ORIGINAL RESEARCH

Can Perfusion index as a surrogate indicator of intra operative neuromuscular dose requirement

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ABSTRACT
Introduction: Neuromuscular monitoring is the key component of the appropriate management of neuromuscular block.This type of monitoring allows safe timing and dosing of neuromuscular blocking and reversal agents.Since TOF monitor is not available in all the set ups,so a study was planned to see whether PI a very simple parameter can be used to check the intraoperative requirement of neuromuscular blocking drug and to compare the effects of Perfusion Index and TOF score on neuromuscular blockade intra-operatively. **Methods:** An observational study was done in 40 patients of ASA physical statusI,II,aged between 18-60 years of either sex scheduled for elective surgeries under General Anaesthesia.TOF score was recorded after stimulating the ulnar nerve before and after giving maintainence doses of neuromuscular agents.Perfusion Index and other hemodynamic vitals were also recorded at the same time intervals. **Results:** The TOF score recorded before giving the 1^{s},2nd and 3rd top up was reduced significantly(p value<0.05) (mean±SD 0.34±0.09,0.36±0.12,0.3±0.8 respectively).However,the TOF score recorded at the time of giving top up was increased significantly(p value<0.05) compared to the score recorded before giving top up(mean±SD 0.59±0.11,0.62±0.14,0.63± 0.13respectively).The Perfusion Index did not show any statistical significant change(p value>0.05) before giving the 1st,2nd and 3rdmaintainance dose of neuromuscular blocking agents when compared with baseline value.However at the time of giving top up the decrease in perfusion index was significant (p value <0.05) at the time of giving 1st,2nd and 3rd top up.The hemodynamic parameters showed changes similar to Perusion index. **Conclusion:** The findings of our study show that TOF monitor can be used for assessing the need for neuromuscular blocking agent intra-operative.The changes in the hemodynamic parameters also match up with the changes in TOF score.Also the change seen in Perfusion Index was similar at the time of giving neuromuscular blocking agents and the changes in Perfusion Index correlated with TOF score and may be used in future for intra-operative neuromuscular block monitoring.
Keywords: Train Of Four, PerfusionIndex,NeuromuscularMonitoring,NeuromuscularBlock,Haemodynamics.

INTRODUCTION

The standard monitoring of the patient during GA is one of the most important role of an anaesthesiologist for the successful outcome of the procedure and patient safety. Monitoring will not prevent all adverse incidents in the peri-operative period.however,it reduces the risk of such accidents.The standard monitoring of the patient recommended by ASA :ECG,BP,Pulseoximetry,capnography,temperature.

Neuromuscular monitoring is a desirable method to monitor neuromuscular blocking action of neuromuscular agents to improve the surgical conditions. Neuromuscular monitoring is not done routinely in current practice and reason being its exclusion from ASA standard monitoring, non availability at every center and difficulty to interpret the results. To avoid the residual neuromuscular block, maintaining optimal surgical conditions and decreasing postoperative morbidity and length of stay ,the international guidelines strongly recommend that the doses of neuromuscular agents and reversal agents must be guided by neuromuscular monitoring.

There are various monitors available to assess the neuromuscular block and among them TOF is 1 such monitor used commonly. In 1970,Ali et al .developed and published the technique of Train of Four to monitor neuromuscular block in anaesthetized patient. It is based on quantitative analysis (acceleromyography) .In non depolazing block progressive depression of twitch occurs and the ratio of the height of 4th response to 1st response is TOF ratio.We used Train Of Four monitor in our study to assess the neuromuscular block and the requirement of neuromuscular agent intra-operatively and to compare the changes in Perfusion Index with TOF score while giving intra-operative neuromuscular relaxation.In partial non-depolarizing block T4/T1 ratio is inversely proportional to degree of blockade .

Perfusion Index is an indirect and non invasive measurement of peripheral perfusion**.**

It is the ratio of the pulsatile component of the blood flow to the non-pulsatile component of the blood flow and indicates the pulse strength at the sensor site. Range - 0.02% (extremely weak pulse) to 20% (very strong pulse).It is normally monitored with pulse oximeters.

Perfusion Index= pulsatile signals of infrared/non pulsatile signals of infrared ×100.

