The Spring-like Function of the Lumbar Fascia in Human Walking

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HYPOTHESIS Although almost every person swings the arms and rotates the trunk in walking, the movement of arms and trunk in gait analysis are generally regarded as one inflexible passenger block serving no function in walking. We introduce the hypothesis that the lumbodorsal fascia acts as an elastic spring helping to propel the mass of the trunk forward. METHODS We developed a model of a walking human body which included the legs, the pelvis, the back, the shoulders and the arms. We described the kinetics of this body using accurate mathematical treatment of applied mechanics. The legs are represented by inverted pendulums. The pelvic and the shoulder girdle are represented by torsion pendulums and the arms by suspended pendulums. A crisscross arrangement of elastic springs acts as a model for the posterior layer of the lumbodorsal fascia (PLF) which is put under tension by the latissimus dorsi and the glutaeus maximus muscles, thus connecting diagonally the contralateral arm and leg pendulums, based on the anatomical findings from [2]. The PLF has an attachment at the trunk (spine) in the lumbar region. Anthropometric data were mainly taken from [3]. The two muscles were assumed to work isometrically, thus giving the LDF a pre-stretch as described in [1]. The elastic stiffness of the PLF in vivo is unknown – instead we used Young's modulus of human tendons. This set of interconnected oscillators in the gravity field was handled by formation of the appropriate Lagrange function. The obtained equation was solved numerically with Maple™ software. The time-dependent values of kinetic and potential energies during the cycle of movement were examined. RESULTS The lumbodorsal fascia, the latissimus dorsi and the glutaeus maximus muscle together form a continuous bowstring-like sling, being able to periodically exert a sagittal force helping to propel the mass of the trunk forward. Acting in this way, these two muscles (being the largest of the human body) can also do work in the normal walking movement in an efficient isometric way, in addition to the generally recognized triceps surae muscle. The values of the kinetic and potential energies during the stride cycle show a shift from pendulum to spring loading and back again. As such, the PLF acts as an active force transmitter. CONCLUSION In contrast to the traditional gait analysis, the pendulum action of the arms and the spring-like action of the lumbar fascia can have the potential to facilitate energetic efficiency in walking. REFERENCES

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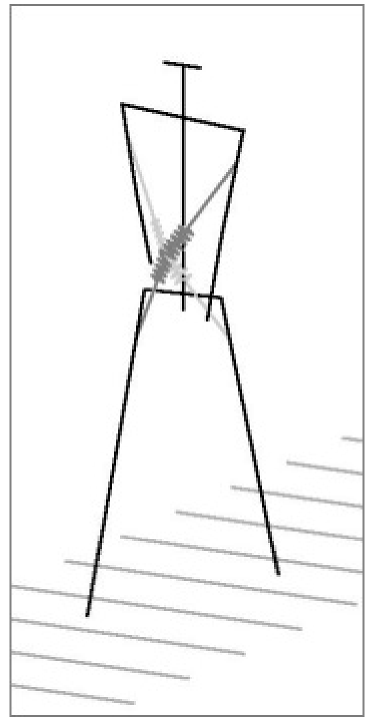

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