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Original Research Article

Comparison of Haemodynamic Responses between Clinical Assessment-Guided Tracheal Intubation and Neuromuscular Block Monitoring-Guided Tracheal Intubation

Ashwin Bhandari[1], Manu G. R.[2], Yogitha B. S.[3], Harshitha G.[4], Suresh C.[5]

[1]Senior Resident, Department of Anaesthesia, Sri Siddhartha Institute of Medical Sciences and Research Centre, T. Begur, Nelamangala, Bangalore, Karnataka, India

[2]Assistant professor, Department of Anaesthesia, Sri Siddhartha Institute of Medical Sciences and Research Centre, T. Begur, Nelamangala, Bangalore, Karnataka, India

[3]Assistant professor, Department of Anaesthesia, Sri Siddhartha Institute of Medical Sciences and Research Centre, T. Begur, Nelamangala, Bangalore, Karnataka, India

[4]Post Graduate, Department of Anaesthesia, Bangalore Medical College and Research Institute, Bangalore, Karnataka, India

[5]Professor, Department of Anaesthesia, Sri Siddhartha Institute of Medical Sciences and Research Centre, T. Begur, Nelamangala, Bangalore, Karnataka, India

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Corresponding author: Manu G. R.

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Abstract

Introduction: Endotracheal intubation is the commonest procedure done during general anaesthesia and it includes stressor response during the procedure. It is a challenging task to do it with minimal stress response. The purpose of our study was to find a better technique to assess the adequate intubating condition to reduce the stress response of endotracheal intubating procedure and hence we compared clinical assessment guided tracheal intubation and train of four (TOF) guided tracheal intubation and looked for the haemodynamic responses.

Aim: To assess the haemodynamic responses of tracheal intubation guided via Train of Four (TOF) monitoring compared to tracheal intubation guided via clinical assessment.

Method: In this prospective randomized clinical study, 70 adults, ASA -1 and ASA-2, MPG- 1 and MPG-2 undergoing elective surgery under general anaesthesia with tracheal intubation were allocated to two groups (n = 35) according to TOF guided (Group T) or Clinical assessment guided (Group C) tracheal intubation. Anaesthesia was induced with Inj.propofol 2mg/kg and after standardization of supramaximal stimulus, Inj.Vecuronium 0.1mg/kg was administered. In group T, trachea was intubated after TOF ratio became zero in Adductor Pollicis muscle, whereas in group C, trachea was intubated after clinical assessment of jaw muscle relaxation, airway tone and ease of ventilation. Changes in heart rate, mean arterial pressure, mean systolic blood pressure, mean diastolic blood pressure were recorded along with intubating conditions which were scored on a Kreig *et al* score. Results were analysed by Paired-t test and chi square test.

Results: Heart rate, mean arterial pressure, mean systolic blood pressure and mean diastolic blood pressure were observed to be significantly higher in Group C compared to Group T ($P<0.05$). Excellent and good intubating conditions were found in both the groups. However, 91.43% excellent intubating conditions were found in Group T compared to 57.14% in Group C.

Conclusion: Neuromuscular block monitoring of Adductor Pollicis muscle based endotracheal intubation can be a suitable, non-pharmacological method in assessing appropriate time of intubation, providing excellent intubating conditions hence significant attenuation of hemodynamic response to laryngoscopy and tracheal intubation.

Keywords: Adequate Intubating Conditions, Haemodynamic Monitoring, Neuromuscular Blockade.

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Introduction

General Anaesthesia being the most common anaesthetic technique used in anaesthesia practice. Securing and maintaining a patent airway is a vital aspect of providing adequate oxygenation and ventilation [1]. Hence, it is very important for an anaesthesiologist to secure airway and endotracheal tube intubation is the best and safe method to prevent aspiration[2]. Intubation is done by direct laryngoscopy and this is known to cause increased sympathetic response, which is exaggerated during inadequate or difficult intubating conditions.

