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Function, quality of life, and community integration of DEKA Arm users after discharge from prosthetic training: Impact of home use experience

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Abstract

Background: Research on adaptation to advanced upper limb prostheses is needed.
Objectives: To (1) examine change in function, quality of life and community integration after prosthetic training, (2) determine whether change in outcomes varied by prosthesis complexity, and (3) compare patterns of change at 1 month for those who withdrew from the study and those who did not.
Study design: Quasi-experimental time series.
Methods: Data were analyzed for 22 participants (18 completers). Performance and self-report outcome measures were collected after in-laboratory training (Part A) and every 4 weeks of home use (Part B). Outcomes from End of A to End of B were compared statistically. Outcomes across assessments and by configuration level were compared graphically. Changes in scores were compared graphically for completers and non-completers.
Results: Quality of life scores did not change between End of A and End of B, whereas scores improved for one activity measure, two measures of self-reported function, and three dexterity measures ($p < 0.05$). Outcomes of community integration, self-reported function, four dexterity measures, and one activity measure varied by prosthesis level. For participants who withdrew early, dexterity and activity scores worsened, perceived disability increased, and prosthesis satisfaction decreased after 4 weeks of home use.
Conclusion: Study completers adapted to the DEKA Arm.

Clinical relevance

Findings suggest that for the majority of upper limb amputees discharged from prosthetic rehabilitation, function continues to improve with home use. However, a minority experience a decline in function, greater perceived disability, and greater dissatisfaction after 4 weeks, suggesting a need for continued therapy after intensive prosthetic training ends.

Keywords

Prosthesis, upper limb, amputation, training, outcomes assessment

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Background

Prosthetic training is recommended to maximize functional use of an upper limb prosthetic device.[1] Prosthetic training protocols for upper limb amputees have been largely published in textbooks,[2] a handful of peer-reviewed papers,[3–5] or through websites of manufacturers.[6] Typical training programs last approximately 5 h for people with transradial (TR) amputation, 10 h for persons with transhumeral (TH) amputations, and 12–20 h for those with bilateral amputations.[2] Training programs are commonly delivered over the course of 3–5 weeks for persons with TR amputation[7] but may last longer. Evidence-based clinical practice guidelines suggest that upper limb amputees should have annual visits to their amputation care team and that prosthetic training should be provided whenever a new type of device is received.[1] However, these guidelines do not specifically recommend follow-up visits in the months after initial prosthetic training is complete.[1]

After initial prosthetic training ends, we expect that many amputees continue to adapt to their devices, gaining proficiency and confidence in their use. However, we suspect that for amputees lacking a therapist's oversight for coaching and troubleshooting, the proficiency of prosthesis use might decline. If this happens, it may result in decreased satisfaction with the device and contribute to eventual abandonment. Therefore, it is important to understand the process of adaptation to a prosthesis and to determine whether and how prosthetic outcomes change in the first few months following prosthetic training. This information may be useful in determining when and whether ongoing or follow-up prosthetic training is needed.

The purposes of this article are to (1) examine change in measures of function, quality of life, and community integration in the first few months after prosthetic training; (2) determine whether change in outcomes varied by complexity of the prosthesis; and (3) compare change in the first month of home use for participants who withdrew without completing all weeks of the home study and those who completed.

Methods

Study design

This multi-site study used a quasi-experimental time series design with repeated measures. Data were included from subjects who completed the VA Home Study of an Advanced Upper Limb Prosthesis (Home Study). Part A of the study involved in-laboratory training with the DEKA Arm. Part B of the study was trial of up to 3 months of home use of the DEKA Arm. The study was approved by the Institutional Review Boards of the Providence VA Medical Center, the VA NY HHS, the James A. Haley VA, and the Center for the Intrepid at Brooke Army Medical Center. All participants provided voluntary informed consent.

DEKA Arm

The Gen 3 DEKA Arm comes in three configurations: the shoulder configuration (SC) for persons with forequarter amputation, shoulder disarticulation, or very short TH amputation; the humeral configuration (HC) for persons with TH amputation; and the radial configuration (RC) for those with TR amputation.[8] All levels have six powered grip patterns and have powered wrist flexion/extension and pronation/supination. The HC and SC configuration levels also have powered elbow flexion/extension and humeral internal/external rotation (with an axis located just above the elbow joint). The SC has two degrees of powered shoulder movement degrees of freedom (flexion/extension and abduction/adduction). The SC device uses endpoint control to control most of the joints, rather than control of individual shoulder and elbow movements.[9] With endpoint control, the user controls movement of the endpoint of the prosthesis in space by moving it up/down, right/left, or forward/back. However, control of shoulder abduction/adduction movement, referred to as voluntary elbow positioning is controlled directly and is not included in endpoint control.

The HC and SC DEKA Arms have two operation modes: hand mode and arm mode. In hand mode, the controls are used to operate hand and wrist movements, while in arm mode, the controls operate elbow or shoulder movements. The DEKA Arm is controlled primarily by inertial measurement units (IMUs), placed on the top of the feet.[10] This control method can be supplemented by other control types including pneumatic bladders, linear transducers, and surface electromyography (EMG) controls.

