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CLINICAL & BASIC RESEARCH

Comparison of Nitroglycerin versus Lignocaine Spray to Attenuate Haemodynamic Changes in Elective Surgical Patients Undergoing Direct Laryngoscopy and Endotracheal Intubation

A prospective randomised study

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مقارنة بخاخ النتروجليسرين ببخاخ الليجنوكايين في تخفيف تغيرات الدورة الدموية لدى مرضى العمليات الجراحية الاختيارية الذين يخضعون لتنظير الحنجرة المباشر والتنبيب الرُّغَامي

دراسة استقصائية عشوائية

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ABSTRACT: ***Objectives:*** This study aimed to compare the effects of nitroglycerin (NTG) versus lignocaine spray in blunting the pressor response during direct laryngoscopy and endotracheal intubation. ***Methods:*** This study was conducted between January and June 2018 in the Department of Anesthesiology, Teerthankar Mahaveer Medical College, Moradabad, India. A total of 90 elective surgical patients of American Society of Anesthesiologists physical status grades I or II were divided into three groups, comprising two treatment groups and one control group. Patients in the treatment groups received either one puff (1.5 mg/kg) of lignocaine 10% spray or one puff (400 µg) of NTG spray in the oropharynx one minute prior to the induction of anaesthesia. Haemodynamic variables and mean rate pressure product at baseline and one, two, three, four and five minutes post-induction were compared. ***Results:*** There was a significant reduction in mean heart rate at 3–5 minutes in both treatment groups compared to the control group (P <0.050), as well as lower increases in mean arterial pressure at 1–3 minutes (P <0.050). However, at 2–4 minutes, there was a significantly greater decrease in mean systolic blood pressure in the NTG group compared to both the lignocaine and control groups (P <0.050). Moreover, a greater decrease in mean rate pressure product response at 1–5 minutes was observed in the NTG group compared to the lignocaine and control groups (P = 0.001). ***Conclusion:*** The NTG spray was more effective than lignocaine in attenuating blood pressure increases and rate pressure product during elective laryngoscopy and intubation.

Keywords: Endotracheal Anesthesia; Intubation; Laryngoscopy; Lignocaine; Nitroglycerin; Comparative Effectiveness Research; India.

الملخص: الهدف: هدفت هذه الدراسة إلى مقارنة تأثيرات بخاخ النتروجليسرين ببخاخ الليجنوكايين في تخفيف حدة ارتفاع ضغط الدم أثناء تنظير الحنجرة المباشر والتنبيب الرُّغَامي. **الطريقة:** أجريت هذه الدراسة بين يناير ويونيو عام 2018 في قسم التخدير، كلية تيرثانكار ماهافير الطبية ،مراد آباد، الهند. تم تقسيم ما مجموعه من مرضى العمليات الجراحية الاختيارية والذين يندرج وضعهم البدني تحت الدرجتين الاولى أو الثانية حسب تصنيف الجمعية الأمريكية لأطباء التخدير إلى ثلاث مجموعات شاملة مجموعتي علاج ومجموعة تحكم واحدة. تلقى المرضى في مجموعتي العلاج إما نشقة واحدة (1.5 مليغرام/كيلوغرام) من بخاخ الليجنوكايين 10% أو نشقة واحدة (400 ميكروغرام) من بخاخ النتروجليسرين في البلعوم الفَموِي قبل دقيقة واحدة من الخضوع للتخدير. تمت مقارنة متغيرات الدورة الدموية ومتوسط ناتج معدل ضربات القلب وضغط الدم عند خط الأساس ودقيقة وثانية وثلاث وأربع وخمس دقائق بعد بدء التخدير. **النتائج:** كان هناك انخفاض اكبر بكثير في متوسط معدل ضربات القلب عند 3-5 دقائق في كل من مجموعتي العلاج مقارنة بمجموعة التحكم (P <0.050)، وكذلك انخفاض أقل في متوسط الضغط الشرياني عند 1-3 دقائق (P <0.050). بالأضافة الى ذلك كان هناك انخفاض كبير في متوسط ضغط الدم الانقباضي في مجموعة النتروجليسرين عند 2-4 دقائق مقارنة مع كل من مجموعتي الليجنوكايين والتحكم (P <0.050). علاوة على ذلك ، لوحظ انخفاض أكبر في متوسط استجابة ناتج معدل ضربات القلب وضغط الدم في مجموعة النتروجليسرين عند 1-5 دقائق مقارنة بمجموعتي الليجنوكايين والتحكم (P = 0.001). **الخلاصة:** كان بخاخ النتروجليسرين أكثر فعالية من الليجنوكايين في تخفيف زيادة ضغط الدم وناتج معدل ضربات القلب وضغط الدم خلال تنظير الحنجرة والتنبيب الاختياريين.

