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Intraoperative pain during caesarean delivery: Incidence, risk factors and physician perception

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Abstract

Background: Intraoperative pain is a possible complication of neuraxial anaesthesia for caesarean delivery. There is little information available about its incidence, risk factors and physician perception.

Methods: Parturients undergoing spinal anaesthesia for elective caesarean delivery were enrolled. Before surgery, parturients were asked about preoperative anxiety on a verbal numerical scale (VNS), anticipated analgesic requirement, postoperative pain levels, Spielberger STATE-TRAIT inventory index, Pain Catastrophizing Scale. After surgery, parturients were asked to answer questions (intraoperative VNS pain). The anaesthesiologist and obstetrician were asked to fill out a questionnaire asking about perceived intraoperative pain. Influence of preoperative anxiety on intraoperative pain (yes/no) was assessed using logistic regression. Mc Fadden's R^2 was calculated. The agreement in physician perception of intraoperative pain with reported pain by the parturient was examined by calculating Cohen's kappa and 95% Confidence Intervals (CI).

Results: We included 193 parturients in our analysis. Incidence of intraoperative pain was 11.9%. Median intraoperative VNS pain of parturients with pain was 4.0 (1st quartile 4.0; 3rd quartile 9.0). Preoperative anxiety was not a good predictor

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of intraoperative pain (p-value of β-coefficient = 0.43, Mc Fadden's R^2 = 0.01). Including further preoperative variables did not result in a good prediction model. Cohen's kappa between reported pain by parturient and by the obstetrician was 0.21 (95% CI: 0.01, 0.41) and by the anaesthesiologist was 0.3 (95% CI: 0.12, 0.48).

Conclusions: We found a substantial incidence (11.9%) of intraoperative pain during caesarean delivery. Preoperative anxiety did not predict intraoperative pain. Physicians did not accurately identify parturients' intraoperative pain.

Significance: Intraoperative pain occurred in 11.9% and severe intraoperative pain occurred in 1.11% of parturients undergoing elective caesarean delivery under spinal anaesthesia. We did not find any preoperative variables that could reliably predict intraoperative pain. Obstetricians and anaesthesiologists underestimated the incidence of intraoperative pain in our cohort and thus, more attention must be put to parturients' pain.

1 | INTRODUCTION

Caesarean delivery (CD) is the most frequently performed surgery in the United States and almost 90% of parturients undergoing elective CD receive spinal anaesthesia (Bucklin et al., 2005; McDermott et al., 2017). This anaesthesia is considered the gold standard because it allows the woman to see the newborn intraoperatively, can provide good postoperative analgesia, and obviates need for airway manipulation (Mhyre & Sultan, 2019). Common complications of spinal anaesthesia, including spinal hypotension, nausea and vomiting, have received much focus in the literature with subsequent recommendations for prophylaxis and treatment (Kinsella et al., 2018).

A potentially devastating complication of spinal anaesthesia for CD is intraoperative pain. In 2016, an article in the anaesthesia literature was published describing a woman's intraoperative pain during an elective CD under spinal anaesthesia (Stanford & Bogod, 2016). She reported intraoperative pain causing her long-term psychological and physical consequences. Indeed, other studies have shown that intraoperative pain during CD can lead to postpartum depression and post-traumatic stress disorder (Lopez et al., 2017). Moreover, intraoperative pain is now one of the main reasons for litigation against anaesthesiologists (Maronge & Bogod, 2018).

In spite of the seriousness of this complication, little information is available on its incidence. In the Obstetric Anaesthetists Association handout for mothers, it is stated that intraoperative pain may occur in 5% of cases, but it is unclear how this number was estimated (www.labourpains.com, accessed March 8, 2021).

In addition to lack of incidence for this phenomenon, we also do not know if there are any preoperative or intraoperative risk-factors that could predict intraoperative pain and thus allow for provision of personalized medicine. For example, after identifying risk factors for postoperative pain after CD, studies have begun to tailor anaesthesia protocols according to risk factors (Booth et al., 2016).

