An experimental study on the self-report of acupuncture needle sensation during deep needling with bi-directional rotation

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ABSTRACT
Background Traditionally, acupuncturists manipulate needles to enhance sensations referred to as de qi or ‘acupuncture needle sensation’. Acupuncture needle sensations are complex and quantifying the experience has been difficult. The aim of this crossover study was to measure self-reported needle sensation during deep and bi-directional rotated needling in 15 healthy volunteers.

Methods Each participant received an experimental intervention consisting of superficial needling followed by deep needling and then deep needling with bi-directional rotation. The control intervention consisted of superficial needling, followed by mock deep needling and then mock bi-directional rotation of the needle. The intensity of overall needle sensation was measured using a visual analogue scale (VAS). The subjective acupuncture sensation scale was used to capture component sensations.

Results VAS scores were higher during ‘deep’ needle penetration when compared to superficial needling with mock deep insertion (p=0.0002). VAS scores were also higher during deep needling with bi-directional rotation compared to superficial needling with mock bi-directional rotation (p<0.0001). There were higher scores for total component sensation scores and for the sensation of throbbing during the deep needling with bi-directional rotation (p=0.001) when compared to superficial needling with mock bi-directional rotation. Tentative evidence that bi-directional needle rotation generated throbbing, heaviness, soreness and aching was also found.

Conclusion Bi-directional rotation of a needle inserted into deep soft tissue produced higher acupuncture needle sensation intensities when compared to superficial needle insertion with mock deep penetration and bi-directional rotation.

INTRODUCTION
Manual manipulation of acupuncture needles is commonly used in clinical practice to increase the intensity of stimulation in order to improve therapeutic effects. Manipulation techniques include deep insertion of needles into deep soft tissue and/ or bi-directional rotation of needles. The relationship between manual needle technique and acupuncture needle sensation is poorly understood.1 There is some evidence that deep needling may be more effective than superficial needling for shoulder and low back pain2 3 although a randomised controlled clinical trial involving 1162 low back pain patients found that deep acupuncture generated only ‘marginally’ superior pain relief than superficial acupuncture.4

Manual manipulation of acupuncture needles can evoke ‘de qi’ in patients.5 De qi is a term derived from traditional Chinese medicine to describe sensations experienced by the patient as a direct result of needling and to describe ‘needle grasp’ where the acupuncturist feels resistance to movement of a needle that has been inserted through the patient’s skin.5 More recently, the term ‘acupuncture needle sensation’ has been used to describe sensations experienced by the patient local to the inserted needle.6 It is claimed that acupuncture needle sensation may be an important determinant of acupuncture-induced pain relief yet surprisingly little research has been conducted to date.5 10 Kong et al5 conducted a pilot study on 11 healthy participants and found that reductions in experimental noxious thermal pain from manual and electroacupuncture were related to needle sensations of numbness and soreness but not stabbing, throbbing, tingling, burning, heaviness, fullness or aching. They used the Subjective Acupuncture Sensation Scale (SASS) to measure the self-report of needle sensation.

There has been limited research into the effect of different needling techniques on acupuncture needle sensation. Hui et al6 characterised needle sensations during manual acupuncture including rotation in 42 healthy volunteers and found that needle sensation was reported in 71% of participants and characterised by sensations of aching soreness pressure and dull pain. In an experiment on 65 healthy participants, Vincent et al7 claimed that deep needling with rotation was necessary to produce acupuncture needle sensation. Kou et al8 found that deep acupuncture with manual stimulation produced more intense sensations of numbness, pressure, heaviness, warmth and radiating paraesthesia when compared to superficial needling in eight healthy participants. Kong et al9 found that manual and electro acupuncture generated tingling, numbness, soreness and aching in 11 healthy participants. However, these studies were often unable to attribute sensations to components of manual needling techniques. Recently, it has been recognised that acupuncture needle sensation should be reported when describing acupuncture technique and dose.15 Consequently, there is a need to systematically investigate the effects of manual manipulation techniques on acupuncture needle sensation under controlled conditions. The aim of this experimental study was to compare the self-report of acupuncture needle sensation during deep needling and bi-directional rotation with superficial needling with mock deep needling and mock bi-directional rotation in healthy human adults.
METHODS
This study employed a crossover design where all participants received an experimental intervention in the form of a deep needle insertion followed by bi-directional rotation in one session and a control intervention in the form of superficial needle insertion with mock deep insertion followed by mock bi-directional rotation (figure 1).

