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Abstract

Microgel support bath enabled bioprinting of 3D multimaterial structures for skin tissue

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Skin tissue engineering has quickly developed as a promising approach for the treatment of chronic dermatological wounds such as diabetic ulcers, severe burns, and incision scars from cancer treatments [1-3]. Integrating 3D bioprinting into this field has begun to revolutionise this field by providing precise control over the cellular arrangement of skin cells and composition of native skin. However, there is still a gap in the field of tissue engineering for disease models, especially for cancer [4-6]. There is a crucial need for the development of accurate skin models to study diseases such as malignant melanoma more accurately to improve patient prognosis. Despite the developments in the field, there are still several drawbacks with existing skin models as they are not complete with all components of the native skin which can give inaccurate results. A full thickness model should ideally contain all three layers of the skin with fibroblasts, keratinocytes, melanocytes, hair follicles for thermal regulation and vasculature as tumourigenesis is dictated by a rich blood supply and oxygen. This abstract introduces a method for 3D bioprinting using a Carbopol support bath for skin tissue engineering. The strategy utilizes Carbopol 980, a water-soluble polymer commonly employed in the pharmaceutical and cosmetic industries. Carbopol 980 is a polyacrylic acid carbomer, and is highly compatible with cells, making it suitable for creating bioinks that can be cross-linked through various mechanisms. The inks can be printed in the Carbopol microgel at low viscosities and therefore low pressures. The printed inks are encapsulated in the microgel before being extracted using an ionic solution. Three distinct bioinks were developed for printing with Carbopol suspension, each utilizing a different crosslinking technique and representing a different layer of skin: a thermally responsive and optimised alginate-gelatin ink (hypodermis, cross-linked through ionic interactions), a 10 % gelatin methacrylate (GelMA) ink (dermis, cross-linked via visible light photo curing), and a PureCol bovine collagen type 1 ink (epidermis, cross-linked through thermal methods at 37 °C). Optical microscopy analysis demonstrates that these selected inks can be printed using low pressures and smaller nozzle tips, resulting in highly precise structures. The biological response of cells, as assessed through Live/Dead assay and Alamar blue tests, reveals negligible differences between printing in air without support and printing in Carbopol. The field of Carbopol suspension printing remains relatively unexplored, offering the potential to fabricate single-component hydrogel structures with customized properties and resolutions, particularly for applications in skin tissue engineering.

AUTHOR'S STATEMENT

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