Risk factors for postoperative pain include preoperative anxiety, high levels of anticipated pain and analgesic need (Pan et al., 2013). However, it is not known if these variables can also predict intraoperative pain.

Finally, it is unclear if physicians accurately assess intraoperative pain. Intraoperative pain may be misinterpreted as anxiety by the physician. No study to date has compared parturient and physician agreement on intraoperative pain.

The primary aim of our study was to assess the incidence and severity of intraoperative pain. Secondary aims were to determine if there are preoperative factors that influence the incidence of intraoperative pain and to examine whether physicians correctly assess intraoperative pain.

2 | METHODS

This was a prospective observational study. After institutional review board approval (IRB 040-19, Helsinki approval on 13/10/2020) and written informed consent approval, parturients undergoing an elective CD were approached for participation. This study was registered on clinicaltrials.gov (NCT04363281).

2.1 | Inclusion

All parturients undergoing an elective CD under spinal anaesthesia were eligible for participation.

2.2 | Exclusion

Parturients were excluded if they refused or were unable to fill out the questionnaire in Hebrew if they had inadequate spinal anaesthesia prior to the beginning of surgery (less than T4 sensory

level to pinprick assessed bilaterally and a T2 sensory level to cold sensation bilaterally) or had a history of psychiatric disease. Further exclusion criteria were significant haemorrhage requiring blood product administration, known foetal anomalies and parturients whose neonates were sent to neonatal intensive care unit without being seen by their mother, where in these cases it is routine in our practice to administer anxiolytics to the mother, thus rendering the filling out of the questionnaires inaccurate. Prolonged surgeries over 90 minutes were excluded.

2.3 | Preoperative evaluation

On the day of surgery, parturients were requested to answer the following questions:

- Verbal numeric score (VNS) preoperative anxiety (0- no anxiety to 10- worst anxiety imaginable).
This score has also been used in our previous studies (Danon et al., 2020; Orbach-Zinger et al., 2012).
- Pan's three questions:
1. VNS anxiety (see above),
2. Anticipated postoperative pain level (0- none, 1- some, 2- severe),
3. Anticipated analgesic requirements (0- none, 1- some, 2- severe).

In a study Pan et al. found that three questions could predict postoperative pain after CD with a sensitivity of 0.68 and a specificity of 0.67 (Pan et al., 2013).

- Spielberger STATE-TRAIT inventory index: a two-part questionnaire with self-reporting scales assessing state and trait anxiety comprising 20 questions each on a 4-point scale (0- not at all, 1- somewhat, 2- moderately so, 3- very much so); Internal consistency and test-retest reliability have been found to be very high (Spielberger, 1983; Spielberger et al., 1970). Spielberger STATE-STRAIT inventory index has been used in previous studies assessing parturients' anxiety (Newham et al., 2012; Orbach-Zinger et al., 2017).

- Pain Catastrophizing Scale (PCS): a 13-item questionnaire assessing pain catastrophizing on a 4-point scale (0- not at all, 1- somewhat, 2- moderately so, 3- very much so) asking parturients to reflect on painful experiences they have had in the past (Sullivan et al., 1995). We have used this score in a previous study (Orbach-Zinger et al., 2017).

Details about VNS anxiety, Spielberger STATE, Spielberger TRAIT, PCS, anticipated postoperative pain level, anticipated analgesic requirements, pelvic adhesion, uterine exteriorization, skin closure technique, number of labours, and number of caesarean sections are presented in the Table S1.

2.4 | Intraoperative management

Spinal anaesthesia was performed at the L3-L4 or L4-L5 spinal interspace in the sitting position. Hyperbaric bupivacaine (0.5%) (AstraZeneca, England) 12 mg, along with fentanyl (Rafa Laboratories, Israel) 20 μg and preservative free morphine (Rafa Laboratories, Israel) 100 μg were injected intrathecally via a 26G needle (Temena, Germany) with the needle orifice oriented in the cephalad direction. After appearance of cerebrospinal fluid during spinal injection, phenylephrine infusion was started at 50 μg/min and titrated to maintain 90% of baseline blood pressure. Parturients were immediately placed in the left uterine displacement position using a wedge under the right flank. Before surgery began, the block was assessed via four distinct tests:

1. Motor-block (parturient unable to lift legs),
2. Sensory assessment to pinprick bilaterally to T4 (using a sharp instrument),
3. Sensory assessment to cold assessed by cold alcohol swab,
4. Surgical test using tweezers at level of skin incision.

