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Original Article

Assessment of retention of training in improving the accuracy of needle penetration depth

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Abstract. [Purpose] This study aimed to assess whether the effects of training in fine motor skills, such as improving the accuracy of acupuncture depth, persisted after the training was completed. [Participants and Methods] Fifteen students (age, 28.0 ± 8.4 years) participated in the study. A 0.2 × 50 mm needle was inserted, as precisely as possible, against an acupuncture training gel at a depth of 15 mm. After explaining how to check the distance using their fingers as indicators and how to use a guide piece to check for depth, the students were instructed to train independently for two weeks. Error distance of the acupuncture depth was evaluated before the training (beginning of the training) and at training 1 (training for 7 days), training 2 (training for 14 days/end of training), and post-training (28 days after training 2). [Results] The error distance (absolute value) from 15 mm in training 1, training 2, and post-training decreased significantly compared with those before the training. The error distance was not significantly different between post-training and training 2. [Conclusion] After two weeks of acupuncture training, the error distance decreased significantly, suggesting that this technique was retained after 28 days of completing the training.

Key words: Retention of training, Fine motor skill, Needle penetration depth

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INTRODUCTION

Medical curricula must teach students the necessary diagnostic and therapeutic skills. However, simply performing the same movement multiple times is not sufficient to achieve this. In joint range of motion measurements, simple repetitive training for three weeks did not significantly change the measurement error before and after training[1)]. However, techniques can be improved with appropriate feedback[2, 3)].

Studies examining basic training of fine motor skills in medical fields have examined educational programs in Surgical Knot-Tying Technique for physicians[4)], the development of a knot-tying and suturing curriculum[5)], a comparison of experienced and unskilled physical therapists using a shoulder joint external rotation limitation model[6)], methods and effectiveness of blood collection skills for nursing students and new nurses[7)], reviewing the comparison of intravenous placement skills among experienced and new nurses[8)], and others. Thus, there have been attempts to evaluate skills and provide effective instruction. However, the effectiveness of repeated training is often evaluated at the end of a lecture or educational program, and few studies have examined whether these skills are retained over time.

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In acupuncture, thin needles are inserted into a living body. Improving the accuracy of acupuncture depth is one of the most important tasks for acupuncturists, not only to achieve the therapeutic effects of reaching different tissues at different sites and depths[9] but also to avoid medical malpractices, such as pneumothorax.

We have shown practitioners' accuracy of acupuncture depth can be improved through two weeks of instruction and training using a method where the depth of the acupuncture needle is determined by its upper end touching the practitioner's finger[10]. However, whether this effect persists after the training completion remains unclear.

Therefore, in this study, we conducted training to improve the accuracy of acupuncture depth and evaluated how the effects of the training persisted after completion.

PARTICIPANTS AND METHODS

The participants included 15 acupuncture students (12 men and 3 women; mean age: 28.0 ± 8.4 years). Participants were second-year students in a three-year vocational training course of a school for the visually impaired who had completed practical training in basic acupuncture techniques. Five participants were completely blind, ten were partially sighted, and all were right-handed. The participants were informed of the purpose and methods of the study and the voluntary nature of their participation before the study began. Their written consent to participate was obtained. This study was conducted with the approval of the Human Research Ethics Committee, University of Tsukuba (Approval No.: East 25-46).

The needles used were 0.20 mm × 50 mm No. 18 disposable stainless-steel needles (Seirin Co., Ltd., Shizuoka, Japan) and are widely used in educational and clinical settings. The body of the needle, which is inserted into the human body, is 50 mm; the handle, which is the part held by the hand and used to manipulate the needles, is 20 mm; the total length is 70 mm.

The object on which the needles were inserted was the Unico Acupuncture Training Gel Type V (Nissin Medical Devices Co., Ltd., Aichi, Japan), which is used for acupuncture manipulation and repetition exercises. It is used at the initial stage of basic acupuncture training before students needle a human body and is available in several schools and training facilities. It is made of six gel sheets, 90 mm wide, 60 mm deep, and 7 mm thick, stacked on top of each other, and has moderate elasticity.

