

Bioinspired Nanographene Oxides Crosslinking: Insight into Nonthermal Microplasma- drug delivery system for anterior cruciate ligament tear treatment

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Abstract:

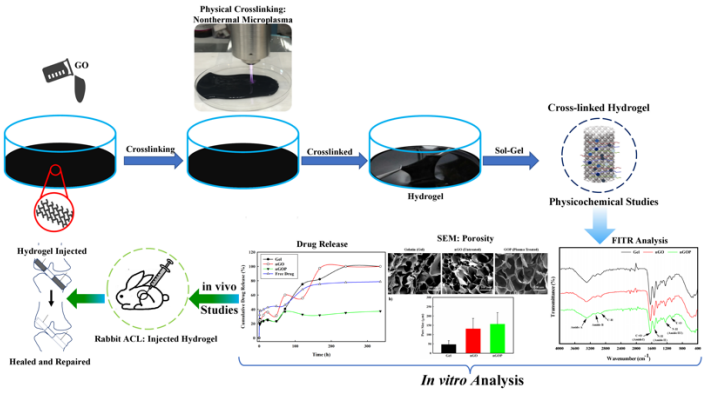
Anterior cruciate ligament (ACL) tears are the most common and severe injuries among all ages in sports, especially those that involve sudden stops and directional changes, jumping and landing such as football, soccer, basketball, and down skiing. In light of the rising incidence of ACL tears, which approximately occurs 1 in 3500 people in the United States alone, with 100,000 to 200,000 ACL tears and sprains – numerous research has contributed to ACL tears healing approaches. In this abstract, a proposed approach was made to bio-fabricate and reinforced nanographene oxides (nanoGOs) hydrogel utilizing a nonthermal microplasma-mediated (NTP) crosslinking, and utilize the biofabricated hydrogel material to enhance and rapidly boost the ACL tear healing after surgery. Interestingly, different treatment approaches are highlighted. However, hamstring tendon autografts have dominated due to the postoperative anterior knee pain on the donor site morbidity commonly associated with the bone-patellar tendon-bone graft. Therefore, the fixation method and tendon-bone healing of tendon grafts could be one of the significant issues due to three fixation problems which may occur: non-union between the tendon-graft and -bone, scar tissue in-growth between the tendon-graft and -bone, and sharpy's fiber in-growth between the tendon-graft and bone. Thus, enhancing the tendon-to-bone healing is a fundamental approach for a successful clinical outcome in ACL tear reconstruction and healing. As per the aforementioned, our research team was able to successfully biofabricated and physicochemically analyzed the fabricated hydrogel aided by an NTP crosslinking for ACL tear healing in tendon-to-bone healing. The in vitro studies with regards to the drug delivery system analysis were thoroughly analyzed.

Results demonstrated, as per physical crosslinking by NTP, could enable the bio-polymerization and crosslink in a controlled manner under ambient condition. The fragmentation of polymer chains leads to the pore-structure formation (owing to large pores sizes) suitable for tissue engineering, which could result in an increased wettability and hydrophilicity. More interestingly, the sufficient roughness of the hydrogel surface was obtained, which is highly suitable for exterior roughness for the hydrogel to act as a bio-adhesive, promoting proper attachment and integration within the surrounding surface and improving tissue regeneration.

In conclusion, our proposed approach could be one of the feasible approaches which can breach the gap and enhances the crosslinking (avoiding the chemical method) for this hydrogel suitable for treatment.

Keywords: Anterior cruciate ligament, nanographene oxide, hydrogel, microplasma, crosslinking

Images/Graphs/Tables:



Recent Publications:

- Satapathy, M.K., ***Manga, Y.B.***, … **Chen, C.H***., 2019. Microplasma cross-linked graphene oxide-gelatin hydrogel for cartilage reconstructive surgery. ACS Appl. Mater. Interfaces, 12(1), pp.86-95.
- Wong, C.C., … **Chen, C.H*.**, 2019. Biocompatibility and osteogenic capacity of Mg-Zn-Ca Bulk metallic glass for rabbit tendon-bone interference fixation. *Int. J. Mol. Sci.*, 20(9), p.2191.
- Chen, Y.P., … **Chen, C.H.***, 2018. Effectiveness of strontium ranelate in the treatment of rat model of leg–calve–perthes disease. *Indian J. Orthop.*, 52(4), p.380.

Biography:

Dr. Yankuba B. Manga received his MSc and Ph.D. degrees from Taipei Medical University, Taipei, Taiwan, both in the Graduate Institute of Biomedical Materials and Tissue Engineering, in 2013 and 2018, respectively. Currently, working as a Postdoctoral researcher at Taipei Medical University, College of Biomedical Engineering, under the project "Liquid-phase plasma-induced nano-graphene-based gelatin hydrogel drug delivery system for tendon-to-bone healing in anterior cruciate ligament reconstruction" funded by the National Health Research Institutes (NHRI), Taiwan. Dr. Manga is currently working/training under the leadership of Dr. Chen. His research interests lie under the domain of nanotechnology, biosensors-FETs, biophysics, nonthermal microplasma, and biomaterials/tissue engineering.

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