WHEN SHOULD WE BIOMECHANICALLY EXAMINE A LOWER-LIMB AMPUTEE?  
A SYSTEMATIC REVIEW OF ACCOMMODATION TIMES

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INTRODUCTION

Over two million Americans are currently living with limb loss, with 185,000 new amputations occurring annually. Of these, approximately 65% involve loss of a lower-extremity. Fifty-four percent of amputations are due to diabetic complications and 45% are due to trauma [1].

Technological advances, particularly over the past 30 years, have completely transformed the care of musculoskeletal disorders, including more advanced prosthetic devices that use a combination of sensing, actuation, and microprocessors to enhance function on even surfaces, hills and stairs, and in other high-demand applications. However, our understanding of how and when patients adapt to a new conventional or advanced prosthesis is unclear. Only one study to our knowledge specifically examined stabilization of data over time but the study was limited to one male above-knee amputee over only three weeks [2]. Other previous studies on above-knee amputees appear to have a wide range of testing timepoints, ranging from testing immediately after receiving a new prosthesis to testing after two years, making it unclear when testing should be performed to ensure accurate and relevant results.

The goal of this systematic review was to identify evidence-based consensus of when biomechanical analysis on amputees should occur after a patient receives a new prosthetic limb.

METHODS

A systematic literature search was conducted in January 2015 using PUBMED (1964-January 2015) and Scopus (1948-January 2015). The databases were searched using generic terms related to lower-limb amputation and prosthetic devices. The following lines were used: (lower limb OR lower-limb OR leg OR thigh OR shank) AND (amput* OR transtibial OR transfemoral) AND (prosth* OR (C-Leg) OR (Intelligent Prosth*) OR (BiOM)).

As the goal of this systematic review was to gather any articles related to an investigation of a prosthesis the inclusion and exclusion criteria were kept simple. The search was limited to peer-reviewed journal articles, human subjects, and the English language. Titles, abstracts, and full texts were then screened as necessary to further exclude articles: conference proceedings; theses; dissertations; reviews; case reports; studies examining bilateral amputees or subjects under the age of 18; studies examining new prosthetic components, such as prosthetic sockets and pylons, or alignment changes; and studies that did not include biomechanical analyses were all excluded from the review.

Once the search was complete, relevant data were pulled from each article. We were most interested in the amputee participant populations and if an accommodation time was given. Data extracted included sex, height, weight, age, type of amputation and cause, time since amputation, experience with a prosthetic, prosthetic device worn prior to testing, prosthetic device(s) tested, and time given to accommodate prior to testing a new prosthetic limb.

RESULTS AND DISCUSSION

A total of 7901 unique hits were found between PUBMED and Scopus. After reviewing titles and abstracts, a total of 283 articles remained. Of these, 116 matched our criteria and were included in this review. For completeness, the references of these articles were examined which resulted in an additional 28 articles for a final total of 144 articles.
A total of 2026 amputees were investigated from all 144 studies. Of these, 1113 (55%) had amputations due to trauma, 286 (14%) were due to vascular causes, 172 (8%) were due to cancer or tumor, 150 (7.4%) due to other causes, and 305 (15%) were not specified.

Of the 144 articles, there were a total of four investigations involving hip or pelvis amputation, 65 involving an above-knee amputation or knee disarticulation, and 85 involving a below-knee amputation. The median number of days given for accommodation for all investigations was 8.5 days with an interquartile range (IQR) of 30 days (Figure 1,2).

![Figure 1: Number of accommodation days for the 144 investigations. Range 0-154 days.](image)

![Figure 2: For hip, above-knee, below-knee, and total population the IQR for accommodation was 57.8, 83, 21, and 30 days, respectively. Median reported in IQR range.](image)

While many investigations clearly stated how much time was given for accommodation, many did not. A total of 53 investigations tested the day of receiving a new limb or did not specifically mention an accommodation time (Figure 3). Phrases such as “given as long as necessary”, “intensive practice phase”, and “break in period” were frequently used. These investigations were placed into the not reported (NR) category and it was assumed testing was done the day of receiving a new prosthetic limb.

![Figure 3: Detailed results for testing on the day of receiving a new limb. Not reported (NR).](image)

From these results, we can see that there is no clear consensus on when a biomechanical investigation should be performed on an amputee subject. Testing time points range from within minutes or hours of receiving a new limb to 5+ months after fitting.

**CONCLUSIONS**

Our systematic literature search resulted in 144 unique biomechanical investigations involving the amputee population. The median number of days to accommodate to a new prosthetic limb was 8.5 days with an IQR of 30 days. Above-knee and hip amputees were given more time to accommodate than below-knee amputees.

**REFERENCES**


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