الكلمات المفتاحية: تخدير داخل الرُّغامَى؛ تنبيب؛ تنظير الحنجرة؛ ليجنوكايين؛ نتروجليسرين؛ بحوث مقارنة الفعالية؛ الهند.

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Advances in Knowledge

- *Although various studies have evaluated different interventions to minimise the adverse haemodynamic effects of direct laryngoscopy and endotracheal intubation, there is limited research comparing the effects of intraoral nitroglycerin (NTG) and lignocaine sprays in this context. This study compares the efficacy of these aforementioned sprays in blunting the pressor response to direct laryngoscopy and endotracheal intubation.*

Application to Patient Care

- *The results of this study suggest that NTG spray is more efficacious than lignocaine in blunting the pressor response to direct laryngoscopy and endotracheal intubation in elective surgical patients.*

Direct laryngoscopy involves stretching the oropharyngeal tissues while the patient is under general anaesthesia in an attempt to straighten the angle between the mouth and the glottic opening; however, this causes pain and triggers a stress response associated with changes in haemodynamic variables.[1,2] Subsequently, tracheal intubation leads to the activation of the sympathetic system, along with the release of plasma catecholamines, which in turn elevates the patient's heart rate (HR) and blood pressure (BP) and can induce arrhythmias.[3]

While these haemodynamic changes may not be significant in normal individuals, they can be catastrophic for cardiovascular-compromised patients and lead to the development of myocardial ischaemia and infarctions, left ventricular failure, cerebrovascular accidents and dysrhythmias.[4,5] The reason for this exaggerated haemodynamic response lies in the activation of the autonomic reflex arc.[6] Changes in HR, heart rhythm and blood pressure depend on various factors including ease of intubation, depth of anaesthesia, time taken for the intubation and the use of various topical/intravenous (IV) anaesthetic agents beforehand. The effects of these factors on haemodynamic variables usually last between 30 seconds to under 10 minutes following intubation.[6]

Various studies have evaluated the effectiveness of a range of techniques and drugs to minimise the deleterious effects of direct laryngoscopy and endotracheal intubation.[2,7,8] Haidry and Khan recommended using a McCoy blade instead of a Macintosh laryngoscope to avoid pressure on the base of the tongue and lifting the epiglottis.[7] Other researchers have assessed the use of β-blockers, local anaesthetics (e.g. lignocaine), antihypertensive agents (e.g. phentolamine) and vasodilators (e.g. magnesium) to blunt pressor responses during laryngoscopy.[2,8]

Lignocaine blocks sodium channels in the myocardium, thus reducing the rate of rise of action potential and altering the conduction velocity throughout the His-Purkinje system and atrial and ventricular musculature.[9] In contrast, the action of nitroglycerin (NTG) on the coronary vessels is not yet fully understood; however, it is believed that NTG increases blood flow to the coronary vessels along with oxygen delivery to the myocardium, if the coronary vessels are dilated immediately prior to the induction of anaesthesia.[10] Accordingly, both of these drugs would counteract the haemodynamic pressor response during direct laryngoscopy and tracheal intubation.

An extensive search of the MEDLINE® database (National Library of Medicine, Bethesda, Maryland, USA) reveals that there is limited research comparing the effects of intraoral NTG versus lignocaine spray in minimising the deleterious haemodynamic effects of direct laryngoscopy and endotracheal intubation. Thus, this comparative study aimed to evaluate the effect of these drugs in blunting the pressor response to direct laryngoscopy and endotracheal intubation. The null hypothesis was that the mean haemodynamic variables of the three study groups would be the same.

