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Original Article

Impact of skin-to-skin contact on maternal comfort in patients with elective caesarean section: A pilot study

Clémence Vamour[a,*], Julien De Jonckheere[b,c], Béatrice Mestdagh[a], Laurent Storme[a,c,d], Pierre Richart[e], Charles Garabedian[a,c], Thameur Rakza[a,c]

[a] CHU Lille, Jeanne de Flandre Hospital, Department of Obstetrics, F-59000 Lille, France
[b] CHU Lille, CIC-IT, F-59000 Lille, France
[c] University of Lille, EA4489, Perinatal Growth and Health, F-59000 Lille, France
[d] CHU Lille, Jeanne de Flandre Hospital, Department of Neonatology, F-59000 Lille, France
[e] CHU Lille, Jeanne de Flandre Hospital, Department of Anesthesiology, F-59000 Lille, France

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ABSTRACT

Objective: Caesarean section is a well-known cause of difficulties in breastfeeding initiation. Mother–infant skin-to-skin contact allows to improve breastfeeding and maternal comfort but remains few practiced during caesarean section. Our objective was to evaluate maternal comfort before and after immediate skin-to-skin contact in case of elective caesarean section.
Methods: This was a prospective, observational, monocenter study including patients with elective caesarean section. Mother–infant skin-to-skin contact was begun immediately after birth. The Analgesia Nociception Index (ANI) is a well know heart rate variability (HRV) index, currently used in anesthesia, which decreases during painful stimulation and increases with maternal comfort. The Analgesia Nociception Index was compared before and after skin-to-skin contact.
Results: 53 patients were included. Skin-to-skin contact was started on average 4 min (2–14, IIQ (3–5)) after birth. The median duration was 21 min (4–40, IIQ (12.3–29.5)). It was interrupted in 24 patients: 9 from mother's wish, 11 for maternal reasons (drowsiness, stress, pain, maternal hypothermia, lipothymia, vertigo, nausea, cough) and 4 for the newborn (respiratory distress, low pH). The median Analgesia Nociception Index at the end of skin-to-skin contact and at the end of the intervention was statistically higher than that before skin-to-skin contact ($p = 0.034$ and $p < 10\text{-}3$ respectively).
Conclusion: Skin-to-skin contact is possible during caesarean section and allows a better maternal comfort. It should be encouraged and proposed to patients during elective caesarean section. It will be interesting to evaluate it in case of caesarean section during labor.

Introduction

The "Baby-Friendly Hospital Initiative" (BFHI) project was defined in 1992 by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF). It recommended that early, prolonged and uninterrupted skin-to-skin contact should be initiated between the newborn and the mother, immediately after birth in the case of vaginal delivery or after a caesarean section without general anaesthesia for one hour [1,2]. Numerous studies have shown the benefits of early and prolonged skin-to-skin contact (maternal-newborn attachment, maternal confidence, 3-day mothers' stress and anxiety reduction [3–5], sensory continuity of the newborn, decreased pain and crying of the newborn [4,6,7], better thermal, cardiorespiratory and glycemic stability [4,6], help with breastfeeding initiation [7–9], duration [4,10] and exclusivity [4,9–11]).

In France, the French Society of Neonatology has elaborated practical guidelines about skin-to-skin contact and recommends practicing skin-to-skin contact after a caesarean section in theater if possible. However, skin-to skin-contact after caesarean section is less practiced in France [12].

In France, the incidence of caesarean section delivery rate was stable for 10 years (21.0% in 2010) [13]. Numerous studies have shown the adverse effects of caesarean section for breastfeeding initiation, mother–infant relationship, increased maternal dissatisfaction and the risk of postnatal depression [14–16]. However, a literature review by Stevens [6] showed the benefits of immediate

* Corresponding author at: CHU Lille, Jeanne de Flandre Hospital, Department of Obstetrics, Avenue Eugene Avinée, 59037 Lille Cedex, France.
E-mail address: clemence.courtecuisse@chru-lille.fr (C. Vamour).

