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Original Paper

Influence of Painful Passive Exercise on Blood Pressure

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Key words : blood pressure, passive exercise, muscle stretching pain

Abstract

To obtain basic data for risk management, the influence on blood pressure of pain when stretching leg muscles during passive exercise was examined. Ten healthy subjects, 19-22 years of age, performed two kinds of Straight Leg Raise Tests with their left legs. In one test, the leg was raised as high as possible without any pain (Test 1). In the second test, the leg was raised until subjects complained of pain because of muscle stretching (Test 2). During the tests, systolic (SBP) and diastolic blood pressure (DBP) were monitored continuously at the right radial artery using a non-invasive blood pressure measuring apparatus. No significant differences were found in maximal and minimal SBP and DBP values during Test 1 when compared with those during the resting period. However, maximal SBP and DBP values during Test 2 were significantly higher than those during Test 1 and the resting period. In addition, minimal DBP values during Test 2 were significantly higher than those during the resting period. These results indicate that occupational and physical therapists should manage the risk of changes in blood pressure more carefully when patients complain of muscle stretching pain during passive exercise.

Introduction

In clinical practice, occupational and physical therapists frequently use passive limb exercise for patients in order to maintain and improve range of joint motion. Some patients complain of pain when doing stretching exercises of shortened muscles and ligaments. For risk management, it is quite important to check blood pressure during the exercises, especially in patients who have unstable blood pressure. However, since it is very difficult to measure blood pressure during exercise without a special apparatus or direct recording by arterial catheterization, occupational and physical therapists commonly measure blood pressure before and after exercise.

Many investigators have reported that blood pressure is influenced by exercise [1-6]. Most exercises, however, are active such as static contractions and lifting of heavy weights. The authors' previous reports of changes in blood pressure were also concerned with active exercise such as static contractions and sit-ups [7-9]. There have been no reports examining changes in blood pressure during passive limb exercise.

The purpose of this study was to examine changes in blood pressure during passive exercise, especially when patients complain of muscle stretching pain. This information is important for risk management.

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Subjects and Methods

Ten healthy volunteers (8 males and 2 females), 19-22 years of age (20.6 ± 0.9), participated in this study. They provided informed consent.

The subjects were laid on beds, and a continuous, non-invasive blood pressure measuring apparatus (JENTOW-7700, Nippon Colin) was attached with a sensor at the right radial artery. After calibration, this apparatus was designed to measure systolic (SBP) and diastolic blood pressure (DBP) of the brachial artery during each heartbeat by monitoring blood pressure at the radial artery. On arriving for the test, the subject's resting blood pressure was measured. Then, they performed two kinds of Straight Leg Raise Tests with their left legs. In each test, the left leg was passively raised with the knee extended (Fig. 1). The right leg was kept firmly on the bed. In the first test, the left leg was raised for 20 seconds to the maximum point without causing pain (Test 1). In the second test, the leg was raised for 20 seconds to the point where the subject complained of pain because of muscle stretching (Test 2). The degree of pain was assessed by a Visual Analogue Scale (VAS) with a range from 0 to 100 [10]. In Test 2, legs were raised until the pain was between 80 and 90 on the VAS.

Subjects were given sufficient rest between each test. Blood pressures were recorded continuously, and the succeeding test was begun after the blood pressure had returned to the resting level.

The maximal and minimal values of SBP and DBP were compared under different conditions. Data was analyzed using the Wilcoxon test with significance defined as $p < 0.05$.

Results

An example of blood pressure measurements recorded during Test 1 and Test 2 is shown in Figure 2. During Test 1, many subjects showed slight increases in both SBP and DBP, while some showed no change. During Test 2, all subjects showed definite increases in both SBP and DBP.

The maximal and minimal SBP and DBP values during the testing and resting periods are shown in

