SRTM Student Research in Translational Medicine

Original Article Doi: 10.22037/srtm.v7.47107

The Effect of Transcutaneous Electrical Nerve Stimulation on Pain Intensity and Analgesic Consumption after Cesarean Section

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ARTICLE INFO
Date Submitted: 30 December 2024
Date Accepted: 12 April 2025

KEYWORDS
Cesarean Section; Pain Management; Transcutaneous Electric Nerve Stimulation; Analgesic

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ABSTRACT

Background and Aim: Different approaches have been investigated to reduce pain after cesarean section. Among these measures is the use of non- pharmacological methods. Since the results of previous studies on the effect of Transcutaneous Electrical Nerve Stimulation (TENS) on reducing pain after cesarean section are of low certainty, this study was conducted with the aim of investigating the effect of TENS on pain intensity and consumption of analgesics after cesarean section.

Methods: In this clinical trial that was conducted in 2023 and 2024, for 40 women who underwent cesarean section under spinal anesthesia, pethidine and diclofenac or pethidine and diclofenac and TENS was administered with a frequency of 80 Hz and an intensity between 0 and 80 mA. The number of prescribed analgesics and pain intensity and patient satisfaction were investigated. Data analysis was done using SPSS version 16 statistical software and independent student t test, Mann- Whitney, Chi- squared and Repeated measures ANOVA statistical tests. P value less than 0.05 was considered significant.

Results: The data showed that the two groups had a significant difference only in the pain score in the second hour and the patients' satisfaction with the analgesia process, and the pain intensity in the other hours and the number of analgesics consumed in the two groups did not differ significantly.

Conclusion: The use of TENS after cesarean section reduces the pain in the second hour after the surgery, but it does not reduce the pain in the following hours and the use of analgesics after the cesarean section.

INTRODUCTION

The prevalence of cesarean sections is increasing worldwide. Data from 150 countries showed that 18.6% of all births were by cesarean section, and this rate is about 26.8% in West Asia (1). In Iran, the prevalence of cesarean sections has been reported between 26% and 66.5% in various studies, and about 72% to 89% in some private centers (2, 3). Acute pain is one of the most common and serious complaints of patients in the postoperative period, which can lead to an increase in various complications such as inability to move properly and thromboembolic events, cardiovascular complications such as tachycardia and increased blood pressure, respiratory complications such as respiratory depression, increased length of hospital stay, gastrointestinal complications such as nausea and vomiting and decreased bowel movement, reduced ability of the individual to self- care, increased risk of opioid use and development of chronic pain. Also, postpartum pain can reduce the ability to care for the infant and breastfeeding, increase the risk of postpartum depression, and increase the risk of opioid secretion in breast milk and respiratory depression in the infant (4-6). A suitable approach to reducing postpartum pain is the use of a combination of oral and injectable analgesics such as acetaminophen, nonsteroidal anti- inflammatory drugs (NSAIDs), and opioids. This approach focuses on reducing opioid use without increasing pain. According to the American College

Please Cite This Paper As:
Beyranvand K, Faghih N, Yaghmaei M. The Effect of Transcutaneous Electrical Nerve Stimulation on Pain Intensity and Analgesic Consumption after Cesarean Section. Stud Res Transl Med. 2025;7:e47107.

of Obstetricians and Gynecologists (ACOG), non-pharmacological methods can be effective in reducing postpartum pain (4). Examples of these non-pharmacological methods are massage, acupuncture, hypnotherapy, heat therapy and transcutaneous electrical nerve stimulation (TENS) (5).

Transcutaneous electrical nerve stimulation (TENS) is a non-invasive, inexpensive, and safe method that uses electrical currents of various frequencies. Although there is disagreement about its mechanism of action, it seems to be justifiable by the gate- control theory and the activation of the endogenous opioid system. According to this theory, the stimulation of large A-beta primary neurons, which transmit touch information, activates interneuronal inhibitors in the dorsal horn of the spinal cord, reducing pain signals transmitted through A-delta and C fibers. In addition, high-frequency TENS exerts its effect on the opioid system by activating delta- opioid receptors, while low- frequency TENS exerts its analgesic effect through mu-opioid receptors and increasing the level of endorphins in the blood and cerebrospinal fluid (7, 8).

Although the use of TENS to reduce pain dates back to the 1970s, there is still no consensus on the results of its use (9). A systematic review of the effect of TENS on reducing pain after cesarean section showed that the quality and number of studies were such that either the reported results had low certainty or no conclusion could be drawn about some outcomes (10). This study was conducted to investigate the effect of TENS on pain intensity and analgesic consumption after cesarean surgery.