Intubating conditions can be assessed clinically or using Neuromuscular monitoring, which is the best non-invasive technique. In clinical practice Neuromuscular block is monitored by assessing response of Adductor Pollicis after ulnar nerve stimulation or Orbicularis oculi after facial nerve stimulation using neuromuscular monitor – Train of Four (TOF). Complete relaxation of the jaw, laryngeal, vocal cord, pharyngeal muscles and diaphragm is needed for excellent intubating conditions in order to reduce the risk of Vocal cord and laryngeal trauma which later can cause laryngeal edema. Response to intubation is seen by both muscular block and the depth of anaesthesia and is possible to intubate a patient with incomplete paralysis if a sufficient depth of anaesthesia is present. Intubating conditions can be improved by using combined dose of narcotics and neuromuscular blocking agents. If only narcotics are used then the required dose for acceptable intubating conditions will produce significant hypotension. It has been demonstrated that poor intubating conditions are associated with an increased incidence of hoarseness of voice and vocal cord damage. Hence, giving neuromuscular blocking agents improved the quality of intubating conditions.

Strong stressor stimuli during direct laryngoscopy and endotracheal intubation often lead to unintended sympathetic nervous system stimulation producing haemodynamic changes which are usually transient and do not result in significant adverse effects.[3] In patients with Coronary artery disease (CAD), hypertension or intracranial pathology, exaggerated haemodynamic parameters may lead to cardiac arrest or secondary brain damage for which many drugs are successfully used to blunt the stressor response.[4] However, administration of more drugs can cause change in haemodynamic effects or increase the depth of anaesthesia. Hence, a non-pharmacological measure is preferred to reduce the response.

Type and depth of general anaesthesia, age, concomitant or systemic diseases like Diabetes Mellitus, HTN and any drugs used along with the duration of laryngoscopy and intubation, also the ease of procedure effect the changes in hemodynamic responses.[4,5,6] Therefore, adequate neuromuscular block with neuromuscular blocking drugs is very vital in attenuation of the sympathetic response.

Materials and Methods

After obtaining approval from ethical committee in our institution (MDC/DOME/32) and taking written consent from patients undergoing elective surgical procedures requiring general anaesthesia, patients were randomly allocated by opening a computer generated 'sealed envelope' method into two groups, sample size obtained was 35 in one group. Hence a total of 70 patients equally distributed into two groups namely, Group C: Patients intubated following clinical assessment of neuromuscular blockade-35cases, Group T: Patients intubated following neuromuscular block monitoring by TOF-GUARD Acceleromyograph – 35 cases.

Inclusion Criteria

- Patients undergoing elective surgical procedures under general anaesthesia.
- Aged18-60 years,
- ASA physical status I and II.
- Mallampati grade I and II.

Exclusion Criteria

- Mallampati grade III and IV
- Difficult airway
- Patients with neuromuscular disorders
- Patients with liver and kidney disorders

Sample size calculation

The minimum sample size formula based on mean and standard deviation is $n= (Z\alpha+Z\beta)2\ (S\ 2\ +S\ 2)\ (d)2$

Where $Z\alpha$ is linked with level of significance and $Z\beta$ is linked with power of test.

For 5% level of the significance $Z\alpha = 1.96$ and $Z\beta = 0.84$ for 80% power of the test. d is difference between means of the Heart rate (HR) of the two groups.

S1 is standard deviation of HR in the first group (14) and S2 is standard deviation of HR in second group (14).

With these values minimum sample size obtained is 31.

For ease of calculations and sake of consistent results, sample size has been taken as 35. There are two groups of 35 each.

Procedure

Following institutional ethical board approval, written informed consent was obtained from patients aged 18 - 60 years, ASA I and II, MPG I and II, scheduled for elective surgical procedures requiring general anaesthesia. Standard anaesthesia monitors including non-invasive blood pressure, pulse oximeter, electrocardiogram, $EtCO_2$ (end-tidal carbon dioxide) and Neuro Muscular monitor –Train of Four (TOF Guard) acceleromyograph monitor were attached. Baseline blood pressure, heart rate(HR) and peripheral oxygen saturation were recorded.

Patients of both group were premedicated with Inj. ondansetron 4 mg, Inj. Ranitidine 50mg 15 minutes before surgery. Inj. Glycopyrrolate 0.005mg/kg, Inj. midazolam 0.05mg/kg, Inj. fentanyl 1 mcg/kg were administered intravenously. Following pre oxygenation for 3 minutes, anaesthesia wasinduced with Inj. propofol 2mg/kg till the disappearance of eyelash reflex. After disappearance of eyelash reflex, supramaximal TOF stimulus was applied to ulnar nerve at the wrist through surface electrodes (stimulation current set at 60 mA) using acceleromyograph after automatic calibration. Baseline TOF ratio percentage was noted. After standardization of supramaximal stimulus intravenous Inj. vecuronium 0.1mg/kg was administered over 5 seconds. After the administration of the muscle relaxant lungs were ventilated with 100% oxygen till the tracheal intubation. In group C patients, tracheal intubation was done after clinical assessment of neuromuscular blockade. In group T patients, tracheal intubation was done after neuromuscular block monitoring by TOF. Patients were monitored continuously using pulse oximetry and automated blood pressure machine was set to record every minute. Timer was started when inj. vecuronium was given to patient and was considered as T0. HR, Mean arterial pressure (MAP), Systolic blood pressure (SBP), Diastolic blood pressure(DBP) was recorded every minute thereafter and was labelled as T1-T6.