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skin-to-skin contact following a caesarean section: better maternal satisfaction, improved mother–child bond, decreased newborn stress, and improved breastfeeding. Despite these results, the large majority of maternity units did not practice skin-to-skin contact after caesarean section. The barriers were mainly organizational and educational (lack of space in theater, patient installation and health status, lack of time and sometimes lack of staff, lack of knowledge of the benefits of skin-to-skin contact from parents and professionals of health, and poor skill for newborn monitoring) [17]. Caesarean section could be a stressful and painful procedure for patients, which often limits the achievement of skin-to-skin contact. The Nolan study that evaluated the benefits of skin-to-skin contact on patient's pain did not show any significant difference [18].

It is well known that pain and stress are associated with a reduction in parasympathetic activity (Fig. 1). One indicator of this activity is heart rate variability (HRV), whose analysis enables the regulation of the cardiovascular system by the autonomic nervous system (ANS) to be assessed [19,20]. The ANS consists of the sympathetic and parasympathetic nervous systems (PNS), and studies have shown that fluctuations of the heart rate beyond 0,15 Hz are mediated by the PNS and centered on the respiratory frequency [21,22]. Our team have developed a HRV-based analytical method for the evaluation of the autonomic activity mediated by the PNS: the Analgesia Nociception Index (ANI). In adults, pain, fear, anxiety or stress are accompanied by a decrease in HRV in high frequencies (>0.15 Hz) indicating a decrease in vagal tone during stimuli or 'unpleasant emotions [23,24].

We hypothesize that early skin-to-skin contact has an impact on parasympathetic tone in patients during caesarean section. Indeed, the objective of this study was to evaluate immediate skin-to-skin contact on maternal comfort in the operative room though a measurement of ANI. The secondary objectives were to compare the numeric pain rating scale (NPRS) in patients before and after skin-to-skin contact, and also the feasibility of skin-to-skin contact during elective caesarean section.

Materials and methods

Study design

This was a prospective, observational, descriptive pilot study in one center (Lille, France) from August 1, 2016 to March 31, 2017. Patients were included in case of singleton pregnancies with elective caesarean section. Patients with vigilance disorders, complications related to caesarean section, not being able to benefit from the PHYSIODOLORIS® (Lille / France) device (cardiopathology, atrial arrhythmia, pacemaker, treatment with Beta-blockers or anti-epileptic drugs, etc.) were not included. Neonates requiring immediate care at birth or requiring resuscitation were excluded from the study. Some patients were secondary excluded if the ANI recording was incomplete or not performed.

The primary outcome was maternal comfort as measured by the ANI index using the PHYSIODOLORIS® monitor, scored from 0 to 100. An elevated ANI reflects maternal comfort. The secondary outcome was the numerical self-report scale of pain (NPRS) encrypted from 0 to 10. ANI and NPRS values were recorded by the anesthesiologists or the midwife during caesarean section (before and at the end of skin-to-skin contact and at the end of the intervention) as well as events during caesarean section (induction time, incision, birth, onset and end of skin-to-skin contact, as well as its interruption and the reason for it).

During caesarean section, the installation of the patient was anticipated to provide skin-to-skin contact to her newborn in good conditions (20° head-up position, electrodes placed in her back, infusions placed in her non-dominant arm, surgical drapes positioned as low as possible). The PHYSIODOLORIS® monitor was plugged in as soon as the patient arrived. The patients received the same spinal anesthesia (the protocol in our maternity is 100 μg of morphine, 2.5 μg of sufentanyl and 10 mg of bupivacaine) with or without an epidural according to the expected duration of the caesarean. Before the incision, the quality of anesthesia was evaluated by the cold test that allows to know the metameric level of anesthesia. If it's insufficient, the patient is placed in Trendelenburg position; and if it's not enough, the patient had an epidural supplement or general anesthesia. The patients received the same analgesia before the caesarean: 1 g of paracetamol and 100 mg of ketoprofene. During the caesarean, anesthesiologists followed the protocol in order to adapt drugs (interfering with heart rate: ephedrine, phenylephrine and noradrenaline) to the evolution of the blood pressure. The ephedrine/phenylephrine syringe was started at the end of the spinal anesthesia and the blood pressure was taken every minute for the first ten minutes to adjust the speed of the syringe. After birth, the newborn was placed in skin-to-skin position on the patient, during caesarean section, following the usual protocol of our department and if possible prolonged without interruption until the end of the caesarean section (Fig. 2).