MATERIALS and METHODS

This single- blind randomized controlled trial was conducted between 2023 and 2024 on 40 women who underwent cesarean section at Aiatollah Taleghani University Hospital in Tehran. Inclusion criteria for the study were: live singleton pregnancy with a cephalic presentation, gestational age of 37 weeks or more, body mass index (BMI) less than 34.9 kg/m², and scheduled for cesarean section outside the of labor or in the latent phase of labor with a Pfannenstiel incision under spinal anesthesia. Exclusion criteria included: maternal age less than 16 years, inability to speak Farsi, smoking or drug use, chronic pain, regular use of analgesics or psychotropic medications, previous use of TENS, allergy to pethidine or diclofenac, and concurrent surgeries with cesarean section such as myomectomy or tubal ligation. Eligible participants were enrolled until the sample size was reached. After providing informed consent, participants were randomly assigned to either the intervention or control group using a block randomization method. For this purpose, a total of 6 blocks of 6 and one block of 4 were used. In each block, there were equal numbers of individuals from both groups. The order of the blocks was chosen by Table of random numbers. For patients in both groups, an information form was completed including maternal age, gestational age, number of deliveries, reason for cesarean section, body mass index, mother's nationality, duration of the procedure more than 60 minutes, cesarean section before the onset of labor, and the presence of underlying disease. In both groups, patients were prescribed one 100 mg rectal diclofenac suppository from Abu Raihan Company for pain intensity of 2 to 6 on the numeric rating scale (NRS) that was graded from zero to ten, and 25 mg pethidine from Caspian Tamin Company for pain intensity of 7 to 10 on the NRS. In the case group, from the time of admission to the ward (about one hour after cesarean section), four TENS device pads were attached, two above and two below the cesarean scar. The pads were connected to the TENS device by a wire. The frequency of the device was set by the researcher at 80 Hz, but the patient could change the current intensity between 0 and 80 mA according to their own desire. They were explained that they could increase the intensity to the point where it produced anesthesia without causing pain. Patients were given a full explanation of how to use the TENS and were guided by a knowledgeable person whenever the patient had questions about how to use the device. The TENS device used in this study was the South Korean-made TENS Hubdick model HMB1000. The control group did not use the TENS device. Patients in both groups were also told that they could use massage therapy by a companion and a hot water bottle on the lower abdomen and back to reduce pain if they wished. In all patients in the two groups, pain intensity according to NRS at 2, 6, 12, 24 and 36 hours after cesarean section, the amount of analgesic consumption in the first six hours, the second six hours, the second twelve hours, and the third twelve hours after cesarean section, and the patient's level of satisfaction with pain control at the time of discharge (in terms of excellent, good and poor) were asked and recorded by an OB& GYN resident who was not part of the research team. In both groups, side effects of analgesic and TENS use were also examined.

Data were analyzed using SPSS version 16. Qualitative data were reported as frequency (percentage), and quantitative data were reported as mean and standard deviation (range). To compare qualitative variables between the two groups, the chi-square test was used. To compare quantitative data, Student's t-test was used if normality was confirmed, and the Mann-Whitney U test was used if normality was not confirmed. For comparing the trend of changes in repeated-measure quantitative variables over time (pain intensity and diclofenac consumption), repeated measures ANOVA was used. A p-value less than 0.05 was considered statistically significant. This study was conducted after approval by the Ethics Committee of Shahid Beheshti University of Medical

Sciences with the code IR.SBMU.MSP.REC.1401.704 and registration of the clinical trial with the number IRCT20170515033989N3 and obtaining informed consent from the patients.

RESULTS

Based on the results, there was no significant difference between the two groups in terms of baseline demographic and clinical characteristics (Table 1).

Table 2 and Figure 1 show pain intensity in both groups during the first 36 hours after cesarean section. As expected, pain intensity decreased over time in both groups. However, pain intensity was significantly different between the two groups only at two hours post- cesarean (P = 0.001). The results of the repeated measures ANOVA also showed that the combined effect of time and group was significant (P = 0.003), meaning that there was a significant difference between the two groups in the rate of pain reduction. The rate of pain reduction between 2 and 6 hours was greater in the group without TENS compared to the group with TENS.

Table 3 shows the amount of diclofenac consumption in the two groups at different times. As expected, diclofenac consumption decreased over time in both groups. There was no significant difference in the trend of changes in diclofenac consumption between the two groups at different times.

Regarding pethidine, the mean consumption in the first 6 hours was 15 ± 12.6 mg in the TENS group and 16.2 ± 12.2 mg in the no-TENS group, and consumption was zero at other times in both groups. The Mann-Whitney U test showed no significant difference between the two groups (P = 0.799).

