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ASSESSING THE RELATION BETWEEN SPINO-PELVIC PARAMETERS AND LUMBAR LOADS THROUGH MUSCULOSKELETAL MODELING APPROACH

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Summary: Introduction: Spinal loads distribution and muscles activations are expected to be in relation with the spino-pelvic anatomical parameters. Unfortunately, assessing this relation accounting for in vivo measurements results unfeasible since acquiring internal loads is highly invasive and identifying the anatomical parameters requires radiographic examination. Conversely, musculoskeletal modeling allows to non-invasively investigate this relation through the so-called inverse dynamic approach, which provides loads and muscles activations in assigned postures. To this aim, the present work exploits the AnyBody full-body model to assess the relation between lumbar loads and spino-pelvic parameters in the lateral plane.
Methods: The model was evaluated in standing position. The simulated postures were set by accounting for spino-pelvic parameters obtained from the literature and characterizing adult healthy populations. The four Roussouly lumbar type (RT) curves were considered. For each RT, three sagittal balance (SB) postures (backward, medium and frontward) were assessed. The pelvic parameters, i.e. sacral slope (SS) and pelvic incidence (PI), ranged from 25° to 55° and from 30° to 70°, respectively, with specific limits imposed in relation with RT. Overall, 2771 configurations were simulated. The following measurements were computed: axial force and postero-anterior shear at L4L5 level; multifidus (MF), longissimus spinae (LS) and rectus abdominis (RA) muscles forces.
Results: Axial force values were lowest in RT3 (ranging from 310N to 440N) and largest in RT1 (545N to 760N). Generally, medium SB provided lower axial forces. Postero-anterior shears were lowest in RT4 (45N to 60N) and largest in RT1 (70N to 170N). Frontward SB provided larger shears in RT1 and RT2, whereas backward SB increased shears in RT3 and RT4. RA and ES resulted activated in backward and frontward SB postures, respectively. MF was found more activated in frontward SB, with the only exception of RT3. The computed measurements resulted affected by SS changes but not by PI variations.
Discussion: Musculoskeletal modeling approach confirmed to be a valuable tool to non-invasively investigate the relation between internal loads and spino-pelvic parameters. The L4L5 loads were found dependent on RT. As expected, medium SB guaranteed lower load values. Surprisingly, PI variations did not affect load distribution and muscles activations.