Pelvis stabilizing muscles' activity patterns in hip flexion and extension resistance exercise in inverse dynamics modeling

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Summary

The study touches on issue of muscle balance in pelvis girdle as one of the factors contributing to motor system health. Activity patterns of pelvis stabilizing muscles of 14 participants were analyzed in inverse dynamic study of hip flexion and extension resistance training. Models were validated with the use of SEMG. The analysis has shown a convergence of muscle activity patterns in hip extension exercise to morpho-functional schemas observed in common low back ailments as hyperlordosis, increased pelvic tilt and chronic low back pain. Hip flexion resistance training was found to activate muscles presenting a tendency for hypertension and shortening in low back ailments symptomatic subject.

Introduction

Pelvic girdle muscular equilibrium constitutes a fundamental determinant of postural integrity and spinal health, as the intricate interplay of agonist and antagonist muscle groups in this region ensures biomechanical stability and optimal force distribution across the axial skeleton. Muscular imbalances can precipitate aberrant postural alignments, leading to chronic low back pain [1], excessive lumbar lordosis [2], or increased anterior pelvic tilt [3]. Such deviations not only compromise musculoskeletal efficiency but also predispose individuals to chronic lumbosacral strain, and vertebral disc degeneration [4].

The opposite exercises were chosen to study congruence between anatomical scheme of pelvis stabilizing muscle and two outmost movements activating those muscles. The study aimed at determining if common motoric schemas correlated with low back ailments may reflect muscles' activation patterns in selected exercises.

Methods

Hip flexion (free weight machine according to the patent P.43561 with 5kg weight plate) and extension (a 34cm step and a 5kg barbell with weight plates 2x2.5kg) resistance exercises of 14 participants (age: 22.36±2.35yrs, height: 175.43±11.79cm, weight: 72.00±17.81kg) were recorded with BTS Smart system (BTS S.p.A., Milanese, IT, Italy). The additional load placed on participants in both exercises (including the training device weight) was ~15kg

Hip flexion (Figure 1a) and extension (Figure 1b) motion capture-driven Musculoskeletal Models (MS) were created in the AnyBody Modeling System (AnyBody Technology A/S, Denmark). Models were verified with selected muscles SEMG. Ground reaction forces were predicted according to method of Fluit, Andersen et al. [5].

Muscles' activity in both exercises was also analyzed in relation to pelvis stabilizing muscles' average volumes. The scheme observed in muscle anatomy in low back ailments was used in the analysis as an indicator of a tendency for muscle elongation and shortening.

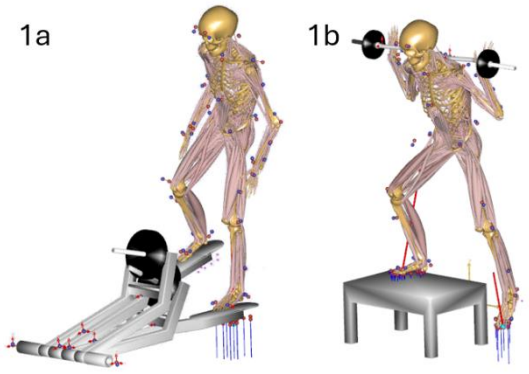

Figure 1: Motion capture-driven AnyBody Musculoskeletal models of resistance hip flexion (1a) and extension (1b) exercise.

Results and Discussion

In the hip flexion exercise the most active muscles were psoas major, tensor fascia latae and iliacus successively. In hip extension the most activity was observed in gluteus maximus, gluteus medius and gluteus minimus successively. The muscle activity of major hip flexors and extensors during the exercise of resistance hip extension was found to be coherent with the morpho-functional scheme observed in low back ailments.

Conclusions

The common emphasis on hip extension resistance training may be a potential contribution to pelvis stabilizing muscles imbalance observed in low back ailments-related morpho-functional schemas. The exercise of hip flexion resistance training requires further studies as a potential tool for balancing the lower body training protocols.

References

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