In group C intubation was done based on clinical assessment from 1 minute of administration of inj. vecuronium and assessed after 30 seconds thereafter. Based on ease of ventilation, jaw and upperairway tone laryngoscopy and intubation was done. Jaw tone was assessed by trying to open patient's mouth and upper airway tone was assessed by amount of jaw support necessary to maintain a patent airway.

In Group T patients 1 minute after administration of inj. vecuronium electrical stimulation was given with 60 mA and 2 Hz current lasting 0.2 ms and observed for complete loss of all responses to TOF stimulation. Once achieved laryngoscopy and intubation was done.

The tracheal intubation was done with appropriate size of endotracheal tube. The cuff of endotracheal tube was inflated over 5 seconds. The patients with oesophageal intubation were excluded from the study. Thereafter, mechanical lung ventilation was carried out using isoflurane inoxygen:nitrous oxide (50:50) The ventilator parameters were adjusted to maintain end –tidal carbondioxide ranging from 25 to 30 mmhg. Intubation conditions were graded using scoring scale described by Kreig et al [5]. This scale distributes intubating conditions into four classes: excellent, good, poor and inadequate.

Table 1: KREIG Score

Points	1	2	3	4
Vocal Cords	Open	Moving	Closing	Closed
Coughing	None	With Diaphragm	Clear	Severe
Laryngoscopy	Easy	Fair	Difficult	Impossible
Total Score	3-4	5-7	8-10	11-12
Intubating Conditions	Excellent	Good	Poor	Inadequate
Class	1	2	3	4

Results

In this study, Anthropometric parameters like Gender, age, weight, ASA and MPG distributions did not account to any statistical significance. There were 23 female, 12 male in group T and 22 female and 13 male in group C. The mean age was 43.06± 13.75 years in Group T and 39.54± 13.27 years in Group C. Mean weight in Group T was 66.4± 7.28 kg and in Group C 67.8± 7.28 kg. Among the subjects 74.29% in Group T belonged to ASA grade I compared to 85.71% in Group C and 25.71% in Group T belonged to ASA grade 2 compared to 14.29% in Group C. As per MPG, 51.43% had MPG I and 48.57% MPG II in Group T as compared to 54.29% MPG I and 45.71% MPG II in Group C. At T0, T1, T2 time points (i.e., in pre intubation period), the mean HR, were comparable among both the groups (P>0.05). The mean HR were higher in Group C with statistical significance (P < 0.05) at the T3, T4, T5, T6 points of time compared to Group T at same time points. This suggests increased mean HR in Group C when compared to group T after laryngoscopy and tracheal intubation was done.

Table 2: Inter group comparison of Heart Rate

HR										
	Group T				Group C					
Time	Mean	S.D.	Minimum	Maximum	Mean	S.D.	Minimum	Maximum	P-value	Inference
T0	77.06	6.54	64	92	76.26	7.08	64	90	0.6250	NS
T1	80.40	7.09	68	96	79.40	8.38	60	98	0.5918	NS
T2	80.69	7.73	70	101	80.46	8.74	62	98	0.9081	NS
T3	85.17	7.50	72	98	88.54	6.07	80	105	0.0458	S
T4	82.69	7.21	70	96	85.80	5.71	76	100	0.0493	S
T5	80.20	6.18	68	93	83.09	5.69	72	98	0.0460	S
T6	79.83	5.53	69	90	82.31	4.14	74	91	0.0417	S

