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Does the effect of acupuncture depend on needling sensation and manipulation?

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KEYWORDS
Acupuncture;
Pain;
Acupuncture manipulation;
Needling sensation

Summary
Background: Acupuncture sensation and manipulation have been considered to be an important component of acupuncture in traditional Asian medicine. However, there has been limited research as to whether acupuncture sensation is associated with therapeutic benefit. This study investigated the relationship between acupuncture sensation and analgesic effect according to acupuncture manipulation.
Method: Fifty-three healthy volunteers received three different forms of acupuncture in a single-blinded crossover design: superficial needling (0.3 cm), deep needling (2 cm) and needling with bi-directional rotation. The effects of acupuncture were evaluated by using the pressure pain threshold. Acupuncture sensation measurement was done in two ways.
Results: Both total acupuncture sensation and increase of the pressure pain threshold were maximum in needling with rotation, followed by deep needling and superficial needling. Repeated-measure analysis of variance (ANOVA) analysis was carried out to assess whether there was a significant difference; both showed significant difference ($p = 0.000$, 0.003). A paired sample *t*-test was carried out, which revealed that needling with rotation showed significant difference from both superficial needling and deep needling. Further, the correlation between the total acupuncture sensation and changes in pressure pain threshold were calculated using Pearson correlation; there was a significant correlation ($p = 0.002$, $p = 0.013$).
Conclusion: Acupuncture sensation and pressure pain threshold increase according to the depth and rotation of acupuncture. Especially, both display significant increase with needle rotation. Further, there is a significant correlation between acupuncture needling sensation and increase in pressure pain threshold. It seems that needle rotation and acupuncture sensation play an important role in verifying the effect of acupuncture.

Introduction

Acupuncture sensation is one of the most important components in acupuncture treatment. Traditionally, while acupuncture needles were inserted, manipulated and retained, patients felt acupuncture sensations of numbness, heaviness, soreness and distension. Deqi is a key term related to this needle sensation, and it refers to excitation

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of qi through the acupuncture channels/meridians by means of needle stimulation. Deqi is assumed by many acupuncturists to be associated with a therapeutic effect and is often sought during needling.[2,8,11] More precisely, both the administering acupuncturists and the patient may be able to detect signs of deqi.[9,11,22] Early definition of deqi focussed on the acupuncturist's perception, but in recent years, researchers have put more weight on the patient's subjective needling sensation.[11,22]

Traditionally, acupuncture sensation has been described to have distinctive features that distinguish it from acute pain. There have been a number of studies to monitor the needling sensation and to create a credible rating scale for subjective sensation.[7,10,11,21,26,28] Further, recent attempts to clarify the needling sensation associated with deqi have concluded that a grouping of seven sensations is associated with the category of deqi ('aching', 'dull', 'heavy', 'numb', 'radiating', 'spreading' and 'tingling'), and a grouping of nine sensations ('burning', 'hot', 'hurting', 'pinching', 'pricking', 'sharp', 'shocking', 'stinging' and 'tender') with the category of acute pain.[19]

There have been some researches investigating the physiological basis for needling sensation. A 1985 study investigated the relationship between characteristics of needle sensation and groups of afferent fibres,[27] and some studies have found that acupuncture stimulation increases both skin and muscle blood flow[23] and blood flow velocity,[16] which may have resulted in acupuncture sensations of warm, radiating and energetic feeling. Recently, there have been some studies that used functional magnetic resonance imaging (fMRI); Limbic and paralimbic structures displayed the attenuation of signal intensity when experiencing deqi.[5] Further, deactivation of the limbic—paralimbic—neocortical network, as well as activation of somatosensory brain regions, was associated with deqi.[6] There were different activation and deactivation patterns of the brain between the predominant deqi group and the acute pain group.[1]

