

DIFFERENCES IN MULTIGRIP MYOELECTRIC HANDS FOR FACILITATING ACTIVITIES OF DAILY LIVING

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ABSTRACT

Most transradial amputees are fitted with a prosthetic hand but use it actively for only 50% of activities of daily living (ADLs). Studies with the multigrip Michelangelo hand reported that many patients perceived ADLs easier to perform than with a conventional prosthetic hand [3] and could also demonstrate improvements in objective ADL performance. Other multigrip hands available on the market offer more grip types than the Michelangelo hand but have not yet been subjected to published clinical studies. Thus, it is unknown whether more grip types result in even greater perceived ease of ADLs execution.

Subjects wearing the bebionic or i-limb hands were assessed with the same hybrid questionnaire as used in the previous Michelangelo study. Demographic information on all subjects was also collected. The results were then compared to the historical data collected in the previous Michelangelo study.

Data were available from 36 unilateral subjects with transradial amputations, 10 each wearing a bebionic or i-limb, respectively, and 16 historical datasets of subjects who used a Michelangelo and conventional hand, respectively.

Means for ease scores and “useful” ratings across 23 ADLs did not differ between the multigrip hands but were better than those for the conventional hands. There were no statistical differences between the 3 multigrip hands. The mean numbers of ADLs by usefulness and method of use (prosthesis actively used to grasp, prosthesis passively used to stabilize, assistance of residual limb, sound hand alone) rating were also similar.

Analyzing the ease of individual activities, Michelangelo mean ease scores for several activities showed modest positive differences compared to conventional myoelectric hands. In contrast, the bebionic profile indicates fewer activities that were scored easier than conventional myoelectric compared with Michelangelo profile, but the difference in the scores for several activities were much greater than for the Michelangelo hand. For the i-limb, there were also several activities for which differences in the mean scores compared to

conventional myoelectrics were much greater than that for Michelangelo.

In conclusion, all multigrip myoelectric hands may reduce the difficulty for performing ADLs vs. conventional hands. However, the availability of more grip types in a hand does not necessarily result in greater ease of performance of ADLs in general. Interestingly, the 3 multigrip hands studied showed different activity profiles that they facilitate. For some activities, there was a clear advantage for some hands over others. Thus, clinicians’ knowledge of the patients’ functional needs and the differential features of the available multigrip hands is crucial for selecting the best suitable hand for an individual patient. In addition, this study also highlights the need for more sophisticated control (e.g. pattern recognition) that facilitates easier and more intuitive access to a greater number of grips in a prosthetic hand than the current 2-channel myoelectric control.

INTRODUCTION

Multiarticulating and multigrip myoelectric prosthetic hands have been available on the market for about 15 years now. A study published in 2015 (3) demonstrated improved ease of performing activities of daily living (ADL), increased usefulness, and more active use to grasp objects with the Michelangelo® hand (Ottobock, Germany) that offers 7 grip types and hand positions as compared to standard myoelectric hands that offer only the opposition grip. The purpose of this study was to gather information on the perceived ease, usefulness and way of use of two multiarticulating hands with multiple grip options, i-limb (Össur hf, Iceland; 12-18 grip types and hand positions, depending on version) and bebionic (Ottobock, Germany; 14 grip types and hand positions), and to compare the results with those previously published for Michelangelo hand [3] to answer the question whether or not more available grip types result in more perceived functionality of a prosthetic hand.

METHODS

IRB approval was obtained for prospective data collection. The Multigrip Myoelectric Hand Survey was launched in March of 2016. Data collection started in June of 2016 and was completed in September of 2017. All subjects were asked to complete two questionnaires. The first was a combination (Pröbsting et al, 2015) of a modified Orthotics and Prosthetics User Survey – Upper extremity Functional Status (OPUS-UEFS) [5, 6] and the Prosthetic Upper Extremity Functional Index (PUFI) [7]. The modified OPUS-UEFS asks subjects to rate how easily he/she can perform ADLs with the prosthetic hand, and the addition of the PUFI asks about how each ADL was performed and how useful the prosthesis was for each ADL. The second questionnaire was a set of questions including the reasons for selecting the type of hand, the most frequently used grip patterns, and ranking the importance of hand features. Demographic information on all subjects was also collected. This included age, sex, years of prosthetic use, amputation side and etiology of the amputation. These results were then compared to previous data collected on the Michelangelo hand [3].

