DESIGN CONSIDERATIONS FOR SUPPORT SURFACES

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Introduction

Support surfaces, placed at bony prominences, can prevent pressure ulcers. Designs routinely aim to reduce contact pressures; yet the clinical effectiveness of such an objective can be questionable [McInnes, 2012]. In addition, the capacity against variations in total tissue thickness, a highly variable subject-specific anatomical marker, is unknown. The role of foam thickness, an easy-to-adapt property, to maximize patient-specific benefits is also unclear. This study therefore utilized finite element analysis to quantify the influence of tissue and foam thickness on internal and external mechanical markers of tissue loading.

Methods

A heel pad model was adapted as an analogue of a bony prominence [Goske, 2006]. A 200 N compressive force simulated contact with a rigid and with a foam surface (Figure 1-A). Tissue thickness was changed within two standard deviations [Erdemir, 2006]. Foam thickness was changed from 3.175 mm to 25.4 mm. Peak contact pressure (pCP) and peak von Mises Stress (pVMS) were extracted.

Results

pCP and pVMS established the external and internal mechanical indicators of damage risk, respectively (Figure 1-B). Tissue thickness had varying effects on both parameters (Figure 1-B). Reduction in pCP was more sensitive to changes in foam thickness (Figure 1-C).

Discussion

As previously illustrated [Oomens, 2003; Sopher, 2011], internal and external mechanics indicated different tissue regions as at risk: centrally located on the surface (pCP), off-centered at bone (pVMS). With increasing tissue thickness, potential damage risk decreased (Figure 1-B). A foam mat was effective to reduce loads at the interface irrespective of tissue thickness. Yet, its capacity diminished for the relief of internal loading. Therefore, a seemingly working support surface may not be adequate to alleviate internal loading for certain patients. The sensitivity of mechanical variables on foam thickness implied that designs can be adapted to minimize interface pressures, but may not have the desired efficacy for internal mechanics (Figure 1-C). Elaborate studies are still needed, e.g. probabilistic analysis and design optimization, to realize precision medicine for prevention of pressure ulcers.

References

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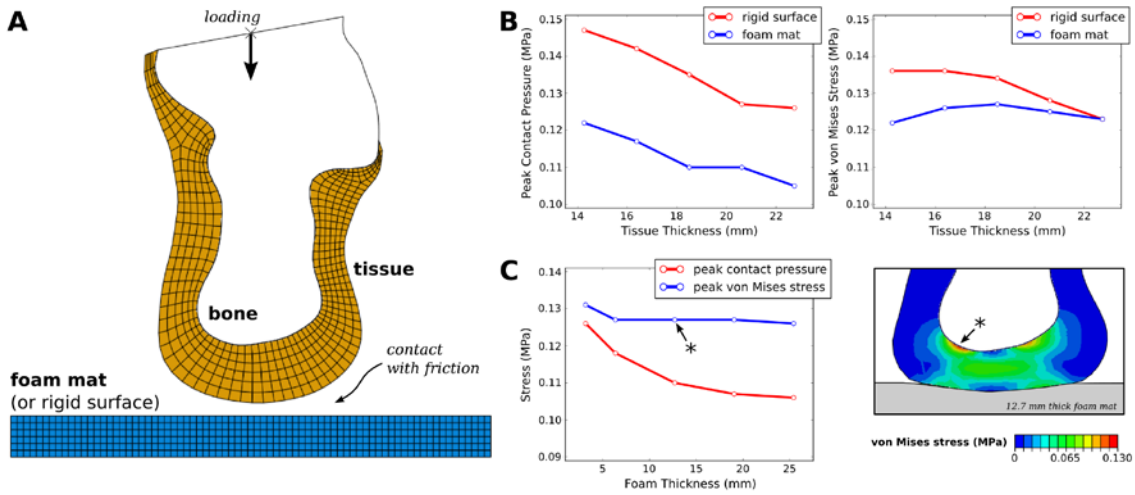

Figure 1: (A) Heel pad model (Abaqus; Simulia, Providence, RI). (B) Internal and external mechanical markers depend on tissue thickness (rigid vs elastomeric foam). (C) Mechanical indicators depend on foam thickness.