Interlimb force facilitation between hands and leg muscles

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Short title: Effects of hand grip strength on maximum leg strength
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[Introduction]
Many activities are performed using both hands and legs in multi-dimensional movements. The integration of muscle activities in the extremities with those in trunk muscles is often required for activities of everyday life and better performance in sports. This believes to be an effective way to stabilize body trunk and to generate larger force in the movements by transferring energy through each joint of extremities. However, despite requiring the integrity of extremities in daily activity, there are only few researches on the study of the integration of extremities on the muscle force generating capacity. The present study investigated the effects of handgrip force generation on the maximum isometric knee extension.

[Methods]
Thirty-eight healthy young individuals (mean+/−S.D.; age, 20.6+/−0.8 yr) participated in this study. In experiment I, maximum isometric knee extension force of the right leg was measured at six different knee angles with the knee extension dynamometer. During the measurements, subjects placed their arms in front of their chest. Separately, maximum isometric handgrip force of the right and left hand together was measured with a handgrip dynamometer. In experiment II, based on the knee joint angle–force relation in the knee extension movement determined in experiment I, the knee joint angle at optimum force was applied to obtain the maximum isometric knee extension force with the maximum handgrip force. For MVC measurement, subjects exerted maximum force for ~3 seconds. Measurements were repeated three times with at least one-minute rest period between bouts, and the mean value among the measurements was calculated for MVC. Data are presented as mean±SD.

[Results]
In experiment I, the knee joint angle–force relation in the knee extension movement was determined. The isometric force exhibited a peak when the knee joint was flexed at 110 degree on average. Based on this result, the joint angle at 110 degree was set for the measurement in experiment II. In experiment II, the maximum isometric knee extension force with the maximum handgrip significantly increased when compared with the maximum isometric knee extension force alone, and these represent 172.47±57.47 Nm and 151.23±52.68 Nm (p<0.001), respectively; however, the maximum handgrip force did not significantly different between the maximum handgrip force together with the maximum isometric knee extension and the maximum handgrip force alone, and these represent 56.82±19.47 kg and 60.45±17.74 kg (p>0.05), respectively.

[Discussion]
The results indicate that the leg muscle force generation integrated with hand force generation is effective to elevate the leg muscle force generation. The mechanism underlying this new phenomenon is not fully understood, but this can be speculated with the stabilizing the trunk through force generation of upper limbs and hands.