Prosthetic Choices for People with Leg and Arm Amputations

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KEYWORDS

• Prosthetics • Amputation • Artificial limbs • Amputees

KEY POINTS

- Provision of a prosthesis is only a component of prosthetic rehabilitation. It takes a coordinated team to optimize outcomes and functional independence.
- The most sophisticated components are not the most appropriate for everyone. All options must be weighed with consideration of the person who will be wearing the prosthesis, their environment, and *realistic* goals.
- Suspension is integral in most socket designs and must be optimized in order to prevent rubbing, slipping and fitting complications.

INTRODUCTION

Prosthesis (*noun*): a single artificial limb

Prostheses (*plural noun*): more than one artificial limb

Prosthetic (*adjective*): of or relating to artificial limbs (ie, prosthetic leg)

Prosthetics (*noun*): the profession or field of study related to artificial limbs

The explosion of options that modern technology has afforded individuals who sustain amputations or who are born with congenital limb deficiencies can be overwhelming for health care practitioners and people who rely on prosthetic technology alike. Powered, microprocessor-equipped components offer enhanced control and sophistication. Material and technology advances, improved socket designs, surgical techniques, and prosthetic rehabilitation have empowered prosthetists (and the health care team) with the ability to truly deliver the most advanced prostheses ever invented. This trend will continue in perpetuity.

Yet the most sophisticated device is not the most appropriate for everyone. The excitement provided through the media often gives people unrealistic expectations

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of the capacities that can be attained through the utilization of the latest and greatest. And for people who are not candidates for the best currently available prostheses, for what type of prostheses *are* they candidates? Strong scientific evidence dictating choices regarding specific components, suspension systems, and/or socket designs does not (yet) exist. How do you choose?

The aim of this article is to present the options that are available for people who rely on artificial limbs to enhance their quality of life for mobility and independence. Components by name, manufacturer, or coding category have been bypassed in lieu of a focus on features and considerations that must be made in order to make informed decisions; however, specific examples are included. Sockets, liners, and suspension systems for all levels of amputation or limb deficiency are presented first, followed by sections about feet, ankles, knees, and hip joints (for lower limb prostheses) and then sections on terminal devices, wrists, elbows, and shoulder joints (for upper limb prostheses). Although funding sources play a significant and often primary role in decisions regarding access to prosthetic rehabilitation services, the impact of funding limitations on one's choices related to prosthetic rehabilitation services are not considerations of this article.

SOCKETS, LINERS, AND SUSPENSION SYSTEMS

> If the interface between the wearer and the device is intolerable, nothing else matters.

Contemporary socket designs include lightweight carbon outer frames wrapped thoughtfully around advanced thermoplastic, anatomically optimized shells. Socket liner technology has evolved from wool socks and polyethylene foam to liners made from urethane, silicones, or thermoplastic elastomers. Grouped generically as *gel* liners, they are the most commonly used prosthetic interface in North America. All gel-type liners must be rolled onto a residual limb with careful attention to avoid air between the skin and the liner; hence, dexterity is required for independent donning. Liners also require daily washing, require regular replacement (6–12 months), may be hot, and perceived as bulky. Different types of liners are integral to different suspension systems.

Cushion liners consist of different thicknesses of gel with or without a fabric covering and are rarely sufficient to provide suspension alone (**Fig. 1**). In transtibial applications, they are combined with a knee sleeve, which seals the residual limb/socket chamber, and an expulsion valve creating a suction socket. The chamber is created between the inner surface of the prosthetic socket and the outer surface of the liner, not between the liner and the skin. Negative pressure (subatmospheric) is created when the residual limb is pressed into the socket on loading and subsequently extracted during unloading. Variations of this sealed suction system have been used on transfemoral, hip disarticulation, and upper limb prostheses.

Elevated vacuum (also known as vacuum assisted) suspension takes the same system described earlier; however, the negative pressure in the chamber is increased by the addition of an electric or mechanical vacuum pump. Elevated vacuum suspension reduces residual limb pistoning,[1] reduces residual limb volume loss,[1–4] and has demonstrated value in residual limb wound healing.[5] In addition to added weight and the need for daily charging (for electric pump systems), the knee sleeve may restrict the knee range of motion in transtibial elevated vacuum wearers. Liners for