



MEDICAL SCIENCES

# COMPARISON BETWEEN ADDUCTOR POLLICIS AND ORBICULARIS OCULI AS INDICATORS OF ADEQUACY OF MUSCLE RELAXATION FOR TRACHEAL INTUBATION FOLLOWING ROCURONIUM INDUCED NEUROMUSCULAR BLOCK: RANDOMIZED COMPARATIVE CLINICAL TRIAL

S.N. Suresh\* and Naveen G Singh

Department of Anaesthesiology, KLE University's Jawaharlal Nehru Medical College, Belgaum- 10, India

## Abstract

**Background:** The purpose of this study was to verify which muscle among the Adductor Pollicis (AP) and Orbicularis Oculi (OO) is a better predictor of optimal intubating condition after administration of Rocuronium.

**Methods:** In this prospective, double blind, randomized study, 80 adult ASA –I and ASA – II undergoing general anaesthesia with tracheal intubation were allocated to two groups (n = 40) according to the reference muscle (AP or OO) used to determine the appropriate intubation time. Induction of anaesthesia was achieved with Inj Thiopentone 5mg/kg, Inj Fentanyl 2 mcg/kg and Inj Rocuronium 0.6mg/kg for muscle relaxation. Supramaximal Train Of Four (TOF–Guard acceleromyograph, neuro muscular monitor) stimulation of the ulnar nerve and facial nerve every 15 secs was used to monitor the neuromuscular block. After Train Of Four responses disappeared at Adductor Pollicis muscle or Orbicularis Oculi muscle, tracheal intubation and quality of intubation assessment was performed by an independent anaesthesiologist. Intubating conditions were scored on a Kreig et al scale.

**Results:** Onset time at Orbicularis Oculi was significantly shorter than Adductor Pollicis muscle (P < 0.001), but adequate intubating condition were significantly increased in the Adductor Pollicis (Excellent – 87.5%, Good – 12.5%, Poor – 0%) compared with Orbicularis Oculi (Excellent – 27.5%, Good – 45%, Poor – 27.5%) after a dose of 0.6mg/kg of Rocuronium (P < 0.001)

**Conclusion:** After administration of Rocuronium, twitch monitoring at Orbicularis Oculi allows a faster intubation but is associated with an unacceptable incidence of inadequate intubating condition. Adequate intubating conditions were observed with Adductor Pollicis muscle. Hence Monitoring neuromuscular activity of the Adductor Pollicis using Train of Four to determine the appropriate tracheal intubation time and condition is more clinically relevant than monitoring the Orbicularis Oculi muscle.

**Keywords:** Intubating conditions, Neuro Muscular Blockade Monitoring, Orbicularis Oculi, Adductor Pollicis, Rocuronium, Train of Four, Acceleromyography

## Introduction

General Anaesthesia is most common anaesthetic technique used in anaesthesia practice in which securing and maintaining a patent airway is a vital aspect for anaesthesiologist to provide adequate oxygenation and ventilation<sup>1</sup> which is achieved using Endo Tracheal intubation. 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 trauma<sup>2</sup>. Onset time differs from one muscle to another. Neuro muscular block is faster at diaphragm, masseter, adductor muscles of larynx and orbicularis of the eye as compared to adductor pollicis (AP) after injection of a bolus dose of non depolarizing muscle relaxant<sup>3,4,5</sup>. There has been discrepancies as to which muscle is better predictor for intubating conditions between Orbicularis Oculi and Adductor Pollicis. Studies states that Orbicularis Oculi (OO) and laryngeal adductor

muscles have similar onset time, Sensitivity to muscle relaxants and recovery profile<sup>3,6</sup>, hence is a better predictor of intubating condition<sup>7,8,9</sup>. Where as other studies have shown monitoring Adductor Pollicis to determine tracheal intubating condition is more clinically relevant than monitoring Orbicularis Oculi muscle.<sup>10,11</sup> using Train of Four (TOF) watch Acceleromyography, neuro muscular monitor. Visual monitoring is a less objective method of measurement than the continuous monitoring and registration of the evoked mechanical or electromyographic response<sup>12</sup>.

