Original Paper

ASSESSMENT OF REVERSAL PATTERN OF NEUROMUSCULAR BLOCKADE: A COMPARATIVE STUDY BETWEEN CLINICAL AND INSTRUMENTAL METHODS

Azad AK[1], Ahsan MN[2], Tauhid-ul-Mulk M[3], Rahman MA[4]

Abstract

Introduction: Delayed reverse from the effect of neuromuscular blockade and from the effect of anaesthesia is a concern among anaesthesiologists.

Objectives: Objectives of the study were to compare reversal pattern of neuromuscular blockade by clinical and instrumental methods and to elicit reliable clinical parameters.

Methods: This prospective study was carried out in CMH, Dhaka among 50 adult patients and reversal pattern of neuromuscular blockade was evaluated by clinical and instrumental methods among pancuronium group(Group-I) and rocuronium group(Group-II). All data were collected in data collection sheet and were compiled and analyzed by Student's't' test.

Results: Clinical assessment was carried out by bedside test for muscular function & instrumental assessment was carried out by nerve stimulator and Train of Four (TOF). In pancuronium group (Gp-I) clinically patient was reversed on average (6.19 ± 2.04 min) (mean±SD, n=25) earlier than instrumental method of which tidal volume was found less reliable. But in rocuronium group (Gp-II) instrumentally patient was reversed average (12.56 ± 3.41 min) (mean±SD, n=25) earlier than clinical method of assessing reversal, here also tidal volume was found less reliable among clinical variables.

Conclusion: The study revealed that tidal volume is the less reliable among the clinical variables. In Group-I clinical reversal criteria for neuromuscular blockade were fulfilled earlier than that of instrumental method but in Group-II instrumental criteria were fulfilled earlier than clinical method. We should combine 2 or 3 clinical criteria for adequate reversal from neuromuscular blockade.

Key-Words: Neuromuscular blockade, Reversal pattern, Train of four

Introduction

Delayed recovery is a concern among anaesthesiologists. Therefore assessment of adequacy of reversal from neuromuscular block has prime importance in the course of recovery. There are some clinical and instrumental methods of assessing reversal of neuromuscular blockade and there are variations in sensitivity among clinical criteria. In remote hospitals of third world countries like Bangladesh, there is limited scope of assessing neuromuscular blockade by instrumental methods. So, a reliable clinical criterion should have been the best parameter for assessing the level of neuromuscular blockade during reversal. But no single clinical criterion is safe and we have to assess the reversal from neuromuscular blockade by combining several clinical parameters.

There is lack of study in the comparison between clinical and instrumental method of assessing reversal pattern of neuromuscular blockade. Some clinical investigators have relied upon testing for head lift, based on the observation that the muscles of the neck are among the first to be influenced by the paralyzing action of muscle relaxants before any significant effect on respiratory muscles can be detected. Measurement of voluntary muscular contraction can not be carried out

1. Lt Col Abul Kalam Azad, MBBS, DA, FCPS, Graded Spl in Anaesthesiology, CMH, Dhaka **2. Brig Gen Md Nazmul Ahsan,** MBBS, FCPS, Classified Spl in Anaesthesiology, CMH, Dhaka **3. Lt Col Md Tauhid-ul-Mulk,** MBBS, DA, FCPS, Classified Spl in Anaesthesiology, CMH, Dhaka **4. Lt Col Md Aminur Rahman,** MBBS, DA, FCPS, Graded Spl in Anaesthesiology, CMH, Dhaka.

during anaesthesia. Even in conscious volunteers, the accuracy of the above mentioned clinical tests is limited by the ability of an individual to reproduce a given effort. Tidal volume, inspiratory force measurements in anaesthetized patients cannot be considered satisfactory method for monitoring neuromuscular function because drugs such as narcotics, hypnotics and inhalational anaesthetics all depress respiratory function. The only satisfactory method they described is stimulation of an accessible peripheral motor nerve and observation or measurement of the response of the skeletal muscle supplied by this nerve[1].

