

Design and Biomechanical Analysis of a Passive Shock-Absorbing Forearm Crutch for Prevention of Secondary Upper-Limb Pathologies

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Abstract:

Standard forearm crutches are hard devices that immediately transfer impact forces to the upper limb when they hit the ground. This could cause other musculoskeletal problems in the future, like joint degeneration, nerve compression, and shoulder pain. This work presents the design and biomechanical evaluation of a passive shock-absorbing forearm crutch featuring a 3D-printed thermoplastic polyurethane damping element incorporated into a lightweight structural frame made of a nylon-carbon fiber composite. The design's goal is to reduce impact without making the device more complicated or expensive. Finite element analysis was used to check the safety of the structure, and a high safety factor was found when it was tested under normal conditions. We used a universal testing machine to do compression tests on the damping element to figure out how stiff and energy-absorbing it was. Preliminary findings indicate a significant ability for energy dissipation and progressive viscoelastic deformation. The purpose of the planned motion capture biomechanical validation is to check for changes in the rate of force development and peak ground reaction force during crutch-assisted walking. The suggested design is a cheaper, more reliable alternative to complicated robotic crutch systems. It will make users more comfortable and usable over time.

Keywords:

Assistive devices, biomechanical analysis, crutch design, shock absorption.