



# The analgesic tolerance to electroacupuncture in patients with chronic musculoskeletal pain: an observational pilot study

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## Abstract

**Introduction:** Musculoskeletal disorders are one of the most common reasons for requesting home healthcare services in Vietnam. Multiple studies have demonstrated the effectiveness of electroacupuncture (EA) in treating chronic musculoskeletal pain (CMP). This study aimed to provide preliminary insights into the development of analgesic tolerance to EA in patients with CMP.

**Method:** This observational pilot study was conducted on 60 patients with CMP. All participants provided information regarding their age, gender, origin, location of pain, duration of EA's analgesic effect, changes in EA effectiveness over the course of treatment, concurrent therapies, and any adverse effects during randomly selected treatment sessions.

**Results:** Among the patients with CMP, 51.6% reported that the pain-relieving effect of EA lasted more than one hour post-treatment. The duration of this effect varied, lasting from over 12 hours to over 72 hours (90%). The majority of participants (81.7%) noted that the effectiveness of EA either improved or remained stable throughout the treatment sessions. However, 18.3% of patients experienced a reduction in the analgesic effect of EA with the progression of treatment sessions.

**Conclusions:** The pain-relieving effect of EA typically unfolds gradually and persists for a notable duration. Consistent and repeated EA treatment in patients with CMP could potentially lead to the development of analgesic tolerance.

**Keywords:** musculoskeletal pain; electroacupuncture; pain management

## 1. INTRODUCTION

Musculoskeletal disorders encompass a wide range of conditions affecting bones, joints, muscles, and connective tissues. These ailments can lead to pain and reduce functionality, ranking among the most debilitating health issues [1]. The cost associated with the management of chronic pain from musculoskeletal conditions represent a significant

portion of healthcare expenditures [2]. In Vietnam, the most commonly sought-after home healthcare service was related to musculoskeletal disorders [3].

Several studies have showcased the effectiveness of electroacupuncture (EA) in treating chronic pain, particularly in various chronic musculoskeletal conditions [4,5]. In clinical settings, EA is widely used for chronic pain management, exerting its analgesic impact by activating the neuroendo-

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crine system. The outcomes of EA are contingent upon the frequency used, with different frequencies triggering the release of distinct endorphins [6]. Nevertheless, recurrent high-intensity EA could progressively diminish its analgesic effects [4–7]. Recent rat studies have indicated that repeated high-intensity sessions might lead to analgesic tolerance to EA [8,9].

Similarly, repeated use of therapeutic electrophysical agents that reduce pain through the release of endogenous opioids could gradually diminish their analgesic effect. Transcutaneous electrical nerve stimulation (TENS), a type of electrotherapy that alleviates chronic pain similarly to EA, has also been demonstrated to induce analgesic tolerance in patients following repeated application [10]. The aforementioned evidence suggests that consecutive EA treatment could potentially reduce its pain-relieving effectiveness. Therefore, this study aimed to observe the emergence of analgesic tolerance to EA in patients with musculoskeletal disorders.

## 2. MATERIALS AND METHODS

### 2.1. Study design and participants

This observational pilot study was conducted on 60 patients with chronic musculoskeletal pain (CMP). Participants were recruited from the University of Medical Center Ho Chi Minh City—Branch no. 3 (UMC—Branch no. 3). Data was collected from January 2023 to April 2023. The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement. As this is the first research on EA tolerance in patients with CMP, we determined a sample size of 60 following the Central Limit Theorem [11].

The study included patients who met the following criteria: (1) aged 18 or older who provided their agreement to participate in the study; (2) diagnosed with chronic musculoskeletal disorders characterized by pain perceived in musculoskeletal tissues lasting or recurring for more than three months, accompanied by significant functional disability and emotional distress [12]; (3) treated with EA according to the standard treatment procedure at the UMC—Branch no. 3.

Patients who did not comply with prescribed treatment were excluded.

### 2.2. Study setting

At the UMC—Branch no. 3, patients with CMP are typically treated with EA alone or in combination with nonsteroidal anti-inflammatory drugs (NSAIDs), acetaminophen, or herbal decoctions following the standard treatment procedure. Conventionally trained physicians perform the EA technique using the KWD808I EA Stimulator (manufactured by Changshansh, China), which employs a continuous pulse pattern of 60 Hz for 20 minutes per session.

### 2.3. Data collection

An EA Multiple-Choice Questionnaire, adapted by the authors from the TENs Multiple-Choice Questionnaire by Johnson et al. [13] was used to evaluate the analgesic effects in patients undergoing EA treatment overtime. This questionnaire was administered through face-to-face interviews with each participant during randomly selected treatment sessions. It collected information on the pain's origin, location, duration of EA analgesic effect, changes in the effectiveness of EA as treatment sessions progressed, concurrent therapies, and any adverse effects (Appendix 1).

