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Comparison of Electromyography and Kinemyography in Recovery from Non-Depolarising Neuromuscular Blockade

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Background and Objectives

This is a preliminary study to compare two techniques for monitoring residual neuromuscular blockade.
Neuromuscular Blocking Drugs (NMBD) are frequently used as part of an anaesthetic technique. Extreme interpatient variability is the result of pharmacodynamic and pharmacokinetic differences. Recent publications have recommended that quantitative (objective) neuromuscular transmission monitoring (NMT) be used in every case of neuromuscular blockade to reduce the effects of residual blockade.[1] The best technique for this has not been clearly established.[2] This study compares two commercially available monitoring techniques, electromyography (EMG) and kinemyography (KMG) during recovery from shallow non-depolarising neuromuscular blockade. They were compared using Repeatability, Bias and Limits of Agreement.

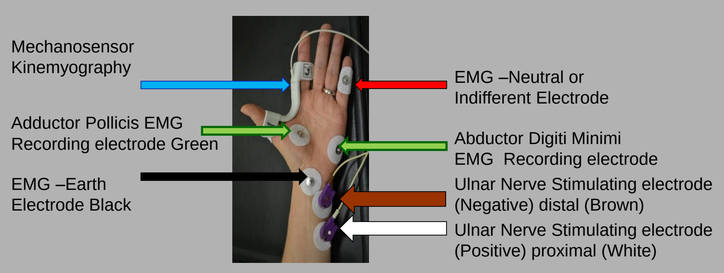
Datex Ohmeda Monitor

Complete and clear display of all information on the recovery from neuromuscular blockade on one screen on a single integrated monitor.

Residual Neuromuscular Blockade (RNMB), now defined as a Train of Four (TOF) Ratio of less than 0.9 or 90 % using mechanomyography, has long been recognised as a common and potentially serious complication of anaesthesia.[3] An incidence of up to 88% has been reported using acceleromyography.[3] The complications of RNMB including ventilatory depression, airway obstruction, hypoxia and aspiration of gastric contents, delayed discharge from PACU and post operative pulmonary complications have been demonstrated in volunteer studies, data base studies and clinical studies.[3]

Methodology

Ethics Committee Approval was received and patient consent obtained. Anaesthetic technique was at the discretion of the anaesthetist. Stimulating surface Ag/AgCl electrodes were attached to the cleansed skin on volar side of the distal forearm. The negative (brown) electrode 1 cm proximal to the proximal wrist skin crease on the lateral side of the flexor carpi ulnaris tendon over the ulnar nerve and the positive (white) electrode positioned a further 3 to 5 cm proximally and slightly offset across the ulnar nerve. The supramaximal stimulus was determined prior to administration of the NMBD. A TOF stimulus with square wave pulse width of 200 µsec was delivered at 2 Hz with the cycle repeating with Datex Ohmeda NMT monitor.



The cycle time was set at 20 seconds, with three sequential recordings of KMG at the Adductor pollicis (AP) and then from EMG sensors over the Adductor pollicis (AP), Abductor Digiti Minimi (ADM) and the First Dorsal Interosseous (FDI) during spontaneous recovery in each muscle group. Then the cycle was repeated. If neostigmine was administered then one recording with each group was made each twenty seconds. Sugammadex provides such rapid and complete reversal from all depths of NMB that comparisons could not be made for this study. Hand temperature was kept above 32 º C.

Results

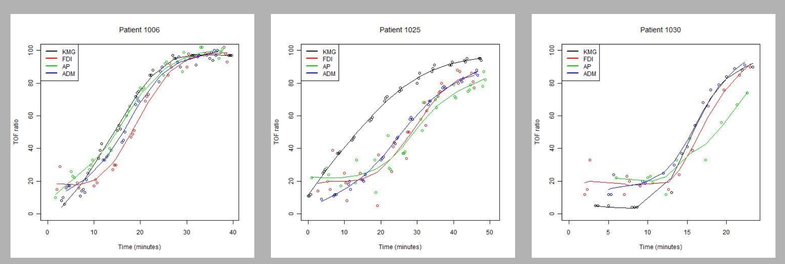
Demographics	n=21
Age: mean (range)	51.2 (16-85)
Gender - F : M	13:8
BMI:mean (range)	27.9 (20.3 – 43.3)

Repeatability

	Coefficient of repeatability (CR)
KMG (mechanosensor)	3.5 %
EMG AT ADM [4]	4.4 %
EMG AT AP [4]	5.9 %
EMG AT FDI [4]	5.8 %

