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Abstract

Development of fat-holding and drug-eluting implant for breast-conserving surgery

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Breast conserving surgery (BCS) is a standard treatment for breast cancer, aimed at removing tumours whilst preserving as much of the healthy breast tissue as possible. However, the surgical procedure often leaves a noticeable dent at the surgery site and necessitates subsequent radiotherapy to minimise cancer reoccurrence risk. This presents a significant aesthetic and therapeutic challenge, prompting demand for effective post-BCS partial breast reconstruction. Traditional reconstruction approaches, such as autologous fat injection, suffer from substantial fat loss (40-60%) to the surrounding tissue, resulting in suboptimal outcomes [1].

To address these issues, a novel biodegradable breast implant with the capacity to elute anti-cancer drugs is proposed. The contour of this implant is customised based on MRI-derived dimensions of the excised tumour and adjacent healthy tissue from individual patients. For modelling and design simplification, a spherical tumour with a 20 mm diameter is utilised as the model. Lattice designs for the implant were explored using FLatt Pack, an open-source software enabling the addition of lattice infill to the 3D model [2]. The triply periodic minimal surface (TPMS) gyroid lattice was chosen for its interconnectivity of internal pores and good permeability [3]. 3D models with a range of dimension-to-cell ratios (from 1:0.5 to 1:2) were generated and printed by LCD printing.

To evaluate the implant's fat holding capability, a solution mimicking adipose tissue, composed of 25% w/v xanthan gum in water with blue colouring, was prepared. The solution was injected into a silicone mould containing the implant, to evaluate the permeation, injection resistance, and fat holding capacity. Of the examined samples, the dimension-to-cell ratios of 1:1 showed the best permeation of fat and lowest injection resistance. Evaluation of drug incorporation into the bioresorbable scaffold to enable the drug eluting function of the implant is ongoing.

AUTHOR'S STATEMENT

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