### 2.4. Statistical analysis

Data was processed using Epidata 3.1 and analyzed with SPSS 20. Quantitative variables were presented as mean±SD due to normal distribution, while qualitative variables were presented as frequencies. Statistical significance was considered at  $p < 0.05$ .

## 3. RESULTS

### 3.1. Characteristics of participants

This study included a total of sixty eligible patients. These participants experienced an average of  $12.3 \pm 8.37$  EA sessions, and their characteristics, including age, gender, pain's origin, location, adverse effects, and concurrent treatment, are presented in Table 1.

**Table 1. Characteristics of participants**

	Value (%)
Age (years)	57.71±14.4
Number of EA sessions	12.3±8.37
Gender	
Male	25 (41.7)
Female	35 (58.3)
Pain location	
Neck	16 (26.7)
Back	32 (53.3)
Limbs	12 (20)
Pain origin	
Osteoarthritis	33 (55.0)
Herniated disc	16 (26.67)
Trauma	3 (5.0)
Inflammation	4 (6.67)
Autoimmune disorders	1 (1.66)
Others	3 (5.0)
Concurrent treatment	
Herbal decoctions	35 (58.3)
Acetaminophen and/or NSAIDs	1 (1.7)
Acetaminophen and/or NSAIDs with herbal decoctions	13 (21.7)
None	11 (18.3)
Adverse effects	
Swelling	3 (3.3)
Skin irritation	1 (1.67)
Dizziness	1 (1.67)
Fatigue	1 (1.67)
Others	0 (0.0)

EA, electroacupuncture; NSAID, nonsteroidal anti-inflammatory drug.

**Table 2. The analgesic effect of EA**

	Value (%)
Analgesic effect onset (hours)	
0	9 (15.0)
0–0.5	10 (16.7)
0.5–1	10 (16.7)
1.0–2.0	5 (8.3)
>2	26 (43.3)
Duration of the analgesic effect (hours)	
0–6	2 (3.4)
6–12	4 (6.7)
12–24	18 (30.0)
24–48	26 (43.3)
48–72	4 (6.7)
>72	6 (10.0)
Alterations in EA analgesic effect at random treatment sessions	
Increase	30 (50.0)
Unchanged	19 (31.7)
Decrease	11 (18.3)

EA, electroacupuncture.

### 3.2. The analgesic tolerance to electroacupuncture (EA)

The majority of patients experiencing a pain-relieving effect from EA lasting more than one hour after the EA treatment. This effect was observed to last from over 12 hours up to more than 72 hours in 90% of cases. However, some participants (accounting for 18.3%) indicated a decrease in the effectiveness of EA as the treatment sessions progressed (Table 2).

## 4. DISCUSSION

### 4.1. Characteristics of participants

This study found a predominance of female participants, aligning with findings from Jacobs et al. which also reported a higher

prevalence of CMP among women in the Vietnamese population [14]. This gender difference may arise from various factors, including women's tendency to communicate pain to healthcare providers and variations in biological factors (including hormonal and physiological aspects), pain tolerance, and psychological factors [15]. The mean age of individuals with CMP in our study was 57.71±14.40, consistent with observations by Parsons et al., who noted a higher prevalence of CMP in the age group between 50–60-year-old\_group [16].

The majority of patients in this study reported pain originating from osteoarthritis and chronic back issues. This observation could be attributed to the lumbar spine's role in bearing weights in supporting the body [17]. Additionally, similar prevalence patterns of back pain predominance have been observed in several studies conducted in traditional medicine hospitals [18,19].

According to our findings, only five participants experienced adverse effects. Similar to a study by Patil et al., which reported that 2.2% of patients encountered adverse effects such as swelling, pain, fatigue, and depression [20]. This demonstrates the safety of EA therapy in treating CMP.

#### 4.2. The analgesic tolerance to electroacupuncture (EA)

The results indicated that the onset of the analgesic effect often occurred more than one hour after the EA treatment. Price et al. reported that the analgesic effect of EA typically does not begin immediately but after 1 to 24 hours [21]. These findings suggest that the analgesic effect typically has a gradual onset, implying a neurohumoral mechanism of action. Previous studies have indicated increased endorphin and dynorphin levels in the cerebrospinal fluid following EA [22]. Some patients experienced immediate pain relief following EA treatment, which can be explained by Melzack and Wall's gate control theory [23] or attributed to the cumulative effect of multiple EA sessions [24].

