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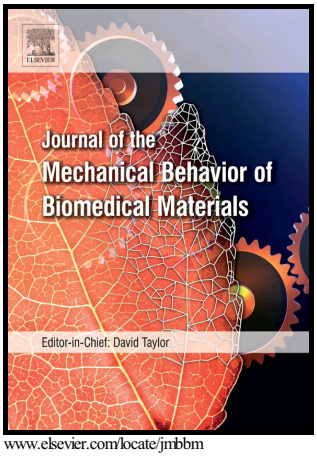

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Scalp Simulation – A Novel Approach to Site-Specific Biomechanical Modeling of the Skin

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Abstract

Objectives: This study aimed to determine the hardness of the human scalp in vivo in order to identify an appropriate scalp simulant, from a range of commercially available silicone materials, for force impact assessment. Site-dependent variation in scalp hardness, and the applicability of contemporary skin simulants to the scalp were also considered. **Materials and Methods:** A Shore A-type durometer was used to collected hardness data from the scalps of 30 human participants (five males and five females in each of the three age categories: 18-30, 31-40, 41-50) and four commercially available silicones (light, medium, and heavy-bodied PVS, and duplication silicone). One-sample t-tests were used to compare the mean hardness of simulants to that of the scalp. Site-dependent variation in the hardness of the scalp was assessed using a mixed-model repeated measures ANOVA. **Results:** Mean human scalp hardness derived from participants was 20.6 Durometer Units (DU; SD = 3.4). Analysis revealed only the medium-bodied PVS to be an acceptable scalp simulant when compared to the mean hardness of the human scalp ($p=0.869$). Scalp hardness varied significantly anteroposteriorly (with an observable linear trend, $p<0.001$), but not mediolaterally ($p=0.271$). Comparisons of simulants to site-specific variation in scalp hardness anteroposteriorly found the medium-bodied PVS to be only suitable in the central region of the scalp ($p=0.391$). In contrast, the duplication silicone ($p=0.074$) and light-bodied PVS ($p=0.147$) were only comparable to the posterior region. **Conclusions:** Contemporary skin simulants fail to accurately represent the scalp in terms of hardness. There is strong support for the use of medium-bodied PVS as a scalp simulant. Human scalp hardness varies significantly anteroposteriorly, but not mediolaterally, corresponding to regional anatomical variation within the scalp. A number of materials were identified as potential simulants for different regions of the scalp when more site-specific simulant research is required.