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Walking-Assisted Gait in Rehabilitation

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Abstract

Walkers are extensively used by individuals to improve stability and ambulatory ability. Despite common usage and prolonged existence, the basic walker design still remained unchanged. The objective of this study is to develop an instrumented walker and evaluate the force transferred through the subject hand's resultant pressures. The corresponding forces are used for the analyses of upper extremity kinetics and kinematics. Human motion tracking system is used for the kinematic analysis, which is used to modify a walker that is capable of reducing the stress experienced by the subject without changing the usage pattern of the walker. The upper extremity kinematics and kinetics data were acquired through QTM motion capturing system incorporate with Visual3D motion analysis system. The internal force and joint moment for the wrist, elbow and shoulder were determined using inverse dynamics method.

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Keywords: Walker-Assisted Gait; Upper Extremity; Joint Angle; Joint Moment; Force Measurement,; Kinematics

1. Introduction

According to the report did by United Nations, since 2010, there already have 530 million elder people all over the world[1]. Out of 300, there would be one person who using walkers[2]. Therefore the numbers of using walkers continuously increase each year. Such mobility aids are often required by older adults or by people with various clinical conditions so that they can move independently. Walker-Assisted Gait is a common device for ambulatory assistance for individuals with balance difficulties or to reduce lower extremity demands following injury or surgery. The long-term use of a walker imposes significant demands on the patient's upper extremities that may lead to increased risk for development of secondary conditions such as wrist, elbow or shoulder pain[3]. When there are

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injuries that not allow the patient to standing posture and walking, they usually force to use a wheelchair for mobility. Life in a wheelchair often results in secondary complications[4]. Reconstruction of walking is desirable to improve not only loco motor functions but also physiological problems[5]. Most of the walkers were designed without analyzing upper extremity of the human gait locomotion while using it. Upper limb extremity conditions, such as carpal tunnel syndrome, median neuropathy[6], stress fractures and upper limb risk of pain were previously associated to chronic use of ambulatory devices[7]. However, little is known about the stresses placed on the upper extremities during ambulation with assistive devices. The objective of this study is to investigate the biomechanics of upper extremity and modify the 4 legs pickup walker to make it able to minimize load distribution on the hand based on the three dimensional loads obtained from wrist, elbow, and shoulder.

2. Methods

2.1 Modelling

Modelling the gait permits predictions of performance and demand which may assist in the selection of optimal conditions for rehabilitation. The purpose of the study is to identify the kinematics features of walking frame ambulation using a simple model of a body segments and to validate the model with reference to a population of healthy subjects walking with a frame.

2.2 Assumptions

The staircase arranged from several platforms to create a two steps stair with step height of 18cm. The motion is captured by 6-cameras, Qualysis motion capture cameras. The ground reaction force is measured using Bertec force plate placed on the second stair step. The data is recorded at a sampling rate of 100 HZ both for Qualysis cameras and force plate. The 3D model is created along with the kinetic and kinematic data are collected using Visual 3D software on personal computer. A number of assumptions such as segment length, walking frame level, spine single segment etc., were made prior to the theoretical analysis of the activity in order to permit solution of the various equations generated throughout the analysis.

2.3 Experimental procedures

Eight subjects (4 male and 4 female), mean age of 46.4 (from 23 to 63) with normal health conditions are involved with the studies. Motion tracking System is used to track the motion of the walking gait. Four markers were used to define the Thorax/Ab bone segment. Upper arm segment was defined by a total of seven markers. Forearm was modeled by a total of eight markers. Hand segment was defined by five markers [Fig 1]. Force plate is used to measure the user body weight before and after use of walker. QTM (Qualisys Track Manager) supports a range of force plates, which enables force data capture along with the motion capture. Measure ground reaction force, centre of pressure and moments. Visual3D software utilized the model parameters to obtain the kinematics and kinetic data through inverse dynamics. After bone segment setup, Visual3D software obtained the kinetics and kinematics data from each segment, such as angular velocity, angular acceleration, segment center of mass position, segment center of mass velocity, and segment center of mass acceleration [Fig 2]. This typical human arm is demonstrated by modeling the 3 link planar robotic arm as shown in Fig.3.

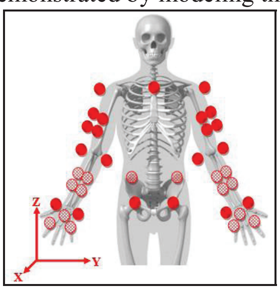

Fig. 1. Hold Body Marker Position

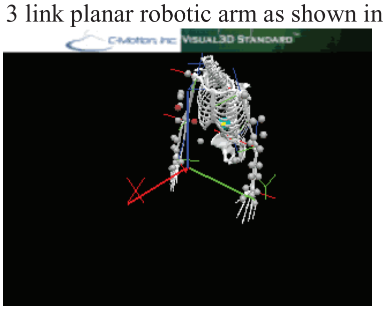

Fig. 2. Human Bone Segment by Visual3D

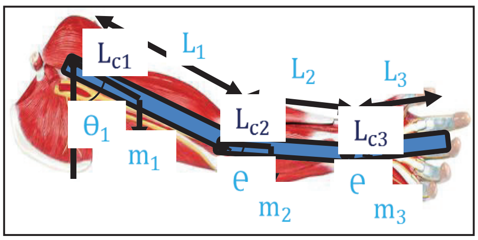

Fig. 3. Human arm which as 3 link mechanical arm