

Characterizing Self-Reported Prosthesis Use in Everyday Tasks

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ABSTRACT

A sample of 411 individuals with either unilateral or bilateral upper limb amputation (ULA) reported prostheses engagement when they performed a spectrum of common one- and two-handed tasks. We compared frequency of performing one- and two-handed activities by laterality (unilateral versus bilateral), by amputation level (for unilateral amputees), and by type of prosthesis used (for unilateral transradial amputees). A greater proportion of persons with bilateral amputations reported engaging their prosthesis in both one- and two-handed tasks. Those with more proximal amputation engaged their prostheses in fewer activities, and persons using myoelectric single degree of freedom devices engaged their prostheses in a greater proportion of activities as compared to those using other device types.

INTRODUCTION

Few studies have characterized upper limb prosthesis engagement in everyday tasks. Prior research suggests that persons with unilateral upper limb amputation rely on their non-amputated side and perform the majority of daily activities with their non-involved side. [1] Unilateral combat amputees reported using their prostheses during 21-25% of 23 activities, with those with more distal limb loss tending to perform more activities with their prostheses as compared to those with proximal (transhumeral (TH), shoulder level (SH)) limb loss. However, this study did not include persons with bilateral amputations. A separate study of unilateral and bilateral upper limb amputees reported that they engaged their prosthesis during 34-36% of activities included in the OPUS Upper Extremity Function Scale (UEFS). [2]

While we expect that persons with bilateral limb loss would engage their prosthesis in a greater

proportion of activities, prior work did not stratify the sample by laterality, [1] or reported no differences [3]. It is likely that the type of prosthesis would impact the number and type of activities performed with a prosthesis. Myoelectric prostheses, for example, should not be exposed to water or harsh environments. Additional research is needed to describe prosthesis engagement during everyday activities. Such data would be useful for informing prosthetic training activities. Therefore, the purpose of this study was to characterize prosthesis engagement during everyday tasks, comparing performance for persons with unilateral and bilateral amputation. Further, we compared engagement of the prosthesis by unilateral amputation level, and by prosthesis type for persons with unilateral transradial (TR) amputation.

METHODS

The data for this report is a subset of cases collected in a large telephone survey. The sample consisted of U.S. military Veterans and civilians recruited through a variety of sources including VA databases, the Amputee Coalition of America, and a private prosthetics service company. Participants with major amputation (at wrist or more proximal) of at least one upper limb were included. Participants from the larger survey were included in this report if they were prosthesis users and reported information on prosthesis type and activity performance with the prosthesis.

Respondents shared demographic characteristics, amputation history, and current prosthetic device use and engagement in everyday tasks. Respondents reported whether they performed or attempted to perform each of 34 items with the assistance of their prosthesis in the past 2 weeks. The 34 items included 23 items from the UEFS, 5 additional items recommended by Jarl [4], and additional items identified by our research team as being challenging or relevant to women with upper limb amputation. We categorized 11 of these

activities as likely to be performed using one hand and 23 as two-handed activities.

We stratified the sample by laterality and calculated the proportion of each subgroup who completed each of the 34 tasks with their prosthesis. We compared the proportions using chi-square analyses. We compared proportions by amputation level for those with unilateral amputation using Kruskal-Wallis tests. We corrected for multiple comparisons using the Benjamini Hochberg procedure. [5]

We calculated the proportion of one and two-handed tasks completed by unilateral and bilateral amputees, and for unilateral amputees by amputation level, and compared the proportion of tasks completed using t-tests and ANOVA.

We classified the type of prosthesis used as body powered, myoelectric single degree of freedom (DOF) terminal device, and myoelectric multi-DOF terminal device, and compared the proportion of respondents who completed each activity with their prosthesis using Kruskal-Wallis tests. We also compared the proportions of tasks completed by prosthesis type using ANOVAs. These comparisons were limited to the sample with transradial/wrist disarticulation in order to provide robust estimates.

