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Influence on Probe Reaction Time of Rhythmic Stabilization during Sitting

MING HUO, PT, PhD[1)] KE YIN, PT[2)], DESHENG LI PT[3)], HITOSHI MARUYAMA, PT, PhD[1)], SUMIKAZU AKIYAMA, PT, PhD[1)]

[1)]*Department of Physical Therapy, Faculty of Health Science, International University of Health and Welfare: 2600–1 Kitakanemaru, Ohtawara City, Tochigi, 324-8501 Japan. TEL: +81 287 24 3000, E-mail: huoming@iuhw.ac.jp*
[2)]*Jilin Province Rehabilitation Center*
[3)]*China Rehabilitation Research Center*

Abstract. [Purpose] This study examined the influence of the probe reaction time on sitting stability during rhythmic stabilization. [Subjects] The subjects were divided into two groups of thirty-three elderly subjects (70.0 ± 6.0 years), and ten younger subjects (22.4 ± 2.8 years). [Methods] We evaluated the simple reaction time, the probe reaction time during rhythmic stabilization, and the resistance force of rhythmic stabilization. [Results] The probe reaction time was significantly longer than the simple reaction time in both groups. The resistance force of rhythmic stabilization decreased in the Elderly group compared with the Younger group. Partial correlation analysis gave correlations of $r = 0.87$ for the probe reaction time, $r = 0.87$ for the simple reaction time, $r = -0.34$ for the probe reaction time and the resistance force, and $r = 0.80$ for the probe reaction time and the ΔRT (ΔRT= probe reaction time - simple reaction time). [Conclusion] The results suggest that not only the trunk muscle force but also the attention are factors influencing the sitting stability.
Key words: Probe reaction time, Rhythmic stabilization, Sitting stability

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INTRODUCTION

Improvement of the balance function is important for preventing falls by the elderly. The rhythmic stabilization (RS) of proprioceptive neuromuscular facilitation (PNF) is a technique used to improve the balance function. The RS technique uses isometric contraction of antagonistic patterns and results in co-contraction of the antagonists if the isometric contraction is not broken by the physical therapist[1)]. RS may be appropriate for improving short-term trunk muscle endurance and trunk mobility in people with chronic low back pain[2,3)]. RS is effective in the treatment of patients with impairments in motor coordination[4)]. RS is also used as a clinical examination technique for slight cerebellar disease[5)].

Recently, dual tasks have been used to evaluate falls in many studies[6–8)]. For instance, when a movement task is going on, and another task is concurrently applied, the two tasks are known as a dual task. If the main task is comparatively simple, a comparatively large amount of attention can be allocated to the second task. This makes it possible to perform the second task comparative quickly. Thus, it is interpreted that a lot of attention resources allocated to the second task. If the second task is demanded during movement task enforcement and the reaction time to the dual task is relatively short, it implies that the main task is performed automatically. The response time to a dual task is called the probe reaction time.

Table 1. Subject Characteristics

	Age (y)	Height (cm)	Weight (kg)
Elderly group	70.0 ± 6.0	161.2 ± 9.4	63.2 ± 12.1
Younger group	22.4 ± 2.8	165.1 ± 9.6	58.7 ± 13.5

Note: values are mean ± standard deviation.

Measuring phonatory reaction time is particularly recommended for the probe reaction time as it sensitively recognizes slight changes in attention demanded by voluntary movements[9]. This study examined the influence on the probe reaction time of rhythmic stabilization during sitting.

SUBJECTS AND METHODS

The subjects were divided into two groups of thirty-three elderly subjects (70.0 ± 6.0 years, 11 males, 22 females), and ten younger subjects (22.4 ± 2.8 years, 5 males, 5 females) (Table 1). All subjects gave their informed consent to participation in this study.

A physical therapist conducted the experiment, which measured the simple reaction time (SRT), the probe reaction time (P-RT) during RS, and the resistance force of RS.

A digital audio player/recorder (Rio · Japan) was used as an auditory stimulator. The recording device was a digital voice recorder (Panasonic · Japan). An auditory stimulation file was prepared on a computer as a preparatory activity. The file was edited as a series of 16 warning signal and auditory stimulus (50 ms) using the personal computer overtone opinion processing software, DigionSound5 (Digion). The file was recorded on the digital audio player/recorder, and the digital audio player/recorder was connected to both digital voice recorder and a headset used a two-socket adaptor, so as to form an auditory cue box. The warning signal was completely randomized between 2–5 seconds before the auditory stimulus.

