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Original Article

Effect of coaching the sit-to-stand motion and attentional focus

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Abstract. [Purpose] The present study investigated whether (1) “standing up while bowing” is effective for promoting the sit-to-stand (STS) motion and (2) whether this coaching promotes internal focus. [Participants and Methods] The participants included 17 healthy adults who performed the 30-s chair stand test with two sets of verbal instructions. The verbal instructions were as follows: “Please stand up as many times as possible for 30 s” (control condition) and “Please stand up while bowing as many times as possible for 30 s” (bowing condition). The participants performed the tests successively under the two conditions. In the 30-s chair stand test, a three-axis accelerometer was attached to the participants and the sagittal STS motion was filmed using a video camera. After the 30-s chair stand test, we used the modified Movement-Specific Reinvestment Scale (MSRS) to evaluate attentional focus. Differences in the measurements were analyzed using the Wilcoxon signed-rank test or paired t-test for each condition. [Results] Statistical analysis revealed significant differences in the CS-30 count, time from sitting to standing, time from sitting to lift-off, time from lift-off to standing, and the trunk tilt angle on lift-off. Regarding the questionnaire, Statistical analysis revealed significant differences in the MSRS and “conscious motor processing”. [Conclusion] These results suggest that “standing up while bowing” has limited effectiveness in promoting the STS motion because the coaching promotes internal focus.

Key words: Attentional focus, Sit-to-stand, Bowing

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INTRODUCTION

Sit-to-stand (STS) is a common activity, but it poses a risk to elderly people and stroke patients with low STS ability. In stroke patients, it has been reported that 37% of falls in daily life occur during transferring, which includes the STS motion; it is therefore important to improve the STS ability[1)]. The ability of STS varies, and one of the factors that affects it is movement strategy. STS strategies are classified into two types: stabilization and momentum strategies. A person with a high STS ability uses the momentum strategy[2–4)]. In the case of a momentum strategy, the trunk bends quickly in the early phase of STS motion, and the activity of the rectus femoris, vastus lateralis, and tibialis anterior muscles is reduced after the lift-off phase, based on the law of momentum conservation[4)]. In the stabilization strategy, it takes much more time to maintain balance when the individual is unable to lift-off[3)], and the movement is less efficient in comparison to the momentum strategy[2, 5, 6)]. Because the stability strategy is used by individuals with a low STS ability or a history of falls[2)], and because it is easier for the individual to lift-off in the momentum strategy[2–6)], therapists often coach patients on “standing up while bowing” to teach the momentum strategy[4–6)]. To the author’s knowledge, there is no evidence that this teaching technique is effective in promoting STS motion.

Coaching is divided into two types based on attentional focus internal focus, in which the individual focuses on one’s own body; and external focus, in which the individual focuses on the external environment[7, 8)]. In general, external focus

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is superior to internal focus for motor control and motor learning. This is because conscious motor control with an internal focus interferes with natural and unconscious movement control in the central nervous system[7–9], and previous studies have reported that internal focus causes lateral body sway during movement[10]. In this background, it is possible that "standing up while bowing" promotes internal focus. This coaching does not mention body parts, but may be focused on the head and trunk. Therefore, the present study was conducted to investigate whether (1) "standing up while bowing" is effective for promoting STS motion, and (2) whether this type of coaching promotes internal focus. I hypothesize that "standing up while bowing" is increases trunk angular velocity and make lift-off easier, and it promotes internal focus so it increase body shaking from side to side.

PARTICIPANTS AND METHODS

The study population included 17 healthy adults (female, n=7; male, n=10). The mean (± SD) age was 30.1 ± 7.2 years, the mean (± SD) body weight was 58.8 ± 8.8 kg, and the mean (± SD) height was 165.7 ± 8.4 cm. Participants were healthy people between 20 and 40 years, and given their consent, and no specific sampling was performed.