Aim of the study was to determine whether monitoring Orbicularis Oculi (OO) or Adductor Pollicis (AP) could predict adequate intubating conditions after giving Non- depolarizing muscle relaxant, Inj Rocuronium 0.6mg/kg in adults using Train Of Four (TOF) Guard acceleromyographic (Organon-Teknika, Belgium) response and to compare the Acceleromyographic estimation of early onset of complete Neuro Muscular blockade (NMB) at

\* Corresponding Author, Email: dr\_snsuresh@yahoo.com

Orbicularis oculi (OO) muscle and Adductor pollicis (AP) muscle.

**Methodology**

After obtaining institutional ethics committee's approval and written informed consent, 80 ASA grade I and II patients aged 18 – 60 yrs, posted for elective surgeries were enrolled for the study. Exclusion criteria were abnormal airway, CVS, Respiratory, neuromuscular, hepatic and renal diseases or concurrent administration of any drug interfering with neuromuscular transmission. Patients were randomly divided into two groups of each, Group OO (Orbicularis Oculi) and Group AP (Adductor Pollicis) using computer generated randomization table. In the operating room, patients were attached to pulse oximeter, ECG, non invasive blood pressure monitor and Neuro Muscular monitor -Train of Four (TOF – Guard) acceleromyograph monitor.

Patient was pre-oxygenated with 100% oxygen for 3 mins using face mask. Anaesthesia induced with Inj Thiopentone 5mg/kg and Inj Fentanyl 2 microg/kg I.V. IPPV was given using face mask with 100% oxygen until tracheal intubation. After induction, surface electrodes were applied over the ulnar nerve at wrist (to stimulate AP) and facial nerve, near orbit i.e anterior to ear lobe (to stimulate OO) and connected to respective TOF(Train Of Four) Guard

acceleromyograph monitor. Neuro Muscular monitoring done using Train Of Four(TOF) GUARD acceleromyograph (Organon-Teknika, Belgium). Both nerves were stimulated with Train of Four (TOF) stimulation (a series of four twitches in 2 sec, 2 Hz frequency, each 0.2ms long) every 15 secs after loss of the eyelash reflex. Current intensity of 20mamps for facial nerve and 50 mamps for ulnar nerve were used. The evoked responses at thumb and around the orbit were recorded using (Train of four) TOF - GUARD acceleromyograph.

Patients in each group were given Inj Rocuronium 0.6mg/kg injected over 10secs. Onset of neuro muscular block was defined as the interval between the administration of rocuronium injection and complete disappearance of all four TOF responses. Intubation was performed when all four TOF responses from OO muscle was abolished in OO group. In Group AP intubation was performed when AP was completely blocked, i.e all four TOF responses from AP muscle was disappeared, selection of muscle group was randomly done. Intubation was performed by an independent Anaesthesiologist within 10secs, who was blinded about patient grouping and the time course of NMB, not involved in Anaesthesia technique and was unaware about NMB agent's dose and observations. Intubation conditions were graded using scoring scale described by Kreig et al<sup>9</sup>. (Table – 1)

Table 1: Intubation conditions graded using scoring scale described by Kreig et al.

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
Class	I	II	III	IV
Intubating condition	Excellent	Good	Poor	Inadequate

Sample size was calculated as Total = 80 ( 40 in each group) with 90% power with Alpha error = 0.05, B error = 0.1, Z alpha = 1.96, Z beta = 1.28. Paired student t – test was used to compare the onset time at Orbicularis Oculi and Adductor Pollicis muscle within each group. Chi square test with Yate's correction and / or Fisher Exact test was used to compare intubating condition between the two groups. Probability values < 0.05 are considered significant.

