University of Malaya

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HIR Prosthetics research group achievements: road to success

AREZOO ESHRAGHI, University of Malaya

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HIR Prosthetics research group achievements: road to success

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HIR research group: prosthetics

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Aim

Design enhancement of prosthetic limbs
RESEARCH PROJECTS TO DATE

• Study of two current prosthetic suspension systems

• Design, development & clinical evaluation of a new prosthetic suspension system

• Interface pressure investigation with different prosthetic liners

• Ergonomic considerations for prosthetics: suspension systems
Grants

- FRGS
- ERGS
- IPPP
- UM/HIR MOHE
- Ossur, Iceland
• A Global leader in orthopedics, applies the smartest minds and the most advanced technologies to help keep people mobile.

Life Without Limitations
Collaboration with Ossur Academy

• Project 1 (2009-2012): Comparative study of roll-on silicone liners
  RM 400,000

• Project 2 (2013): Evaluation of a new energy-storing prosthetic foot
  RM 600,000
Collaborators

Tehran University of Medical Sciences, Iran

Isfahan University of Medical Sciences, Iran

PIPOS
PAKISTAN INSTITUTE OF PROSTHEIC AND ORTHOTIC SCIENCES

THE UNIVERSITY OF MELBOURNE
PATENTS

National:

- New magnetic prosthetic suspension systems, 2012
- Novel prosthetic liner, 2013
- Prosthetic hook & loop suspension, 2013
PATENTS

International:

- New magnetic prosthetic suspension systems, Feb 2013
Awards

- Malaysia Technology Expo (MTE) 2012
- ITEX 2012
- Forchheimer prize, 2013
- Best research in “Advancing Technology”, 2013
1. Introduction

Transitional amputees need prosthetic devices after amputation surgery in order to regain their functional mobility and appearance. (Wong et al., 2000). The socket design plays a significant role in determining the quality of the fit and provides an interface between the prosthetic socket and residual limb skin. This study, therefore, was conducted to evaluate the interface pressure between the residual limb and the socket and the anterolateral skin in the proximal stump area. Prosthetic socket design allows for improved stability and function by reducing the load on the residual limb skin. The results indicated that the weight of the patient and the condition of the residual limb skin significantly affected the socket fit and function. The fit and function of the socket are significantly affected by the condition of the residual limb skin. The results indicated that the weight of the patient and the condition of the residual limb skin significantly affected the socket fit and function. The fit and function of the socket are significantly affected by the condition of the residual limb skin.
ACHIEVEMENTS

• Must-read article by the Editor:
  Prosthetics & Orthotics International

Literature review
Publications

• 2011-2013

12 Tear 1 papers

Conference proceedings: 10
ISPO world congress
Hyderabad, India
4-7 Feb 2013

International Society For Prosthetists & Orthotists
Best research in “Advancing Technology”, 2013
Biomechanical analysis of a new prosthetic suspension system for lower limb amputees
Statistics talk!

In Latin America, Africa, and Asia combined, almost **0.5%** of the population require artificial (prosthetic) limbs (WHO, 2010).
Developing countries

80%

Malaysia
Amputation (limb loss) is a permanent disability.
Back to high-quality life

• Artificial limbs: prosthetics

World champion double-amputee Oscar Pistorius
Prosthesis

Suspension system
Prosthetic Suspension

significant role in*:

- prosthetic function,
- patient’s mobility
- amputee’s overall satisfaction

*Eshraghi A, Abu Osman NA et al., 2012, Prosthet Orthot Int
*Kristinsson Ö., 1993, Prosthet Orthot Int
*McCurdie I, et al., 1997, Prosthet Orthot Int
Prosthetic Suspension

• **Suspension failure can result in:**
  - Gait deviations
  - Pistoning within the prosthetic socket
  - Discomfort
  - Low confidence
  - Cosmetic issues
  - Noisy community ambulation
Luxury Components!

