

Glimpse into the future: Three-dimensional Bioprinting Reimagines Jaw Reconstruction



Amongst the emerging techniques adapted to oral and maxillofacial surgery is the three-dimensional (3D) bioprinting technology. Very soon, bone grafts harvested from distant anatomical sites, leaving behind scars and compromising donor sites, would be a thing of the past. The dawn of personalised, biocompatible jaw reconstruction is upon us, and the recent explosion of research in this domain hints at a thrilling picture of what's to come in the near future.

Recent studies have demonstrated the potential of 3D bioprinting in creating cartilaginous templates for large bone defect healing. The study by Pitacco *et al.*, revealed that 3D bioprinting could be a viable approach to scale up the engineering of developmentally inspired templates for bone tissue engineering. Their research showed that early hypertrophic templates supported accelerated regeneration in critically sized, load-bearing bone defects. This study demonstrated the remarkable potential of 3D bioprinted cartilaginous templates in regenerating critically sized femoral bone defects in rats. This study, employing human mesenchymal stem cells and fibrin-based bioinks, highlights the feasibility of bioprinting developmentally inspired templates that mimic the natural process of endochondral ossification.^[1] Similar successes have been reported in mandibular reconstruction using 3D-printed titanium grid scaffolds, showcasing the efficacy of this technology in promoting osteogenesis within jaw defects. Li *et al.*, fabricated 3D-printing titanium grid scaffolds, which possess sufficient pores and basic biomechanical strength, to facilitate osteogenesis in mandibular segmental defects. Their results demonstrated that these scaffolds could facilitate bone regeneration in large-segment mandibular bone defects.^[2]

The rapid pace of research in this field is nothing short of exhilarating. With each passing month, discoveries and advancements are unveiled, pushing the boundaries of what was once considered science fiction. The sheer volume of

research papers being published speaks volumes about the burgeoning interest and immense potential of 3D bioprinting in jaw reconstruction. This rapid knowledge expansion paves the way for the imminent arrival of the first human case reports, marking a pivotal moment in the history of maxillofacial reconstructive surgery.

The ultimate goal of 3D bioprinting – personalised surgical solutions – is no longer a distant dream. Imagine a future where a patient walks into your clinic, their computed tomography scan readily available. Within hours, a custom-designed, bioprinted jawbone scaffold, perfectly mimicking their unique anatomy, may be prepared using their cells (perhaps stem cells). This personalised implant, meticulously crafted layer by layer, promises precise reconstruction, faster healing and minimal donor-site morbidity. Such a scenario, once relegated to the realm of fantasy, is now within the grasp of reality.

While we celebrate these advancements, it is crucial to remember that the journey is just beginning. While the outlook is undeniably optimistic, it is crucial to acknowledge that challenges remain. Regulatory hurdles, cost considerations and ethical implications surrounding the use of stem cells must be carefully navigated to ensure safe and equitable access to this technology. The medical community must continue to explore this promising technology, refining techniques and expanding applications to fully harness its potential. Hope the New Year 2024 will usher in such renewed hope and scientific vigour.

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