Perfusion Index has been used in the past, as an early indicator of successful nerve block or sympathectomy and topredict hypotension after spinal anaesthesia during caeseriandelivery.Thishas been also been usedto detect stress response during anesthesia and as a marker for assessment and management of surgical pain.The Perfusion Index may decrease due to increased vasomotor tone and the contraction of peripheral blood vessels when the sympathetic nervous system is activated by pain. On this premise we hypothesized that Perfusion Index may vary when the neuromuscular block is reduced enough as indicated by variation in vitals, breathing movements in reservoir bag and TOF monitor.Hence we planned a study to use TOF monitor as an indicator for assessing the need for neuromuscular blocking agent intra-operatively and to compare the effects of Perfusion Index and TOF score on neuromuscular blockade intra-operatively.

AIMS AND OBJECTIVES

The find out whether PI can be used as a surrogate indicator of intraoperative neuromuscular dose requirement and to compare the effects of perfusion index and TOF score on neuromuscular blockade intraoperatively.

MATERIAL AND METHODS

After obtaining approval from the institutional ethical committee the present randomized controlled study was conducted in the Department of Anaesthesiology and Intensive Care, AcharyaShriChander College of Medical Sciences and Hospital, Jammu.A total of 40 patients were included in the study (18-60 years old) of both gender,ASA I,II physical status,cooperative and who underwent elective surgeries under genralanaesthesia.Informed written consent was obtained from the patients preoperatively.

Patients with unstable vitals,age<18 years or>60 years,pre-existing neurological issues,peripheral vascular disease,neuromuscular disease and patients undergoing emergrncy surgery were excluded.

Pre anaesthetic check up was done 1 day prior to surgery and included a detailed history, general physical as well as systemic examination and airway assessment of all patients.All the routine investigations and any other specific investigations necessary for the patient were undertaken. Basic demographic profile like age , weight ,height ,BMI was noted.

Baseline parameters were recorded before intubation including the baseline perfusion index(PHILIPS healthcare monitor).

General anaesthesia was induced with Fentanyl at 1µg/kg, Propofol at 2 mg/kg, and rocuronium 0.6 mg/kg and endotracheal tube was secured,confirmed and fixed.1 mg/kg diclofenac injection and 1 gram paracetamol infusion was given for intra operative analgesia .The inhalational Isoflurane was maintained at a concentration of 1 MAC and adjusted according to the patient's vital signs. The TOF monitoring(XavantStimpod NMS450X monitor) was done by attaching two electrodes over the path of the ulnarnerve.The 1st electrode was attached at the level of the wrist on the ulnar surface at the flexor crease and the 2nd electrode 1-2 cm proximal to 1st and parallel to flexor carpiulnaris tendon and then 4 successive 0.2milisecond stimuli were given in 2 sec(2 hertz).The TOF ratio was recorded and repeated at every 10 minute interval.The TOF score was recorded along with perfusion index and other parameters whenever the maintainence dose of neuromuscular blocking agent was needed.During surgery the maintainence dose of neuromuscular blocking agent was given on the basis of TOF score of 0.6 and respiratory efforts in the reservoir bag.

or The TOF score was recorded when hemodynamics of the patients started changing and at the time of giving top up when respiratory efforts were observed in the reservoir bag.

DATA ANALYSIS

A statistical analysis was done by using IBM SPSS VERSION 21. The qualitative data was expressed in terms of percentages and quantative data was expressed in terms of mean and standard deviation and was compared by using paired t test. A value of $p<0.05$ was considered as statistically significant otherwise non significant.

RESULTS

This observational study include 40 patients after meeting the inclusion criteria.The demographic characteristics of the patients are shown in Table 1.The mean age ±SD of the patients was 35.98 ± 7.68 with maximum of patients in the age group of 26-31 and 32-37 years comprising 32.5% each.The total number of females(52.5%) were slighty more than males(47.5%).The mean weight ±SD of the patients was 60±8.47.

In our study, the change in mean arterial pressure before giving1st ,2nd and 3rd top-up (mean±SD 96.12±11.61,96.18±11.23 and 88.09±7.06 respectively) of neuromuscular blocking agent was not significant (p value >0.05) when compared with baseline values(mean±SD 95.3±11.79) at all time intervals{Table 2,4,6}.However,siginificant change in the above parameter was seen at the time of giving 1st,2nd and 3rd top-up(mean±SD 98.9±10.6,101±9.06 and 98.91±12.42 respectively) at all time intervals (p value<0.05).{Table 3,5,7}.

