BALANCE CONTROL OVER INCLINED SURFACE DURING DIFFERENT POSTURES

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SUMMARY

The purpose of this study was to examine the effects of posture and surface inclination on forward and backward reaching performances. The balance performance was significantly poor during kneeling posture relative to other postures in both forward and backward reaching tests. Balance ability is reduced at posterior tilting in backward reaching. Arm reaching forward during standing is performed better than kneeling and sitting.

INTRODUCTION

The functional reach is usually used to clinically measure of balance performance, is the difference between arm's length and maximal forward reach, using a fixed base of support [1].The functional reach test was originally designed as a simple forward reach test designed to assess standing balance. It was then modified by Lynch et al. (1998) to assess sitting balance in individuals with SCI (i.e. modified FRT) [2]. Newton et al (2001) using the Multi-Directional Reach Test for measuring the limits of stability as derived by reach in four directions (forward, to the right, to the left, and leaning backward) [3]. Balance is defined as the ability to maintain control over upright posture including sitting, kneeling and standing posture during reach without stabilization. To maintain quiet posture at different inclined surfaces, both passive and active mechanisms contribute to generate muscle torque counteracting gravity [4]. Hadders-Algra et al (1999) indicated that reaching efficiency improved by forward tilting of seat surface in special group [5]. The purpose of this study was to examine the effects of posture and surface inclination on forward and backward reaching performances.

METHODS

18 healthy subjects (13 males and 5 females; mean age 33.5±6.6 years old) participated in this study. Each subjects receipted Functional Reaching Test in forward and backward reaching at three types of inclination surface during three types of postures. First, the subjects were positioned in sitting, kneeling or standing posture on SMARC SC103 and SC104 (Preventive Medical Health Care CO., LTD., Taiwan, R.O.C.), then the inclination surface was set at flat, anterior-inclined, and posterior-inclined positions. All subjects performed those reaching tests in 9 conditions at 3 types of surface inclinations during 3 postures by random order (Figure1-3). The starting position of functional reaching test was keep the elbow extended with fingers extended in standing position and with the palm fisted in sitting and kneeling position. The balance performance measured the maximal distance one can reach beyond arm's length while maintaining the same base of support in reaching test.
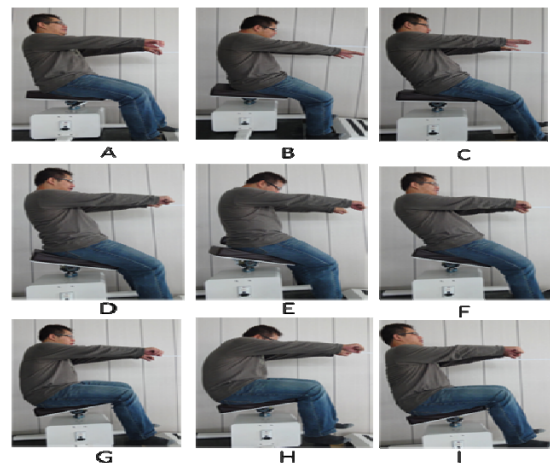

Figure 1: Reaching test in different surface inclination during sitting posture

A.Neutral position at flat surface , B.FR at flat surface, C.BR at flat surface,
D.Neutral position at anterior titling, E.FR at anterior titling,
F.BR at anterior titling ,G.Neutral position at posterior titling,
H.FR at posterior titling, I.BR at posterior titling;
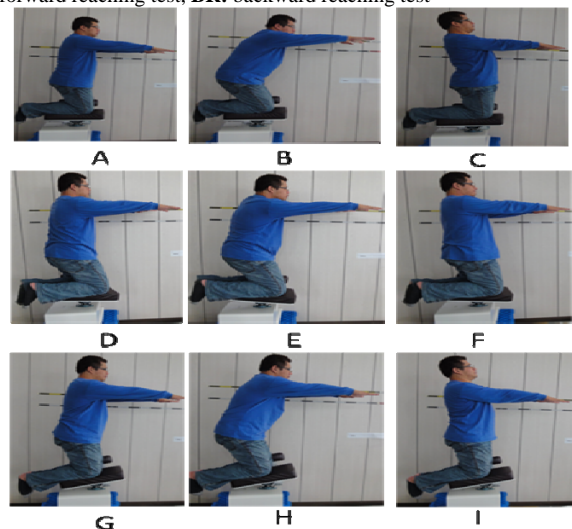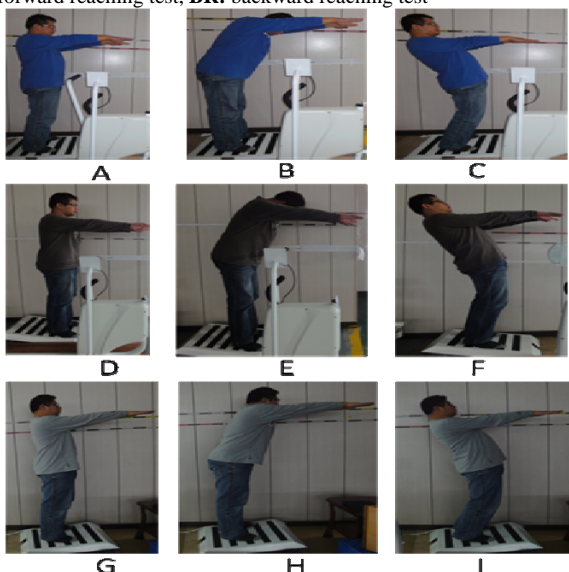**FR:** forward reaching test, **BR:** backward reaching test

