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LETTER TO THE EDITOR

Behavior of children emerging from general anesthesia correlates with their heart rate variability

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To the Editor:

Children emerging from anesthesia may experience a variety of behavioral disturbances described as postoperative agitation [1]. We could easily expect some autonomic changes in these agitated children. Frequency-domain analysis of heart rate variability (HRV) is a sophisticated noninvasive tool to assess autonomic nervous system (ANS) regulation of the heart [2]. When humans are under various physical and mental stress conditions, disturbances in the ANS occur. In the present study, we calculated children's HRV and analyzed the relationship between their behavior on emerging from anesthesia and the low frequency components (LF) to high frequency components (HF) (LF/HF) ratio of their HRV.

After obtaining approval from the Ethics Committee of Aichi Medical University and written informed parental consent, we studied 28 children, aged 2–4 years, who were scheduled for removal of a nevus. Forty-five minutes before anesthetic induction, midazolam 0.5 mg kg^{-1} was given orally. After arrival in the operating room at 08:15, the mothers were encouraged to sit in a straight-back chair and to hold their child during the anesthetic induction. After anesthesia was induced with 7% sevoflurane in 100% oxygen, fentanyl 1 μg kg^{-1} and vecuronium 0.1 mg kg^{-1} were injected intravenously to facilitate tracheal intubation. Then, plastic surgeons infiltrated the nevus with 0.25% lidocaine 5–10 ml. Anesthesia was maintained with sevoflurane (1.5%–2.5%) in 100% oxygen and fentanyl 4 μg kg^{-1} without further vecuronium. On completion of the surgery, sevoflurane was discontinued and a palm-sized electrocardiographic unit (Active Tracer.AC300; GMS, Tokyo, Japan) [2] was placed on each child for continuous recording of variation in their autonomic nervous activities. When the child displayed a facial grimace, purposeful movement, and protective upper airway reflexes, and was breathing spontaneously, regularly, and adequately, and had opened their eyes, the tracheal tube was removed. We transferred the children to the recovery room and observed them for 20 min. An observer scored the child's emergence behavior on a five-point scale: (1) obtunded with no response to stimulation; (2) asleep but responsive to movement or stimulation; (3) awake and responsive; (4) inconsolable crying; and (5) thrashing behavior requiring restraint. For 20 min in the recovery room, the observer recorded the highest level reached. Data recorded for more than 30 min in the palm-sized electrocardiographic unit were analyzed for HRV by the maximum entropy method (CHIRAM; Suwa Trust Japan, Japan). Since three children were excluded because of refusal to midazolam, 10 boys and 15 girls were included in the study; median age (range) was, 3 (2–4) years; median weight, 16 (12–22) kg; and median anesthetic time, 125 (67–194) min. The relationship between the score for emergence behavior and the LF/HF ratio of their HRV showed a significant, positive correlation ($r_s = 0.6219$, $n = 25$, $p < 0.0009$) (Fig. 1).

Stressful conditioning leads to the augmentation of sympathetic nerve activity, thereby influencing heart rate and blood pressure [3, 4]. Also, emotional factors are known to influence the sympathetic nervous system [5]. Thus, we believe that, in the present study, emergence from

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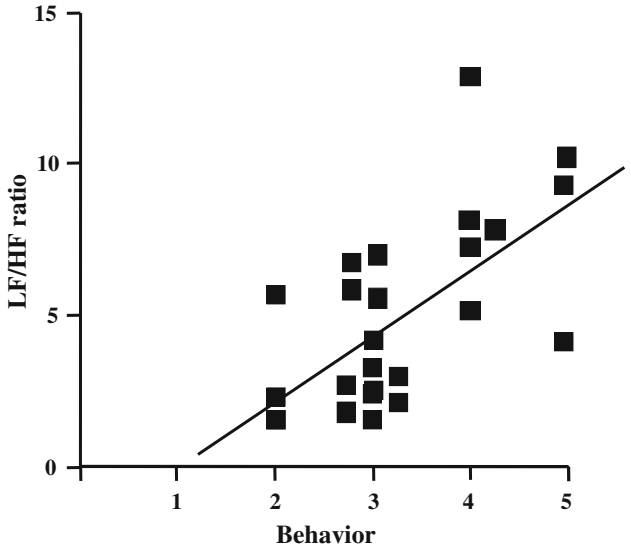

Fig. 1 Scatterplot of scores for emergence behavior versus the low frequency components (LF) to high frequency components (HF) (*LF/HF*) ratio with regression line; low emergence scores indicate that the patient was less agitated. $r_s = 0.6219$, $n = 25$, $p < 0.0009$; Spearman's rank correlation coefficient

sevoflurane anesthesia would have led to behavioral and emotional disturbances in some children, thereby having induced augmentation of sympathetic nerve activity.

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