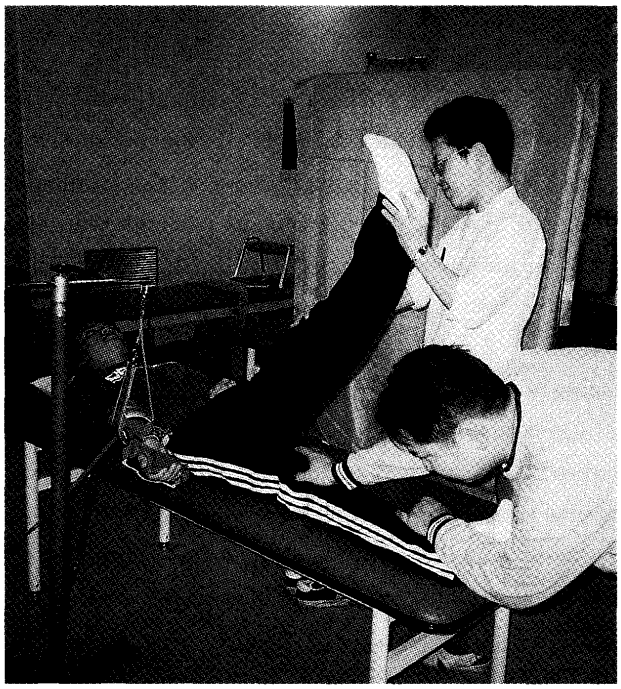

Fig. 1 Straight leg raise test

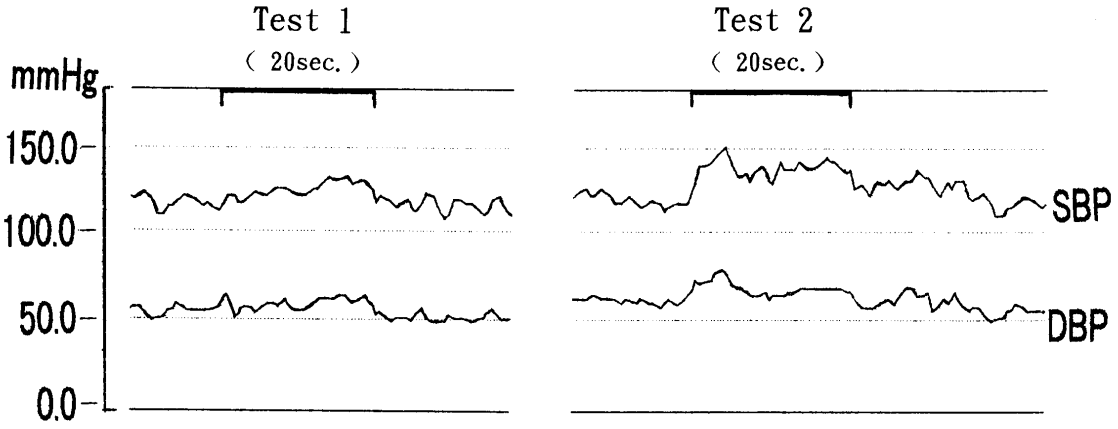

Fig. 2 An example of blood pressure recording during Test 1 and Test 2

Table 1 The maximal and minimal SBP and DBP values at rest, during Test 1 and Test 2

	SBP		DBP	
	Maximum	Minimum	Maximum	Minimum
Rest	122.6 ± 15.0	114.7 ± 13.0	59.5 ± 6.7	54.6 ± 6.7
Test 1 (painless)	128.8 ± 18.7 *	115.9 ± 13.4	65.1 ± 9.9 *	55.6 ± 9.3 *
Test 2 (painful)	136.8 ± 20.4 *	119.0 ± 15.3	71.7 ± 9.2 *	57.4 ± 6.6

mean ± SD (mmHg) *: $p<0.05$

Table 1. No significant differences were found in maximal and minimal SBP and DBP values during Test 1 when compared with those during the resting period. However, maximal SBP and DBP values during Test 2 were significantly higher than those during Test 1 and the resting period. In addition, minimal DBP values during Test 2 were significantly higher than those during the resting period.

Discussion

Many investigators have reported that blood pressure is influenced by exercise [1-6]. Most exercises, however, are active such as static contractions and lifting of heavy weights. The authors' previous reports on changes in blood pressure were also concerned with active exercises such as static contractions and sit-ups [7-9]. No one has reported on changes in blood pressure during passive limb exercise, so the authors decided to examine the problem. It was found that blood pressure did not change significantly during passive exercise without pain (Test 1). However, when subjects complained of pain (Test 2), blood pressure increased significantly compared with those during rest and passive exercise without pain. Thus, passive exercise accompanied by pain due to the stretching of muscles and tendons seemed to cause an increase of blood pressure.

Morikawa et al [11] reported that cardiac output did not change significantly in passive exercise. The passive exercise in their study was knee extend-flex movements at a rate of 60 per minute for 1-1.5 minutes. Therefore, they suggested that the effect of passive movement on the cardiovascular system could be

neglected. This conclusion was supported by the results of the present study.

Generally, pain is known to cause a rise in blood pressure [12]. Some possible causes of this presser response are stimulation of the vasomotor centers in the medulla, hypothalamus and cortex, and the influence of secretory hormones [12-14]. The relationship between pain and blood pressure seems to be complex and remains unclear. Schmidt [15] described the components of pain activated by noxious signals. He explained that all the components of pain, namely, the sensory discriminative, affective (emotional), autonomic, motor, cognitive, and psychomotor factors, usually appeared together, although their magnitudes varied.

The increase in blood pressure during passive exercise due to pain from muscle stretching should be given careful consideration, especially in patients with unstable blood pressure. Further studies should be undertaken under more clinical conditions, since patients who undergo occupational and physical therapy are usually older and susceptible to unstable blood pressure.

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