However, there are opposing results about whether specific acupuncture needling sensations, including deqi, are associated with therapeutic benefit.[11] In a small clinical trial of acupuncture for osteoarthritis of the knee, the participants' experience of deqi sensation was a predictor for improved outcome.[25] A pilot study also found a relationship between acupuncture analgesia, numbness and soreness, but not for other sensations commonly associated with deqi.[10] However, White et al. *conducted* a secondary analysis of data gathered in a randomised controlled clinical trial and found no relationship between the strength of *deqi* and pain reduction for osteoarthritis of the knee and hip.[29]

There has been limited research compared the analgesic efficacy and acupuncture needling sensation within individuals. Only one pilot study investigated the influence of manual, electro, and placebo acupuncture in a single subject cohort.[10] We thought that difference in depth and rotation of the acupuncture is the important factor to investigate the relationship between acupuncture needling sensation and analgesic effect according to acupuncture stimulation.

Bi-directional rotation of a needle inserted into deep soft tissue produces a greater acupuncture needling sensation intensity when compared to superficial needle insertion with mock deep penetration and bi-directional rotation.[3] A study reported that introduction of needle rotation significantly increased the deep, dull, heavy sensation.[22] Further, a preliminary study indicated a strong connection between acupuncture sensation and both tissue depth and needle rotation[22] In addition, there is a hypothesis that winding of tissue during needle rotation causes deqi, and needle manipulation transmits a mechanical signal to connective tissue cells *via* mechano-transduction.[13–15] Moreover, an Australian research group reported that needle manipulation increased the pressure pain threshold (PPT).[30]

We hypothesised that different intensities of stimulation, in the order of superficial needling, deep needling and needling with rotation, may cause different acupuncture sensations and as a result we can investigate the relationship between acupuncture needling sensation and analgesic effect within individuals.

Methods

Subjects

A total of 53 healthy volunteers (26 men and 27 women) were recruited by an advertisement posted at Kyung-Hee University, Seoul. The mean age of the participants was 22.1 ± 2.7 years. Inclusion criteria were ages between 18 and 40 years. All subjects participated voluntarily and were given written informed consents. They did not receive any form of compensation. Subjects were excluded if they were pregnant or diagnosed with a chronic medical disorder within 1 year. The study participants did not receive medications or any other medical treatment for at least 1 month before inclusion in the study. The Institutional Review Board at the Kyung-Hee University Hospital approved this study.

Design

Each subject's baseline PPTs were measured in session 1. Then, randomisation was done by throwing a dice. After that, in sessions 2, 3 and 4, acupuncture treatment was done using three modes in random order, and PPT change and acupuncture sensation were measured (Fig. 1). The three acupuncture treatments were superficial needling (0.3 cm), deep needling (2 cm) and needling with bi-directional rotation. The interval between each visit was more than 48 h. Measuring PPT and acupuncture sensation was performed during acupuncture treatment.

Acupuncture

Acupuncture points were selected on their frequent use in pain management: spleen 6 (SP6), spleen 9 (SP9), stomach 36 (ST36) and gallbladder 39 (GB39).[12] All subjects received acupuncture on the left leg. Acupuncture was applied by five trained and licensed acupuncturists with at least 1 year of experience. Acupuncture was performed using stainless steel single-use acupuncture needles (0.20 mm × 30 mm; DongBang Acupuncture). Each acupuncture treatment lasted for 5 min. The superficial needle was inserted to a depth of 0.3 cm and the deep needle was inserted to a depth of

