



## ELECTRONIC SUPPLEMENTARY MATERIAL

### **Kiatchai T *et al.*: Accuracy of Bispectral Index™ monitoring in an alternative nasal position in pediatric patients under general anesthesia: a prospective observational study**

**Disclaimer:** *Electronic Supplementary Material (ESM) is supplied by the authors for the benefit of readers. This feature is intended to provide additional information, context, and/or dimension to complement articles. Readers should be aware that unlike the main print manuscript, ESM may not undergo extensive peer review and typically is posted as supplied by the authors without editing, proofreading, accuracy checking, copyediting, or typesetting; it is published online only.*

#### TABLE OF CONTENTS

|                 |                                                                                                                                                                                                                                                                      |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>eTable 1</b> | Demographic data and surgical characteristics                                                                                                                                                                                                                        |
| <b>eTable 2</b> | Matched-pair analysis, Bland–Altman analysis, and correlation of electroencephalography-derived parameters obtained from frontal and nasal sensors across three anesthetic phases; preincision (Phase 1), steady-state anesthesia (Phase 2), and emergence (Phase 3) |
| <b>eTable 3</b> | Matched-pair analysis, Bland–Altman analysis, and correlation of electroencephalography-derived parameters obtained from frontal and nasal sensors across low (0–47 dB) and high ( $\geq 48$ dB) electromyography subgroups                                          |
| <b>eTable 4</b> | Matched-pair analysis, Bland–Altman analysis, and correlation of electroencephalography-derived parameters obtained from frontal and nasal sensors across subgroups of patients aged 4–6 and 7–12 yr old                                                             |
| <b>eFigure</b>  | Bland–Altman analysis of differences between frontal and nasal Bispectral Index™ in each subgroup                                                                                                                                                                    |

**eTable 1** Demographic data and surgical characteristics

| Patients, characteristics        | Total<br>( <i>N</i> = 40) |
|----------------------------------|---------------------------|
| Sex                              |                           |
| Male                             | 27 (68%)                  |
| Female                           | 13 (32%)                  |
| Age (yr), mean (SD)              | 7.2 (1.4)                 |
| Body weight (kg), mean (SD)      | 28 (9)                    |
| ASA classification               |                           |
| I                                | 21 (53%)                  |
| II                               | 18 (45%)                  |
| III                              | 1 (2%)                    |
| Operation type                   |                           |
| Abdomen                          | 11 (28%)                  |
| Orthopedic                       | 5 (12%)                   |
| Superficial                      | 3 (8%)                    |
| Urology                          | 20 (50%)                  |
| Plastic                          | 1 (2%)                    |
| Anesthetic time (min), mean (SD) | 147 (21)                  |
| Surgery time (min), mean (SD)    | 103 (18)                  |

All numbers are *N* (%) unless otherwise specified

SD = standard deviation

**eTable 2** Matched-pair analysis, Bland–Altman analysis, and correlation of electroencephalogram-derived parameters obtained from frontal and nasal sensors across three anesthetic phases; preincision (Phase 1), steady-state anesthesia (Phase 2), and emergence (Phase 3)

