Original Article

Incidence of Postoperative Residual Paralysis in a Nigerian Teaching Hospital

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ABSTRACT

Background: Postoperative residual paralysis (PORP) is a known risk factor after general anesthesia (GA) for critical respiratory events and increased postoperative morbidity. PORP is defined as a train-of-four ratio (TOFR) of <0.9 using acceleromyography (AMG). TOFR <0.9 has been associated with increased risk of aspiration, obstruction of the upper airway and an impaired hypoxic ventilatory response. **Aim:** The aim of this study was to determine the incidence of PORP, associated factors related with its occurrence and critical respiratory events in the postanesthesia recovery room (PAR) at our institution. **Methodology:** Forty-one adult patients were scheduled for elective surgeries requiring GA with the use of at least 1 dose of a nondepolarizing neuromuscular blocking drug (NMBD). An independent anesthetist quantitatively measured TOFR of recruited patients postoperatively in the recovery room using the TOF-watch SX acceleromyograph (Organon Teknika) 5 min after arrival. **Results:** The incidence of PORP was 75.6% (n = 31), with severe PORP (TOFR <0.7) seen in 41.5% (n = 17) of patients. Median time to full recovery in the PAR was 33 min (range 5–164 min). There was no statistical difference in the incidence of PORP related to the choice of NMBD (P = 0.186) or duration of surgery (P = 0.175). No respiratory complications or events were observed in patients with residual blockade. **Conclusion:** The incidence of PORP is quite high and undetected in our environment. Quantitative monitoring for residual paralysis is advocated as part of routine monitoring with the use of NMBDs for improved patient safety.

Keywords: *Incidence, neuromuscular blockade, Nigeria, postoperative, residual paralysis*

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Introduction

Neuromuscular blocking drugs (NMBDs) have been used as an essential component of general anesthesia (GA) for optimal surgical conditions. The risk of undetected residual paralysis has been identified as a frequent cause of critical respiratory events in the postanesthesia recovery room (PAR).[1-3] Acceleromyography (AMG) is widely accepted to be the method of choice for quantitative estimation of neuromuscular recovery.[4-6]

Postoperative residual paralysis (PORP) has been defined as a train-of-four ratio (TOFR) <0.9.[4] TOFR values of <0.9 have been associated with increased risk of aspiration, abnormal swallowing, impaired pharyngeal function with obstruction of the upper airway, and an impaired hypoxic ventilatory response.[1,7,8]

Despite the incidence of PORP ranging from 26% to 88% in different populations,[9] neuromuscular monitoring is still poorly used worldwide. In Nigeria, the degree of residual paralysis is ascertained by subjective clinical tests and intuition in most institutions. Clinical tests have been found to be of low sensitivity and cannot preclude the presence of high degrees of residual paralysis.[10]

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The aim of this study was to determine the incidence of PORP, associated factors related with its occurrence and critical respiratory events in the PAR at our institution.

Methodology

This was a nonrandomized prospective observational study conducted following the approval of the Research and Ethics Committee of the Hospital for a 3-month period. After obtaining informed consent, all adult patients for elective surgery requiring GA with endotracheal intubation and planned use of NMBD were included in the study. Exclusion criteria included patients with neuromuscular diseases, severe kidney or liver disease, burns, and emergency surgery. The choice of drugs for GA and neuromuscular blockade were left to the discretion of the anesthetist in charge of the patient.