~ 15,000 USD

~ 80,000 USD
Current Systems

- Noisy;
- Bulky;
- Costly;
- High pistoning;
- Low durability;
- Pain (milking);
- Skin problems;
- Difficult don/doff

Eshraghi A, Abu Osman NA et al., 2012, *Prosthet Orthot Int*
Gholizadeh H, Abu Osman NA et al., 2013, *Arch Phys Med Rehabil*
• Noisy
• Difficult to use
• Expensive
• Uncomfortable

• Low durability
• High pressure
• High pistoning
• Pain
AN IDEA HAS BEEN BORN
Patent pending: PI2012700220
Mechanical Testing*

Mechanical testing

<table>
<thead>
<tr>
<th></th>
<th>Yield point*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin/lock</td>
<td>580 N</td>
</tr>
<tr>
<td>Seal-In</td>
<td>460 N</td>
</tr>
<tr>
<td>New magnetic lock</td>
<td>350 N</td>
</tr>
</tbody>
</table>

~ 30-50 N during normal walking**

*Eshraghi A, Abu Osman NA et al., *J Biomech* (In prep)
** Winter DA, 1991
** Gholizadeh H, Abu Osman NA et al., 2012, *Clin Biomech*
Static

- Loading: 20 to 100 N

Ethics approval by University Malaya Medical Center Ethics committee
Suspension

Pistoning [1]

Interface pressure [2]

Satisfaction [4]

Gait [3]

Method

- Seal-In X5 (A,B)
- Pin/lock (C,D)
- New magnetic design (E,F)

Eshraghi et al., 2012, Am J Phys Med Rehabil
Method

- Subjects: Ten unilateral transtibial amputees (sample of convenience)
- Activity level of K2-K3
- Ethics approval by University Malaya Medical Center Ethics committee
Method
Method
Method

Pistoning
- Static
- Dynamic

Interface pressure
- Level walking
- Stair/ramp negotiation

PEQ → Satisfaction
Pistoning:

- Static

- Gholizadeh H, Abu Osman NA et al., 2012, *Prosthet Orthot Int*
Pistoning

• Dynamic (during gait)

Vicon motion system

Eshraghi A, Abu Osman NA et al., *J Biomechanics* (In prep)
Gholizadeh H, Abu Osman NA et al., 2012, *J Rehabil Res Dev*
Eshraghi A, Abu Osman NA et al., *J Biomechanics* (In prep)
Gholizadeh H, Abu Osman NA et al., 2012, *J Rehabil Res Dev*
Interface Pressure

- Walking $^{[1,2]}$
  Tekscan pressure system

Interface Pressure

Eshraghi A, Abu Osman NA et al., 2012, *Clin Biomech*
Ali S, Abu Osman NA et al., 2012, *Clin Biomech*
Interface Pressure

The graph shows the mean peak pressure (kPa) for different sensor sites and two types of locks: Pin lock and New magnetic lock.

- Ant
- Pos
- Med
- Lat

For each sensor site, the bar for Pin lock is blue, and the bar for New magnetic lock is red.
Satisfaction

Eshraghi A, Abu Osman NA et al., 2012; Am J Phys Med Rehabil
Satisfaction

Eshraghi A, Abu Osman NA et al., 2012; Am J Phys Med Rehabil
Conclusions

- Lower peak pressures were produced at the anterior and posterior surfaces during the swing phase of gait with the new magnetic system in comparison to the pin/lock.

Eshraghi A, Abu Osman NA et al., 2012; Clin Biomech
Ali S, Abu Osman NA et al., 2012, Clin Biomech
Conclusions

• The new magnetic system and the pin/lock system caused comparable **pistoning**, but higher pistoning than the Seal-In system ($P<0.05$). [1]

• significantly **less pain** with the new magnetic system compared with the pin/lock suspension system ($P = 0.000$). [2]

Conclusions

• Easier donning and doffing with the new magnetic system in comparison to the Seal-In X5 and pin/lock. [1]

• Higher stability with the new magnetic system in comparison to the pin/lock system. [1]

Advantages

- Durable: at least 10 years
- No noise
- Less pain
Advantages

Shuttle lock: 2000 RM

Seal-in liner: 2000 to 2500 RM

Our design: only RM 800
Invited speaker

2013 O&P World Congress
Orlando, FL, USA
18-21 SEP
THANK YOU

Innovation distinguishes between a leader and a follower.

