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Postoperative pain assessment in children: a pilot study of the usefulness of the analgesia nociception index†

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Abstract

Background: The ability to perform objective pain assessment is very important in paediatric patients. The goal of this study was to investigate the relationship between the analgesia nociception index (ANI), which is based on the heart rate variability, and objective measurements of pain intensity in young or cognitively impaired children, after surgical or imaging procedures (control group) under general anaesthesia.

Methods: On arrival in the recovery room and subsequently at 5–10 min intervals, the level of pain was rated using the FLACC pain scale (0–10). The ANI values (0–100; 0 indicating the worst pain) were recorded simultaneously. The area under the receiver operating characteristic curve (AUC) and grey zone approach were used to evaluate the performance of the ANI to detect patients with FLACC >4. Instantaneous ANI values were compared with ANI values averaged over 256 s periods of time.

Results: All children in the surgical group (n=32) developed moderate-to-severe pain (FLACC >4). Children in the control group (n=30) exhibited minimal pain. Instantaneous ANI values were lower in children of the surgical group than in the control group [52 (SD16) *vs* 69 (16), P<0.001]. The AUC for the 256 s ANI recording period [0.94 (95% confidence interval 0.85–0.99)] was significantly higher than for instantaneous ANI (P<0.05). When measured for a period of 256 s, an ANI cut-off value of 56 (grey zone [58–60]) was most predictive of a FLACC ≥4.

Conclusions: The ANI may provide an objective measurement of acute postoperative pain, which is correlated with that measured on a FLACC scale in young or cognitively impaired children.

Key words: analgesia, paediatric; children; pain, paediatric; parasympathetic nervous system

Postoperative pain in children needs be managed effectively to avoid postoperative behavioural problems[1] and persistent postsurgical pain.[2 3] Adequate pain management in children requires adapted pain assessment using tools that must be developmentally appropriate. As recently underlined by Morton, 'good pain assessment is always linked to appropriate pain control measures',[4] emphasizing the key role of pain assessment in the provision of optimal pain relief. However, pain assessment in children can be extremely challenging, especially in infants or in children with cognitive impairment.[5] Even in cognitively intact children, the choice of the best pain-assessment tool remains controversial and has been the subject of many debates.[6–9]

Regardless of which tool is used to assess pain, factors such as age, anxiety, language, ethnic background, and the child's level of cognition need to be taken into account.[10] The Association of Paediatric Anaesthetists recognizes that more than one tool is

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Editor's key points

- Objective methods to assess pain in children may help to direct postoperative pain control.
- The analgesia nociception index (ANI) is a non-invasive technique to measure autonomic variabilty.
- The predictive value of the ANI is assessed for identifying postoperative pain in children.
- The ANI was useful in predicting postoperative pain, but needs further study in children.

necessary, because no individual scoring system will be appropriate for pain assessment for all children and in all contexts.[11] Recently, several monitoring tools have been developed to provide a better evaluation of pain and analgesia in anaesthetized and awake patients.[12] One of them, the analgesia nociception index (ANI, Physiodoloris™; Metrodoloris, Loos, France) is a non-invasive tool based on the analysis of the respiratory fluctuations of heart rate that mainly reflect the variability in the parasympathetic tone.[13] The ANI monitor records the ECG signal continuously, enabling a quantitative assessment of the respiratory variability of heart rate, which decreases during a nociceptive stimulation.[14] The majority of studies assessing the ANI have been performed in adult patients under general anaesthesia[13] or in the immediate postoperative period[15] and have shown that the measurement of ANI was significantly correlated with pain intensity. To date, very few data are available regarding the usefulness of ANI in children, and those data that are available were obtained in children during surgery under general anaesthesia.[16 17] The goal of this prospective observational study was to investigate the relationship between ANI measurement and postoperative pain intensity in young or cognitively impaired children during recovery from general anaesthesia.

