Background

Awareness under general anesthesia (GA) is a dreadful complication\(^1\). Various EEG-based technologies (like BIS) were developed in order to identify it \(^2\). However, studies assessing BIS been unable to demonstrate detection of awareness. Moreover, BIS is influenced by the effect of muscle activity \(^3\), further confounding its ability to detect anesthesia depth, especially under sedation. Previous studies shown that alpha activity anteriorizes under anesthesia, thus the process of anteriorization might correlate also with the depth of anesthesia and sedation \(^4\). We developed a novel index, posteriorization/anteriorization (P/A) index, based on analyzing auditory evoked
EEG signal from posterior versus anterior EEG channels (O1, O2/ F3, F4). Due to low % of recall under GA, we elected to assess recall in surgical patients undergoing sedation in order to validate this novel evoked EEG index.

In this pilot study, we hypothesized that the new index would differentiate between patients with or without recall under sedation.

Methods

With institutional ethics approval (NIH number: NCT02938325), we assessed 26 patients undergoing sedation. We utilized awake volunteers (n=14) and patients under GA (n=12) as positive and negative controls for recall, respectively. During the surgery evoked EEG and BIS were recorded. All participants were assessed for recall using the BRICE questionnaire. Data were analyzed by one-way ANOVA on ranks and linear regression.

Results

Of the 26 sedated patients, 18 received midazolam [MD] and 8 received propofol [PR] as the primary sedating drug. Recall was identified in 100% of awake patients and in none of patients who received general anesthesia. Twelve patients in the sedated MD group experience recall [MD+R]. None of the patients sedated with propofol experienced recall.

The P/A index was able to differentiate between patients with recall (MD+R) (median 66.75, IQR 53-78) and those with no recall (MD-R) (median 27.5 IQR 15.5-50, p=0.006). There was no relationship between PA index and EMG (P=0.693 R 2 = 0.009) (figure1A, C). By contrast, BIS could not separate between [MD+R] (median 83.5 IQR 81.5-84) and [MD-R] (median 69.76, IQR 67-83, p=0.348). Further, linear regression showed that EMG contributes 31% for the variation of the data to BIS (P=0.013 R 2 = 0.311) (figure 2A, B). The area under the receiver operating curve (ROC) was 0.9583 for the P/A index.

Discussion

In this pilot study, we evaluated the ability of a novel evoked EEG P/A index to predict recall under sedation. Within midazolam-induced sedation, the P/A index was able to discriminate between patients with recall vs. those without recall. This ability to detect recall was not influenced by muscle activity. Further research is required to further validate this novel index.
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References:

3. *BJA* 2015; 115 Suppl 1:i95-i103
5. *Frontiers in Human Neuroscience.* 2013; 7

BIS and P/A index description in midazolam group and in correlation to EMG

A. Comparison in P/A index and in BIS separately, between Yes/NO recall in patients in the MD group, using Rank Sum Test. Left: BIS can not differentiate between patients with recall (median 85.5, IQR 81-89.25) or without recall (median 69.76, IQR 67-83, p=0.348). Right: A/P index differentiate between patients with recall (median 66.75, IQR 53-78) or without recall (median 27.5 IQR 15.5-50, p=0.006). B. BIS in correlation to EMG in Awake volunteers. All Data points: P=0.013 R2 =0.311 . Thus, the relationship between EMG and BIS Index accounts for 31% of the variation of the data. C. P/A in correlation to EMG in Awake volunteers. All Data points: P=0.693 R2 = 0.009. Thus, The relationship between EMG and AP Index accounts for 0.9% of the variation of the data.