Friction Management
For Diabetic Foot Problems

Presented at the 36th Annual Meeting and Scientific Symposium
of the American Academy of Orthotists and Prosthetists

Technical Workshop #33: “Diabetic Foot Problems and Novel Ways to
Treat Them with ShearBan”

Prepared by Mark Payette, CO
February, 2010
Diabetic / Neuropathic Foot Problems

23.6 Million Americans
(7.8% of Population)

1958 = 1.5 Million
2007 = 17.9 Million

5.7 Million do not know they have Diabetes

Health Care Costs = $174 Billion
(Direct Medical Costs = $116 Billion)

20% of people who present for routine care will have a treatable foot care problem

15% lifetime incidence of foot ulcer

Ref: National Diabetes Education Program Statistics and NIH Publication
Working Together to Manage Diabetes 2007
Preventive Foot Care in Diabetes

- Risk Identification
- Provider Education
- Prevention of High Risk Conditions
- Management of High Risk Conditions
- Foot Exam
- Patient Education

Ref: American Diabetes Association - Diabetes Care, Volume 27 Supplement I, January 2004
Patient Education

- Implications of Sensory Loss
- Importance of Daily Foot Monitoring
- Selection of Appropriate Footwear
- Nail and Skin Care
- Ability to Self Assess Foot Condition
- Care Assistance

Ref: American Diabetes Association - Diabetes Care, Volume 27 Supplement I, January 2004
Goal for Low-Risk Foot Patient education

- Keep Low Risk Status
- Control ABC’s: A1C, Blood Pressure, and Cholesterol – Lipid Profile
- Tobacco Cessation

Ref: NIH Publication *Working Together to Manage Diabetes* 2007
High Risk Foot Status

- Loss of Protective Sensation
- Foot Deformity
- Absent Pedal Pulses
- Prior Amputation
- History of Foot Ulcers

Ref: NIH Publication *Working Together to Manage Diabetes* 2007
Goal for High Risk Foot Patient Education

Prevent Foot Ulcers

- Self-Management Education
- Clear Walking Spaces of Potential Hazards
- Regular Foot Care (Podiatry, Pedorthic/O&P)
- Use Appropriate Footwear
- Stress The Role of Minor Trauma
- Prompt (Same Day) Care for Injuries

Ref: NIH Publication Working Together to Manage Diabetes 2007
Foot Evaluation

Neuropathy

Vasculopathy

Dermatological Conditions

Musculoskeletal Symptoms

Lifestyle and Family History

Ref: NIH Publication *Working Together to Manage Diabetes* 2007
Pedorthic / O&P Interventions

Proper / Ideal Footwear

Accommodate Deformities

Cushion and Redistribute Pressure

Patient Education

Follow Up

Ref: NIH Publication Working Together to Manage Diabetes 2007
What Else Can We Do?
Pressure force off-loading is routine.

\[
\text{Full Load, } L = \text{Perpendicular/Normal Load Component, } L_n + \text{Shear/Friction Load Component, } L_f
\]

"Rub" Component
Shear/Friction
Force

Off-loading is Routine!

Pressure
Force

Off-loading is Routine!

Full Load, \( L \)

Perpendicular/Normal Load Component, \( L_n \)

Shear/Friction Load Component, \( L_f \)

“Rub” Component
“There is an inverse relationship between the friction force and the number of rubs required to form a blister”
“Blisters, Callusities and Ulcers are primarily caused by excessive shear forces, commonly referred to as friction acting on the skin ”
Repetitive Loading

• Most trauma on the foot is generated by repetitive loading associated with ambulation

• The load is applied, reaches a maximum, then is released / reduced

• This cycle repeats again and again with each step

• The skin takes the first injury and sends the first warning (if sensation is intact)
Joseph Knapik

Excellent Review of Repetitive Loading Skin Trauma Research Findings with very useful explanations for Military and Sports Application
What About Pressure?