On arrival in the recovery room, an independent anesthetist not involved in the perioperative management of the patient ensured that all enrolled patients met the criteria for inclusion in the study. Neuromuscular function monitoring using the TOF-watch SX acceleromyograph (Organon Teknika, The Netherlands) of the ulnar nerve at the adductor pollicis muscle of the thumb was performed after standard monitoring and oxygen supplementation (3 l/min by nasal cannula) was initiated. TOF stimulation was done at 50 mA (four pulses of 0.2 ms in duration at a frequency of 2 Hz) at the ulnar nerve after calibration. Three consecutive TOF measurements were obtained, and the average of the three values was recorded. If measurements differed by >20%, additional TOF values were not obtained and the patient was excluded from the study. Patients were classified into three groups on the basis of their TOFR values – TOFR ≥0.9, 0.7–0.9, and ≤0.7. TOFR recordings were done every 5 min till TOFR was ≥0.9 and time to achieving this in the recovery room was noted. Episodes of hypoxemia (SpO_2 <90%), lowest spO_2 observed, requirement for stimulus to maintain SpO_2 >90%, and airway obstruction evidenced by performing maneuvers to relieve obstruction such as chin lift, introduction of nasal airway, or re-intubation were recorded by the PAR nurse.

Information obtained from each patient enrolled included the age, sex, American society of anesthesiologists physical status, surgical diagnosis, surgical procedure performed, comorbidities, duration of anesthesia and surgery, NMBD used, NMBD reversal agent used and dose, timing of last NMBD, and NMBD reversal agent used. All data were collected after the TOF measurements were calculated. Statistical analysis was done using the Statistical Package for the Social Sciences (SPSS) version 23 (IBM Corp, Armonk NY, USA). Mean and standard deviation were used to present continuous data, whereas frequency and percentage values were used for categorical variables. Fisher's exact was used to find the association between PORP and anesthesia variables and type of NMBD used. $P \leq 0.05$ was considered statistically significant in this study.

Results

During the 3-month study period, a total of fifty patients were selected for inclusion in the study, of which nine patients were disqualified due to movement distorting TOF measurement and incomplete data. Data were

Table 1: Demographics and anesthesia variables in the study group (*n*=41)

Variable	Frequency (%)
Gender	
Male	15 (36.6)
Female	26 (63.4)
Age group (years)	
21-40	17 (41.5)
41-60	17 (41.5)
>60	7 (17.1)
ASA physical status	
I	17 (41.5)
II	20 (48.8)
III	4 (9.8)
Surgery	
General surgery	16 (39)
Gynecology	11 (26.8)
Orthopedics	5 (12.2)
Plastic surgery	2 (4.9)
Urology	4 (9.8)
Thoracic surgery	3 (7.3)
Relaxant use	
Pancuronium	13 (31.7)
Atracurium	23 (56.1)
Vecuronium	5 (12.2)
Duration of anesthesia (min)	
Mean±SD	142.1±59.7
Median	132.0
Range	63-360

ASA=American Society of Anesthesiologists; SD=Standard deviation

Table 2: Association between postoperative residual paralysis with relaxant use and duration of surgery

	Present (%)	Absent (%)	Total (%)	Statistics (*P*)
Relaxant				
Pancuronium	12 (92.3)	1 (7.7)	13 (100)	0.186
Atracurium	15 (65.2)	8 (34.8)	23 (100)	
Vecuronium	4 (80)	1 (20)	5 (100)	
Duration (min)				
≤60	5 (100)	0	5 (100)	0.175
>60	26 (72.2)	10 (27.8)	36 (100)	
Total	31 (100)	10 (100)	41 (100.0)	

