

# Postcesarean Section Pain Prediction by Preoperative Experimental Pain Assessment

Michal Granot, D.Sc.,\* Lior Lowenstein, M.D.,† David Yarnitsky, M.D.,‡ Ada Tamir, D.Sc.,§ Etan Z. Zimmer, M.D.||

**Background:** Postcesarean section pain is a common cause of acute pain in obstetrics, yet pain relief and patient satisfaction are still inadequate in many cases. The present study was conducted to determine whether preoperative assessment of experimental pain perception by quantitative sensory tests could predict the level of postcesarean section pain.

**Methods:** Fifty-eight women who were scheduled for elective cesarean section were enrolled in the study. Heat pain threshold and magnitude estimation of suprathreshold pain stimuli at 44°–48°C were assessed for both algosity (the sensory dimension of pain intensity) and unpleasantness 1 or 2 days before surgery. The day after the operation, the women reported the level of pain at the surgical wound on a visual analog scale at rest and during activity. Regression analysis was performed to evaluate the usefulness of preoperative scores in predicting postcesarean section pain.

**Results:** Postoperative visual analog scale scores at rest and during activity significantly correlated with preoperative suprathreshold pain scores at 44°–48°C ( $r = 0.31$ – $0.58$  for algosity and  $r = 0.33$ – $0.74$  for unpleasantness). The stimulus of 48°C was found to be the best predictor of postoperative pain for both conditions ( $r = 0.434$ – $0.527$ ;  $P < 0.01$ ). In contrast to suprathreshold pain stimuli, pain threshold was not correlated with postoperative pain.

**Conclusions:** The results show that a simple and quick preoperative test is useful in identifying those women who will experience greater pain after a cesarean section. This test may be suggested for caregivers to tailor the postoperative treatment to specific patient needs and to improve postoperative outcome and patient satisfaction.

POSTCESAREAN section pain is a common cause of acute pain in obstetrics. Various methods of analgesia are currently in use; however, pain relief and patient satisfaction are still inadequate in many cases. This may be

related to inadequate analgesia due to difficulties in pain assessment, gaps between patients and medical staff with regard to estimation of the severity of the pain, and variability of perceived pain among different patients due to physiologic and psychologic factors. Several studies have shown the importance of adequate postoperative analgesia on well-being, mobilization, rehabilitation, and decreasing the length of hospital stay.<sup>1–3</sup>

Several studies have been devoted to searching for preoperative factors that may predict the level of postoperative pain. However, an analysis of these studies reveals conflicting results. For instance, whereas some investigators found a correlation between different characteristics of personality and postoperative pain, others did not find such a correlation.<sup>4–9</sup> Likewise, there are inconsistent findings on the importance of preoperative patient education and information regarding the surgical procedure<sup>5,10–13</sup> or preoperative local or systemic preemptive analgesia<sup>14–16</sup> on the experienced postoperative pain.

Pain is a subjective experience that incorporates physiologic, cognitive, and emotional domains. The impact of personal pain perception, such as pain threshold and magnitude estimation of suprathreshold pain, on the experience of postoperative pain has not yet been established. The relationship between preoperative experimental pain assessment and postoperative pain has not yet been addressed. The aim of the present study was to evaluate whether preoperative assessment of experimental pain perception by quantitative sensory tests could predict the level of postcesarean section pain.

## Materials and Methods

The Rambam Medical Center Review Board (Haifa, Israel) approved this study in accordance with the Helsinki Declaration of Health.

### Study Population

Healthy women with a normal pregnancy at 38–41 weeks' gestation who were scheduled for an elective cesarean section were enrolled in the study after giving informed consent.

### Experimental Preoperation Pain Assessment

Heat pain threshold and magnitude estimation of suprathreshold pain are accepted psychophysical measures of pain perception.<sup>17–19</sup> Quantitative sensory testing was performed 1 or 2 days before the cesarean section with a Thermal Sensory Analyzer (TSA-2001; Me-

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\* Lecturer, Faculty of Health and Welfare Studies, University of Haifa, and Senior Fellow, Department of Neurology, Rambam Medical Center and Faculty of Medicine, Technion-Israel Institute of Technology. † Instructor, Faculty of Medicine, Technion-Israel Institute of Technology, and Chief Resident, Department of Obstetrics-Gynecology, Rambam Medical Center. ‡ Associate Professor, Faculty of Medicine, Technion-Israel Institute of Technology, and Chairman, Department of Neurology, Rambam Medical Center. § Instructor, Faculty of Medicine, and Senior Fellow, Department of Community Medicine and Epidemiology, Faculty of Medicine, Technion-Israel Institute of Technology. || Clinical Associate Professor, Faculty of Medicine, Technion-Israel Institute of Technology, and Director of Obstetrics, Rambam Medical Center.