The changes in systolic blood pressure before giving 1st,2nd and 3rd top up(mean±SD 117.42±13.56,118.42±13.66 and 119.73±8.31 respectively) of neuromuscular blocking agent was not significant (p value >0.05) when compared with baseline values(mean±SD 116.7±14.04) at all time intervals{Table 2,4,6}.There was significant difference seen at the time of giving the 1st,2nd and 3rd maintainence dose(mean±SD 127.68±14.24,130.55±14.01 and 135.55±8.31 respectively) at all time intervals(p value <0.05).{Table 3,5,7}.

There was no significant difference(p value>0.05) seen between baseline diastolic blood pressure(mean±SD 77.08±8.41) and diastolic blood pressure recorded before 1st,2nd and 3rd top up(mean 77.65±9.24,76.65±9.56 and 76.18±8.31 respectively){Table 2,4,6}.At the time of giving the maintainence dose the change seen was statistically significant(mean±SD 82±8.5,85±7.14 and 84.45±8.39 respectively)at all time intervals(p value<0.05){Table 3,5,7}.

The change in baseline heart rate(mean±SD 78.03±7.08) was not significant (p value>0.05) when compared with values recorded before giving 1st,2nd and 3rd top up(mean 78.08±7.08,78.50±7.16 and 81.18±3.6 respectively){Table 2,4,6}.There was a significant change(p value <0.05)seen at the time of giving 1st,2nd and 3rd top up(mean 89±8.9,91.5±5.22 and 93.36±4.78 respectively){Table 3,5,7}

The Perfusion Index also did not show any statistical significant change(p value>0.05) before giving the 1st,2nd and 3rd (mean±SD 5.78±5.82,5.78±5.67 and5.47±0.86 respectively)maintainance dose of neuromuscular blocking agents when compared with baseline value()mean±SD 5.95±1.34){Table 2,4,6}.However at the time of giving top up the change in perfusion index was significant (p value <0.05) at the time of giving 1st,2nd and 3rd top up(mean±SD5±1.3,4.3±1.2 and 3.77±1.15 respectively){Table 3,5,7}.

The temperature and oxygen saturation remained more or less near the baseline values at all times showing no significant difference(p value>0.05){Table 2,3}.

The TOF score recorded before giving the 1st,2nd and 3rd top up was reduced significantly(p value<0.05) (mean±SD 0.34±0.09,0.36±0.11,0.3±0.12 respectively){Table 8}.However,the TOF score recorded at the time of giving top up was increased significantly(p value<0.05) compared to the score recorded before giving top up(mean±SD 0.59±0.11,0.62±0.14,0.63±0.13 respectively){Table 8 }.

Table 1:patients characterstics

Age(inyears)	No.ofpatients	Percentage(%)
26-31	13	32.5
32-37	13	32.5
38-43	06	15
44-49	05	12.5
≥50	03	7.5
Total	40	100
Mean±SD	35.98±7.68	
Gender		
Male	19	47.5
Female	21	52.5
Total	40	100
Weight		
Mean±SD	60±8.47	

Table 2:comparison of baseline parameter with before 1st top up

Parameters	Baseline		Before1sttopup		p-value
	Mean	SD	Mean	SD	
sbp	116.7	14.04	117.42	13.56	0.861(N.S)
dbp	77.08	8.41	77.65	9.24	0.991(N.S)
map	95.3	11.79	96.12	11.61	0.883(N.S)
hr	78.03	7.08	78.08	7.52	0.994(N.S)
perfusionindex	5.95	1.34	5.78	5.82	0.912(N.S)
spo2	99	0	99	0	1(N.S)
temp	98.5	0.02	98.5	0.01	0.999(N.S)