Subjects

Subjects were eligible for enrollment in Part A, if they were at least 18 years old; had an upper limb amputation at the TR, TH, shoulder disarticulation/scapulothoracic level (shoulder); and had sufficient control sites available to operate a DEKA Arm. Subjects were excluded if their residual limb length or skin conditions prohibited socket fitting or if they had health conditions that the study staff believed might limit their future participation. At the completion of Part A, the Principal Investigator and study staff used clinical judgment to determine whether subjects had at least fair functional skills with the DEKA Arm, good safety awareness, and sound judgment in troubleshooting common operational

problems. If so, they were invited to progress to Part B and a subset of those considered eligible agreed to participate in Part B. All videotaped testing sessions and study notes were reviewed by the analytic team. Each case was discussed by the entire team before a decision to progress to Part B was made.

Data collection

Self-report and performance measures (described in Table 1) were administered at the End of Part A, and after 4, 8, and 12 weeks of home use (Part B). One measure, the T-MAP,[16] was only administered at the End of Part A and at week 12.

Data analyses

All measures were scored using published algorithms. Descriptive statistics were used to examine means and distribution of scores at each assessment point. Using data from the 18 study completers, outcomes at End of A and End of B were compared using two-tailed *t* tests. Multiple categories were identified to adjust for false discovery rates in "families" or categories of tests. The following categories were used: dexterity, activity performance, self-reported function, pain, quality of life, community integration, and satisfaction with prosthesis. The Benjamini–Hochberg method was used to maintain a false discovery rate of 0.10 within each category of tests.[28]

Effect size (ES) and standardized response mean (SRM) response means were calculated to determine the magnitude of change between End of A and End of B. ES was calculated as the difference in mean scores divided by the pooled standard deviation (SD). SRM was calculated as the mean difference in scores divided by the SD of the difference. Trends in outcomes over time were examined by creating line graphs that show measures at End of A, 4, 8, and 12 weeks of home use. Variation by DEKA Arm configuration level was compared by graphically displaying outcomes at End of A and End of B by configuration level. Similar comparisons were made between outcomes at End of Part A and after 4 weeks of home use, for those who did not complete Part B.

Results

Characteristics of the sample are shown in Table 2. A total of 22 subjects began Part B of the study, and 18 completed End of Part B testing, though 1 of the completers had missing data for week 4 and 8 testing. All subjects who withdrew had acquired amputation and 50% were prosthesis users at baseline. Amputation level in the full sample of completers was 56% TR, 39% TH, and 5.6% shoulder level. The sample was predominantly male (89%) and White (89%), with mean age of 45 years. About 89% of completers were prosthesis users at baseline, and 66% used a myoelectric device at baseline testing. One participant, who identified as a prosthesis user (but only used his device some of the time), did not bring his prosthesis to baseline testing, thus no prosthesis description was provided. On average, completers had 8.6 (SD: 3.6) 2-h training visits.

Table 3 shows the results of *t* tests comparing End of A and End of B dexterity and activity measures and ES and SRM values. In dexterity, scores significantly improved in the JTHF Writing, Page Turning, and Heavy Cans tasks. Among measures of activity, only the AM-ULA scores improved significantly at End of B. After correcting for multiple comparisons with the Benjamini–Hochberg procedure, all findings remained significant. No statistically significant differences were observed in any other measure.

Table 4 shows results comparing End of A and End of B for self-report, pain, quality of life, and community integration measures. Scores of the Upper-Extremity Functional Scale (UEFS) and Patient-Specific Functional Scale (PSFS) were significantly better at the End of Part B, while scores of UEFS use were worse. No statistically significant differences were observed in any other measure. After correcting for multiple comparisons with the Benjamini–Hochberg procedure, all three self-reported function findings remained significant. Outcomes over each month of time are shown in Table 5. Overall, there was a trend toward improvement in dexterity and activity performance with each month of home use experience for those measures that did improve.

Descriptive comparisons of Part A and Part B outcomes by configuration level are shown in Appendix 1—Figure 1(a)–(d). Patterns of change appeared to differ for SC users as compared to RC and HC users, in that SC users had higher scores of CRIS-CAT Perceived limitations and CRIS-CAT Satisfaction with participation, and lower QuickDASH scores. In addition, SC users had similar improvements in the three JTHF tests as compared to RC and HC users but did show improvements in two additional tests (small items and light cans) as well. Scores of the UEFS use scale indicated that HC device users were using their prosthesis for fewer activities at the End of B as compared to End of A, while RC and SC users' scores were equivalent. However, HC users' BAM-ULA scores improved, whereas RC users' scores remained constant.

Those who withdrew showed a decrease in JTHF scores from End of Part A to 4 weeks of Part B for 6/7 tests, while those who completed Part B improved in 1 test, stayed the same in 4, and decreased in 2 tests (Appendix 1—Figure 2(a)–(d)). Measures of activity

Table 1. Brief description of outcome measures used in the study.