Methods

This prospective, randomised, double-blind placebo-controlled study was conducted in the Department of Anesthesiology, Teerthankar Mahaveer Medical College, Moradabad, India, from January to June 2018. A total of 90 adult patients scheduled for elective general surgical procedures and classified as being of American Society of Anesthesiologists (ASA) grades I or II were included in the study. Patients with jaundice, bronchial asthma, epilepsy, uncontrolled diabetes mellitus/hypertension, metabolic/endocrine disease, a history of previous myocardial infarctions, morbid obesity or any chronic renal, liver or cardiorespiratory disease were excluded. In addition, patients for whom intubation was anticipated to be difficult were not included.

A pilot study was conducted which found that systolic BP (SBP) increased by 67.8% among patients in a control group compared to 25% among those who received a single dose of NTG spray. Taking into account an alpha error of <0.05 and power of 0.8, a sample size calculation determined that a total of 83 patients was required. In order to compensate for dropouts, patients were allocated into three groups of 30 participants each using a randomised selection method [Figure 1]. This involved preparing 90 identical

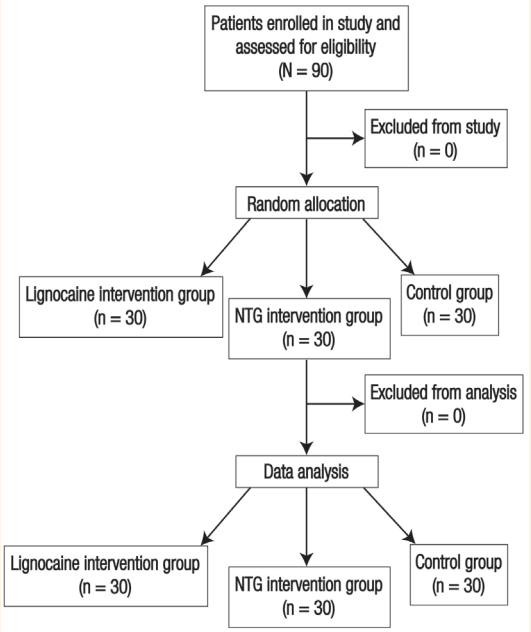

Figure 1: Flowchart showing the prospective randomised design used in the current study.
NTG = nitroglycerin.

paper slips with one of the three group allocations and blindly drawing papers until all patients had been allocated to a group. Once randomly assigned to each group, none of the patients were lost to follow-up or excluded from the final analysis.

The first group received one puff (1.5 mg/kg) of lignocaine 10% spray in the oropharynx one minute prior to the induction of anaesthesia after opening the mouth and protruding the tongue, while the second group received one puff (400 µg) of NTG spray sublingually one minute prior to the induction of anaesthesia. The third group functioned as the control group and no drug was administered prior to induction. In order to ensure double-blinding, doses were administered using veiled spray containers by an independent anaesthesiologist who did not participate further in the study. In this way, both the patients and investigators were unaware of specific group allocations and which drug was being administered in order to prevent any potential bias.

On the day of the surgery, all patients were prepared for the procedure. A 20-gauge *cannula* was secured and an intravenous (IV) infusion of Ringer's lactate solution was administered. In addition, premedication with 0.2 mg of IV glycopyrrolate, 4 mg of IV ondansetron, 2 mg/kg of IV tramadol and 0.02 mg/kg of IV midazolam was administered 30 minutes prior to the induction of anaesthesia. Standard monitors were attached to all patients, including a pulse oximeter and non-invasive BP, electrocardiography and end-tidal carbon dioxide monitoring equipment. Various baseline haemodynamic parameters—including HR, SBP, diastolic BP (DBP) and mean arterial pressure (MAP)—were measured using a B40 GE Monitor (General Electric Co., Auckland, New Zealand). The rate pressure product (RPP) was calculated as the product of HR and SBP.

After pre-oxygenation for three minutes using 100% oxygen, all patients were induced with 2 mg/kg of IV propofol and relaxed with 1.5 mg/kg of IV succinylcholine. Direct laryngoscopy and endotracheal intubation were performed using a Macintosh laryngoscope (Welch Allyn, Skaneateles Falls, New York, USA) after placing the patient in a 'sniffing' position with an appropriately-sized 7.5- or 8.0-mm (for females and males, respectively) cuffed endotracheal tube (Smiths Medical India Pvt. Ltd., Mumbai, Maharashtra, India). The position of the tube was confirmed using capnography. Anaesthesia was maintained using an oxygen-nitrous oxide mixture combined with intermittent doses of 0.05 mg/kg of IV vecuronium and isoflurane 1%.