| Parameter                                      | Matched-pair Analysis |                    |                | Adjusted Bland–Altman Analysis |             | Adjusted CCC |
|------------------------------------------------|-----------------------|--------------------|----------------|--------------------------------|-------------|--------------|
|                                                | Frontal <sup>a</sup>  | Nasal <sup>a</sup> | <i>P</i> value | Difference <sup>b</sup>        | 99% LoA     |              |
| Phase 1 pre-incision ( <i>N</i> = 600 pairs)   |                       |                    |                |                                |             |              |
| BIS (0–100)                                    | 52 (9)                | 50 (9)             | < 0.001        | 2 (4)                          | -9 to 14    | 0.89         |
| SQI (%)                                        | 95 (8)                | 91 (16)            | < 0.001        | 4 (16)                         | -38 to 46   | 0.12         |
| EMG (dB)                                       | 32 (2)                | 29 (2)             | < 0.001        | 3 (2)                          | -2 to 8     | 0.21         |
| Total power (dB)                               | 75 (2)                | 70 (2)             | < 0.001        | 5 (2)                          | 1 to 9      | 0.27         |
| SEF-95 (Hz)                                    | 16.5 (3.1)            | 15.6 (3.2)         | < 0.001        | 0.9 (0.9)                      | -1.5 to 3.3 | 0.93         |
| Median frequency (Hz)                          | 6.5 (2.7)             | 5.9 (2.7)          | < 0.001        | 0.6 (1.0)                      | -1.9 to 3.2 | 0.91         |
| Impedance (Kohms)                              | 7.5 (2.8)             | 8.6 (3.0)          | < 0.001        | -1.1 (3.1)                     | -9.2 to 7.0 | 0.48         |
| Phase 2 steady state ( <i>N</i> = 4,034 pairs) |                       |                    |                |                                |             |              |
| BIS (0–100)                                    | 52 (9)                | 51 (9)             | < 0.001        | 1 (4)                          | -11 to 12   | 0.84         |
| SQI (%)                                        | 94 (8)                | 94 (9)             | 0.70           | 0 (9)                          | -24 to 24   | 0.43         |
| EMG (dB)                                       | 32 (2)                | 30 (4)             | < 0.001        | 2 (4)                          | -8 to 12    | 0.31         |
| Total power (dB)                               | 73 (3)                | 68 (3)             | < 0.001        | 5 (1)                          | 2 to 9      | 0.29         |
| SEF-95 (Hz)                                    | 17.1 (2.8)            | 16.6 (2.8)         | < 0.001        | 0.5 (0.8)                      | -1.5 to 2.6 | 0.95         |
| Median frequency (Hz)                          | 6.8 (2.9)             | 6.6 (2.9)          | < 0.001        | 0.2 (0.8)                      | -1.8 to 2.3 | 0.96         |
| Impedance (Kohms)                              | 8.4 (2.7)             | 9.2 (3.0)          | < 0.001        | -0.8 (2.8)                     | -8.0 to 6.4 | 0.47         |
| Phase 3 emergence ( <i>n</i> = 415 pairs)      |                       |                    |                |                                |             |              |
| BIS (0–100)                                    | 74 (5)                | 72 (6)             | < 0.001        | 2 (4)                          | -9 to 13    | 0.78         |
| SQI (%)                                        | 92 (11)               | 87 (16)            | < 0.001        | 5 (13)                         | -28 to 37   | 0.76         |
| EMG (dB)                                       | 37 (8)                | 36 (9)             | 0.018          | 0 (4)                          | -10 to 11   | 0.92         |
| Total power (dB)                               | 63 (4)                | 61 (5)             | < 0.001        | 2 (3)                          | -6 to 10    | 0.38         |
| SEF-95 (Hz)                                    | 25.4 (2.0)            | 24.3 (2.4)         | < 0.001        | 1.1 (1.3)                      | -2.3 to 4.6 | 0.79         |
| Median frequency (Hz)                          | 15.0 (4.3)            | 13.6 (4.6)         | < 0.001        | 1.4 (3.0)                      | -6.5 to 9.2 | 0.77         |
| Impedance (Kohms)                              | 8.2 (2.5)             | 8.9 (2.4)          | < 0.001        | -0.7 (2.5)                     | -7.1 to 5.7 | 0.57         |

<sup>a</sup>Data are presented as mean (standard deviation)

<sup>b</sup>Mean differences (standard deviation) are for the frontal values relative to the nasal values. Bland–Altman analysis and concordance correlation coefficients were adjusted for repeated measures within the subjects.

BIS = Bispectral Index; CCC = concordance correlation coefficient; EMG = electromyography;  
LoA = limits of agreement; SEF-95 = spectral edge frequency; SQI = signal quality index

**eTable 3** Matched-pair analysis, Bland–Altman analysis, and correlation of electroencephalography-derived parameters obtained from frontal and nasal sensors across low (0–47 dB) and high ( $\geq 48$  dB) electromyography subgroups

| Parameter                                      | Matched-pair Analysis |                    |                | Adjusted Bland-Altman Analysis |              | Adjusted CCC |
|------------------------------------------------|-----------------------|--------------------|----------------|--------------------------------|--------------|--------------|
|                                                | Frontal <sup>a</sup>  | Nasal <sup>a</sup> | <i>P</i> value | Difference <sup>b</sup>        | 99% LoA      |              |
| Low EMG group (0–47 dB) <i>N</i> = 4,989 pairs |                       |                    |                |                                |              |              |
| BIS (0–100)                                    | 53 (11)               | 52 (10)            | < 0.001        | 1 (4)                          | -10 to 12    | 0.88         |
| SQI (%)                                        | 94 (8)                | 93 (11)            | < 0.001        | 1 (11)                         | -27 to 28    | 0.41         |
| EMG (dB)                                       | 32 (3)                | 31 (4)             | < 0.001        | 2 (4)                          | -8 to 12     | 0.42         |
| Total power (dB)                               | 73 (4)                | 68 (4)             | < 0.001        | 5 (2)                          | 1 to 9       | 0.47         |
| SEF-95 (Hz)                                    | 17.7 (3.5)            | 17.0 (3.5)         | < 0.001        | 0.6 (0.9)                      | -1.6 to 2.8  | 0.95         |
| Median frequency (Hz)                          | 7.4 (3.6)             | 7.0 (3.6)          | < 0.001        | 0.3 (1.1)                      | -2.5 to 3.2  | 0.95         |
| Impedance (Kohms)                              | 8.3 (2.7)             | 9.1 (3.0)          | < 0.001        | -0.8 (2.8)                     | -8.0 to 6.4  | 0.46         |
| High EMG group (≥ 48 dB) <i>N</i> = 60 pairs   |                       |                    |                |                                |              |              |
| BIS (0–100)                                    | 77 (6)                | 77 (6)             | 0.83           | 0 (6)                          | -15 to 16    | 0.63         |
| SQI (%)                                        | 85 (17)               | 72 (21)            | < 0.001        | 13 (17)                        | -32 to 58    | 0.28         |
| EMG (dB)                                       | 51 (2)                | 50 (4)             | 0.54           | 0 (4)                          | -10 to 11    | 0.43         |
| Total power (dB)                               | 62 (3)                | 63 (4)             | 0.20           | -1 (4)                         | -10 to 9     | 0.51         |
| SEF-95 (Hz)                                    | 25.4 (2.4)            | 24.0 (3.2)         | < 0.001        | 1.4 (1.9)                      | -3.4 to 6.2  | 0.50         |
| Median frequency (Hz)                          | 14.1 (5.2)            | 11.0 (5.6)         | < 0.001        | 3.1 (3.8)                      | -6.7 to 12.9 | 0.63         |
| Impedance (Kohms)                              | 8.5 (2.8)             | 9.8 (2.0)          | < 0.001        | -1.3 (2.6)                     | -8.1 to 5.4  | 0.33         |

