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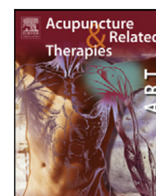

The needling sensation: A factor contributing to the specific effects of acupuncture?

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ABSTRACT

Acupuncture is a complex intervention, and there are both specific and non-specific influences associated with its therapeutic benefit. Although large randomized controlled trials (RCT) and systematic reviews have demonstrated the efficacy of acupuncture, the conclusions are controversial due to the lack of a significant difference in the results between real and sham acupuncture. This similarity may be due to the omission of important components of the acupuncture treatment itself, such as the needling sensation. The needling sensation is considered to represent an important component of acupuncture. Despite this importance, several RCTs have lacked data on whether the needling sensation has been achieved. From a Traditional Chinese Medicine (TCM) perspective, the needling sensation, deQi, is a combination of unique sensations that are interpreted as the flow of Qi, or "vital energy." Furthermore, acupuncture is believed to be successful only upon the arrival of "vital energy," Qi. This state is suggested to be essential to the specific therapeutic effect of acupuncture. From a biomedical perspective, acupuncture excites sensory receptors and nerve fibers in the stimulated tissue, resulting in a needling sensation. Moreover, acupuncture induces both the deactivation of a limbic–paralimbic–neocortical network in the brain (the default mode network and the anti-correlated task-positive network) and the activation of somatosensory regions. A distinct needling sensation is associated with a marked deactivation of these brain networks, whereas the lack of a needling sensation (as during sham needling) is associated with significantly less deactivation. Conversely, when acupuncture induces sharp pain sensations, there is an activation of these networks instead. In a clinical context, this difference means that the therapist needs to identify a stimulation intensity that is scaled to the needling response of each patient, i.e., a sharp uncomfortable pain sensation during the needle stimulation should be avoided.

Both the empirical bases of TCM and biomedical acupuncture research suggest that the therapist should strive for a needling sensation during an acupuncture treatment. If such a sensation is not achieved, are the specific effects of acupuncture likely smaller? This conclusion suggests that deQi is part of a proper acupuncture treatment and that the experience of a needling sensation should universally be assessed and reported in all types of clinical and experimental trials.

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1. Introduction

Acupuncture is a part of Traditional Chinese Medicine (TCM), and the World Health Organization (WHO) endorses acupuncture for various conditions, including pain. However, several randomized controlled trials (RCTs) have reported that acupuncture has only a limited specific effect on pain. In a recent individually based systematic review of RCTs of acupuncture based on the ratings of 17,922 chronic pain patients (patients suffering from back and neck pain, osteoarthritis, headache, and shoulder pain), acupuncture was found to be superior both to no-acupuncture and to a "sham" control for each pain condition; indicating that there are specific effects of acupuncture [1]. In addition, it has been argued that some of the RCTs did not satisfy the criteria for dosage adequacy that were required for optimal clinical efficacy and that the "sham" procedure was not inert [2,3]. The intensity of the psychophysical and neurophysiological response of the needling sensation deQi has been proposed as a means for dosage measurement [4–6], calling for better qualitative and quantitative characterizations of the needling sensation.

2. Needling sensation

2.1. Traditional Chinese Medicine perspective

The needling sensation is considered by many to be an important component of acupuncture. From a TCM perspective, the

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needling sensation deQi is anamalgamation of unique sensations that indicate the flow of Qi or "the arrival of vital energy." Patients often experience deQi as multiple sensations at and around the needle site. The needling sensation includes soreness or aching (*suan*), numbness or tingling (*ma*), fullness/distention or pressure (*zhang*), heaviness (*zhong*) and warmth. Based on the theory of TCM, acupuncture is successful only in conjunction with the experience of deQi, which indicates a correct localization of the acupuncture point and the arrival of Qi [7].

2.2. Biomedical perspective

From a biomedical medical perspective, the needling sensation is mediated by sensory (afferent) nerves. Needle grasp is a biomechanical phenomenon of deQi and is characterized by an increase in the force necessary to pull the needle out of the tissue. A trial by Langevin supports the conclusion that connective tissue winding is the mechanism responsible for the increase in pullout force induced by needle rotation [8,9]. It is also possible that needle grasp is partly mediated by a reflex triggered by the needle rotation within the muscle, triggering a segmental reflex that results in an increased contraction around the tip of the needle.

