Archives of Anesthesiology and Critical Care (Autumn 2023); 9(4): 338-342.

Available online at http://aacc.tums.ac.ir

Research Article

Comparison of Intubating Conditions on the basis of Neuromuscular Monitoring versus Clinical Assessment Guided Tracheal Intubation: A Randomized Interventional Study

Namita Garg Prajapati, Reema Meena, Adhokshaj Joshi, Ashish Kumar Sharma*

Department of Anesthesiology, SMS Medical College and Hospital, RUHS University, Jaipur, India.

ARTICLE INFO

Article history:
Received 13 September 2022
Revised 27 September 2022
Accepted 15 October 2022

Keywords:
Train of four;
Intubating conditions Krieg's score;
Cormack lehane grading

ABSTRACT

Background: Laryngoscopy and endotracheal intubation have been associated with marked hemodynamic responses and hazards. This study was undertaken with the purpose to compare the intubating conditions when the suitable time for intubation was judged by either clinical assessment or train-of-four monitoring.

Methods: 60 patients without any difficult airway predictors, posted for surgery under general anaesthesia, were randomised into two groups. In Group A patients, the trachea was intubated after train of four counts became zero in adductor pollicis muscle, whereas in Group B patients, intubation was done after clinically judging jaw muscle relaxation. The primary objective was to compare Intubating conditions and mean duration of time between the administration of a neuromuscular blocker and endotracheal intubation. The secondary objectives included number of attempts, changes in hemodynamic parameters. Results were analysed by the Analysis of variance and chi-square tests.

Results: In all Group A patients excellent and good intubating conditions were observed, whereas 25 out of 30 patients (83%) in Group B showed excellent and good intubation conditions. The mean time required for intubation was significantly longer in Group A compared to Group B (369 ± 79 s vs. 191 ± 5 s). HR and mean arterial pressure were significantly higher in Group B as compared to Group A after laryngoscopy and tracheal intubation ($P < 0.05$).

Conclusion: Better intubating conditions and more haemodynamic stability are seen after attaining complete relaxation of laryngeal muscles, as detected by neuromuscular monitoring of adductor pollicis muscle.

Introduction

Laryngoscopy and endotracheal intubation elicits a strong noxious stimulus which leads to unintentional stimulation of sympathoadrenal system. This leads to cardiovascular responses, manifested as changes in blood pressure, heart rate, cardiac rhythm and increased catecholamines [1]. The severity of cardiovascular responses depends on age of patients, type and depth of general anaesthesia, coexisting chronic diseases such as diabetes mellitus, cardiovascular disease, intracranial pathology, hyperreactive airways or any systemic drug use [2]. Other factors include the duration of laryngoscopy, which is expressed as a duration of more than 30 seconds [3] and intubation along with ease of intubation [4]. These hemodynamic responses are less exaggerated if intubation is performed after complete neuromuscular

The authors declare no conflicts of interest.
*Corresponding author.
E-mail address: culnamita@gmail.com

blockade as there will be less stimulation of epipharynx and larynx [5].

As anaesthesiologists mostly commence laryngoscopy and endotracheal intubation based on the 'clinical feel' after a standard set duration of onset of action of neuromuscular blocking agent, which makes clinical judgement subjective and produces less favourable intubation conditions causing more hemodynamic instability [6]. Adequate conditions require an amalgam of hypnosis, complete musclular relaxation and analgesia for endotracheal intubation [7]. Therefore, to avoid undesirable stimulation of sympathetic nervous system, appropriate timing of laryngoscopy and intubation is of vitality to attenuate hemodynamic responses [8–10].

The above study was done to compare intubating conditions on the basis of neuromuscular block monitoring versus clinical assessment guided tracheal intubation.

Statistical Analysis

A sample size of 30 in each group would be required at 95% confidence and 80% power to verify the expected difference of 210 plus minus 101 seconds in time duration taken for intubation in both groups (385 versus 175 seconds) according to previous study [9]. Statistical analysis was performed with SPSS version 21 for windows statistical software package (SPSS inc. Chicago, IL, USA). The categorical data were presented as numbers (percent) and compared using Chi square test. The quantitative data was depicted ± standard deviation and compared by student t test. The significance of statistical analysis was judged by P value and $P<0.05$ was considered as significant.

