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# The Effect of Transcutaneous Electrical Nerve Stimulation on Pain During Venous Cannulation

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## ABSTRACT

**BACKGROUND:** The venous cannulation procedure was widely used in many clinical procedures; however, it is associated with pain or discomfort.

**OBJECTIVES:** The purpose of this study was to investigate whether transcutaneous electrical nerve stimulation (TENS) could reduce pain during cannulation of vein.

**METHODS:** One hundred patients were allocated randomly to 2 groups. In the active TENS group, TENS was delivered via 2 electrodes on the venous cannulation site (radial side of the wrist of dominant forearm) 20 minutes before venous cannulation, and the control group received placebo (no current) TENS. Venous cannulation with a 22-gauge cannula was performed. During venous cannulation, the pain intensity (0 = no pain, 10 = worst pain imaginable) was measured. Any side effects during study periods were recorded.

**RESULTS:** The incidence of pain during venous cannulation was similar between the 2 groups. However, pain intensity was significantly lower in the active TENS group than placebo group ($P < 0.01$). There was no significant difference in the side effects such as erythema and itching between the groups.

**CONCLUSIONS:** TENS may be a suitable option for reducing the pain intensity during venous cannulation. ClinicalTrials.gov identifier: NCT01607463. (*Curr Ther Res Clin Exp.* 2012;73:134–139) 

**KEY WORDS:** cannulation, pain, transcutaneous electrical nerve stimulation, vein.

## INTRODUCTION

The venous cannulation procedure was widely used in many clinical procedures. However, it is associated with pain or discomfort. Consequently, the pain of venous cannulation can increase stress and anxiety in some patients, which is often addressed by the use of topical anesthesia.[1] But intact skin presents a significant barrier to

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available topical anesthetic preparations. Therefore, many topical anesthetics must be applied at least 45 to 60 minutes before the clinical procedure to achieve the desired level of anesthesia. In addition, these topical anesthetic creams or gel-based preparations may require the use of occlusive dressings, adding to the time required for their application.[2] These factors can result in delays in performing the planned procedure.

Transcutaneous electrical nerve stimulation (TENS) is an established noninvasive clinical modality, which has been used for the symptomatic relief of acute and chronic pain.[3] Application of TENS segmentally to the pain site is commonly used in clinical practice, depending on the condition to be treated and the individual patient characteristics.[4] Moreover, a good deal of physiologic evidence from stimulation studies suggests that the most effective way to produce analgesia is by stimulating peripheral nerves innervate the area from which pain originates.[5]

In the present study, we investigated whether TENS could have analgesic effect on pain during venous cannulation.

## METHODS

After receiving approval from the Ethics Committee of Kyungpook National University Hospital and written informed consent, 100 outpatients who underwent plastic surgery were recruited in this randomized, single-masked, placebo-controlled study. Exclusion criteria were concomitant sedative or analgesic medication and neurological disease. In addition, we excluded all patients with potentially dangerous internal diseases (American Society of Anesthesiologists physical status $>3$).

One hundred patients were allocated randomly to 2 groups: 2 electrodes ($5 \times 5$ cm; TensCare) were attached to the radial side of dominant forearm and then active or placebo TENS was delivered by an anesthesiologist who was aware of the group allocation, using Select TENS units (Empi, St. Paul, Minnesota). The cephalic vein was marked 1 cm proximal to radial styloid process, and the cathode was placed at this point, whereas the anode was placed 3 cm away, more proximally. In the active TENS group, TENS at 80 pulses per second (PPS) with a pulse duration of 200 $\mu$sec were delivered for 20 minutes. Current amplitude was slowly increased until a level was reached that participants reported was the maximum level that they could tolerate below their pain threshold without noticeable muscle contraction and maintaining this intensity. In the placebo group, the TENS device had no current output, although the power "on" indicator light remained active. Participants were told they may or may not feel a sensation during the intervention.

Twenty minutes after application of TENS, the electrodes were removed and venous cannulation with a 22-gauge cannula was performed at the mark on the radial side of the wrist by the same nurse who was not involved in this study. The pain intensity during venous cannulation using a visual analog scale (VAS) from 0 to 10 (0 = no pain, 10 = worst pain imaginable) was measured by a study-blinded anesthesiologist. Any adverse effects during the study periods were recorded.