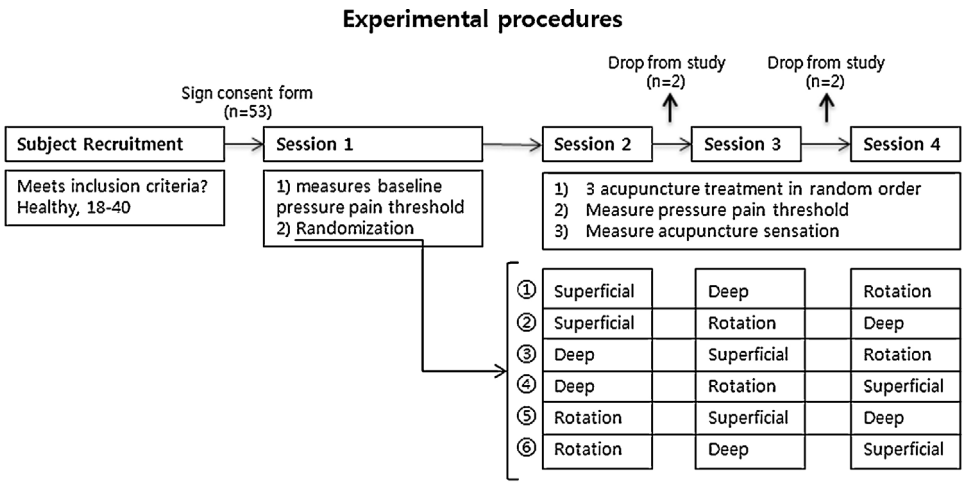

Figure 1 Flow chart of the experiment.

2 cm. During needling with rotation session, the needle was rotated 180° in a clockwise manner followed by a rotation of 180° in an anti-clockwise motion at approximately 1 Hz. This rotation procedure was repeated every minute and carried out five times. Participants were informed about the adverse effects of acupuncture (Fig. 2).

Pressure pain thresholds

PPTs were measured using a PD&T pressure algometer within a range between 2 and 20 kg. The algometer was pressed to the skin and an increasing ramp of 0.5 kg s^{-1} was applied. Each participant was instructed to respond verbally as soon as the pressure became painful. This procedure was performed three times. PPTs were measured on the anterolateral skin of the right lower limb, in the middle of the four acupuncture points (SP 6, SP 9, ST 36 and GB 39).

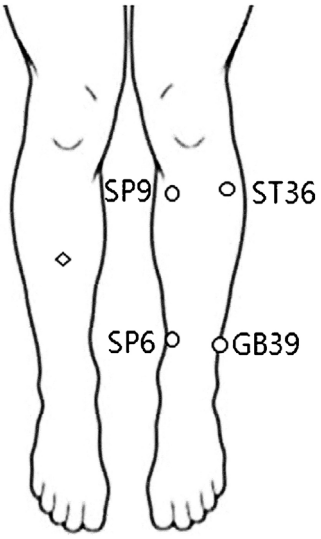

Figure 2 Location of acupuncture points for study. All participants received the acupuncture treatments on the left leg. Pressure pain thresholds were measured on the right leg, in the middle of the four acupuncture points.

Acupuncture sensation

Acupuncture sensation measurement was done in two ways. Four acupuncture points were measured at the same time, and participants were asked to quantify the overall sensation of the four points, mainly focussing on the most powerful point. Before the acupuncture treatment, participants were informed that sensations of numbness, heaviness, soreness and distention may be evoked by the acupuncture stimulation.[11] During acupuncture treatment, participants were asked to quantify the overall intensity of acupuncture needling sensation on a 100-mm visual analogue scale (VAS) to the statement ''During acupuncture, I felt a sensation at the acupuncture point as. . .'' with anchors being 'not at all' (0 mm) and 'very strong' (100 mm) every minute. They also completed the Subjective Acupuncture Sensation Scale (SASS), which uses 100-mm VAS to record the intensity of the following acupuncture needling sensation: stabbing, throbbing, aching, tingling, heaviness, soreness, numbness, fullness and burning.[10] Participants recorded needle sensations onto a paper sheet after the acupuncture treatment.

Data analyses

The analgesic effect of the three modes of acupuncture was determined by comparing the PPT before and after the acupuncture administration. All PPT values were expressed as a percentage of the mean pre-intervention (before the acupuncture administration) value. This was calculated using the following formula:

$$\text{PPT value as \% of pre-intervention mean} = \left\{ \frac{\text{PPT (kg cm}^{-2})}{\text{mean pre-intervention PPT (kg cm}^{-2})} \right\} \times 100$$

This transformation was applied because of the wide range of baseline PPT encountered, both among and within subjects.[17,30]

The total acupuncture sensation score of each acupuncture mode was calculated by a simple summation of the

Table 1 Mean of total acupuncture sensation (±SE).