RESULTS

The sample for this report included 379 unilateral and 32 bilateral amputees. Characteristics of the sample are shown in Table 1. Participants were predominantly male (81%), white (83%), and not Hispanic (94%). TR amputation was most common (66%), followed by TH (20%) and SH (6%) levels.

Table 1: Characteristics of the Analytic Sample (N=411)

Gender	N (%)	Mn (sd)	
Female	79 (19.2)	Age 61.8 (14.3)	
Male	332 (80.8)		
Laterality	N (%)	Race	
Unilateral	379 (92.2)	White	340 (82.7)
Bilateral	32 (7.8)	Black	32 (7.8)
Amputation level (unilateral only)	N (%)	Unknown	25 (6.1)
		Mixed	14 (3.4)
		Ethnicity	N (%)
Shoulder	25 (6.1)	Hispanic	26 (6.5)
Transhumeral	62 (20.0)	Not Hispanic	373 (93.5)
Transradial	272 (66.2)		

Persons with unilateral amputation engaged their prosthesis in an average of 24% of unilateral tasks and 38% of bilateral tasks. While those with bilateral

amputation engaged their prosthesis in 64% of unilateral and 46% of bilateral tasks (Figure 1).

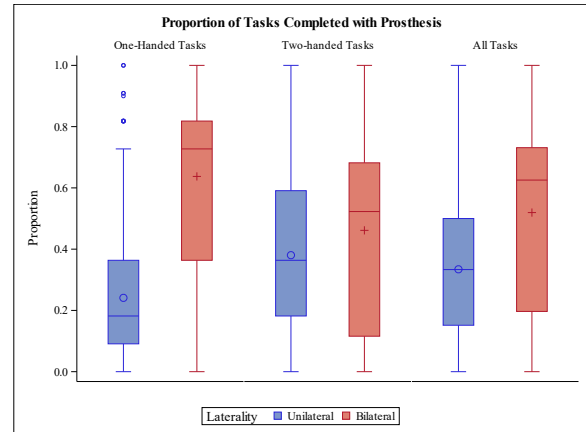


Figure 1. Box plots showing mean, median and distribution of proportion of tasks completed with prosthesis by laterality

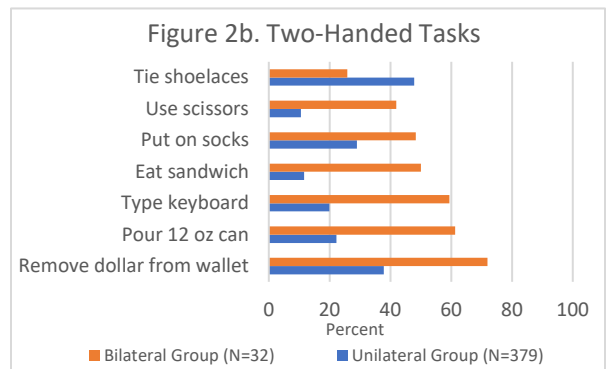
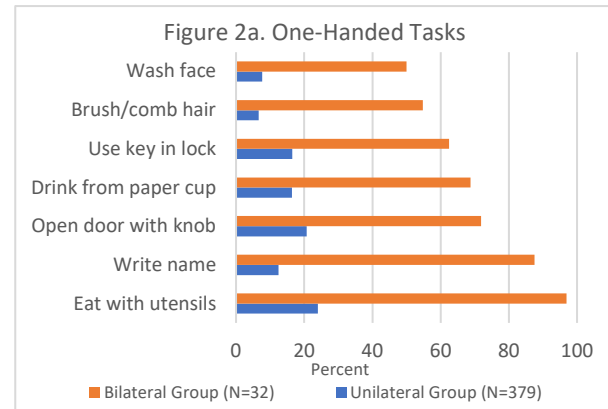
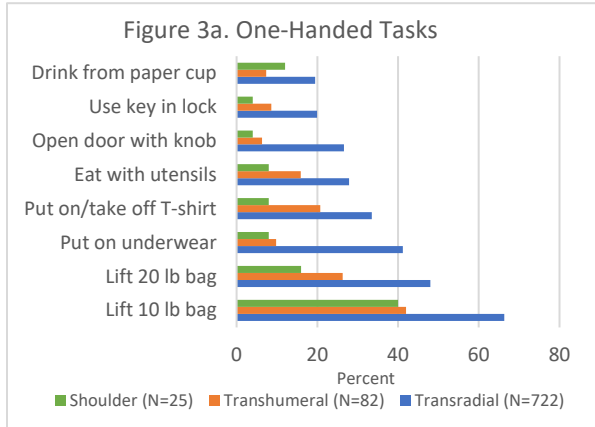