At the end of the surgery, 75 mg of intramuscular diclofenac was administered before the reversal of the neuromuscular blockade to pre-empt postoperative pain. Muscle relaxation reversal was then accomplished using 0.04 mg/kg of IV neostigmine and 0.01 mg/kg of IV glycopyrrolate. Subsequently, after confirming adequate reflexes and respiration, the patient was extubated. During the postoperative period, nausea, vomiting, vital signs, postoperative pain and any other adverse effects were monitored by an anaesthesia nurse.

Mean haemodynamic values (i.e. HR, SBP, DBP, MAP and RPP) were recorded at baseline and one, two, three, four and five minutes after the induction of the anaesthesia for patients in all three groups. In addition, intubating responses were compared on a scale of 0–3, with zero indicating poor jaw relaxation, closed vocal cord and severe coughing or bucking when intubated, one signifying minimal jaw relaxation, closing vocal cord and mild coughing when intubated, two indicating moderate jaw relaxation, moving vocal cord and slight diaphragmatic movement when intubated and three signifying good jaw relaxation, open vocal cord and no response to intubation.[11] A total score of 8–9 was considered excellent, while total scores of 6–7, 3–5 and 0–2 were indicative of good, fair and poor intubation conditions, respectively.[11]

Data were analysed using the Statistical Package for the Social Sciences (SPSS), Version 22.0 (IBM Corp., Armonk, New York, USA). The comparison of baseline data was performed using an analysis of variance test. In addition, the Student's t-test and Chi-squared or exact Fisher's tests were used to analyse parametric and non-parametric data, as applicable. A *P*

Table 1: Demographic and anaesthesia-related characteristics of elective surgical patients undergoing direct laryngoscopy and endotracheal intubation (N = 90)

Characteristic	n (%)				*P* value
	Total	Control group (n = 30)	Lignocaine group (n = 30)	NTG group (n = 30)	
Mean age in years ± SD	41.63 ± 11.91	38.80 ± 11.51	43.10 ± 11.51	43.01 ± 12.57	0.072
Mean weight in kg ± SD	55.06 ± 7.91	56.07 ± 7.73	56.47 ± 7.73	52.63 ± 7.97	0.121
Gender					
Male	36 (40)	14 (46.7)	10 (33.3)	12 (40)	0.633
Female	54 (60)	16 (53.3)	20 (66.7)	18 (60)	0.084
ASA grade					
I	59 (65.6)	17 (56.7)	20 (66.7)	21 (70)	0.132
II	31 (34.4)	13 (43.3)	10 (33.3)	9 (30)	0.231
Mean DL duration in seconds ± SD	23.17 ± 2.54	23.83 ± 2.33	22.17 ± 2.47	23.50 ± 2.57	0.060

NTG = nitroglycerin; SD = standard deviation; ASA = American Society of Anesthesiologists; DL = direct laryngoscopy.

Table 2: Mean heart rates according to intervention group among elective surgical patients undergoing direct laryngoscopy and endotracheal intubation (N = 90)

PIT in minutes	Mean HR in bpm ± SD			*P* value		
	Control group (n = 30)	Lignocaine group (n = 30)	NTG group (n = 30)	Control versus lignocaine group	Control versus NTG group	Lignocaine versus NTG group
Baseline	93.77 ± 16.29	91.63 ± 13.41	92.33 ± 8.69	0.581	0.195	0.432
1	97.94 ± 20.77	97.50 ± 13.84	95.03 ± 9.49	0.922	0.494	0.424
2	109.47 ± 16.35	102.90 ± 13.90	99.24 ± 8.24	0.100	0.001*	0.223
3	113.17 ± 15.54	103.77 ± 14.94	104.53 ± 14.85	0.020*	0.030*	0.841
4	110.37 ± 15.42	99.80 ± 15.93	99.67 ± 7.84	0.010*	0.001*	0.972
5	106.90 ± 14.59	94.93 ± 12.95	93.33 ± 8.63	0.001*	0.001*	0.573

*PIT = post-induction time; HR = heart rate; bpm = beats per minute; SD = standard deviation; NTG = nitroglycerin. *Statistically significant at P <0.050.*

