Assessing BIS Stimulation Response and BIS Monitor Delay during Sedation

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Introduction

This study was part of a project using the BIS monitor to assess the speed of onset of a variety of intravenous sedative agents in children. The Bispectral Index Monitoring [Figure 1] System (BIS) is an EEG providing a numerical value to measure a sedated patients' level of hypnosis. There is a BIS monitor analysis delay that may interfere with correlation between clinical events and their actual BIS values.

This study had 3 components to it, firstly to evaluate the delay between BIS EEG data acquisition and it's post analysis display on the monitor (BIS delay) after a painful stimulus. Secondly to assess the amount of BIS data in the data stream (Buffer) after probe disconnect, and thirdly, what level of sedation depth (i.e. BIS value) may obtund the response to either a sharp stimulus or a pressure like stimulus in patients undergoing deep sedation.

Methods

After IRB approval and informed consent, patients recruited for a BIS monitored hypnosis onset sedation bolus response were also assessed for this BIS project. Inclusion criteria were patients of ages 10-17 undergoing a surgical extraction under deep intravenous sedation (Table 1). Exclusion criteria were BMI greater than 30, complex medical history (ASA greater than II), patients who report using recreational drugs, and patients on multiple psychotropic or seizure medications. All patients received the same sedative based regimen: Midazolam, Fentanyl and Propofol. Sedation doses were age and weight based (Table 2). The only difference was the sequence of sedative administration prior to procedure start. On initial local anesthetic placement and initial surgical extraction, the BIS monitor to computer data stream was real-time highlighted. The BIS probe was also disconnected to assess the stored buffer both during and after the procedure. Patient movement in response to either stimulation was assessed by two observers.

Results

36 pediatric patients were recruited for this study. The average age was 15.1 years with an average BMI of 21.9 (Table 1), 64% were ASA 1 and 56% were female. The procedure had an average sedation time of 8.5 minutes with an average procedure time of 16.0 minutes and recovery time of 34.8 minutes until patient discharge (Table 3). For the first stimulus (STIM 1), a "sharp" stimulus of initial palatal local anesthetic administration, 40% of patients were reported to move (Table 4). As seen in [Figure 2], all three groups had an increase in BIS score after the initial stimulus. There was no significant difference between the three different groups. From those patients, the average time from the highlighted stimulus to a detectable BIS increase was 26.8 seconds. Since the BIS time works in five second intervals, this suggests the BIS delay is about 25 seconds. For STIM 2, a "pressure" stimulus of initial elevation of the tooth, 50% of patients had reported movement (Table 5). Similarly to the first stimulus, an increase in BIS score was also noted [Figure 2]. There was also no noted difference between the three groups. Of those patients, the average time between the reported stimulus and the elevated BIS score was 29.2 seconds. At two instances (in the middle and end of the procedure), the BIS probe was disconnected to assess the stored buffer. The average duration of time from when the probe was disconnected until there was no longer a BIS score was 50 seconds (Table 6). However, it usually takes about half of that time (about 25 seconds) for the signal quality to decrease below an accepted value. Furthermore, when examining the pharmacokinetic blood levels of each group [Figure 3], there was no significant difference between each of the groups in respects to propofol levels between the first and second stimulus. In respect to the midazolam levels, there was no change in either Midazolam group; however, a decrease is noted after the second stimulus in the Fentanyl group. A decrease of fentanyl is noted in all three groups after the second stimulus. There was variability in the BIS response to STIM (Table 7). Of note, a BIS of < 55 was predictive of non-movement in response to STIM 1 (Table 8), however after the LA was placed the BIS did not predict movement with STIM 2.

Figure 1. BIS monitor and BIS Probe

Table 1 DEMOGRAPHICS	AGE (YEARS)	WEIGHT (KG)	BMI	DOSE WT (KG)
AVERAGE	15.1	63.8	21.9	60.4
SD	1.8	14.4	3.7	11.7
MEDIAN	15.0	62.9	22.0	60.6
MIN	11.0	30.0	13.0	30.0
MAX	17.0	98.5	28.6	85.9

Table 2 SEDATION USE	TOTAL MID (mg)	TOTAL FENT (mcg)	TOTAL PROP (mg)
AVERAGE	4.6	97.9	154.9
SD	1.2	18.3	34.5
MEDIAN	4.0	100.0	155.0
MIN	2.5	50.0	80.0
MAX	8.0	175.0	200.0