Only after all tests were negative, was surgery allowed to commence. After the umbilical cord was clamped and cut, one unit oxytocin push was given over 15 s, lactated Ringer's solution was replaced by 1 litre of lactated Ringer's solution with oxytocin 10 units which was administered at 500 ml/h. A bolus of dexamethasone 10 mg and ondansetron 4 mg were administered IV according to the institutional protocol. Surgery was performed using a standard Pfannenstiel incision. The decision to exteriorize the uterus was at the discretion of the attending obstetrician and was recorded. The decision of skin closure with staples or sutures was also at the discretion of the attending obstetrician.

2.5 | Intraoperative pain evaluation

In the post anaesthesia care unit, parturients were approached and asked to fill out a questionnaire regarding intraoperative pain. The parturients were asked a number of questions in order to blind them to this study's aim (assessing intraoperative pain), such as intraoperative anxiety, nausea, vomiting, satisfaction with anaesthesia services, request for medication. Intraoperative pain was assessed on a VNS scale (0- no pain,

10- greatest pain imaginable). Content and construct validity were reached using a modified Delphi approach.

2.6 | Physician questionnaire

Postoperatively, the anaesthesiologist and the obstetrician were given a form to fill out regarding intraoperative parturient pain. Both, the anaesthesiologist and obstetrician were asked to identify their rank (1- resident within first half of residency, 2- resident in last half of residency, 3 -attending physician). In order to blind them to the aim of this study, they were asked to fill out other questions (such as parturient anxiety, uterotonics given, anxiolytics required). In addition, the obstetrician was asked questions involving surgical technique including uterine exteriorization (yes/no), degree of adhesions (0- none, 1 -mild, 2-moderate, 3 -severe), performance of a bilateral tubal ligation (yes/no), skin closure technique (staples/sutures). Obstetricians and anaesthesiologists were asked whether the parturient had any intraoperative pain (yes/no). Before the performance of this study, this questionnaire also underwent construct and content validation at our institution via a modified Delphi approach.

2.7 | Data collection

Additional data were collected from an electronic medical file database. Data collection included parturients' demographic data and obstetric data, including birth number and CD number.

2.8 | Sample size calculation

We performed a sample size calculation using data of a pilot study including 20 parturients. The incidence of intraoperative pain was 7.8%. With a 4% margin of error, this resulted in a sample size of 177 parturients that needed to be recruited. In order to make up for potential drop-out, we decided to enrol 235 parturients.

2.9 | Statistics

All variables were assessed for normality using histograms and QQ-plots.

The influence of various variables (VNS anxiety, Spielberger STATE, Spielberger TRAIT, PCS, anticipated postoperative pain level, anticipated analgesic requirements, pelvic adhesion, uterine exteriorization, skin closure technique, number of labours and caesarean deliveries) on intraoperative pain were tested by running a logistic binary regression with above mentioned variables as independent variables and intraoperative pain yes/no as the dependent binary variable. Before conducting the binary logistic regression, we checked if the following model assumptions have been met: lack of multicollinearity of independent variables, linearity between the logit of intraoperative pain and independent variables and no extreme values.

Furthermore, a possible association between maternal anxiety and obstetrician's/anaesthesiologist's evaluation of pain was assessed using a logistic binary regression.

Mc Fadden's R^2, a coefficient of determination adapted for logistic regression, was calculated in order to examine how much variability in intraoperative pain (yes/no) could be explained by one variable exclusively or multiple variables when included in a prediction model.

