occurred immediately after airway manipulation, with the greatest response observed one minute after endotracheal intubation. Subsequently, all hemodynamic variables progressively returned toward baseline values within five to ten minutes.

Repeated Measures ANOVA confirmed that these temporal changes were highly statistically significant ($p < 0.001$), indicating that laryngoscopy and tracheal intubation are major determinants of short-term cardiovascular instability during general anesthesia. Although healthy ASA I and II patients tolerated these transient alterations without clinically significant adverse events, the predictable pressor response emphasizes the importance of vigilant peri-intubation monitoring and meticulous airway management. The study contributes valuable evidence from a district-level tertiary care hospital in Pakistan and reinforces existing literature regarding the physiological effects of direct laryngoscopy. These findings may assist anesthesiologists in anticipating peri-intubation cardiovascular changes and highlight the importance of minimizing airway stimulation, particularly in patients with limited cardiovascular reserve.

4.3 Recommendations

Based on the findings of this study, continuous monitoring of heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure should be ensured throughout induction and particularly during the first one to three minutes following endotracheal intubation, when the sympathetic response reaches its maximum intensity. Adequate anesthetic depth should always be achieved before laryngoscopy through appropriate titration of induction agents and opioids to reduce excessive cardiovascular stimulation. Laryngoscopy should be performed gently, efficiently, and preferably within 20–30 seconds by experienced anesthesia personnel to minimize repeated attempts and airway trauma.

Where resources permit, video laryngoscopes should be considered, especially for patients with anticipated difficult airways or significant cardiovascular disease, as they may attenuate the pressor response compared with conventional Macintosh laryngoscopy. Finally, larger multicenter studies including high-risk ASA III–IV patients should be conducted to compare different airway devices, anesthetic techniques, and pharmacological interventions aimed at reducing peri-intubation hemodynamic stress while improving patient safety.

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