Participants and recruitment
Ethical approval was obtained from Leeds Metropolitan University’s Faculty of Health Research Ethics Subcommittee. A convenience sample of 15 pain-free, healthy human volunteers aged over 18 was recruited from staff and students at the university using poster advertisements. Volunteers were given a participant information pack that explained they were invited to take part in two experiments comparing how sensations were perceived in response to two different types of acupuncture technique. No restrictions were placed on sex, ethnicity or previous acupuncture experience. Volunteers attended a familiarisation session during which they were screened and excluded if they had a chronic medical condition, a fear of needles causing severe anxiety or any skin disorders in the area surrounding the acupuncture point LI10. Volunteers were invited to take part in the experiments and were given a minimum of 48 h to consider whether they wished to participate.

Procedures
Participants took part in two identical experiments where they received an ‘experimental’ intervention in one experiment and a control intervention in the other (see later). Before the start of the first experiment participants provided written consent and were told that they could withdraw consent at any time and without reason. They were told that needling may produce sensations and that these may cause some discomfort and that they could ask the investigator to stop the procedures at any time without affecting the results. Computerised unconstrained randomisation was used to determine the order of the experimental and control interventions. A washout period of more than 72 h was used between interventions to allow any minor bruising resulting from the needling during the first experiment to subside. It was planned that the second experiment would be postponed to a later date if any tenderness or bruising was still present, although this did not happen for any participant.

Each experiment consisted of six cycles, each lasting 5 min. Recordings of acupuncture needle sensation using a 100 mm visual analogue scale (VAS) and the SASS were taken during the fourth minute of each cycle (figure 2). A single acupuncture needle was inserted during the first three cycles. During the first cycle the acupuncture needle was inserted superficially in both experimental and control interventions (superficial condition). During the second cycle the acupuncture needle was inserted more deeply in the experimental intervention and a mock deep insertion performed in the control intervention (deep condition). During the third cycle the acupuncture needle was bi-directionally rotated in the experimental intervention and a mock bi-directional rotation performed in the control intervention (rotation condition). Acupuncture needles were removed at the end of the third cycle and recordings taken at 5, 10 and 15 min after the needle had been removed.

During each experiment participants sat on a plinth with their head elevated and their non-dominant hand supported on a table to the side of the plinth. A small screen was placed above the participant’s elbow preventing them from viewing the acupuncture needle in situ thereby blinding them to the different acupuncture interventions. The principal investigator (AB) is a physiotherapist and trained Western acupuncturist with over 2 years experience, administered all acupuncture and was not blind to the intervention group.

Interventions
During each intervention a single sterile, disposable acupuncture needle (C&G, UK) was inserted through the skin at LI10 of the non-dominant forearm using a guide tube. LI10 was chosen because it is claimed to be a good point to elicit acupuncture needle sensations and is centrally located on the forearm enabling sensations to be recorded in all directions from needle insertion (ie, distal and proximal). Needles with identical diameters were used for both interventions (0.25 mm). However, a short needle was used for the control intervention (25 mm) when compared to the experimental intervention (40 mm). This was to ensure that the control needle, which remained superficially inserted throughout the first three cycles, remained perpendicular to the skin and did not accidently fall out under the momentum of a longer shaft.

The superficial condition (cycle 1) was identical for experimental and control interventions. The needle was inserted superficially to a depth of approximately 5 mm by comparing the dif-
ference in length of the respective needle and the top of the guide tube, which was 5 mm.

