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Editorial

Hand and Wrist Biomechanics

Verónica Gracia-Ibáñez *, Néstor J. Jarque-Bou and Margarita Vergara

Department of Mechanical Engineering and Construction, Jaume I University, Castellón de la Plana, 12071 Castellón, Spain
* Correspondence: vgracia@uji.es

The complexity of the human hand enables us to carry out a huge variety of activities, providing us with functional independence [1]. In-depth knowledge of healthy hand behaviour, from grasping biomechanics to complex manipulation in daily life activities, regarding both kinematics and muscle activation comprehension, is a challenging field. This knowledge is of vital importance in areas such as robotics and prosthetics [2,3], especially when trying to imitate the behaviour of the human hand, which is one of the most difficult parts of the human body to imitate. It is also key in ergonomics, for product design as well as for improving work environments [4]. Designs must consider healthy hand and wrist operating parameters to avoid forcing the human mechanisms, in order to avert injuries [5]. In addition, many injuries and pathologies affecting the hand and wrist cause a large number of people each year to suffer from disabilities, preventing them from a fully functional life [6]. Understanding the biomechanical limitations produced by these diseases is of vital importance in clinical decision making and in rehabilitation treatments [7].

This Special Issue contains contributions on (i) studies that improve the biomechanical understanding of the healthy human hand and wrist; and (ii) applied health studies that use biomechanical parameters of the healthy human hand and wrist as a gold standard. These parameters are used in certain pathologies for a better understanding of the functional limitations they produce or for the design of implants to improve surgical techniques.

This Special Issue comprises a total of five papers, including work on the use of smoothness metrics; tackling whether to characterize healthy wrists or to analyse improvements in hand trajectories after rehabilitation in paediatric patients with spinal cord injury (SCI); the use of finite element modelling to analyse carpal tunnel syndrome behaviour; and even the test of a novel passive implant to restore finger flexion following tendon transfer surgery. Finally, a short communication analysing a kinematic data glove with pressure sensors is also included. Scano et al. (Contribution 1) provide mapping of four smoothness metrics for the wrist (NJ: normalized jerk, SM: speed metric, SAL: spectral arc length, and NP: number of speed peaks wrist). Smoothness is correlated with motor impairment and with clinical measures; thus, the study enables a better characterization and understanding of smoothness behaviour in healthy subjects, establishing benchmark values for clinical applications. Future works analysing wrist metrics in specific pathologies should be performed. Salas-Moreno et al. (Contribution 2) analysed smoothness and efficiency metrics of the hand trajectory in paediatric SCI patients after rehabilitation supported by a humanoid robot. They found that the training produced improvements in tetraplegia patients, but not in paraplegia patients without impaired manipulative dexterity. Peshin et al.'s model (Contribution 3) shows wrist flexion as the most traumatic movement in compressing the median nerve, compared to wrist extension or finger flexion. A decrease in compression during finger flexion was noticed with wrist extension followed by finger flexion. The passive implants proposed by Raja et al. (Contribution 4), to be used instead of tendon transfer surgery after high median-nerve palsy, improved finger flexion and force production, thus improving grasp performance whilst implying only one additional suturing step, increasing the surgery by 15 min at the most. Roda-Sales et al. (Contribution 5) analysed the feasibility of using a kinematic data glove with pressure sensors to automatically

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differentiate free motion from product manipulation, stating that it would be very useful in kinematic analysis, but the current design of the gloves does not allow for this at the moment.

Although the scope of the articles in the Special Issue was broad, four of the five articles have focused on the application of hand and wrist biomechanics for clinical use, which gives an idea of the relevance of research in this field.

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