DiaMiR: A MicroRNA (miR-23) Microneedle Patch for Type-2 Diabetes Control

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422 million adults worldwide have diabetes, and 48% of all juvenile deaths are due to diabetes or diabetes-inflicted diseases; diabetes in low-income families has risen rapidly---up to 21% worldwide. By combining recent advances in microRNA (miR) technology and applying a novel miR-based LNP loading and microneedle hyaluronic chain-linked drug-infusion method, DiaMiR (Diabetes MicroRNA injected Reparation) aims to mitigate the adverse effects of Type-2 Diabetes (T2D) by activating T2D-inhibited signaling pathways. This study provides proof of concept, in-vitro, and in-vivo data for developing a cost-effective and accessible microRNA (miR) - loaded wearable microneedle patch to control T2D. Scanning electronic microscope (SEM) and fluorescence imaging reveal the conformality of the microneedle patch after miR-23 loading. In-vitro tests were conducted to investigate miR-23 effects of AKT insulin pathway, PTEN expression, glucose output, and glucose uptake on the liver (Hep-G2), adipose (3T3-L1), and skeletal muscle (L6). The in-vivo tests (animal studies) were conducted on diabetic mice. IVIS (In-Vivo Imaging System) was used to determine the degradation profile. Our results suggest that miR-23 decreased glucose output in HepG2 liver cells [control vs. miR-23b ($p < 0.0001$; highly significant)], but increased glucose uptake in L6 skeletal cells [control vs. miR-23b ($p < 0.0001$)] and 3T3-L1fat cells [control vs. miR-23b ($p < 0.0001$)]. One DiaMiR microneedle patch significantly lowered blood glucose levels in diabetic mice for 3-4 days. This approach is safe: DiaMiR showed no toxicity in the treated mice and did not induce inflammation. Using technologies in bioengineering, biomaterials, and sustained drug delivery, our study offers an innovative solution to control T2D.

Awards Won:

First Award of $5,000

EU Contest for Young Scientists Award

Drug, Chemical &amp

Associated Technologies Association (DCAT): DCAT First Prize

Long Island University: Presidential Scholarships