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3D Printing in Fractures: A Game Changer?

SHORT ABSTRACT

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ABSTRACT

Background: 3D printing (3DP) or additive manufacturing has become an established technique in many industries for its fast production of objects with a large range of shapes and designs. Whereas it was initially used for rapid prototyping and product design evaluation, it has been applied more and more in small batch production as well. In the medical field 3DP has demonstrated its potential for various purposes, ranging from mere display of anatomy to printing of implants in tissue, although the latter application still needs to be translated to the clinical field and demonstrate usefulness.

Applications of 3D printing: We will present an overview of the different clinical uses of 3DP in the process of fracture treatment and where these uses may prove to be beneficial. This will encompass the use for patient interaction, in which a physical model of the anatomy is used to explain the complexity of the fracture to the patient. We will also consider the preparation of the intervention in which the 3D model is used: i) to understand and appreciate the fractures lines, ii) to come up with a suitable classification, and iii) realize a surgical plan (***Figure 1***). A third use is the surgical simulation of the intervention, in which the surgeon conducts a trial surgery on a 3D printed model. Finally, 3DP can be employed in the design of surgical templates or guides that enable the surgeon to accurately transfer a digital preoperative plan to the surgical environment.

Figure 1 Left: Segmentation of a fractured calcaneus (in yellow) that is being prepared for printing. For clarity the talus is shown as well in grey. In the middle the actual printing of the calcaneus. On the right the post-operative models (calcaneus+talus) are shown.

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Practical implications: Realizing a 3DP solution within a clinical environment can be challenging and often requires a multi-disciplinary approach. Hence, it is important to know the pitfalls of such an endeavor. We will present the different practical steps involved in the realization of a 3DP solution in clinical practice. This involves image acquisition, image segmentation for anatomical model generation, surgical preparation and/or modeling, and the actual 3DP the anatomical part or surgical guide.

Finally, we will highlight important considerations that may be prohibitive for deploying a 3D-printed solution in the hospital. More specifically we will touch upon the legal boundaries that are set by the recent introduction of the Medical Device Regulation (MDR) but also on aspects of cost-efficiency of 3DP solutions. In this respect, some applications may find that 3D visualization of the anatomy is a valid alternative to 3DP and (future) developments in the field of artificial intelligence may reduce the cost of patient-tailored solutions.

COMPETING INTERESTS

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