Although the perception of the needling sensation may vary between individuals and according to the manual technique used, this distinct sensation is generally characterized by soreness, numbness, heaviness, distension, and aching in the deep tissues surrounding the inserted needle [10]. At the site of the needling, the sensation is accompanied by an increase in blood flow and a feeling of warmth [11]. The sensation may also coincide with and be perceived by the therapist as an increased resistance to further movement of the inserted needle [12]. The needling sensation is not a single sensation but rather a compound sensation that is generated from the activation of various sensory receptors and their afferent fibers. In particular, small fiber innervated nociceptors and thin myelinated fiber innervated mechano-receptors have been implicated in the needling sensation [13–15]. It has been demonstrated that numbness, heaviness, and distension during needling are associated with the activation of myelinated $A\alpha$- and $A\beta$-afferents in deep issues, whereas aching and soreness are correlated with the stimulation of small myelinated $A\delta$- and unmyelinated C-fibers. Clinical data also suggests that numbness, heaviness, and distension are more frequently elicited when manual manipulation is performed in muscle-spindle- and tendon-organ-rich acupuncture sites, whereas the sensation evoked in cutaneous-receptor-rich acupuncture sites is dominated by aching and soreness [15].

Studies by Hui et al. [16] have shown that acupuncture induces the deactivation of a limbic–paralimbic–neocortical network (LPNN) and the activation of somatosensory brain regions. In a study published in 2009, they explored the activity and functional connectivity of these regions during acupuncture vs. tactile stimulation and vs. acupuncture associated with inadvertent sharp pain. Clusters of deactivated regions were identified in the medial prefrontal, medial parietal and medial temporal lobes during acupuncture, in addition to activated regions in the sensorimotor cortex and in a few paralimbic structures. Importantly, these clusters showed virtual identity with the default mode network and the anti-correlated task-positive network. In addition, the amygdala and hypothalamus were frequently involved during acupuncture. However, when acupuncture induced sharp pain, the deactivated regions were attenuated or became activated instead. Tactile stimulation induced a greater activation of the somatosensory regions but a less extensive deactivation of the LPNN. This indicates that acupuncture mobilizes the anti-correlated functional networks of the brain to mediate its actions and that the effect is dependent on the psychophysical response, which includes the needling sensation [16].

3. Rated experience of needling

The sensory component of deQi is difficult to study because of its subjective nature and the fact that it is influenced by a variety of factors, such as the constitution of the patient, the severity of the illness, the location of the acupuncture points, and the needling techniques [17]. There appears to be a limit to the number of sensations that can be discriminated by each individual patient. A number of researchers have sought to establish a credible rating scale for deQi, such as the McGill Pain Questionnaire, the Subjective Acupuncture Sensation Scale, the Massachusetts General Hospital Acupuncture Sensation Scale, the Southampton Needle Sensation Questionnaire, and the 'deQi composite' [7,17–19,4,20]. Although deQi may have been traditionally intended to describe the perceptions of both the therapist and the patient [10], most of these scales only assess one perspective. DeQi should be considered in all types of clinical trials evaluating effects of acupuncture, and further research is required to understand its underlying mechanisms.

4. Needling sensation and analgesia

Experimental studies have reported that the intensity of the needling sensations is associated with analgesia [16,21]. Kong et al. [22] reported a relationship between acupuncture-induced analgesia and the needling sensations of numbness and soreness. In addition, although there is difference in the therapeutic efficacy between acupuncture and "sham" acupuncture, the analgesic mechanism of action of acupuncture remains unclear. The involvement of diffuse noxious inhibitory control (DNIC) has been suggested to account for part of the acupuncture-induced pain relief. DNIC refers to an endogenous pain modulatory pathway that has often been described as "pain inhibits pain" [23]. It occurs when the response to one painful stimulus is inhibited by another, often spatially distant, noxious stimulus. DNIC refers to the mechanism by which the dorsal horn wide dynamic range neurons that are responsive to stimulation from one location of the body may be inhibited by noxious stimuli (such as heat, high pressure or electric stimulation) applied to another remote location of the body. This inhibition is believed to originate in the brain and to affect both the wide dynamic range and the nociception-specific neurons in the dorsal horn [23].