<sup>a</sup>Data are presented as mean (standard deviation)

<sup>b</sup>Mean differences (standard deviation) are for the frontal values relative to the nasal values. Bland–Altman analysis and concordance correlation coefficients were adjusted for repeated measures within the subjects.

BIS = Bispectral Index; CCC = concordance correlation coefficient; EMG = electromyography; LoA = limits of agreement; SEF-95 = spectral edge frequency; SQI = signal quality index

**eTable 4** Matched-pair analysis, Bland–Altman analysis, and correlation of electroencephalography-derived parameters obtained from frontal and nasal sensors across subgroups of patients aged 4–6 and 7–12 yr old

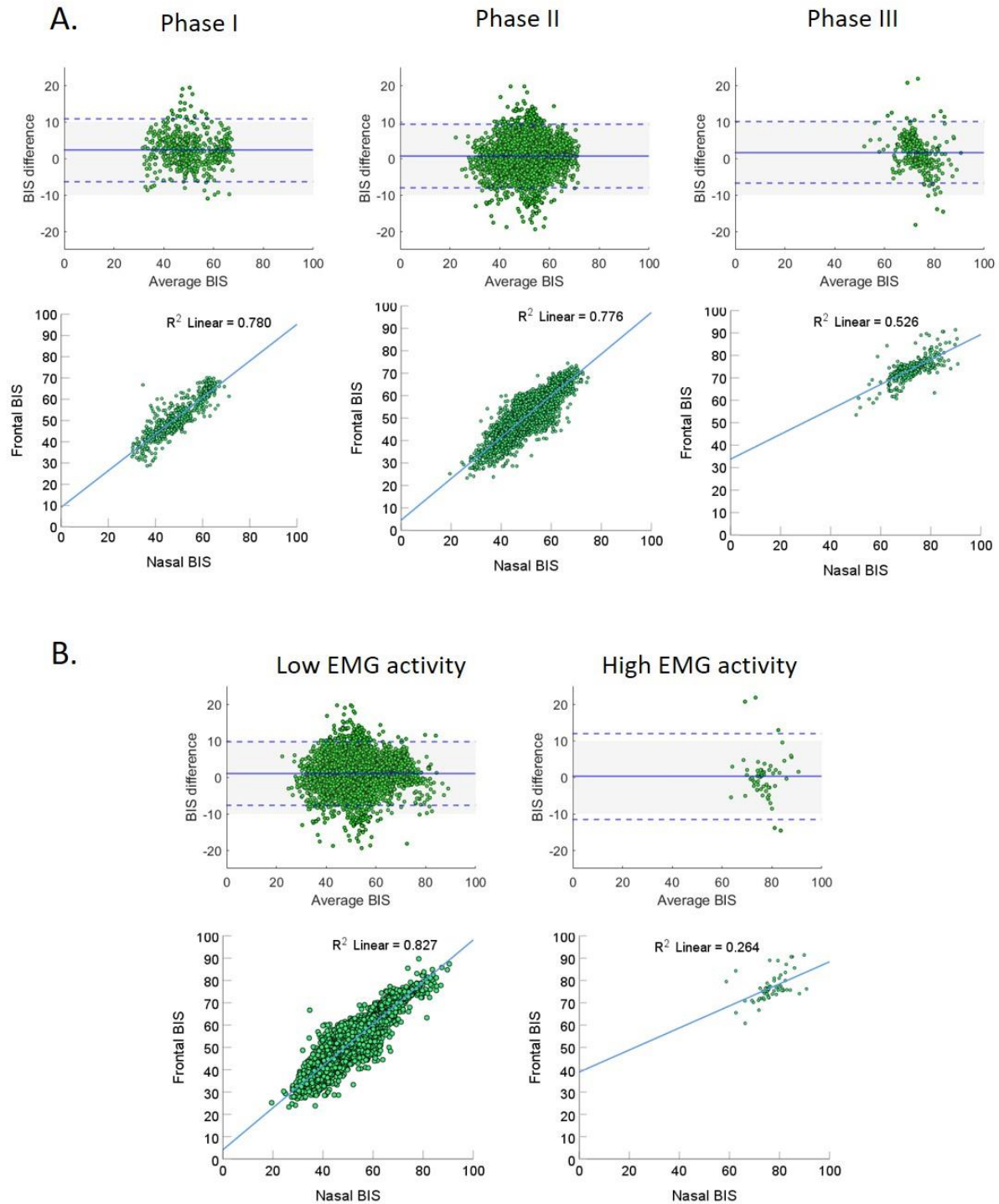
| Parameter                           | Matched-pair Analysis |                    |                | Adjusted Bland-Altman Analysis |             | Adjusted CCC |
|-------------------------------------|-----------------------|--------------------|----------------|--------------------------------|-------------|--------------|
|                                     | Frontal <sup>a</sup>  | Nasal <sup>a</sup> | <i>P</i> value | Difference <sup>b</sup>        | 99% LoA     |              |
| Age 4–6 yr, <i>n</i> = 2,156 pairs  |                       |                    |                |                                |             |              |
| BIS (0–100)                         | 55 (10)               | 54 (10)            | < 0.001        | 1 (5)                          | -10 to 13   | 0.88         |
| SQI (%)                             | 95 (8)                | 93 (11)            | < 0.001        | 2 (11)                         | -26 to 29   | 0.45         |
| EMG (dB)                            | 33 (3)                | 31 (4)             | < 0.001        | 3 (3)                          | -6 to 11    | 0.53         |
| Total power (dB)                    | 73 (4)                | 68 (4)             | < 0.001        | 5 (2)                          | 0 to 10     | 0.48         |
| SEF-95 (Hz)                         | 17.7 (3.7)            | 17.0 (3.7)         | < 0.001        | 0.7 (0.9)                      | -1.7 to 3.0 | 0.95         |
