

VALIDATING THE EFFICIENCY OF HYDRO-CAST SOCKETS THROUGH PRESSURE DISTRIBUTION AND GAIT ANALYSIS

¹ Sharifah Sofiah Syed Shikh, ¹Noor Azuan Abu Osman and ²Lydia Abdul Latif

¹Department of Biomedical Engineering, University of Malaya, Malaysia

²Department of Rehabilitation Medicine, University of Malaya, Malaysia; email: shsofiah@um.edu.my

INTRODUCTION

Most of Malaysian's transtibial amputee population are middle income earners, where their monthly income is one-tenth the cost of a transtibial prosthesis. The high cost of prostheses fabrication is due mainly to the lack of resources and skill in the field of rehabilitation. As a result, only less than 10% of the 29 469 transtibial amputees are prostheses users according to statistics from the Social Welfare Department of Malaysia [1]. The authors have investigated the use of a hydrostatic casting system as an alternative method to prosthetic socket fabrication in order to reduce cost and resources while maintaining the quality of traditional hand-cast sockets.

This paper describes the efficiency of hydro-cast sockets studied through stump-socket pressure maps and gait analysis.



Figure 1: Difference in socket shape can be detected between the PTB (left) and hydro-cast (right) sockets.

METHODS

Unilateral transtibial amputees with healthy stumps and are current patellar tendon bearing (PTB) socket users were recruited for the study. The casting process replaces the need for manual hand casting as uniform water pressure is used to produce molds that take the exact shape as the subject's residual limb (Figure 1). During fabrication, no modifications were done to the cast in order to maintain the original shape of the limb.

For the pressure-gait analysis part of the study, subjects were asked to walk using both the hydro-cast and PTB sockets. Four F-Socket sensors, TEKSCAN model 9811E, were placed at the stump-socket interface to obtain a pressure map of the stump during gait for each socket. These pliable sensors have a total of 96 sensels covering an area of 154.84cm² with a scan rate of 850Hz and a spatial resolution of 0.6 per-square-cm. Kinetic and kinematic parameters were also tracked using the Vicon NEXUS 1.3.109 motion capture system and two KISTLER force platforms.

RESULTS AND DISCUSSION

Contact pressures at the anterior, posterior, medial and lateral regions of the stump were mapped for both

hydro-cast and PTB sockets during gait. A single factor ANOVA analysis on the hydro-cast trials found that the four areas are not significantly different ($p < 0.05$). The uniform pressure distributions recorded between these regions are characteristic of a total contact socket [2]. In contrast, the PTB socket mapped regions were significantly different ($p > 0.05$) with pressure peaks at the patellar-tendon (29.75kPa) and popliteal fossa (24.75kPa). A comparison of the sockets contact pressures shows a slightly higher reading for hydro-cast sockets (Figure 2). However, these recorded pressure values are still at least 12x lesser in magnitude than the minimum transtibial pain threshold (0.35 ± 0.09 MPa) [3]. Subjects also did not report any pain while using the hydro-cast sockets.

The gait analysis found no modifications in the hydro-cast's kinetic and kinematic parameters when compared to the PTB socket. The average of both socket's ground reaction forces resulted in a Pearson correlation coefficient of 0.8, a high indicator of shared gait patterns.

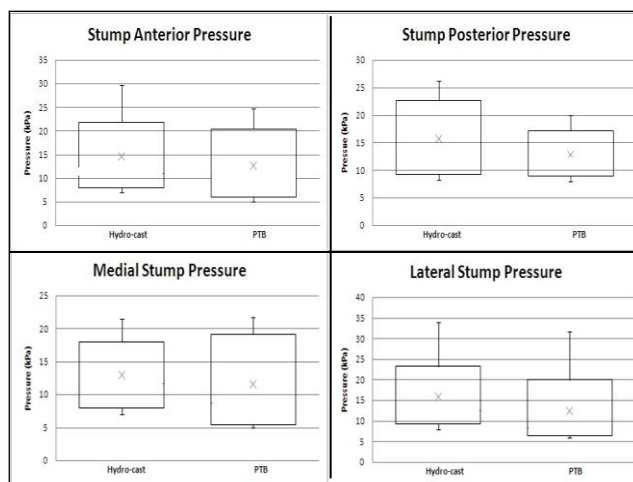


Figure 2: Socket-stump contact pressure range for the hydro-cast and PTB socket

CONCLUSIONS

The hydrostatic casting system is a plausible socket casting alternative method that can be applied in countries lacking in resources and rehabilitation skills. Although the socket design differs from traditional hand cast sockets, the quality is maintained and fabrication cost is decreased ten-fold.

REFERENCES

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