The depth of penetration of an acupuncture needle is the total length of the acupuncture needle subtracted by the length of the uninserted portion. The length of the part of the needle that is not inserted can be estimated or read visually by holding a ruler or object of a certain length against it. This study used a customized guide piece[10], which was 6 cm × 6 cm × 2 cm. The top surface of the guide piece was staircase-shaped at 5 mm intervals. When the needle was parallel to the inserted acupuncture needle, the length of the uninserted portion was ascertained by checking the positional relationship between the top of the acupuncture needle and the top surface of the guide piece.

The process of the training was as follows. Seven days before training (control) started, a physical profile was obtained from each participant, and the acupuncture depth accuracy was measured. On the first day of training (before training), participants were given a demonstration and explanation of the repetition training method. The acupuncture depth accuracy was measured for Before, Training 1 (Day 7), during Training 2 (Day 14, the last day of training), and Post Training (28 days after Training 2).

The participants' profile questionnaires recorded their age and sex. They were also asked to complete the Edinburgh Handedness Test[11] with their dominant hand in a self-administered form, which was collected directly from them.

The acupuncture depth task was performed three times during each measurement. On the examiner's cue, participants were asked to perform acupuncture needling at a target depth of 15 mm at an arbitrary site on the training gel. The target depth was set at 15 mm because the Acupuncture and Moxibustion Safety Committee has set a safe depth of 19 mm for acupuncture points in the interscapular region, which is frequently used for acupuncture treatment[12]. We verbally informed the patients in advance that the needles would be inserted with an awareness of not exceeding 15 mm and that they should not pull them up. The depth of acupuncture was measured by placing a 3 cm × 7 cm piece of cardboard parallel to the inserted needles, fixing the needles to it with cellophane tape, pulling the needle from the gel, and measuring the portion not overlapping the cardboard with a scale as the penetration depth[10]. The time participants took to complete the activity was measured to the nearest tenth of a second using a stopwatch according to the examiner's signal. The activities included in the measured time were removing the needles from their packaging, inserting them into the skin using a guide tube, plugging them into the body, and returning hands to the desk after the needles were inserted with both hands on[10].

The repetitive training task proceeded as follows. At the beginning, the researcher demonstrated the training method. First, the fingertip used for insertion (index or middle finger) was propped against the gel in the vicinity of the needles inserted 15 mm apart, and the participants were asked to remember where the top of the needles touched their fingers. When inserting needles during training, they were instructed to use the point touched by their finger as a guide. Each time they inserted an acupuncture needle, they were instructed to place a depth guide piece near the acupuncture needle and touch the height of the top of the needle and the guide piece to check the positional relationship and confirm whether the insertion depth was appropriate[10]. Outside the class, self-training was assigned to practice at least once a day for two weeks. The training involved inserting needles to a depth of 15 mm, passing through a 6 mm diameter hole made in a hard rubber sheet, inserted 7 mm below the surface of the acupuncture training gel.

The changes in absolute error value were analyzed, from 15 mm and time for 45 trials of 3 times per person, with 15 people, for Control, Before, Training 1, Training 2, and Post training. Posthoc tests were performed using the Wilcoxon t-test

with Bonferroni correction. In all cases, the significance level was set at 5%. All statistical analyses were performed using the SPSS ver. 27, Japanese version (IBM Japan, Tokyo, Japan).

RESULTS

All 15 participants were able to implement the instructed training methods and completed the 2-week self-training instructions.

The absolute error values from 15 mm and the acupuncture time are shown in Table 1.

At the start of training (Before), the acupuncture depth was 18.4 ± 3.5 mm, the error distance from 15 mm was 4.2 ± 2.5 mm, and the required time was 33.6 ± 11.5 seconds. At the end of the 2-week training (Training 2), the acupuncture depth was 15.7 ± 1.5 mm, the error distance from 15 mm was 1.3 ± 1.0 mm, and the required time was 28.9 ± 17.7 seconds. Twenty-eight days after the training ended (Post training), the acupuncture depth was 16.0 ± 1.7, the error distance from 15 mm was 1.5 ± 1.3 mm, and the required time was 28.9 ± 13.9 seconds.