Methods

Being approved from the institutional ethics committee and registering in the clinical trials registry- India [CTRI/2021/07/035294], this prospective, randomized study was carried out. Patients aged 18–60 years of both sex and belonging to the American Society of Anesthesiologists grade I or II, posted for surgery under general anaesthesia were made a part of this study. Patient refusal, anticipated difficult airway and presence of hepatic, renal, cardiovascular, neurological or muscular disease, any preoperative medicine within last 72 hours that interferes with neuromuscular transmission and more than three attempts of intubation were the exclusion criterias. A written informed consent was obtained and a standard protocol for nil per oral status was followed.

Standard monitoring like automated non-invasive blood pressure, pulse oximeter, electrocardiogram and neuromuscular monitor {Train of Four (TOF) watch}, bispectral (BIS) index monitor were attached and baseline parameters were noted. Peripheral venous line was checked. Premedication was done with inj. Metaclopramide 10mg, inj. Glycopyrrolate 0.004mg/kg, inj. Midazolam 0.01mg/kg, inj. Fentanyl 2mcg/kg intravenously. After pre-Oxygenating for 3 minutes, anaesthesia was induced with inj. Etomidate 0.3mg/kg intravenously. Following this, 0.1mg/kg inj. Vecuronium was given over 5 seconds. After administration of drugs patients were efficiently ventilated with 100% oxygen, maintaining a BIS score of 40–60 till the tracheal intubation. In group A, the neuromuscular block monitoring was done by observing the thumb adductor response to stimulation of ulnar nerve at the wrist with the a current of 60mA, 2Hz current each stimulus lasting 0.2 ms induced by peripheral nerve stimulator after 1 minute of relaxant and then every 30 seconds (TOF count became zero) and intubation was then attempted after complete loss of all 4 responses to TOF stimulation assessed visually. In group B, moment for intubation was judged by clinical assessment, starting 1 minute after giving muscle relaxant and at every 30 seconds which was based on ease of ventilation, jaw and upper airway tone. Jaw tone was assessed by the ability to open the patient's mouth whereas jaw support vital to maintain a patent airway determined the upper airway tone. The trachea was intubated with endotracheal tube and cuff inflated over 5 s. The time from administration of vecuronium to the tracheal intubation and cuff inflation was noted. The patients who were encountered with oesophageal intubation were excluded from the study.

Surgery was allowed to proceed and anaesthesia maintained with 66% nitrous oxide, 33% oxygen and sevoflurane mixture. End tidal carbon dioxide was maintained in the range of 35 to 40mmHg. Inj. Vecuronium 0.015mg/kg, fentanyl 30mcg given to maintain hemodynamic indices within 20% of the baseline value intraoperatively.

The primary outcome was to compare intubation conditions which were assessed on the basis of Krieg's score ranging from 3 (favorable intubating conditions) to 12 (worst intubating conditions) and the time taken from administration of vecuronium to end of intubation and inflation of sealing cuff. The secondary outcomes included number of attempts and changes in hemodynamic parameters. Cormack-Lehane (CL) grading was also assessed to grade laryngoscopic views.

Results

All 60 subjects included in this study were analysed. The demographic data among both the groups were comparable and statistically insignificant ($p>0.05$) (Table1).

Table 1- Demographic data

Parameter	Group A(n=30)	Group B(n=30)	P value
Age (years)	38.8±13.85	40.3±11.69	0.652
Gender (female/male)	12/18	11/19	0.701
Weight (kg)	51.47±7	51.77±7	0.812

Mallampati class (I/II)	12/18	10/20	0.591
Thyromental distance (cm)	6.77±0.36	6.90±0.35	0.168
ASA grade (I/II)	11/19	12/18	0.791

Significantly better intubating conditions were seen in group A as compared to group B (P<0.02). The mean time from administration of vecuronium to tracheal intubation was significantly longer in Group A in comparison to Group B (P<0.0001). The CL grading was more favourable in Group A as compared to Group B (P= 0.01). Intubating score was better in Group A as compared to Group B (P = 0.03). Krieg's score 3 and 4 are taken as favourable intubating conditions (Table2).CL: Cormack Lehane grading.

Table 2- Study parameters

Parameters	Group A(n=30)	Group B(n=30)	P value
Intubating condition score/Krieg's score (3:4:5:6)	26:4:0:0	15:10:3:2	0.03(s)
Mean time from administration of neuromuscular blocker to tracheal intubation (s)	369±79 s	191±5 s	0.0001(s)
Cl grading (1:2:3:4) (n)	26:2:1:1	20:6:3:1	0.01(s)

The mean HR and mean arterial pressure were significantly higher in Group A in comparison to Group B post intubation.