The agreement in pain perception by the physician (anaesthesiologist or obstetrician; yes/no) and pain reported by the parturient (yes/no) were assessed by calculating Cohen's kappa with corresponding 95% Confidence Intervals (CI).

For parturient characteristics, two-sided *p*-values were calculated using Mann-Whitney-U test, as variables were not-normally distributed.

All statistical analyses were done using SPSS and R (version 4.0.2) (IBM SPSS, 2020; R Statistical Software, 2017).

3 | RESULTS

A total of 193 parturients were included in our analysis. A flow chart of parturient recruitment is presented in Figure 1.

3.1 | Incidence of intraoperative pain

Twenty-three parturients (11.9%) reported intraoperative pain (yes/no). Of these, 8 parturients (34.7%) reported pain before the baby was delivered, 15 (65.2%) reported pain after the baby was delivered, while 5 (21.7%) of them reported pain both before and after the baby was delivered. Parturient characteristics of parturients with versus without pain are presented in Table 1. There was no statistically significant difference in parturient or operative characteristics between parturients that reported intraoperative pain and those that did not report intraoperative pain, apart from number of labours which was greater in the parturients who had intraoperative pain ($p = 0.009$). The median intraoperative VNS pain of those that reported pain, was 4.0 (1st quartile 4.0; 3rd quartile 9.0) [minimum 1.0; maximum 10.0]. Two parturients (1.11%) reported severe pain (intraoperative VNS pain ≥7).

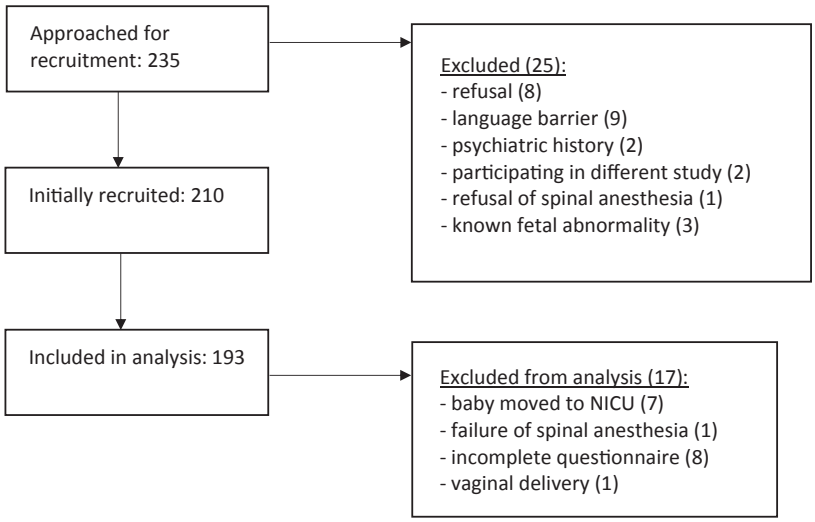

FIGURE 1 Flow chart of study recruitment. NICU, neonatal intensive care unit

TABLE 1 Parturient characteristics

Variable	Overall n = 193	Intraoperative pain n = 23	No intraoperative pain n = 170	*p*-value
Age	33 (30; 38) [20; 53]	31 (30; 34.5) [27; 37]	34 (30; 38.75) [20; 53]	0.08
Number of labors	2.0 (2.0; 3.0) [1; 8]	3.0 (2,0; 4.0) [1; 7]	2.0 (2.0; 3.0) [1; 8]	0.009
Number of cesarean sections	2.0 (1.0; 2.0) [1; 5]	2.0 (1.0; 3.0) [1; 5]	2.0 (1.0; 2.0) [1; 5]	0.18
Number of pelvic adhesions	1.0 (0; 1.0) [0; 3]	1.0 (0; 1.5) [0; 3]	0 (0; 1.0) [0; 3]	0.47
Uterine exteriorization	24 (12%)	4 (17%)	20 (12%)	0.64
Stitches (rather than staples)	128 (66%)	16 (70%)	112 (66%)	0.30
Obstetrician's experience	1.0 (0; 3.0) [0; 3]	3.0 (0; 3.0) [0; 3]	1.0 (0; 3.0) [0; 3]	0.12

Numbers are presented as median (1st quartile; 3rd quartile) [minimum; maximum] or as absolute numbers (relative proportion in %). *p*-values are two-sided. Obstetrician's experience ranged from 0 to 3 (0—before first resident's exam, 1—after first resident's exam but before second, 2—after second resident's exam, 3—consultant).