During the deep condition (cycle 2) the superficial needle was inserted deeper into the soft tissues to a depth of approximately 15–25 mm for the experimental intervention. This was achieved by attempting to insert the 40 mm needle to approximately half of its length in all participants. For the control intervention a ‘mock deep insertion’ of the needle was performed yet the depth of needle insertion remained superficial. This was achieved by handling the participant in an identical manner to the experimental intervention but without touching the needle in any way. A screen was used to hide the needle and investigators lower arm from view of the participant giving the impression that the investigator was manipulating the needle.

During the rotation condition (cycle 3) the deeply inserted needle in the experimental intervention was rotated 360° in a clockwise followed by a rotation of 360° in an anticlockwise motion at approximately two rotations per second (ie, 2 Hz) for a period of 30 s. This was followed by 30 s of no rotation. This procedure was repeated for the first 4 min of the cycle. A mock bi-directional rotation of the needle was performed during the control intervention by the investigator rolling a guide tube between the thumb and index finger. The guide tube did not touch the participant’s skin and the investigator’s lower arm remained behind a screen and out of view of the participant. The needle was not touched in any way during the mock procedure.

**Outcome measures**

During each cycle participants were asked to quantify the overall intensity of acupuncture needle sensation on a 100 mm 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). They also completed the SASS which uses 100 mm VAS to record the intensity of the following acupuncture needle sensations; stabbing, throbbing, aching, tingling, heaviness, soreness, numbness, fullness and burning. Participants recorded needle sensations onto paper sheets that remained out of view from the principal investigator until the end of the experiment.

**Data analysis**

The overall intensities of needle sensation recorded using VAS and total SASS (score out of 900) were normally distributed for each of the six conditions (p>0.05, Shapiro–Wilks test). Paired t tests were used to detect differences in VAS and total SASS scores between the interventions for all conditions with the significance level set at p<0.008 following Bonferroni correction (α=0.05/6). Differences in VAS scores between experimental and control interventions were plotted for each participant to explore response profiles across the experiment. Differences in total SASS scores between interventions were analysed with paired t tests for the rotation condition with statistical significance set at p<0.005 following Bonferroni correction (α=0.05/9).

**RESULTS**

Fifteen volunteers (eight male) with a mean age of 27.07 years (SD 5.91) fulfilled the eligibility criteria and completed both experimental sessions (figure 1). No adverse effects were reported during the study.

**Overall intensity of needle sensation**

Similar response profiles for participants (in overall intensity) were observed during the experiment (figure 3). No statistically significant differences in scores of overall acupuncture needle sensation intensity were found between the interventions during the superficial condition when measured by VAS (p=0.31) or by SASS (p=0.276, table 1). Deep insertion of the needle in the experimental intervention produced significantly higher needle sensation intensity scores (VAS) when compared to mock deep penetration in the control intervention (p=0.0002, deep condition, cycle 2). However, total SASS scores did not reach statistical significance during the deep condition (p=0.048, α=0.008 following Bonferroni correction). Bi-directional rotation of the deeply inserted needle (experimental intervention) produced significantly higher scores for VAS (p<0.0001) and total SASS (p=0.001) when compared to mock bi-directional rotation of the superficial needle (control intervention) during the rotation condition (cycle 3). No statistically significant differences in VAS or total SASS were detected between interventions at 5, 10 or 15 min after the needles had been removed.

**Needle sensation descriptors**

Summary data for the mean difference in SASS scores for the nine SASS descriptors across the experiment are provided in figure 4. During the rotation condition there were higher SASS scores of throbbing (p=0.002) for the experimental intervention when compared to the control intervention (figure 5). Although higher scores were noted for the experimental intervention for stabbing (p=0.02), tingling (p=0.039), heaviness (p=0.027), soreness (p=0.014) and aching (p=0.009) these failed to reach statistical significance following Bonferroni correction (α≤0.005).