The research design is a crossover comparative study. Participants took the 30-s chair stand tests (CS-30) with two sets of verbal instructions. The CS-30 is a measure of the sit-to-stand ability in which the maximum number of times a participant can stand up from a chair in 30 s is counted[11]. Two sets of verbal instructions were used. In the control condition, participants were instructed to "Please stand up as many times as possible for 30 s". In the bowing condition, participants were instructed to "Please stand up while bowing as many times as possible for 30 s." Participants performed each condition on the same day. The order of each condition was randomized using a lottery. Before taking the CS-30, the participants practiced standing up about five times to confirm whether they correctly understood the verbal instructions and then took a break. After the first CS-30, the participants took a sufficient break, and their fatigue was checked. If they were relieved from fatigue, the s CS-30 was started. The sitting height is adjusted by putting a duckboard on a 30 cm or 40 cm stand so that the hip, knee, and ankle joints are at an angle of approximately 90 degrees when the participant is sitting. Sagittal STS motion was measured with a video camera that was placed 4 m from the subject (Fig. 1), and the video camera data was analyzed using Image-J (NIH), to obtain the time from sitting until lift-off, the time from lift-off until standing, the time from sitting until standing (Fig. 2), the trunk tilt angle on lift-off, and the angular velocity during the trunk tilt (Fig. 3). In addition, a 3-axis accelerometer (2000, MicroStone, Nagano, Japan) was attached to the spinous process of the third lumbar vertebra to confirm lateral body sway during CS-30[12]. The root mean square (RMS) was calculated from the lateral acceleration data of the 3rd to 8th STS motion during CS-30. The RMS is an index that squares the value, takes the average, and extracts the square root. The RMS is a valid and reliable index for evaluating STS motion[9]. In addition, after each CS-30 session, the modified Movement-specific Reinvestment Scale (MSRS) was used to evaluate attentional focus during the STS movement. The MSRS is a valid and reliable index that consists of two factors: "movement self-consciousness" (self-consciousness about one's movements); and "conscious motor processing", (conscious monitoring and control of the mechanics of one's movements)[9, 13]. However, the MSRS was modified to investigate STS movement, and the validity of the Japanese version of the MSRS has not been reported, which may affect the validity of the present study.

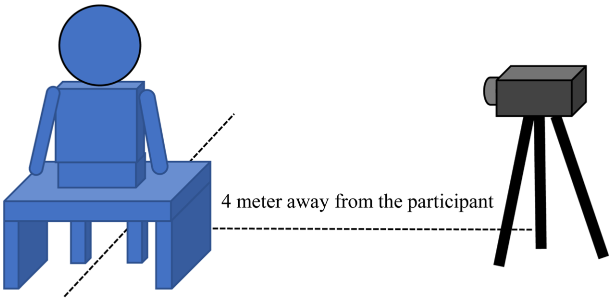

Fig. 1. measurement of sagittal motion with the video camera.

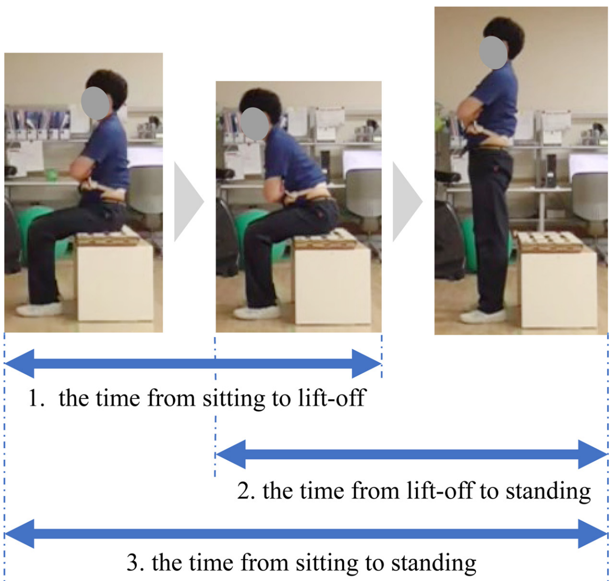

Fig. 2. Time parameter by data of video camera.

