Effect of the Technical Training on the Mechanical Work Done in the Kip of Horizontal Bar

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INTRODUCTION
The kip in horizontal bar is one of the important skills, but it is difficult maneuver for beginners to learn and execute. Most of the investigations on the kip compared successful trials with failed ones, and/or the executions of the skilled subjects with the unskilled one. Although the technical training is mandatory to success the kip, there is no study on effects of the technical training on the learning of the kip skill. The purpose of this study was to investigate the effects of the technical training of the kip on the mechanical energy in the process of training.

METHODS
Three male subjects who had no experience to perform the kip were selected. They practiced the kip on the horizontal bar for five to twelve days. All the trials were videotaped in the sagittal plane with a VTR camera (60Hz). The trials of every five trial were selected to analyze the joint torques and powers and mechanical works done by the joints of the shoulder and hip. The motion range analyzed was between the instant that the CG of the subject passed under the bar during forward swing and the instant of the maximal CG height.

RESULTS AND DISCUSSION
The number of trials to success the kip was ranged from 47 to 108, depending on the subjects. Maximal CG height gradually increased with the increase in the number of trials, and peak hip extension torque also increased. However, the peak torques of the other joints did not change remarkably.

Figure 1 shows relationships between the number of trials and mechanical work done by the shoulder and the hip joints in the case of subject A. Filled circle indicates successful trial. The amount of mechanical work was large in the shoulder than the hip.

![Figure 1. The relationships between number of trials and mechanical work done by the shoulder and the hip joints in the case of subject A.](image-url)
Although the mechanical work done by the shoulder joint did not significantly relate to the number of trials in all three subjects, that of the hip joint significantly related (subj. A : r=0.66, p<0.05; subj. B : r=0.77, p<0.001; subj. C : r=0.78, p<0.001). These results indicate that increasing mechanical work done by the joints, especially by the hip joint plays a role to rise CG and to success the kip.

Figure 2 shows change in the shoulder and hip joint angular velocities, joint torques, and joint torque powers in the successful, the fifth last, and the middle trials during training for subject A. The vertical line shows the instant that the subject’s CG passed under the bar during the backward swing. In the successful trial, the shoulder extension angular velocity had three peaks, while there was two peaks in the other trials. The hip extension angular velocity in the successful trial was larger and the peak appeared later than in the other trials. The hip extension torque in the successful trial was larger and the peak appeared later than in the other trials.

The maximum power of the shoulder was observed in the middle trial. The hip torque power had peaks, i.e. during forward swing and backward swing, each. The second peak in the successful trial was remarkably larger than in the other trials. It is likely that the increase in the mechanical work done by the hip joint torque with technical training resulted from the increase in the second peak, mentioned previously.

In summary, it is important for beginners learning the kip to develop the hip extension torque during the backward swing and to extend the range of motion of the hip joint.

Figure 2. Change in the shoulder and hip angular velocities, joint torques, and joint torque powers in the successful, the fifth last, and the middle trials during training for subject A.