**PROJECT RESUME UPDATED NOVEMBER 2023**

**TITLE: Advanced Synovial Microneedle Technology for Drug Delivery to Prevent Post Traumatic Osteoarthritis**

The objective of this project is to develop a microneedle-based technology to facilitate drug-delivery to the knee joint to prevent diseases such as Post Traumatic Osteoarthritis (PTOA). PTOA is distinctively possible threat among patients who are in their 30s and 40s since most knee traumas happen in physically active young adults. As the incidence and prevalence of PTOA increase, the financial burden on the healthcare system, and the economy will also increase. The condition currently affects more than 5.6 million people in the US alone, and more than $3 billion is being spent every year. PTOA is a condition that occurs after acute joint traumas, such as intra-articular fractures and meniscal, ligamentous and chondral injuries. Given how costly and problematic PTOA is and will likely continue to be there it is a significant need to develop new technologies and treatments to address this issue.

To plan and develop new treatments, a useful strategy is to start with the current gold standard of treatment. Currently, there are two treatment approaches for ACL ruptures, one being surgical and the other conservative (physiotherapy and rehabilitation). In the majority of cases, the surgical route is chosen, and this is partly because the procedure has a very high success rate. This success rate for surgical repair is high, from the point of view of mechanical stabilization, but no steps are currently taken to prevent PTOA from developing. Standard biologic therapeutic approaches are unlikely to be effective since clearance from the joint space occurs very quickly either via the vasculature, or the lymphatics. Thus, a delivery system with a long dwell time, and a controlled slow-release mechanism would be advantageous.

Thus, we are proposing a novel concept that will exploit the Microneedle patch (MAP) technology and tailor it for an internal (intra-articular) application *via* arthroscopic delivery for the first time. This state-of-the-art concept will play an important role in drug delivery technology and will offer a range of benefits. Firstly, the lack of a strong ‘barrier function’ in the synovium (but which is present in the skin) will expedite the potentiality of the longer-term implantation of MAPs in the tissue. Secondly, the idea of a ‘backing compartment’ on an intra-articular (or any other) internal MAP. In traditional transdermal systems, the backing layer has no significant use (since it is open to air) whereas in internal MAPs, the presence of a drug depot on an MAP, and its positioning within the joint, allows the possibility of multi-targeting of important tissues like cartilage/bone with one device. Furthermore, secure mechanical anchorage of the device in the synovium circumvents the long-standing problem of rapid drug-egress of drugs from the joint. Finally, by designing this concept around existing gold standard arthroscopic/keyhole surgeries, which are carried out in almost all cases of ACL rupture, there is genuine potential for rapid and widespread uptake by the orthopaedic/arthroscopic surgical community.

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