Tissue Trauma from Pure Pressure Looks like a Bruise
Friction Loading Against the Skin

- Reddened Skin Areas
  - Angry, Red Skin
  - Skin Rubbed Off
- Blisters
- Calluses
- Ulcers
How are Pressure Loads and Friction Loads Related?

Friction Forces Do the Damage
BUT
There Can Be No Friction Without Forceful Contact (Pressure)
Friction is the force which develops at an interface resisting sliding of one surface relative to the other.

The Friction Force $L_f$ is the sum of resisting forces at the interface.
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The Friction Force $L_f$, is the sum of Resisting forces at the interface.

If $L_n =$ Block Weight, 
$L_{FL} = L_n \cdot COF$
Friction is the force which develops at an interface resisting sliding of one surface relative to the other.

The Friction Force $L_f$, is the sum of Resisting forces at the interface.

If $L_n = \text{Block Weight}$, 
$LFL = L_n \cdot \text{COF}$
Please Notice

Friction Load Peaks Can Be No Greater Than Contact Pressure Load ($L_n$) Times CoF
Coefficient of Friction (CoF)

• Ratio of the force required to slide two materials (in contact) to the force perpendicular to the surfaces
• A lower friction coefficient indicates that there is less resistance to the sliding motion
• The CoF is always related to two materials
Friction is Not All Bad...

Stability
Control
Suspension
Propulsion Energy
Friction is **Only** Bad Where it Peaks High Enough To Cause A Problem

Reducing CoF In Identified Problem or Risk Areas is...

Friction Management
If \((\ln \cdot COF)\) is lowered by 30%.

When & where friction reaches this level, the sock breaks free and a bit of sliding occurs.

Back and forth sliding in this area.
Shear / Friction Forces Generated By Relative Movement of Bones Within the Shod Foot
Sock and skin are “released” to move with calcaneous before friction/shear loading builds to trauma-causing levels.
Tamarack Habilitation Technologies Introduces ShearBan Technology
Skin “Mobility”; A Critical Issue

- Scarred / Adhered Areas
- Skin Grafts
Adhered scars and skin grafts will see the limiting friction load whatever it is.

So we must make the friction load low.
\[ \text{Full Load, } L \quad = \quad \text{Perpendicular/Normal Load Component, } L_n \quad + \quad \text{Shear/Friction Load Component, } L_f \]

“Rub” Component
Questions / Discussion
• Since 1998
• Ongoing testing and improvements
• Product guide
Clinical Case Examples

Courtesy of:

• Dennis Janisse, CPed
• Charlie Kuffel, CPO, FAAOP
• Dane Hupp, PT
Courtesy of Dennis Janisse, CPed
National Pedorthic Services, Inc.
50 y/o Male
Diabetes, Type 2 Diabetes
Peripheral Neuropathy, Previous Amputations

Courtesy of Dennis Janisse, CPed
National Pedorthic Services, Inc.
3 months later

Courtesy of Dennis Janisse, CPed
National Pedorthic Services, Inc.
Courtesy of Dennis Janisse, CPed
National Pedorthic Services, Inc.
68 y/o Male
Type 1 Diabetes,
Charcot Deformity
Neuropathy, Post ulcerations

Courtesy of Dennis Janisse, CPed
National Pedorthic Services, Inc.
70 y/o Female
Arthritis
Midfoot/Toe Deformities

Courtesy of Dennis Janisse, CPed
National Pedorthic Services, Inc.
Courtesy of Dennis Janisse, CPed
National Pedorthic Services, Inc.
Case Study 1

Courtesy of Charlie Kuffel CPO, FAAOP
Arise Orthotics and Prosthetics
Case Study 2

Before

After (11 weeks)

Courtesy of Charlie Kuffel CPO, FAAOP
Arise Orthotics and Prosthetics
Case Study 2

Courtesy of Charlie Kuffel CPO, FAAOP
Arise Orthotics and Prosthetics
Callus Care

Courtesy of Dane Hupp, PT
National Hansen’s Disease Center