| Median frequency (Hz)               | 7.5 (3.7)             | 7.0 (3.8)          | < 0.001        | 0.5 (1.1)                      | -2.4 to 3.4 | 0.95         |
| Impedance (Kohms)                   | 7.6 (2.5)             | 9.8 (3.4)          | < 0.001        | -2.2 (2.5)                     | -8.6 to 4.2 | 0.52         |
| Age 7–12 yr, <i>n</i> = 2,893 pairs |                       |                    |                |                                |             |              |
| BIS (0–100)                         | 53 (11)               | 52 (10)            | < 0.001        | 1 (4)                          | -11 to 12   | 0.89         |
| SQI (%)                             | 93 (9)                | 93 (11)            | 0.39           | 0 (11)                         | -28 to 29   | 0.41         |
| EMG (dB)                            | 32 (3)                | 31 (5)             | < 0.001        | 1 (4)                          | -9 to 12    | 0.56         |
| Total power (dB)                    | 73 (4)                | 68 (4)             | < 0.001        | 5 (2)                          | 0 to 10     | 0.47         |
| SEF-95 (Hz)                         | 17.8 (3.5)            | 17.2 (3.4)         | < 0.001        | 0.6 (0.9)                      | -1.7 to 2.9 | 0.95         |
| Median frequency (Hz)               | 7.4 (3.7)             | 7.2 (3.5)          | < 0.001        | 0.3 (1.3)                      | -3.0 to 3.5 | 0.92         |
| Impedance (Kohms)                   | 8.8 (2.7)             | 8.6 (2.4)          | < 0.001        | 0.2 (2.6)                      | -6.5 to 7.0 | 0.45         |

<sup>a</sup>Data are presented as mean (standard deviation)

<sup>b</sup>Mean differences (standard deviation) are for the frontal values relative to the nasal values. Bland–Altman analysis and concordance correlation coefficients were adjusted for repeated measures within the subjects.

LoA = limits of agreement; CCC = concordance correlation coefficient; BIS = bispectral index; SQI = signal quality index; EMG = electromyography; SEF-95 = spectral edge frequency

**eFigure** Bland–Altman analysis of differences between frontal and nasal Bispectral Index™ in each subgroup



A) Phases of anesthesia, B) EMG activity, and C) Age groups

BIS = Bispectral Index; EMG = electromyography