Table 3: Mean arterial pressure values according to intervention group among elective surgical patients undergoing direct laryngoscopy and endotracheal intubation (N = 90)

PIT in minutes	Mean MAP in mmHg ± SD			*P* value		
	Control group (n = 30)	Lignocaine group (n = 30)	NTG group (n = 30)	Control versus lignocaine group	Control versus NTG group	Lignocaine versus NTG group
Baseline	98.01 ± 7.95	101.00 ± 6.50	99.02 ± 6.77	0.111	0.603	0.251
1	113.80 ± 13.97	103.22 ± 11.15	103.33 ± 10.87	0.001*	0.001*	0.972
2	109.48 ± 19.24	99.16 ± 8.89	96.39 ± 8.53	0.010*	0.001*	0.223
3	108.45 ± 15.46	99.43 ± 7.08	95.27 ± 9.85	0.001*	0.001*	0.06
4	106.71 ± 15.08	100.3 ± 9.20	95.01 ± 8.49	0.060	0.001*	0.020*
5	100.76 ± 12.64	99.31 ± 8.89	96.92 ± 8.22	0.61	0.172	0.284

*PIT = post-induction time; MAP = mean arterial pressure; SD = standard deviation; NTG = nitroglycerin. *Statistically significant at P <0.050.*

value of <0.050 was considered statistically significant.

This study was approved by the institutional ethical committee of Teerthanker Mahaveer University (#TMMC/IEC/2017/47). Written informed consent was obtained from all participants and all patients were provided with a detailed explanation of the procedure before it was performed.

Results

All 90 patients included in the study were between 18–60 years old and had body mass indexes of 8–24 kg/m^2. There were no significant differences in age, weight, gender distribution, ASA grades or laryngoscopy duration according to group allocation [Table 1]. In terms of

Table 4: Mean rate pressure product values according to intervention group among elective surgical patients undergoing direct laryngoscopy and endotracheal intubation (N = 90)

PIT in minutes	Mean RPP ± SD			*P* value		
	Control group (n = 30)	Lignocaine group (n = 30)	NTG group (n = 30)	Control versus lignocaine group	Control versus NTG group	Lignocaine versus NTG group
Baseline	12,002.56 ± 164.53	12,021.86 ± 103.26	12,076.76 ± 83.16	0.591	0.060	0.061
1	14,871.21 ± 344.37	13,045.5 ± 216.19	12,581.97 ± 144.44	0.001*	0.001*	0.001*
2	15,745.07 ± 343.02	13,380.09 ± 121.62	12,308.74 ± 105.81	0.001*	0.001*	0.001*
3	16,138.04 ± 281.12	13,458.97 ± 133.41	12,906.32 ± 165.73	0.001*	0.001*	0.001*
4	15,234.37 ± 260.6	12,901.15 ± 159.62	12,222.53 ± 87.73	0.001*	0.001*	0.001*
5	13,925.86 ± 186.9	12,018.14 ± 121.21	11,743.72 ± 93.29	0.001*	0.001*	0.001*

*PIT = post-induction time; RPP = rate pressure product; SD = standard deviation; NTG = nitroglycerin. *Statistically significant at P <0.050*

Table 5: Intubating condition according to intervention group among elective surgical patients undergoing direct laryngoscopy and endotracheal intubation (N = 90)

Condition	n			*P* value		
	Control group (n = 30)	Lignocaine group (n = 30)	NTG group (n = 30)	Control versus lignocaine group	Control versus NTG group	Lignocaine versus NTG group
Excellent/ good	20/10	24/6	28/2	0.243	0.001*	0.134

*NTG = nitroglycerin. *Statistically significant at P <0.050.*

HR, patients in the lignocaine group showed a greater decrease at 3–5 minutes compared to the control group (*P* <0.050), while patients in the NTG group demonstrated a lower increase in HR at 2–5 minutes compared to the control group (*P* <0.050) [Table 2].

