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CURRENT EVIDENCE ON BIOMECHANICAL MODELING FOR THE ANALYSIS OF CRUTCH-ASSISTED GAIT

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ABSTRACT

Crutches are utilized as a mean of locomotion by patients with a variety of long-term disabilities, such as cerebral palsy or spinal cord injury. These assistive devices help reducing the load imposed on the injured lower extremities, while allowing an upright posture. However, crutch-assisted gait places a considerable repetitive effort on the upper extremities (UE), which are not adapted to weight-bearing tasks, thus contributing to the onset of secondary health conditions. Due to the raising significance of this problem, the research on biomechanical modeling strategies for the analysis of the loads imposed on the UE during crutch-assisted gait has been growing. The resulting scientific knowledge may provide promising options for the improvement of crutch design based on patients' biomechanical outcomes and, thus, a detailed evaluation of this topic is strongly warranted. This has been the main motivation for preparing this review, which provides a comprehensive discussion and summary of the biomechanical modeling strategies currently available in the literature used to study crutch-assisted gait. PubMed, Scopus, and Web of Science electronic databases were searched on July 2021, and 18 studies, dated from 1985 to 2021, were included. Six studies used commercial software (OpenSim or Anybody), while the remaining developed in-house codes. Fifteen studies considered three-dimensional biomechanical models, among which six focused on the UE, eight modeled the entire human body and one did not provide this information. Musculoskeletal models were considered only in 17% of all studies. Three strategies were used to incorporate crutches on the biomechanical models, namely defining this assistive devices as a rigid body independent of the forearm/hand, imposing a position constraint on the glenohumeral joint, and using an arm/crutch or forearm/crutch system as a single rigid body. Forces exerted on the glenohumeral, elbow and wrist articulations during swing-through crutch gait were double the ones during reciprocal gait.

Keywords: Biomechanical modeling, Assistive devices, Crutches, Multibody dynamics

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