	Superficial needling	Deep needling	With rotation
[a]	8.58 ± 7.85	12.80 ± 10.75	27.92 ± 12.48
[b]	10.22 ± 11.26	15.73 ± 13.69	26.89 ± 15.44

[a] Sum of the overall acupuncture sensation measured every minute.
[b] Sum of the elements of Subjective Acupuncture Sensation Scale (SASS).

overall intensities of acupuncture sensation which was measured every minute, and also by adding SASS elements. Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) for Windows version 20. Data of PPT% met the assumptions of the general linear model (normal distribution and homogeneity of variance). Repeated measure analysis of variance (RMANOVA) was used, with a factor of three acupuncture modes. *Post hoc* analyses were carried out using paired *t*-test. Meanwhile, analysis of covariance (ANCOVA) analysis was used to observe the changes in PPT increase depending on the intensities of acupuncture stimulation when acupuncture sensation is controlled for covariates.

Correlation analysis (Pearson correlation) was performed between the total acupuncture sensation and the analgesic effect determined by changes in PPT%. On each element of SASS, the analgesic effect correlation verification was carried out as well. SASS elements were divided in the deqi group and acute pain group. The deqi group is comprised of tingling, heaviness, fullness, soreness and aching and, in the acute pain group, stabbing, throbbing and burning.[19] By finding the average of SASS elements of the deqi and acute pain groups, a correlation between the deqi group and the analgesic effect, and the acute pain group and the analgesic effect were evident.

Results

Subjects

Of the 53 volunteers who consented to the study, 49 (27 females) completed all four sessions. Four subjects were dropped since they did not return. No adverse effects were reported during the study.

Acupuncture sensation

Total acupuncture sensation

The average of total acupuncture sensations for the three modes of treatment is shown in Table 1. Mean acupuncture sensation was largest in needling with rotation, followed by deep needling and superficial needling. RMANOVA analysis indicated a significant difference ($p = 0.000$). The paired sample *t*-test was carried out for *post hoc* analysis, and all the combinations showed significant differences. Moreover, except for the combination of superficial and deep needling ($p = 0.013$, 0.003), all had *p* values of 0.000.

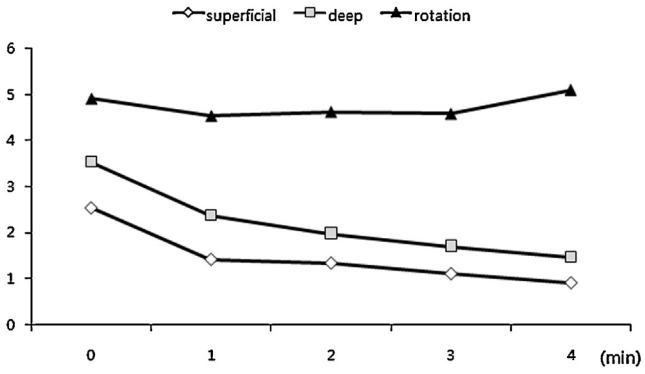

Figure 3 Acupuncture sensation measured every minute.

Acupuncture sensation measured by time

The overall intensity of acupuncture sensation measured every minute is shown in Fig. 3. The acupuncture sensation of superficial and deep needling gradually decreased over time. Instead, the acupuncture sensation of needling with rotation remained constant above certain levels until 4 min.

Acupuncture sensation descriptors

SASS elements are shown in Fig. 4. All SASS scores were largest in needling with rotation, followed by deep needling and superficial needling. Compared to superficial needling, two factors that showed the greatest increase in deep needling were stabbing and throbbing; both of these were in the category of acute pain. Further, compared to deep needling, soreness and aching were the two most increased factors in needling with rotation; both of these were in the category of deqi.