The acupuncture accuracy and required time differed significantly between Before and Training 2 and Before and Post training ($p<0.05$). However, participants' accuracy and required time did not differ significantly between Training 2 and post-Training.

There were no significant differences between the Control and Before; by contrast, there were significant differences between Control and Training 1, Control and Training 2, and Control and Post training. There were significant differences between Before and Training 1 but none between Training 1 and Post training.

DISCUSSION

Training methods for improving acupuncture depth accuracy have been shown in previous studies[10, 13]. However, the evaluations were only made for the period immediately after training, and the long-term outcomes of training after the training period were unknown. It was unclear whether these skills become ingrained once they are learned, or whether they are forgotten if not periodically revised. The results of this study showed that accuracy improved to an average error of 1.5 mm after one week of teaching the practice method and self-practice and that participants' ability to use this technique was maintained even 28 days after the end of the practice period.

This study described a method for checking acupuncture depth by checking the depth at which the acupuncture needle touches the finger. This method was devised to teach visually impaired people[10]. Although both visually impaired and sighted acupuncturists practice in Japan, acupuncture and moxibustion anma schools for the visually impaired have existed since the 1600s. They developed diagnosis and treatment through training in palpation and touch confirmation.

Some people complain of uneasiness about receiving acupuncture treatment from a visually impaired practicioner[14]; however, a comparison of acupuncture depth accuracy between blind and sighted teachers showed that the blind teachers were more accurate. Thus, this is considered to be an individual difference rather than a difference based on whether the practitioner has vision[3].

The needle depth can be estimated from the length of the uninserted area, which is often visually confirmed. However, this is not always accurate because visual confirmation can include human errors in perception. In addition, because the patient must remove their hand from the inserted needle and check it visually, they must repeat the process of manipulation and visual inspection to adjust the length of the needle.

By contrast, the method taught in this study involves placing one's finger near the acupuncture needle to check where the upper end of the needle touches the hand and then placing the reference piece in the same manner and checking whether the height of the reference piece is the same as that of the upper end of the acupuncture needle. The visually impaired practitioner can use their fingers or other body parts when measuring dimensions[15]. Since the tactile sensation of one's own fingers is used as the standard, the reproducibility of this method is high. Additionally, the depth can be checked with the finger inserted without removing the hand from the acupuncture needle.

Table 1. Effect of training on improving accuracy of acupuncture depth

	Acupuncture depth	Error distance with 15 mm (mm)	Time required (seconds)
Control	19.5 ± 3.2	4.7 ± 2.9	37.6 ± 15.3
Before	18.4 ± 3.5	4.2 ± 2.5^{*1*2*3}	33.6 ± 11.5^{*4*5*6}
Training 1	15.5 ± 1.6	1.5 ± 0.9^{*1}	29.7 ± 14.8^{*4}
Training 2	15.7 ± 1.5	1.3 ± 1.0^{*2}	28.9 ± 17.7^{*5}
Post training	16.0 ± 1.7	1.5 ± 1.3^{*3}	28.9 ± 13.9^{*6}

The task was to insert the needle at a target depth of 15 mm.
$^{*1–6}$: $p<0.05$.

The study suggested that checking the acupuncture depth using finger touch is an accurate, simple procedure and a method that is retained even after one month of training. This method could likely be used by sighted people.

There were limitations to our study. First, the number of eligible students was limited owing to the small number of students being taught at the school for the blind. Second, we only investigated medium-term retention at 4 weeks after training.

The average error recorded in this study was 1.5 mm within one week, and the same accuracy was maintained for 28 days after the 2-week training period ended. The results showed that the technique of accurate depth of target penetration could be acquired and maintained in a short period using our instructional method. Future studies could follow up on the long-term durability of the acquired skills. This study and any related follow-up study could also be useful in developing a curriculum with long-term skill retention.

Conflict of interest

There are no conflicts of interest to declare.

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