Use of Contact Detection Reflex to Improve Fragile Item Grasp in Myoelectric Prostheses: A Novel Technology

Berke, G.M.[1,2], Matulevich, B.[3], Lin, C.H.[3], Pandit, V.[3], Muller, K.[3,4], Loeb, G.E.[3,4] and Fishel, J.A.[3]
Stanford University[1], Berke Prosthetics[2], SynTouch LLC[3], University of Southern California[4]

INTRODUCTION

While myoelectric prostheses have been available for many years, widespread use has been limited by issues of rejection and narrowed use patterns. One limitation of myoelectric hand use is the cognitive burden required for difficult tasks like grasping fragile items, which is postulated to lead to limited use, passive use, or rejection. The purpose of this research is to determine if a contact detection reflex that is inspired by a biological reflex can improve the use of myoelectric prostheses for fragile item grasp. This has the potential to decrease cognitive load and improve long-term use and function.

METHODS

Subjects were recruited from the research area using IRB protocol. 4 subjects (2 male and 2 female) meeting the criteria agreed to participate. Each subject had unilateral limb loss/failure of formation of the upper extremity below the elbow and a history of sustained myoelectric prosthesis use (3-27 years). All subjects used an Ottobock proportional control myoelectric hand optimized by his or her personal prosthetist and were comfortable using this device throughout the testing process.

Each subject was asked to accomplish three separate tasks as quickly as possible: grasp and move ten 'Ritz' crackers to a cup, grasp and move ten hollowed eggshells from one tray to another, and lift and move ten full soda cans. In all tasks, this distance moved was two feet and objects that were dropped or broken did not count towards the total. The tasks were performed under three testing conditions: using the sound side limb (SS), with the subject's personal myoelectric prosthesis (PP), and with a modified prosthetic terminal device incorporating a contact detection reflex (CD). Time was recorded during each task and five timed trials of each condition were performed.

The modified terminal device (CD) is a standard VariPlus Speed hand (Ottobock) altered by replacing the fingers and thumb with compliant NumaTac contact sensors (SynTouch) and a microprocessor that altered the hand's behaviour by reducing EMG signal gain after contact to facilitate low force grips. Each subject was given a short questionnaire before and after testing to obtain self-reported outcome data. Data was analyzed using a repeated measures ANOVA and a Holm t-test to compare both devices with sound side performance and with one another.

RESULTS

Results for <u>all</u> subjects on the two tasks with fragile items (crackers and eggs) showed that time with the prosthesis with contact detection was <u>significantly improved</u> compared to the subjects' personal prostheses (CD vs PP). Additionally, on the cracker-grasping task, <u>the modified prosthesis was *not* statistically worse than the sound side performance (CD vs SS)</u>. On the rigid grasping task (soda), both prostheses had similar performance (PP vs CD).

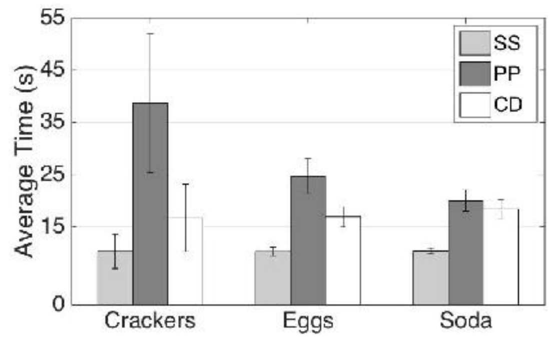

Figure 1. Experiment Results.

DISCUSSION

The contact detection strategy employed made fragile grasping with a prosthesis significantly faster and easier, despite little training. Timed scores indicate improvement in the fragile item domains with no change in time for heavier item grasp. With additional experience, it is anticipated that the modified device would facilitate increased daily use and improved function.

CLINICAL APPLICATIONS

Analysis of self-reported outcome data demonstrated that subjects avoid fragile grasping tasks with their personal prosthesis despite rating it as an important activity. Every subject stated preference for the experimental prosthesis on ease of use and confidence in grasping fragile objects, as well as requiring less concentration to use. <u>All subjects preferred the experimental prosthesis to their current device</u> and reported that it would increase both wear time and hand usage.

CONCLUSION

The combination of contact sensing and a contact detection reflex, resulting in quick and responsive movement before grasping and sensitive and intuitive force control after grasping, significantly improved ease and efficiency of fragile grasping tasks with no adverse effects on rigid item grasping. Future research will focus on understanding the effect of this technology on cognitive load and making further improvements to the NumaTac technology.

REFERENCES

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