Measure	Construct(s)	Item content	Rating criteria	Interpretation
Dexterity				
Jebsen Taylor Hand Function Test (JTHF)[11,12]	Dexterity	7 tests of fine motor activities	Performance speed; items/ per second	Higher scores indicate better performance
Activity performance				
University of New Brunswick Test of Prosthetic Function for Unilateral Amputees (UNB)[13,14]	Prosthetic skill Prosthetic spontaneity	10 components of daily tasks that require bimanual engagement	Skillfulness of terminal device use. Spontaneity of engaging the prosthesis in activities	Higher scores indicate better performance
Activities Measure for Upper Limb Amputees (AM-ULA)[15]	Activity performance	18 everyday tasks	Task completion: speed, movement quality, skill, and independence	Higher scores indicate better performance
Timed Measure of Activity Performance (T-MAP)[16]	Activity performance	5 daily activities	Speed of completion	Lower scores indicate better performance
Brief Activity Measure for Upper Limb Amputees (BAM-ULA)[17]	Activity performance	10 everyday tasks	Task completion	Higher scores indicate better performance
Self-reported function				
Patient-Specific Functional Scale (PSFS)[18]	Difficulty performing activities	5 self-selected activities difficult to do because of the amputation	Difficulty in performance	Higher scores indicate less difficulty
Upper-Extremity Functional Scale (UEFS)[19,20]	Difficulty performing activities	Self-reported difficulty performing 23 everyday activities	Difficulty in performance	Lower scores indicate less difficulty
Upper-Extremity Functional Scale (Use)[12]	Use of prosthesis	Self-reported use of the prosthesis during 23 everyday activities	Prosthesis use	Higher scores indicate >proportion of activities done with prosthesis
Disabilities of the Arm, Shoulder and Hand Score (QuickDASH)[21,22]	Disability	Self-reported functional difficulty, sleep, sensation, pain	Performance difficulty and impairment severity	Higher scores indicate greater disability
Pain, quality of life, community reintegration				
Wong-Baker = Wong-Baker FACES Pain Rating Scale[23]	Pain	6 faces showing levels of pain severity	Pain intensity	Higher scores indicates greater pain
Quality of Life (QOL)[24]	Quality of life	16 question items about quality of life	Satisfaction with quality of life	Lower scores indicate worse QOL
Trinity Amputation and Prosthesis Experience Scales (TAPES)[25]	Prosthetic satisfaction	10 items satisfaction with prosthesis	Satisfaction	Higher scores indicate greater satisfaction
Community Reintegration of Injured Service Members Computer Adaptive Test (CRIS-CAT) Extent[26,27] 3 scales	Extent of participation Perceived difficulty in participation Satisfaction with participation	Computer adaptive testing	Frequency and amount Perceived limitations Satisfaction scale	Higher scores indicates better community integration

Table 2. Characteristics of subjects who withdrew from the study during Part B but completed some week 4 testing, completed testing at the End of Parts A and B, and completed testing at weeks 4 and 8.

	Withdrew, but completed week 4 *N* = 4	**End of A and B *N* = 18**	**Part B weeks 4 and 8 *N* = 17**
	Mean (SD)	**Mean (SD)**	**Mean (SD)**
Age	51.2 (17.7)	44.8 (16.0)	43.4 (15.2)
Time since amputation (years)	26.9 (27.0)	20.6 (19.5)	19.2 (19.1)
Congenital amputees	–	37.5 (11.2)	37.5 (11.2)
Acquired amputees	26.9 (27.0)	15.7 (18.8)	13.6 (17.6)
Years as a prosthesis user	22.3 (31.0)	13.4 (16.0)	11.6 (14.8)
Number of training visits	8.8 (2.5)	8.6 (3.6)	8.4 (3.6)
	***N* (%)**	***N* (%)**	***N* (%)**
Gender			
Male	4 (100.0)	16 (88.9)	15 (88.2)
Female	0 (0.0)	2 (11.1)	2 (11.8)
Etiology			
Congenital limb absence	0 (0.0)	4 (22.2)	4 (23.5)
Acquired amputation	4 (100.0)	14 (77.8)	13 (76.5)
Race			
White only	3 (75.0)	16 (88.9)	15 (88.2)
Black only	1 (25.0)	2 (11.1)	2 (11.8)
Mixed/other	0 (0.0)	0 (0.0)	0 (0.0)
Veteran status			
Non-Veteran	1 (25.0)	7 (38.9)	7 (41.2)
Veteran	2 (50.0)	8 (44.4)	7 (41.2)
Active duty	1 (25.0)	3 (16.7)	3 (17.7)
Prosthesis at baseline			
Non-user	2 (50.0)	2 (11.1)	2 (11.8)
User	2 (50.0)	16 (88.9)	15 (88.2)
Type of prosthesis used at baseline			
Body powered	0 (0.0)	5 (33.3)	4 (28.6)
Myoelectric	2 (100.0)	10 (66.7)	10 (71.4)
Amputation level			
Transradial	3 (75.0)	10 (55.6)	10 (58.8)
Transhumeral	1 (25.0)	7 (38.9)	6 (35.3)
Shoulder disarticulation/forequarter	0 (0.0)	1 (5.6)	1 (5.9)
Bilateral amputation			
No	4 (100.0)	16 (88.9)	17 (94.4)
Yes	0 (0.0)	1 (5.6)	1 (5.9)
DEKA Arm configuration level			
RC	3 (75.0)	10 (55.6)	10 (58.8)
HC	1 (25.0)	6 (33.3)	5 (29.4)
SC	0 (0.0)	2 (11.1)	2 (11.8)

