145: Personalized Foot Orthoses through a Patient-Centered Design Approach Using Generative AI

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Introduction

The personalization of orthopedic products, such as foot orthoses, is essential for ensuring high user acceptance, leading to consistent use and sustained medical effectiveness. While previous research has predominantly explored conventional user-centered design approaches, some studies have also investigated orthosis design assisted by Artificial Intelligence (AI), particularly for hand orthoses. However, these AI-driven approaches have primarily focused on visual design aspects or the feasibility of model generation, rather than a fully personalized wearable development process integrating AI. To address this gap, we propose a patient-centered design framework that integrates generative AI into orthopedic product development, enhancing personalization and adaptability.

Methods

The proposed framework follows an iterative eight-stage workflow, integrating generative AI into orthopedic product development. The process includes (1) patient requirements analysis, (2) Generative Pre-trained Transformer (GPT) configuration, (3) GPT-based design generation, (4) 3D modeling, (5) post-processing, (6) product personalization using foot scan data, (7) additive manufacturing, and (8) physical testing. To demonstrate feasibility, we applied the framework from design to the manufacturing of a customized foot orthosis based on patient requirements.

Results

A short-term usability and appearance assessment by one patient using the AttrakDiff Mini questionnaire showed a positive trend across pragmatic and hedonic quality, as well as overall attractiveness. Additionally, a semi-structured interview with an orthopedic technician highlighted the potential of this workflow as an innovative alternative to traditional methods by directly involving patients in the design process. However, challenges remain, particularly the need for specialized orthopedic software, regulatory challenges in AI-based solutions, and the integration of AI expertise into clinical workflows.

Conclusion

In conclusion, this study contributes to the field of human-AI-driven orthopedic product development and provides recommendations for researchers and practitioners. Despite its current limitations, the findings have broader implications for the development of wearable devices, where user-centered design principles can be effectively applied.