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Original Paper

Changes in Blood Pressure in the Trunk and Pelvis during Exercises

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Abstract

The purpose of this study was to investigate changes in blood pressure during exercises of the trunk and pelvis. This information is important for the management of risk in the clinical physical and occupational therapy setting. The subjects were 10 healthy young people (20.6 ± 1.0 years old). Systolic (SBP) and diastolic blood pressure (DBP) were measured at the right radial artery with a continuous blood pressure measuring apparatus while the subjects performed three exercises involving the trunk and pelvis. Maximal SBP and DBP values increased significantly during all exercises compared with those at rest. Minimal SBP and DBP values decreased significantly during sitting up and pelvic tilt exercises compared with those at rest. Blood pressure fluctuated in a range of 23-36 mmHg during these exercises. These results indicate that physical and occupational therapists should manage the risk of changes in blood pressure carefully when patients are asked to practice these kinds of exercises.

Introduction

In clinical practice, physical and occupational therapists frequently have patients practice exercises of the trunk and pelvis, because these movements are required for locomotion in the activities of daily life. They are also used in therapeutic exercises for impairments such as hemiplegia and lumbago. It is very important to check blood pressure for the management of risk during the exercises, because some patients have unstable blood pressure. However, since it is very difficult to measure blood pressure continuously without a special apparatus or direct recording by catheterization of arteries, physical and occupational 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 the lifting of heavy weights and static contractions [1]. There have been no reports examining changes in blood pressure during dynamic exercises of the trunk and pelvis such as sit-ups, pelvic tilts and pelvic lifts. In this study, continuous blood pressure changes were recorded during these three types of exercises of the trunk and pelvis to obtain basic information for the management of risk.

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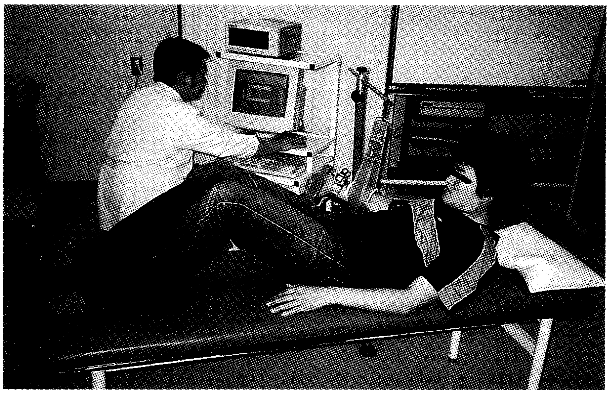

Fig. 1 Subjects were directed to sit up and return to the resting supine position.

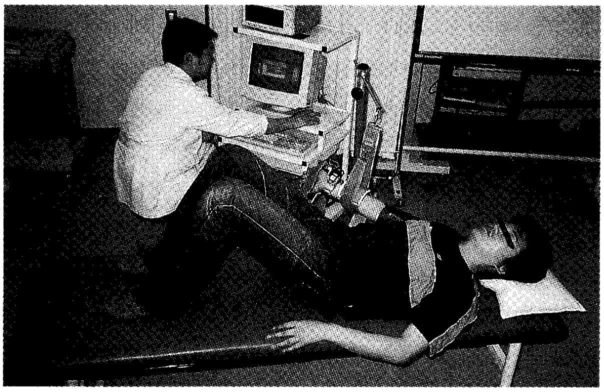

Fig. 2 Subjects were directed to tilt the pelvis backward and return to the resting supine position.

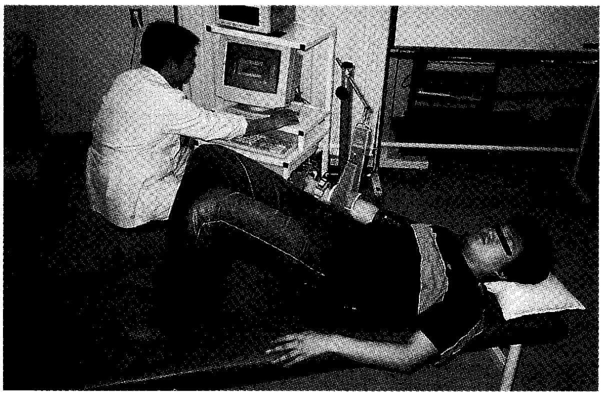

Fig. 3 Subjects were directed to lift the pelvis and return to the resting supine position.