Walt et al[2] stated that sustained muscular contraction in response to tetanic stimulation (30 Hz) for 5 sec is a good test because it correlates with recovery to more than 90% of vital capacity and maximum voluntary ventilation. Head lift and hand grip strength were found to be 38% and 45% of control when both inspiratory and expiratory flow rates were more than 90% of control[3]. They concluded that the head lift test, the duration of which was not stated, is an unreliable index of recovery because it does not return to control when vital capacity to tetanic stimulation have recovered to 90% of control. Perhaps the head raising test is a most sensitive index of residual neuromuscular blockade[4].

Furthermore, Ali et al[4]. found inspiratory force to be only 70% of control when vital capacity and expiratory flow rate were more than 90% of control. Even when the result is normal, none of this test assumes that all of the receptors are free of relaxant. The data suggest that the sensitivities of the clinical tests assessing grade of muscle strength for detecting residual block were: head lift > hand grip > inspiratory force > inspiratory and expiratory flow rates > tetanic stimulus (30 Hz) and normal vital capacity > normal tidal volume and normal twitch height. They proposed TOF stimulation as the test of choice because this test does not require a control twitch and is not painful. However, 70% of the receptors can be occupied and still permit a normal TOF. Thus, the test is slightly more sensitive than that using a single twitch and tetanic stimuli at 30 Hz.

By using clinical parameters and nerve stimulator if we can precisely assess the residual blockade of various muscle relaxants; timely antagonism of neuromuscular blockade by anticholinesterase will curtail unnecessary delayed recovery. In terms of reliability, if reliable parameter can be determined among clinical parameters; it will be easy to assess reversal from neuromuscular blockade in field areas and ambulatory anaesthesia practices for the professionals. The aim of this study was to find out reliable clinical criteria and to compare between clinical and instrumental methods.

Materials and Methods

This prospective study was carried out in Combined Military Hospital, Dhaka among 50 adult patients of ASA (American Society of Anaesthesiologists) grade-I & II scheduled for routine surgery during the period of Jan 2008 to Dec 2008. Day before operation all selected patient were briefed about questionnaire of clinical assessment so that they can cooperate during recovery. Experiments were carried out using bedside tests of muscular function for clinical assessment (Table-1) and using nerve stimulator (TOF watch) for instrumental assessment (Table-2) of neuromuscular blockade. Anaesthetized patients had been allocated by card sampling method into two groups, Group-I received pancuronium bromide and Group-II received rocuronium bromide for neuromuscular blockade depending on body weight in dose of either pancuronium (0.08-0.1 mg/kg) or rocuronium (0.5-0.9 mg/kg).

Standard technique was adopted using same drugs and fluids during premedication, induction and maintenance of anaesthesia. All patients were monitored with same monitoring equipment. During anaesthesia, ulnar nerve was located according to land-mark of surface marking on the ventral surface of wrist. The negative (distal) electrode of TOF watch was positioned where the positive (proximal) bending line crosses the radial side of the flexor carpi ulnaris just lateral and proximal to bone. The proximalelectrode was

transducer was placed with its largest flat side against the thumb. Peroperatively, ulnar nerve was stimulated at 10-15 min interval at a rate of 2 Hz for 2 sec with 50 mA current and TOF ratio, muscle strength grade were recorded at a operating room temperature of 24-26^{o}C.

At the end of the surgery, anti-cholinesterase was administered when TOF count was two. Then four supramaximal stimuli of 2Hz (four stimuli every 0.5 sec) were applied over 2 seconds interval which were repeated every 10-12 second. The response was observed as TOF count or TOF ratio. For clinically assessing the neuromuscular blockade reversal, following criteria were used (1) ability to sustain a head lift for 5 sec (2) ability to open eye widely for 5 sec (3) assessment of hand grip strength (4) tidal volume (5) strength of leg lift, and for instrumental assessment, TOF ratio 0.7 (visual impression between T4 and T1 ratio) was considered as adequate reversal. Time required to fulfill the criteria of reversal was calculated from the time of administering reversal agent upto extubation. Relevant data were collected on a predesigned proforma then compiled and analyzed by Student's 't' test . Patients were selected as per following criteria's:

