Analysis of the Skills to Acupuncture

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Abstract. In Japan, health care has been carried out by Western medicine, but acupuncture has been handled in a different form from the health care system of Western medicine. Not only doctors and dental doctors, but also acupuncturists have rights to practice. Therefore, Japanese acupuncture is responsible for the treatment of disease and the health maintenance and promote. Japanese acupuncture has been widely used in a variety of diseases and symptoms in the medical field. In addition, since acupuncture be performed using a simple means, it is possible also performed in an area that does not meet the medical institutions. For acupuncture, in order to play a role in the medicine, it is necessary to academic support, and it is required the achievements and steady research. Although it has been accumulated research results with respect to the reaction of the body caused by acupuncture, there is not research relating to the operation of acupuncturists to acupuncture. Therefore, the purpose of this study is to target acupuncture with advanced technology, and it was performed motion analysis. As a result, we clarified the acupuncture motion skill of high-skilled acupuncturist.

Keywords: Acupuncture · Motion analysis · DLT method · z component · z coordinate

1 Introduction

Acupuncture and moxibustion have a history of 1500 years, and within that span Japanese acupuncture and moxibustion developed in their own unique way. In the mid-Edo period, around the 18th century, a painless method of inserting the needle (the needle-tube method, where a pipe encompasses the needle, which is inserted by tapping with the finger) was invented for acupuncture treatment [1–10]. Many years of clinical acupuncture and moxibustion led to the knowledge that if the insertion is made in the skin at high speed, then there is close to no pain. The insertion speed was never measured, but was passed on experientially. We used skin like material and a three-dimensional high-speed camera to record the motion of insertion, with the objective of quantitatively evaluating the speed of needle insertion. To investigate the factor of experience, we used as participants an experienced acupuncturist and a beginner.

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2 Method

2.1 Participants

The participants of the investigation were one acupuncture/moxibustion teacher (experienced: Expert) and one student enrolled at an acupuncture college (inexperienced: Non-expert). The experienced person was a 66-year-old male who had 30 years of clinical experience with acupuncture/moxibustion. The inexperienced person was a 26-year-old female who was a third-year student at the school of acupuncture and moxibustion and had just acquired foundational learning. Thorough explanations of the experiment were given to the test participants beforehand, and their consent was attained about their participation.

2.2 Environment of the Experiment and Experimental Procedure

The experiment was done indoors. A reflective marker with a diameter of 5 mm was put on the participants' right index fingernail. Four high-speed cameras (made by Dragonfly Express Point Grey Research Inc, recording speed 200 frames per second, exposure time 1/1000 s) were set in place, one each on the left side, right side, left front, and right front of the participant, to record their motions.

In the experiment, a sponge fixed atop a table was used as substitute for a human body, and the test participants were made to go through the motion of inserting a needle in it using an acupuncture tube. A reflective sheet was attached 5 mm to 15 mm from the head of the needle. To accustom the participants to the conditions of the experiment, at most three practice trials were made, and motions of 10 trials were recorded.

For the inexperienced person, after the simulated experiment using a sponge, four trials were made using an acupuncture tube to insert a needle into an actual human arm.

The images recorded were synchronized on a computer, and the coordinates were calculated using a video motion analysis system (Frame: DIAS IV, made by DKH). The time from when the index finger commenced rising to the end of the tapping and insertion was the section for analysis, and the central point of the reflective sheet attached to the needle and the reflective marker on the nail of the right index finger of the target person were digitized (Fig. 1). A three-dimensional frame of reference was made using the three-dimensional DLT method from the coordinates on the photographic images of 20 pre-recorded calibration points and the actual distances between them, and the coordinates of the index finger and needle were calculated. The direction to the right from the participant in a ready position was made the x axis, the front side of the participant the y axis, and the vertical direction the z axis.

