Technical Note

Prosthetics and Orthotics International

INTERNATIONAL SOCIETY FOR PROSTHETICS AND ORTHOTICS

Three-dimensional printing in prosthetics: Method for managing rapid limb volume change

Prosthetics and Orthotics International
1–4

DOI: 10.1177/0309364620934340
journals.sagepub.com/home/poi
SAGE

Eric Nickel[1], Kyle Barrons[1], Barry Hand[2], Alana Cataldo[1] and Andrew Hansen[1,3]

Abstract

Background and Aim: During post-amputation recovery or rapid body mass change, residual limb volume can change quickly, requiring frequent adjustments or replacement of the socket to maintain fit. The aim of this pilot test was to evaluate the feasibility of using a three-dimensional-printed insert to extend the service life of a prosthetic socket after substantial residual limb volume loss.

Technique: One research subject with a well-fitting transtibial prosthetic socket had an oversized socket fabricated to simulate substantial limb volume loss. The digital shapes of the oversized and well-fitting sockets were used to create a three-dimensional-printed insert to restore fit.

Discussion: Two-minute walk test distance decreased when using the oversized socket without the insert, but not when using the socket with the insert. Socket comfort score was 8+ under all conditions. These results suggest that three-dimensional-printed inserts may be an effective method of extending the service life of prosthetic sockets when rapid limb volume loss occurs.

Clinical relevance

Three-dimensional (3D) printing gives prosthetists a new tool to manage large volume changes without refabricating entire sockets. Sockets can be fabricated in anticipation of volume gain/loss, using replaceable 3D-printed inserts to maintain fit and comfort.

Keywords

Socket fit, three-dimensional printing, lower limb prosthesis, socket volume

Date received: 27 August 2019; accepted: 27 April 2020

Background and Aim

Traditional prosthetic sockets have a rigid, fixed volume but the human body is a dynamic system that is always changing. Prosthetic sockets are fabricated with the expectation of some limited limb volume changes, both increases and decreases. Minor fluctuation in limb volume throughout the day and from day to day are traditionally managed by adding or removing residual limb socks or periodically doffing the prosthesis.[1–4] Limb volume changes due to long-term trends such as slow physiological changes (e.g. muscle atrophy, steady body mass gain/loss) may result in poor fit due to excessive limb volume loss.[4] The Amputee Coalition of America recommends keeping weight (body mass) loss or gain to within 2% of body weight (mass) to preserve socket fit.[5] Large volume changes as the residual limb matures (the first 6 months post-amputation and at a slower rate up to 18 months post-amputation)[6–8] require frequent new prosthetic sockets or socket alterations to improve fit,[4] leading to an increased cost of care. Some prosthetic socket designs, (such as the Revo Fit socket, by RevoLabs, Salt Lake City, UT) are intended to accommodate some volume change, but the fabrication challenges of such systems remain a barrier for clinical application to patients with rapidly changing limb volume, such as during the post-amputation recovery phase, despite recent evidence of the benefits for patients.[9,10]

[1]Minneapolis VA Health Care System, Minneapolis, MN, USA
[2]Reify LLC, Johns Island, SC, USA
[3]University of Minnesota, Minneapolis, MN, USA

Corresponding author:
Eric Nickel, Minneapolis VA Health Care System, Mail Stop 151, 1 Veterans Drive, Minneapolis, MN 55417-2309, USA.
Email: eric.nickel@va.gov

Associate Editor: Laura Miller