

Applications of pain-related evoked potentials and short-latency somatosensory evoked potentials in acupuncture research: a narrative review

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RESULTS: Thirty-seven articles were included in the review. Researchers usually use PREPs to study the analgesic effect of acupuncture, observe influential factors, or for mechanistic exploration. In the SLSEP studies, researchers focused on response characteristics of acupuncture, acupoint specificity, and influential factors of the treatment. There were some problems with the study design and conclusions.

CONCLUSION: Researchers could use PREP and SLSEP to objectively validate the effects of acupuncture and explore its mechanisms using nerve electrophysiology. Further studies can benefit from observing more acupoints' effects using PREPs or SLSEPs and investigating the placebo effect of acupuncture.

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Key words: Acupuncture; Evoked potentials, somatosensory; Electrophysiology; Review

Abstract

OBJECTIVE: To review and discuss the Chinese and English literature on the use of pain-related evoked potentials (PREP) and short-latency somatosensory EP (SLSEP) in acupuncture research.

METHODS: China National Knowledge Infrastructure Database and MEDLINE were searched for the following key words: acupuncture and PREP or SLSEP.

INTRODUCTION

Evoked potentials (EP) have developed to be a commonly applied technique in clinical neurology over the past half century.¹ EPs are electrical signals generated by the nervous system in response to sensory stimuli, such as auditory, visual, and somatosensory stimuli.¹ The electrical signals evoked by somatosensory stimuli are called somatosensory EPs (SEPs), and are used to evaluate the conduction of neural structures along the somatosensory pathways.¹ In the 1970s, SEP methodology started to be used in acupuncture studies. Pain-related EPs (PREPs) and short-latency SEPs (SLSEPs)

are two kinds of SEPs that are commonly used in acupuncture studies. PREPs are evoked by pain stimuli and are commonly used in pain-related studies. The later-latency components of PREPs (> 150 ms) are related to the sensation of pain. SLSEPs are conventional SEPs that are evoked by somatosensory stimuli whose intensity is adjusted to induce a visible twitch of the related muscle, but no pain. SLSEPs are widely used in clinical practice, because they are rarely influenced by consciousness and have explicit neural origins. This article reviews the application of PREPs and SLSEPs in clinical trials of acupuncture.

METHODS

An electronic database search of all fields was conducted on 6 May, 2014. For Chinese literature, the China National Knowledge Infrastructure Database (CNKI) was searched from 1980 to 2014. We used the following search terms: "(acupuncture) AND pain-related evoked potentials;" and "(acupuncture) AND short-latency somatosensory evoked potentials," which yielded 63 and 186 articles, respectively. For English literature, MEDLINE was searched from 1950 to 2014. We used the following search terms for PREP: "[acupuncture] AND pain AND evoked potentials] AND English (language)" To prevent omissions, we repeated the search multiple times, replacing "evoked potentials" in the above search term with "brain activity," "evoked responses," "somatosensory processing," and "deactivation". In total, 263 articles related to PREP and acupuncture research were yielded. We used the following search terms for SLSEP: "[acupuncture] AND somatosensory evoked potentials] AND English (language)" In total, 62 articles related to SLSEP and acupuncture research were yielded. A total of 574 articles resulted from the English language search. Articles were selected according to the following inclusion criteria: (a) using PREPs or SLSEPs to study the characteristics of acupuncture; and (b) carried out on humans. Excluded studies included those that: (a) used other neurophysiologic technologies such as brainstem auditory evoked potentials, functional magnetic resonance imaging, visual evoked potential, auditory evoked potentials, event related potentials, motor evoked potentials, or electroencephalogram; (b) were animal experimental studies; and (c) did not use PREP or SLSEP as outcome measures to assess the effect of a therapy to a disease. According to the above inclusion and exclusion criteria, we included 37 articles in this review.

RESULTS

Studies in the Chinese literature using PREPs

Pain is subjective feeling that includes both experiences of intensity and emotion, and is often evaluated by visual analogy score (VAS). The development of PREPs

has opened a new avenue for the study on pain. It is widely accepted that the later-latency components of PREPs can reflect sensation-discrimination processes of the brain in response to pain stimuli, such as locating stimuli and evaluating intensity. For example, the amplitude of the second positive wave of PREP (P2) is positively correlated with VAS scores.² For evaluating pain objectively, researchers started to use PREPs to investigate acupuncture analgesia. PREPs are often shown as an NP waveform, which is composed of a negative wave and a positive wave. The EP nomenclature states that a capital N or P represents a negative or positive wave, and a number after the letter represents its peak latency or its order of occurrence. For example, N20 represents a negative wave that appeared at 20 ms, and N2 represents the second negative wave. Because of different environments in different laboratories, the same components can have different latencies, which leads to different names. For example, Xia *et al.*³ blocked blood flow to isolate PREPs, which were evoked by posterior tibial nerve stimulation, and named the components P250-N350 according to the latencies. This means that the components are composed of a positive wave appearing at 250 ms and a negative wave appearing at 350 ms. Xia *et al.*⁴ used inverse averaging based on the computer average principle to separate the pure painful components of cerebral evoked potentials, which ranged from 170 to 240 ms and were different from those of Xia *et al.*³ Researchers mainly used PREPs as an objective indicator of pain to verify the analgesic effect of acupuncture. Xia *et al.*⁵⁻¹² reported that electro-acupuncture and auricular needling could both reduce the amplitude of PREPs, indicating an analgesic effect. Zeng *et al.*¹³ found that electro-acupuncture on both Hegu (LI 4) and non-acupoints could inhibit the amplitudes of the medium and late components of PREPs, and the effect of electro-acupuncture on Hegu (LI 4) was strikingly superior to that of electro-acupuncture on non-acupoints. This study suggested that acupoints had a more noticeable effect of analgesia than non-acupoints. Others observed that acupoints ipsilateral to the nerve stimulation were more effective at reducing the amplitude of PREPs than those contralateral to the nerve.¹⁴ Some researchers who focused on how the acupuncture and suggestion affected PREPs, and found that acupuncture had analgesic effects, while suggestion did not play a major role in acupuncture analgesia.¹⁵ According to the Chinese literature mentioned above, researchers mainly investigated how different interventions, acupuncture positions and suggestion affected acupuncture analgesia using PREPs.

Studies in the Chinese literature using SLSEPs

Researchers observed acupuncture efficacy using SLSEP and different interventions and acupuncture positions, which is similar to PREP studies. Xiong *et al.*¹⁶ found that both electro-acupuncture and tactile stimuli

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