Alpha power decreases with age during isoflurane anesthesia

Hight, D.,[1] Stucki, M.,[1] Krejci, V.,[1] Lersch, F.,[1] Hartwich, V.,[1] Rummel, C.,[1 2] & Kaiser, H.[1]

1. University Hospital of Bern (Inselspital), Bern, Switzerland, 2. University Institute for Diagnostic and Interventional Neuroradiology, University Hospital Bern (Inselspital), Bern, Switzerland.

Introduction:

Alpha power (8 – 12 Hz) in the frontal electroencephalogram (EEG) during general anesthesia is thought to originate from thalamocortical oscillations, and decreases with increasing age (1). To date, this relationship has not been examined during isoflurane anesthesia. It is also unclear to what degree alpha power loss with ageing is dependent on the anesthetic concentration at the time point of sampling, as this factor has been reported, but not controlled for.

Methods:

We analyzed preliminary data from 987 patients undergoing isoflurane anesthesia for cardiac surgery (EPOCAS study (NCT02976584)). In Matlab® (R2016a) initial spectra were calculated from two-second (non-overlapping) artefact and burst-suppression free sections of pre-bypass frontal EEG using the Fast Fourier Transform ('spectrogram.m'). Alpha power was the mean of the alpha range. Three sampling strategies were tested: (i) non-bounded, where all spectra were included in the final patient mean spectrum, (ii) VGA (Volatile Gas Anesthetic) bounded, where only spectra where the VGA concentration was within a ± 0.1 % isoflurane range were included, and (iii) C_eMAC-bounded, where only spectra where the age-adjusted effect-site estimated (C_e) MAC (Minimal Alveolar Concentration) was within a ± 0.1 C_eMAC range around the median were included in each final patient spectrum. We used an end-tidal to brain diffusion model with a half-life of 144 seconds to estimate effect-site anesthetic concentrations (MAC) which were then age-adjusted according to Mapleson (2).

Results: In all patients, median patient age was 67 years (Inter-quartile range (IQR): 15).

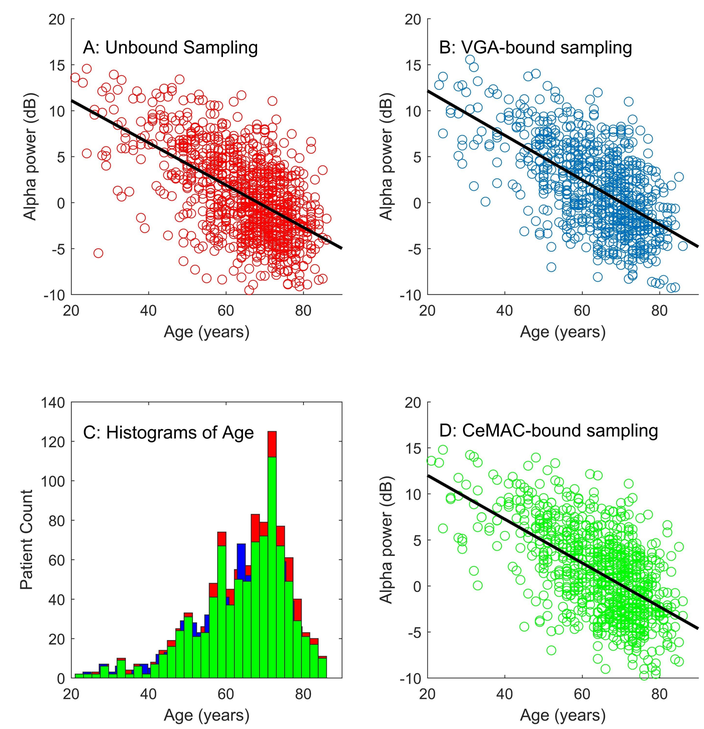

Figure 1: Relationship between Age (in years) and Alpha Power (in decibels, dB) for three sampling strategies: (A) unbounded, (B) sampling bound to volatile gas anesthetic (VGA) isoflurane values between 0.7 and 0.9 %, and (D) sampling bound to effect-site age adjusted MAC values between 0.67 and 0.87 MAC. Section (C) shows a histogram of patient ages for all three sampling strategies.

Median VGA concentration was 0.8 % isoflurane (IQR: 0.3 %), and median age-adjusted effect-site MAC was 0.77 (IQR: 0.24). Alpha power decreased with increasing age in the unbounded ($R = -0.58$, $R^2 = 0.34$, $p < 0.001$) and in both bounded sampling strategies (VGA-bounded: $R = -0.60$, $R^2 = 0.36$, $p < 0.001$; C_eMAC-bounded: $R = -0.59$, $R^2 = 0.35$, $p < 0.001$), as shown in Figure 1. The strength of these associations are similar to previously published values for both propofol ($R = -0.65$, $R^2 = 0.43$, $p < 0.01$) and sevoflurane ($R = -0.68$, $R^2 = 0.46$, $p < 0.01$) (2). In the two bounded sampling strategies, 222 and 130 patients (in the VGA- and C_eMAC-bounded groups respectively) did not have EEG sections fitting the restricted criteria, and fell out of the analysis, but the median age was the same for all strategies.

Conclusion:

Alpha power decreases with age during dependent isoflurane anesthesia, and the alpha-age relationship is not on sampling strategies.

References:

(1) Purdon, P. L., et al. The Ageing Brain: Age-dependent changes in the electroencephalogram during propofol and sevoflurane general anaesthesia. British Journal of Anaesthesia (2015), i46–i57

(2) Mapleson, W. W. Effect of age on MAC in humans: a meta-analysis. British Journal of Anaesthesia (1996), 179 – 185.