USING PROXIMITY SENSORS TO DIGITALLY MEASURE BI-PLANAR ALIGNMENT ANGLES OF PYRAMID ADAPTORS IN LOWER LIMB PROSTHETICS

Delazio, A.M. 1, Fielder, G. 2

1 Department of Bioengineering, University of Pittsburgh, 2 Department of Rehabilitation Science and Technology, University of Pittsburgh

INTRODUCTION

In the US in 2005, there were approximately 1.04 million people with lower limb loss. By 2050 this number is expected to increase to 2.34 million (Ziegler-Graham, 2008). With this increase, more people will need lower limb prosthetics and prosthetic alignments.

To date, there is no standardized way to quantify the alignment of prosthetic pyramid adaptors outside of estimation and counting set screw rotations. The lack of clear, repeatable alignment angles limits the efficiency of clinical practice and research protocols (Neumann, 2009). The goal of this project was to develop a device that digitally measures the bi-planar alignment angles of pyramid adaptors. This device was designed to fit the standard pyramid adaptor so that it would neither obstruct adaptor movement nor include any internal electrical components.

METHOD

Proximity sensors that output voltages in response to magnetic field strength using the Hall Effect were investigated to devise a touchless sensor system (Hall, 1879). The procedure was divided into three tasks: 1) Determine the best sensor position by investigating the relationship between sensor placement and magnetic field strength at various alignment angles; 2) Determine the conversion between sensor voltage (V) and the linear distance (mm) between them; 3) Develop a final prototype.

RESULTS

Sensor placement on the outside of the pylon directly in front of the middle of the North Pole of the magnet yielded the maximum magnetic field response. A spherical magnet provided the most uniform field for both bi-planar sensors. The voltage-to-distance conversions with and without the pylon were approximated by a fourth order polynomial equation. The pylon angle was then found using a trigonometric equation. Hall Effect Sensors (MLX90215, Digi-Key Electronics) were chosen to be placed on the outside of the pylon in bi-planar directions using an additive manufactured clip. A magnet was placed on the pyramid adaptor. An LCD board displayed the bi-planar alignment angles (Figure 1) and was housed in an acrylic case with two calibration buttons.

DISCUSSION

To date there is no commercially available device that digitally displays pyramid adaptor alignment angles using proximity sensors. Other tools such as the LASAR posture (Blumentritt, 1997) and the “smart pyramid” (Kobayashi, 2013) measure the effects of alignment changes but not the direct angle changes that are important for quality control and documentation.

Further evaluation studies and field tests on the device are planned. Additional work can be done to provide users with angle readouts on their hand held devices.

CONCLUSION

A device to measure and display the bi-planar alignment angles of pyramid adaptors will allow practitioners to more easily and accurately align lower limb prostheses, providing patients with clearly defined, repeatable adjustment to their prosthesis.

CLINICAL APPLICATIONS

With an increased amount of lower limb prosthetics necessary in the years to come, innovations like this will help decrease the number of revisits to clinics for prosthetic readjustment, therefore improving patient quality of care and reducing health care costs.

REFERENCES