SC: shoulder configuration; HC: humeral configuration; RC: radial configuration.

performance were similar for completers and non-completers, except for the BAM-ULA, where scores of those who withdrew decreased and scores of those who completed increased. In self-reported function, subjects who withdrew reported an increase in disability (QuickDASH) and lower scores on the PSFS, while those who completed reported a decreased disability and greater function on the PSFS. Finally, those who withdrew reported decreased satisfaction with the prosthesis (TAPES (Trinity Amputation and Prosthesis Experience Scales)), while the satisfaction ratings of those who completed did not change between End of A and week 4.

Table 3. Comparison of scores of performance at End of Part A and End of Part B.

Performance-based measures	*N*	End of A	Part B Week 12	Paired *t* test	ES	SRM
		Mean (SD)	Mean (SD)	*p* value		
Dexterity						
Jebsen Taylor Hand Function Test (JTHF)						
Writing items (s)	18	0.38 (0.16)	0.45 (0.19)	*0.0239	0.36	0.59
Page Turning items (s)	17	0.06 (0.03)	0.10 (0.07)	*0.0136	0.69	0.68
Small items (s)	17	0.08 (0.05)	0.08 (0.06)	0.6211	0.05	0.11
Feeding/eating items (s)	17	0.10 (0.05)	0.09 (0.08)	0.4270	−0.20	−0.20
Checkers items (s)	17	0.10 (0.07)	0.10 (0.07)	0.8234	0.04	0.05
Light Cans items (s)	17	0.22 (0.14)	0.24 (0.16)	0.2018	0.17	0.32
Heavy Cans items (s)	17	0.22 (0.16)	0.28 (0.15)	*0.0169	0.35	0.65
Activity performance						
Activities Measure for Upper Limb Amputees (AM-ULA)	16	18.3 (4.3)	19.7 (4.4)	*0.0186	0.37	0.66
UNB: Spontaneity	16	3.2 (0.4)	3.2 (0.4)	0.9061	0.03	0.03
UNB: Skill	16	3.0 (0.5)	3.1 (0.4)	0.5442	0.14	0.15
T-MAP summary	12	745.3 (477.5)	689.5 (430.3)	0.4403	−0.12	−0.23
BAM-ULA summary (new)	10	8.3 (1.2)	8.9 (0.9)	0.1934	0.57	0.44

ES: effect size; SRM: standardized response mean; SD: standard deviation.
*Significant after Benjamini–Hochberg adjustment with false discovery rate = 0.1.

Table 4. Comparison of self-report measures at End of Part A and End of Part B.

Prosthesis and non-prosthesis users	*N*	End of A	Part B week 12	Paired *t* test	ES	SRM
		Mean (SD)	Mean (SD)	*p* value		
Self-reported function						
QuickDASH	18	20.7 (9.3)	20.1 (12.0)	0.6570	−0.06	−0.11
Upper-Extremity Functional Scale (UEFS)	13	44.7 (3.0)	37.9 (9.9)	*0.0257	−0.93	−0.71
UEFS use	17	0.7 (0.3)	0.6 (0.2)	*0.0496	−0.28	−0.21
Patient-Specific Functional Scale (PSFS)	18	5.7 (1.6)	6.6 (2.1)	*0.0244	0.49	0.58
Quality of life						
Wong-Baker Pain Scale	18	0.7 (0.8)	0.9 (1.0)	0.3863	0.25	0.21
Quality of life (QOL) scale	18	5.8 (0.7)	5.9 (0.8)	0.6113	0.07	0.12
Community integration						
CRIS-CAT Extent	18	57.2 (8.1)	58.4 (9.5)	0.3324	0.14	0.24
CRIS-CAT Perceived	18	53.9 (9.9)	60.0 (17.5)	0.0780	0.43	0.44
CRIS-CAT Satisfaction	18	51.8 (6.2)	55.8 (12.6)	0.1182	0.40	0.39
TAPES Satisfaction Scale	18	3.8 (0.6)	3.8 (0.9)	0.7057	0.07	0.09

ES: effect size; SRM: standardized response mean; SD: standard deviation.
*Significant after Benjamini–Hochberg adjustment with false discovery rate = 0.1.

Discussion

This study examined change in outcomes after initial prosthetic training as measured in the first few months of home use of a new prosthesis, the DEKA Arm. Overall, the findings demonstrate that the majority of new prosthesis users experienced an adaptation effect, in that their physical performance improved after formal training ended and they had the opportunity to use the device at home. We found that for persons who continued to use the device for approximately 3 months, there was evidence of medium to large improvements in some measures of dexterity and activity performance and small improvements in measures of self-reported disability. At the same time, there was also evidence that use of the prosthesis during everyday activities declined, although this was a small effect. However, a greater decline in prosthesis engagement in daily tasks

Table 5. Outcome measures across assessment time points.