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Address reprint requests to Dr. Zimmer: Department of Obstetrics and Gynecology, Rambam Medical Center, Haifa 31096, Israel. Address electronic mail to: granot@research.haifa.ac.il. Additional article reprints may be purchased through the Journal Web site, [www.anesthesiology.org](http://www.anesthesiology.org).

doc, Ramat-Yisai, Israel), using a  $30 \times 30\text{-mm}^2$  contact probe (thermode).

Before starting the tests, the women received an explanation of the difference between the two aspects of pain: namely, *algoty* (the sensory dimension of pain intensity) and *unpleasantness* (the emotional dimension of pain). To illustrate the differences between the domains, a loud noise analogy was used: the volume of the music represents the intensity, and the obtrusiveness of the music represents the unpleasantness.

#### Pain Threshold

Heat pain threshold was determined by methods of limit.<sup>20,21</sup> The thermode was applied to the volar forearm of the nondominant hand. Temperature was elevated from the level of  $32^\circ\text{C}$  at a rate of  $1^\circ\text{C/s}$ . The interstimulus interval was 5 s. The women were asked to indicate the transition point at which the nonpainful warm sensation changed into a painful heat sensation by pressing a button. A course of training stimuli was first given, to familiarize the subjects with the measurement. Once interstimulus variance had decreased to less than  $0.5^\circ\text{C}$ , the mean of four successive stimuli was calculated as the pain threshold.

#### Suprathreshold Pain

A magnitude estimation of suprathreshold noxious stimulation assessment was performed by applying phasic heat stimuli at five different temperatures:  $44^\circ$ ,  $45^\circ$ ,  $46^\circ$ ,  $47^\circ$ , and  $48^\circ\text{C}$ . Fixed temperatures were given to examine the response to similar stimulus intensities. The various temperatures were given in a randomized order, and each temperature was given twice. Each stimulus started at the level of  $32^\circ\text{C}$  and increased at a rate of  $1^\circ\text{C/s}$ . After reaching the destination temperature, the stimulus remained for 1 s at that temperature, and then it rapidly decreased back to baseline at a rate of  $8^\circ\text{C/s}$ . The interstimulus interval between successive stimuli was 30 s. The women were asked to report the level of perceived pain intensity and unpleasantness by means of a visual analog scale (VAS) for each pain aspect immediately after each stimulus. The 100-mm VAS ranges from "no pain" at one end to "the worst pain imaginable" at the other end.<sup>22</sup> For measurements of unpleasantness, the wording was changed in accordance with "no unpleasantness" on one end and "the most unpleasant feeling" on the other end.

#### Treatment Protocol for Postcesarean Section Pain

Cesarean sections were performed under epidural anesthesia with bupivacaine (0.5%) without opioids. The catheter was removed after the completion of the cesarean section, and no postoperative parenteral analgesia was used. Oral analgesia with dipyrone (Optalgin; Teva Pharmaceuticals, Jerusalem, Israel) was provided at the patient's request, allowing patients to get a solution of

**Table 1. Magnitude Estimation (Mean  $\pm$  SD) of Suprathreshold Pain Stimuli**

Temperature, $^\circ\text{C}$	Pain Algoty	Pain Unpleasantness
44	$13.7 \pm 16.7$	$11.3 \pm 14.7$
45	$26.5 \pm 20.8$	$23.2 \pm 19.8$
46	$36.4 \pm 22.9$	$34.7 \pm 23.8$
47	$44.9 \pm 25.8$	$42.3 \pm 26.5$
48	$59.7 \pm 28.9$	$58.8 \pm 31.0$

1 g dipyrone every 4 h. Dipyrone is a nonsteroidal, antiinflammatory agent that exhibits analgesic and antipyretic activity. It has been demonstrated to inhibit cyclooxygenase, thromboxane synthesis platelet aggregation induced by arachidonic acid, and total body synthesis of prostaglandin  $E_1$  and prostaglandin  $E_2$ . The half-life of dipyrone is 2 to 3 h. A single dose of oral dipyrone (500 mg) has an efficacy similar to that of ibuprofen (400 mg) and other analgesics frequently used in the treatment of moderate to severe postoperative pain. Its main adverse effect is agranulocytosis. Dipyrone is not available in the United States, but it is on the market in Western Europe and other countries as well.<sup>23,24</sup>

All patients were informed that they could receive a rescue dose of a 30-mg tablet of immediate-release morphine sulfate (MIR; Rafa Laboratories, Jerusalem, Israel) for breakthrough pain if further analgesia was needed before the 4 h elapsed. This treatment protocol has been previously reported<sup>25</sup> and is the standard of care in our department.