Pressure pain threshold

The mean changes in PPT% of three modes of treatment are shown in Table 2. Mean increase of PPT was largest in needling with rotation, followed by deep needling and superficial needling. RMANOVA analysis was carried out, and the data did not meet the assumption of sphericity. Instead, Greenhouse—Geisser analysis indicated a significant difference ($p = 0.003$). A paired sample *t*-test was carried out for *post hoc* analysis; needling with rotation showed significant difference from both superficial needling ($p = 0.002$) and deep needling ($p = 0.032$). However, no significant differences were found between superficial needling and deep needling ($p = 0.115$).

The collective results from Tables 1 and 2 indicated that acupuncture sensation increased with higher intensity of stimulation, in the order of superficial needling, deep needling and needling with rotation. Further, the change in PPT increased. However, there is relatively little difference between superficial needling and deep needling (Fig. 5).

Meanwhile, ANCOVA analysis was used to control for acupuncture sensation. Change in PPT was an independent variable and intensity of acupuncture stimulation (superficial, deep and rotation) was a dependent variable; acupuncture sensation was used as covariates. The *p* value was 0.391 (when acupuncture sensation was calculated by time) and 0.142 (when acupuncture sensation was calculated by SASS).

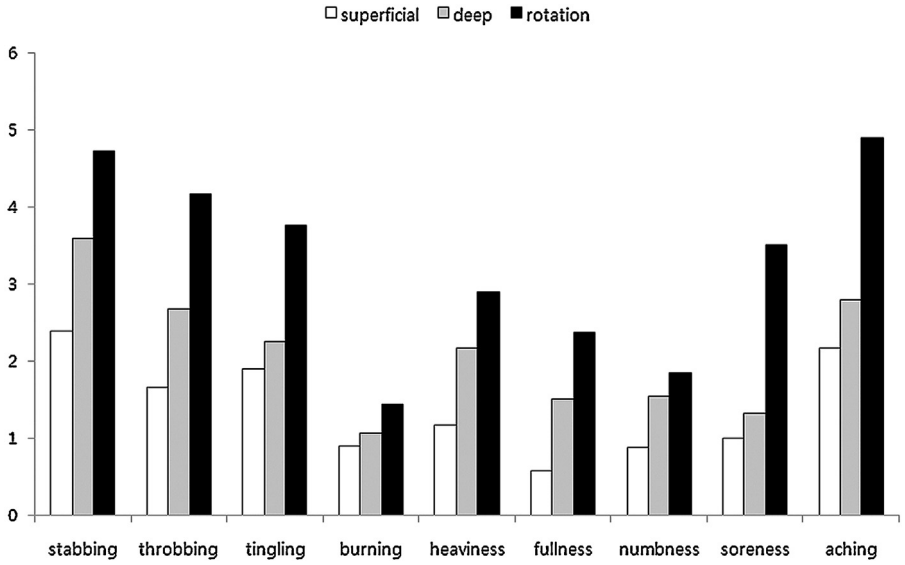

Figure 4 Acupuncture sensation descriptors (SASS).

Table 2 Mean changes in pressure pain threshold % (PPT%) and 95% confidence intervals (CI).

Superficial needling	Deep needling	With rotation
7.94 (3.18, 12.71)	11.31 (5.78, 16.84)	17.74 (12.75, 22.73)

Correlation

Overall acupuncture sensation and analgesic effect

Correlation between the acupuncture sensation and changes in PPT% was calculated using Pearson correlation; there was a significant correlation. The summation of the figures of overall acupuncture sensation measured every minute led to a p value of 0.002, and the summation of SASS elements led to a p value of 0.013. This was the result of correlation analysis carried out by compiling the data of superficial needling, deep needling and needling with rotation (Fig. 6). However, when analyses were performed separately for each mode, significant correlation between acupuncture sensation and changes in PPT% was not noted: superficial needling mode ($p = 0.052$, $p = 0.357$), deep needling mode ($p = 0.785$, $p = 0.948$) and needling with rotation mode ($p = 0.395$, $p = 0.199$).