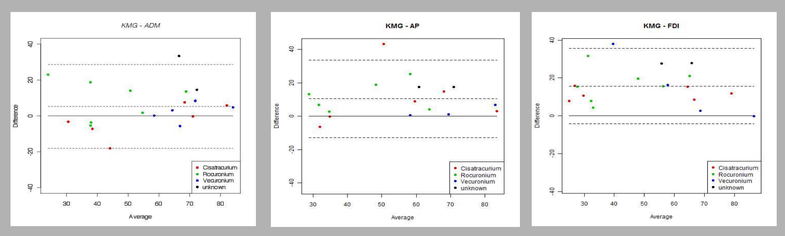
95% of differences between two single measurements will be below the Coefficient of Repeatability. All methods show acceptable repeatability. The measurements from Datex Ohmeda KMG –M-NMT and EMG monitor at ADM are, however, more repeatable than measurements from the EMG monitor at FDI and AP.

Examples of graphs of TOF recovery against time



Bias and Limits of Agreement

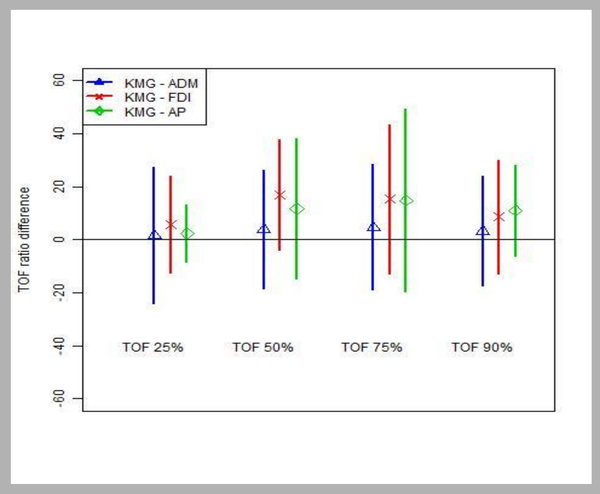
These were calculated as described by Bland and Altman.[5] For each subject, the difference between pairs of corresponding measurements was plotted against the average. The corrected SD was calculated from repeated measurements.
The upper and lower limits of agreement was defined as 2 SD either side of the mean. (upper and lower dotted lines in the three graphs below).



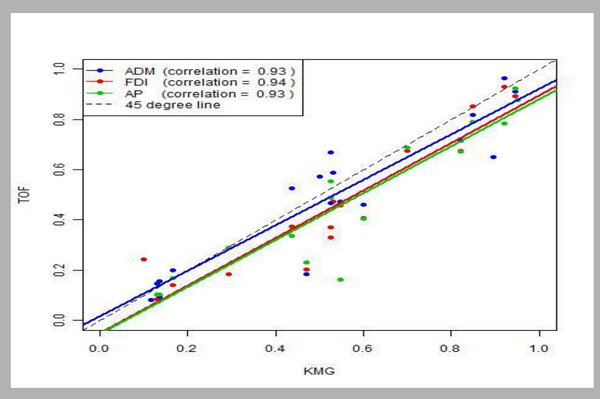
Three plots of the bias and limits of agreement across all TOF.

At (mean of KMG - EMG) TOF of 0.9 or 90 %	BIAS	CONFIDENCE INTERVAL 95 %
EMG ADM	3 %	-17 % to 24%
EMG AP	11 %	- 6 % to 28 %
EMG FDI	9 %	-13 % to 30 %

Bias compared with KMG



Graph of bias and limits of agreement at different TOF % (KMG-EMG). Note the limits of agreement and bias vary according to TOF