#### Postcesarean Section Pain Assessment

In the morning hours of the first day after surgery, the women were asked to report on the level of abdominal pain at the surgical wound by means of the VAS. The perceived postoperative pain was assessed in two conditions: at rest in bed and during activity—changing position to either sitting up or standing.

#### Statistics

Statistical analysis was done with the SPSS (Chicago, IL) 9.0 statistics program. The Pearson correlation coefficient between preoperative experimental pain measurements of algosity and unpleasantness and postcesarean section pain at rest and during activity was evaluated by the *t* test. The predictive value of preoperative pain measurements was assessed with a linear regression model. Separate regression analyses were performed on both of the postoperative VAS scores against each algosity or unpleasantness VAS score individually, to determine the best predictive model for postoperative pain. The level of significance was set at  $P < 0.05$ .

#### Results

Fifty-eight healthy women at a mean gestation  $\pm$  SD of  $39.1 \pm 2.2$  weeks were enrolled in the study.

**Table 2. Pearson Correlation Coefficient between Precesarean Section Pain Assessment (Algosy and Unpleasantness) and Postoperative Pain Estimation**

Temperature, °C	Pain Algosy		Pain Unpleasantness	
	<i>r</i>	<i>P</i>	<i>r</i>	<i>P</i>
At rest				
44	0.479	0.0003	0.453	0.002
45	0.389	0.0038	0.561	0.0002
46	0.601	0.0001	0.486	0.0004
47	0.535	0.0001	0.483	0.0005
48	0.616	0.0001	0.599	0.0001
During activity				
44	0.311	NS	0.325	0.037
45	0.415	0.0032	0.598	0.0001
46	0.495	0.0004	0.581	0.0001
47	0.500	0.0003	0.633	0.0001
48	0.577	0.0004	0.736	0.0001

NS = not significant.

### Preoperative Pain Assessment

The mean heat pain threshold  $\pm$  SD was  $44.2^\circ \pm 2.6^\circ\text{C}$ . Magnitude estimations of each suprathreshold temperature for pain algosy and unpleasantness VAS scores are presented in table 1. Of note, there were 11 women with a pain threshold of greater than  $44^\circ\text{C}$ , 6 with a pain threshold of greater than  $45^\circ\text{C}$ , and 3 with a pain threshold of greater than  $46^\circ\text{C}$ .

### Postcesarean Section Pain Scores

The mean VAS scores  $\pm$  SD for the level of postcesarean section pain were  $27.6 \pm 21$  at rest in bed and  $52.5 \pm 24$  during activity.

### Relationship between Preoperative Pain Scores and Postcesarean Section Pain Scores

Postoperative pain scores at rest and during activity were significantly correlated with preoperative suprathreshold pain scores for algosy and unpleasantness (table 2). No significant correlation was found between

the preoperative pain threshold and postcesarean section pain scores for either condition.

### Predictive Model for Postoperative Pain

Postoperative VAS scores at rest and during activity were separately regressed against each of the individual preoperative algosy and unpleasantness scores, resulting in six separate regression models at  $46^\circ$ ,  $47^\circ$ , and  $48^\circ\text{C}$ . The regression analysis was performed for those women whose three suprathreshold stimuli were at a temperature level greater than the pain threshold ( $n = 38$ ). The coefficients and *P* values are presented in table 3.

The model of  $48^\circ\text{C}$  provides the most statistically significant fit for both postoperative conditions (at rest and during activity), with a reasonably high *r*, suggesting that it can be used as a predictive model for postoperative pain.

The correlation between preoperative pain scores for algosy at  $48^\circ\text{C}$  and postoperative pain is presented in figure 1. According to this prediction model, coefficient (0.516) times the preoperative VAS score plus the intercept (23.94) equals predicted postoperative pain.

### Effect of Analgesia on Postcesarean Section Pain

Postcesarean section pain assessment was performed in 13 women within 3 h of dipyrone administration, and the other 45 women were tested more than 3 h after dipyrone administration. Regarding the possible effect of the interval from the last analgesic administration on the postoperative VAS scores, no significant differences were noted between these two groups of patients. The mean postoperative number of analgesic doses  $\pm$  SD was  $3.24 \pm 1.112$  in the first 24 h after surgery.