The Analgesia Nociception Index (ANI), which is a heart rate variability (HRV) based index, is measured by using the PHYSIODOLORIS® monitor (Mdoloris Medical Systems, Lille, France). Other technologies for nociception/anti-nociception balance evaluation can be used like pupillometry or skin conductance [25]. There are based on the analysis of the Autonomous Nervous System reactions to a changing environment during anesthesia and surgery. No gold standard exists for the assessment of nociception / anti-nociception balance. ANI can be used with patients unconscious or conscious [26,27].

Although most of the published methods are based on a spectral analysis of heart rate variability (HRV), the ANI index is derived from a filtering method followed by a continuous analysis of the filtered signal magnitude in the time domain. Heart rate oscillations above 0.15 Hz represent autonomic activity mediated by the parasympathetic nervous systems (PNS) and are mainly

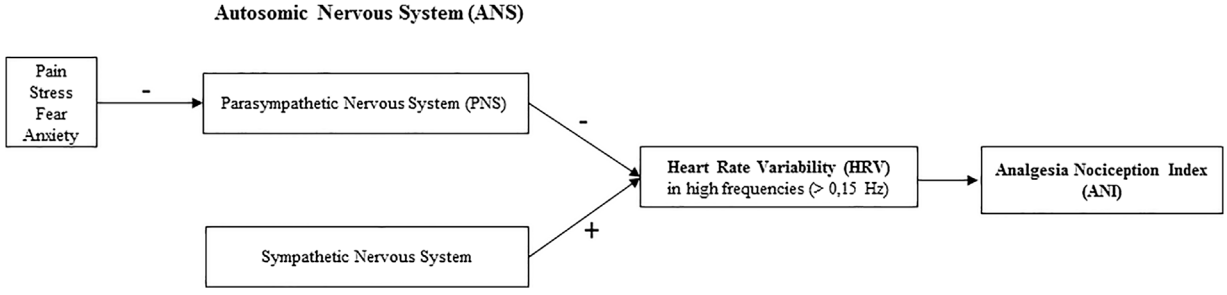

Fig. 1. Diagram of the link between stress and Analgesia Nociception Index.

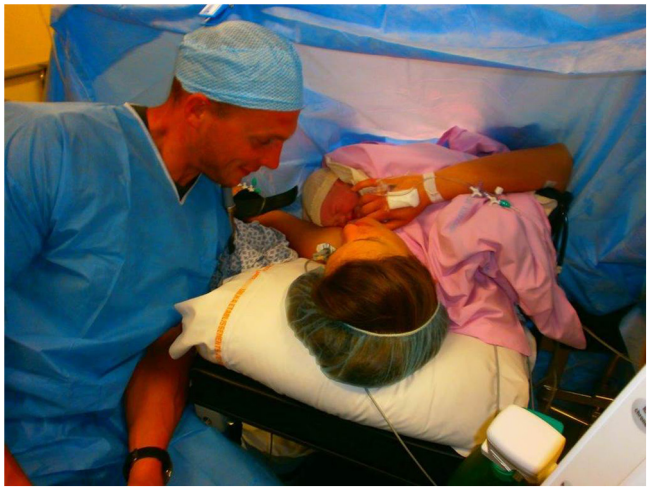

Fig. 2. A new-born in skin-to skin contact during caesarean section.