The level of patient satisfaction with pain management was significantly higher in the TENS group compared to the no-TENS group (P = 0.016) (Figure 2).

In the intervention group, four patients reported turning off the TENS device due to lack of pain during most of the first 24 hours after surgery and using it for a short time. Also, patients who used the TENS device frequently asked the responsible person for further explanation about the device and how to use it. The data also showed that no adverse events were observed in either group with the administration of diclofenac. After the administration of pethidine, one person in the intervention group experienced mild nausea and vomiting, and two people in the control group experienced dizziness. One person also experienced a burning and itching sensation at the TENS pad site.

Table 1. Baseline demographic and clinical characteristics of participants by group

Variable	TENS Group (n = 20)	No TENS Group (n = 20)	P-value
Age (years)	29.8 ± 6.18 (18-42)	29.4 ± 7.09 (17-43)	0.85[1]
Gestational age (weeks)	38.4 ± 0.82 (37-39)	38.6 ± 0.94 (37-40)	0.67[2]
First delivery	5 (25)	6 (30)	0.72[3]
Cesarean due to previous cesarean	13 (65)	12 (60)	0.74[3]
Body mass index (kg/m²)	26.6 ± 3.81 (19.9-33.3)	26 ± 3.59 (19.9-32.3)	0.63[1]
Iranian nationality	15 (75)	16 (80%)	0.71[3]
Surgery duration > 60 minutes	4 (20)	4 (20)	1[3]
Cesarean before labor onset	14 (70)	12 (60)	0.51[3]
Presence of underlying disease	7 (35)	10 (50)	0.33[3]

Quantitative variables are presented as mean ± standard deviation (range), and qualitative variables are presented as number (percentage). Test used: 1 Independent t-test, 2 Mann-Whitney U test, 3 Chi-square test

Table 2. Comparison of changes in pain intensity over 36 hours post-cesarean between the two groups

Group / Time	2 hours	6 hours	12 hours	24 hours	36 hours	Test Result (Group effect*)	Test Result (Time & Group interaction***)
TENS Group (n = 20)	6.05 ± 0.94	4.70 ± 0.73	4.20 ± 0.61	0.65 ± 0.49	0.70 ± 0.92	P < 0.0001	P = 0.003
No TENS Group (n = 20)	7.60 ± 1.10	4.60 ± 0.82	4.15 ± 0.59	0.50 ± 0.60	0.65 ± 0.67	P < 0.0001	
Test Result (Time effect) **	P < 0.001	P = 0.687	P = 0.794	P = 0.395	P = 0.864	-----	

Independent t-test (result of group effect) ** ANOVA (result of time effect) * Repeated measures ANOVA (result of combined effect of group and time)**

Table 3. Comparison of diclofenac use after cesarean section between two groups

Group / Time	The first 6 hours	The second 6 hours	The second 12 hours	The third 12 hours	Test Result (Group effect*)	Test Result (Time & Group interaction***)
TENS Group (n = 20)	155 ± 51.04	35 ± 48.9	35 ± 58.7	5 ± 22.4	< 0.0001	0.455
No TENS Group (n = 20)	140 ± 50.3	45 ± 51.04	15 ± 36.6	0	< 0.0001	
Test Result (Time effect) **	0.355	0.531	0.204	0.324	-----	

Independent t-test (result of group effect) ** ANOVA (result of time effect) * Repeated measures ANOVA (result of combined effect of group and time)**