## Discussion

This study aimed to assess whether a systemic preoperative perception of experimental pain in women scheduled for an elective cesarean section could predict

**Table 3. Linear Regression Model for Predicting Postoperative Pain, According to the Preoperative Pain Score ( $n = 38$ )**

Status	Temperature, °C	Coefficient ( $\beta$ )	Intercept	<i>r</i>	<i>P</i>
VAS algosy					
Rest	46	0.502	10.26	0.433	0.010
Rest	47	0.458	8.83	0.401	0.016
Rest	48	0.539	-4.35	0.492	0.003
Activity	46	0.432	40.24	0.389	0.033
Activity	47	0.442	37.24	0.401	0.028
Activity	48	0.516	23.94	0.527	0.003
VAS unpleasantness					
Rest	46	0.432	14.19	0.350	0.042
Rest	47	0.377	13.49	0.345	0.045
Rest	48	0.461	1.66	0.434	0.010
Activity	46	0.331	45.80	0.298	NS
Activity	47	0.398	38.91	0.397	0.029
Activity	48	0.479	27.43	0.511	0.003

NS = not significant; VAS = visual analog scale.

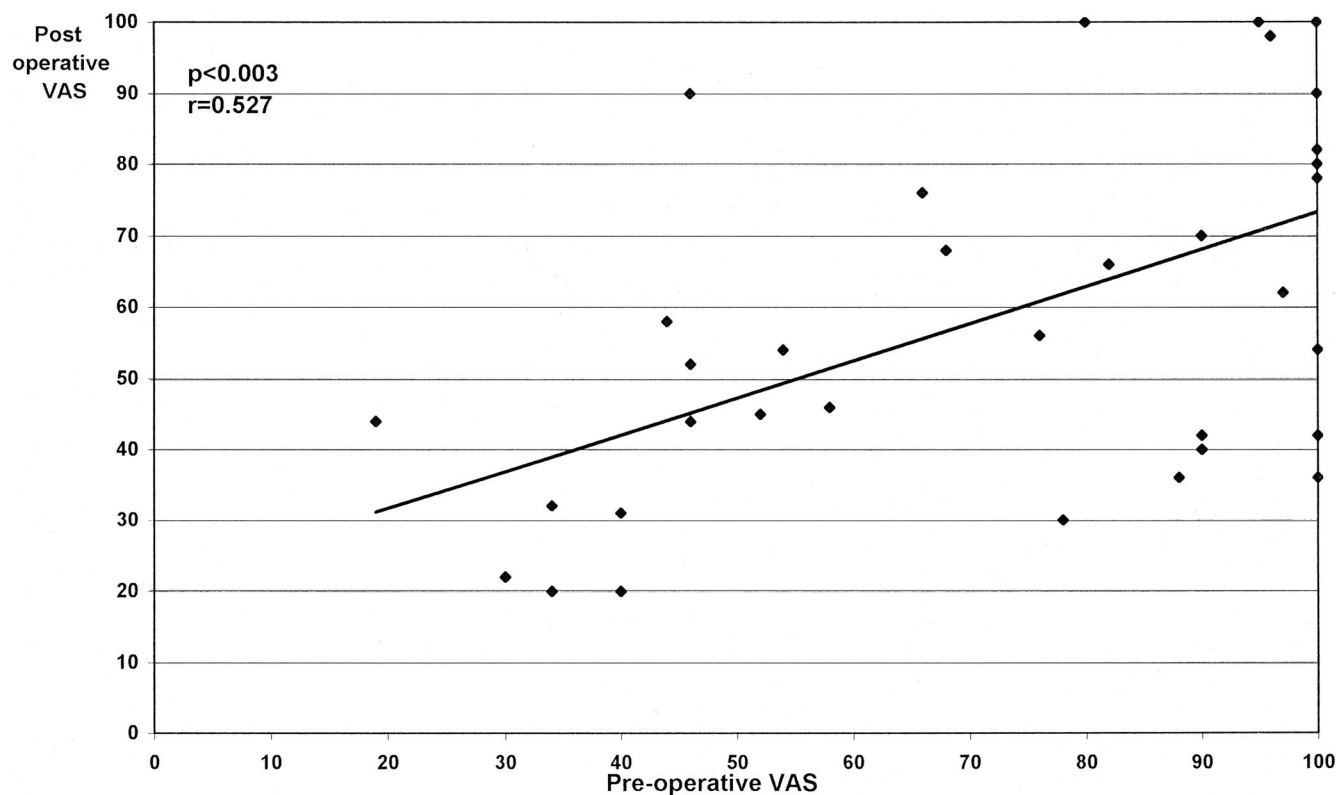


Fig. 1. Correlation between preoperative visual analog scale (VAS) scores for algosity at 48°C and postoperative pain during activity.