Figure 2a and 2b. Statistically significant differences in task performance by laterality

After adjusting for multiple comparisons, there were statistically significant differences in performance of 7 one-handed and 7 two-handed tasks by laterality (Figure 2). A higher percent of those with bilateral

amputation (compared to unilateral) completed these tasks, except tying shoelaces which had a higher completion rate for those with unilateral amputation. For persons with unilateral amputation, those with TR amputations engaged their prosthesis in an average of 28% of unilateral tasks and 43% of bilateral tasks as compared to those with TH (14% and 26%) and SH level

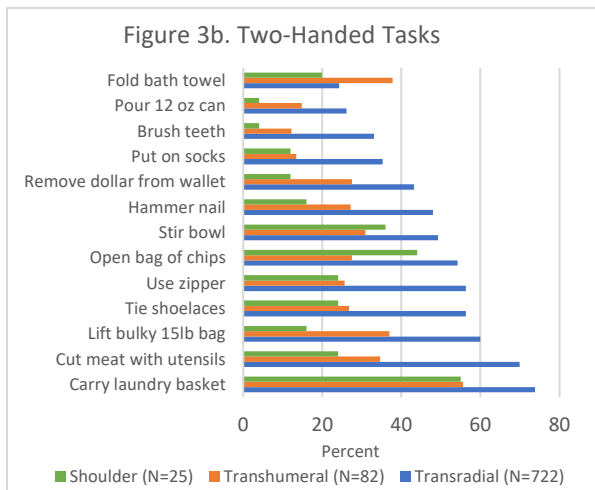


amputation (10% and 22%), respectively.

Figure 3a and 3b. Statistically significant differences in task performance by amputation level

Task completion rates varied significantly by amputation level for 8 one-handed tasks and 13 two-handed tasks (Figure 3). For these tasks, a higher percentage of the TR amputation group completed tasks with their prosthesis compared to those with more proximal levels.

A comparison of task performance by prosthesis type (for TR, unilateral amputees only) found that on average, body-powered prosthesis users engaged their prosthesis in 27% of unilateral tasks and 43% of



bilateral tasks, compared to myoelectric single DOF

users (35% and 50%), and myoelectric multi-DOF users (24% and 36%), respectively.

Two one-handed tasks and 6 two-handed tasks differed significantly by prosthesis type (Figure 4).

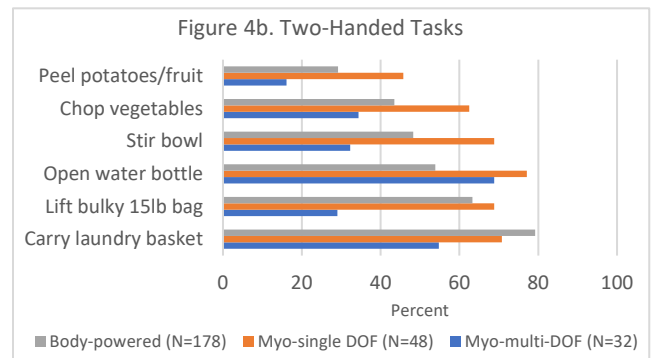
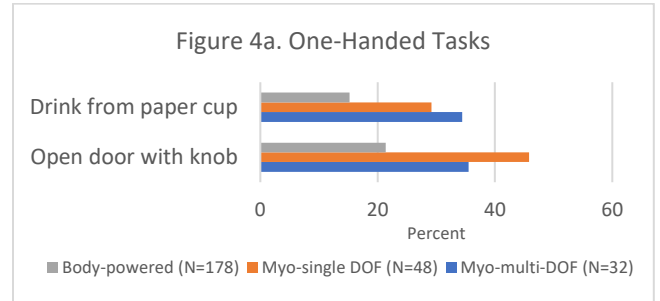


