水中環境下での脚筋力トレーニングは筋血流制限下のトレーニングと言えるのか

国士舘大学　須藤明治
（共同研究者）同　角田直也
鹿屋体育大学　田口信教
東京大学大学院　藤原寛康
和光大学　矢田秀昭

Is Thigh Muscle Training in Water Immersion Done under Muscle Blood Flow Control?

by

Akiharu Sudo, Naoya Tsunoda
Faculty of Physical Education,Kokushikan University
Nobutaka Taguchi
National Institute of Fitness and Sports in Kanoya
Hiroyasu Fujiwara
Graduate School of Arts and Sciences,Univeristy of Tokyo
Hideaki Yata
Department of Humanrelations,Wako University

ABSTRACT

The purpose of this study is to clarify the changes in oxygen saturation inside the muscle tissue compartment at rest during and during dynamic knee-extension exercise under several circumstances in six male subjects. The study was carried out under the following circumstances: standing position on the ground, sitting position on the ground,

recumbent position on the ground, standing position A（depth = 77 cm）in water, and standing position　B（depth = 117 cm）in water. We observed that the oxygenated hemoglobin（HbO_2）during rest was unchanged, a decrease in the amount of deoxygenated hemoglobin（HbD）commensurate with an increase in the venous return. We observed similar results when comparing the recumbent position on the ground with the standing position（B）in water, and when comparing the sitting position on the ground with the standing position（A）in water. The surface electromyograms（EMG）of latissimus dorsi muscle,vastus medialis muscle,gluteus maximus muscle and biceps femoris caput longum muscle. During the resting time, the standing position（B）in water showed a greater amount of latissimus dorsi muscle activity compared with the recumbent position on the ground by the integrated EMGs（iEMG）. Changes in positions and circumstances did not produce observable changes in the tissue oxygen saturation（StO_2）and arterial blood oxygen saturation（SpO_2）during exercise. With compared the resting state any significant rise in heart rate（HR）was not observed during exercise when. Also, the iEMG of latissimus dorsi did not change when the latissimus dorsi were out of the water compared with the iEMG of latissimus dorsi of the exercise on the ground, but lower activity was observed when the latissimus dorisi were in the water. From the above results it is believed that exercise in water, as done in this study, was not done under control of muscle blood flow. it was observed in this exercise that muscle activity became less when the water level was made higher. In water 117 cm deep（xiphoid process level）approximates the physiology of the bloodstream observed in the state of lying down. This indicates that there is no overload on the heart, and moreover, that there is not much load on the muscle. Therefore, it is concluded that the nature of the exercise environment can contribute to improving joint mobility.

要　旨

陸上立位，陸上座位，陸上臥位，浅水立位（A:77cm），深水立位（B:117cm）の各姿勢・環境において，安静時及び膝関節伸展運動時の内側広筋部の組織内酸素飽和度の測定とその時の筋電図測定を行った．その結果，陸上立位と比較して他の姿勢や環境は，安静時の組織ヘモグロビン量（HbT）において低値を示した．その原因は，組織脱酸素化ヘモグロビン量（HbD）の減少であった．HbDは静脈の還流量を表していることから，椅座位や仰向け姿勢及び水没によって静脈の還流が多くなり，内側広筋部の静脈血流入量が減少したものと考えられた．

そして，組織酸素飽和度（StO_2）と心拍数（HR）の値から陸上臥位と深水立位，陸上座位と浅水立位との間に血流動態が類似していることが確認された．次に，運動時のHbTは，陸上時と比べ深水立位時に有意に低値を示し，安静時と同様にHbDの有意な低下が観察された．しかし，

StO_2には有意な差が認められなかった．これは，運動時のHbTの減少が安静時と比べると少なかったため，StO_2には影響を及ぼさない程度の静脈還流の増加量であったことが窺えた．また，運動により，動脈血流入量の増加による組織酸素化ヘモグロビン量（HbO_2）の増加傾向および静脈還流量の増加によるHbDの減少傾向が認められた．そして，運動時の各環境における動脈血の酸素飽和度（SpO_2），HbO_2の有意な差はなかった．

以上の結果から，本研究における水中環境下での運動は，筋血量制限下の運動ではなく，浅水位A:77 cm（大転子レベル）では陸上座位，深水位B:117 cm（剣状突起レベル）では陸上臥位の血流動態に類似した環境での運動であることがわかった．