3.2 | Association between preoperative anxiety and intraoperative pain

Examining the relationship between intraoperative pain with preoperative anxiety as the independent variable using logistic regression did not result in a good prediction model (*p*-value of β-coefficient = 0.43, Mc Fadden's R^2 = 0.01). Neither Spielberger STATE (*p*-value of β-coefficient = 0.71, Mc Fadden's R^2 = 0.0001), nor Spielberger TRATE (*p*-value of β-coefficient = 0.28, Mc Fadden's R^2 = 0.01) or PCS (*p*-value of β-coefficient = 0.49, Mc Fadden's R^2 = 0.01) were predictors of intraoperative pain. Anticipated pain (*p*-value of β-coefficient = 0.09, Mc Fadden's R^2 = 0.002) and anticipated analgesic requirement (*p*-value of β-coefficient = 0.60, Mc Fadden's R^2 = 0.02) were also not good predictors of intraoperative pain.

A multivariable regression model using Pan et al.s' three questions (anticipated analgesic requirement, anticipated pain level and preoperative VNS anxiety) as independent variables did not result in good prediction of intraoperative pain (*p*-value of β-coefficient = 0.08, 0.93, 0.29, respectively; Mc Fadden's R^2 = 0.03) (Pan et al., 2013).

Creating a prediction model using the variables anticipated analgesic requirement, anticipated pain level and preoperative VNS anxiety, obstetrician's experience, PCS score and pelvic adhesions as independent variables of a binary logistic regression model in order to predict intraoperative pain (yes/no) resulted in only a poor prediction model (*p*-value of β-coefficients all above 0.05; Mc Fadden's R^2 = 0.11).

A logistic binary regression with maternal anxiety as the independent variable and obstetrician's/anaesthesiologist's evaluation of pain as the dependent variable did not result in a good model (*p*-value of β-coefficient

0.141 [obstetrician's evaluation as dependent variable]/0.6 [anaesthesiologist's evaluation as dependent variable]; Mc Fadden's $R^2 = 0.012$ [obstetrician's evaluation as dependent variable]/0.001 [anaesthesiologist's evaluation as dependent variable]).

Adding uterine exteriorization and stitches rather than staples as well as number of labours and caesarean deliveries as independent variables to all of the above-mentioned models did not result in an improvement of the model.

3.3 | Parturient and physician pain perception

The Cohen's kappa effect estimate between reported pain by the parturient and perceived pain by the obstetrician was 0.21 (95% CI: 0.01, 0.41). Obstetricians perceived intraoperative pain in 8 out of 193 parturients (4.1%). The false-positive rate (when the obstetrician thought there was pain, but the parturient did not report any pain) of obstetricians' assessment of intraoperative pain (yes/no) was 2.4%, the false-negative rate (when the obstetrician thought there was no pain, but the parturient reported pain) was 82.6%.

Analysing the agreement in pain reported by the parturient and perceived by the anaesthesiologist, we found fair agreement with Cohen's kappa of 0.30 (95% CI: 0.12, 0.48). Anaesthesiologists perceived intraoperative pain in 32 out of 193 parturients (16.7%). The false-positive rate of anaesthesiologists' assessment of intraoperative pain (yes/no) was 12.3%, the false-negative rate was 52.2%. Both anaesthesiologists and obstetricians underestimated maternal pain.

4 | DISCUSSION

In this study, we found that a non-negligible proportion (11.9%) of parturients suffered from intraoperative pain, in spite of rigorous preoperative sensory testing. In addition, two parturients (1.11%) had severe intraoperative pain (as measured by VNS $\geq$ 7). Furthermore, we did not find any pre- or intraoperative factor associated with intraoperative pain. We also demonstrated that physicians (obstetricians and anaesthesiologists) were unable to accurately identify parturients' pain.