The auditory cue box was attached to the abdominal region of the subjects to measure the probe reaction time. The subjects were required to respond to the auditory cues by loudly saying the word “Pa” as quickly as possible. The headset was fitted to the subjects. The warning signal, the auditory stimulus and the response of the subjects were recorded on the digital voice recorder.

The SRT was consecutively measured five times in total while the subjects sat on a chair. One minute after a subject started RS, the P-RT was consecutively measured for five times in total. Prior to the experiment, the subjects were informed what would be done in the experiment, and they made trial exercises to familiarize themselves with the procedure. Data was input into a personal computer, and DigionSound5 sound-processing software was used for the analysis. The difference value of RT (ΔRT= P-RT - SRT) was calculated.

Manual contact was applied alternately to both shoulders during RS. RS was executed in four directions on the diagonal line and ten seconds, unidirectionally. To measure the resistance force of RS, two hand-held dynamometers (HDD, ANIMA MT-1) were held in each hand of the physical therapist, and the maximal resistance force was measured using the tester function of HDD.

The resistance force was the maximum resistance force that doesn’t appear as for the trunk shake of the subjects. The mean value of the maximum resistance force of both hands was assumed to be a representative value.

To examine the reproducibility of the measurements in the Elderly group, nine subjects (two males and seven females; 68.6 ± 2.0 yr; 65.8 ± 0.4 kg; 162.3 ± 12.3 cm) were selected at random from among the Elderly group. The retest was implemented on the next day. We evaluated the SRT, the P-RT, and the resistance force.

In order to determine the reliability of measurement values, the interclass correlation coefficient (ICC) was calculated. To determine whether there were differences of RT, two-way analyses of variance was performed. The measurement condition and the group were assumed to be factors. An independent t-test was performed for the maximal resistance force. To determine the correlation between each item, partial correlation analysis was performed, and the control variable was age. Data were analyzed using SPSS Ver. 12.0 for Windows.

RESULTS

The ICC (1, 1) of the SRT was 0.98, 0.94 for P-RT, and 0.98 for the resistance force, show high reproducibility.

Table 2 shows the result of each measurement. As a result of the two-way analyses of variance, A statistically significant main effect between the SRT and the P-RT ($F(1,41) = 13.6$, $p<0.01$) was

Table 2. Comparison of the results of physical tests[a]

	SRT (msec)		P-RT (msec)		ΔRT (msec)	RF(kg)		SRT and P-RT
Younger group (n=10)	291.4 ± 78.1	**	336.9 ± 89.5	**	45.5 ± 32.0	6.99 ± 1.29	**	**
Elderly group (n=33)	436.0 ± 135.2		624.6 ± 212.1		88.6 ± 112.9	5.33 ± 1.07		**

mean ± SD, **p<0.01. [a]: SRT= Simple Reaction Time, P-RT= Probe Reaction Time, ΔRT= P-RT - SRT, RF= Resistance Force of Rhythmic Stabilization.

found, and there was also a statistically significant main effect between the Elderly group and the Younger group (F(1,41) =8.9, p<0.01). There were no significant interactions (p>0.05), between groups since the change pattern of RT was similar. P-RT was longer than SRT in both groups. Moreover, the Elderly group's resistance force was less than that of the Younger group (p<0.01). There were significant correlations between P-RT and ΔRT (r = 0.80, p<0.01), between P-RT and resistance force (r = 0.34, p<0.05), between SRT and P-RT (r = 0.87, p<0.01), and between SRT and ΔRT (r = 0.41, p<0.01).

DISCUSSION

The result for the Elderly group showed that their resistance force of RS was less than that of the Younger group. P-RT was longer than SRT in both groups. We consider that the attention distribution to RS was decreased by the dual task. Excluding the influence of the age, there was a significant negative correlation between P-RT and the resistance force for all subjects. In addition, we consider that the change pattern of RT in both groups was similar because there was no interaction in the change pattern of RT in both groups as determined by the analysis of variance. Therefore, we suggest that not only the trunk muscle force but also attention are factors influencing sitting stability at all ages.

Resistance force delivered by a therapist as disturbance stimulation, can be effective in facilitating a patient's righting reaction. In the present research, because P-RT of RS was longer than SRT, we suggest that attentional demand is associated with trunk muscle force. Accordingly we consider that RS exercise should improve direct attention the muscle force.

Previous studies have used the P-RT to examine risk of falls among the elderly or patients with post-stroke hemiplegia[10–12]. Further investigations will need to use a larger number of subjects, and examine the relationship between the P-RT during RS and falls among the elderly.

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