	N	End of A	Week 4	Week 8	End of B
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Dexterity					
Writing	14	0.41 (0.16)	0.44 (0.14)	0.45 (0.14)	0.48 (0.18)
Page turning	14	0.07 (0.03)	0.09 (0.07)	0.10 (0.06)	0.11 (0.07)
Small items	14	0.08 (0.10)	0.09 (0.07)	0.09 (0.08)	0.09 (0.06)
Feeding	14	0.10 (0.11)	0.09 (0.06)	0.10 (0.05)	0.10 (0.08)
Checkers	14	0.11 (0.07)	0.09 (0.05)	0.12 (0.07)	0.11 (0.08)
Light cans	14	0.25 (0.14)	0.25 (0.15)	0.25 (0.16)	0.27 (0.17)
Heavy cans	14	0.25 (0.16)	0.26 (0.15)	0.25 (0.15)	0.31 (0.14)
Activity performance					
AM-ULA	13	19.0 (4.4)	19.8 (3.8)	20.9 (4.4)	20.3 (4.6)
UNB Skill	13	3.3 (0.4)	3.5 (0.4)	3.2 (0.5)	3.3 (0.3)
UNB Spontaneity	13	3.1 (0.5)	3.3 (0.4)	3.1 (0.6)	3.2 (0.3)
BAM-ULA	7	8.6 (1.0)	9.3 (0.8)	8.7 (1.4)	8.7 (0.8)
Self-reported function					
QuickDASH	17	20.9 (9.5)	17.0 (11.2)	20.1 (12.1)	20.6 (12.1)
Upper-Extremity Functional Scale (UEFS)	8	44.9 (2.1)	41.5 (7.5)	38.5 (10.2)	37.3 (11.0)
UEFS use	16	0.7 (0.3)	0.6 (0.2)	0.6 (0.2)	0.6 (0.2)
Patient-Specific Functional Scale (PSFS)	17	5.7 (1.6)	6.1 (2.0)	6.5 (2.2)	6.5 (2.1)
Quality of Life					
Wong-Baker Pain Scale	17	0.7 (0.8)	0.8 (0.9)	0.9 (1.3)	1.0 (1.0)
Quality of Life (QOL) Scale	17	5.8 (0.7)	5.9 (0.7)	5.8 (0.8)	5.8 (0.8)
Community Integration					
CRIS-CAT Extent	17	57.2 (8.3)	57.5 (9.9)	58.0 (8.4)	58.1 (9.6)
CRIS-CAT Perceived	17	54.2 (10.2)	56.7 (13.4)	58.1 (14.7)	59.2 (17.7)
CRIS-CAT Satisfaction	17	51.6 (6.3)	54.6 (8.8)	55.1 (10.3)	55.4 (12.8)
TAPES Satisfaction Scale	17	3.8 (0.6)	3.9 (0.8)	3.8 (0.8)	3.9 (0.9)

SD: standard deviation.

was found among users of the HC arm as compared to users of the RC arm. For the full group of subjects who completed the home use study, we did not observe any impact of the DEKA Arm on quality of life or community integration. The findings demonstrate that use of the DEKA Arm at home was associated with improvements in community integration for the small number of persons in our sample who used an SC device.

About 25% of subjects who began Part B of the study withdrew without completing all home use weeks. Two-thirds of these subjects did complete some testing 4 weeks after beginning the home trial. To test the hypothesis that experiencing a decrease in function would be associated with device abandonment (as measured by study withdrawal during Part B) and decreased prosthetic satisfaction, we compared the outcomes from End of Part A to 4 weeks for the subset of participants who withdrew from Part B early but had completed some week 4 testing. Overall, in the first month of home use, those who withdrew had worse dexterity and activity, greater perceived disability, and lower prosthetic satisfaction. We did not observe the same pattern among those who remained in the study. These findings suggest that worsening function and decreased satisfaction are associated with device abandonment. Of those who withdrew during Part B, two participants relocated and were unable to meet the demands of the study. Two others withdrew due to musculoskeletal pain which may have been related to operation of the foot controls and/or the weight of the device. Although testing sessions took more than 30 min to complete, we do not believe that the length of sessions was a factor in participants' desire to continue in the study. In a separate paper, we reported major reasons for attrition which included scheduling and factors related to the DEKA arm.[29]

This study has several limitations. First, our findings are limited to upper limb amputees who were new users of the DEKA Arm and cannot be generalized to other types of prostheses. The study results not only provide empirical data to support an adaptation effect but also demonstrate that for one-fifth of upper limb amputees trained to use the DEKA Arm, their function declines

after discharge from training. Although it is likely that similar patterns of adaptation and decline occur among new users of other devices, we cannot be certain that this is the case for other types of devices or initial training protocols. Further research is needed to understand the optimal progression of care. Another study limitation is that we were unable to compare change in outcomes over time for all participants who dropped from the study because two of six did not return for testing visits. One did not return due to family and personal reasons, while the other said he was too busy to travel back to the study site for testing.

Conclusion

These findings provide empirical evidence to support the widely held clinical opinion that the function of upper limb amputees continues to improve after formal prosthetic training ends, as patients gain greater experience and home use. However, in 20% of subjects, who later withdrew from the study, there was a decline in function, greater perceived disability, and greater dissatisfaction after 4 weeks of home use, suggesting that these subjects might have benefited from continued occupational therapy follow-up after the intensive training period had concluded.

