INTRODUCTION

Prosthetic sockets are the fundamental connection between an amputee’s residual limb and their prosthesis. However, prosthetic sockets are not subjected to a standard test evaluation like most other prosthetic components (International Standard, ISO 22675 and 10328). In addition, only a limited number of studies have assessed the strength of prosthetic sockets (Current, 1999; Graebner, 2007) and these studies took measures to control variability.

The purpose of this research was to evaluate the static strength and variability of diagnostic sockets, copolymer sockets, and definitive laminated sockets as they are currently produced by the industry.

METHOD

Socket Design: Sockets were generated from a generic transtibial (TT) residual limb CAD file which was extrapolated to represent a 98th percentile male. This provided a worst case scenario for pulled thermoplastic sockets.

Number of Sockets: Sockets were provided by nine facilities: three Central Fabrication Facilities, three Private Practice Facilities, and three Military/VA Hospital Facilities. Testing included 34 diagnostic sockets, 31 copolymer sockets, and 33 definitive laminated sockets for a total of 98 sockets.

Procedures: Sockets were tested according to a modified ISO 10328 static testing procedures in Condition II A125 level using a simulated TT residual limb model. Tests were conducted to failure; and, the resultant yield strengths were compared to the A125 passing criteria (4426 N for brittle failure and 3421 N for ductile failure).

Data Analysis: Statistical significance in strength was evaluated using a one-way ANOVA and post hoc Tukey’s HSD means comparison test (5% significance level). Static strength values were also evaluated against the ISO 10328 A125 passing static criteria.

RESULTS

Most of the diagnostic sockets’ and all the copolymer sockets’ strengths were below the ISO 10328 ductile passing criterion. A majority of the definitive laminated sockets’ strengths were also below the ISO 10328 brittle passing criterion.

The range and variability for each type of socket across the industry is displayed in Figure 1.

DISCUSSION

A majority of the sockets, regardless of type, failed to pass the same strength standard other prosthetic components are required to pass. Sockets strengths also varied significantly. Potential sources of variability for diagnostic and copolymer sockets included thickness and fabrication method. Diagnostic sockets also varied by material type. In contrast, definitive laminated sockets were influenced more by construction material and technique.

Suggested areas of improvement for socket fabrication include (1) the development of industry wide best practices, (2) the optimization of practices to reduce variability, and (3) the evaluation of new materials and practices with improved strength properties.

CONCLUSION

This study demonstrated the inconsistency and large variability in strength of sockets currently being delivered to lower limb amputees. The results also provide a foundation for additional investigation and a comparison for future technology.

REFERENCES

Current, T. A. Prosthet Orthot Int 23, 113-122, 1999

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