Table 3: comparison of baseline parameter with at 1st top up

Parameters	Baseline		after1st topup		p-value
	Mean	SD	Mean	SD	
sbp	116.7	14.04	127.68	14.24	0.0001*
dbp	77.08	8.41	82	8.5	0.0001*
map	95.3	11.79	98.9	10.6	0.0001*
hr	78.03	7.08	89	8.5	0.0001*
perfusionindex	5.95	1.34	5	1.3	0.0001*
spo2	99	0	99.1	0.01	0.986(N.S)
temp	98.5	0.02	98.5	0.02	1(N.S)

Table 4:comparisonofbaselineparameterwithbefore2nd topup

Parameters	Baseline		before2nd topup		p-value
	Mean	SD	Mean	SD	
sbp	116.7	14.04	118.42	13.66	0.661(N.S)
dbp	77.08	8.41	76.65	9.56	0.891(N.S)
map	95.3	11.79	96.18	11.23	0.864(N.S)
hr	78.03	7.08	78.50	7.16	0.935(N.S)
perfusionindex	5.95	1.34	5.78	5.67	0.982(N.S)

Table 5: comparisonofbaselineparameterwithafter2nd topup

Parameters	Baseline		after2nd topup		p-value
	Mean	SD	Mean	SD	
sbp	116.7	14.04	130.55	14.01	0.0001*
dbp	77.08	8.41	85	7.14	0.0001*
map	95.3	11.79	101	9.06	0.0001*
hr	78.03	7.08	91.5	5.22	0.0001*
perfusionindex	5.95	1.34	4.3	1.2	0.0001*

Table 6:comparison of baseline parameter with before 3rd top up

Parameters	Baseline		before3rd topup		p-value
	Mean	SD	Mean	SD	
sbp	116.7	14.04	119.73	8.31	0.58(N.S)
dbp	77.08	8.41	76.18	5.74	0.57(N.S)
map	95.3	11.79	88.09	7.06	0.061(N.S)
hr	78.03	7.08	81.18	3.6	0.132(N.S)
perfusionindex	5.95	1.34	5.47	0.86	0.056(N.S)

Table 7: comparison of baseline parameter with after 3rd top up

Parameters	Baseline		after3rd topup		p-value
	Mean	SD	Mean	SD	
sbp	116.7	14.04	135.55	10.96	0.0001*
dbp	77.08	8.41	84.45	8.39	0.0001*
map	95.3	11.79	98.91	12.42	0.0001*
hr	78.03	7.08	93.36	4.78	0.0001*
perfusionindex	5.95	1.34	3.77	1.15	0.0001*

Table 8: comparison of TOF score of before top up and after top up

TOFscore	Mean	Sd	p-value
Before1topup	0.34	0.09	0.0001*
After1topup	0.59	0.11	
Before2topup	0.36	0.12	0.0001*
After2topup	0.62	0.14	
Before3topup	0.3	0.8	0.0001*
After3topup	0.63	0.13	

Correlation between PI and TOF is r=0.51(p=0.001*)

DISCUSSION

Neuromuscular blocking agents are usually administered during anaesthesia to facilitate endotracheal intubation and to improve surgical conditions.Neuromuscular block should be monitored for all patients who receive neuromuscular blocking agents during anaesthesia,to guide dosing of neuromuscular blocking agents and reversal agents, and to assess the degree of recovery.This monitoring can be done by quantitative methods(accelerometry,electromyography,kinemyography) and qualitative method (TOF).However,the use of neuromuscular monitoring is not yet a consolidated standard in clinical routine and also clinicians do not use it routinely because of the cost of the devices,the lack of adequate training.This condition increases the risk of postoperative morbidity due to the residual effects of neuromuscular blocking drugs.In our study we used Train Of Four monitor to assess the neuromuscular block and the requirement of neuromuscular agent intra-operatrively and to compare the changes in perfusion index with TOF score while giving intra-operative neuromuscular relaxation.

Perfusion Index is an indirect and non-invasive measurement of peripheral perfusion normally monitored with pulse oximeter.It has been used for successful nerve block,to predict hypotension after spinal anaesthesia and to assess and manage surgical pain .On this premise we hypothesized that Perfusion Index may vary when the neuromuscular block is reduced enough as indicated by variation in vitals,breathing movements in reservoir bag and TOF monitor.Hence we planned a study to compare the changes in Pefusion Index with TOF score while giving intra-operative neuromuscular relaxation and to assess the neuromuscular block using TOF monitor.

