A Comparison of Finger, Ear and Forehead SpO_2 on Detecting Oxygen Desaturation in Healthy Volunteers.

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Introduction

Forehead reflectance oximetry has been marketed as having a faster response to changing oxygen saturations compared to standard digit pulse oximetry. In this study, Tokuda and coworkers compare the response times to changing SaO_2 of a Masimo LNOP digit sensor, a Nellcor MaxFast forehead sensor and a Masimo TC-1 ear sensor in healthy subjects during breath-holding while in three body positions; head-down, supine and head-up.

Methods

Eight healthy volunteers each wore a Nellcor MaxFast forehead sensor with headband, a Masimo TC-1 ear sensor and a Masimo LNOP digit sensor, connected to the appropriate pulse oximeters and a computer to record data every second. To test the response time to desaturation and resaturation of each pulse oximeter and sensor pair, subjects were instructed to take a deep breath then hold it for as long as possible while in head-up, head-down and supine positions. Recorded data was then analyzed with a Kruskal-Wallis or Wilcoxon Signed Ranks test, as appropriate.

Results

Observed SpO_2 and time for desaturation and resaturation in three positions

Position	SpO_2 Site	Time for desaturation (sec)	Time for start of resaturation (sec)
Head-down	Finger	122.4 ± 42.6	17.2 ± 6.2
	Forehead	111.9 ± 43.4 †	9.6 ± 3.2 ‡
	Ear	112.6 ± 41.1 ‡	10.5 ± 2.2 ‡
Supine	Finger	137.9 ± 51.3	18.8 ± 4.2
	Forehead	134.7 ± 49.2	10.3 ± 2.5 ‡
	Ear	131.0 ± 51.3 †	10.5 ± 2.1 ‡
Head-up	Finger	142.6 ± 46.2	19.5 ± 5.0
	Forehead	136.4 ± 44.9	10.6 ± 3.3 ‡
	Ear	133.8 ± 47.2 †	9.7 ± 3.3 ‡

Data are expressed as mean ± SD. * $P < 0.05$ compared with each other. † $P < 0.05$ and ‡ $P < 0.01$, compared with the finger SpO_2 at each position. Time for desaturation is the interval from the beginning of breath-holding to SpO_2 declining below 90%. Time for resaturation is the interval from the end of breath holding to SpO_2 exceeding minimum value.

While in the head-down position, the ear and forehead sensors detected desaturations significantly faster than the digit sensor. In the supine and head-up position, the ear sensor but not the forehead sensor was significantly faster than the finger sensor. For detecting the time until recovery, both the ear and forehead sensor were significantly faster than the digit sensor.

Conclusions

Forehead reflectance oximetry has been marketed as being faster to changes in oxygen saturation and not prone to the effects of low peripheral perfusion compared to digit transmission pulse oximetry, but its accuracy can to be significantly impaired by venous pooling in supine patients. The ear lobe is a central site where transmission oximetry can be used, thus avoiding low perfusion problems that can affect oximetry from the finger or toe and the accuracy problems that plague forehead reflectance oximetry. This study shows that the Masimo ear sensor is as fast or faster than the Nellcor forehead sensor in detecting desaturations and resaturations in healthy subjects.