



## Comparative Study of the Residual Neuromuscular Blockade between Pancuronium, Vecuronium and Rocuronium Using Train of Four

Swastika Swaro<sup>1</sup>, Soumya Samal<sup>1</sup>, Jayaprakash Pani<sup>2</sup>, Mahesh Chandra Sahu<sup>3</sup>

<sup>1</sup>Assistant Professor, Dept of Anaesthesiology, IMS and SUM Hospital, Siksha O Anusandhan University, K8, Kalinganagar, Bhubaneswar, Odisha, India.

<sup>2</sup>Consultant, Department of Obstetrics and Gynaecology, Apollo Hospital, Bhubaneswar, Odisha, India.

<sup>3</sup>Research Associate, Central Research Laboratory, IMS and SUM Hospital, Siksha O Anusandhan University, Kalinganagar, Bhubaneswar, Odisha, India.

\*Corresponding author's E-mail: [drswastika81@yahoo.com](mailto:drswastika81@yahoo.com)

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### ABSTRACT

Restoration of complete skeletal muscle strength postoperatively is essential to ensure adequate ventilation and maintaining a patent airway. Residual neuromuscular blockade (RNMB) depends upon several factors including type of muscle relaxant used. We can access it by train of four (TOF) ratio using TOF guard. A prospective randomized trial was performed on 90 patients of ASA grade 1&2 who were scheduled for operation under general anaesthesia. They were induced with injection propofol and fentanyl. Intubation was done with injection scholine. Maintenance with nitrous oxide, oxygen and isoflurane. Patients randomly received rocuronium (group R, n=20), vecuronium (group V, n=20), pancuronium (group P, n=20). At end of surgery neuromuscular blockade was reversed with injection neostigmine and glycopyrolate. After 10 minutes of reversal, residual neuromuscular blockade was accessed with TOF ratio. TOF ratio <0.9 indicates residual neuromuscular blockade. In our study 37% in group P, 27% in group R and 10% in group V exhibited RNMB defined by TOF Ratio<0.9. Thus we conclude, the incidence of residual neuromuscular blockade is higher in long acting neuromuscular blocking agent pancuronium. Among 2 intermediate acting agents rocuronium had higher incidence of residual neuromuscular blockade than vecuronium.

**Keywords:** pancuronium, rocuronium, vecuronium, Train of Four ratio, RNMB.

### INTRODUCTION

Residual neuromuscular blockade is defined by inadequate neuromuscular recovery as measured by objective neuromuscular monitoring. More specifically, recent opinion suggests a definition of inadequate train of four ratio of less than 0.9 (TOFR < 0.9)<sup>1</sup>.

The train of four method of peripheral nerve stimulation was introduced in the 1970s. The use of a threshold ratio of 0.7 was derived from several studies to establish the concept of "acceptable recovery". With advances in monitoring and continued studies, TOFR < 0.9 is now considered as residual neuromuscular blockade. This ratio was derived after several studies demonstrated an increased risk of aspiration and pharyngeal dysfunction at TOFR < 0.9, and impaired inspiratory flow and partial airway obstruction at TOFR < 0.8<sup>1</sup>. Practically the concept of adequate neuromuscular recovery is intended as return to baseline muscle function particularly ability to breath normally, maintain patent airway and retain protective airway reflex.

Restoration of complete skeletal muscle strength postoperatively is essential to ensure that patients are able to sustain adequate ventilation, cough and maintain a patent airway<sup>2</sup>. The diaphragm recovers from the effects of non-depolarising neuromuscular blocking drugs more rapidly than does the adductor pollicis<sup>2,3</sup>. Thus a patient having adequate respirations may not have complete recovery of the smaller muscles of the airway, whose recovery is paralleled by that of the adductor

pollicis. The muscles around the eye (orbicularis oculi and corrugator supercillii) recover early (much like the diaphragm) and a TOFC 4 here is often Correlated with a TOFC of less than or equal to 2 at adductor pollicis<sup>4</sup>. The incidence of residual neuromuscular blockade depends on several factors including the choice of the muscle relaxant used during anaesthesia. So, we have conducted this study to know about residual neuromuscular blocking among three commonly used muscle relaxants Pancuronium, Vecuronium and Rocuronium using train of four (TOF).

### MATERIALS AND METHODS

A prospective, randomized double blinded study was conducted after obtaining Institutional ethical committee approval. Ninety patients with ASA grade I and II scheduled for surgery under general anaesthesia with time duration of 45–60 minutes were selected for the study. Their age ranged between 20–60 years from either sex. Patients with hepatic, renal or neuromuscular disease or those taking anticonvulsants, aminoglycosides or polypeptide antibiotics or any other medication known to modify the action of neuromuscular blockers were excluded from the study.

The purpose and procedure of the study was explained to all patients and written informed consent for anaesthesia and the procedure was obtained. The patients were randomly allocated into three groups of thirty each to receive a bolus dose of one of the drugs chosen for study.



Group P: Injection Pancuronium bromide (0.1mg/kg IV initially & 0.025mg/kg subsequently)

Group R: Injection Rocuronium bromide (0.8mg/kg IV initially & 0.2mg/kg subsequently)

Group V: Injection Vecuronium bromide (0.1mg/kg IV initially & 0.025mg/kg subsequently)

Patients were premeditated with injection midazolam 0.06mg/kg intramuscularly, 30 minutes prior to the induction of anaesthesia. On arrival in the operating room, intravenous access was secured and heart rate, blood pressure and oxygen saturation were monitored. Anaesthesia was induced with injection propofol 2-3mg/kg and fentanyl 1µg/kg intravenously. Intubation of the trachea was facilitated by intravenous suxamethonium 2mg/kg. The anaesthesiologist in the operation theatre was directed as to which muscle relaxant was to be used, according to the randomization schedule. Anaesthesia was maintained with 60% N<sub>2</sub>O, 40% O<sub>2</sub> and isoflurane concentration 0.5-1%.