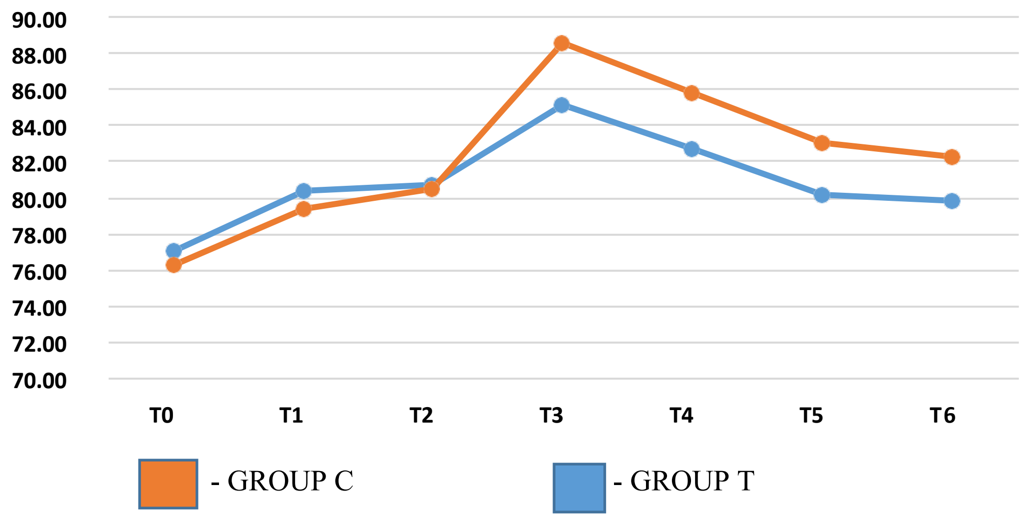

Figure 1: Intergroup comparison of Heart Rate

At T0, T1, T2 time points (i.e., in pre intubation period), the mean MAP were comparable among both the groups (P>0.05). In Group C MAP was higher with statistical significance (P < 0.05) at theT3, T4, T5, T6 points of time compared to Group T at same time points. This suggests increased mean MAP in Group C when compared to group T after laryngoscopy and tracheal intubation was done.

Table 3: Inter group comparison of MAP

MAP										
	Group T				Group C					
Time	Mean	S.D.	MINIMUM	MAXIMUM	MEAN	S.D.	Minimum	Maximum	P value	Inference
T0	95.33	6.17	84.67	106.67	93.75	10.67	70.00	113.33	0.4508	NS
T1	84.42	9.24	60.67	104.00	85.70	9.50	67.33	103.33	0.5708	NS
T2	83.47	7.80	65.33	102.67	85.24	9.45	68.00	103.33	0.3954	NS
T3	88.45	8.40	71.00	107.33	101.91	6.12	93.33	116.33	< 0.0001	HS
T4	88.12	6.90	70.67	104.67	99.92	5.14	89.33	114.67	< 0.0001	HS
T5	88.36	6.98	64.00	104.67	96.79	5.88	82.67	110.00	< 0.0001	HS
T6	88.74	5.48	76.00	104.00	95.10	5.98	79.33	109.33	< 0.0001	HS

At T0, T1, T2 time points (i.e., in pre intubation period), the mean SBP were comparable among both the groups (P>0.05)The mean SBP were higher in Group C with statistical significance (P < 0.05) at the T3, T4, T5, T6 points of time compared to Group T at same time points. This suggestsincreased mean SBP in Group C when compared to group T after laryngoscopy and tracheal intubation was done.

