The biomechanical efficacy of dressings in preventing heel ulcers

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Key questions

- How can we understand the mode of action of prophylactic dressings in preventing pressure ulcers?

- Does the Mepilex® Border Heel dressing differ from other prophylactic dressings?
Introduction

- The Border II trial (Dr. Santamaria) demonstrated the effectiveness of the Mepilex® Border Heel dressing in preventing heel pressure ulcers.

- No study yet has investigated the mechanical loading internally in the soft tissues of the heel and how these are influenced by the use of prophylactic dressings.

- Several laboratory studies have demonstrated superficial pressure re-distribution properties but this is insufficient from a biomechanical perspective, given that *heel ulcers are essentially deep tissue injuries*.

- The primary cause of a deep tissue injury is exposure to sustained internal tissue deformations, which hence need to be minimized to achieve tissue protection.

(International Pressure Ulcer Prevention and Treatment Guidelines, EPUAP-NPUAP-PPPIA 2014)
The FE method is a computational technique for calculating the internal mechanical loads (e.g. deformations and stresses) in structures with complex shapes and multiple materials.

FE modeling is used extensively in different fields of bioengineering in order to develop e.g. orthopaedic and cardiovascular devices.

FE modeling has been employed in the past both for examining potential risk factors for pressure ulcer development and for evaluating the biomechanical efficacies of support surfaces.

Here we use FE modeling, for the first time, to study the efficacy of prophylactic dressings.
Heel anatomy and model configurations

Mepilex® Border Heel (Mölnlycke Health Care)

- Achilles Tendon
- Calcaneus Bone
- Fat
- VOI
- Multilayer dressing
- Elastic support

Bare skin

- Prescribed displacements
- Tied interfaces
- Frictional sliding

Single-layer dressing

Modeled volume

Levy et al. Journal of Tissue Viability 2015
The 5 layers of the Mepilex® Border Heel

**Safetac®:**
- Tied Interface

**Polyurethane Foam:**
- 1.6 mm

**Non-woven:**
- 0.2 mm

**Airlaid:**
- 2.2 mm

**Backing Film:**
- Friction

Tetrahedral mesh of the heel and dressing
Published results

**Compressive strains in soft tissues**

- **Dressing off**
- **Dressing on**

**Maximal shear strains in soft tissues**

- **Dressing off**
- **Dressing on**

**% soft tissues in volume of interest (VOI):**

The cumulative percentage of soft tissue volumes (skin, fat and tendon) exposed to critical strain levels

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Levy et al. *Journal of Tissue Viability* 2015
Single-layer versus the Mepilex® Border Heel design (on a support with stiffness of 63 kPa)

Published results (cont.)

Levy et al. Journal of Tissue Viability 2015
Results from phase II of the study: Posture in bed

Use of the Mepilex® Border Heel dressing consistently and considerably reduced internal soft tissue (skin, fat and tendon) loads at the posterior heel regardless of the posture of the foot.
Results from phase II of the study: Diabetic tissues

Use of the Mepilex® Border Heel dressing consistently and considerably reduced internal soft tissue loads at the posterior heel regardless of the (stiffer) diabetic tissue conditions.
Discussion

- Use of the Mepilex® Border Heel consistently and considerably reduced internal soft tissue loads at the posterior heel regardless of foot posture and tissue conditions

- The Mepilex® Border Heel design showed clear benefit over a single-layer foam design in terms of dissipating tissue deformations, by promoting internal shear in the dressing, which diverts loads from the tissues of the heel
  
  (Levy at el. Journal of Tissue Viability 2015)

- The protective efficacy of the Mepilex® Border Heel dressing evidently applies to the regions of high tissue deformations, where cell and tissue viability are at risk
  
  (Levy at el. Journal of Tissue Viability 2015)
It is very important to focus on internal tissue deformations as opposed to just examining skin pressures.

The Mepilex® Border Heel clearly provides a biomechanical protective effect against heel ulcers.

We attribute this protection to the specific multi-layered structure in the Mepilex® Border Heel design, the arrangement of stiffnesses of its layers, the tied Safetac® interface and the low friction at the external surface.

Further FE modeling indicates that there are also significant benefits in the use of the Mepilex® Border Heel in older patients and with diabetic patients.

Levy et al. Journal of Tissue Viability 2015
Basic research

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Abstract    The heels are the most common site for facility-acquired pressure ulcers (PUs), and are also the most susceptible location for deep tissue injuries. The use of multilayer prophylactic dressings to prevent heel PUs is a relatively new prevention concept, generally aimed at minimizing the risk for heel ulcers (HUs) through mechanical cushioning and reduction of friction at the dressing-support interface. We used 9 finite element model variants of the posterior heel in order to evaluate the biomechanical performance of a multilayer dressing in prevention of HUs during supine lying. We compared volumetric exposures of the loaded soft tissues to effective and maximal shear strains, as well as peak stresses in the Achilles tendon, without any dressing and with a single-layer or a multilayer dressing (Mepilex® Border Heel-type), on supports with different stiffnesses. The use of the multilayer dressing consistently and considerably reduced soft tissue exposures to elevated strains at the posterior heel, on all of the tested support surfaces and when loaded with either pure compression or combined compression and shear. The aforementioned multilayer design showed (i) clear benefit over a single-layer dressing in terms of dissipating tissue strains, by promoting internal shear in the dressing which diverts loads from tissues; (ii) a protective effect that was consistent on supports with different stiffnesses. Recent randomized controlled trials confirmed the efficacy of the simulated multilayer dressing, and so, taken together with this modeling work, the use of a prophylactic multilayer dressing indicates a great promise in taking this route for prevention.

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