Data are presented as number (%) or mean (SD). Demographic data were analyzed with the Student $t$ test. VAS scores during cannulation were compared using Wil-

**Table I. Demographic data.**

| | Placebo TENS Group (n = 50) | Active TENS Group (n = 50) |
|---|---|---|
| Male, no. (%) | 19 (38) | 21 (42) |
| Female, no. (%) | 31 (62) | 29 (58) |
| Age, y (SD) | 51.2 (11.7) | 48.2 (13) |
| Height, cm (SD) | 164.7 (8.5) | 165.2 (7.8) |
| Weight, kg (SD) | 59.93 (8.7) | 61 (9.3) |

TENS = transcutaneous electrical nerve stimulation.
There were no significant differences between groups.

coxon rank sum test with continuity correction. Pain incidence and skin condition in 2 groups were compared using the $\chi^2$ test or Fisher exact test. The SPSS software version 14.0 (SPSS Inc, Chicago, Illinois) was used for statistical analysis. $P < 0.05$ was considered as significant.

## RESULTS

All participants were cannulated on the first attempt. The groups were similar with regard to age, sex, height, and weight (Table I). The incidence of venous cannulation pain was similar between 2 groups ($P > 0.05$) (Table II). However, the pain intensity with active TENS (1.9 [1.2]) group was significantly lower than that with placebo TENS (4.8 [1.5]) ($P < 0.01$). There were no significant differences in the incidences of side effects such as erythema and itching between the groups ($P > 0.05$).

**Table II. Clinical outcomes.**

| | Placebo TENS Group (n = 50) | Active TENS Group (n = 50) |
|---|---|---|
| Pain incidence, no. (%) | | |
| No pain | 0 | 5 (10) |
| Pain | 50 (100) | 45 (90) |
| Pain intensity score on VAS (SD) | 4.8 (1.5) | 1.9 (1.2)* |
| Side effects, no. (%) | | |
| Erythema | 5 (10) | 7 (14) |
| Itching | 2 (4) | 1 (2) |

TENS = transcutaneous electrical nerve stimulation; VAS = visual analog scale.
*$P < 0.01$.

## DISCUSSION

Our results demonstrated that active TENS significantly reduced the pain intensity, although it did not significantly decrease the pain occurrence during venous cannulation compared with placebo TENS.

Pain during venous cannulation is unpleasant and often frightening for patients. In fact, discomfort from the insertion of the venous catheter could be ranked fifth after incisional pain, nausea, vomiting, and preoperative anxiety when anesthesiologists judge the top 5 clinical anesthesia outcomes associated with ambulatory anesthesia.[6] TENS is an acknowledged noninvasive clinical modality that has been used for the management of painful conditions for >35 years.[3] It could reduce postoperative complications such as nausea, vomiting, acute pain, and chronic musculoskeletal pain without adverse effects.[7–10] However, the exact mechanism of action of TENS is still largely unknown. It has been suggested that afferent activity produced by TENS inhibits nociceptive transmission in the spinal cord through pre- as well as postsynaptic inhibitory mechanisms.[11]

In the present study, TENS at 80 PPS was chosen because this was the recommended potentially effective frequency for human studies.[12–14] Low-frequency TENS acts by $\mu$-opioid receptors and 5-hydroxytryptamine receptors,[15,16] whereas high-frequency TENS acts by $\delta$-opioid receptors and increasing $\gamma$-aminobutyric acid.[17,18] In previous studies, high-frequency TENS at 80 PPS elevated pain threshold to pressure algometry[13] or reduced ischemic pain[14] than low-frequency TENS at 3 PPS, when TENS intensity was strong but comfortable at the site of experimental pain. Nonpainful impulse generation by TENS at 80 PPS would lead to stronger afferent input to the central nervous system, resulting in stronger inhibition of nociceptive transmission of second-order neurons, similar to the gate-control theory of pain.[13,14] In the present study, the incidence of pain during venous cannulation was similar between 2 groups. However, pain severity was significantly lower in the active TENS group than the placebo TENS group. In addition, there was no significant difference in the side effects such as erythema and itching. TENS is a simple and safe procedure. The only limiting factors are patients with implanted electronic devices like pacemakers, cardiac defibrillators, and spinal cord or deep brain stimulators.[19] The veins at the antecubital fossa, forearm, and wrist and at the dorsum of the hand that are commonly used for venipuncture or cannulation are superficial to cutaneous nerves. Therefore, repeated attempts at venipuncture or resulting hematomas can, although rarely, cause nerve injury, which leads to the neuropathic pain syndrome.[20] In the present study, all participants were cannulated on the first attempt, and there were no patients who reported any abnormal sensation such as paresthesia and burning sensation.

## CONCLUSIONS

Our study found that strong nonpainful TENS at 80 PPS significantly decreased pain severity during venous cannulation compared with placebo TENS. Because of its ease of use and lack of side effects, TENS may be a useful option to reduce pain during venous cannulation.

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## CONFLICTS OF INTEREST

The authors have indicated that they no conflicts of interest regarding the content of this article.

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