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PELVIS STABILIZING MUSCLES ACTIVITY AND FORCES IN HIP FLEXION RESISTANCE TRAINING ANYBODY MODELING

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INTRODUCTION

One of the most important aspects of physiotherapy is the problem of muscle balance in the pelvis girdle region. The typical observed scheme include hip flexors shortening and hypertension and hip extensors weakening and elongation. The scheme is present both in typical posture defects [2] and low back pain [1]. The idea of the hip flexion resistance training arised basing on muscle resistance training morpho-physiological adaptation mechanisms [3,4]. Since typical daily activities include a variety of hip extension resistance and endurance training, the oposite exercise was selected as a potential sollution to the pelvis stabilizing muscles inbalance.

METHODS

The movement of the resistance hip flexion was recorded with the BTS Smart system for one healthy individual (woman, age 29, weight 49 kg, height 168 cm). There were 28 movement cycles recorded. Each trial contains the exercise performed with both legs in the order: 1) right leg, 2) left leg. Equipment used in the exercise was a free weight machine constructed according to the patent P.435615 (Figure 1B). The exercise was performed with the use of the device weight only. Strain gauges were placed under the feet platforms (separately for the front foot and the back foot) and in the bindings (placed on the back of the feet). A motion capture-driven Musculoskeletal Model (MS) (Figure 1A) was created in the AnyBody Modeling System (AnyBody Technology A/S, Denmark) with the measured forces applied as boundary conditions.

RESULTS AND DISCUSSION

The MS model inverse dynamics study showed that all crucial hip flexors and abductors were highly activated in the exercise. The force generated by each muscle (Figure 1C) was determined by its size and function and did not reflect the muscle activity level. The exercise was designed as a multijoint opposite equivalent of the squat exercise. The resistance application in the movement was therefore untypical for human motor system anatomy. The obtained training conditions showed that the most active muscles generate unproportionally low forces. The disproportion suggests a potential for hypertrophy in long term training [5].

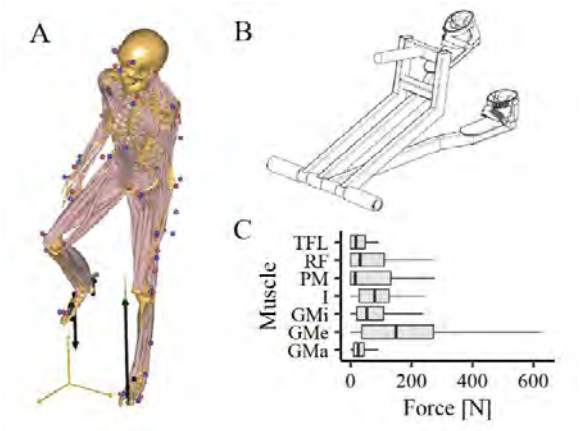

Figure 1A MS model of the exercise, **1B** training equipment construction scheme, **1C** Selected muscles forces in hip flexion resistance training, GMa – Gluteus maximus, GMe – Gluteus medius, GMi – Gluteus minimus, I – Iliacus, PM – Psoas major, RF – Rectus femoris, TFL – Tensor fasciae latae.

CONCLUSIONS

The results show that the proposed exercise activates targeted muscles (hip flexors and abductors) and has a potential to build hypertrophy in muscle groups that present the scheme of shortening in individuals diagnosed with posture defects or chronic low back pain. The exercise requires further validation as a candidate for posture and pain kinesitherapy.

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REFERENCES

[1] Geisser ME et al. *J. Pain* **6**:711-26, 2005.
[2] Hrysomallis C et al. *J. Strength Cond. Res* **15**:385-90, 2001.
[3] Joanisse S et al. *F1000Res* **24**, 2020.
[4] Jones DA et al. *Q. J. Exp. Physiol* **74**:233-56, 1989.
[5] Lim C et al. *Med Sci Sports Exerc* **54**:1546-59, 2022.