In our study, the change in mean arterial pressure before giving1st ,2nd and 3rd top-up of neuromuscular blocking agent was not significant (p value >0.05) when compared with baseline values at all time intervals.However,siginificant increase in the above parameter was seen at the time of giving top up at all time intervals (p value<0.05).

The changes in systolic blood pressure before giving top up of neuromuscular blocking agent was not significant (p value >0.05) when compared with baseline values at all time intervals.There was significant increase seen at the time of giving the 1st,2nd and 3rdmaintainence dose at all time intervals(p value <0.05).

There was no significant difference(p value>0.05) seen between baseline diastolic blood pressure and diastolic blood pressure recorded before 1st,2nd and 3rd top up.At the time of giving the maintainence dose the increase seen was statistically significant at all time intervals(p value<0.05).

The change in baseline heart rate was not significant (p value>0.05) when compared with values recorded before giving 1st,2nd and 3rd top up.There was a significant increase (p value <0.05)seen at the time of giving top up at all time intervals compared with baseline heart rate.A study done by **Colema AJ et al.,(1980)** to study the cardiovascular effects of anaesthesia and Beta adrenergic blockade by metoprolol among 3 study goups.In group **1** patients metoprolol was not given after induction and increases in blood pressure and heart rate was significant following laryngoscopy and intubation which was reduced by deep anaesthesia and blocked by phentolamine.In group 2 and 3 intravenous metoprolol 2mg and 4mg respectively was given prior to induction and changes in heart rate and blood pressure were either reduced or not increased significantly and concluded that metoprolol was effective in blunting the hemodynamic response to endogenously released catecholamines.Another study done by **King BD et al.,(1951)** with the purpose to record and evaluate the cardiovascular changes during light and deep anaesthesia and concluded that during light anaesthesia direct laryngoscopy or tracheal intubation is capable of producing rise in blood pressure and heart rate.While as deeper ananesthesia obtunds or abolishes these phenomena.

The Perfusion Index also did not show any statistical significant change(p value>0.05) before giving the 1st,2nd and 3rdmaintainance dose of neuromuscular blocking agents when compared with baseline value.However at the time of giving top up the decrease in perfusion index was significant (p value <0.05) at the time of giving 1st,2nd and 3rd top up.A study done by**Shah PN et al.,(2023)** to assess changes in PI during endotracheal intubation and extubation.they recorded the hemodynamics and PI pre-intubation,post-intubation,during neuromuscular block reversal,pre-extubation and post extubation.Similar to our study they found significant change in PI at all intervals with maximum decrease in PI occurring during neuromuscular block reversal(42.6% at the start and 56.7% at the end of neuromuscular block reversal).A negative correlation was noted between PI and the other non-invasive hemodynamic parameters.

The temperature and oxygen saturation remained more or less near the baseline values at all times showing no significant difference(p value>0.05).

The TOF score recorded before giving the 1st,2nd and 3rd top up was reduced significantly(p value<0.05).However,the TOF score recorded at the time of giving top up was increased significantly(p value<0.05) compared to the score recorded before giving top up.

In our study the patients were provided with adequate analgesia and amnesia throughout during the intra-operative period and the changes in TOF score at the time of giving maintainence dose was due to reduced level of neuromuscular blockade.The findings of our study show that TOF monitor can be used for assessing the need for neuromuscular blocking agent intra-operative.The changes in the hemodynamic parameters also match up with the changes in TOF score.Also the change seen in Perfusion Index was similar at the time of giving neuromuscular blocking agents and the changes in Perfusion Index correlated with TOF score and may be used in future for intra-operative neuromuscular block monitoring.

LIMITATIONS

In our study all the patients were normtensive ,therefore we cannot be sure whether hemodynamic response in hypertensive patients will be same or exaggerated.The invasive blood pressure should have been ideal.The study was done in a single center with a limited sample size.We did not use any monitor to assess nociception intra-operatively.

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ABBREVIATIONS

Perfusion Index-Pi
Systolic Blood Pressure-Sbp
Diastolic Blood Pressure-Dbp
Mean Arterial Pressure-Map
Heart Rate-Hr
Train Of Four-Tof
Neuromuscular Blocking Agent-Nmba
Oxygen Satutaion-Spo2