modulated by the respiratory sinus arrhythmia; inhaled inhibitors the influence of the PNS and increases heart rate, exhalation stimulates the PNS and decreases heart rate. The ANI index constitutes an assessment of this oscillation magnitude. Each heartbeat is detected on the ECG signal and a series of heartbeats. RR series artifacts are removed using a nonlinear filtering algorithm [23]. The resulting RR series is resampled with an 8 Hz sampling frequency and then centered on the mean and normalized in a 64-second moving window. Finally, a 4-factor Daubechies wavelet-based high-pass filter permits to isolate HRV oscillations above 0.15 Hz, indicating the autonomic activity mediated by the PNS [24,28]. To compute the resulting signal magnitude, local maxima and minima are detected and used to plot the lower and upper limits (Fig. 3). The 64-second window is then divided into 4, 16-second sub windows, to compute the area between the limits in each sub window (A1, A2, A3, and A4) [24]. The area under curve (AUC) *min* corresponds to the minimum value among A1, A2, A3, and A4, and the ANI is defined as follows: ANI = 100x(5.1 area under the curve *min* + 1.2)/12.9, yielding a numerical value between 0 and 100, reflecting the visual aspect of the filtered RR series. Continuous computation is achieved by sliding the moving window with a 1-second moving period.

Statistical analysis

An arbitrary number of 50 patients was defined prior to the study. All patients meeting the inclusion criteria were included consecutively and comprehensively after collecting their oral informed consent. The data was analyzed using Statistical Package for the Social Sciences software (SPSS® version 20.0, SPSS Inc., Chicago, IL). The evolution of numerical parameters over time was analyzed in repeated measurements using the non-parametric Wilcoxon test. The differences were considered significant if $p < 0.05$. The declaration of patient information was made to the National Commission on Informatics and Liberty (CNIL).

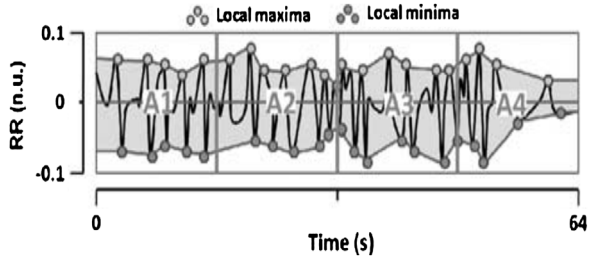

Fig. 3. Exemple of normalized and filtered RR series (black curve, in normalized unit).
Local maximum and local minimum are detected (respectively upper and lower plots). Upper envelop is plotted between maximums and lower envelop is plotted between minimum (lower lines). Area between upper and lower envelops (lower in blue) is divided in 4 subareas A1, A2, A3, and A4. The lowest area (AUCmin) is then selected (A4) and ANI is computed. AUC indicates area under the curve; ANI, mother parasympathetic evaluation.

Results

53 patients were included. The flow diagram is shown in Fig. 4. Mother and neonate's clinical characteristics were compared to characteristics of all elective caesarean section during the same period in Table 1. The median age was 34 (range: 20–42), median parity 2 [1–7]. 26 (49.1%) had a previous caesarean section and 15 (28.3%) had two or more caesarean sections. Caesarean section indications were previous caesarean section (n = 36, 68%), feto-pelvic disproportion (breech/transverse presentation, macrosomia) (n = 8, 15%), history of a corporal scar (n = 3; 7%), placenta previa (n = 1), history of uterine rupture (n = 1), uterine myoma (n = 1), convenience (n = 1), history of obstetrical anal sphincter injury (n = 1), and anal fissure (n = 1). 37 patients (69.8%) had spinal anesthesia and 16 (30.2%) had combinated epidural and spinal anesthesia. The sex ratio (M/F) of neonates was 20/33 with a median gestational age of 39 + 1 WG (37 + 1–41 + 3, interquartile range (IIQ) (39–39 + 3)), and a median birth weight of 3240 g (2 150–5000, IIQ (3050–3660)). 51 newborns (96.2%) had a 10/10 Apgar score at 1 min, the median umbilical arterial pH was 7.21 (6.94–7.3, IIQ (7.16–7.25)) and the median venous umbilical pH of 7.33 (7.09–7.44) IIQ (7.30–7.36)).

