Effect of the fatigue in the equilibrium training

Innopolis, 2021
A series of experimental works in a group of 17 unpaid conditionally healthy volunteers (8 male and 4 female) was carried out. Age of the volunteers ranged from 25 to 42 years, the physical conditions corresponded to the characteristics of a normal body mass index and an average level of physical activity. The duration of the experiment was about 45 minutes. During the recording of signals, subjects were standing on the balance platform. The structure of the experiment included three 10-minutes sessions with two 5-minutes rest pauses between them.
EMG registration

TA – Tibialis Anterior
GM – Gastrocnemius Medialis
RF – Rectus Femoris
ST – Semitendinosus

During the experimental session, we were recoding EMG, angle and velocity of the balance platform signals simultaneously.
For all sessions on the records of all subjects in this way were calculated total number of attempts, as well as their duration, start position of the platform. Before going to a position close to zero slope. For marking successful attempts can use balance keeping duration parameters and the boundary angle from which the position is considered to be equilibrium.

Number of the attempts versus cutoff degree angle and successful attempt duration.

To obtain equal number of successful (Ns) and unsuccessful (Nu) attempts we tested such parameters as cutoff degree value (alpha), duration time (dt) and number of excluded subjects (R). The lowest area of intersection (3rd row) corresponding to the longest possible duration with the tightest boundary was chosen as an optimized value.
Repeated measures correlation

Repeated measures correlation between the equilibrium attempt duration and platform velocity variance in 0.5 s. before achieving equilibrium demonstrates significant negative effect. That means subject should minimize the velocity of the platform to make better attempt.
Significant muscle interaction cluster

Repeated measures ANOVA for correlation between all muscle pairs revealed a muscle interaction cluster in which correlation constantly increasing between the experimental sessions.
Fatigue estimation

To estimate the muscle fatigue we used a method proposed in the work:


The RMS represents the square root of the average power of the EMG signal for a given period of time. Then Wigner-Ville transform was performed on the RMS data and Wigner-Ville Distribution (WVD) obtained. From WVD Instant Median Frequency (IMDF) can be calculated. Lower values of IMDF correspond to the stronger muscle fatigue.
IMDF averaged for all subjects during the whole experiment.
It is possible to see the activity corresponding to the three sessions and two rest breaks between them.
Statistical analysis revealed the significant changes in muscle fatigue between sessions, especially notable between the third session and others.
Fatigue

IMDF distribution analysis and its RM ANOVA established that shin muscles were suffering from fatigue more than the hip muscles.
Repeated measures correlation between the sum of equilibrium attempt duration and IMDF demonstrates significant negative effect. That means stronger fatigue leads to the better global performance and helps with the equilibrium training.
Conclusions

- Thus, the learning effect has been demonstrated in the work, growing from the session to the session.
- The growth of the correlation between muscle pairs can act one of the reasons for this effect.
- The uneven fatigue between individual muscles was shown.
- Positive influence of the fatigue on the total equilibrium duration is found.