3 Results and Discussion

Figure 2 shows the z coordinates of the reflective markers on the fingertip during the time of needle insertion. The time when the finger touched the needle was set as zero. The locations of the finger marker are shown in chronological order for the motion of insertion by the experienced person. It can be seen that the experienced person

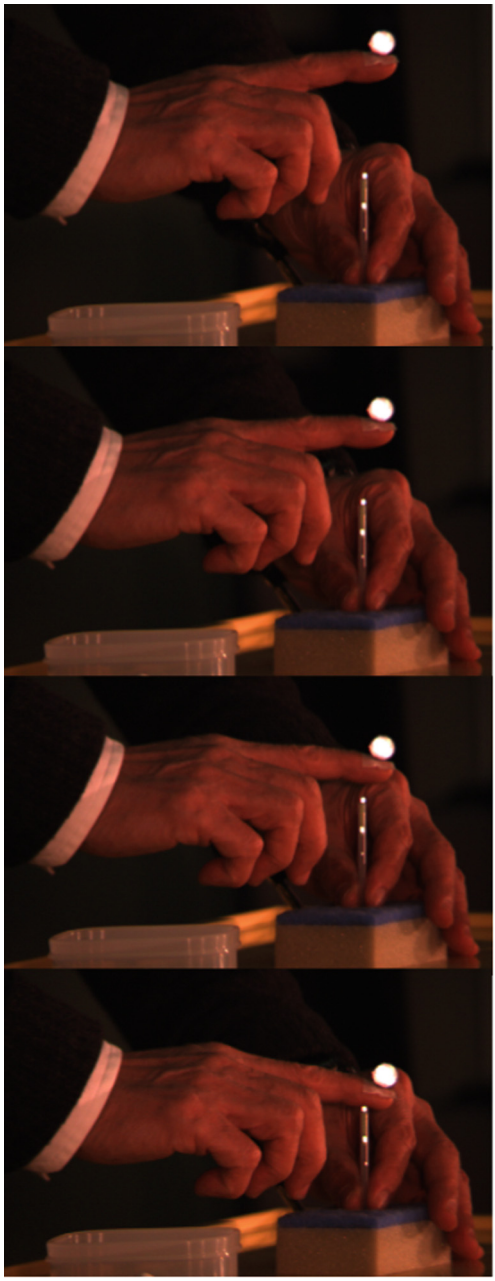

Fig. 1. Recorded images

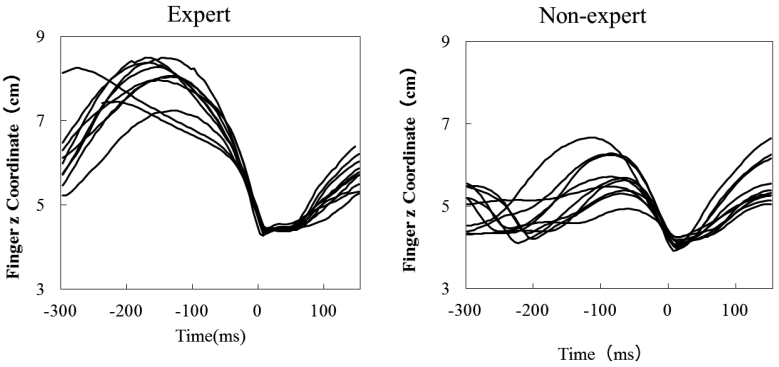

Fig. 2. Movement of the finger during needle insertion

performs the insertion from a higher point compared to the inexperienced person. The value of the difference in z coordinates from the highest point until the point of contact with the needle for the experienced person was 3.70 ± 0.41 cm, and for the inexperienced person 1.73 ± 0.35 cm; compared to the inexperienced person, the experienced person's value was significantly larger. The time required to approach the highest point for the experienced person was 170 ± 45 ms, and for the inexperienced person 150 ± 102 ms; there was no significant difference between the two (Fig. 3).

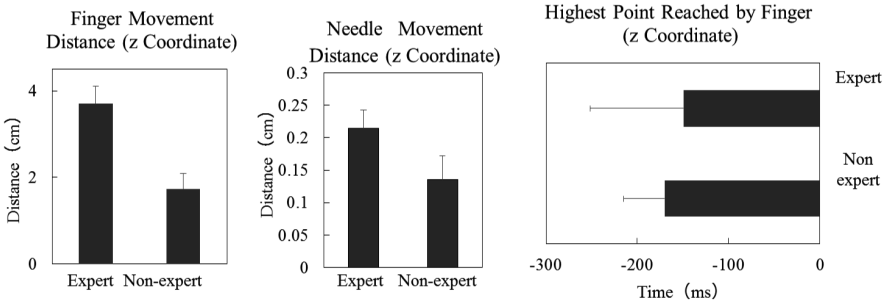

Fig. 3. Comparison of movement distance and time of highest point reached

Next, the z coordinates of the reflective sheet on the needle during the insertion are shown in chronological order (Fig. 4). The movement distance of the needle for the experienced person was 2.14 ± 0.03 mm, and for the inexperienced person it was 1.35 ± 0.04 mm; compared to the inexperienced person, the value of the experienced person was significantly longer.