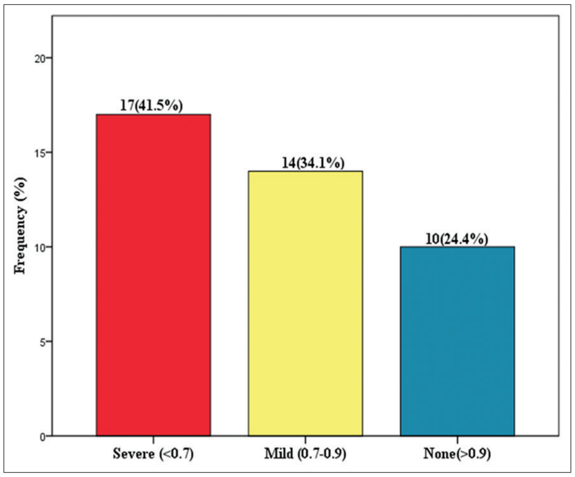

Figure 1: Incidence of postoperative residual paralysis

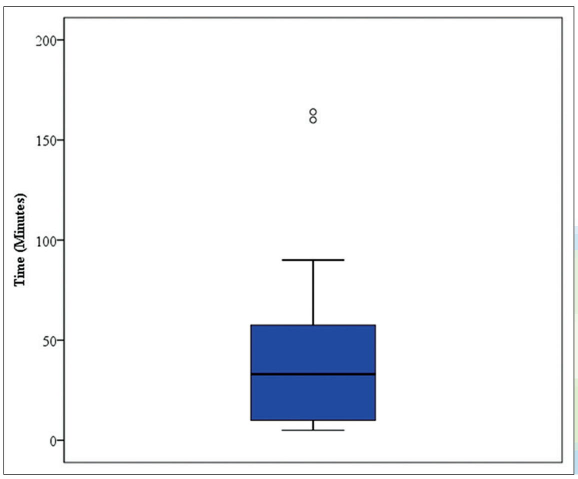

Figure 2: Time taken to return to train-of-four ratio of ≥0.9

analyzed for 41 patients, and 15 men and 26 women with a mean age of 46.25 ± 13.7 years. Patient characteristics and anaesthesia variables of the study population are provided in Table 1.

Reversal of neuromuscular blockade was performed in all of the patients using neostigmine at a dose of 0.05 mg/kg combined with atropine at 0.02 mg/kg. The mean duration of anesthesia was 142.1 ± 59.7 min.

The total incidence of PORP was 75.6% for TOFR <0.9 (=31) and 41.5% for severe PORP (TOFR <0.7, n = 17) seen in Figure 1.

The most frequent NMBDs used were atracurium (56.1%) and pancuronium (31.7%). The median time to full recovery of neuromuscular function in the PAR after initial measurement in patients with PORP was 33 min with a range of 5–164 min [Figure 2]. There was no statistically significant difference in the occurrence of PORP relating to the type of NMBD used or duration of anesthesia [Table 2].

No respiratory complications or critical events were observed in the recovery room in patients with residual blockade or any of the patients enrolled in this study.

Discussion

In this study, 75.6% of patients exhibited PORP (TOFR <0.9) on arrival at the recovery room. This value seems high compared to other studies with incidences ranging from 4% to 57%.[11-14] This may be because recent studies have avoided the use of long-acting NMBDs such as pancuronium, which still remains a mainstay in the practice of anesthesia in this environment due to its availability and price. Although there was no statistical difference noted due to the type of NMBD used in the incidence of PORP (P = 0.186), there was, however, a preponderance of PORP seen in the pancuronium and vecuronium group of patients relative to the frequency of their use (92.3%; 80%). Spontaneous recovery of neuromuscular function when long-acting NMBDs are used is slower, leading to an increased risk of residual paralysis,[14] and one of the methods recommended for reduction in the incidence of residual paralysis by Viby-Mogensen is avoidance of the use of long-acting NMBDs.[15] The longer the duration of NMBD action, the higher the risk of residual paralysis.[16]

Cammu *et al*.[13] found the incidence of residual paralysis to be higher in inpatients compared to outpatients (47% to 38%) and suggested that this was due to the use of short-acting NMBDs for short outpatient procedures. This was, however, not evident in our study where the duration of surgery was found not be statistically significant in the incidence of PORP (P = 0.175) as PORP was observed in all the surgeries with a short duration. However, since the choice of NMBD was left to the discretion of the anesthetist, long-acting NMBDs were not preferentially chosen for surgical operations with expectedly longer duration (≥60 min).

