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Original Paper

Change in Blood Pressure while Sitting up from a Supine Position and Standing up from a Sitting Position

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Key words : blood pressure, sitting up, standing up

Abstract

The purpose of this study was to investigate the change in blood pressure while sitting up and standing up to obtain basic data for the management of risk in the clinical physical therapy setting. The subjects in Experiment 1 (sitting up) were 9 healthy young people (21.6±0.7 years old) and those in Experiment 2 (standing up) were 11 healthy young people (24.4±6.1 years old). Systolic (SBP) and diastolic blood pressures (DBP) were measured beat by beat at the right radial artery with a continuous blood pressure measuring apparatus while the subjects were sitting up or standing up. The maximal value of SBP while sitting up increased. The minimal values of SBP and DBP decreased significantly compared with those at rest. The maximal values of SBP and DBP increased and the minimal values of SBP decreased significantly while standing up from a sitting height of 20 cm. Blood pressure fluctuated in a range of about 40mmHg in the process of sitting up and standing up. These results indicate that physical therapists should manage the risk of changes in blood pressure carefully when they have their patients practice sitting up and standing up.

Introduction

In clinical practice, physical therapists frequently have patients do sitting up and standing up exercises, because these movements are the basis for locomotion in activities of daily life. It is very important to check blood pressure for the management of risk, because some patients have unstable blood pressures. However, since it is very difficult to measure blood pressure during these movements without a special apparatus or direct recording by catheterization of arteries,

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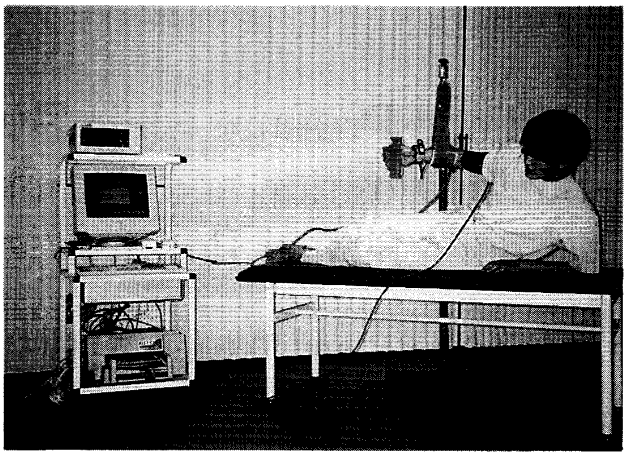

Fig. 1 Subjects were directed to sit up and to return to the supine position like right hemiplegic patients.

physical therapists commonly measure blood pressure before and after exercise. Many investigators have reported that blood pressure is influenced by exercise. Most exercises, however, are static ones such as lifting of heavy weights and static contractions [1]. The authors investigated changes in blood pressure during sitting up and standing up to obtain basic information for the management of risk.

Subjects and Methods

Experiment 1 (sitting up) : Nine healthy volunteers (seven men, two women, 21.6±0.7 years old) took part in Experiment 1. All were fully informed of the purposes of the study and associated risks. The subjects were directed to sit up after resting on a bed in a supine position and to return to the supine position using the left arm, simulating the action of right hemiplegic patients (Fig. 1). This movement was repeated four times at a comfortable speed. A continuous non-invasive blood pressure measuring apparatus (JENTOW- 7700, Nippon Colin), connected with a sensor at the rightradial artery, was utilized to measure and analyze SBP and DPB during each heart beat. After calibration, this apparatus measures SBP and DBP of the brachial artery by monitoring blood pressure at the radial artery with the pressure sensor (Fig. 2). The maximal and minimal SBP and DBP values during sitting up procedure were compared with those at rest. The values were the mean and standard deviation of 20 heart beats. These were analyzed using the paired t test with the level of significance set at $p < 0.05$.

Experiment 2 (standing up) : Eleven healthy people (six men, five women, 24.4±6.1 years old) volunteered to participate in Experiment 2. Informed consent was obtained from all subjects. After resting, they were instructed to stand up from chairs and sit down five times at a comfortable speed without using the hands (Fig. 3). Three chair heights were used. All subjects took enough rest during each movement. Measurement and analysis of SBP and DBP were the same as in Experiment 1.

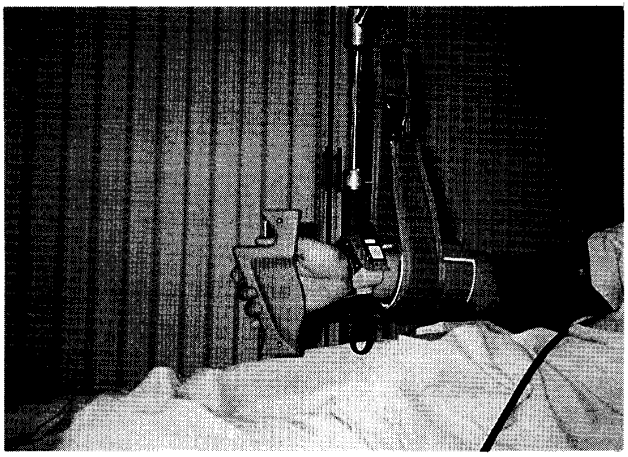

Fig. 2 A continuous non-invasive blood pressure measuring apparatus connected with a sensor at the right radial artery was utilized to measure and analyze SBP and DBP beat by beat.