Table 3 PROC. TIMES	SED TIME (mins)	PROC TIME (mins)	PHASE 1 (mins)	DC TIME (mins)
AVERAGE	8.5	16.0	20.0	34.8
SD	1.0	6.4	6.2	8.8
MEDIAN	8.0	15.5	18.0	33.0
MIN	7.0	6.0	9.0	20.0
MAX	12.0	36.0	40.0	55.0

Table 4. STIM. 1 RESPONSE	MOVEMENT SCORE	BIS @ STIM	BIS MAX post STIM	RESPONSE TIME (secs)
AVERAGE	0.4	56.9	64.8	26.8
SD	0.7	7.7	6.6	8.0
MEDIAN	0.0	59.2	64.9	25.0
MIN	0.0	41.7	48.6	15.0
MAX	2.0	71.8	75.4	45.0
STIM 1 pair TT B_M p=0.253				

Table 5. STIM. 2 RESPONSE	MOVEMENT SCORE	BIS @ STIM	BIS MAX post STIM	RESPONSE TIME (secs)
AVERAGE	0.5	57.1	65.1	29.2
SD	1.4	10.0	9.7	10.0
MEDIAN	0.0	60.0	67.9	27.5
MIN	0.0	30.7	50.7	15.0
MAX	8.0	74.0	79.0	45.0
STIM 2 pair TT B_M p=0.215		*STIM1-STIM 2 TT time p=0.48*		

TABLE 6. DISCONNECT	DURATION BUFFER	DURATION BUFFER LATE
AVERAGE	49.7	50.6
SD	6.2	6.1
MEDIAN	50.0	50.0
MIN	30.0	35.0
MAX	55.0	60.0
M G1	48.3	49.6
M G2	50.0	50.8
F G2	50.8	51.3

Table 7. STIM. BIS CHANGES	SHARP STIMULUS	PRESSURE STIMULUS
% BIS INCREASE	42	33
% BIS NO CHANGE	33	36
% BIS DECREASE	25	31

Figure 2. BIS & STIMULUS RESPONSE

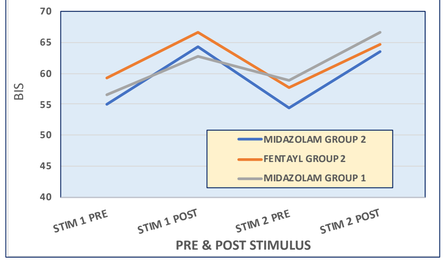

Figure 3. PHARMACO-KINETIC BLOOD LEVELS

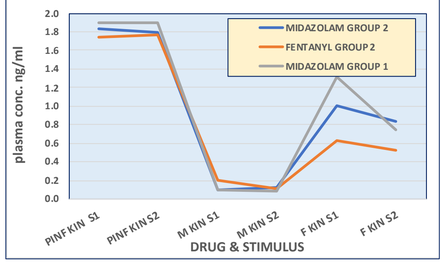

TABLE 8. STIMULATION, MOVEMENT AND BIS RESPONSE					
STIM 1	BASELINE	MAX BIS	STIM 2	BASELINE	MAX BIS
SIG. INCREASE	59.9	66.5	SIG. INCREASE	56.8	62.1
NO SIG. INCREASE	55.1	52.6	NO SIG. INCREASE	57.1	55.9
STIM 1	BASELINE	MAX BIS	STIM 2	BASELINE	MAX BIS
BIS MOVER	62.8	65.5	SIG INCREASE	59.4	62.1
BIS NON MOVER	54.9	55.6	NO SIG INCREASE	56.1	56.8
	0.005	*0.016*		*0.402*	*0.214*
BIS < 55 13.3 % MOVEMENT			*BIS < 55 28.6 % MOVEMENT*		
BIS > 55, 38.0 % CHANCE MOVEMENT			*BIS > 55, 22.7 % CHANCE MOVEMENT*		

Discussion

For first "sharp" stimulus, if BIS score is below 56, there is a 38% chance of movement. If the BIS score is greater than 55, there is a 13% chance of movement. Likewise, for the second "pressure" stimulus if the BIS score is below 56, there is a 23% chance of movement. If the BIS score is greater than 55, there is a 29% chance of movement. This indicates that patients are three times more likely to move with sharp stimulus if their BIS score is below 56 that if it is above 55. This difference is not noted as well when patients undergo the pressure stimulus, after the LA has been placed.

Based on the data collected for both stimulus, the average BIS delay is about 25 seconds. When the probe was disconnected, it took 50 seconds for the BIS score to no longer be recorded; however, 25 seconds of that data was a signal below the accepted value, which further confirms a BIS delay of 25 seconds.

This study could have been biased by outliers. Further research would benefit from an increased sample size to dampen the effects of these outliers.