Dilatancy System for Prosthetic Socket Fabrication

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INTRODUCTION

There are 6-billion people live in developing countries, where many disabled persons lack access to prosthetic-orthotic (P&O) services, trained prosthetic personnel, affordable technology and materials. Since 1998, with funding from the National Institute on Disability and Rehabilitation Research (NIDRR), the Center for International Rehabilitation (CIR) and the NUPOC have collaboratively developed innovative dilatancy technologies for the fabrication of prosthetic sockets and orthoses for the world. In order to develop better, cheaper, faster and greener appropriate P&O technologies for low-income countries, we aimed to use low-cost equipment and to eliminate the use of Plaster-of-Paris for fabricating prosthetic sockets or orthoses.

Like vacuum-packaged coffee beans, granules that are enclosed in a flexible container can form and retain any shape as long as the air inside is evacuated. This phenomenon, called dilatancy, was first investigated and patented 66 years ago (Mead, 1949), applied in wheelchair seating system (Germans, 1975) and recently developed into clinical procedures (Wu, 2003, Wu, 2009, Wu, 2010). By placing a bag (or bags) of polystyrene beads or silica sand around a body segment, upon application of vacuum, the granule-filled bag can instantly become a solid negative mold of the body segment. The negative mold can be filled with sand, sealed, and the air inside evacuated to create a positive sand model for vacuum forming prosthetic sockets or orthoses.

METHOD

The development of dilatancy prosthetic socket technologies started with laboratory testing of prototype casting systems on plaster models, followed by clinical evaluation under IRB approved protocol on consented subjects with amputations and finally underwent independent evaluation in the field.

RESULTS

We have successfully developed two plaster-less dilatancy systems for fabricating lower limb prosthetic sockets. The procedure for transtibial prosthetic sockets has been independently evaluated by the International Society for Prosthetics and Orthotics (ISPO) in Vietnam (Jensen, 2005), which confirmed improvement of socket fitting and speedy service provision. The dilatancy casting system has been widely translated in many low-income countries. From 2008 to 2014, 9,627 prostheses were fabricated in Thailand using dilatancy technology. In addition, **nine** prostheses have been fabricated for two landmine-injured elephants using the same approach.

Dilatancy transfemoral system using Spandex casting bag filled with polystyrene beads has been developed pending further clinical evaluation.

Figure 1, the prosthesis can be made in two hours during a clinic visit. (Photos from Mobility India, India)

Figure 2, In addition to thousands of lower-limb prostheses for amputees, prostheses were made using dilatancy system for two landmine-injured elephants in Thailand (Photos from Prostheses Foundation, Thailand)

DISCUSSION

Dilatancy casting system is a Spandex casting bag filled with micro-polystyrene beads and sealed in a plastic bag. Under vacuum suction, it shrinks slightly thus works as a pressure-casting for an intimate impression of the residual limb. Being plaster-less, it eliminates waste. The casting system costs minimal to set up and to maintain. It is easy to learn and apply.

CONCLUSION

Dilatancy technology for prosthetics socket fabrication is emerging as a potentially better, cheaper, faster and greener approach that is appropriate for providing service for individuals with amputation worldwide.

CLINICAL APPLICATIONS

Dilatancy P&O technology is an effective alternate to plaster or CAD-CAM-based approaches for prosthetic socket fabrication.

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