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DEVELOPMENT OF A VALIDATED MUSCULOSKELETAL MODEL TO PREDICT SPINAL LOADING FOR VOLLEYBALL ATHLETES

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Summary: Volleyball is a demanding sport with high bearing on the lumbar spine. Studies have reported the high prevalence of low back pain (LBP) in volleyball, mostly associated with degenerated intervertebral discs. Enhanced knowledge of spinal loading in volleyball and its variation during specific movements is important towards injury prevention and professional training. Therefore, the objective of this study was to provide a validated biomechanical model to predict the muscular forces and spinal loading during specific movements in volleyball. Three male volleyball players of regional level (age: 20.67(±2.52) yrs., mass: 84(±7.55) kg and height: 1.91(±0.05) m) participated in this study upon informed consent. The participants were asked to perform typical movements: upright standing, spike, bump set and block, which were executed using a ball passed by a third player. Forty markers were placed on reference points, and the kinematic data were captured using six VICON T-Series infrared cameras (VICON, Oxford, UK) at 500 Hz. The electrical activity of the muscles (EMG) was also monitored using surface electrodes. An instrumented force plate was used to measure the ground reaction forces/moments. A musculoskeletal model was developed using Standing Model from AnyBody (AnyBody Technology, Denmark). All kinematic data was obtained from the model in MATLAB under the relevant conditions and input to AnyBody. Inverse dynamics were then used to balance the external loads based on minimum energy principles. The average EMG data and GRF were used to check the validity of the model. For each activity, the calculated forces in the intervertebral disc were extracted. The results demonstrated that the maximum force was observed in proximo-distal region of the L5-S1, in alignment with literature. For all lumbar discs, including L5-S1, the minimal force occurred in the medio-lateral region. Compared to the upright standing, the force in proximo-distal direction of the L5-S1 increased by 428 (±85.7)%, 342 (±56.3)% and 118 (±23.9)% for spike, bump set and block, respectively. This work provides a novel tool that can be used to estimate spinal loading during sports. Prediction of spinal loading associated with movements executed in particular sports is invaluable towards injury prevention and performance optimization.