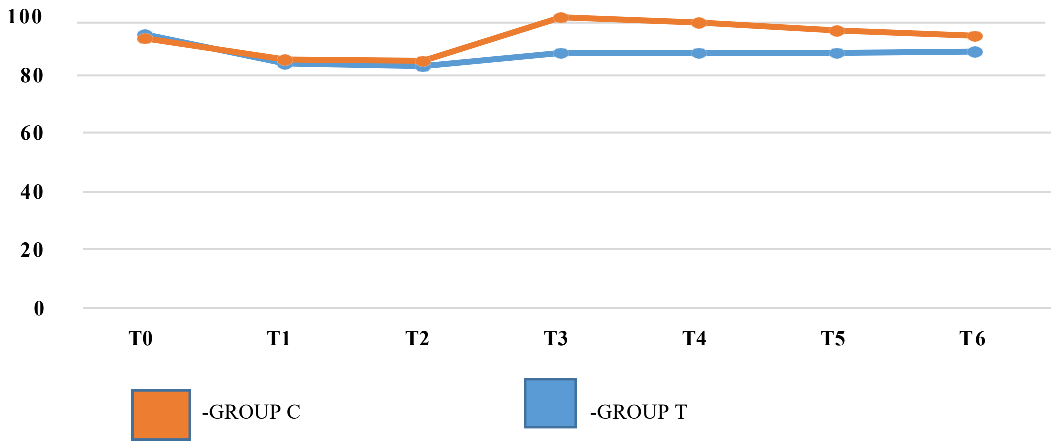

Figure 2: Intergroup comparison of MAP

Table 4: Intergroup comparison of SBP

SBP										
	Group T				Group C					
Time	Mean	S.D.	Minimum	Maximum	Mean	S.D.	Minimum	Maximum	P-value	Inference
T0	126.00	11.98	106	155	123.43	15.83	90	150	0.4462	NS
T1	111.20	14.04	90	143	110.74	15.70	80	135	0.8982	NS
T2	109.60	12.53	90	145	110.80	16.52	80	134	0.7330	NS
T3	117.06	12.79	97	150	136.49	7.87	114	156	< 0.0001	HS
T4	116.89	11.07	94	150	134.97	7.17	120	150	< 0.0001	HS
T5	117.14	10.53	96	154	130.20	9.24	96	150	< 0.0001	HS
T6	118.40	9.00	105	152	128.03	8.30	98	148	< 0.0001	HS

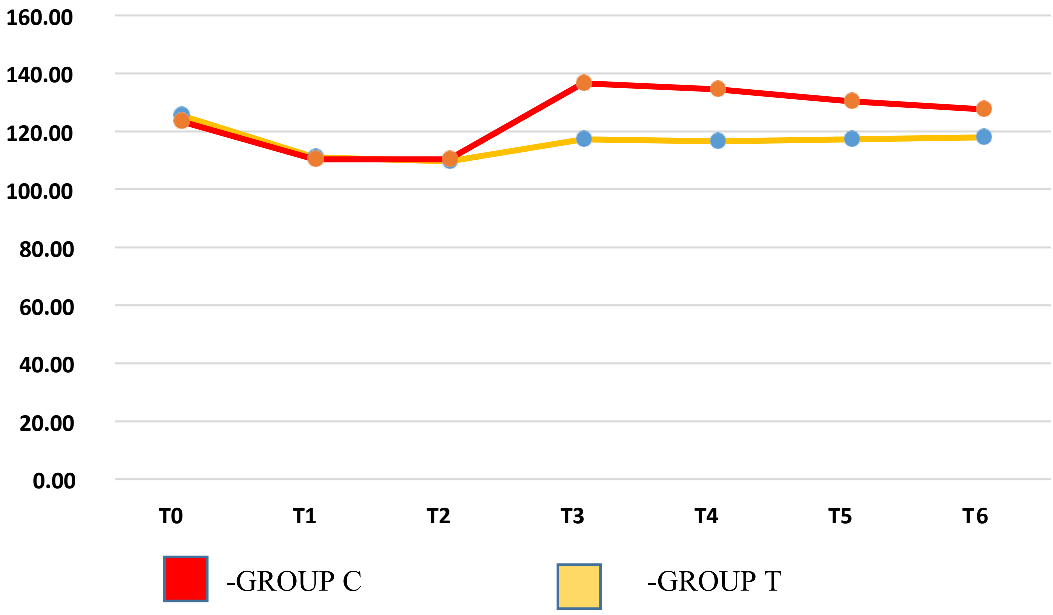

Figure 3: Intergroup comparison of SBP

At T0, T1, T2 time points (i.e., in pre intubation period), the mean DBP were comparable among both the groups (P>0.05)The mean DBP were higher in Group C with statistical significance (P < 0.05) at the T3, T4, T5, T6 points of time compared to Group T at same time points. This suggests increased mean DBP in Group C when compared to group T after laryngoscopy and tracheal intubation was done.

Table 5: Intergroup comparison of DBP

DBP										
	Group T				Group C					
Time	Mean	S.D.	Minimum	Maximum	Mean	S.D.	Minimum	Maximum	P-value	Inference
T0	80.00	5.68	68	90	78.91	9.57	60	100	0.5657	NS
T1	71.03	8.19	45	92	73.17	7.96	60	92	0.2711	NS
T2	70.40	6.92	52	90	72.46	6.78	62	88	0.2135	NS
T3	74.14	7.62	57	94	84.63	7.25	72	103	0.0000	HS
T4	73.74	6.07	59	90	82.40	5.84	72	100	0.0000	HS
T5	73.97	6.68	48	88	80.09	6.12	72	96	0.0002	HS
T6	73.91	5.39	61	86	78.63	6.36	70	95	0.0013	VS