Subjects and Methods

Ten healthy volunteers (eight men, two women, 20.6 ± 1.0 years old) took part in the experiment. All were fully informed of the purpose of the study and associated risks, and trained before testing. The subjects were directed to perform three exercises (sit-ups, pelvic tilts and pelvic lifts) from a supine position on a bed (Fig. 1-3). Each exercise was done for five seconds and repeated five times with a five second rest between each repetition. Before beginning the next exercise, the subjects rested until blood pressure values returned to the resting level. A continuous non-invasive blood pressure measuring apparatus (JENTOW-

7700, Nippon Colin), connected with a sensor at the right radial artery, was used to measure and analyze SBP and DBP continuously. 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. 4). Maximal and minimal SBP and DBP values during exercise were compared with those at rest. The values were the mean and standard deviation during 20 heart beats. Data were analyzed using the paired t-test and the level of significance was considered to be $p < 0.05$.

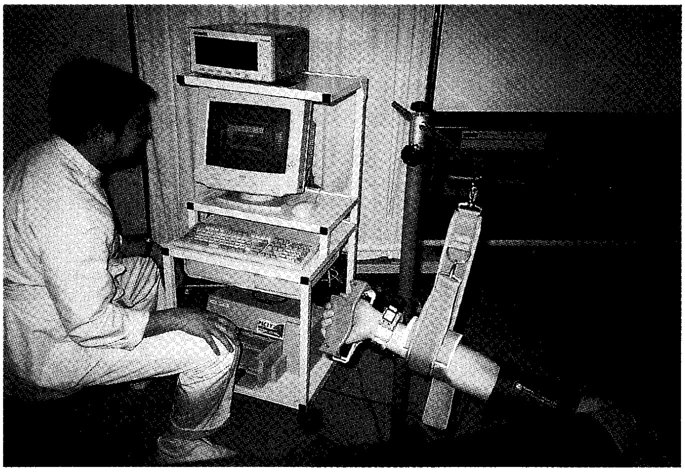

Fig. 4 A continuous non-invasive blood pressure measuring apparatus connected with a sensor at the right radial artery was utilized to measure and analyze SBP and DBP.

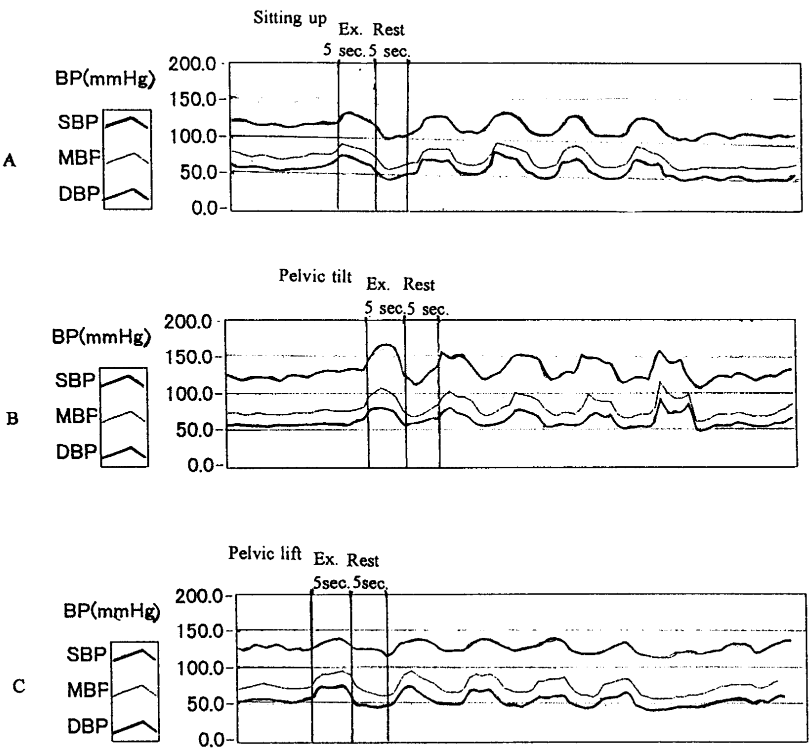

Fig. 5 Some sample recordings of blood pressure while subjects performed the three types of exercises. "Ex." and underlines indicate exercising periods and "Rest" indicates resting periods.
A: Sitting up exercise
B: Pelvic tilt exercise
C: Pelvic lift exercise