**Table 1** Mean (SD) scores for overall acupuncture needle sensation measured using VAS on a 100 mm VAS and the total summed scores of the nine sensations of the SASS each measured on 100 mm VAS (maximum score 900 mm)

<table>
<thead>
<tr>
<th>Experimental condition</th>
<th>Superficial condition</th>
<th>Deep condition</th>
<th>Rotation condition</th>
<th>5 min after needle removed</th>
<th>10 min after needle removed</th>
<th>15 min after needle removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental intervention VAS (SD)</td>
<td>6.67 (5.90)</td>
<td>28.80 (18.43)</td>
<td>61.73 (18.64)</td>
<td>16.13 (18.12)</td>
<td>9.32 (11.90)</td>
<td>5.53 (9.59)</td>
</tr>
<tr>
<td>Control intervention VAS (SD)</td>
<td>9.60 (9.88)</td>
<td>8.40 (12.03)</td>
<td>5.67 (9.32)</td>
<td>3.13 (5.22)</td>
<td>3.33 (8.02)</td>
<td>2.53 (6.72)</td>
</tr>
<tr>
<td>Difference VAS (SD)</td>
<td>−2.93 (10.91)</td>
<td>20.40 (15.85)</td>
<td>55.67 (20.03)</td>
<td>13.00 (19.77)</td>
<td>6.00 (15.67)</td>
<td>2.80 (9.07)</td>
</tr>
<tr>
<td>p Value</td>
<td>0.31</td>
<td>0.0002*</td>
<td>0.0001*</td>
<td>0.02</td>
<td>0.16</td>
<td>0.25</td>
</tr>
<tr>
<td>Experimental intervention total SASS (SD)</td>
<td>14.33 (17.65)</td>
<td>67.40 (75.64)</td>
<td>148.80 (117.96)</td>
<td>61.93 (75.64)</td>
<td>28.00 (30.34)</td>
<td>22.73 (26.80)</td>
</tr>
<tr>
<td>Control intervention total SASS (SD)</td>
<td>28.47 (51.06)</td>
<td>67.40 (33.86)</td>
<td>21.87 (38.07)</td>
<td>4.73 (9.36)</td>
<td>6.93 (11.60)</td>
<td>4.60 (11.39)</td>
</tr>
<tr>
<td>Difference total SASS (SD)</td>
<td>−14.13 (48.33)</td>
<td>40.03 (73.11)</td>
<td>126.93 (124.72)</td>
<td>57.20 (79.31)</td>
<td>21.07 (37.12)</td>
<td>18.13 (30.01)</td>
</tr>
<tr>
<td>p Value</td>
<td>0.276</td>
<td>0.048</td>
<td>0.001*</td>
<td>0.014</td>
<td>0.045</td>
<td>0.035</td>
</tr>
</tbody>
</table>

*Statistically significant finding after Bonferroni correction.

SASS, subjective acupuncture sensation scale; VAS, visual analogue scale.
DISCUSSION

To our knowledge, this is the first study to have recorded the self-report of the overall intensity of acupuncture needle sensation in response to deep and bi-directional rotation of a needle in comparison to superficial insertion of a needle followed by mock deep insertion and mock bi-directional rotation. Higher overall acupuncture needle sensation intensity scores were found during insertion of a needle to a depth between 15 and 25 mm into the soft tissue of the forearm when compared to a needle inserted to ~5 mm and during bi-directional rotation when compared to mock bi-directional rotation. Bi-directional rotation of a needle inserted into deep soft tissue produced a higher intensity of a throbbing sensation when compared to superficial needle insertion with mock bi-directional rotation. There was tentative evidence that bi-directional rotation of a needle inserted into deep soft tissues generated higher needle sensation intensities for stabbing, tingling, heaviness, soreness and aching.

Our findings build on previous studies that have captured the experience of needle sensation using a variety of sensation scales. These studies report similar findings to ours that needle sensations associated with insertion of needles into deep soft tissue, include throbbing, stabbing, heaviness soreness and aching with the intensities of these sensations increasing during rotation of the needle.\(^5\)\(^9\)\(^15\)\(^\text{-}17\) Kou et al\(^12\) found that deep acupuncture generated higher intensities of acupuncture needle sensation ratings of numbness, pressure, heaviness, warmth, radiating paraesthesia when compared to superficial needling in eight healthy participants. In our study, throbbing and to some extent stabbing, tingling, heaviness, soreness and aching were associated with bi-directional rotation of a needle inserted into deep tissues. However, anecdotes taken during experimental debriefing found that some participants found it difficult to distinguish individual sensations on the SASS and this may have compromised the cumulative score of total SASS. It was noticeable that data for total SASS tended to cluster in the lower third of the range of possible total SASS scores. In contrast, scores of overall intensity taken from VAS were spread across the entire spectrum of the 100 mm scale. Thus, we suggest that ‘overall’ acupuncture needle sensation recorded using a simple 100 mm VAS may be a more reliable measure of overall intensity of acupuncture sensation compared with total SASS score.