the level of postcesarean section pain. We used heat pain stimuli, which is an accepted modality of experimental pain that provides an established measure of pain.<sup>17,18,26,27</sup>

The current study is the first to show that preoperative measurement of experimental pain by quantitative sensory testing may serve as a predictor of postcesarean section pain. Surgery is a stressful situation that evokes both physiologic and emotional reactions. Previous studies have therefore focused on the possible impact of psychologic factors and personal characteristics on the level of postoperative pain. These studies, which included both women and men undergoing various surgical procedures, provided conflicting data as to the effect of these variables on postoperative pain. Hansson *et al.*<sup>7</sup> did not find a significant correlation between the level of preoperative stress and tension and the development of postoperative pain. Jamison *et al.*<sup>8</sup> found that analgesic usage was significantly related to preoperative and postoperative emotional distress factors. State anxiety was found to be a significant predictor for postoperative pain, whereas trait anxiety was not predictive.<sup>5</sup> In contrast, a correlation between high levels of trait anxiety and increased pain perception was found, but no such correlation was found with regard to state anxiety.<sup>6</sup> Kain *et al.*<sup>16</sup> found that preoperative anxiolysis had only minimal beneficial effects on the postoperative course.

The importance of information regarding the surgical procedure as well as the preoperative education of patients using patient-controlled analgesia has also been

evaluated, but these studies revealed conflicting results. Scott *et al.*<sup>5</sup> noted that information about the impending surgery was associated with higher levels of pain. Their results suggested that this information might sensitize the patients to the experience. In contrast, Svensson *et al.*<sup>13</sup> found that pain experience was in accordance with preoperative expectations. Griffin *et al.*<sup>11</sup> and Lam *et al.*<sup>12</sup> found no benefit in preoperative education of patients, whereas an improvement in pain control in patients who were taught the aims and risks of pain therapy was noted by Wilder-Smith and Schuler.<sup>10</sup>

According to the prediction model presented in our study, a stimulus of 48°C can predict the level of the postoperative pain both at rest and during activity conditions. All the women in the study group were healthy and free of painful situations when preoperative experimental pain assessments were performed. This finding is in contrast to those of previous studies in which patients with various pathologic disorders were included.

Our study revealed the predictive value of suprathreshold pain stimuli. However, it should be noted that no significant correlation was found between heat pain threshold and postoperative pain. Pain threshold represents the transition point between nonpainful and painful sensations, whereas suprathreshold painful stimuli more closely mimic the clinical pain experience, being at a level between threshold and tolerance. Therefore, the two tests represent two different dimensions of the



pain experience, and several investigators have used the two simultaneously in the assessment of pain.<sup>28-31</sup>

Increases in pain threshold have been observed during gestation in humans and animal models. The exact mechanism responsible for this increase in maternal pain threshold is not yet well established.<sup>32-39</sup> It is possible that because of this physiologic phenomenon, the preoperative pain threshold was not sensitive enough to predict postcesarean section pain. We found that the suprathreshold pain stimuli had a predictive value. There are currently no well-defined data in the literature on the response to suprathreshold stimuli during pregnancy. Further studies on this issue are therefore needed.

Regarding postcesarean section pain assessment and treatment, it should be noted that, as opposed to other major surgical procedures after which patients are allowed to recover gradually, women after cesarean sections are expected to recover expeditiously to care for their newborns. Furthermore, women after cesarean sections are reluctant to feel sleepy, drowsy, or restricted by equipment that does not allow them access to their babies. Accurate assessment of the level of pain and personal adjustment of treatment are therefore of importance to these women.

Since postoperative VAS scores were not assessed in all women at the same interval from the last analgesic administration, we evaluated the possible effect of this factor. No significant differences were found in postcesarean section pain levels of women tested at less than 3 h or at greater than 3 h after dipyrone administration. Taking into consideration that the half-life of dipyrone is 2 to 3 h, the data indicate that our postcesarean treatment protocol, which allows analgesic treatment on patient request, provides a satisfactory mode of postoperative analgesia.

In summary, this study shows that a simple and quick preoperative assessment by quantitative sensory testing is useful in identifying those women in whom a higher level of postcesarean section pain is expected. Further studies are needed of other surgical patient populations, such as those undergoing major thoracic, abdominal, or spine surgery, to determine the application of preoperative pain assessment in the management of postoperative pain.

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