At one minute, mean SBP values were 151.84 ± 16.58 mmHg and 133.80 ± 15.62 mmHg in the control and lignocaine groups, respectively (*P* <0.010). Similar results were seen for the NTG group in comparison to the control group (132.40 ± 15.22 mmHg versus 151.84 ± 16.58 mmHg; *P* <0.010). However, at 2–4 minutes, the greatest decrease in mean SBP values was observed in the NTG group, followed by the lignocaine group and then the control group (*P* <0.050). At 1–3 minutes post-induction, a lower increase in mean DBP values was observed in the lignocaine group compared to the control group. Similarly, NTG resulted in better control in mean DBP at 1–4 minutes compared to the control group.

Patients receiving lignocaine showed better MAP control at 1–3 minutes compared to the control group (*P* <0.010). Similarly, at 1–4 minutes post-induction, patients in the NTG group showed better MAP control than patients in the control group (*P* = 0.001). However, at minute four, a higher decrease in MAP was observed among participants receiving NTG compared to those receiving lignocaine (*P* = 0.020) [Table 3].

An intergroup comparison at 1–5 minutes revealed the highest decrease in mean RPP response was in the NTG group, followed by the lignocaine group and then the control group (*P* = 0.001) [Table 4]. Based on their intubating scores, patients receiving NTG were in significantly better condition in comparison to patients in the control group (*P* = 0.001), while lignocaine administration did not result in a significant difference in this aspect (*P* = 0.243) [Table 5].

Discussion

Orotracheal intubation involves two separate stages of airway stimulation; firstly, a direct laryngoscopy is performed to identify the vocal cords, followed by the insertion of an endotracheal tube through the vocal cords into the trachea. Takahashi *et al.* suggested that laryngoscopy followed by intubation produced more significant hypertension in comparison to laryngoscopy alone.[12] The mechanisms involved in these procedures act as powerful *stimuli* for the elevation of haemodynamic parameters, which must be attenuated using adequate premedication, the smooth induction of anaesthesia and rapid intubation.[13]

The present study was performed in order to evaluate the pressor responses of normotensive patients receiving NTG versus lignocaine oral spray in comparison to a control group during direct laryngoscopy and endotracheal intubation. When sprayed either sublingually or in the oropharynx, NTG can be detected within two minutes and up to about 90 minutes. This agent is metabolised in the liver,

with the active metabolites possessing a half-life of approximately 40 minutes.[14] Lignocaine 10% sprayed in the oropharynx provides local anaesthetic action within one to five minutes of administration, with the effects lasting approximately 10–15 minutes. It is rapidly metabolised in the liver and excreted in urine; around 90% of the drug is excreted as metabolites, while the rest remains unchanged.[15]

Sukumar *et al.* conducted a study comparing the effect of an IV *bolus* of propofol at anaesthesia induction and recovery and suggested that propofol aids in smooth anaesthesia induction, maintenance and early recovery.[16] Moreover, Mishra *et al.* observed that induction with an IV *bolus* of propofol in neurosurgical patients leads to better haemodynamic values and earlier recovery compared to thiopentone-isoflurane.[17] Van den Berg *et al.* compared IV *boli* of esmolol, NTG, magnesium sulphate, lignocaine and normal saline (as a placebo) to attenuate haemodynamic responses in patients undergoing cataract surgery; the researchers concluded that esmolol resulted in better haemodynamic stability compared to the other agents.[18] Singh *et al.* also observed that esmolol results in better modification of the haemodynamic response to laryngoscopy and intubation compared to NTG and lignocaine.[6] In the present study, NTG was found to result in better haemodynamic outcomes compared to lignocaine.

There was an increase in HR in all three groups at various time intervals post-induction in the current study; this was due to the pressor response generated as a result of laryngoscopy and endotracheal intubation.[1–3] However, there was a statistically significant decrease at minute two between the NTG and control groups, while an insignificant decrease was noted between the lignocaine and control groups at the same time interval. This can be attributed to the reflex tachycardia produced due to peripheral vasodilation.[2] Manjusha *et al.* compared intraoral NTG spray versus IV lignocaine to attenuate the haemodynamic response due to laryngoscopy and endotracheal intubation.[19] Their findings support those of the current study, with similar results observed among the three groups at one, three and five minutes post-induction.[19]

In the present study, SBP was significantly reduced in both the lignocaine and NTG groups compared to the control group at 1–4 minutes post-induction. The statistical analysis showed a significant decrease in SBP in the NTG group compared to the lignocaine group at 2–4 minutes. Fassoulaki and Kaniaris observed that SBP did not increase significantly with intranasal NTG spray administration during the initial minutes post-intubation and significantly decreased at minutes three and five; in contrast, the control group showed a significant increase in SBP at all recorded time intervals.[10]