Figure 4a and 4b. Statistically significant differences in task performance by prosthesis type

DISCUSSION

This study compared frequency of self-reported engagement of the prosthesis when performing one- and two-handed activities of bilateral and unilateral amputees by amputation level and by type of prosthesis.

Persons with bilateral amputation engaged their prosthesis in more activities as compared to those with unilateral amputation. Specifically, persons with unilateral amputation engaged their prostheses in 24% of unilateral and 38% of bilateral tasks, while those with bilateral amputation engaged their prosthesis in 64% of unilateral and 46% of bilateral tasks. Our findings differ from that of Ostlie et al. who found that prosthesis users reported engaging their prostheses in approximately half of daily activities with a non-significant tendency for bilateral amputees to use their prosthesis in more tasks. [3]

Our study provides new information about the types of activities performed by prosthesis users, augmenting recent data obtained through accelerometer-based activity monitoring that found individuals with unilateral TR amputation engaged in bimanual activity

an average of 4 hours a day, but engaged in unilateral activities with their prosthesis for only 20 minutes [6].

Tying shoelaces emerged as a commonplace two-handed activity among those with unilateral amputation, along with removing paper currency from a wallet and donning socks. Among one-handed activities, eating with utensils, opening a doorknob, manipulating a key in a lock, and drinking from a paper cup were reported with the greatest frequency.

By comparison, bilateral amputees used their prostheses in 64% of unilateral and 46% of bilateral tasks. The most common one-handed tasks were eating with utensils and writing. Engagement of prostheses in two-handed tasks was less common than reported with one-handed tasks. Removing paper currency from a wallet, pouring a 12 oz. can and typing on a keyboard were the most commonly performed tasks.

While users of TR prostheses reported engaging their prostheses in one- and two-handed tasks more often than those with more proximal amputations, individual from this latter group reported engaging their prostheses across a spectrum of tasks (lifting and carrying tasks were performed the most). With respect to prosthesis type, engagement in both one- and two-handed tasks was highest for those using single degree of freedom myoelectric prostheses. This finding may reflect the enhanced grip strength associated with this prosthetic design.

Some persons with ULA may perform everyday tasks with only one extremity, or perform them by engaging their knees, teeth or other body parts or using assistive devices. We did not ask how respondents performed tasks, only whether they engaged the prosthesis during tasks. We did not ask about non-prehensile tasks and cannot make conclusions about differential engagement of the prostheses in these types of tasks. Spiers et al. observed a preponderance of non-prehensile prosthetic activities in daily activities [7]. Further research is needed to determine how prostheses are used, and whether there is active prehensile manipulation or non-prehensile use.

SUMMARY & CONCLUSIONS

Our findings demonstrate that individuals with bilateral ULA engage their prostheses in more tasks, especially more one-handed tasks as compared to those with unilateral ULA. Task performance with a prosthesis was reported less often for those with more proximal amputation levels than those with more distal amputation levels. Lifting and carrying tasks were the most common one-handed tasks performed by people with more proximal amputation levels. While similar patterns were observed across prosthesis type,

engagement of single degree of freedom myoelectric devices was reported with greater frequency than engagement with body-powered or multi-articulating myoelectric hands.

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