The Obstetric Anaesthetist's Association warns parturients that intraoperative pain may occur in 5% of CD under spinal anaesthesia (www.labourpains.com, accessed March 8, 2021). We found a higher incidence (11.9%). There may be a number of reasons: In our study we used 12 mg of hyperbaric bupivacaine, which is our clinical practice according to a study by Ginosar et al. who reported an effective dose (ED) of 95% of 11.5mg of hyperbaric bupivacaine (Ginosar et al., 2004). However, newer studies have found that the use of phenylephrine infusion may increase the ED95 (Xiao et al., 2018). Furthermore, another possible reason might be that obstetricians in our hospital perform uterine exteriorization which may be associated with higher pain levels (El-Khayat et al., 2014). However, in our study, we did not find that uterine exteriorization was associated with intraoperative pain. Moreover, our standard practice is not to give intravenous pain medication during CD which may lead to undertreatment of pain; the recent PROSPECT guidelines for CD recommended the addition of intravenous non-steroidal anti-inflammatory drugs and paracetamol intraoperatively after the baby is delivered (Roofthooft et al., 2020). In our study, a majority of parturients suffered pain after the baby was delivered. Perhaps, addition of these medication intraoperatively could have decreased the number of parturients experiencing pain.

Intraoperative pain may have long-term implications for the mother, including postpartum depression, posttraumatic stress disorder and chronic pain (Komatsu et al., 2020; Lopez et al., 2017; McCombe & Bogod, 2020; Stanford & Bogod, 2016). Furthermore, postpartal mental health disorders may cause long-term sequalae in mother, partner and child (Heesen et al., 2020; Torres et al., 2019).

We were unable to predict intraoperative pain using preoperative anxiety, anticipated analgesic requirements or anticipated intraoperative pain levels as independent predictors.

This finding contrasts with prediction models for predicting postoperative pain (Pan et al., 2013).

Including any pre- and intraoperative variables to the logistic regression model, did not result in a good prediction model.

To our knowledge this is the first study that compares the parturient's intraoperative pain perceived by the physician with the intraoperative pain reported by the parturient. The obstetrician's and anaesthesiologist's perception of intraoperative pain did not match with the intraoperative pain as reported by the parturient. In our study, obstetricians and anaesthesiologists underestimated the incidence of intraoperative pain (yes/no. This is shown by the higher false-negative rate of obstetricians' ratings. In concordance, the false-positive rate of anaesthesiologists' ratings were higher.

Strengths of our study are the meticulous study design and assessment of the anaesthetic block for every parturient in exactly the same way.

Limitations of this study are possible overestimation of pain as parturients were explicitly asked about pain levels in a questionnaire. In addition, since the parturient was questioned about pain postoperatively there could exist some recall bias. Possible recall bias might also have affected the physician's assessment of intraoperative pain (yes/no).

5 | CONCLUSIONS

In conclusion, the non-negligible incidence (11.9%) of intraoperative pain during CD shows that further attempts must be made to better manage and prevent intraoperative pain. It is important to develop further studies to perform direct assessment of intraoperative maternal pain. Preoperative anxiety or pain catastrophizing did not predict intraoperative pain and therefore other possible predictors should be tested. Moreover, physicians did not accurately identify parturients' intraoperative pain.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

A.K and S.OZ conceived of the presented idea. A.K, S.OZ and P.H conceptualized. The methodology has been planned out by A.K, P.H, A.K, L.A.E and S.OZ. Formal analysis of the study has been undertaken by P.H, A.K, Y.B and S.OZ. The original draft has been written by P.H, I.N, A.M, K.A, Y.B, E.H and S.OZ. The manuscript was reviewed and edited by A.K, P.H, I.N, A.M, K.A, Y.B, E.H, L.A.E, A.K and S.OZ.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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