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Book Review 3D "Printing in Orthotics and Prosthetics: Innovations and Opportunities"

Ebrahim Sadeghi-Demneh[1], Mohammad Javad Nouri[2]

Letter to Editor

Abstract

In recent years, 3D printing technology has emerged as one of the most transformative tools in the field of digital health, opening new horizons in the personalization of medical and rehabilitation services. This technology, through its capability of layer-by-layer fabrication of three-dimensional objects based on digital models, has been able to overcome the limitations of traditional manufacturing methods in the production of orthotic and prosthetic devices, paving the way for the design and fabrication of devices fully tailored to each patient's anatomy and specific needs. The convergence of advances in materials science, increasing accessibility to 3D printers, and growing clinical demand has created a fertile ground for the widespread application of this technology in rehabilitation services. From the fabrication of custom orthopedic implants and limb prostheses to the production of orthotic braces and customized insoles for diverse patient populations, the scope of 3D printing applications is rapidly expanding. However, the effective utilization of this technology requires a simultaneous understanding of engineering fundamentals, materials science, biomechanics, and clinical principles, and the lack of comprehensive resources that present these multidisciplinary perspectives in an integrated manner has always been apparent. In this regard, the book 3D printing in Orthotics and Prosthetics: Innovations and Opportunities by Dr. Salman Shaikh, published by Springer, has endeavored to bridge this gap by integrating clinical experience with technical knowledge. The present article reviews and critiques this book, and while elucidating its structure, content, and strengths, it also addresses its limitations and offers suggestions for future studies.

Keywords: 3D printing; Book review; Orthotics; Prosthesis

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Introduction

In the rapidly advancing field of digital health, few technologies have demonstrated as much potential as three-dimensional (3D) printing in translating conceptual innovations into tangible clinical applications. 3D Printing in Orthotics and Prosthetics: Innovations and Opportunities, authored by Salman Sheikh (1), has been published at a time when the convergence of increased accessibility to 3D printing technologies, advances in materials science, and growing clinical demand has the capacity to transform the personalization of rehabilitation services. Published by Springer as part of the Biomedical Materials for Multi-Purpose Applications series, this book endeavors to present practical solutions enabled by 3D printing technology to enhance functional outcomes and improve the quality of life of individuals with limb loss and musculoskeletal disorders.

Dr. Sheikh brings a unique synthesis of clinical, entrepreneurial, and academic excellence to this work. Drawing on fifteen years of expertise in rehabilitation, his leadership as the founder of MetaFix Ortho, and his

1- Professor, Musculoskeletal Research Center AND Department of Orthotics and Prosthetics, School of Rehabilitation Sciences, Isfahan University of Medical Sciences, Isfahan, Iran
2- Assistant Professor, Department of Orthotics and Prosthetics, School of Rehabilitation Sciences, Hamadan University of Medical Sciences, Hamadan AND Musculoskeletal Research Center AND Department of Orthotics and Prosthetics, School of Rehabilitation Sciences, Isfahan University of Medical Sciences, Isfahan, Iran
Corresponding Author: Mohammad Javad Nouri; Assistant Professor, Department of Orthotics and Prosthetics, School of Rehabilitation Sciences, Hamadan University of Medical Sciences, Hamadan AND Musculoskeletal Research Center AND Department of Orthotics and Prosthetics, School of Rehabilitation Sciences, Isfahan University of Medical Sciences, Isfahan, Iran; Email: mj.nori@umsha.ac.ir

role as visiting faculty in Biomedical Engineering at renowned universities such as Savitribai Phule Pune University and MIT World Peace University, he provides a multidimensional and practical perspective that bridges theory with real-world application. The technical discussions are presented through practical examples, while efforts are made to preserve the scientific depth of the content. The book is systematically organized into eleven chapters, guiding readers through diverse applications of 3D printing in rehabilitation. The text begins with foundational knowledge, progresses toward specialized applications, and ultimately concludes with a forward-looking analysis of future challenges and opportunities.