Inclusion criteria:

1.All adult patients of either sex undergoing routine surgical procedure under general anaesthesia with neuromuscular blockade.
2.Patients having physical status ASA grade I & II

Exclusion criteria:

1.Patients with hepatic, renal dysfunction, psychiatric and neurological disorders.
2.Patients unable to understand normal command.
3.Not willing to participate in this study.
4.Patients requiring bilateral limb surgery.
5.Patients having preoperative neuromuscular disorders.
6.Neurosurgical patients.

Table-I: Clinical assessment for muscular function (bedside tests).

Bedside tests for muscular function	**Interpretation** [10]
❖ Ability to sustain a head lifts for 5s. ❖ Assessment of hand grip strength ❖ Ability to open eye widely for 5s. ❖ Tidal volume	Medical Research Council of Great Britain recognize five grades of muscle strength that will be recorded as follows: ❖ Grade - 0: complete paralysis - TOF - ?0.4 ❖ Grade - 1: Minimal Contraction - TOF -0.5 ❖ Grade - 2: Active movement with gravity eliminated - TOF - 0.6 ❖ Grade - 3: Weak contraction against gravity - TOF - 0.7 ❖ Grade - 4: Active movement against gravity & resistance - 4^{-} : TOF - 0.8 & 4^{+} : TOF - 0.9 ❖ Grade - 5: Normal strength - TOF -1

TOF-Train of Four

Table-II: Instrumental assessment of muscle by nerve stimulator (TOF watch).

Stimulus Parameter	Stimulus rate	Clinical application	Interpretation
TOF	2 Hz for 2 s Single or repetitively at 10 -12 s intervals.	? To judge onset of block ? Tracheal intubations ? To judge depth of block during maintenance of relaxation. ? To judge adequacy of recovery from block.	TOF ratio and Count will be recorded according to muscle strength of the patient

TOF, Train of Four

Results

Demographic data:

Patient's characteristics are shown in Table-III. Mean age of group-I was 33.6 ± 3.14 (minimum 19 years and maximum 55 years) and group-II was 33.78 ± 3.51 (minimum 19 years and maximum 55 years). Mean body weight of group-I was 60.3 ± 7.17 (minimum 50 kg and maximum 70 kg) and group-II was 61.82 ± 7.34 (minimum 50 kg and maximum 70 kg). There were no significant differences.

Table-III: Demographic data.

Characteristics	Group - 1	Group - 2	Significance level
Age (years)	33.6 ± 3.14	33.78 ± 3.51	NS
Body wt (kg)	60.3 ± 7.17	61.82 ± 7.34	NS
Male: Female	18:7	20:5	NS

Values are expressed as mean ± SD.

NS: not significant p > 0.05 (among two groups) for age, body weight and sex distribution; analysis was done by Student's't' test.

In group I, clinical reversal criteria for neuromuscular blockade were fulfilled earlier than (6.19 ± 2.04 min) that of instrumental reversal criteria (12.56 ± 3.41 min). But in group II, instrumental criteria (5.28 ± 3.15) were fulfilled earlier than that of clinical criteria (13.27 ± 2.98 min) [Table-IV]. There were significant differences between two groups.

Table-IV: Reversal time from NM blockade (from administration of anti cholinesterase to extubation) in group-I and group-II.

Group	Clinically reversal time (min)	Instrumentally reversal time (min)	Significant level
Group I	6.19 ± 2.04	12.56 ± 3.41	Sig
Group II	13.27 ± 2.98	5.28 ± 3.15	

Values are expre ssed as mean ± SD.

Sig: significant p < 0.05 (among two groups) for reversal time; analysis was done by Student's 't' test.