Both DBP and MAP were significantly reduced at 1–3 minutes in the present study in both the lignocaine and NTG groups compared to the control group. Moreover, there was a sustained decrease in MAP with NTG compared to lignocaine, with significant results noted after four minutes. These findings are comparable with those of Kumari *et al.* wherein NTG lingual spray was found to be effective in attenuating the pressor response due to laryngoscopy and intubation in terms of preventing significant rises in SBP, DBP and MAP values in comparison to a control group.[20] Anant and Waghray similarly found that intranasal NTG spray significantly decreased DBP compared to a control group, thus proving NTG spray to be a convenient method of drug administration which significantly attenuates the pressor response caused by laryngoscopy and intubation.[21] Various studies have supported the fact that NTG blunts the pressor response when administered via either intranasal, topical or IV routes.[19,22]

The haemodynamic response to intubation includes increases in HR, MAP and pulmonary capillary wedge pressure as well as a decrease in ejection fraction; these responses are more pronounced in patients with diseased epicardial arteries which constrict as a result of sympathetic stimulation, thus further compromising coronary perfusion.[23] However, the vasodilatory properties of NTG can reverse this to some extent, making this drug the best option for patients with low cardiac output and moderately elevated resistance.[24] Additionally, as RPP correlates with myocardial oxygen demand, this variable is related to the onset of angina *pectoris*, especially among patients with compromised coronary perfusion.[25] In the current study, RPP values were significantly lower in the NTG group compared to the lignocaine and control groups. Dich-Nielsen *et al.* concluded that intranasal NTG spray effectively attenuates the RPP due to laryngoscopy and endotracheal intubation in patients undergoing coronary artery bypass surgery.[26] Kamra *et al.* also noted similar results with a topical NTG ointment.[27]

Hamaya and Dohi suggested that topical lignocaine spray inhibits tactile stimulation of the airway primarily due to the direct blockade of mechanoreceptors.[28] In another study, Bülow *et al.* found that a laryngotracheal lignocaine spray resulted in satisfactory intubating conditions from 73–100% during anaesthesia induction using an IV *bolus* of 2.5 mg/kg of propofol and 30 μg/kg of alfentanil without muscle relaxants.[29] In the present study, NTG spray resulted in better intubating conditions compared to the control group.

This study was subject to certain limitations. Firstly, an invasive arterial line was not used for continuous blood pressure measurements; however, while invasive measurements of arterial pressure are considered to be

more accurate, previous research has demonstrated that non-invasive measurements are still clinically useful.[30] Moreover, invasive arterial pressure measurements are technically difficult and often complicated and expensive; therefore, such methods are usually reserved for critically-ill patients or those in whom a major fluid shift is expected, not for elective general surgical procedures. Additionally, arterial *cannulae* pose a potential risk of infection. Accordingly, invasive arterial pressure monitoring was considered unnecessary. Nevertheless, the use of non-invasive arterial pressure monitoring inhibited the measurement of certain haemodynamic variables, such as cardiac output and systolic volume.

Secondly, the study included only normotensive patients without any associated cardiovascular or cerebrovascular diseases. Thus, the findings of this study cannot be extrapolated for patients with ischaemic heart disease, hypertension or airway difficulties. Moreover, the study did not compare other airway devices, with all patients undergoing direct laryngoscopy and endotracheal intubation using a Macintosh laryngoscope (Welch Allyn) to ensure unbiased results. Finally, while the study could have been performed with other induction drugs such as etomidate, which maintains better haemodynamic stability compared to propofol, this was not possible due to a limited supply of this agent at Teerthankar Mahaveer Medical College.[31]

Conclusion

This study compared the administration of NTG versus lignocaine spray prior to the induction of anaesthesia for blunting the haemodynamic pressor response to direct laryngoscopy and endotracheal intubation among elective surgical patients. Overall, NTG was significantly more effective than lignocaine in attenuating MAP and RPP changes and maintained equal efficacy in controlling other haemodynamic variables. Moreover, this agent resulted in significantly better intubating conditions compared to those observed in the control group.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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