

# 3D printed anatomical models for preoperative planning of complex orthopedic surgical operations of the lower limb

Dr Petar Valchanov, Faculty of Medicine, Medical University of Varna, Bulgaria

Dr Stoyan Ivanov, Faculty of Medicine, Medical University of Varna, Bulgaria

## Abstract

**Statement of the Problem:** Complex Multifragmental fractures of the pelvis and lower limb are a major challenge for the operative orthopedical surgery [1]. The successful metallic osteosynthesis of those fractures requires an extensive planning process, which can be dramatically improved with the 3D printed anatomical models – replicas of the bones with high fidelity, which are generated from CT and MRI imaging studies [2]. Those models represent the spatial properties of the skeleton with dimensional error of approximately 8  $\mu\text{m}/\text{mm}$  and can be manufactured easily and with high reproducibility with commercial or open access software and FDM 3D printing [3].

The preoperative models are used by the orthopedical surgeons as a highly accurate physical model of complex fractures and gives them the opportunity to choose and prepare the optimal operation window, surgical tools, metallic implants, and as a template for recontouring (pre bending) of fixation plates, which will be used during the surgery [4]. This approach provides a new level of personalization in operative orthopedic surgery and significantly reduces the duration of the operation, the amount of blood loss and the intraoperative X-rays. The proper anatomical reposition of the fracture is achieved at a higher rate in the surgeries, which are planned with 3D printed anatomical models [5]. The planning of surgical operations with 3D printed models increases the overall effectiveness of the surgery and reduces the rate of postsurgical complications, which makes them a valuable tool of personalized medicine.

**Conclusion & Significance:** In this article, we will describe the methods for the manufacturing of accurate 3D printed anatomical models, representing complex fractures and their application for preoperative planning of orthopedical operation.

**Acknowledgement:** This study is financed by the European Union-NextGenerationEU, through the National Recovery and Resilience Plan of the Republic of Bulgaria, project № BG-RRP-2.004-0009-C02“

## Image



## Recent Publications

1. Mostafa A, Kyriacou H, Khan W; An overview of the key principles and guidelines in the management of pelvic fractures. *Journal of Perioperative Practice*, Volume 31, Issue 9; <https://doi.org/10.1177/1750458920947358>
2. Paramasivam V, Sindhu , Singh G, Santhanakrishnan S; 3D Printing of Human Anatomical Models for Preoperative Surgical Planning; *Procedia Manufacturing*; Volume 48, 2020, Pages 684-690; <https://doi.org/10.1016/j.promfg.2020.05.100>
3. Valchanov P, Pavlov S; High Fidelity Anthropomorphic 3D Printed Models - Accuracy, Precision and Quality Control; 2022 E-Health and Bioengineering Conference (EHB), Iasi, Romania, 2022, pp. 1-4, doi: 10.1109/EHB55594.2022.9991424.
4. Marinescu, R.; Popescu, D.; Laptoiu, D. A Review on 3D-Printed Templates for Precontouring Fixation Plates in Orthopedic Surgery. *J. Clin. Med.* 2020, 9, 2908. <https://doi.org/10.3390/jcm9092908>
5. Ivanov, S.; Valchanov, P.; Hristov, S.; Veselinov, D.; Gueorguiev, B. Management of Complex Acetabular Fractures by Using 3D Printed Models. *Medicina* 2022, 58, 1854. <https://doi.org/10.3390/medicina58121854>

Email:

## Photograph



## Biography

Dr. Petar Valchanov actively engages in various areas of medical 3D modeling and 3D printing, including the creation of models for preoperative planning, medical devices, and imaging phantoms. He has produced hundreds of clinical-anatomical models for preoperative planning and personalized trainers for several surgical specialties. His interests are related to clinical anatomy, radiology, materials science, 3D arts, 3D bio/printing, implantology, personalized, and regenerative medicine. He participated in initiating and organizing a laboratory for 3D bio/printing in the Department of Anatomy and Cell Biology at the Medical University of Varna. In 2024, he defended his PhD thesis on the topic "Modeling and 3D printing of morphologically accurate bone matrix".

Email: [petar\\_valchanov@mu-varna.bg](mailto:petar_valchanov@mu-varna.bg)