Comparison of Biomechanical Characteristics of Gait Between Osseointegrated and Socket Prosthesis Users following Transfemoral Amputation: A Systematic Review Protocol

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Introduction

Amputation is a life-altering event with a noticeable effect on the quality of life. Depending on a prosthesis can improve the physical activities and independence of persons with amputation. Most people with above-knee amputation are fitted with a prosthesis attached to the residual limb with the socket's aid. However, the socket prosthesis's comfort and efficiency depend on how well the socket fits onto the residual limb [1]. Common problems of the socket prosthesis experienced by people with unilateral above-knee amputation are pressure pain, sores, skin irritation, inability to walk quickly, heat and sweating in the socket [2]. These inefficiencies affect mobility, daily activities, and quality of life in people with lower-limb amputation [3].

In order to address the problems associated with socket-suspended prosthetic devices, osseointegration surgery is an option. Osseointegration (OI) surgery creates a direct connection between the bone and the prosthesis. Implants, which connect the bone and the prosthesis, are biocompatible metal devices, surgically inserted into the residual bone. Over a few months, the implant integrates with the bone. The advantages of osseointegration surgery include easy and fast prosthesis attachment, maintaining the same position of prosthesis during daily activities such as walking, and no socket to cause sweating, sores, or discomfort [4,5]. The implant allows forces from daily activities (such as walking) to be transferred directly to the bone, whereas in a socket prosthesis, these forces are also transferred to the soft tissue, which causes some skin problems. [6].

Optimizing gait biomechanics is important to address the efficiencies and inefficiencies of osseointegrated prosthetic devices. Instrumented gait analysis is a way to collect the quantitative data of the gait cycle to evaluate the walking performance in people with healthy and pathologic gait. It investigates kinematic, spatiotemporal, kinetic, and electromyography (EMG) data to identify pathologic gait [7]. Kinematic data describes the movement of the joints without regard to force generation [8], and it includes displacement and orientation of body segments, joint angles, and spatiotemporal gait parameters [9]. The magnitude of the ground reaction forces and its relationship to joint centers and lower-limb joint mechanical moments and powers are the factors that determine moments or torque about a joint, which represent the magnitude and direction of the kinetic data [8]. EMG within instrumented gait analysis analyzes the muscle activation patterns during the gait cycle by obtaining the timing and action of muscles that contribute to walking.

This systematic review aims to report on kinematics, spatiotemporal, kinetics, and EMG activation data for persons with transfemoral amputation who use traditional socket-suspended or osseointegrated prosthetic devices in order to understand whether the gait of osseointegrated prosthesis users is closer to that of unimpaired gait compared to the socket prosthesis users.

Criteria for including studies in the review

Population

This systematic review will include studies that report on adults with transfemoral amputation over the age of 18 who walk with socket-suspended or osseointegrated prosthetic devices.

Intervention

People with transfemoral amputation who walk with osseointegrated prosthetic devices will be considered as the intervention group in this systematic review.

Comparator

The comparator group in this review are people with transfemoral amputation who walk with socket-suspended prosthetic devices.

Outcome

Biomechanical characteristics including kinematics, spatiotemporal, kinetics, and EMG data for persons with transfemoral amputation who use socket-suspended and osseointegrated prosthetic devices will be reviewed in this paper.

Studies

This systematic review will consider all study designs, including systematic reviews and excluding case-report studies.

Review Question

What are the differences in kinematics, spatiotemporal, kinetics, and EMG data between transfemoral socket prosthetic ambulation and osseointegrated prosthetic ambulation on level walking surfaces as reported by instrumented gait analysis? Specifically, in persons with transfemoral amputation, is the gait of osseointegrated prosthesis users closer to unimpaired gait than that of socket prosthesis users?

Methods

Search Strategy

A search will be executed by a health librarian/expert searcher in the following databases: (Ovid Medline, Ovid Embase, EBSCO CINAHL, E I Compendex, Scopus, PEDro, Cochrane Library (CDSR and Central Register of Controlled Trials). No limits will be applied. .Reference lists of included articles will be searched for additional sources. Authors of primary sources will be contacted for further information if necessary.

on The following study types will be excluded: animal models, non-prosthesis users, radiographic or microbiological investigations, ramp or inclined walking, the investigation of gait quality without identification of biomechanical features, or studies based on systems other than optical motion capture systems. References will be exported to Covidence systematic review software, where duplicates will be removed.

Data Extraction

Two independent reviewers will screen titles, abstracts and full text using Covidence, and assessing the risk of bias. The following daata from included studies will be extracted including the name of author(s), year of publication, origin/country of origin (where the source was published or conducted), aims/purpose, study population and sample size within the source of evidence, methodology/methods, type of study, details of any intervention (if applicable), outcomes and details of how the outcomes are measured (if applicable), and key findings that are relevant to the objectives of this systematic review will be developed in a spreadsheet. The outcomes of this review will be included the kinematics, spatiotemporal, kinetics, and EMG data of people with transfemoral amputation during gait. Kinematics data are including pelvic tilt/obliquity/rotation, hip flex/extension, hip ab/adduction, and knee flex/extension. Velocity (unit: m/s), cadence (unit: steps/min), stride length (unit: m), and step length (unit: m) are spatiotemporal data that will be investigated in this paper. Kinetics data include hip ab/adduction moment, hip flex/extension moment, knee flex/extension moment, and ankle dorsi/plantarflexion power. Data extraction will be piloted with 5 included articles to verify or modify the extraction strategy. Finally, to assess the quality of included studies, reviewers will use the STROBE checklist to determine the strengths and weaknesses of relevant content and methodology used in each paper.

Data Analysis

Upon extracting data from included studies, we will collate information about each of the biomechanical gait variables reported and provide a preliminary summary of findings. Furthermore, a comparative analysis between the biomechanical variables in persons with transfemoral amputation who are socket-suspended or osseointegrated prostheses users and similarities and inconsistencies in the outcomes in the included studies will be developed. Additionally, how and why the intervention works and the relationships within and between studies will also be discussed.

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