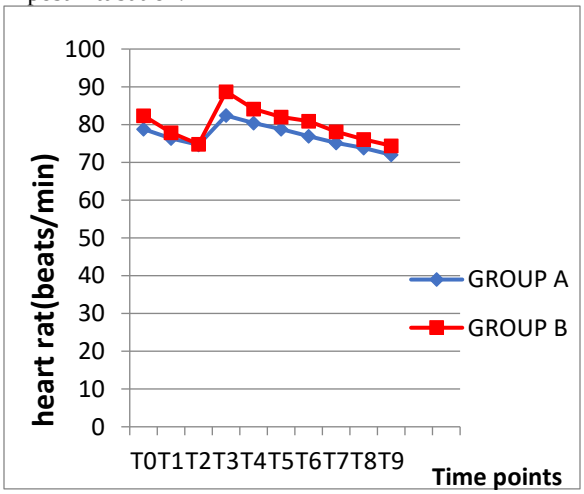

Figure 1- Mean heart rate (beats/min) are plotted in vertical axis and time axis are plotted in horizontal axis

T0- baseline data, T1 – immediate after vecuronium administration, T2- 1 min after vecuronium administration, T3- after inflation of cuff, T4- 1 min postintubation, T5- 2 min postintubation, T6- 3 min postintubation, T7- 5 min postintubation, T8- 8 min postintubation, T9- 10 min postintubation.

Above line diagram shows increase in heart rate in both the groups from T2 (1 minute after vecuronium administration) to T3 (after inflation of cuff following intubation). But the extent of rise of was more appreciable in clinical group (group B) than the neuromuscular monitoring group (group A).

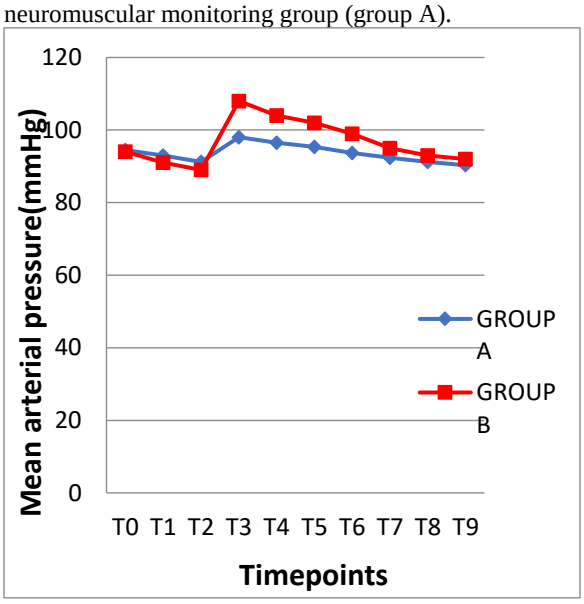

Figure 2- Mean arterial pressure (mmHg) are plotted in vertical axis and time points are plotted on horizontal axis

There was increase in mean arterial pressure from T2 (1 minute after vecuronium administration) to T3 (after inflation of cuff). But the rise in mean arterial pressure was more significant in clinical group (group B) than the neuromuscular monitoring group (group A).

Pre-intubation, the mean HR and mean arterial pressure were comparable amongst the groups (P> 0.05) (Figures 1-2). Intragroup analysis demonstrated increase in HR and mean arterial pressure post intubation in both groups A nd B which was statistically significant. However, level of increase in HR and mean arterial pressure were significantly lower and of transient nature in neuromuscular monitoring group and then the clinical assessment group (P<0.05).

Discussion

In the following study, use of neuromuscular monitoring to guide tracheal intubation produced better intubating conditions, laryngeal view and lesser

hemodynamic instability as opposed to clinical assessment guided intubation.

Laryngoscopy followed by intubation causes intense sympathetic nervous system stimulation which causes striking changes in hemodynamic parameters and intracranial pressures [1,11-12] accompanied by catecholamine release [10,13] which causes increase in heart rate, arterial pressure, motor response, central nervous system stimulation with a characteristic electroencephalographic evidence of increased alpha and decreased delta power [14]. These effects are shortlived but sometimes can proceed to arrhythmias, myocardial ischemia [1,12] and cerebral haemorrhage [15].

Many pharmacological interventions have been used to blunt this exaggerated hemodynamic instability [16-17]. This response is also dependent on laryngoscopy and intubation duration [6] and ease of intubation [4]. Another way, to avoid undue responses is to achieve adequate muscle relaxation which is a type of non-pharmacological intervention [9-10,18]. Thus, assessment of neuromuscular blockade is important before tracheal intubation. It can be achieved when laryngeal muscles are completely paralysed (TOF count zero), which decided the timing of tracheal intubation in neuromuscular monitoring group.