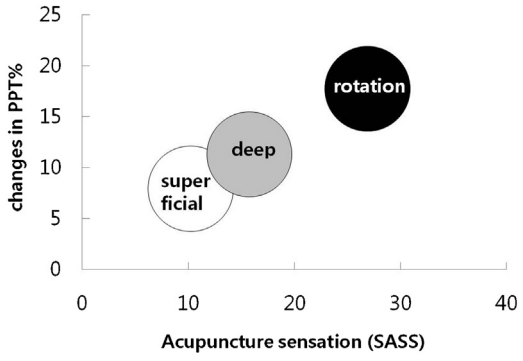

Figure 5 Acupuncture sensation and changes in PPT%.

Acupuncture sensation descriptors and analgesic effect

Five scales showed significant correlations in correlation analysis between the analgesic effect and each of the nine sensations quantified on the SASS: the numbness

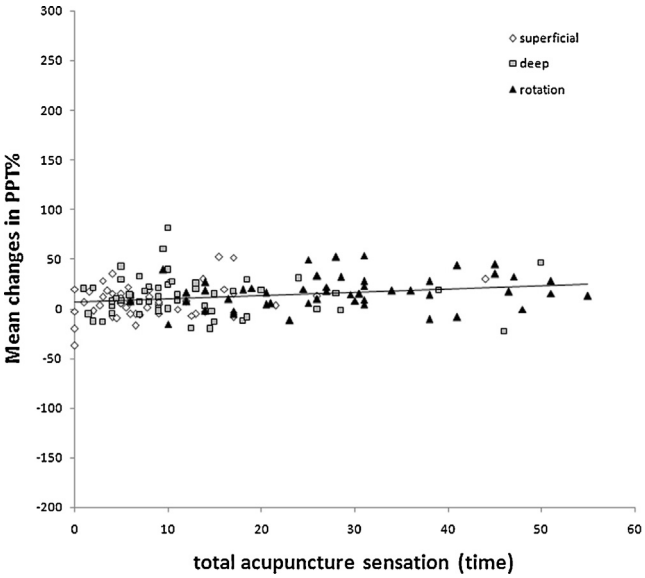

Figure 6 Correlation between total acupuncture sensation and changes in PPT%. Data of superficial needling, deep needling, and needling with rotation is put together ($p = 0.002$).

sensation ratings ($p = 0.020$), aching sensation ratings ($p = 0.021$), heaviness sensation ratings ($p = 0.025$), fullness sensation ratings ($p = 0.028$) and the burning sensation ratings ($p = 0.046$). Significant correlations of analgesia and three SASS ratings, numbness, aching, heaviness, fullness and burning were found, but not the ratings of throbbing ($p = 0.065$), tingling ($p = 0.095$), stabbing ($p = 0.129$) or soreness ($p = 0.311$).

Deqi and acute pain sensation and analgesic effect

Sensations that correspond to deqi are tingling, heaviness, fullness, soreness and aching, and those that correspond to pain are stabbing, throbbing and burning.[19] There was a significant correlation between the averaged sensations of deqi and analgesic effect ($p = 0.008$). Further, significant correlation was found between the averaged sensations of pain and analgesic effect, but the p value was lower than that between deqi and analgesic effect ($p = 0.036$).

Discussion

Does acupuncture sensation affect treatment outcome?

There have been many clinical studies regarding the correlation of acupuncture sensation and analgesic effect. In 2010, Peter et al. analysed patients of degenerative arthritis to see whether deqi actually had effect on treatment of pain.[29] Despite the belief, no significant difference related to analgesic effect was noted in those who felt strong acupuncture sensation and those who did not. In this study, rotation techniques were applied to individuals until each of them felt deqi to take into account the real clinical settings. Presently, significant correlation between acupuncture sensation and analgesic effect was evident when results from different modes of acupuncture stimulation were combined; little correlation was found under the same acupuncture stimulation of needle rotation. From this, it can be assumed that the reason no correlation could be found in the study of Peter et al. is that the same acupuncture stimulation, namely needle rotation, was applied to study participants. It can be said that the factors that affect the differences of acupuncture sensation in individuals have much to do with how sensitive one is to acupuncture and which subjective standard one has on the intensity of acupuncture sensation.[10] What needs to be pointed out is that how sensitive one is to acupuncture does not carry important meaning. In other words, individuals can be good or poor responders, but this does not have influence on analgesic effect. On the contrary, it was found that increase in acupuncture sensation induced by different acupuncture stimulations leads to increase in analgesic effect. Furthermore, when the acupuncture sensation is controlled, the analgesic effect in different modes of acupuncture stimulation showed decreased statistical significance. Therefore, it is important that patients sense more acupuncture sensation when being treated with acupuncture in clinical practices.