Mild PORP (TOFR: 0.7–0.9) was seen in 34.1% (n = 14/41) of the patients which is remarkable since all patients were reversed of neuromuscular block using neostigmine, an acetylcholinesterase inhibitor at the end of the procedure. This finding may be the result of varying times of onset of effect of neostigmine depending on the degree of blockade and timing of administration of reversal agents. The role of neostigmine in the incidence of PORP has been widely reported as PORP can still persist even when combined with intraoperative neuromuscular function monitoring.[17,18] Neostigmine is limited as a reversal agent in the presence of profound blockade with adequate time needed to allow for onset of action. Complete recovery of neuromuscular function can only be achieved with neostigmine when spontaneous recovery is already on its way. Typical reversal times for a profound neuromuscular block range from 20 to 30 min, whereas a mild neuromuscular block is within 5–6 min.[19] In a patient without spontaneous regular respiration (i.e., not showing signs of spontaneous recovery), there is no advantage in using neostigmine early, even in large doses, and unwarranted use may increase the risk of pulmonary edema and re-intubation.[20]

The median time to recovery to a TOFR ≥0.9 was 33 min in this study which meant that majority of the patients with residual paralysis had recovered neuromuscular function before transfer to a nonmonitored setting as the protocol in our recovery room is a minimum recovery time of 45 min for GA patients. This is reassuring because, in the recovery room, monitoring for perioperative respiratory events is maximal with supplemental oxygen readily available in the event of respiratory compromise. This may also be one of the reasons residual paralysis goes largely undetected in this environment as the more severe phase of residual paralysis occurs at the time of optimal monitoring in the recovery room.

There were no critical respiratory events seen in the recovery room in this study despite the high incidence of residual paralysis. This is similar to the Canadian Residual Curarization and its Incidence at Tracheal Extubation study where though the incidence of PORP was 56.5%, only three patients were noted to have had critical respiratory events.[9] Murphy *et al*.[2] quantified the severity of residual paralysis in 7459 patients over a 1-year period in the PAR with a critical respiratory event incidence of 0.8% (61 patients). These patients also had a high incidence of residual blockade (73.8% with TOFR ≤0.7) compared with a matched control group in the same period. The most common respiratory events discovered were severe hypoxemia in 52.4% and upper airway obstruction in 35.7%. Sauer *et al*.[1] in a randomized placebo-controlled prospective study also found mild residual blockade to be associated with a higher incidence of hypoxemia in the recovery room while studying the effects of critical respiratory events in relation to PORP. The multifactorial etiology of postoperative respiratory events in the recovery room includes factors relating to the patient, surgical procedure, and anesthesia variables, with studies suggesting that PORP is a primary contributor to these events.[2,21] The discrepancy between the high prevalence of PORP in recovery rooms and clinically significant respiratory events is in correlation with the lack of awareness of the potential threat to patients' safety and arbitrary use of neuromuscular monitoring devices worldwide.

Neuromuscular function monitoring is not routinely used in most countries[22-24] even though prevention of PORP can be achieved by effective NMBD management, intraoperative monitoring, and use of reversal agents.[14] The use of quantitative monitoring such as AMG has been shown to detect small degrees of residual blockade compared to qualitative monitoring. The effectiveness of neuromuscular monitoring is still debatable as use has not been associated with a reduction in the rate of PORP in a meta-analysis by Naguib *et al*.[16] It can, however, serve to improve NMBD management perioperatively and reduce the unwarranted use of anticholinesterases for reversal in our operating rooms.

The limitations of our study include a small sample size, which makes our findings less generalizable, but it does show that PORP is a major undetected problem in our recovery rooms which needs to be further investigated with adequately powered trials in the future. Second, the observational nature of the study should be considered when relating our findings to associated factors discussed.

Conclusion

The incidence of PORP is quite high and undetected in our environment. Quantitative monitoring for residual paralysis is advocated as part of routine monitoring with the use of NMBDs for improved patient safety. Caution should also be taken in the use of neostigmine for reversal in patients suspected of having a profound block. More research needs to be conducted to determine the extent and full impact of PORP in this environment.

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Conflicts of interest

There are no conflicts of interest.

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