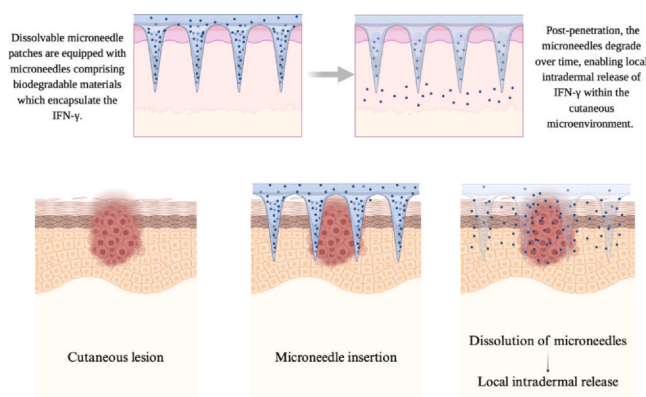


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IFN- γ -Loaded Dissolvable Sugar Microneedles for Local Intradermal Delivery in Cutaneous Squamous Cell CarcinomaT. Akmandor^{1,2}, S. Outram¹, C. Russo¹, E. Loizidou^{1,3}¹ Middlesex University, Department of Natural Sciences, London, United Kingdom² University College London Hospitals NHS Foundation Trust, Department of Cellular Pathology, London, United Kingdom³ University College London, School of Pharmacy, London, United Kingdom

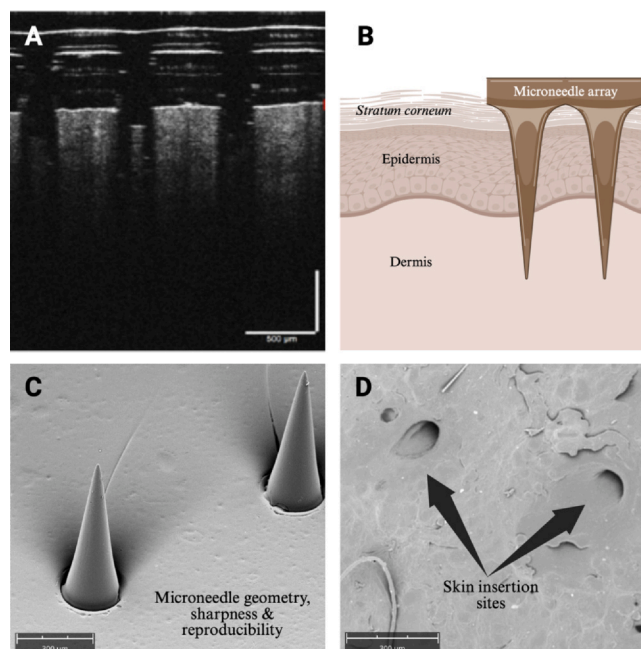
Background: Cutaneous squamous cell carcinoma (cSCC) is a common non-melanoma skin cancer in which local immune modulation is clinically relevant. Interferon-gamma (IFN- γ) is a key immunomodulatory cytokine; however, its clinical application in skin disease is limited by challenges associated with controlled local delivery. Dissolvable microneedles offer a minimally invasive approach to bypass the stratum corneum and enable intradermal delivery of biologics. This study aimed to develop IFN- γ -loaded dissolvable sugar-based microneedles and evaluate their structural integrity and ability to achieve reproducible intradermal penetration in skin-relevant models.



Conceptual schematic of dissolving microneedle-mediated IFN- γ delivery. Microneedles penetrate the stratum corneum and dissolve following insertion, enabling local intradermal cytokine release within the cutaneous microenvironment. The approach is intended for localised cutaneous immunomodulation.

Methods: IFN- γ -loaded dissolving microneedles were fabricated using a sugar-based matrix via micro-moulding. Microneedle morphology and structural integrity were assessed using scanning electron microscopy (SEM). Intradermal penetration and delivery depth were evaluated using ex-vivo human skin and optical coherence tomography (OCT), with penetration depth assessed across multiple insertion sites.

Results: IFN- γ -loaded microneedles demonstrated uniform geometry and intact needle tips suitable for skin insertion. SEM confirmed consistent microneedle architecture, while OCT imaging demonstrated reproducible disruption of the stratum corneum and formation of intradermal microchannels extending into the viable epidermis and superficial dermis. Penetration depth was consistent across multiple microneedles within each array, supporting reliable intradermal delivery.



Structural integrity and skin penetration of dissolving microneedle arrays. (A) OCT imaging demonstrating consistent microneedle penetration into skin. (B) Schematic illustrating microneedle insertion across skin layers. (C) SEM showing microneedle geometry and tip sharpness. (D) SEM of skin surface confirming microneedle insertion sites.

Conclusions: This study demonstrates the feasibility of delivering IFN- γ -loaded dissolving microneedles into human skin using a minimally invasive approach. These findings support the potential of dissolvable microneedles as a local intradermal delivery platform for cytokine-based strategies in cutaneous squamous cell carcinoma, with future work required to evaluate pharmacodynamic and biological effects.

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A-141

Imiquimod-Loaded Dissolving Microneedles for Enhanced Dermal Penetration in Basal Cell Carcinoma Immunotherapy: A Feasibility and Delivery Study

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Background: Topical imiquimod is widely used for the treatment of superficial basal cell carcinoma (sBCC) however its clinical efficacy is limited by variable stratum corneum penetration, prolonged treatment courses, and frequent local skin reactions. Improving intradermal delivery while reducing epidermal exposure could enhance both efficacy and tolerability in dermatology. The aim of this study is to develop and characterise a dissolving microneedle (MN) platform for imiquimod delivery designed to improve dermal penetration and enable targeted local immunotherapy for basal cell carcinoma.