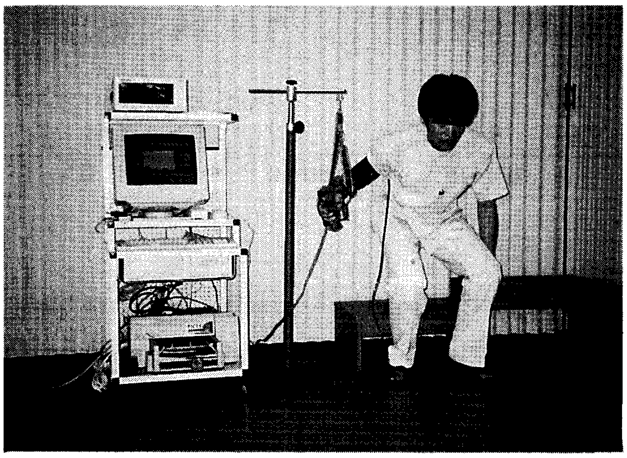

Fig. 3 Subjects were directed to stand up from chairs of three heights (40cm, 20cm and 10cm) and to sit down.

Result

The maximal and minimal values of SBP and DBP during each movement and the resting periods of Experiments 1 and 2 are shown in the Tables. The maximal SBP increased significantly while sitting up, while the minimal SBP and DBP decreased significantly compared with those at rest. The mean fluctuation of SBP was 41mmHg. The minimal SBP and DBP while standing up from a height of 40cm decreased significantly. The maximal SBP and DBP while standing up from a sitting height of 20cm increased significantly and the minimal SBP decreased significantly. The mean fluctuation of SBP was 38mmHg. The maximal DBP increased significantly and the minimal SBP and DBP decreased significantly while standing up from a sitting height of 10cm. The mean fluctuation of SBP was 44mmHg. Differences in height had no significant influence on maximal and minimal SBP and DBP values.

Table 1 The maximal and the minimal values of SBP and DBP during sitting up and the resting periods of Experiment 1 are shown.

	rest	maximum	minimum
SBP	116± 9	132± 8*	91±14*
DBP	77±18	85±11	48±14*

mean ± SD(mmHg) * P< 0.05

Table 2 The maximal and the minimal values of SBP and DBP during standing up and the resting periods of Experiment 2 are shown.

	rest	maximum	minimum
40cm			
SBP	117±17	124±22	92±18*
DBP	64±13	73±12	44±13*
20cm			
SBP	110±11	123±13*	85±21*
DBP	58±11	71± 9*	65±27
10cm			
SBP	111±14	125±18	81±22*
DBP	60±14	75±15*	41±16*

mean ± SD(mmHg) * P< 0.05

Discussion

Several investigators have reported that some exercises influence blood pressure. Lind and McNicol [2] reported that blood pressure increased during static exercise. Freyschuss [3] studied the cardiovascular responses during contraction of the forearm at 70% maximal voluntary contraction (MVC). Hollander & Bouman [4] reported a rather sudden increase in the hemodynamic response to isometric contractions. In a study by McCloskey and Streatfield [5] , a comparison was done between finger and forearm contractions at 40% MVC. Mitchell et al. [6] reported that the blood pressure response to sustained contraction at a given % MVC was dependent on the muscle mass. However, there have been few reports concerning the change in blood pressure during basic movements such as sitting up or standing. The authors thought that changes in blood pressure during these movements were important, because physical therapists commonly instruct patients to do them as exercises. It is very difficult to measure blood pressure during exercise by catheterizing and recording directly, but this procedure is invasive. Therefore, we utilized the non-invasive method of tonometry. Blood pressure is measured at the radial artery with a pressure sensor at each heart beat after this pressure is related to blood pressure at the brachial artery by calibration.

The authors believe that the increase in SBP while sitting up was caused by the activity of the upper extremity and abdominal muscles and the Valsalva maneuver, and that the decrease in SBP and DBP was caused by orthostatic hypotension and the Valsalva maneuver. The Valsalva maneuver is known to both increase and decrease blood pressure. It is thought that the increase in blood pressure while standing up from sitting heights of 10cm and 20cm was brought about by the activities of anti-gravity muscles in the lower extremities, and the decrease was brought about by orthostatic hypotension. The 40mmHg fluctuation in SBP of 40mmHg while sitting up and standing up from heights of 10cm and 20cm should be given careful consideration, especially in patients with unstable blood pressures. A previous study by the authors [7] showed that maximal isometric exercise of the unilateral quadriceps femoris muscle caused a range of fluctuation of 75mmHg. It was thought that the difference was brought about because movements like sitting up and standing up are dynamic, unlike isometric exercises. Also, the intensity of exercise is less than that of the maximal contraction. During forceful isometric exercises, the increase in blood pressure is the result of an increase in heart rate and cardiac output, and, to a lesser extent, vasoconstriction in the vessels of nonexercising muscles. When subjects attempted to maintain maximum isometric contractions, the increase in blood pressure remained the same despite a marked diminution in force. Thus, the magnitude of the blood pressure response depends on the intensity of effort or central command and not the actual force produced. The mechanisms responsible for this pressor response are believed to include two components, a central one originating in the supraspinal areas of the brain and a peripheral or reflex neural component originating in the contracting muscles and transmitting along group III and IV muscle afferents to the cardiovascular control center. Further studies should be carried out under more clinical conditions, because the patients who undergo physical therapy are usually older, need more effort to perform these kinds of movements and may have unstable blood pressures.

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