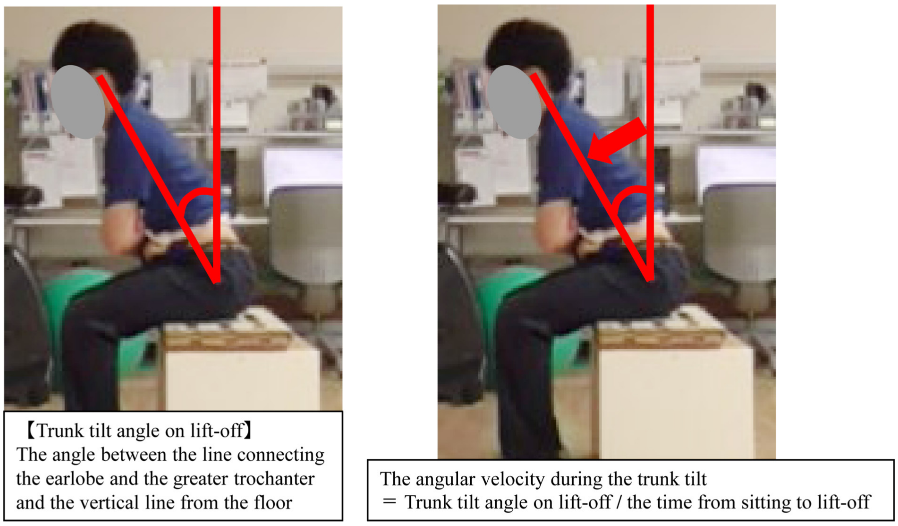

Fig. 3. Trunk tilt angle and angle velocity parameter by data of video camera.

In the statistical analysis, the normality of the results was first confirmed using the Shapiro–Wilk test, while the paired t-test was used to determine the time from sitting to lift-off, total MSRS score, and "conscious motor processing", for which normality was confirmed. The Wilcoxon signed-rank test was used to analyze values that were not normally distributed, including the number of times the participant stood in the CS-30, the differences in Borg scale before and after the CS-30, "movement self-consciousness", trunk tilt angle on lift-off, time from lift-off to standing, time from sitting to standing, angular velocity during trunk tilt, and the RMS of lateral sway. All statistical analyses were performed using R, version 2.8.1. This study was conducted according to the principles of the Declaration of Helsinki. The personal information of the participants was carefully protected, the study was explained to all participants, and each participant provided their informed consent to participate in the study. The study was approved by the Ethics Committee of Hirosaki University Graduate School of Health Sciences. (Approval No. 2021-028).

RESULTS

Of the 17 participants, one participant was missing his 3-axis accelerometer data, and another was missing his MSRS questionnaire data. Table 1 presents the results. In the control condition, the mean (± SD) CS-30 count was 15.3 (± 1.9) times, the median (IQR) was 15 (14, 16) times. The mean (± SD) time from sitting to disengaging was 0.33 (± 0.09) s, and the median (IQR) was 0.32 (0.28,0.39) s. The mean (± SD) time from release to the standing position was 0.55 (± 0.06) s, and the median (IQR) was 0.55 (0.52, 0.57) s. The mean (± SD) time from sitting to standing was 0.88 (± 0.12) s, and the median (IQR) was 0.88 (0.81, 0.97) s. The mean (± SD) trunk inclination angle was 25.9 (± 7.4) degrees, and the median (IQR) was 25.8 (21.4, 31.7) degrees. The mean (± SD) trunk inclination angular velocity was 72.3 (± 35.9) degrees per second, and the median (IQR) was 74.5 (34.1, 96.1) degrees per second. The mean (± SD) lateral acceleration was 0.07(± 0.75) m/s^2, and the median (IQR) was −0.07(−0.49, 0.65) m/s^2. The mean (± SD) RMS was 0.76 (± 0.64) and the median (IQR) was 0.45 (0.29, 1.16) m/s^2. The mean (± SD) difference in the Borg scale before and after CS-30 was 3.8 (± 2.5) points, and the median (IQR) was 4 (1,6) points. The mean (± SD) MSRS was 29.8 (± 5.8) points, and the median (IQR) was 31 (28, 32) points. The mean (± SD) motor self-consciousness score was 15.1 (± 3.3) points, and the median (IQR) was 16 (12.3, 17) points. The mean (± SD) conscious motor processing score was 14.7 (± 3.1) points, and the median (IQR) was 16.5 (14.8, 18.3) points.