- Steve Jobs
A new approach for pistoning measurement in transtibial amputees

Hossein Gholizadeh, MEngSc, PhD candidate, Registered prosthetist-orthotist

Awarded Bright Spark
A recognition by ISPO
Forchheimer Prize

• The Forchheimer Prize was established by the Forchheimer family to honour the memory of Sylvia and Alfred Forchheimer.
• Alfred Forchheimer, was a pioneer in the engineering of prosthetics and orthotics devices.
• It is awarded every three years at the World Congress of ISPO during the Closing Ceremony. The prize is awarded for the most outstanding paper on objective clinical assessment, clinical evaluation or clinical measurement published in Prosthetics and Orthotics International during the three years prior to the Congress.
• This year, the ISPO president, in front of about 2000 researches from 85 countries, handed the prize to me, on behalf of Professor Azuan.
The suspension system is the most critical component of the prosthesis in close contact with the person’s residual limb.

Pistoning

*(Vertical movement inside the socket [1,2]*)

Different methods have been used to measure pistoning in prosthetic limbs [1-3]:

- Radiological methods
- Ultrasound sensor
- Transducers
- Axial movement detector

Purpose of this study

- To introduce a new simple and accurate method for measuring pistoning in transtibial prosthesis to be applied in any rehabilitation center by every prosthethist.
Methodology

- Digital Camera (high resolution)
- four markers
- two reference rulers
- 3, 6 and 9 kg load [1,2]

Methodology

- A. Amputee standing full weight bearing on prosthesis
- B. Amputee standing with no weight on prosthesis with the leg straight
- C. Applying 30, 60, 90 N load [1,2]

University of Malaya Medical Centre (UMMC) approved study protocol.

Summary

➢ This new method enabled us to measure the pistoning between the liner and prosthetic socket. These amounts of vertical movement (pistoning) obtained by this method support the findings of previous studies with different measuring methods. This provides faster and easier way of clinical pistoning measurement. It can be implemented in any rehabilitation center by every prosthetist.
We hope this method can help clinicians to enhance the prosthetic suspension system and patient’s satisfaction in lower limb amputees.
O & P BUSINESS NEWS

Sadeeq Ali,
PhD candidate, Prosthetist-Orthotist
Published by SLACK Incorporated

A reputable news source for orthotic, prosthetic, pedorthic and affiliate professionals
1) Wearers favor seal in-liners in study of socket satisfaction

Based on the ISI paper:

Methods

243 questionnaires administered to men with a unilateral transtibial amputation about wearer satisfaction and perceived problems with prosthesis use.
Results

The study participants the most satisfied and experienced the fewest problems with the seal-in liner.

However, users of the seal-in liner had greater problems with donning and doffing.

The polyethylene liner was the most durable of the three suspension systems.
2) Seal-In Liner Provides High Patient Satisfaction

Methods

• Ninety males with traumatic transfemoral amputation who had used both a seal-in liner and common suction socket completed two questionnaires

• to evaluate their satisfaction and problems experienced with the two suspension systems.
Findings

Overall, participants were more satisfied with the seal-in liner with regards to

- fitting,
- sitting,
- donning and doffing
Findings

The seal-in liner was less problematic with:

• Sweating,
• Wounds,
• Pain,
• Pistoning,
• Edema,
• Smell and sound

Durability was significantly better with the suction socket
Special thanks to:

UM/MOHE/HIR grant No. D000014-16001
References: (our published papers)

• Gholizadeh H, Abu Osman NA, Eshraghi A, Ali S., A.AbdRazak, Transtibial prosthesis suspension systems: systematic review of literature, Clinical Biomechanics
Thanks for your attention