

## ORIGINAL ARTICLE

# Comparison of Entonox and Transcutaneous Electrical Nerve Stimulation (TENS) in Labor Pain

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One of the concerns among mothers for delivery is labor pain. There are various methods to decrease labor pain, of which epidural anesthesia is an effective one, but not all mothers agree to receive this invasive intervention. Transcutaneous electrical nerve stimulation (TENS) is an inexpensive, safe, and easily applicable method which can be used in patient control mode. To find proper noninvasive methods to pain relief during labor this study was conducted to compare TENS, Entonox and combination of them during the first phase of labor. In this RCT study, 120 pregnant women in the age range of 20-40 years, singleton pregnancy, at 37-42 weeks' gestation, at cervical dilatation of less than 4 cm in phase one of labor were selected and randomly divided into three groups including TENS, Entonox and combination group. Pain severity was recorded based on VAS at the time of presentation to the maternity unit, cervical dilatations of 4-6cm, 6-8cm, and 8-10cm and demographic characterizations. There were no significant differences regarding to age, parity, and BMI between the three groups. Pain was less severe in combination group compared to other two groups at cervical dilations of 4-6cm and 6-8cm. At cervical dilation of 8-10cm, VAS score was higher in Entonox group than in other two groups, but no significant difference existed between TENS and combination group. Duration of the first phase of labor was longer in TENS group than the other two groups. TENS is a non-invasive, safe, easy applicable and self-administered method with low rate of complications which can be used alone or in combination with other methods in relieving labor pain.

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### INTRODUCTION

One of the concerns among mothers who are preparing for delivery is labor pain. By applying proper methods to decrease labor pain, not only this concern can be somehow addressed, but also maternal and fetal complications will decrease as a result of decreased stress responses (Saghiri *et al.*, 2008). It has been shown that labor pain plays a role in the development of posttraumatic stress syndromes after childbirth (Arendt and Tessmer-Tuck, 2013).

There are various techniques to decrease labor pain,

of which epidural anesthesia is an effective method with appropriate outcome in managing labor pain (Gomar and Fernandez, 2000), but not all mothers agree to receive this intervention. Furthermore, this method cannot be accessed in all maternity centers. It was determined that epidural analgesia associated with prolonged labor, use of oxytocin augmentation and increased incidence of instrumental vaginal delivery (Kukulu and Demirok, 2008; Simmons *et al.*, 2012).

Another adverse effects related to epidural analgesia are hypotension, motor blockade, fever and urinary retention (Jones *et al.*, 2012). Also it has been shown that epidural anesthesia has a negative impact on breast-feeding in the first 24 hours of life (Baumgarder *et al.*, 2003). Among other interven-

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tions to relieve labor pain are pharmacologic agents such as narcotics, hypnotics, Entonox, and non-pharmacologic methods like transcutaneous electrical nerve stimulation (TENS) (Habanananda, 2004; Miller, 2010; Jones *et al.*, 2012).

Entonox is a gas mixture of oxygen (50%) and nitrous oxide (50%) which is inhaled through a one-way valve by mask during inspiration. Labor relief which is achieved by Entonox is associated without decrease in consciousness level. As it can be used in patient control mode, this method has gained much attention in labor. Intermittent use of Entonox is not associated with any complications and it is exhaled rapidly by expiration (1970; Baskett and Bennett, 1971; Latta *et al.*, 1973; Pazandeh *et al.*, 2004).

TENS is a non-invasive, inexpensive, safe, and easily applicable method which can be used in patient control mode. In this method, electricity is delivered through the skin causing stimulation of peripheral nerves and yielding a rapid relief in pain. It is used in both acute and chronic painful conditions (Augustinsson *et al.*, 1977; Robson, 1979; Nesheim, 1981; van der Spank *et al.*, 2000). There is no evidence that TENS causes any harm to mother and baby (Cluett, 1994).

Fibers which related to the transmission of pain are A-delta and C fibers which are thin fibers with high threshold. TENS stimulates A-beta fibers which are thick fibers with low threshold and are related to touch sensation. Based on gate-control theory, stimulation of A-beta fibers inhibits transmission of action potential to A-delta and C fibers in the dorsal horn of the spinal column. This, in turn, inhibits transmission of pain to brain centers. In addition, TENS has an inhibitory mechanism and also releases endogenous opioids (Robson, 1979). To find proper noninvasive methods for relieving pain during labor, this study was conducted to compare TENS, Entonox and combination of them during the first phase of labor.

## MATERIALS AND METHODS

### Study design and population

This study is registered on IRCT.ir (Ref. No.

IRCT201011295274N1) as a randomized clinical trial (RCT). In this study, 120 pregnant women in the age range of 20-40 years, singleton pregnancy, at 37-42 weeks' gestation, fetal vertex presentation, cervical dilatation of less than 4 cm, and in phase one of labor who did not request epidural anesthesia were included. Exclusion criteria were multifetal pregnancy, cardiac diseases of mother, having pace maker, skin infectious diseases, and epilepsy.