Is it meaningful to separate Deqi from acute pain?

Several studies have concluded that deqi and acute pain induce different effects in the brain, and predicted that acute pain can have negative influence on the effect of acupuncture.[1,5,6] However, in this study, there was no evidence that acute pain hinders the analgesic effect. Still, when correlation analysis was done using deqi sensations without pain, the correlation with analgesic effect was higher. On the other hand, there was lower correlation between pain sensation and analgesic effect. Although those who felt strong deqi sensation had a tendency to feel strong pain sensation, there was even higher correlation between deqi and analgesic effect.

Looking into specific deqi descriptors, Kong et al. reported that soreness and numbness correlated with analgesic effect,[10] whereas numbness, aching, heaviness, fullness and burning were presently correlated with an analgesic effect. Numbness, aching, heaviness and fullness are all sensations that can be categorised into deqi sensations, not pain. The fact that burning, which falls under the category of pain sensation and not deqi, was related with an analgesic effect is noteworthy and needs consideration. There have been scientific studies concerning warm feelings as deqi sensation, but there was no indicator that took this into account in SASS. Therefore, some contemplation on what is deqi and what is acute pain is needed. In addition, the high correlation between numbness and analgesic effect is worth paying attention to.

Acupuncture induces stimulation to the human body, and it is important whether it is a negative or a positive one in uncovering what treatment effects acupuncture has. It is a traditional belief that stimulation of an incorrect acu-point or inappropriate needling techniques induces unpleasant acute pain that can be distinguished from deqi. Therefore, it can be anticipated that deqi, which follows beneficial effects of acupuncture treatment, plays an important role in demonstrating the effects of acupuncture. Deqi could also act as a unique indicator of positive effects of acupuncture, which means that acupuncturists should endeavour to present patients with deqi sensations such as numbness.

Are acupuncture techniques important? Depth and rotation

Several recent studies have concluded that deep needling is crucial for acupuncture sensation and is a more effective analgesic than superficial needling.[4,7] Other studies have found no difference in neural responses or therapeutic effect between shallow *versus* deep needling.[18,20,24] In this study, deep needling displayed a more pronounced acupuncture sensation than superficial needling, but in terms of analgesic effect there was no notable difference between the two. This leads us to infer that acupuncture treatment, whether superficial or deep needling, induces an analgesic effect, but depth is not related to the effect.

On the other hand, both acupuncture sensation and analgesic effect displayed significant increase with needle rotation. Langevin et al. found that needle rotation increases pull-out force through connective tissue winding, which modifies the biomechanical behaviour of soft tissue.[14]

A preliminary study reported that introduction of needle rotation significantly increased deep, dull, heavy sensations, but not pricking and sharp sensations.[22] Further, an Australian research group by Dr. Zaslawski reported the impact of needle manipulation on changes to PPT.[30] Our study has some limitation of not having the group of superficial needling with rotation. Even so, in this study, both PPT and acupuncture sensation were measured. As a result, we found out that needle rotation gave the most increase in aching and soreness, which are acupuncture sensation descriptors that have high correlation with analgesic effect. Moreover, analysis of the measurement results of overall intensity of acupuncture sensation, measured every minute, has shown that, because rotation was applied every minute, high acupuncture sensation was maintained with time. It can be assumed that continuous stimulation by rotation had effect on the increase of acupuncture sensation and analgesic effect. From the results of this study that applying manipulation would increase deqi sensation and treatment effect, the additional effect of electro-acupuncture, which continuously electrostimulates following acupuncture, is promising.

Conflict of interest

There are no conflicts of interest to report.

Acknowledgements

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