Blood Flow of the Ipsilateral and Contralateral Lower Limbs after Isometric Contraction

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Summary Calf and thigh blood flows in both of right and left legs were measured simultaneously after isometric contraction of the right thigh muscle. Isometric contraction was performed at a force of about 50% of maximal voluntary contraction for 15 sec. The thigh blood flow of the right leg increased immediately after voluntary contraction in all subjects, while the calf blood flow of right leg decreased conversely in spite of exercised ipsilateral leg.

The redistribution of blood flow which occurs during exercise involves an alteration of blood flow to resting regions of the limbs has been investigated by several authors (Bishop et al., 1957; Blair et al., 1961; Bevegard and Shepherd, 1966; Lind et al., 1964; Eklund et al., 1974). They measured the blood flow of the contralateral limbs such as forearm of the right and left or upper limb and lower limb. Recently, however, the question has been raised as to the blood distribution in active and non-active parts of the ipsilateral limb. In a previous study (Matsui et al., 1978), we measured the blood flow of thigh and calf with a femoral venous occlusion method. With this method, it was possible to examine the blood flow in the ipsilateral side of the exercised leg (Kitamura et al., 1979). The present study, therefore, was undertaken to examine whether or not there were any differences in the changes of blood flow between ipsilateral and contralateral sides of the leg after isometric contraction.

The subjects were 6 healthy male students of our university, aged 19 to 22 years. All experiments were performed in the supine position with the legs at heart level; the subjects lay on a firm couch with their feet suspended from the ceiling as shown in Fig. 1.

After a resting control period of 30 min the subject started to contract the right thigh at a force of about 50% of maximal voluntary contraction for 15 sec; the researcher lifts the right knee of the subject up a little as his foot leaves the

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suspension from the ceiling, and then the subject performs isometric contraction of the right thigh so that he exerts force downward against the rising knee. The force during contraction was checked by the dynamometer. The subject was also required to remove or minimize any muscular contraction in his non-active leg during contraction of the right thigh.

Blood flow of the calf and thigh in both of the right and left legs were measured simultaneously before and after isometric contraction with mercury-in-rubber strain gauge venous occlusion plethysmography. Four strain gauges, under a tension of 25 g, were wound lightly around the maximal circumferences of the calf and thigh, respectively. In order to occlude venous blood flow in the leg, both right and left femoral veins were pressed simultaneously by 2-3 kg/cm² pressure on the anterior surface of the femoral triangle near the sulcus inguinalis as reported previously (Matsui et al., 1978). The calculation of blood flow was performed based on the assumption described by Whitney (1953).

The blood flow in the resting condition was measured for 4 times at 1-min intervals. Post-exercise blood flow was taken as quickly as possible immediately after exercise (within 10 sec), and then in about 20-sec intervals until one minute of recovery. The values of mean and standard deviations for the resting blood flow of the thigh and calf were 4.38±1.85 and 3.86±1.75 ml/100 ml·min for the right leg, and 4.34±1.61 and 3.49±1.11 ml/100 ml·min for the left leg, respectively. The difference in resting values for the two legs was not significant.

Figure 2 shows the results of thigh and calf blood flow after isometric contraction of the right thigh for 15 sec, expressed as percentage of its value at rest. A significant fall in blood flow immediately after isometric exercise was observed in the non-active lower limbs. It is of interest that immediately after exercise the calf blood flow of right leg decreased in all subjects in spite of having exercised the ipsilateral leg. Although it is well known that $P_{CO_2}$, $H^+$, lactate and temperature in the arterial blood increase by exercise (Sahlin et al., 1978), the reason for the decrease of blood flow in the non-active lower limbs after exercise seems to be the results of a vasoconstriction via vasomotor center from peripheral chemoreceptor (carotid and aortic bodies) as consequence of increment in $P_{CO_2}$, $H^+$ and
Fig. 2. Thigh blood flow (TBF) and calf blood flow (CBF) both of right and left legs after isometric contraction at a force of about 50% of maximal voluntary contraction for 15 sec. Values are expressed as percentage of its value at rest.

lactate. On the other hand, thigh blood flow of right leg increased after isometric contraction as shown in Fig. 2. This increase could be explained by a balance of two competitive factors, one is a vasoconstriction, and the other is a vasodilation; if vasoconstriction by the vasomotor center exists in the right thigh, the increase of blood flow in the right thigh after exercise appears to be due to the
vasodilation in the working muscle because the rise of $P_{CO_2}$, $H^+$ and temperature will act directly on blood vessels as vasodilation. In other words, it is possible to assume that vasodilator tone in the right thigh may be higher than that of vasoconstrictor. However, the possibility mentioned above needs further investigation.

REFERENCES