Figure 5 shows the average value of the 10 trials for the movement of the needle and movement of the finger differentiated between the experienced and inexperienced persons. Figure 6 shows the average value of the 10 trials in terms of the z component of the speed of the finger differentiated between the experienced and inexperienced

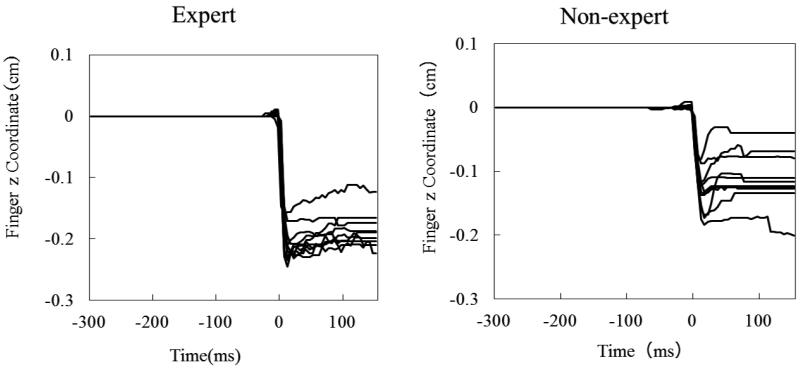

Fig. 4. Movement of needle during time of insertion

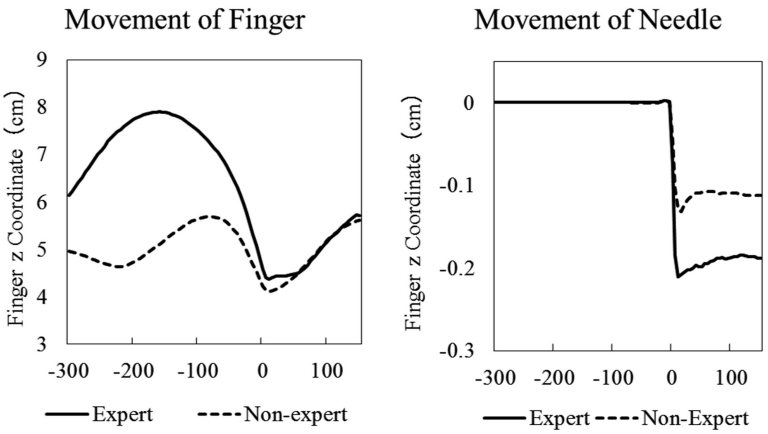

Fig. 5. Movement of finger and needle

persons. With the inexperienced person, the highest speed just before the finger came in contact with the needle was an average of −31.4 cm/s, but with the experienced person the value was at −49.5 cm/s which was 1.5 times faster. Figure 7 shows the z component in terms of the speed of the needle. The highest value of the movement speed of the needle for the inexperienced person was −11.5 cm/s, but for the experienced person it was −21.7 cm/s which was about twice as fast.

Figures 8 and 9 shows the results of the comparison of the simulation using a sponge vs actually inserting a needle into a real person. For the simulation, the average value of 10 trials is shown, but for the insertion in an actual person the average value of 4 trials is shown. Because the number of insertions in an actual person was small there is influence of noise, but as there was no great difference between the two trials, it can be said that the method used was adequate.