Methods

After approval by the Institutional Review Board (Comité de Protection des Personnes Ile-de-France VI) and written informed consent, children who had undergone elective surgery associated with moderate-to-severe postoperative pain, and for whom analgesia with morphine titrated i.v. was planned, were included in the experimental group. Patients were recruited if they were aged <7 yr or if they had a communication disability that would prevent self-rating-based pain assessment. Children <7 yr of age or cognitively impaired, who were admitted to the postanaesthesia care unit (PACU) after medical imaging procedures (without any painful stimulus) under sedation or general anaesthesia, were included in the control group.

Exclusion criteria included dysrhythmia, autonomic neuropathy, and administration of atropine, neostigmine, β-blockers, ketamine, or clonidine during the surgery or imaging procedure. Children who received any form of regional anaesthesia were not considered for inclusion; otherwise, the study protocol did not place any other restriction on the anaesthetic technique. During surgery, multimodal analgesia was provided with a combination of paracetamol, ketoprofen, or both, and morphine as required, according to our standard practice.[18]

The study began upon admission to the PACU (Fig. 1). Pain intensity was assessed by the PACU nurse, using the FLACC behavioural observational scale (0–10) at the time of admission and every 5 or 10 min thereafter.[19] The PACU nurses were unable to see the ANI values displayed on the monitor. The FLACC score, which assesses pain based on five criteria (facial expression, leg position, degree of activity, quality of cry, and consolability) is used in children who are unable to report a pain score.[19] The revised FLACC was used in children with significant neurological impairment.[20 21]

Noxious stimulus can induce sympathovagal imbalance. Heart rate variability measures the cardiac autonomic activity non-invasively and can detect autonomic responses to noxious stimuli in patients. The ANI is based on ECG data and is computed from a frequency domain-based analysis of the high-frequency component of heart rate variability (high frequency, 0.15–0.5 Hz) corresponding to parasympathetic tone, using a wavelet transform-based numerical filter, and also includes the respiratory rate as a potential confounding variable. The algorithm used for ANI computation has been described previously.[13 22] The ANI, expressed as a numerical value between 0 and 100, is continuously displayed on a specific monitor (PhysioDoloris monitor; MetroDoloris™, Loos, France).

The ANI values were stored on a hard drive in ASCII format. Event markers, such as first pain assessment yielding FLACC ≥4 and administration of morphine, were stored in the same file. Heart rate (HR), mean arterial pressure (MAP), and respiratory rate were collected from the patient PACU monitor at the time of pain assessment.

Data were recorded with the child recumbent; the parent was invited to stay nearby. Attempts were made to minimize noise and disturbance in the PACU, which is a 12 bed open space.

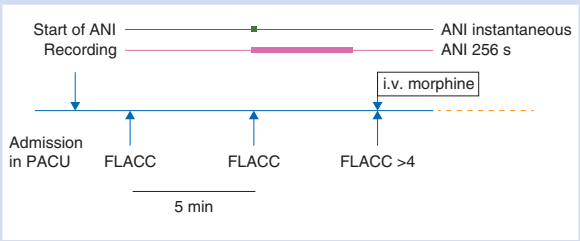

Fig 1 Measuring periods after admission to the PACU. ANI, analgesia nociception index; PACU, postanaesthesia care unit.

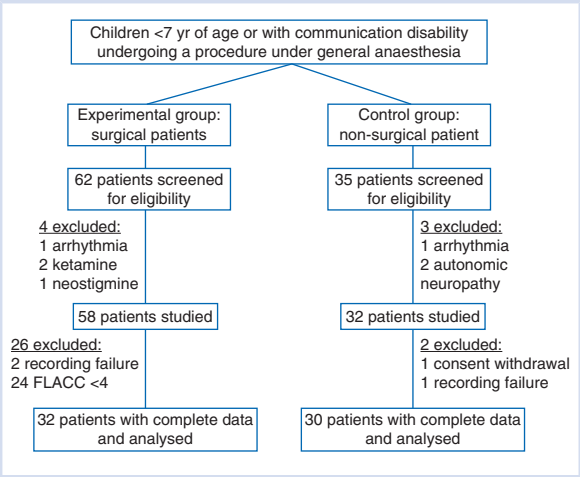

Fig 2 Flow chart of the study.