RESULTS

Patient Population

Data were collected from 25 subjects using either a bebionic or i-limb hand. Five subjects were excluded from the final analysis; two had above-elbow amputations and the other three were bilateral users. 70% of these subjects were male, and 30% were female. The results from 20 i-limb and bebionic users with unilateral transradial amputations were then compared to results from a previous study of 16 male myoelectric hand users fitted with a Michelangelo hand. The mean age for the i-limb group was 50.4±17.6 years, while the mean age for the bebionic group was 37.4±14.2 years. In comparison, the mean age for the Michelangelo group was 43.9±17.3 years. Bebionic users had had their device for an average of 1.65±1.10 years, while i-limb users had had their device for an average of 2.08±1.87 years. In contrast, the Michelangelo users had only been using their myoelectric hand for 0.24±0.18 years.

Clinical Results

The means for ease scores across the subset of 23 ADLs for each of the multi-grip myoelectric hands were remarkably similar (Table 1), but all higher than the scores reported for the conventional myoelectric hands in the study with the Michelangelo hand [3].

Table 1: Ease scores and # activities for which hand was rated Very Useful or Useful for 23 ADLs

| Mean ± SD | Conventional | Michelangelo | bebionic | i-limb |
|--|---------------|---------------|---------------|---------------|
| Ease score for performing 23 ADLs | 27 ± 9.7 | 37 ± 12.7 | 33 ± 13.5 | 35 ± 14.9 |
| # activities for which hand was rated Useful | 15.7 ± 3.6 | 17.9 ± 4.0 | 17.2 ± 4.9 | 17.7 ± 4.9 |

The mean numbers of ADLs by usefulness rating were also similar and, likewise, higher than the mean for the conventional myoelectrics (Table 2).

Table 2: PUFI Prosthesis Usefulness Ratings by Prosthetic Hand

| Mean #Activities ± SD | Conventional | Multi-grip Myoelectric Hands | | |
|-----------------------|---------------|------------------------------|--------------|--------------|
| | | Michelangelo | bebionic | i-limb |
| Not Useful | 11.7 ± 3.1 | 9.8 ± 3.9 | 9.7 ± 4.0 | 8.9 ± 5.0 |
| Useful | 4.9 ± 3.4 | 4.2 ± 2.7 | 3.8 ± 3.1 | 6.1 ± 2.6 |
| Very Useful | 6.4 ± 4.1 | 9.1 ± 4.3 | 9.2 ± 3.7 | 7.2 ± 4.4 |

The mean number of ADLs by way of use was also similar, with the number of ADLs performed by using both hands and the prosthesis *actively* was slightly higher for bebionic, and the number using only the sound hand slightly lower for bebionic (Table 3).

Table 3: PUFI Method Assessment by Prosthetic Hand

| Mean #Activities ± SD | Conventional | Multi-grip Myoelectric Hands | | |
|----------------------------------|--------------|------------------------------|---------------|--------------|
| | | Michelangelo | bebionic | i-limb |
| Both hands, prosthesis actively | 7.1 ± 4.1 | 9.3 ± 4.6 | 10.7 ± 2.9 | 9.8 ± 3.0 |
| Both hands, prosthesis passively | 2.4 ± 2.4 | 1.8 ± 1.9 | 2.1 ± 2.5 | 2.2 ± 1.8 |

The comparative ease of performing the 23 ADLs of the OPUS-UEFS with the multigrip or conventional prosthetic hands showed that each of the advanced hands had strengths and weaknesses (Figure 2). While the Michelangelo hand scored somewhat better than the conventional hands across the board (except 2 ADLs), the bebionic and iLimb hands scored considerably better in some (6 or 9, respectively) but also much worse than the conventional hands in some other (5 or 3, respectively) ADLs.