Our findings support earlier work by Vincent et al\(^11\) that deep needling with rotation stimulation produced acupuncture needle sensation. However, we found that 5 of 15 participants reported the intensity of overall acupuncture needle sensation of 10 mm or more on the VAS suggesting that acupuncture needle sensations can be evoked by superficial needle insertion without additional manipulation. Recently, Hui et al\(^9\) characterised the frequency and intensity of needle sensations in 42 healthy volunteers and reported that manual acupuncture including rotation produced sensations in 71% of the participants compared to 21% receiving non-invasive tactile stimulation (von Frey hairs). The proportion of sensations achieved during tactile stimulation (von Frey hairs) was similar to our control intervention using needle insertion to a depth of ~5 mm. Likewise, a pilot study by Kong et al\(^5\) in 11 healthy participants found that manual, electro and placebo acupuncture generated tingling, numbness, soreness and aching, although they did not isolate the contributions of manual needling techniques.

The increased intensity of sensations observed in our study during bi-directional rotation compared to deep needling alone.
may be attributed to connective tissue fibres being caught around the tip of the needle, stimulating intramuscular primary afferent nerve fibres. 6 Mense 18 suggested that stimulation of intramuscular afferent nerve fibres that convey noxious and non-noxious information generates a non-localised dull, aching sensation. A particularly interesting observation in our study was the apparently sustained nature of the aching sensation 15 min after removing the needle, which we speculate may be a result of activity in intramuscular fibres. Electrophysiological studies have shown that electrical stimulation of deep afferent nerves generates a stronger and prolonged inhibition of central nociceptive cells compared to superficial afferents. 19–21 Therefore, it seems plausible that more intense needle sensations associated with deep insertion of a needle may be indicative of superior pain relief in humans. 1–10 Experimental evidence for this hypothesis is not forthcoming as yet although Kong et al 5 found that hypoalgesia to experimentally induced thermal pain was positively correlated with increasing intensity of rating of numbness and soreness, but not with other needle sensations in a study using in 11 healthy participants.

One shortcoming of our study was a failure to record whether participants could correctly identify experimental and control interventions. It is possible that participants inflated reports of acupuncture needle sensation during the experimental intervention although we are confident that our procedure for keeping manipulation techniques out of view of the participant was successful. This would reduce reporting bias because the participant could not see that the investigator was performing mock insertion and mock rotation techniques. However, as the interventions produced different sensations we cannot discount the possibility that participants may guess that the intervention that generated the strongest sensation was likely to be the experimental intervention. However, they would only be able to do this once they had undertaken both experiments so we believe that this would limit the impact of such bias on the findings.

In conclusion, bi-directional rotation of a needle inserted 15–25 mm into deep soft tissues produced a higher intensity of overall acupuncture sensation when compared to a needle inserted through the skin to a depth of 5 mm with mock deep needle insertion and mock bi-directional rotation. Throbbing was the main acupuncture needle sensation with tentative evidence that sensations of stabbing, tingling, heaviness, soreness and aching were also involved. Most of these sensations disappeared within 5 min following removal of the needle.

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**Competing interests** None.

**Ethics approval** This study was conducted with the approval of the Leeds Metropolitan University, Faculty of Health Research Ethics Sub-committee.

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Detail has been removed from this case description or these case descriptions to ensure anonymity. The editors and reviewers have seen the detailed information available and are satisfied that the information backs up the case the authors are making.

**REFERENCES**

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