Motion Generated by Machine or by Volunteer to Study Accuracy of Motion Resistant Pulse Oximeters - Does It Matter?

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Introduction

Reliable performance of Pulse Oximeters (PO) during motion artifact is critical. "Motion resistant" POs are available that claim to function better during motion. These POs have been studied in volunteers under conditions of either machine generated motion (MGM) or volunteer generated motion (VGM). The literature is not clear whether the method used to test POs will make a difference or not in their performance. This study compares the performance of three motion resistant POs duirng MGM and VGM in volunteers during normoxia and hypoxia.

Methods

After IRB approval, 9 ASA I volunteers (5 M, 4 F) between the ages of 18-40 years were consented and enrolled. Masimo Radical (v. 4.3), Philips CMS (rev C1), & Nonin 9700 (2004) were studied. Sensors were placed on index, middle, & ring fingers of both the right hand (control) and left hand (test). Sensors were covered to prevent optical cross-talk & to shield from extraneous light. The room was cooled down to 16-18 degree C to reduce peripheral perfusion. All POs were tested on each of the three fingers. A Masimo Radical PO placed on the right ear served as the control during hypoxia. During normoxia, MGM included tapping at 3 Hz with disconnect-reconnect of the sensors, random tapping, tapping at 3Hz & random rubbing. VGM included random tapping with disconnect- reconnect & random rubbing. Hypoxia was induced by employing a disposable rebreathing circuit with a CO2 absorber to a SpO2 of 75% & the volunteer was then given 100% oxygen until the control SpO2 reached 100%. During hypoxia, MGM consisted of tapping at 3Hz, tapping at 3Hz with disconnect-reconnect of the sensors, random tapping with disconnect-reconnect, & random rubbing. VGM included random tapping with disconnect-reconnect & random rubbing. Pulse Rate (PR) & SpO2 data were recorded on-line for off-line analysis.

Parameters calculated were % of time when SpO2 was Off by 7% (off 7) & PR was Off by 10% (off 10), % of time when the POs Zero Out SpO2 &/or PR (when the PO displays -- or zero), Missed event (ME) during hypoxia (inability of the PO to detect a desaturation event by the time the control PO reached 100%), False alarm (FA) during normoxia (SpO2 of 90% or less during motion), Recovery time (RT) (the time required for the POs to recover for SpO2 & PR to the control value), & Failure rates (FR) (% of time the POs displayed values off by 7% for SpO2 & 10% for PR of control value at the end of the motion). All of these variables were calculated differently for MGM & VGM. Multivariate & Univariate ANOVA, Fischer's post hoc test were employed for statistical comparison and $p < 0.05$ was considered statistically significant.

Results

There were a total of 189 motion tests (117 during MGM & 72 during VGM) when POs could fail. The tables show our results.

Conclusion:

Multifactorial ANOVA revealed no difference between the motion types except for zero out of SpO2. This lack of difference suggests that the POs perform similarly regardless of the use of MGM or VGM and that therefore MGM may be used to simulate VGM.

SpO2

Motion Type	Off 7 (%)	Zero Out (%)	RT (Seconds)	FR (%)	ME	FA
MGM	7.5	1.6	24.2	6.8	20	11
VGM	8.5	3.6*	15.8	7.8	11	15

* = p<0.05 versus MG

Pulse Rate

Motion Type	Off 10 (%)	Zero out (%)	RT (seconds)	FR (%)
MGM	12.1	2.1	19.2	7.9
VGM	14.2	6.6	9.7	9.2