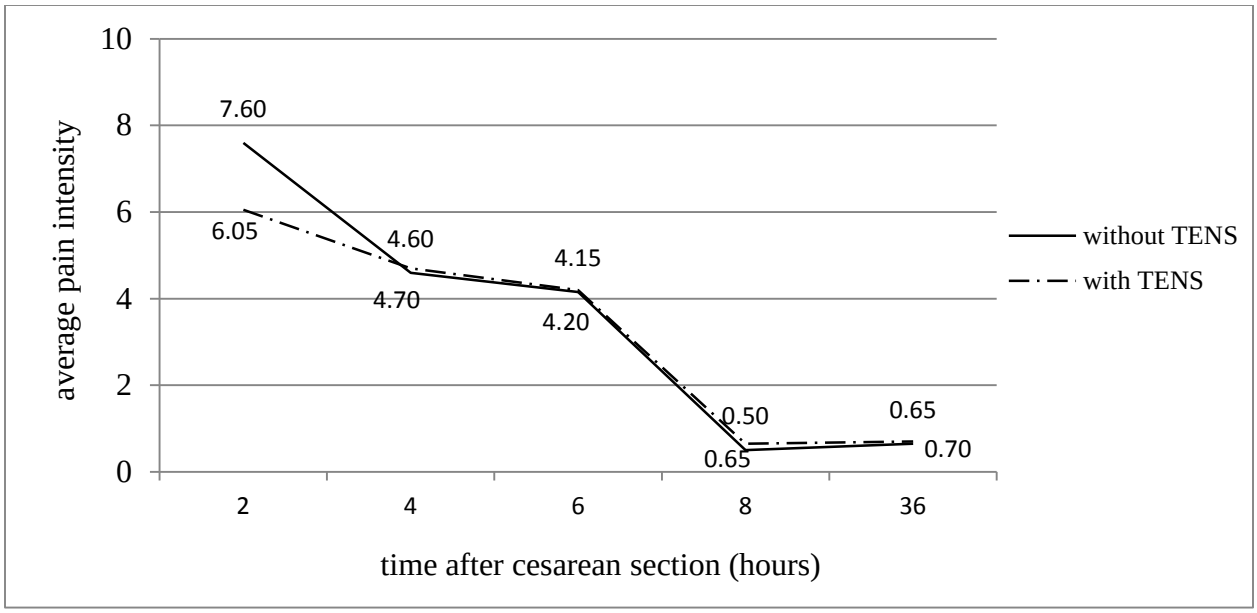

Figure 1. Changes in pain intensity in the 36 hours after cesarean section between the two groups

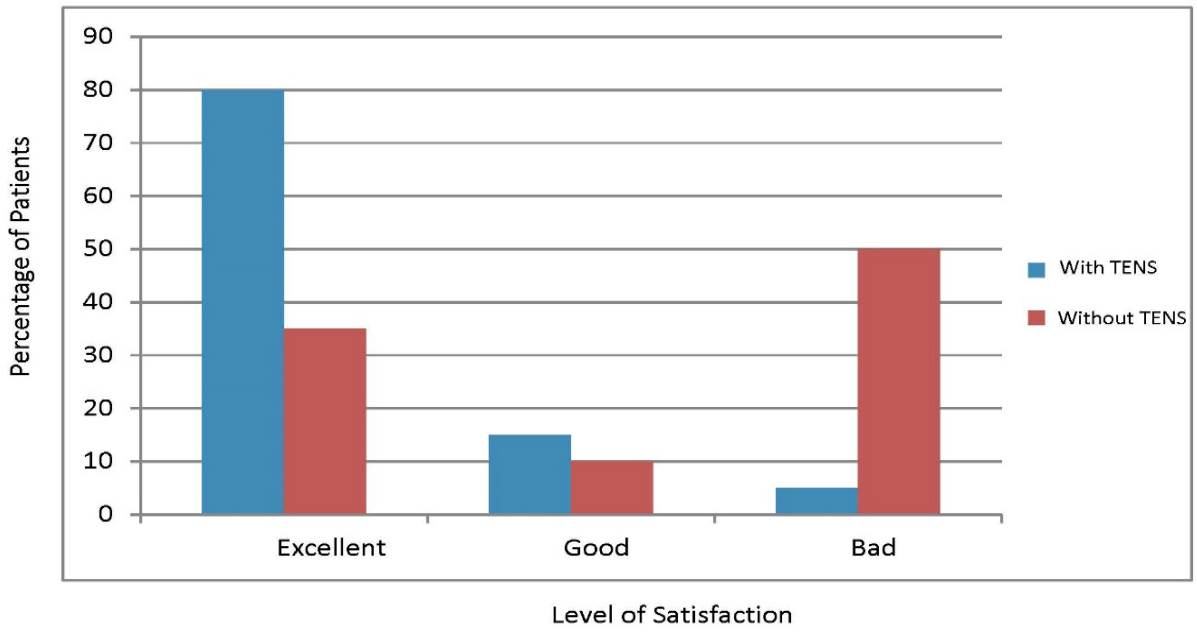

Figure 2. Patient satisfaction with pain control (20 patients in each group)

DISCUSSION

The study results indicated that the use of TENS reduced pain levels after cesarean section only in the second hour post-surgery. TENS administration did not significantly impact pain levels in subsequent hours or reduce postoperative analgesic consumption. However, TENS increased patient satisfaction at discharge, which could be attributed to a placebo effect. Future studies should include a third group using inactive TENS to further analyze this.