Chapters 1 and 2 trace the evolution of 3D printing through a historical narrative, from Charles Hull's invention of the technology in 1984 to its contemporary industrial applications. One of the notable strengths of the book is its presentation of a standardized classification of 3D printing technologies. In a field where beginners are often confronted with a confusing array of acronyms and technical terminology, the book provides much-needed clarity in nomenclature and terminology. In addition, it offers a detailed examination of printing materials, ranging from commonly used polymers such as PLA (Polylactic Acid) and ABS (Acrylonitrile Butadiene Styrene) to biocompatible titanium alloys, thereby equipping readers with the knowledge required for clinical practice and application.

Chapters 3 and 4 focus on the prerequisite processes of 3D printing, namely scanning and design. The book provides a detailed account of three-dimensional scanning technologies, including triangulation scanners, structured-light systems, and photogrammetry. This discussion is subsequently extended to three-dimensional reconstruction and computer-aided design (CAD) based on radiological imaging data. The inclusion of specific software tools, such as Meshmixer, Fusion 360, and Grasshopper, together with descriptions of their practical applications, further enhances the clinical relevance and utility of these chapters.

Chapters 5 through 9, which constitute the core of the book, systematically examine applications of 3D printing across the spectrum of prosthetic and orthotic practice. The chapter devoted to orthopedic implants effectively contrasts the limitations of standardized products with the advantages of patient-specific solutions tailored to individual clinical needs. This discussion is strengthened through the presentation of case studies and compelling visual examples, including prosthetic reconstruction following hemipelvectomy. Parallel chapters addressing lower- and upper-limb prostheses appropriately consider the distinct biomechanical requirements of each application. Likewise, the sections dedicated to orthotic braces and insoles demonstrate the versatility of 3D-printing technology across diverse patient populations, ranging from infants with clubfoot deformity to individuals with diabetes who are at risk of foot ulceration.

Chapters 10 and 11 integrate the preceding discussions with perspectives on future developments in the field. The presentation of current research, including studies on clubfoot braces, finger splints, and custom-made insoles, provides a valuable body of evidence that may serve as a foundation for future work. The final chapter offers a systematic analysis of the technological, economic, regulatory, and workforce-related challenges facing the field, thereby presenting a balanced and comprehensive critical appraisal of this evolving area of science and technology.

Perhaps the book's most distinguishing characteristic lies in its successful integration of multidisciplinary perspectives. Texts on 3D printing in healthcare are often authored either by engineers with limited clinical insight or by clinicians who lack sufficient technological depth. Dr. Sheikh addresses and overcomes this divide with considerable care. For example, his discussion of the three-point pressure correction principle simultaneously addresses both the underlying biomechanical theory and its digital implementation within CAD software. This integrated approach is likely to benefit both prosthetists and orthotists seeking to understand digital workflows and engineers aiming to appreciate the clinical rationale underpinning device design.

Another notable strength of the book is its emphasis on practical workflows. Dr. Sheikh meticulously documents the digital chain of processes, including scanning, mesh editing and modification, computer-aided modeling, and additive manufacturing. This content is particularly valuable for practitioners, as it clarifies not only the technologies involved but also the expertise and quality-control measures required at each stage of the workflow.

The visual content of the book is also of high quality. Detailed illustrations of three-dimensional scans, CAD models, and fabricated devices effectively complement the textual explanations. Furthermore, the inclusion of software interface screenshots helps elucidate processes that may otherwise appear complex or inaccessible to novice readers.

Despite its considerable strengths, the book is not without limitations, some of which merit

consideration. Although its primary focus on thermoplastic and metallic applications appropriately reflects the current state of clinical practice and technological implementation, emerging frontiers such as bio printing and smart assistive devices remain comparatively underrepresented. While the concluding chapter briefly acknowledges these rapidly developing areas and their future potential, the discussion does not attain the same level of depth and analytical rigor that characterizes the book's core chapters.

In an era characterized by the rapid evolution of three-dimensional printing technologies and the growing emphasis on personalization across healthcare systems worldwide, this volume provides a timely and valuable resource for individuals seeking to harness the transformative potential of additive manufacturing in rehabilitation practice

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Search in Data Base: Mohammad Javad Nouri
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