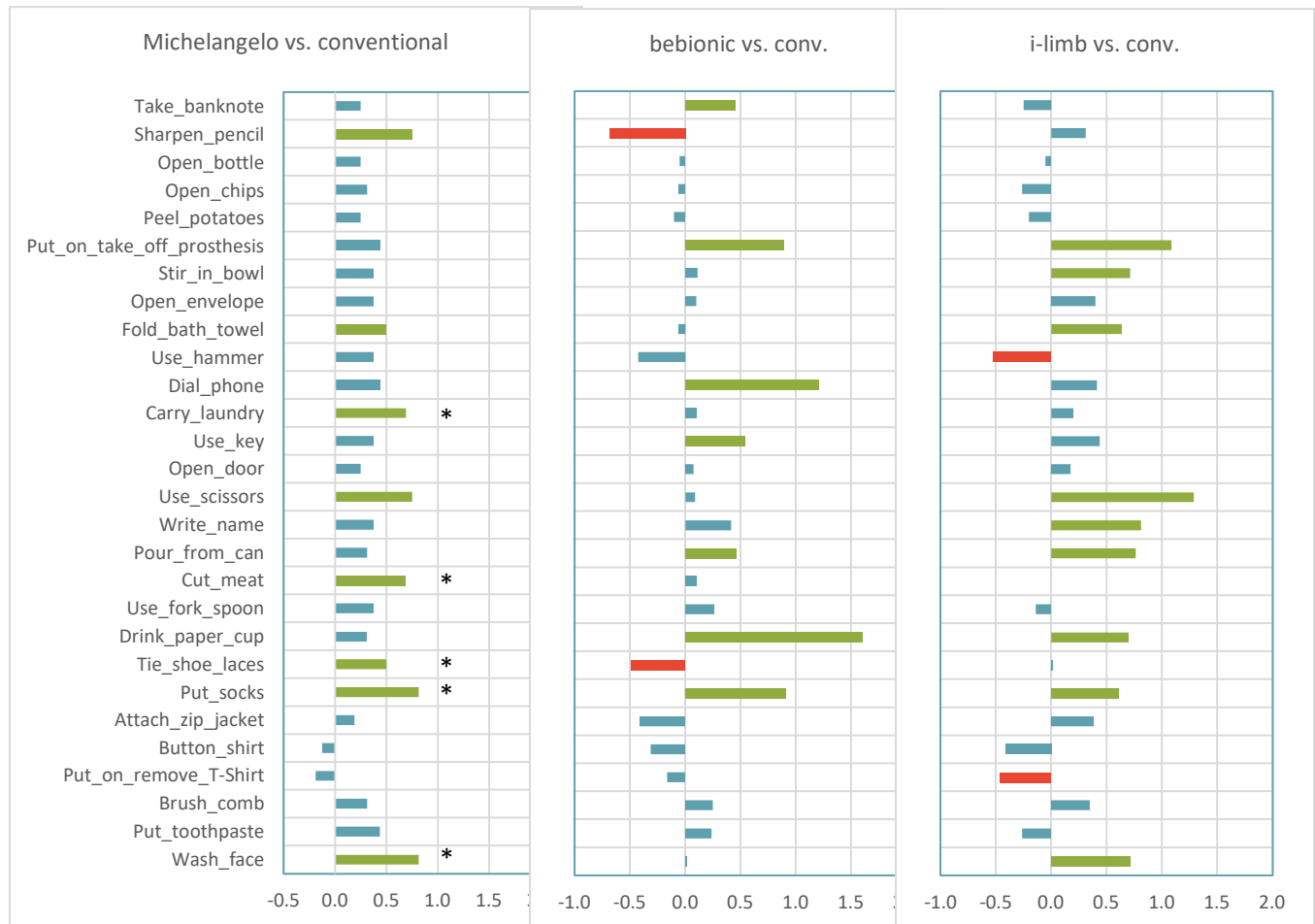


Figure 2 ADL Ease Profiles. Differences in mean ease scores by ADL for multi-grip hands compared to conventional myoelectric hands. **Red** bars signify decreased ease, **Green**, increased ease approaching a clinically meaningful difference, and **Blue** differences less than what could be considered clinically meaningful. * $p < 0.05$ as reported in the Michelangelo study.

DISCUSSION

The aim of the study was to investigate whether more than 12 grip types and hand positions offered by a myoelectric hand might further reduce the difficulty of ADLs as shown for the Michelangelo hand with its 7 grips and hand positions.

Overall, the ease, usefulness and way of use of all three multigrip hands did not significantly differ compared to each other. Compared to conventional myoelectric hands, there was an overall improvement in ease and usefulness ratings and an increase in ADLs in which the multigrip hands were actively used to grasp. While Michelangelo showed moderate improvement in all but two ADLs, bebionic and i-limb showed considerable improvement for some ADLs but also substantial decline in ease and usefulness for some other ADLs. This suggests that there is no “perfect” posthetic hand and that clinicians must match the functional ADL needs of each patient with the hand that meets these specific needs best.

CONCLUSIONS

All multigrip myoelectric hands may reduce the difficulty for performing ADLs vs. conventional hands. However, the availability of more grip types in a hand does not necessarily result in greater ease of performance of ADLs and greater perceived usefulness in general. Interestingly, the 3 multigrip hands studied showed different activity profiles that they facilitate. For some activities, there was a clear advantage for some hands over others. Thus, clinicians’ knowledge of the patients’ functional needs and the differential features of all multigrip hands available on the market is crucial for selecting the best suitable hand for an individual patient. In addition, this study also highlights the need for more sophisticated control (e.g. pattern recognition) that facilitates easier and more intuitive access to a greater number of grips in a prosthetic hand than the current 2-channel myoelectric control.

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