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Author contribution

All authors contributed equally in the preparation of this manuscript.

Declaration of conflicting interests

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Ethical approval

Ethical approval for this study was obtained from the Institutional Review Boards of each participating data collection site (Center for the Intrepid at Brooke Army Medical Center (CFI), VA New York Harbor Healthcare System, the James A. Haley VAMC), and the Coordinating site, the Providence VA Medical Center.

Informed consent

Written informed consent was obtained from all subjects before the study.

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Appendix 1

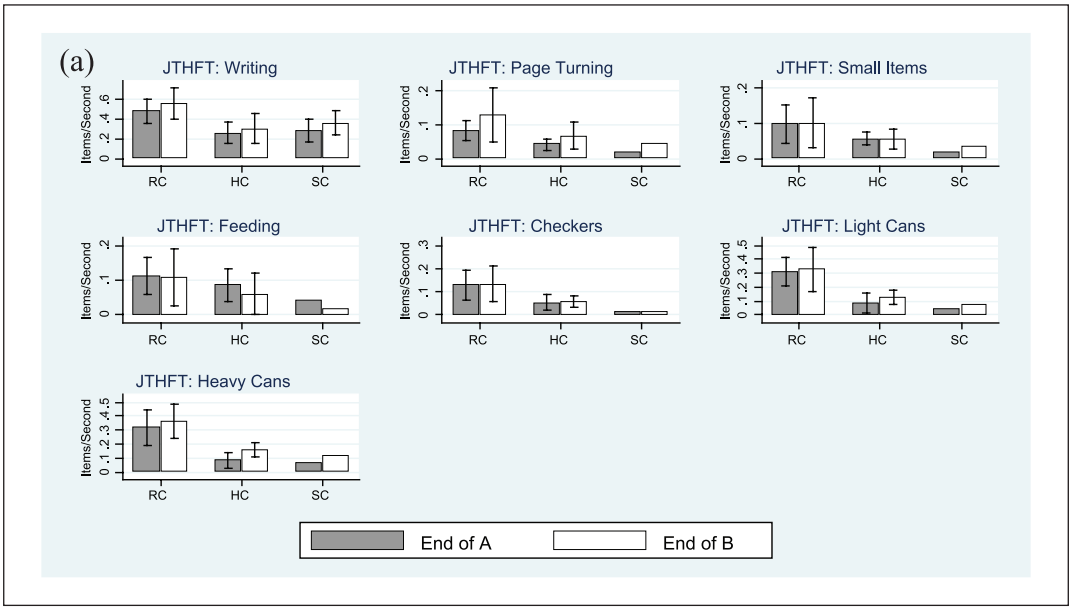

Figure 1. (Continued)