Tidal volume was shown in Table-V, and it was measured just before extubation. It was measured by Wright's respirometer. There was no significant difference between two groups (p value > 0.05), but the volume was satisfactory for assessing neuromuscular reversal. Among the clinical parameters of assessing neuromuscular blockade, tidal volume was found less reliable. Because adequate tidal volume may be achieved when TOF ratio is 0.4 and reversal of neuromuscular blockade is 30-50%.

Table-V: Tidal Volume assessment just before extubation in group-I & group-II.

	Tidal volume (ml)	Significant level
Group-I	380 ± 57.38	NS
Group-II	394 ± 64.21	

Values are expressed as mean ± SD.

NS: not significant p > 0.05 (among two groups) for tidal volume; analysis was done by Student's 't' test.

Discussion

The aim of reversal is to restore the patient's ability to maintain satisfactory ventilatory function and a patent airway[6]. Ali et al[7]. found the sensitivities of the clinical tests assessing grade of muscle strength for detecting residual block were: head lift > hand grip > inspiratory force > inspiratory and expiratory flow rates > tidal volume. Tidal volume and inspiratory force measurements in anaesthetized patients cannot be considered satisfactory methods for monitoring neuromuscular function because drugs such as narcotics and hypnotics and inhalational anesthetics all depress respiratory function[1]. In another study[6] it was found that incidence of residual block higher with pancuronium than rocuronium. Miller et al[8,9] observed that when twitch height more than 20% of control, time from neostigmine administration to attainment of control twitch height is 3-14 minutes. With twitch heights less than 20% of control, recovery takes 8-29 minutes. Walt's et al[2] stated that head-raising test, the duration of which was not stated, is an unreliable index of recovery. Ali et al. states that that train of four stimulation is the test of choice. In our study we found that tidal volume remained less reliable among clinical variables because patient remains drowsy and couldn't reply with verbal command immediately after anaesthesia even after giving questionnaire pre-operatively. Moreover block developed more quickly in central muscles of diaphragm and airway also recover more quickly[9]. Englbaek et al. reported that the TOF ratio had to recover 0.8 before all patients could sustain a head lift for 5 sec and it could not be sustained for any patients at a TOF[10] ratio of 0.5.

In rocuronium group, instrumentally patient reversed from neuromuscular blockade earlier than clinical method (Table-IV), because clearance rate from bio-phase of intermediate acting relaxant is more than that of long acting relaxant[9]. In pancuronium group, clinically patient reversed from neuromuscular blockade earlier than instrumental method (Table-IV), because as central muscle cleared off from muscle relaxant earlier than peripheral muscle so diaphragm cleared off earlier and patient took respiration earlier than peripherally sited nerve stimulator in ulnar nerve, and pancuronium leave bio-phase more slowly from neuromuscular junction of peripheral muscle[9].

Among the clinical criteria of assessing neuromuscular blockade, satisfactory tidal volume was observed earlier than other clinical parameters and was found to be less reliable[11]. The patient remains drowsy under anaesthesia and can't co-operate well to elicit other clinical parameters. Moreover tidal volume measurement does not require patient's cooperation unlike other clinical variables. In our study, tidal volume was found satisfactory even before the fulfillment of clinical or instrumental reversal criteria. Tidal volume may be adequate when TOF ratio is 0.4 and with 30-50% of reversal of neuromuscular

blockade[11]. So there is chance of residual block if we rely on tidal volume during reversal of neuromuscular blockade.

Conclusion

We conclude that longer acting neuromuscular blocking agents like pancuronium bromide shows earlier recovery with the clinical methods of reversal criteria than that of instrumental methods. Whereas, for intermediate acting drugs like rocuronium bromide shows earlier recovery with instrumental method. From this study, it was difficult to elicit a single reliable clinical criterion for recovery. Most of the anaesthesiologists usually perceive tidal volume as a first subjective clinical criterion, which could be a misguiding parameter for reversal of neuromuscular blockade. But in our study, it was found to be relatively unreliable clinical criterion. We should combine 2 or 3 clinical criteria for adequate reversal from neuromuscular blockade.

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