Breast Enhancement using 3D Printing

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Abstract

Breast cancer surgery frequently results in the removal of the breast. Existing breast reconstruction techniques, on the other hand, may not be able to address the requirement for replacement tissue. The utilization of new materials in tissue engineering holds the potential of developing adequate substitutes. In recent years, there has been a substantial surge in interest and implementation of three-dimensional (3D) printing technology in the medical sector. This is especially true in intricate medical settings, such as when anomalous or sophisticated anatomical surgical concerns or exact reconstructive techniques are being considered. Furthermore, 3D bioprinting, which mixes cells with biomaterial scaffolds, is an interesting technique with substantial tissue engineering applications. The goal of this article is to look at a few types of research that employed 3D printing technology in breast reconstructive surgery operations, as well as prospects and uses of 3D bio-printing.

Keywords: Breast reconstruction • 3D printing • Breast cancer • Tissue engineering

Introduction

As of 2019, breast cancer is the most prevalent cancer diagnosed in American women, and it is only second to lung cancer as a cause of cancer mortality in women. Because 268,600 new instances of invasive breast cancer (almost six times the number of DCIS cases) are diagnosed each year, many women are forced to undergo breast ectomy with prompt consideration of replacement tissue. Although this was gratifying for many patients, both saline and gel-filled breast implants have significant risks of infection, capsular contracture; implant displacement, and abnormalities [1-4]. Autologous restoration is more texturally natural cosmetically, but it involves a more difficult treatment, a longer recovery period, and the risk of muscle weakening or hernia development at the tissue donor site. By merging 3D printing technology with synthetic or natural structural components, tissue engineering aims to overcome these restrictions.

Three-dimensional (3D) printing, also known as Computer-Aided Manufacturing (CAM), relied on digital model files to manufacture products with computer-guided accuracy, layer by layer. Simply expressed, an STL (Standard Tessellation Language or Stereolithography) file is used to turn a virtual representation of an item into a printed object using a Computer-Aided Design (CAD) application [5]. The product then takes shape gradually and precisely as each thin layer is added following the design file, and is made up of the appropriate material for that object in the form of "ink" utilizing the 3D printer. Not only has this technology been utilized to create intraoperative 3D printed models that serve as templates, but it has also been used to create implanted scaffolds that have been used to fix defect-specific areas, clearly improving patient care [6]. One such application is the accurate rebuilding of faults in the load-bearing axial skeleton on an individual basis. The use of scaffolds made using 3D bio-printing for soft tissues, on the other hand, greatly increases the complexity and difficulty. Soft tissue defects, unlike the rigid, anatomically accurate skeleton, appear in a variety of forms and sizes, are flexible, and have a wide range of textures. Materials for 3D bio-printing that match a wide range of soft tissue mechanical characteristics are limited, and they don't sufficiently replicate the physical, chemical, and biological complexity and diversity of tissues and organs in the human body [7]. Beyond anatomical restoration, the idea of functional restoration is perhaps the most frightening task in soft tissue healing. For example, despite significant efforts, the major challenge of producing 3D bio-printed, functioning tissue-engineered liver scaffold has yet to be met.

In breast reconstruction, functional restoration may be an exception, as this quality is typically less important than obtaining an ideal visual form and mechanical qualities. The potential therapeutic importance of extraordinary 3D bio-printing scaffolds for breast reconstruction is enormous. Such scaffolds would have to have unusually high biocompatibility, mechanical characteristics equivalent to natural breast tissue, and be biodegradable within a particular time frame to be incorporated into or even replace present breast reconstruction.

Since the initial patent for 3D printing technology-stereo lithography-in 1986, the breadth of this cutting-edge technology has exploded in study and use. Other 3D printing techniques have been created since the introduction of the first Stereo Lithography Technology (SLA), such as inkjet printing, Selective Laser Sintering (SLS), and melt deposition modelling printing methods (Fused Deposition Modelling) [8].

The early uses of 3D printing technology were in the automobile and aerospace production industries, which were constrained by traditional printing processes and materials. 3D printing entered the area of medicine in the early twenty-first century, mostly for bone and artificial limb implants, thanks to the continual innovation and evolution of printing technologies and materials. Clemson University's Thomas Boland suggested the notion of cell printing in 2000, and it was first realized in 2003. Printed cell scaffolds with a micro-resolution of fewer than 100 m and a cell survival rate of more than 95% have been reported less than two decades later. This degree of accomplishment encourages the development of more medically relevant 3D printing technologies and will almost certainly lead to more study in the field of soft tissue healing. In 2015, Xi'an Jiao tong University's mechanical manufacturing department invented melt electrostatic printing technology, which combines the benefits of melt electro spinning with 3D printing to make micro nano-fibres [9].

Conclusion

Overall, the functional requirements of breast tissue are low, focusing mostly on aesthetics and tissue matching, and making 3D printing technology acceptable for breast restoration. Scaffolds that can fully heal faults have vast application prospects, thanks to the development of novel materials and cell printing technology, allowing for tailored reconstruction and repair.

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