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LOAD-SHARING IN HAND-HELD STANDING POSTURE: COMBINED MUSCULOSKELETAL AND FINITE ELEMENT MODELING

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Summary: Understanding load-sharing among passive and active components of human lumbar spine during various daily and sport activities is vital to injury prevention, implant design, as well as the evaluation and treatment of spinal disorders. Load-sharing at segment L4-L5 has been previously investigated using a combined passive and active musculoskeletal model based on in-vivo load [1]. Recently, we investigated load-sharing over the entire lumbar spine in upright standing and forward flexion postures also using a combined FE and musculoskeletal model [2]. The current study extends this work by quantifying changes in load-sharing while holding a load of 198N with the arms extended parallel to the trunk. The body height and weight of the musculoskeletal model were specified at 168 cm and 70 kg, respectively. The musculoskeletal model predicts the muscle forces and joint reactions, which are then input into the FE model to predict load-sharing, intradiscal pressure, and disc loads.

Our results reveal that adding the load, in comparison with the no load upright posture, increases the total local muscle forces by 10%, and decreases the total global muscle forces by 23%. The IDP also increased at all levels, such that the highest increase (45%) occurred at the L5-S1. Disc shear, compression and moment also increased considerably at all levels except the L5-S1, where the disc moment was reduced to zero. The role typically played by the disc as a major load-bearer in the upright posture was not affected by the hand-held load. On the other hand, the contribution of the ligaments in resisting disc shear and moment, although minimum, was slightly affected by adding the load. The facet joints did not contribute to the load sharing in both loading scenarios. Such detailed information of the spinal load-sharing is of high relevance to research and clinical communities, alike.

References

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