Skin-to-skin contact was started in all cases with on average 4 min (2–14, IIQ (3–5)) after birth. The median duration was 21 min (4–40, IIQ (12.3–29.5)). The median temperature of neonates after skin-to-skin contact was 37.2 °C [37.1–37.4]. 2 newborns were breastfed during skin-to-skin contact and during caesarean section. Skin-to-skin contact was interrupted in 24 patients: 9 from mother's wish, 11 for maternal reasons (drowsiness, stress, pain, maternal hypothermia, lipothymia, vertigo, nausea, cough) and 4 for the newborn (respiratory distress, low pH). The median duration for these patients was 12.5 min (4–32).

The median ANI at the end of skin-to-skin contact and at the end of the intervention was statistically higher than that before skin-to-skin contact ($p = 0.034$ and $p < 10\text{-}3$ respectively). No difference was observed for NPRS (Table 2).

Discussion

Caesarean section is a frequent intervention, stressful for patients and is a well-known cause of breastfeeding difficulty. In our pilot study, we showed a significant difference between patient ANI during caesarean section before and after skin-to-skin contact. Thus, maternal comfort seemed to be improved by skin-to-skin contact during caesarean section.

None study has specially assessed HRV in patients with skin-to-skin contact. Indeed, other studies have investigated the decrease in patient pain after skin-to-skin contact, but it was still a secondary endpoint and no study showed a significant difference. The 2009 Nolan study compared VAS (Visual Analogue Scale) in 50 patients at 1, 2, and 4 h after birth in the skin-to-skin and no skin-to-skin groups [18]. Patients in the skin-to-skin group had lower VAS than in the no skin-to-skin group for each time slot, but the difference was not significant. The authors mentioned the lack of power of the study due to missing data and low population. In our study, there was no significant

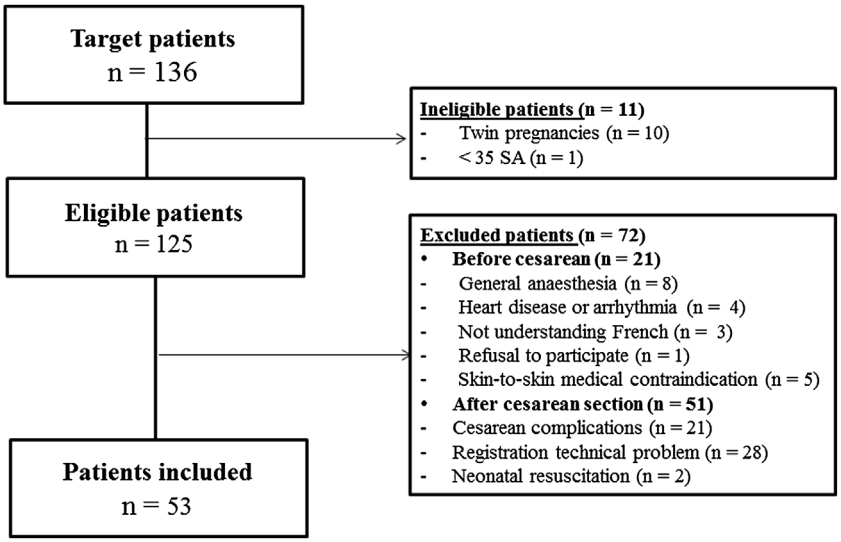

Fig. 4. Flow diagram.

difference between NPRS before and after skin-to-skin contact. This was related to the fact that measurements were performed early when patients were still undergoing locoregional analgesia. To highlight a difference, the measurements should be continued over an extended period of time after the caesarean section is over. In the 2014 literature review [16], evaluating early skin-to-skin contact after a caesarean section, Stevens mentioned two studies explaining the feelings of a patient and a nurse-anesthetist ("mothers forget their pain through skin-to-skin contact"). He concluded that further studies would be needed to determine if skin-to-skin contact has an impact on the pain felt by patients.