In the bowing condition, the mean (± SD) CS-30 count was 13.1 (± 1.3) times and the median (IQR) was 14 (12, 14) times. The mean (± SD) time from sitting to disengaging was 0.41 (± 0.05) s, and the median (IQR) was 0.4 (0.37, 0.43) s. The mean (± SD) time from release to standing position was 0.64 (± 0.1) s and the median (IQR) was 0.64 (0.58, 0.69) s. The mean (± SD) time from sitting to standing was 1.05 (± 0.12) s and the median (IQR) was 1.04 (0.97, 1.08) s. The mean (± SD) trunk inclination angle was 39.7 (± 8.5) degrees and the median (IQR) was 42.1 (36, 45) degrees. The mean (± SD) trunk inclination angular velocity was 85.4 (± 29.5) degrees per second and the median (IQR) was 100.1 (55.9, 108.8) degrees per second. The mean (± SD) lateral acceleration was 0.1(± 0.79) m/s^2 and the median (IQR) was −0.11(−0.47,0.68) m/s^2. The mean (± SD) RMS was 0.81 (± 0.7) m/s^2 and the median (IQR) was 0.52 (0.27,1.24) m/s^2. The mean (± SD) difference in the Borg scale before and after CS-30 was 3.5 (± 2.5) points and the median (IQR) was 2 (2,6) points. The mean (± SD) of MSRS was 32.6 (± 5.4) points and the median value (IQR) was 35 (30,37) points. The mean (± SD) motor self-consciousness score was 15.8 (± 3.3) points and the median (IQR) was 14.5 (12.8, 17.3) points. The mean (± SD) conscious motor processing score was 16.8 (± 2.9) and the median (IQR) was 17 (15.8, 19).

Table 1. Each evaluation index for both conditions

Measurement	Control condition		Bowing condition	
	Mean (± SD)	Median (IQR)	Mean (± SD)	Median (IQR)
Number of CS-30 (times)		15 (14, 16)		14 (12, 14)*
Time from sitting to standing (s)		0.88 (0.81, 0.97)		1.04 (0.97, 1.08)*
Time from sitting to lift-off (s)	0.33 (± 0.09)		0.41 (± 0.05)*	
Time from lift-off to standing		0.55 (0.52, 0.57)		0.64 (0.58, 0.69)*
Trunk tilt angle on lift-off (degrees)		25.8 (21.4, 31.7)		42.1 (36, 45)*
Angular velocity during the trunk tilt (degrees/s)		74.5 (34.1, 96.1)		100.1 (55.9, 108.8)
RMS of lateral sway (m/s^2)		0.45 (0.29, 1.16)		0.52 (0.27, 1.24)
Differences in Borg scale before and after CS-30 (points)		4 (1, 6)		2 (2, 6)
Total MSRS score (points)	29.8 (± 5.8)		32.6 (± 5.4)*	
Movement self-consciousness (points)		16 (12.3, 17)		14.5 (12.8,17.3)
Conscious motor processing (points)		16.5 (14.8, 18.3)		17 (15.8, 19)*

*p<0.05.
SD: standard deviation; IQR: interquartile range; RMS: root mean square; MSRS: movement-specific reinvestment scale.

The statistical analysis revealed significant differences in the CS-30 count, time from sitting to standing, time from sitting to lift-off, time from lift-off to standing, and the trunk tilt angle on lift-off. However, no significant differences were observed in the angular velocity during trunk tilt, RMS of lateral sway, or Borg scale before and after the CS-30. Regarding the questionnaire, there were significant differences in the MSRS. With regard to the subscales, there was no significant difference in "movement self-consciousness", but there was a significant difference in "conscious motor processing".