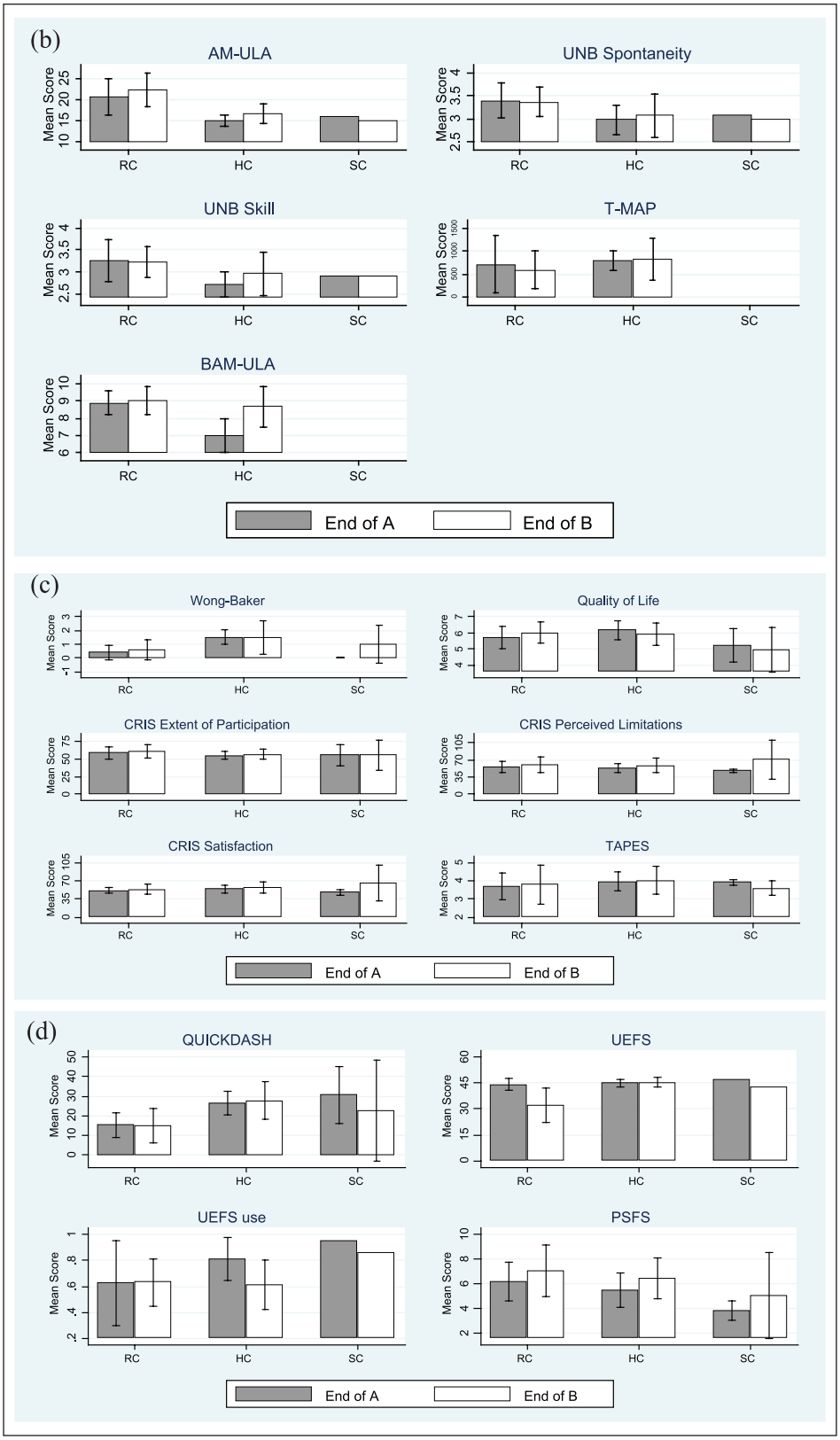

Figure 1. Outcome measures at End of A compared to End of B by configuration level.
(a) Jebsen-Taylor Hand Function Test (JTHF) subtests, (b) Performance measures: Activities Measure for Upper-Limb Amputees (AM-ULA), University of New Brunswick Test of Prosthetic Function for Unilateral Amputees (UNB), Timed Measure of Activity Performance (T-MAP), Brief Activity Measure for Upper Limb Amputees (BAM-ULA), (c) Self-report measures: Wong-Baker FACES Pain Rating Scale (Wong Baker), Quality of Life (QOL), Community Reintegration of Injured Service Members Computer Adaptive Test (CRIS-CAT), Trinity Amputation and Prosthesis Experience Scales (TAPES), (d) Self-report measures continued: Disabilities of the Arm, Shoulder and Hand Score (QuickDASH), Upper-Extremity Functional Scale (UEFS), UEFS use and Patient-Specific Functional Scale (PSFS).

