SLOW AND FAST COVARIANT TORQUE CHANGES PRODUCED AT THE ANKLE AND HIP JOINTS DURING HUMAN QUIET STANDING

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The stability of quiet standing (QS) in humans is considered to be maintained mainly by the control actions at the ankle joint. However, as can be easily predicted, the torque changes at the ankle joint can affect the hip joint torque required to balance the upper body segments. Therefore, the cooperative torque exertion at both joints would be needed for stabilizing the QS. The present study investigated the time-dependent torque patterns produced at both joints during human QS.

Eight healthy young subjects were requested to stand quietly for 30 sec. The subtle angular displacements around both joints in a sagittal plane were measured using four highly sensitive CCD laser displacement sensors (Keyence, LK-2500). The angular acceleration was calculated numerically. The joint torques were estimated by substituting the kinematic data into the equation of motion (the torques extending joints were defined as positive).

The estimated torques consisted of slow and fast fluctuating components. The contribution of the slow trend in the total torque variance was below 70% for both joints, indicating that there are considerable amount of fast component which is not directly related to the static postural equilibrium. Furthermore, the torque at the hip joint covaried linearly with that at the ankle joint not only for the slow trend but also for the fast component. The values of their proportional constants were different (slow:0.51 ± 0.22, fast:0.75 ± 0.15). These results indicate that, during human QS, both joint torques are simultaneously controlled according to two kinetic constraints with different time scales.

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