Skin-to-skin contact is still few performed during caesarean section and we also showed in this study the feasibility of this method. It was started immediately after birth with a median free interval of 4 min and the duration was 21 min, which represents the quasi entire suture duration. In the 2009 Nolan study, mean duration of skin-to-skin contact was 33 min [18]. In 2010, Gouchon's study, mean duration of skin-to-skin contact was 82.9 min (+/− 45.9 min) but it was started when the patient returned to her room and not immediately after birth [29]. Skin-to-skin contact was interrupted in 24 patients from maternal or newborn reasons. They were included in the analysis because ANI was recorded before the end of skin-to-skin and some patients do more than 20 min of skin-to-skin before interrupted it. It was the real conditions and could maybe minimize the effect of skin-to-skin on maternal comfort.

Even if our study has strengths (monocentric, allowing homogeneous skin-to-skin contact practice in the theater for caesarean section thanks to a local protocol developed), it also has limits. The study population was not representative of the general population because we included only those patients who had elective caesarean section. However, the population in this study was representative of the population in our maternity who have an elective caesarean section (Table 1). In fact, for logistical reasons, we were unable to include caesarean sections performed in semi-emergency or emergency because the PHYSIODOLORIS® monitor was only available in one theater. The biases of our work may have affected the representativeness of the results. A total of 72 patients were excluded from the analysis, which could create a selection bias. In fact, 21 patients were excluded because of a complicated caesarean section; the team need to be focused on the caesarean and skin-to-skin would not be done in safety conditions. (for example, a patient with Hirschsprung disease and multi operated, a patient who need an associated digestive surgery, a patient with a multicicatricial uterus anda lot of adhesions, a patient with a bladder wound preventing immediate skin-to-skin contact). 5 patients were excluded for skin-to-skin medical contraindication (2 for HIV and need an antiseptic bath, 2 for hepatocele, and 1 for omphalocele). 28 patients were excluded for technical reasons (intervention performed in another theater without the monitor, forgotten recording or data collection, technical problem of the monitor).

The NPRS is a scale close to the visual VAS [30]. NPRS was chosen, given its greater clinical simplicity for self-assessment of pain. However, it has been shown in validation studies that about 9% of patients were unable to use the numerical scale, which may have been a bias in the study results.

The increase of the ANI remained small and a clinical relevance of the increase the ANI of only a few points can be discussed. Many factors can influence the ANI like emotion, the end of Superior Vena Cava Syndrome, drugs interfering with heart rate (Ephedrine, Phenylephrine and Noradrenaline) used to control blood pressure. There is a confounding bias that birth alone, with or without skin-to-skin contact, decreases patient stress. ANI would maybe be increase without skin-to-skin contact because patients are less stress when they know that their newborns are alive and healthy. This bias could be limited by taking into account the ANI before skin-to-skin contact just after birth. Surgical stimulation is often stopped more than 10 min before the end of skin-to-skin because patients have to be wash. ANI is recorded at the end of skin-to-skin so ANI increase is probably not due to the end of the surgical stimulation. A study with a group control is necessary to conclude.

One lack of our study is there is no control group. A randomized controlled trial should be conducted to confirm the data from this pilot study by comparing the ANI in the groups with and without skin-to-skin contact. This type of study was not possible in this level-3 maternity labeled Baby Friendly Hospital Initiative (BFHI) because it was not ethical to deprive patients of skin-to-skin contact with their newborn in a maternity where this practice is already performed.

It would be interesting to evaluate mother's satisfaction and feeling after skin-to-skin, feelings and facility of installation for nurses and anesthetists. Theater's team accepted to participate in the study with a lot of interest and motivation. It would be also

Table 1
Mother and neonate's clinical characteristics compared to characteristics of all elective caesarean section during the same period.