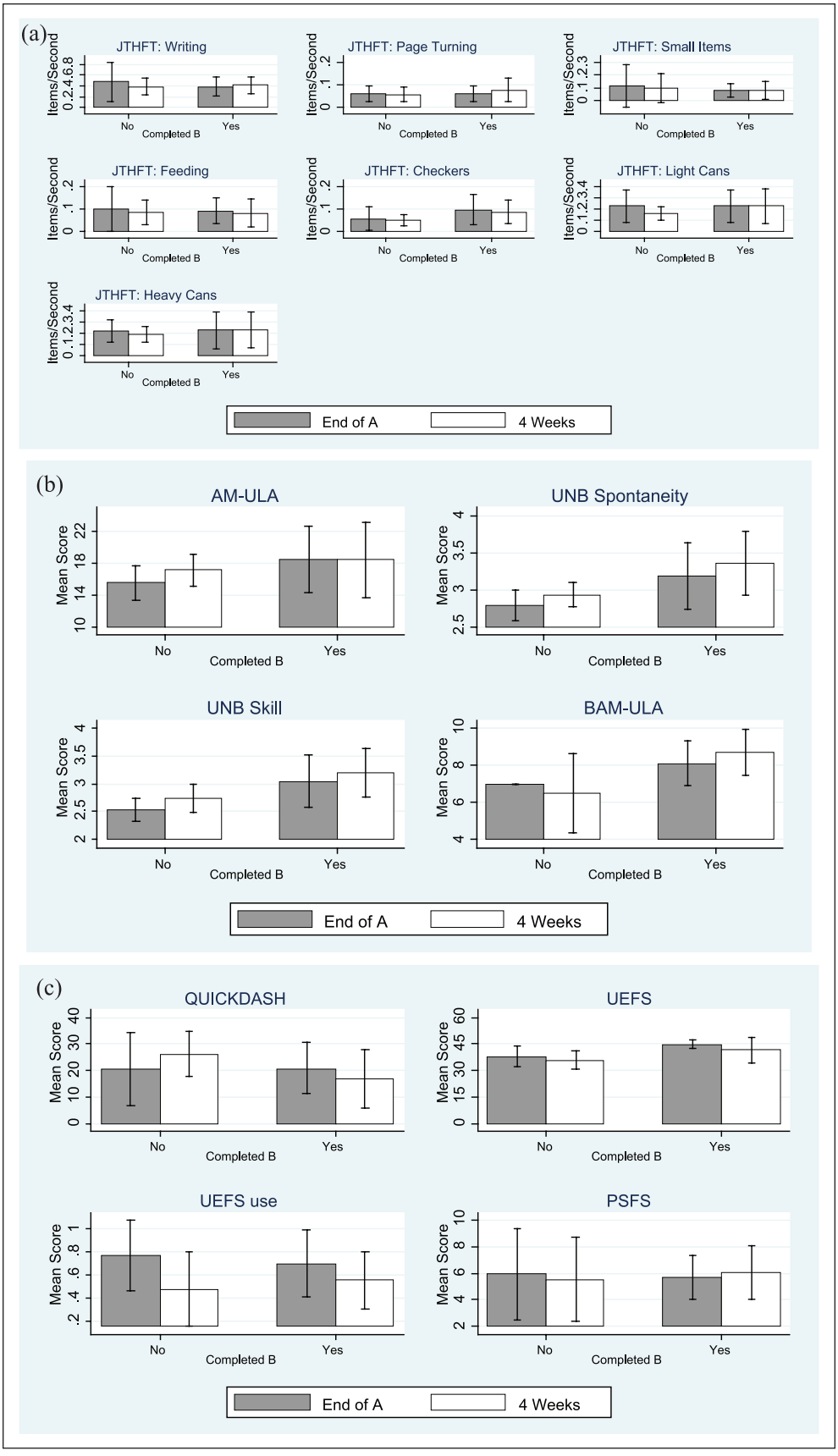

Figure 2. (Continued)

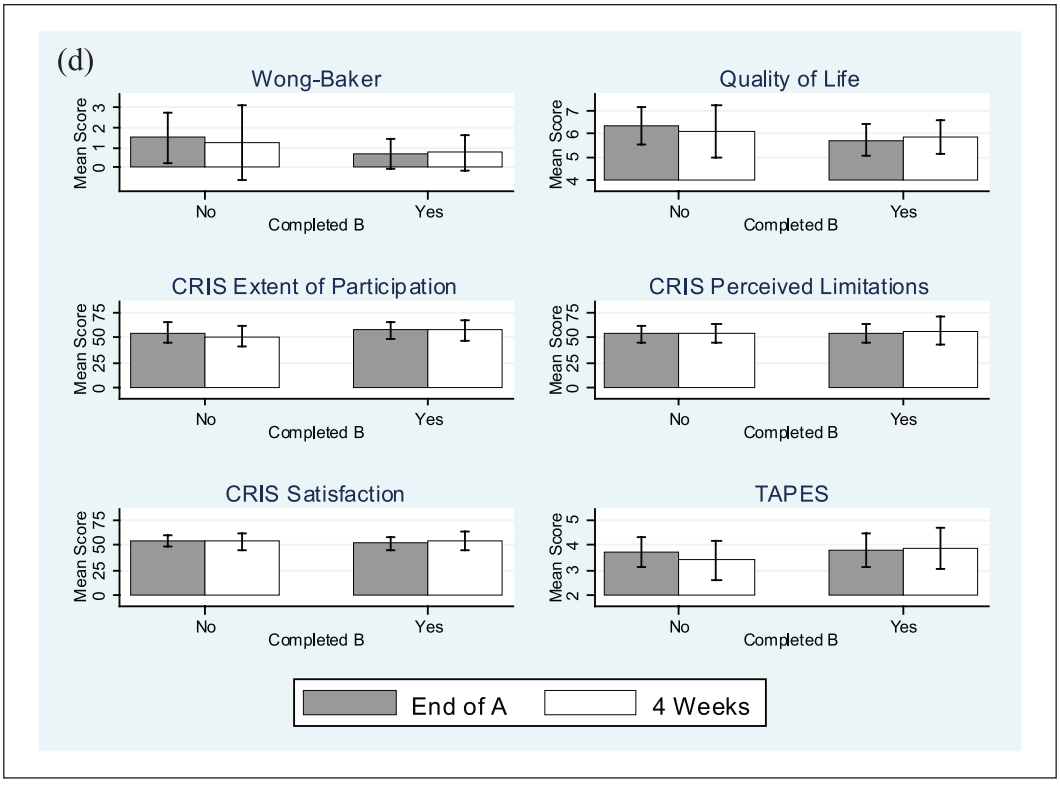

Figure 2. Outcome measures at End of A compared to week 4 of Part B for study completers ($N = 18$) and those who withdrew from Part B but completed some week 4 testing ($N = 4$).
(a) Jebsen-Taylor Hand Function Test (JTHF) subtests, (b) Performance measures: Activities Measure for Upper-Limb Amputees (AM-ULA), University of New Brunswick Test of Prosthetic Function for Unilateral Amputees (UNB), Brief Activity Measure for Upper Limb Amputees (BAM-ULA), (c) Self-report measures: Disabilities of the Arm, Shoulder and Hand Score (QuickDASH), Upper-Extremity Functional Scale (UEFS), UEFS use and Patient-Specific Functional Scale (PSFS)), (d) Self-report measures continued: Wong-Baker FACES Pain Rating Scale (Wong Baker), Quality of Life (QOL), Community Reintegration of Injured Service Members Computer Adaptive Test (CRIS-CAT) and Trinity Amputation and Prosthesis Experience Scales (TAPES).