NEUROVASCULAR RESPONSES TO SEQUENTIAL DEEP INSPIRATIONS ASSESSED VIA LASER-DOPPLER PERFUSION CHANGES IN DORSAL FINGER SKIN

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INTRODUCTION

BACKGROUND: A vasomotor reflex that is triggered by a rapid and deep inspiration causes an acute vasoconstriction and induces a transient decrease in skin blood flow. Reports of this phenomenon appeared over 50 years ago, but many details of the sympathetic neural pathways involved are not yet known. Although the reflex causes vasoconstriction, an initial small blood flow increase may precede it and often a flow increase follows (Figs 1-4). This inspiratory gascy vascular response (IGVR) has most often been measured on plantar aspects of toes and fingers with laser-Doppler or photoplethysmography and has been used to study aspects of neurovascular function in many conditions including diabetes, Raynaud's phenomenon, erythromelalgia and leprosy.

RATIONALE: An important issue related to the use and interpretation of IGVR findings is its variability within the same subject and among subjects. Factors that may affect the magnitude of vasoconstrictive component include skin temperature, age, gender and vital capacity. This variability may represent an intrinsic limit to the utility of the IGVR tests. However, systematic studies of the magnitude of variability and its implications for experimental design & interpretation of findings are sparse. Such variability affects the ability to detect possible differences when comparing normal subjects to patient groups and also affects the ability to detect changes that might be induced by rapidly acting therapeutic interventions in patients with suspected neurovascular deficits.

OBJECTIVES: The present study was undertaken to characterize key features of normal IGVR variability and to explore sampling strategies that might minimize the impact of this variability. Specifically, it was our initial objectives to:

1. Estimate the effect of the number of sequential IGVR samplings on the precision of repeat measurements and the variability among subjects
2. Estimate the extent to which IGVR sample size affects the ability to detect acute changes in IGVR responses that would be associated with acute interventions in individual subjects.

METHODS

SUBJECTS: Twenty-eight volunteers (14 male) were studied. Subjects had no history of cardiovascular or respiratory abnormality, hypertension or diabetes.

PROCEDURES: Subjects sat in a height adjustable chair with hands placed palm down on a support surface. A laser-Doppler probe was placed on the right index finger dorsum (Fig 1A). A small thermocouple was placed under the probe and the finger wrapped with elastic self-adhering bandaging material (Fig 1B). The hand was covered with a towel and skin temperature monitored. Testing began when a steady state was reached (15-20 min).

RESULTS

The strategy of Fig 4 has 19 triplicate samples for each of the 28 subjects. Each sample-set yields a separate estimate of mean IGVR for that subject. To estimate an overall SD, the SD of the mean estimated of each sample-set is averaged across subjects and the average of these 19 is used as an estimate of the overall SD of the mean IGVR for the full group. The same approach was used for samples-set sizes of 1, 2, 4, 5, 6 and 10 sequential IG samples.

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Effects of IG sample-set size on the ability to detect acute changes were estimated with set sizes of 1, 2, 5 and 6 IGVR samples. Each set, SD of differences between 1st & 2nd sets were used. As the goal was to estimate detectable levels of change between "baseline" and an "intervention", 1st sets simulated baseline & set starting at 10 & 20 minutes afterwards simulated intervention responses. The diagram shows a 20" separation example. For triplicate samples, responses 1-3 are the 1st set & responses 4-10 are the response set on so up to a sample-set size of. The method was used to estimate a minimum number of subjects needed to detect an IGVR change of either 10 or 20% of the overall mean for a = .05 and a power of 90%.

CONCLUSIONS

1. In this group of 28 healthy subjects the overall mean perfusion decrease induced by 21 sequential inspiratory & expiratory movements measured at the finger dorsum was 72% of each responses immediately preceding two-minute baseline blood perfusion. This magnitude of IGVR is comparable to values reported for those obtained at finger palmer surface that is rich in arterial-venous anastomoses (AVAs). This suggests that the magnitude of the IGVR is not fully dependent on AVA presence.

2. Variability of IGVR, within and across subjects, depends on the N of sequential sample-sets used in the estimation of IGVR and on the time separation between sample-sets for within subject measures.

3. The ability to statistically detect differences in IGVR between normals and patients with suspected neurovascular deficits thus depends on the number of IGVR samples used to characterize the mean response and on the number of subjects N.

4. Similarly, the ability to detect acute changes in IGVR, potentially associated with effects of rapidly acting therapeutic interventions that modify IGVR, depends on the IG sample-set size, the correlation between time separated sample-sets and on N.

5. The analyses provide a framework for, and specific estimates of, the minimum N needed to detect specified IGVR differences between groups or changes in IGVR after such interventions.

6. Applying these findings to results reported in the literature suggests that some previously drawn conclusions lack suitable statistical underpinnings.

REFERENCES


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