Utilizing FDM 3D Printing to Fabricate Biodegradable PCL-Dexamethasone Implants for DME

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Diabetic macular edema (DME) is a leading cause of vision impairment, affecting up to 30% of diabetics. It results from retinal fluid buildup due to vascular leakage and is commonly treated through sustained corticosteroid delivery. While the Ozurdex biodegradable dexamethasone implant offers extended release, it often requires reinjections, raising the risk of complications and high costs. This study aims to fabricate biodegradable polycaprolactone (PCL)-based dexamethasone implants using fused deposition modeling (FDM) 3D printing (3DP) as a cost-effective alternative that reduces the need for repeated injections. Cylindrical implants were designed in Tinkercad, exported as STL files, and printed with an FDM printer. Drug incorporation was achieved by soaking PCL filament -chosen for its biocompatibility and slow degradation- in a supersaturated dexamethasone-ethanol solution, followed by controlled drying. Dimensional accuracy was measured using electronic calipers, while scanning electron microscopy (SEM) analyzed surface morphology. In-vitro drug release was evaluated by immersing implants in PBS at 37°C, with absorbance measured at 243nm using UV-VIS spectrophotometry. A calibration curve correlated absorbance with concentration. Results showed fabrication precision with dimensional deviations under 2.5%, and SEM confirmed smooth surfaces, indicating consistent extrusion. In-vitro drug release testing demonstrated an initial drug release phase and suggests potential for extended delivery with further optimization. Cost analysis demonstrated significant affordability compared to conventional implants. This study establishes FDM 3DP of PCL-dexamethasone implants as a scalable, cost-effective method with the potential to offer a safer alternative for DME treatment.

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