### Data collection

After obtaining informed consent and providing explanations about Entonox and TENS, the patients were randomly divided (by method of 1:1:1) into three groups. First group was TENS group (40 subjects) for whom pure oxygen was applied instead of Entonox and electrode pads were attached on T10-L1 and S2-S4 dermatomes on both sides of the spinal column. Electrodes were attached and the TENS machine turns ON while a continuous frequency of 50Hz was applied. During uterine contractions, mother was supposed to push the button ON resulted in burst stimulation with 2-Hz frequency and 0.25ms duration. The machine used was TENS (TENS MED, Netherland, Enrofnonius, 911) which measured 70\*70mm. The electrode pads measured 90\*32mm.

The second group (40 subjects) was Entonox group for whom similar to the first group; electrodes were placed on both sides of the spinal column and TENS machine was ON, but electrodes were not attached to the machine and Entonox was inhaled via mask during uterine contractions. Third group was combination group (40 subjects) in which both Entonox and TENS were applied.

In case of severe pain (VAS > 5), 25mg of meperidine was administered intravenously. Pain severity was recorded using visual analog scale (VAS) at the time of presentation to the maternity unit, and at cervical dilatations of 4-6cm, 6-8cm, and 8-10cm. The VAS used here was a 10-cm scale with 0 as no pain status and 10 as the most severe pain represented on the scale. Other variables recorded were age, parity, gestational age, BMI, duration of the first phase of labor from cervical dilation of 4cm,

the amount of meperidine that used, and nausea and vomiting frequency.

### Statistical analysis

Analysis of qualitative data was done by Chi-squared test and one-way logistic regression. Analysis of continuous variables were done by the Kolmogorov–Smirnov test, The Kruskal–Wallis test, and two-by-two comparisons. P values of less than 0.05 were considered statistically significant.

### RESULTS

There were no significant differences with regard to age, parity, and BMI between the three groups

(Table 1). Pain was less severe in combination group compared to other two groups at cervical dilations of 4-6cm and 6-8cm. It should be noted that at the mentioned cervical dilations VAS score was higher in Entonox group than in TENS group, but the difference was not statistically significant.

Nausea frequency was different between the three groups and one-way logistic regression analysis demonstrated that the incidence of nausea in TENS and Entonox groups was respectively 2 and 5 times higher than in combination group (P= 0.004) (Table 2).

**Table 1. Demographic and Patients Characteristics of Patient Population**

Demographic data	Entonox group No = 40	TENS group No = 40	Combined group No = 40	P value
Age (year)	26.68 ± 6.49	25.9 ± 5.84	29.31 ± 6.41	0.085
Parity (frequency)	1.9 ± 1.6	1.8 ± 1.2	1.9 ± 1	0.893
BMI (Kg/m <sup>2</sup> )	25.8 ± 3.9	24.6 ± 3.9	24.9 ± 3.2	0.126

*Data presented as Mean ± SD, p-value <0.05 is statistically significant; BMI-body mass index*

**Table 2. Comparison of Pain Severity in all Groups of Study**

Uterine group Cervical Dilatation	Mean (SD)	P value
4-6cm		
TENS	3.60 ± 1.44	0.039
Entonox	3.85 ± 1.91	
Combined	2.93 ± 1.42	
6-8cm		
TENS	4.50 ± 2.14	0.019
Entonox	4.93 ± 2.46	
Combined	3.55 ± 1.37	
8-10cm		
TENS	4.73 ± 2.11	0.010
Entonox	6.23 ± 3.02	
Combined	4.35 ± 1.51	

*Data presented as Mean ± SD, p-value <0.05 is statistically significant*

At cervical dilation of 8-10cm, VAS score was higher in Entonox group than in other two groups, but no significant difference existed between TENS and combination group (6.5, 5, and 4.3 respectively in Entonox, TENS, and combination groups) (Table 3).

The duration of first phase of labor was longer in TENS group (300.1 224.8) than other two groups and not significantly difference between combination (214.6 151.4) and Entonox group (228.5 92.4). Regarding the amount of analgesic administered, a significant difference was found between the three groups (P< 0.001). According to the Chi-squared test, no significant difference existed between Entonox and TENS groups (P= 0.066), but this variable was significantly lower in combination group compared to other two groups (P< 0.001).

**Table 3. Results from Intervention in all Groups of Study**

Results	Entonox, n(%)	TENS, n(%)	Combined, n(%)	P value
Nausea and vomiting	17 (42.5)	17 (42.5)	5 (20)	0.004
Amount of meperidine (mg)	34 (85)	27 (67.5)	12 (30)	< 0.001

*Data presented as Mean ± SD, p-value <0.05 is statistically significant; BMI-body mass index*

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### DISCUSSION

Effectiveness of Entonox and TENS in decreasing pain were similar at the initial and middle stages of phase one of labor as pain was not severe, but influence of applying both methods were more significant in pain relief. At the end of labor and more cervical dilatations, using TENS alone or in combination with Entonox were more effective in relieving pain than using of Entonox alone.