Table The maximal and minimal SBP and DBP values during exercises and the resting periods are shown.

	rest	maximum	minimum
sitting up			
SBP	121 ± 14	134 ± 17*	98 ± 12*
DBP	59 ± 13	74 ± 12*	43 ± 10*
pelvic tilt			
SBP	120 ± 16	143 ± 25*	110 ± 17*
DBP	57 ± 10	80 ± 17*	50 ± 14*
pelvic lift			
SBP	117 ± 14	137 ± 21*	114 ± 15*
DBP	55 ± 9	73 ± 10*	48 ± 13*

mean ± SD (mmHg)*P<0.05

Result

Some examples of recorded blood pressure measurements during exercise are shown in Fig.5. In all subjects, both SBP and DBP increased immediately at the start of the exercises and reached the maximum within 2 to 3 seconds. This increase was followed by a gradual decrease during the remainder of the exercises. After exercise was stopped, both SBP and DBP decreased rapidly to the minimum. Maximal and minimal SBP and DBP values during each exercise and the resting periods are shown in the Table. Maximal SBP and DBP values increased significantly during all exercises, while minimal SBP and DBP values decreased significantly during sit-ups and pelvic tilts compared with those at rest. The mean maximal and minimal SBP value during sit-ups was 36 ± 19 mmHg and that of DBP was 32 ± 15 mmHg. The means for pelvic tilts were 33 ± 22 mmHg and 30 ± 17 mmHg, while those for pelvic lifts were 22 ± 8 mmHg and 25 ± 8 mmHg. Maximal values were found during each exercise and minimal values were found immediately after each exercise.

Discussion

Several investigators have reported that exercises influence blood pressure. Lind and McNicol [2] reported that blood pressure increased during static exercise. They compared circulatory responses to sustained hand grip contractions performed during other exercises, both rhythmic and static. Freyschuss [3] reported on the cardiovascular response to contractions 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, to the best of our knowledge, there have been no reports concerning changes in blood pressure during basic movements of the trunk and pelvis, such as when doing sit-ups, pelvic tilts, and pelvic lifts. Changes in blood pressure during these movements are important, because physical and occupational therapists commonly instruct patients to do these exercises. Sit-ups and pelvic tilts are commonly used as therapeutic exercises for lumbago, such as in the Williams exercise. The pelvic lifts exercise is commonly employed to make the hip extensor muscle more functional and stronger. It is not practical to measure blood pressure during exercises by inserting a pressure sensor into the artery, and this procedure is invasive.

Therefore, it was decided to use the continuous and non-invasive method of tonometry. Blood pressure was measured continuously at the radial artery with a pressure sensor after this pressure was correlated to the blood pressure at the brachial artery by calibration. Thus, it was possible to measure detailed changes in blood pressure during the exercises.

When the exercises were started, both SBP and DBP increased immediately, and then decreased rapidly when the exercises were stopped. The increase in SBP and DBP during the exercises was considered to be caused by contractions of the abdominal and pelvic girdle muscles, and that the decrease was caused by the unloading reflex. The greatest range in maximal and minimal SBP was found during sit-ups and the least during pelvic lifts. The disparity was due to a difference in the intensity of exercise. The SBP level of 36 mmHg during sit-ups should be given careful consideration, especially in patients with unstable blood pressure. A previous study by the author [7] showed that maximal isometric exercise of the unilateral quadriceps femoris muscle caused a level of 75 mmHg. This difference was also attributable to the difference in exercise intensity. During forceful isometric exercises, the increase in blood pressure is the result of an increase in heart rate and cardiac output plus intestinal vasoconstriction by the activity of sympathetic nerves. When subjects attempted to maintain maximum isometric contractions, the increase in blood pressure remained constant 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 which originates in the contracting muscles and is transmitted along the groups III and IV muscle afferents to the cardiovascular control center. Further studies should be carried out under more controled clinical conditions, because the patients who undergo physical and occupational therapy are usually older, require more effort to perform these types of movements, and are susceptible to unstable blood pressure.

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