Peripheral nerve stimulator electrodes were positioned over the ulnar nerve on the volar side of the wrist, so that the distal electrode was positioned where the proximal skin crease crossed the radial side of the flexor carpi ulnaris muscle. The proximal electrode was placed 2-3 cm proximal to the distal electrode.

At the end of surgery, neuromuscular blockade was reversed with neostigmine 0.05mg/kg and glycopyrrolate 0.008mg/kg after two responses were recorded on the TOF Guard. After ten minutes of giving reversal agents, Train of four stimuli was delivered at 40mA using TOF

Guard in the right arm and TOF ratio was noted. RNMB was diagnosed if TOF ratio < 0.9.

The total duration of anaesthesia, the total dose of nondepolarising muscle relaxant and the time elapsed between the last dose of nondepolarising muscle relaxant and their reversals were recorded. Statistical analysis was done with student *t*-test. A *p* value < 0.05 is considered to be significant.

## RESULTS

Patient's demographic data and the details of anaesthesia are given in table 1. There was no statistical significance amongst the three groups. There was no significant difference in the total duration of anaesthesia, the total dose of nondepolarising muscle relaxant used, the time elapsed since the last dose of nondepolarising muscle relaxant and the reversal.

In our study 37% in group P, 27% in group R and 10% in group V exhibited RNMB defined by TOF Ratio<0.9. None of the patients in group R & V needed intubation and ventilation. Only 1 patient of group P shifted to recovery room with tube in situ. With the help of SPSS 20, by performing *t* test with table1 and it was found that there is statistical significant at *p*=0.04 by comparing group P and group R, in which R is better than P. Similarly by comparing group R with group V, it was found V is significant at *P*=0.04. So Vecuronium is better than Rocuronium and Rocuronium is better than pancuronium, as was found in our study.

**Table 1:** Demographic data and details of anaesthesia.

	Group P (n=30)	Group R (n=30)	Group V (n=30)
Age( years)	39 ± 19.1	38 ± 18.1	40 ± 18.3
Weight (kg)	52 ± 12.1	52 ± 10.9	54 ± 11
Total duration of Anaesthesia (min)	55 ± 25.2	50 ± 25.1	45 ± 15.1
Total dose of nondepolarising muscle relaxant (mg)	5 ± 1.3	45 ± 14.2	6 ± 2.3
Time elapsed (min) since the Last dose of nondepolarising muscle relaxant and reversal	30 ± 10.5	25 ± 5.5	20 ± 5.5

## DISCUSSION

Inadequate recovery from non-depolarising blocking agents continues to be a common problem in modern post-anaesthesia care units (PACUs)<sup>6,7</sup>, residual neuromuscular blockade has not gone away with change from long duration to intermediate acting neuromuscular blocking agents. The presence of adequate spontaneous ventilation postoperatively does not guarantee either restoration of complete skeletal muscle strength or complete reversal of residual neuromuscular blockade.<sup>6</sup> Clinical assessment of recovery will not detect minor degree of residual neuromuscular blockade. The clinical tests like adequate tidal volume, vital capacity>15 ml/kg and the ability to lift the arms, sustained head lift for 5

seconds, eyeopening, tongueprotrusion, handgrip strength to assess muscle power directly are influenced by factors other than the degree of neuromuscular blockade such as sedation, residual effects of volatile anaesthetics or narcotic over dose. In this situations it is not feasible to perform these clinical tests to assess recovery from neuromuscular blockade. The use of peripheral nerve stimulator is essential in these situations for proper evaluation of residual neuromuscular blockade.

Our study revealed 37%, 27% and 10% patients receiving pancuronium, rocuronium and vecuronium respectively had RNMB with train of four ratio< 0.9. The use of long acting NMB (such as pancuronium) is associated with a 3



fold higher risk of TOF<0.7 in the post-operative period<sup>5</sup>. Intermediate acting NMB (such as rocuronium and vecuronium) should be preferred when feasible. Khan<sup>9</sup> compared residual neuromuscular blockade (TOF Ratio < 0.7) following rocuronium and vecuronium and found that 33% patients receiving rocuronium and 17% patients in the vecuronium group exhibited RNMB. The incidence of RNMB following pancuronium (37%) is similar to that reported by other studies<sup>8,10</sup>.

Hayes<sup>11</sup> and others compared RNMB following rocuronium and vecuronium, and found that 35% patients in the rocuronium group and 52% patients in the vecuronium group exhibited RNMB. But, in contrast to our study where all patients received neostigmine to reverse neuromuscular, 32% of their patients did not receive reversal agents.

In their study, the incidence of RNMB was 60% when reversal agents were not given, as compared to 49% when reversal agents were given. The overall incidence of RNMB was found to be 24% in our study<sup>8</sup>.

There are studies where rocuronium and pancuronium were compared in patients undergoing cardiac surgery, and neuromuscular blockade was not reversed<sup>12-14</sup>. All these studies clearly demonstrated that recovery was superior after rocuronium compared to pancuronium type. Our study also demonstrated that pancuronium (37%) group exhibited that higher incidence RNMB as compared to rocuronium (27%).

Our study represents clinical anaesthesia practice as far possible apart from random use of pancuronium, vecuronium and rocuronium. Intraoperative neuromuscular monitoring was not done. This study aims to assess the incidence of residual neuromuscular blockade with use of pancuronium, rocuronium and vecuronium. It does not assess in detail all factors that may have.

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