Harrison *et al.* compared the analgesia induced by epidural anesthesia, Entonox, TENS, and intravenous narcotic during labor. They indicated that effective analgesia was achieved in 88% of mothers who underwent epidural anesthesia and partial effectiveness was observed in other methods. They also pointed out that Entonox was more effective in women who presented in earlier stages of labor (Harrison *et al.*, 1987).

Chia *et al.* also compared analgesia induced by TENS and Entonox in labor and observed that these two methods had similar effect in decreasing labor pain and the best time that these exert their analgesic effect is when interval time between uterine contractions is 5-10 minutes (Chia *et al.*, 1990).

Augustinson and colleagues studied the efficacy of TENS in labor pain and advocated TENS as a safe and beneficial method in decreasing labor pain. They proposed TENS could be used as a basic method for labor pain management without any side effect and the other methods can be added to this method for more efficacy. This is supported by our results since TENS is helpful in final period of the first phase of labor when labor pain is aggravated more (Augustinsson *et al.*, 1977).

Kaplan *et al.* made use of TENS for pain management in the first phase of labor in 104 pregnant women (both primiparous and multiparous women). Most patients stated that TENS is effective in labor pain and asked to repeat this method in their future pregnancy and labor. They also reported that duration of the first phase of labor was shorter in the group for which TENS was applied compared to control group (Kaplan *et al.*, 1998).

However, in the current study, TENS subjects did not have shorter first phase of labor. This discrepancy could be justified by the fact that in Kaplan's study, the control group had no pain, but in our study TENS group was compared to Entonox group and presumably Entonox was a factor which contributed to shortening of the first phase of labor. As seen in Harrison's study, where Entonox, TENS, epidural anesthesia, and intravenous medications were compared, it was reported that Entonox shortened the first phase of labor which is compatible with our results (Harrison *et al.*, 1987). Tashani *et al.* also reported that TENS is a proper method for pain management in labor and in interpretation of mechanisms involved in pain relief stated that this method not only inhibits sending of signals through the dorsal horn to the brain, but also it causes release of endorphins and other neurochemicals such as 5HT, GABA, acetylcholine, adrenaline, and adenosine (Tashani and Johnson, 2009).

Stewart *et al.* stated that TENS has moderate efficacy in relieving labor pain (Stewart, 1979). But Vander *et al.* studied the effect of TENS on epidural anesthesia request in mothers, concluded that TENS had no effect on epidural anesthesia requests (van der Spank *et al.*, 2000). This conclusion can be based on the fact that TENS can only induce a partial pain relief and compared to epidural anesthesia which has complete analgesia, TENS was not so demanded.

Nesheim *et al.* also indicated that TENS is not effective in labor pain relief (Nesheim, 1981). Van der ploeg *et al.* concluded that TENS was not more effective than a placebo during the first stage of labor (van der Ploeg *et al.*, 1996). Bedwell *et al.* supporting a review of evidence on the effectiveness of TENS for pain relief in labor, stated that there is only limited evidence that TENS reduces pain in labor (Bedwell *et al.*, 2011).

Tsen *et al.* made use of TENS in combination with CSE (combined spinal epidural) and concluded that TENS had no effect on lengthening the duration of analgesia by CSE (Tsen *et al.*, 2001). All of these

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studies emphasized that TENS has a partial analgesic effect in labor pain and in comparison to CSE and epidural analgesia has less analgesic effect. Regarding to medication, we concluded that analgesic was less frequently requested in combination group and no significant difference was found between Entonox and TENS groups. Nesheim *et al.* did not report a decrease in analgesic use when compared TENS to control group (Nesheim, 1981).

Harrison *et al.* stated that in their study, requirement for analgesia was similar in TENS and Entonox groups (Harrison *et al.*, 1987) which is consistent with our results and demonstrates the cumulative effect of using two methods for pain control at the same time. According to the obtained findings, nausea and vomiting was more common in Entonox group compared to TENS group, but this was lower in combination group than in other groups. This may indicate relationship between pain and occurrence of nausea and vomiting owing to the fact that there was less nausea in the combination group. It is likely that lower rate of nausea and vomiting in combination group correlates with less use of narcotics in this group. It is suggested to do a study in the future to investigate the relationship between Entonox and occurrence of nausea and vomiting.

### CONCLUSION

Transcutaneous electrical nerve stimulation (TENS) which is serve as non-invasive, safe, easy applicable and self-administered method with low rate of complications can be used alone or in combination with other methods in relieving labor pain.

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### COMPETING INTERESTS

The authors declare that they have no competing interests.

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