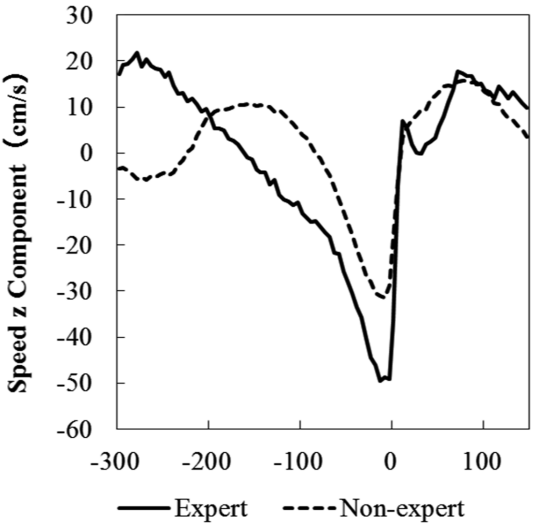

Fig. 6. Speed of finger

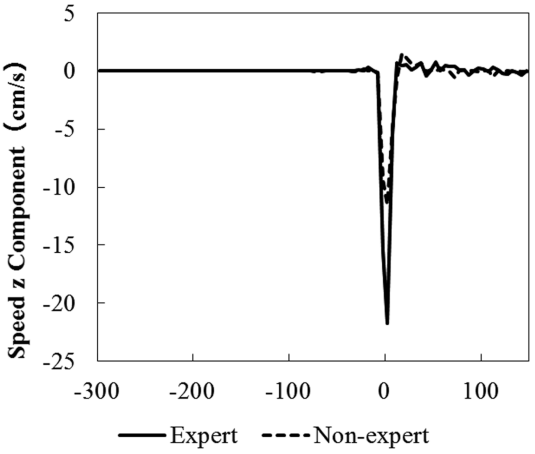

Fig. 7. Speed of needle z component

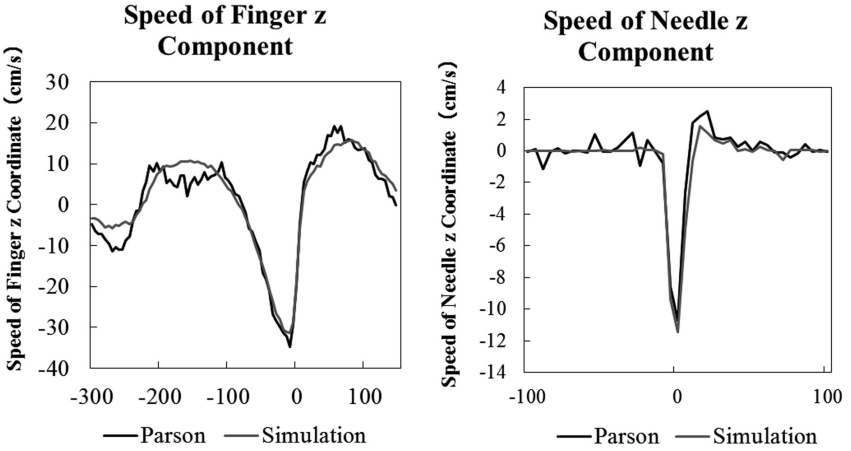

Fig. 8. Comparison of simulated experiment vs insertion into real person

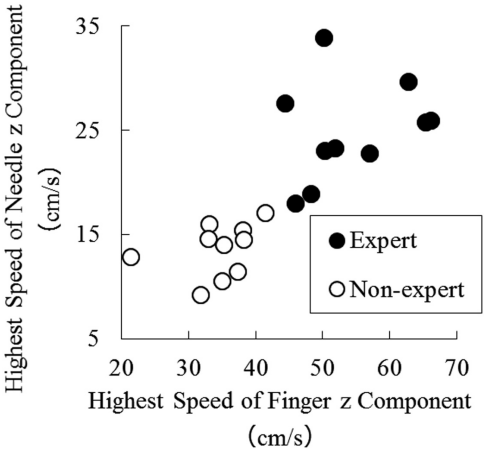

Fig. 9. Relationship between the movement of finger and movement of needle

4 Conclusion

In order to clarify the skill of acupunctures' needle insertion, we recorded the motion of insertion. As a result, the highest value of the movement speed of the needle for the Inexperienced person was −11.5 cm/s, but for the experienced person it was −21.7 cm/s which was about twice as fast. For the first time of the world, we were able to measure the movement speed of acupuncture needle.

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