**Results**

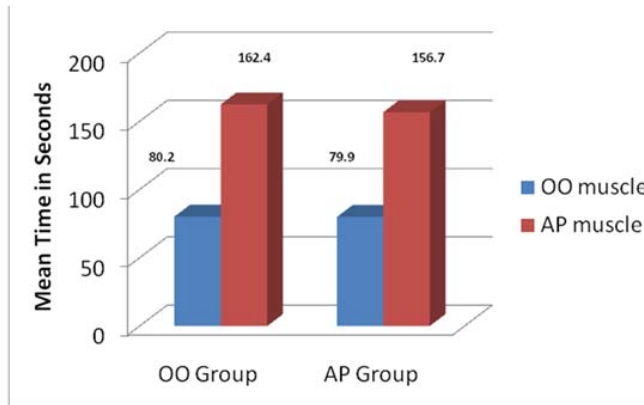
Demographic data were similar between the two groups (Table -2). Onset time was shorter at OO (Orbicularis oculi muscle) than at the AP (Adductor pollicis) muscle in both group i.e 80.2 +/- 26.21 seconds in OO muscle Vs 162.4 +/- 37.80 seconds in AP muscle for OO group in which intubation was done when Orbicularis oculi muscle was blocked and 79.9

+/- 19.03 seconds in OO muscle Vs 156.7 +/- 29.21 seconds in AP muscle for AP group in which intubation was done when AP muscle was blocked (P = <0.001) (Table – 3, Figure – 1). The onset time at the same muscle did not differ significantly between the two groups.

In group OO complete blockade was achieved 82.2 +/- 22.27 seconds earlier at Orbicularis Oculi muscle than at Adductor Pollicis muscle. Similarly in Group AP, Orbicularis Oculi muscle was blocked 76.8 +/- 21.26 seconds earlier than at Adductor Pollicis muscle.

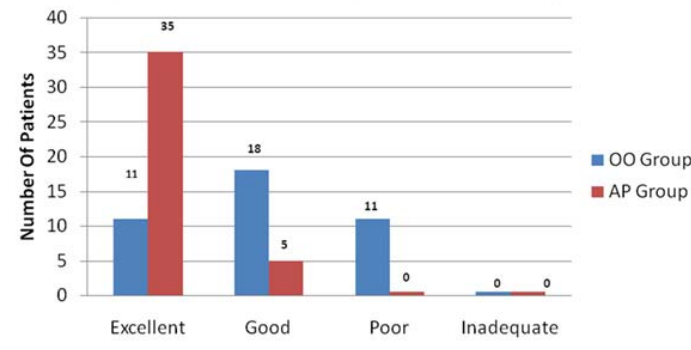
Intubating condition after Inj. Rocuronium 0.6 mg/kg in the Adductor Pollicis group (AP Group) (Excellent – 87.5%, Good – 12.5%, Poor – 0%) were significantly better than in the Orbicularis Oculi group (OO Group) (Excellent – 27.5%, Good – 45%, Poor – 27.5%) → P = <0.001. (Table :- 4, Figure :- 2)

Fig. 1: comparison of onset time between the two muscles



OO = Orbicularis Oculi  
AP = Adductor Pollicis

Fig. 2: Comparison of intubating condition between two groups



OO = Orbicularis Oculi  
AP = Adductor Pollicis

Table 2: Demographic Data

Group	Age (Yrs)	Weight (Kgs)	Sex (M/F)	ASA (I/II)
OO group	38.7 ± 13.11	66.4 ± 7.8	26/14	32/8
AP Group	39.9 ± 14.26	67.8 ± 7.28	24/16	31/9
P Value	> 0.05	> 0.05	> 0.05	> 0.05

OO = Orbicularis Oculi  
AP = Adductor Pollicis  
ASA = American Society of Anaesthesiologist

Table 3: Comparison of onset time between the two muscles

Group	Onset Time	Mean Time ± S.D (Seconds)	Significance
OO Group	Onset at OO Muscle	80.2 ± 26.21	t = 23.322
	Onset at AP Muscle	162.4 ± 37.80	P = 0.000 (< 0.001)
AP Group	Onset at OO Muscle	79.9 ± 19.03	t = 22.865
	Onset at AP Muscle	156.7 ± 29.21	P = 0.000 (< 0.001)