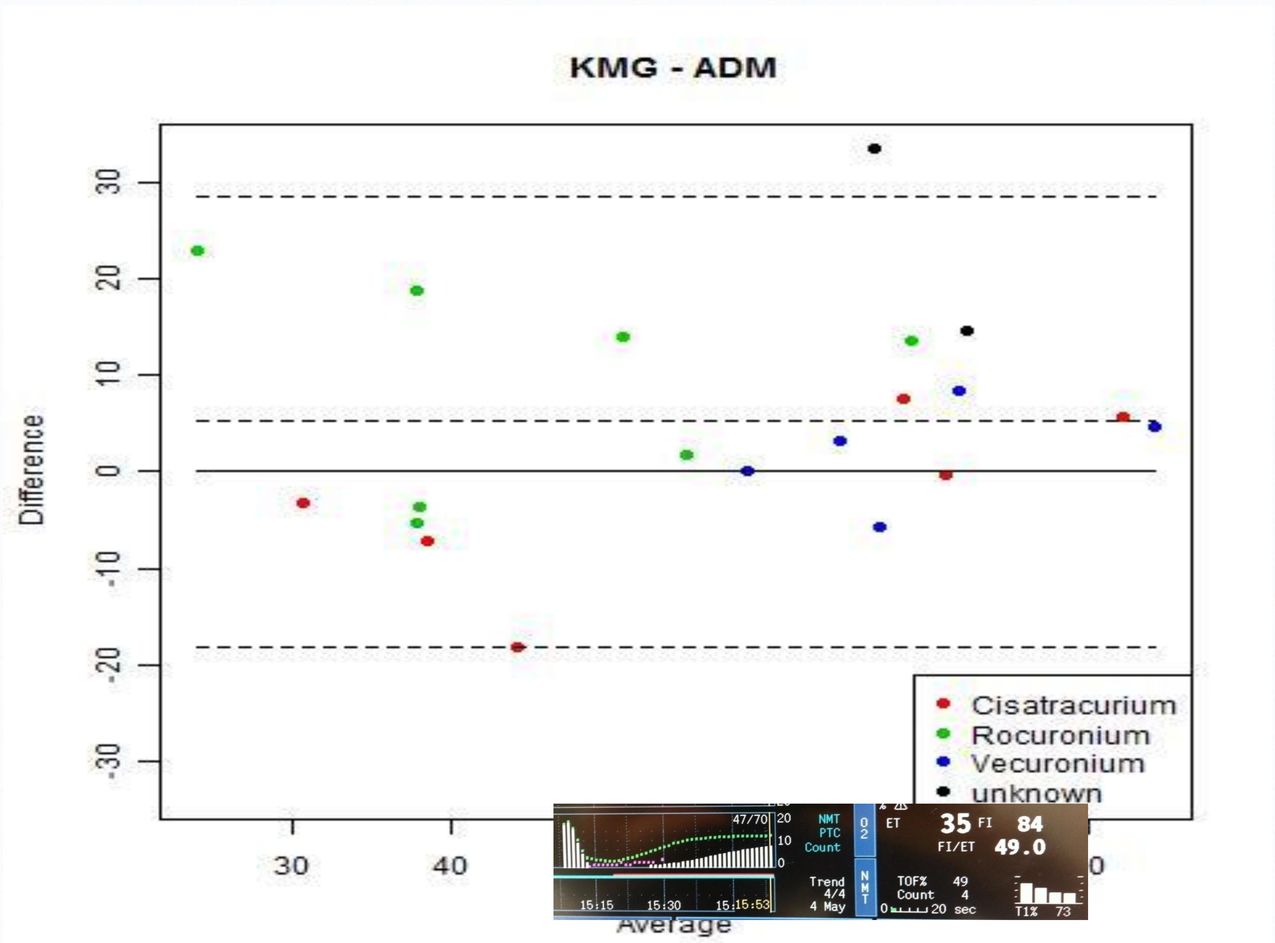
Scatter plot of KMG TOF ratios against TOF of ADM, FDI and AP over the entire range of values.

Conclusion

• KMG is the most **repeatable** technique but the repeatability coefficients of all measures are acceptable.
•At TOF of 0.9 the KMG shows the **best agreement** with the EMG ADM reading. KMG is only 3% higher than EMG ADM, on average, compared with 11% higher than EMG AP, and 9% higher than EMG FDI.
•AP and FDI are **more sensitive** to non-depolarising NMBAs since they are slower to recover.
•Datex Ohmeda KMG – Mechanosensor and the Datex Ohmeda EMG - Electrosensor are **suitable** for use in clinical practice.
•Integration into the standard monitor with a graphical display of EMG and KMG allows **easy interpretation** of the level of NMB.
•A **Record** of TOF data can be printed graphically or numerically.
•The **limits of agreement** are wide, but may be reduced by meticulous attention to technique. It may be due to movement artefact in the EMG recordings and some researchers recommend that the muscle recorded should be immobilised with tape. The KMG sensor must be allowed to move freely and it should be ensured that its position does not change. should be paid to electrode position. Correct electrode position is essential.

References

1.Viby-Mogensen J, Claudius C, Anaesthesia & Analgesia 2010;111(1)
2.Viby-Mogensen J, Claudius C, Anesthesiology, 2008 ;108(6)
3.Murphy GS, Brull S, Anesthesia & Analgesia 2010;111(1)
4.Phillips S, Stewart P, ASA 70th Scientific Congress Sydney 9th September 2011
5.Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* 1986; **8**: 307–313


KMG - ADM
Difference
Average
30
20
10
0
-10
-20
-30
30
40
Cisatracurium
Rocuronium
Vecuronium
unknown
47/70
NMT
PTC
Count
Trend
4/4
4 May
15:15
15:30
15:15:53
O2
NMT
ET
35
FI
84
FI/ET
49.0
TOF%
49
Count
4
20 sec
T1%
73