Figure 2: Reaching test in different surface inclination during kneeling posture

A.Neutral position at flat surface , B.FR at flat surface, C.BR at flat surface,
D.Neutral position at anterior titling, E.FR at anterior titling,
F.BR at anterior titling ,G.Neutral position at posterior titling,
H.FR at posterior titling, I.BR at posterior titling;
FR: forward reaching test, **BR:** backward reaching test

Figure 3: Reaching test in different surface inclination
during standing posture
A.Neutral position at flat surface , B.FR at flat surface, C.BR at flat surface,
D.Neutral position at anterior titling, E.FR at anterior titling,
F.BR at anterior titling ,G.Neutral position at posterior titling,
H.FR at posterior titling, I.BR at posterior titling;
FR: forward reaching test, **BR:** backward reaching test

RESULTS AND DISCUSSION

Balance performances (Table1) were significantly affected by posture only (F=8.007, p=0.000), interaction between posture and surface inclination (F=231.892, p=0.000) in forward reaching test. In backward reaching test, balance performances were significantly affected by surface inclination only (F=10.310, p=0.001), posture only (F=36.730, p=0.000), interaction between posture and surface inclination (F=2024.370, p=0.000). Post hoc analyses showed that the balance performance during kneeling was significantly poor relative to those during sitting (p=0.041) and standing (p=0.000), then the balance performance of standing was significantly better relative to those during sitting (p=0.025) in forward reaching tests. In backward reaching tests, the balance performance during kneeling was significantly poor relative to those during sitting (p=0.000) and standing (p=0.000), then the balance performance at the posterior-inclined positions was significantly poor relative to those at flat surface (p=0.006) and anterior tilting (p=0.000). Sitting and standing are common postures during activities of daily life, but kneeling is an unusual posture. One study showed that the different

anthropometric parameters between kneeling and standing due to biomechanical factors (e.g., lowered center of gravity), or also reflected changes in the neural processes involved in the control of balance [6]. The balance performance was significantly poor during kneeling posture relative to those during other postures in both forward and backward reaching tests. Greater isometric contraction strength of calf muscles were showed at posterior tilting than those at flat and anterior titling [4]. It was hard to maintain posture control at posterior tilting position relative to those at other positions. Balance ability is reduced at posterior tilting, especially in backward reaching.

CONCLUSIONS

Balance ability is reduced at posterior tilting in backward reaching. The performance of arm reaching forward during standing is better than those during kneeling and sitting. Kneeling is an unusual posture during activities of daily life, and there is more balance challenge than those during sitting and standing in both forward reaching and backward reaching.

ACKNOWLEDGEMENTS

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Table 1: Balance performances in different surface inclination during different postures

posture / surface inclination	Sitting (FR/BR)(cm)	Kneeling (FR/BR) (cm)	Standing (FR/BR) (cm)
Flat	17.7± 4.3/21.0±6.1	15.5± 4.3/12.9±3.8	29.5± 5.5/18.8±5.1
Anterior-inclined	33.4±60.6/21.6±5.4	12.9± 2.8/14.6±3.8	28.7± 5.3/20.5±4.6
Posterior-inclined	16.7± 6.3/16.7±5.6	16.6±14.0/10.7±4.6	31.5± 5.5/18.4±4.9

FR: forward reaching test, BR: backward reaching test