DISCUSSION

There was no significant difference in the change in the Borg scale before and after the CS-30 under each condition, but there was a significant difference in the CS-30 count, the time from sitting to standing, the time from sitting to lift-off, and the time from lift-off to standing. Therefore, it is suggested that the control condition was more efficient than the bowing condition for teaching the STS motion. Additionally, there was a significant difference in the trunk tilt angle on lift-off under each condition, and the bowing condition increased by an average of 13.78°. There was no significant difference in the angular velocity during the trunk tilt; however, on average the bowing condition was 13.05 degrees/second higher than the control condition. From the above, it is assumed that the center of gravity was largely and quickly shifted forward from sitting to lift-off in the bowing condition, which made it easy to lift-off. Hughes reported that the STS time in the stabilization strategy is over 6 s, and the STS time in the momentum strategy is within 3 s[2]. In this study, the average time of STS in the control condition is 0.88 s and in the bowing condition is 1.05 s. Therefore, in the present study, it was assumed that the participants used the momentum strategy in both conditions. However, in the momentum strategy, the strategy that tilts the trunk excessively is called the "exaggerated trunk flexion strategy"[5, 14]. The "exaggerated trunk flexion strategy" is significantly affected by the tilting of the trunk, which extends the time from lift-off to standing. and when the hip flexion angle is approximately 45 degrees, it is the most efficient STS motion. However, in the "exaggerated trunk flexion strategy", the hip flexion angle is approximately 58 degrees[5], so this strategy decreases the efficiency of STS motion. Therefore, it can be assumed that the "exaggerated trunk flexion strategy" was used in the bowing condition, and that it reduced the efficiency of the STS motion. From the above, instructing participants to "stand up while bowing" may not be the best strategy to promote efficient STS movement. However, if you want to change the patient's form of STS motion from the stabilization strategy to the momentum strategy and to teach an easy lift-off method, "stand up while bowing" may be a good coaching method. In the future, it will be necessary to research elderly people and stroke patients with low STS ability who are at risk of falls.

There was a significant difference in the MSRS under each condition. Therefore, it was found that the attentional focus of participants became an internal focus in the bowing condition. On the subscale, there was no significant difference in "movement self-consciousness; however, there was a significant difference in "conscious motor processing". In general, "movement self-consciousness" is the scale reflecting how the subject appears to outsiders, while "conscious motor processing" is a scale that reflects the body working by itself and determining whether the movement has failed[4]. The present study found that coaching participants to "please stand up while bowing" changed the attentional focus of participants on how they worked their body during STS motion. Wong reported that those with a high MSRS score are more likely to fall[15], instructing participants to "stand up while bowing" may increase their risk of falls in daily life if they have a low STS ability. However, internal focus has a good aspect. For example, in a study of motor learning and attentional focus in experts and beginners, it was found that experts had better external focus performance, while beginners had better internal focus performance[16]. In addition, in a study of stroke patients, it was reported that internal focus resulted in better motor control in stroke patients[17].

Therefore, internal focus may be a good attentional focus for stroke patients when their body image is disturbed. From the above, it is possible that the instruction to "stand up while bowing" is better for individuals to practice STS in the early stage of training and for stroke patients with a disturbed body image; however, there is a risk of impairing motor control and motor learning if it is used to practice STS from the middle to later stages of training, based on the "constrained action hypothesis". There was no significant difference in the RMS of the lateral sway, but it tended to increase under bowing conditions. Based on the results of the MSRS, it may be considered that instructing individuals to "stand up while bowing" induces internal focus and causes lateral sway of the body during STS motion. However, the RMS score in the control condition was 0.76 points, and that in the bowing condition was 0.81 points, so the difference is slight, and it may not be necessary to consider the influence of stability. This may be because the STS task is too easy for healthy adults to perform. Tasks that are often used in the study of attentional focus include playing sports and instruments, such as baseball, golf, tennis, and the piano[7, 18, 19]. These are more difficult than STS tasks because they require more dynamic or precise movements. The slight difference in each condition may result from the motion differences in each condition. As mentioned above, the bowing condition causes the trunk to bend excessively and decreases the efficiency of motor control. Therefore, the increasing RMS of lateral sway in the bowing condition may be due to motion difference, not because of the effect of internal focus.

The present study was associated with some limitations, including its relatively small sample size, difficulty in confirming whether the participants were constantly paying attention as instructed while performing the CS-30, the lack of kinematic data while performing the CS-30 because we did not use three-dimensional motion analysis method and a force plate, the continuous measurement of STS rather than the measurement of a single STS motion, and the lack of validity of the modified MSRS. There is a high possibility that these limitations affected not only the results of this study but also the interpretation of the results. More detailed research should be conducted in consideration of these issues. In addition, the effectiveness of coaching in the rehabilitation of hemiplegic patients after stroke and in elderly people with low ability should be evaluated.

Conflict of interest

The authors declare no conflicts of interest in association with the present study.

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