

## Modeling of a Pendulum Test Including Skin and Muscles under Compression

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**Abstract :** Pendulum tests were used to identify a stretch reflex and diagnose spasticity. Some researches tried to make a mathematical model to simulate the motions. Thighs are subject to compressive forces due to gravity during a pendulum test. Therefore, it affects knee trajectories. However, the most studies on the pendulum tests did not consider that conditions. We used Kelvin-Voight model as compression model of skin and muscles. In this study, we investigated viscoelastic behaviors of skin and muscles using gelatin blocks from experiments of the vibration of the compliantly supported beam. Then we calculated a dynamic stiffness and loss factors from the experiment and estimated a damping coefficient of the model. We also did pendulum tests of human lower limbs to validate the stiffness and damping coefficient of a skin model. To simulate the pendulum motion, we derive equations of motion. We used stretch reflex activation model to estimate muscle forces induced by the stretch reflex. To validate the results, we compared the activation with electromyography signals during experiments. The compression behavior of skin and muscles in this study can be applied to analyze sitting posture as well as developing surgical techniques.

**Keywords :** Kelvin-Voight model, pendulum test, skin and muscles under compression, stretch reflex

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