OO = Orbicularis Oculi  
A.P = Adductor Pollicis  
S.D = Standard Deviation

Table 4: Comparison of intubating condition between two groups

	Excellent	Good	Poor	Inadequate	Total
OO Group	11 (27.5%)	18 (45%)	11 (27.5%)	0	40
AP Group	35 (87.5%)	5 (12.5%)	0	0	40

Excellent Intubating condition :- Chi square = 30.870, P = 0.000 (<0.001)

Excellent + Good Intubating condition :- Fisher Exact test, P = 0.000 (< 0.001) / Chi square with Yate's correction = 10.540, P = 0.000 (< 0.001)

OO = Orbicularis Oculi

AP = Adductor Pollicis

## Discussion

This study demonstrates, which of the two muscles between Adductor Pollicis and Orbicularis Oculi monitoring, following Rocuronium 0.6mg/kg induced neuromuscular block will predict the presence of adequate tracheal intubating condition. For onset of action, monitoring at the eye muscles correlates better with onset and degree of neuro muscular block at the larynx.

In a randomized clinical trial done by Haller et al, patients receiving thiopentone and fentanyl, onset time after administration of a dose of 0.9mg/kg of Rocuronium at the OO was shorter (110 secs) than that at the AP (144 secs) but excellent intubating condition were observed significantly more with AP (95%) compared to OO group (65%)<sup>11</sup>. Cessation of response of the OO muscle did not guarantee satisfactory intubating condition.

In another randomized study done by H.J Lee et al, compared Adductor Pollicis, Orbicularis Oculi and Corrugator Supercilii as indicators of adequacy of muscle relaxation for tracheal intubation using Remifentanil 0.5micro gram /kg/min for 2 min followed by Propofol 2 to 2.5mg/kg and Using TOF –watch (Train of Four) acceleromyograph to guide onset time for Intubation after giving two doses of Rocuronium 0.6mg/kg and 1.0 mg/kg.<sup>10</sup> They concluded that Orbicularis oculi had faster intubation time but associated with inadequate intubating condition. (Excellent being 32%, good 62% and poor 6%) as against Adductor pollicis (Excellent 87% and good 13%).

In our study excellent intubating condition after Inj. Rocuronium 0.6mg/kg was 87.5% in Adductor Pollicis (AP) group, close value as the above two studies, but after a long delay in onset of neuro muscular blockade as compared to Orbicularis oculi. Excellent intubating conditions was 27.5% and poor intubating condition was also 27.5% with bucking and coughing which can be associated with an increased risk of laryngeal trauma and post operative sore throat<sup>13</sup> in Orbicularis Oculi (OO) group. This does contradict<sup>12</sup> previous

study, which says Orbicularis Oculi is more resistant in terms of maximum blockade and its sensitivity is similar to that of laryngeal adductor muscles.<sup>5</sup>

The sensitivities of Orbicularis Oculi were different, with comparable maximum effects with that of the laryngeal adductor muscles.<sup>12</sup> But in my study after 0.6mg/kg dose of Rocuronium rapidly produced a complete block at the OO, where as laryngeal and diaphragm blocks were still incomplete.

This study confirms the findings of previous studies showing that complete relaxation of the Orbicularis Oculi precedes complete relaxation of the laryngeal muscles and diaphragm. Using Orbicularis Oculi relaxation as a guide to adequacy of relaxation for intubation will thus result in an unacceptable incidence of inadequate intubating condition and cannot be recommended.