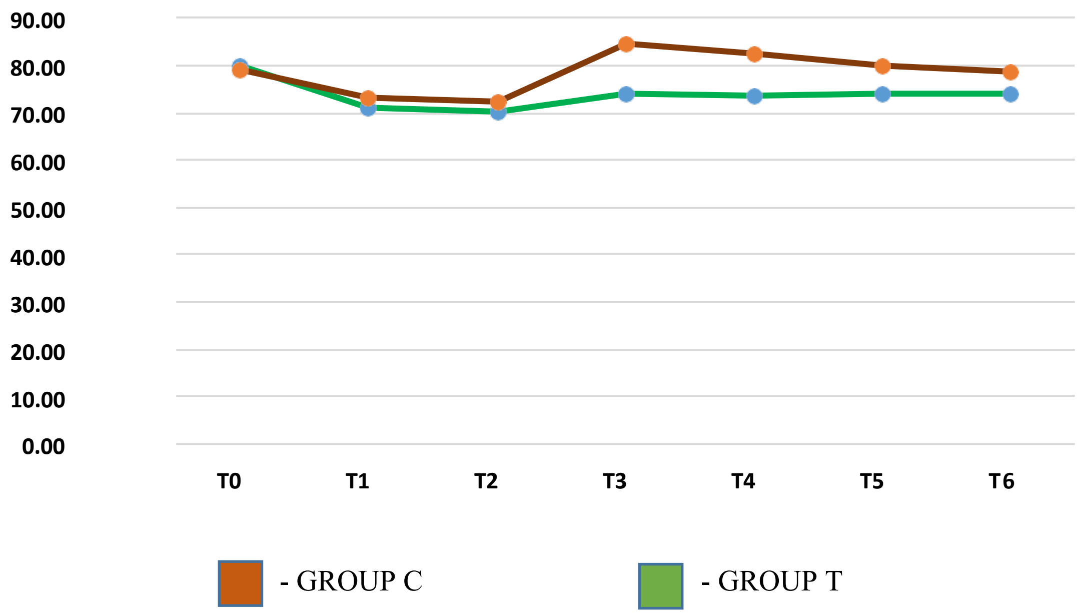

Figure 4: Intergroup Comparison of DBP

Intubating condition in Group T (Excellent - 91.43%, Good – 8.57%) were significantly better than in Group C (Excellent – 57.14%, Good – 42.86%) with P value 0.001. All the patients had Excellentor Good intubating conditions, however, Group T had higher percentage of excellent intubating condition compared to the other group. None of the patients in both the groups had poor or inadequate intubating conditions.

Table 6: Intergroup analysis of scoring of intubating conditions as per Kreig'setal

	Group T		Group C	
	Number	Percentage	Number	Percentage
Excellent	32	91.43	20	57.14
Good	3	8.57	15	42.86
Total	35	100.00	35	100.00
	the p value using chi-square test is 0.0010(vs)			

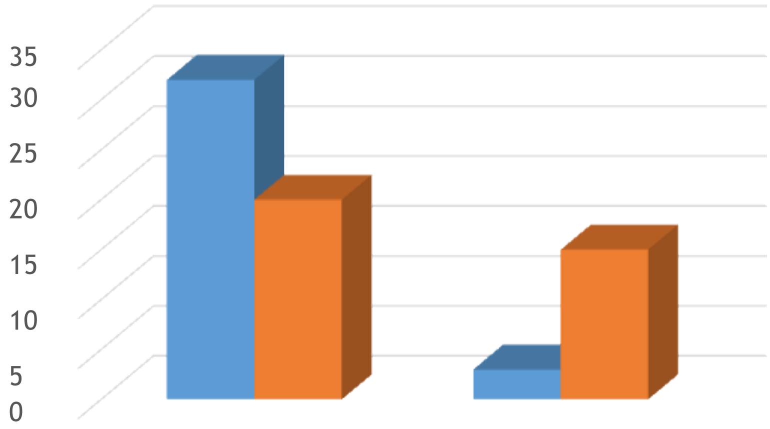

Figure 5: Intergroup analysis of scoring of intubating conditions as per Kreig'setal

Discussion

Laryngoscopy and endotracheal intubation produces significant stressor response and usually these changes are transient and do not produce any significant adverse effects. But in patients of CAD, Hypertensive, with intracranial pathology these changes might lead to myocardial ischemia or secondary brain damage. There are many ways to attenuate the stressor response but pharmacological drugs carry its own adverse effects. Hence, a non-pharmacological measure is important in attenuating these responses. We observed in this study that neuromuscular monitoring-based timing for tracheal intubation produces lesser haemodynamic changes compared to clinical based timing along with better intubating conditions.