Regarding the duration of the pain-relieving effect, the research results showed that the analgesic effect of EA generally endured for a substantial period. Previous research has demonstrated that this effect of EA can last from six hours to five days after a single session and even persist for six to twelve months after the completion of the treatment regimen [25,26]. The prolonged analgesic effect could be attributed to the cumulative impact of multiple EA sessions.

In this study, nearly 20% of participants reported a decrease in the pain-relieving effect of EA over time, which indicates the analgesic tolerance to EA. A similar study by Johnson et al. on TENS effectiveness has shown that 32% of patients experienced a decline in TENS efficacy from the time with a median of four years [13]. This phenomenon has also been observed in animal study, where 100% of rats given EA for six consecutive days and in 100% of patients receiving five straight sessions of TENS [8–10]. Experimental studies in rats have suggested that prolonged, repeated EA stimulation can induce morphine tolerance, involving enzymes that degrade endogenous enkephalinases opioid peptides [22]. Moreover, the release of endorphin induced by EA activates cholecystokinin octapeptide, which might counteract the analgesic effects of these endogenous opioids [27]. These findings suggest that intermittent use of EA might avoid this phenomenon and restore treatment effects.

This study marks the first effort to investigate the onset, duration, and tolerance of EA analgesic effects in Vietnamese patients. This endeavor aims to establish a standardized

treatment protocol, enhancing both cost-effectiveness and the degree of pain relief for patients with CMP. However, our study does have limitations, including a limited sample size and the concurrent use of other therapeutic interventions alongside EA by participants. This situation could potentially make it difficult to avoid bias. With an observational design, it may be hard to manage confounding factors. Further research with a larger sample size and a randomized control trial design is needed to conduct a more accurate assessment of analgesic tolerance to EA.

## 5. CONCLUSION

The pain-relieving effect of EA tends to manifest gradually and endure for a significant duration. However, consistent and repeated EA treatment in patients with CMP may potentially lead to the development of analgesic tolerance. Further research is needed to understand this phenomenon better.

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### Conflict of interest

No potential conflict of interest relevant to this article was reported.

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Conceptualization: MP Bui.

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Methodology: MP Bui.

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Investigation: MP Bui, OTK Ngo.

Writing - original draft: MP Bui.

Writing - review & editing: MP Bui, OTK Ngo, TD Pham.

### Availability of data and material

Upon reasonable request, the datasets of this study can be available from the corresponding author.

### Ethics Approval

All participants were comprehensively informed about the study's particulars, which encompassed the procedures, and anticipated outcomes. The research adhered to the ethical principles outlined in the Helsinki Declaration and received endorsement from the Biomedical Research Ethics Board at the University of Medicine and Pharmacy at Ho Chi Minh City (IRB-VN01002/IORG0008603/FWA00023448, dated 16 January 2023). All participants gave their written consent to participate in the study.

The identities of participants were maintained anonymously. Each patient was allocated a distinct study number, functioning as an identifier to distinguish individual data within the study cohort. Access to personal information was strictly confined to the authorized research team members under the lead investigator's supervision.

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## APPENDIX

### Appendix 1. Electroacupuncture multiple-choice questionnaire

Question	Answer			
Gender	<input type="checkbox"/> Female	<input type="checkbox"/> Male		
Age (years)				
Pain location	<input type="checkbox"/> Cervical	<input type="checkbox"/> Chest	<input type="checkbox"/> Back	<input type="checkbox"/> Limbs
Pain origin	<input type="checkbox"/> Inflammation <input type="checkbox"/> Osteoarthritis <input type="checkbox"/> Others	<input type="checkbox"/> Autoimmune disease <input type="checkbox"/> Trauma <input type="checkbox"/> Herniated disc		
Number of EA sessions				
Analgesic effect onset following EA (hours)	<input type="checkbox"/> 0 <input type="checkbox"/> 1–2	<input type="checkbox"/> 0–0.5 <input type="checkbox"/> >2	<input type="checkbox"/> 0.5–1	
Duration of the EA analgesic effect (hours)	<input type="checkbox"/> 0–6 <input type="checkbox"/> 24–48	<input type="checkbox"/> 6–12 <input type="checkbox"/> 48–72	<input type="checkbox"/> 12–24 <input type="checkbox"/> >72	
Alterations in EA analgesic effect up to now	<input type="checkbox"/> Increase	<input type="checkbox"/> Unchanged	<input type="checkbox"/> Decrease	
Concurrent treatment	<input type="checkbox"/> NSAID and/or acetaminophen <input type="checkbox"/> NSAID and/or acetaminophen and herbal decoctions <input type="checkbox"/> None			
Adverse effect	<input type="checkbox"/> Swelling	<input type="checkbox"/> Skin irritation	<input type="checkbox"/> Dizziness	<input type="checkbox"/> Fatigue