The faster onset of Neuro muscular blockade at Orbicularis Oculi compared to Adductor Pollicis might be due to differences in circulation time and muscle blood flow.<sup>3,14</sup> Muscles which are closer to the central circulation like Orbicularis Oculi or diaphragm have relatively greater perfusion and tend to be paralyzed more rapidly than the peripheral muscles like Adductor Pollicis.<sup>9</sup>

Neuro muscular blocking drugs affect small, rapidly moving skeletal muscles before those of abdomen. Onset of neuro muscular blockade after administration of non depolarizing muscle relaxant is more rapid but less intense at laryngeal muscles than peripheral muscle like adductor pollicis muscle. The sparing effects of Non depolarizing muscle relaxant at laryngeal muscles may be due to role of skeletal muscle fiber types. Muscles involved in closure of glottis have fast contraction times, where as adductor pollicis is composed mainly of slow fibers. The density of acetyl choline receptors is greater in fast than in slow contraction fibers. It is likely that more receptors need to be occupied to block a fast muscle than a slow muscle. More rapid onset at vocal cords than at adductor pollicis suggests more rapid equilibration between plasma concentration and those at the airway

muscles when compared with adductor pollicis muscle.<sup>15</sup>

Factors that determine the sensitivity to neuro muscular blocking drugs of a given muscle or group of muscles are poorly understood. It may depend on type of fibers<sup>5,16</sup> that make of a muscle because the morphology of neuro muscular junction is different whether the muscle fiber is classified as red (slow), intermediate or white (fast)<sup>5,17</sup>. It has been suggested that slow fibers are more sensitive to NDMR although this not been constant finding.<sup>5,16&18</sup> Orbicularis oculi is made up of small, round and 89% fast twitch type 2 fibres.<sup>19</sup> Adductor Pollicis is made up of slow oxidative type of fibers.<sup>5,20</sup>

Based on above Orbicularis oculi has to be better indicator for intubation earlier than adductor pollicis. My study results has been similar to other studies which have shown orbicularis oculi is not a adequate indicator for intubation.<sup>10,11,12&21</sup>

Circulatory factors determine the distribution of NMB agents from site of injection to different muscles. Thus muscle perfusion and consequently onset of NMB, may be affected by haemodynamic effects of I.V anaesthetic agents.<sup>22</sup> Many factors including depth of anesthesia, determine adequate intubating condition. Autonomic and arousal responses to laryngoscopy and tracheal intubation was blunted by optimizing the combination of hypnotics and analgesia drugs during induction.<sup>23</sup> No patients had recall and no dangerous tachycardia or hypertension was observed. Inhalation agents were avoided because of there possible interaction with rocuronium.<sup>24</sup>

Most of the previous studies have used visual estimation of complete neuro muscular block by evaluating area around the eye. Owing to the fact that all studies used visual estimation of the onset of NMB , a subjective element renders the comparison between these studies difficult. Visual monitoring is a less objective method of measurement than continuous monitoring and registration of the evoked mechanical or electromyographic response. Neuromuscular responses to rocuronium by acceleromyography recorded at the OO and AP are similar sensitive.<sup>12</sup> Therefore acceleromyography (TOF – Guard) to detect neuro muscular response in OO and AP was chosen.

One limitation was that, other muscles of the face may be activated by facial nerve stimulation or by direct muscle stimulation and there by interfere with the response measured during contraction of the Orbicularis Oculi. To minimize this direct muscle stimulation , chose to position the stimulating electrodes in such a way as to lessen the direct activation of the OO and to use 20mA of current intensity for stimulation of the facial nerve.<sup>25,26</sup>

## Conclusion

Neuro muscular activity of the Adductor Pollicis using Train of Four (TOF Guard) to determine the appropriate tracheal intubation time and conditions in patients paralyzed with Rocuronium is more clinically relevant than monitoring the Orbicularis Oculi muscle. Monitoring the response of Orbicularis Oculi will reflect the time of onset but not the level of Neuro Muscular Block at the airway musculature. While monitoring peripheral muscles, i.e Adductor Pollicis will underestimate the rate of onset of Neuro Muscular Block, but will adequately estimate the degree of neuro muscular blockade in the airway musculature.

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