Numerous studies have investigated the effects of TENS on acute pain and other surgical outcomes. A systematic review and meta-analysis showed that, overall, across all surgeries, pain intensity at rest ($P < 0.001$) and during coughing ($P < 0.03$) was lower in the TENS group compared to the control group. There was also a significant reduction in morphine consumption, nausea, vomiting, itching and dizziness in the TENS group. However, there was no difference in pain intensity during walking, blood pressure, or length of hospital stay (6). Similarly, a meta- analysis of 21 randomized controlled trials with a placebo group, involving a total of 1350 patients, showed that analgesic consumption decreased after the use of TENS and acupuncture- like TENS (ALTENS) compared to the placebo group. Analysis of 11 studies involving 964 patients revealed that the use of strong but non-unpleasant electrical stimulation at sufficient frequency at the surgical wound site resulted in a 35.5% reduction in analgesic consumption compared to the placebo group (11).

Regarding the effect of TENS on post- cesarean pain, several studies have been conducted. Kurata's study on 180 women (divided into three groups of 60: active TENS, inactive TENS, and no TENS) showed no significant difference in morphine consumption after surgery between the active and inactive TENS groups ($P = 0.31$). Additionally, the two groups did not differ significantly in terms of pain intensity, patient satisfaction, and length of stay. Furthermore, the inactive TENS and no-TENS groups did not differ significantly in terms of opioid consumption ($P = 0.57$), pain intensity, and patient satisfaction (12). Similarly, Reynolds' study showed that the cumulative dose of meperidine required for pain relief after cesarean section was 511 mg in the TENS group and 456 mg in the no-TENS group, with no significant difference between the two groups (8). The results of these two studies were similar to the present study.

Johnson's study found that morphine consumption was significantly lower in 21 women who underwent cesarean section with TENS compared to 21 women who did not receive TENS ($P = 0.007$). However, similar to the present study, there was no significant difference in pain intensity between the two groups, but there was a significant difference in sedation levels at 3 and 12 hours post- surgery ($P = 0.011$). This study showed that although TENS did not reduce pain intensity, it reduced morphine consumption and sedation, allowing mothers to care for their newborns more alertly in the initial hours after cesarean section (13).

A double- blind randomized controlled trial of 87 women who underwent cesarean section under general anesthesia showed that the group receiving paracetamol, diclofenac, and TENS and the group receiving paracetamol and diclofenac had significantly different abdominal pain intensities at 2, 6, 24 and 48 hours post- surgery ($P < 0.05$), but there was no significant difference in the intensity of back and groin pain and consumption of paracetamol and diclofenac ($P > 0.05$) (5).

Contrary to most studies, Kayman-Kose's study on 100 healthy women who underwent cesarean section under general anesthesia and were randomly assigned to two groups showed that pain intensity, as measured by the Visual Analog Scale (VAS) and Numeric Rating Scale (NRS), was lower in the TENS group compared to the no-TENS group ($P = 0.005$ and $P = 0.022$, respectively) (14). However, it should be noted that this study was conducted in patients who underwent cesarean section under general anesthesia, while the present study used spinal anesthesia.

A systematic review on the effect of TENS on reducing post-cesarean pain showed that TENS compared to no treatment (1 study, 40 patients, low- certainty evidence) reduced pain in the first hour (MD -2.26, 95% CI -3.35 to -1.17). Additionally, TENS and analgesics compared to placebo and analgesics reduced pain in the first hour post-surgery (3 studies, 238 patients, low-certainty evidence) (MD -1.10, 95% CI -1.37 to -0.82) and pain at 24 hours post- surgery (1 study, 108 women, low- certainty evidence) (MD -0.70, 95% CI -0.87 to -0.53). The authors also noted that due to the very low quality of studies, it was not possible to comment on the effect of TENS on pain in the first six or 24 hours (10). The results of this systematic review regarding the effect of TENS in reducing pain in the initial hours were consistent with the results of the present study. This study also showed that more studies are needed to investigate the effect of TENS on post- cesarean pain.

Limitations: This study had a small sample size in both groups. Additionally, an inactive TENS device was not used as a placebo in the control group. Future studies with larger sample sizes and the use of inactive TENS as a placebo are recommended.

CONCLUSION

The results of this study showed that the use of TENS reduced pain levels only in the second hour post-surgery and did not reduce analgesic consumption after cesarean surgery. However, patient satisfaction with pain management after cesarean section was higher in the Acknowledgment:

This article is the result of Katayoon Beyranvand Heydari's thesis under the same title. We would like to thank medical school of Shahid Beheshti University of Medical Sciences who approved the proposal of this thesis. Also, the authors express their gratitude to all the patients who participated in the study.

ACKNOWLEDGEMENTS

Not declared.

CONFLICT OF INTEREST

All authors declare no conflicts of interest.

FUNDING

There were no grants or financial support obtained for this study.

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