	Mothers and newborn of the study (53)	All mothers and newborn with elective caesarean section (136)
Mothers		
Age (years), m (range)	34 (20–42)	33 (18–45)
Parity, m (range)	2 (1–7)	No data
Number of previous caesarean sections, n (%)		
1	26 (49,1)	51 (37,5)
2 or more	15 (28,3)	36 (26,5)
Indications of caesarean section, n (%)		
Previous caesarean section	36 (68)	44 (32)
Fetopelvic disproportion (breech/transverse presentation, macrosomia)	8 (15)	39 (29)
History of a corporal scar	3 (7)	4
Placenta previa	1	6 (4)
History of uterine rupture	1	6 (4)
Uterine myoma	1	3
Convenience	1	1
History of obstetrical anal sphinter injury	1	4
Anal fissure or fistula	1	2
Twin pregnancies		10 (14)
Fetal disease		5
Maternal disease (HIV, heart disease, thrombocytopenia . . .)		12 (9)
Anesthesia, n (%)		
Spinal anesthesia	37 (69,8)	84 (61,8)
Combinated epidural and spinal anesthesia	16 (30,2)	40 (29,4)
General anaesthesia	0	12 (8,8)
Neonates		
Sex ratio (M / F)	20/33	65/71
Gestational age (WG), m (range) (IIQ)	39 + 1 (37 + 1 – 41 + 3) (39–39 + 3)	39 (32–41)
Birth weight (g), m (range) (IIQ)	3240 (2150–5000) (3050–3660)	3345 (1350–5000) (2935–3785)
Apgar score 10/10 at 1 minute, n (%)	51 (96,2)	125 (92)
Umbilical arterial pH, m (range) (IIQ)	7,21 (6,94–7,3) (7,16–7,25)	7,22 (6,94–7,36) (7,18–7,25)
Umbilical venous pH, m (range) (IIQ)	7,33 (7,09–7,44) (7,30–7,36)	7,33 (7,09–7,44) (7,30–7,36)

WG: weigh growth.
m (IIQ) : median (IIQ).
n (%) : number (pourcentage).

Table 2
Parameters studied during electrocardiographic recordings.

	n = 53	Missing data
Before skin-to-skin contact		
NPRS	0 (0–0)	0
ANI	61 (49–72,5)	0
At the end of skin-to-skin contact		
NPRS	0 (0–0)	0
ANI	64,5 (55–82,3)	1

NPRS: Numeric Pain Rating Scale.
ANI: Analgesia Nociception Index.
Results are expressed as median (interquartile range).
Non-parametric Wilcoxon test.

interesting to evaluate it in case of emergency section during labor, situation clearly associated with higher maternal stress.

Conclusion

Skin-to-skin contact during elective caesarean section was associated with an elevation of ANI. However we can't conclude about the relationship between skin-to-skin and maternal comfort because there is no control group. The causality has to be confirmed by a randomized study. This knowledge should improve and spread the practice of skin-to-skin contact in caesarean sections, as recommended by the Baby Friendly Hospital Initiative (BFHI).

Contribution to authorship

CV wrote the first draft of the manuscript framed by TR. BM helped for the conception and design of the project and revising it critically. JDJ helped for collecting data, analysis and revising the manuscript critically. CG and LS helped for interpretation of data and revising the manuscript critically. PR helped for collecting data and revising it critically. All authors (CV, BM, TR, JDJ, CG, PR, LS) have taken due care to ensure the integrity of the work and accept responsibility for the paper as published.

Ethics approval

CNIL (Reference DEC16-111 – 07/03/2017), All the patient has been anonymised.

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Declaration of Competing Interest

De Jonckheere J. is scientific adviser for Mdoloris Medical Systems SAS and own shares of Mdoloris Medical System SAS. The others authors report no conflict of interest.

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