In this study, intubation was done after mean time of 191s of vecuronium administration in clinical group and excellent/good intubating conditions were found in 83% patients as compared to the train of four group where intubation was carried out after a mean time of 369s and excellent/good conditions were found in all the patients which were statistically significant ($p<0.0001$). Also, more fluctuations in mean heart rate and mean arterial pressure were observed in patients intubated on the basis of clinical judgement as compared to those with TOF monitoring which were significant ($P<0.05$). The previous studies implicated the use of neuromuscular block monitor to guide tracheal intubation for producing better intubating conditions and less hemodynamic surge as more length of time would be available between administration of neuromuscular blocking agent and adequate relaxation of respiratory muscles [8–10].

In a study where tracheal intubation was done using two techniques using train of four monitoring and clinical assessment with cisatracurium, it was concluded that the mean time for intubation was statistically significantly more (339.3±73.7s) in neuromuscular monitoring group than (162.3±35s) in clinical assessment group ($P<0.05$) [8]. In another study, the vecuronium or rocuronium was used to intubate trachea on the basis of clinical assessment. Twitch height at the same time was also noted in comparison to baseline. Median twitch height value of 8% was achieved in vecuronium group when laryngoscopy was attempted, as compared to median twitch height of 0% in patients who received rocuronium. It also shows that time to laryngoscopy and intubation was 89±20s and 119±28s respectively in the rocuronium group compared with 110±26s and 142±32s in vecuronium group respectively. Less favorable intubating conditions were observed with vecuronium as clinical judgement underestimated the time required for its adequate onset of action [6]. Studies shows that excellent conditions could be produced in 95-100% patients where intubation was attempted after complete loss of reaction to supramaximal TOF stimulation of the ulnar nerve as assessed visually or by accleromyography [8-9,19]. Recently a study was done where intubation was done when TOF count became zero in orbicularis oculi muscle after administration of vecuronium and found that the mean time for onset of its action was 116.66±55.37s but favourable conditions were found only in 70% patients [20]. In another study, intubation intubation was tried after 175s of vecuronium administration and excellent/good intubating conditions were seen in 70%. In neuromuscular group, intubation was attempted after a mean time of 385s of vecuronium administration, excellent and good intubating conditions were found in 100% of patients [9].

We chose Adductor pollicis muscle neuromuscular block monitoring. Various studies show that TOF count becomes zero after administration of neuromuscular blocker earlier in orbicularis oculi [21-22] when compared to adductor pollicis which leads to early intubation, producing unsatisfactory intubation conditions [20,23]. Also, being a peripheral muscle adductor pollicis was easily monitored.

Use of neuromuscular monitor during endotracheal intubation is an uncommon practice. It is used to assess muscle relaxation intraoperatively and to assess residual paralysis before extubation. Hence, it requires more research during intubation. A limitation of the study is that as anaesthesiologists mostly commence laryngoscopy and endotracheal intubation after a standard set duration of onset of action of neuromuscular blocker, which makes clinical judgement subjective and produces less favourable intubation conditions causing more hemodynamic instability.

Conclusion

We concluded that neuromuscular monitoring during tracheal intubation produces better intubating conditions and more hemodynamic stability as intubation was done after achieving complete relaxation of laryngeal muscles as detected by TOF monitoring of adductor pollicis muscle. The mean time from administration of vecuronium to onset of relaxation was longer in neuromuscular group in comparison to clinical group. The clinical method underestimated the onset of action of vecuronium which produced less favorable intubating conditions.

References

[1] King BD, Harris LC, Greifenstein FE, Elder JD, Dripps RD. Reflex circulatory responses to direct laryngoscopy and tracheal intubation performed during general anaesthesia. Anesthesiology. 1951; 12(5):556–66.

[2] Kovac AL. Controlling the hemodynamic response to laryngoscopy and endotracheal intubation. J Clin Anesth. 1996; 8(1):63–79.

[3] Morgan JM, Barker I, Peacock JE, Eissa A. A comparison of intubating conditions in children following induction of anaesthesia with propofol and suxamethonium or propofol and remifentanil. Anaesthesia. 2007; 62(2):135–9.

[4] Angelard B, Debry C, Planquart X, Dubos S, Dominici L, Gondret R, et al. [Difficult intubations. A prospective study.] Ann Oto-Laryngol Chir Cervico Faciale. 1991; 108(4):241–3.