Experimental animal studies suggest that DNIC could contribute to acupuncture analgesia [24]. However, it is important to remember that the animal experimental protocols are different from the clinical treatments in humans, for example, regarding the intensity of the acupuncture stimulation. Classic DNIC-inducing tests in humans, such as the cold pressor test, the ischemic tourniquet test and the thermal heat test, are non-invasive but painful, whereas acupuncture is invasive but usually not painful. The involvement of DNIC in acupuncture may also be questionable because patients suffering from diseases that typically involve impaired DNIC, including fibromyalgia, osteoarthritis of the hip, irritable bowel syndrome, or temporomandibular disorder, still benefit from acupuncture therapy [cf. 26]. Possibly this could be attributed to an effect on the affective but not the sensory component of pain [26]. To date, several trials in humans have demonstrated an increase in pain thresholds after acupuncture and/or a decrease in the ratings of pain intensity [27,28]. Gender differences have also been reported [29]. In a recent study, the analgesic effects of acupuncture needling without stimulation and cold-pressor-induced DNIC were examined using non-penetrating sham acupuncture as a control treatment [25]. Forty-five subjects

received each of the three interventions in a randomized order. The analgesic effect was assessed using pressure algometry before and after each of the interventions. There was no significant difference between acupuncture and non-penetrating sham acupuncture at any time, but there was a significant increase in the pressure pain threshold in the DNIC test compared to the acupuncture and non-penetrating sham acupuncture treatments. The pressure pain threshold decreased after the DNIC test, whereas it remained stable at a higher level after acupuncture and after non-penetrating sham acupuncture. Acupuncture needling at a low pain stimulus intensity showed a small analgesic effect that did not differ from the placebo response and was less than the DNIC-like effect of a painful non-invasive stimulus. Interestingly both modalities have been shown to interact with the endogenous opioid system [30]. Furthermore, Napadow and collaborators have shown that patients with carpal tunnel syndrome responded to acupuncture with a more pronounced fMRI signal increase in the hypothalamus and a signal decrease in the amygdala compared to healthy controls [31]. In a pain patient population with possibly altered DNIC, the difference between authentic acupuncture and non-penetrating sham acupuncture might be more pronounced. In addition, a recent study by Treister et al. [32] revealed that the endogenous analgesia after either noxious or innocuous conditioning stimuli is associated with the rated pain. The weak stimulation resulted in similar pain pressure threshold values relative to the non-penetrating sham acupuncture [33]. Conceivably, acupuncture needles can deliver intense stimulation, until the pain is strong enough to induce a DNIC response, but under therapeutic conditions (i.e., strong but not sharp pain stimulation), the relevant contribution of DNIC to acupuncture analgesia is questionable. Beyond the intensity of the conditioning stimulus, the time profile is another important characteristic of a DNIC response because the effect is most intense during the application of the conditioning stimulus and usually decreases to baseline within 5–10 min [34]. Although recent results show an increase in the pressure pain threshold after acupuncture, the observable decrease does not persist over the following 5 min, as would be expected if the effect was mediated through a DNIC effect.

5. Clinical implications

Both the empirical bases of TCM and biomedical acupuncture research suggest that the therapist should strive to elicit a needling sensation during an acupuncture treatment; if this effect is not obtained; the specific effects of acupuncture are likely going to be smaller. This conclusion suggests that the needling sensation is part of a proper acupuncture treatment and that the experience of deQi should universally be assessed and reported in all types of clinical and experimental trials. A strong needling sensation is associated with a marked deactivation of the brain network areas important for the treatment effects, whereas the lack of needling sensation results in significantly less deactivation. Furthermore, when acupuncture induces sharp uncomfortable pain, the observed deactivation is attenuated or results in an activation instead. In a clinical context, these results mean that the therapist needs to induce a needling sensation according to the individual needling response of the patient.

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