Many studies have shown that haemodynamic responses depend on duration of laryngoscopy and ease of intubation. Hence, complete neuromuscular blockade with muscle relaxant is very important to prevent any undue stimulation of sympathetic system and assessment will help in proper timing for intubation. This assessment was done with response to TOF stimulation and complete paralysis has occurred when the TOF count becomes zero. We hadassessed neuromuscular blockade via TOF – Guard in group T and intubation was done whenthe TOF ratio was Zero on TOF electrical stimulation.

Laryngoscopy and endotracheal intubation elicit strong stressor response like sympathetic stimulation by increase in HR and arterial pressure, ECG changes due to central nervous system stimulation.[7] In this study, we have observed that patients in Group C i.e., intubation by clinical based timing have shown higher mean values of mean HR, mean MAP, mean SBP, mean DBP compared to patients in Group T i.e. Intubation by Neuromuscular monitoring based timing (P <0.05). This shows that patients with incomplete paralysis, laryngoscopy and tracheal intubation can produce stronger sympathetic stimulation.

In study by Smith I et al, trachea was intubated after administration of Vecuronium or Rocuronium on basis of clinical assessment of jaw relaxation, airway tone and ease of ventilation comparing with twitch height from baseline.[8] They found that on attempting laryngoscopy after administration of vecuronium, the median twitch height was 8% whereas in Rocuronium the height was 0%. This means on vecuronium administration when laryngoscopy was attempted complete relaxation was not achieved compared to Rocuroniumwhere complete relaxation was achieved on laryngoscopy based on clinical judgment.

Adductor Pollicis muscle was chosen in this study to monitor the neuromuscular block. Study by Debaene B et al showed that in Orbicularis Oculi, the TOF becomes Zero more faster compared to Adductor Pollicis muscle on administration of muscle relaxant and lead to early intubation and unsatisfactory intubating conditions.[9] In studies like Witkowska M et al and Le Corre F et al, where Adductor Pollicis was used, there were more favorable intubating conditions and therefore reduced haemodynamic surge.[10,11] Hence, Adductor Pollicis was chosen for monitoring and being a peripheral muscle was easier to monitor.

Our study compares with nandi et al where they found haemodynamic responses were significantly attenuated when intubation was done with assessment of TOF[12].

This study is in comparison with jankovic r et al,where they compared the impact of differentpatterns of NMB monitoring during endotracheal intubation and found that the HR,SBP,DBPwere significantly higher in clinical assessed group when compared to TOF and single twitchgroup after intubation[13].

We have observed all patients having excellent or good intubating conditions in both the groups. However, 32 out of 35 patients were of excellent intubating condition in TOF group compared to 20 out of 35 in clinical assessment group. Hence, majority showed excellent intubating condition and the moment of intubation was chosen by loss of reaction to TOF stimulation, assessed visually and also by acceleromyography. Many studies have shown 95% to 100% excellent intubating conditions on assessing similarly to reaction on TOF stimulation of the ulnar nerve. [10,11] Thus, this can be considered as a suitable method in assessing optimal conditions for intubation.

Neuromuscular monitoring during endotracheal intubation is not a common practice and is mainly used to monitor the muscle relaxation intraoperatively and to measure any residual paralysis before extubation. Hence, this is a suitable non-pharmacological method which can be used during endotracheal intubation.

Conclusion

In this study, we have observed that neuromuscular block monitoring based endotracheal intubation has lower haemodynamic changes compared to clinical assessment based endotracheal intubation. Also, 91.43% of the patients had excellent intubating conditions in Neuromuscular block monitoring group compared to 57.14% of patients having excellent intubating condition in clinical assessment-based group.

Hence, we conclude that Neuromuscular block monitoring of Adductor Pollicis muscle during general anaesthesia can be a suitable, non-pharmacological method to be used during endotracheal intubation helping us in identifying appropriate time of tracheal intubation along with providing excellent intubating conditions, which attenuates the stressor haemodynamic responses produced due to laryngoscopy and endotracheal intubation.

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