[5] Shribman AJ, Smith G, Achola KJ. Cardiovascular and catecholamine responses to laryngoscopy with and without tracheal intubation. Br J Anaesth. 1987; 59(3):295–9.

[6] Smith I, Saad RS. Comparison of intubating conditions after rocuronium or vecuronium when the timing of intubation is judged by clinical criteria. Br J Anaesth. 1998; 80(2):235–7.

[7] Punj J, Misra P, Pandey R, Darlong V. Earlier Endotracheal Intubation by Entropy Guidance Versus Neuromuscular Monitoring. Arch Neurosci. 2019; In Press.

[8] Witkowska M, Karwacki Z, Wierzchowska J, Bukowski P. [Neuromuscular block monitoring for optimisation of conditions for endotracheal intubation]. Anestezjol Intensywna Ter. 2009; 41(3):140–4.

[9] Nandi R, Basu SR, Sarkar S, Garg R. A comparison of haemodynamic responses between clinical assessment-guided tracheal intubation and neuromuscular block monitoring-guided tracheal intubation: A prospective, randomised study. Indian J Anaesth. 2017; 61(11):910–5.

[10] Janković RJ, Stojanović MD, Marković DZ, Cvetanovic VA, Z.Vuković A, N.Nikolić A, et al. Impact of Different Stimulation Patterns of Neuromuscular Blockade Monitoring and Clinical Assessment on Intubation Time and Intensity of Hemodynamic Response During Rocuronium Induced Endotracheal Intubation [Internet]. 2020 [cited 2021 Oct 29]. Available from: https://www.signavitae.com/articles/10.22514/sv.2020.16.0011

[11] Smith P, Smith F, Becker P. Haemodynamic response to laryngoscopy with and without tracheal intubation. South Afr J Anaesth Analg. 2008; 14(3):23–6.

[12] Wycoff CC. Endotracheal intubation: effects on blood pressure and pulse rate. Anesthesiology. 1960; 21:153–8.

[13] Della Rocca G, Iannuccelli F, Pompei L, Pietropaoli P, Reale C, Di Marco P. Neuromuscular block in Italy: a survey of current management. Minerva Anestesiol. 2012; 78(7):767–73.

[14] Rundshagen I, Schröder T, Prichep LS, John ER, Kox WJ. Changes in cortical electrical activity during induction of anaesthesia with thiopental/fentanyl and tracheal intubation: a quantitative electroencephalographic analysis. Br J Anaesth. 2004; 92(1):33–8.

[15] Prys-Roberts C, Greene LT, Meloche R, Foëx P. Studies of anaesthesia in relation to hypertension. II. Haemodynamic consequences of induction and endotracheal intubation. Br J Anaesth. 1971; 43(6):531–47.

[16] Safavi M, Honarmand A. Attenuation of cardiovascular responses to laryngoscopy and tracheal intubation--intravenous sufentanil vs pethidine. Middle East J Anaesthesiol. 2008; 19(6):1349–59.

[17] Fassoulaki A, Melemeni A, Paraskeva A, Petropoulos G. Gabapentin attenuates the pressor response to direct laryngoscopy and tracheal intubation. Br J Anaesth. 2006; 96(6):769–73.

[18] Gibbs NM, Harrison BA. The effect of the depth of neuromuscular blockade on the haemodynamic response to tracheal intubation. Anaesth Intensive Care. 1991; 19(1):92–5.

[19] Sharma A, Chittora SP. A Comparison of Haemodynamic Responses Between Clinical Assessment-guided Nasotracheal Intubation and Neuromuscular Block Monitoring-guided Nasotracheal Intubation: A Prospective, Randomised Study, Paripex Indian Journal Of Research (PIJR). 2018; 7(10).

[20] Parasa M, Vemuri NN, Shaik MS. Comparison of equipotent doses of rocuronium and vecuronium. Anesth Essays Res. 2015; 9(1):88–91.

[21] Debaene B, Beaussier M, Meistelman C, Donati F, Lienhart A. Monitoring the onset of neuromuscular block at the orbicularis oculi can predict good intubating conditions during atracurium-induced neuromuscular block. Anesth Analg. 1995; 80(2):360–3.

[22] D'souza J, Sharma SV. Monitoring the onset of neuromuscular block for predicting intubating conditions. Indian Journal of Anaesthesia. 2006; 50(1):32-4.

[23] Haller G, Gardaz JP, Bissonnette B. [Assessment of intubation time and conditions under the influence of rocuronium]. Can J Anaesth J Can Anesth. 1998; 45(4):312–6.