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AAO Foundation Final Report Form
(a/o 1/3/2018)

In an attempt to make things a little easier for the reviewer who will read this report, please consider these two questions before this is sent for review:

- *Is this an example of your very best work, in that it provides sufficient explanation and justification, and is something otherwise worthy of publication? (We do publish the Final Report on our website, so this does need to be complete and polished.)*
- *Does this Final Report provide the level of detail, etc. that you would expect, if you were the reviewer?*

Please prepare a report that addresses the following:

Type of Award Orthodontic Faculty Development Fellowship Award

Name(s) of Principal Investigator(s) Xu Qian

Institution Tufts University School of Dental Medicine

Title of Project Application of mechanical stimulation cues for periodontal tissue engineering

Period of AAOF Support 07-01-19 to 3-31-21, extended once

Amount of Funding $20,000

Summary/Abstract

Over 150 million people worldwide suffer from edentulism, whether due to trauma, caries, periodontitis or genetic disorders [1-3]. Currently, metal dental implants are the most common replacement of missing teeth. However, there are many negative sequelae that come with an implant such as bone loss, peri-implantitis and implant failure [4, 5]. One main concern is lack of periodontal tissue surrounding the implant, rendering it immobile like an ankylosed tooth. Furthermore, implants cannot be placed in growing children and can be problematic when doing orthodontic treatment. Recent discoveries have been functionality of natural teeth [6-8]. The Yelick Lab at Tufts University has recently reported a bioengineered tooth bud with features of a natural tooth bud [9]. However, the difficulty in creating the surrounding periodontal tissue is a main challenge for whole tooth regeneration.

To address this problem, we have conducted a study on application of mechanical stimulation cues for periodontal tissue engineering with a 3D mechanical stimulation model. The Yelick Lab collaborated with a group at the Massachusetts Institute of Technology (MIT) to design and

fabricate a device that can provide cyclic mechanical loading of defined force, to mimic the physiological stimulus of chewing to in vitro cultured 3D cell-encapsulated human dental pulp stem cell constructs [10]. Here, we hypothesize that the 3D mechanical stimulations will promote the formation of bioengineered periodontal ligament tissue on gelatin methacryloyl (GelMA) hydrogel. The GelMA hydrogel, as a scaffold, closely resembles extracellular matrix due to the presence of matrix metalloproteinase to which cells can attach and proliferate [11].

07/2019 – 09/2019 Establish PDL Cell Lines

- Fresh extracted third molars were collected 2-3 times/week at Tufts Oral & Maxillofacial Surgical Clinic
- PDL cells were isolated from these third molars and then under primary cell culture
- 10 PDL cell lines have been established and expanded from the primary culture.

10/2019 – 11/2019 Pilot Studies

- 3D GelMA Hydrogel has been fabricated.
- PDL cell viability, proliferation, and differentiation have been checked with cell live/dead cell viability assays and histological analysis on the 3D GelMA hydrogel after 0 day, 7 days, and 14 days of culture.
- PDL cell line 1 has been selected for the mechanical stimulation experiment because of its better viability, proliferation, and differentiation (Figure 1, 2).

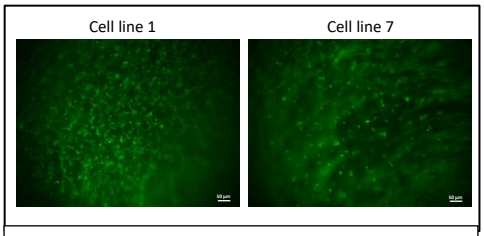

Figure 1. Cell viability assays- Day 14

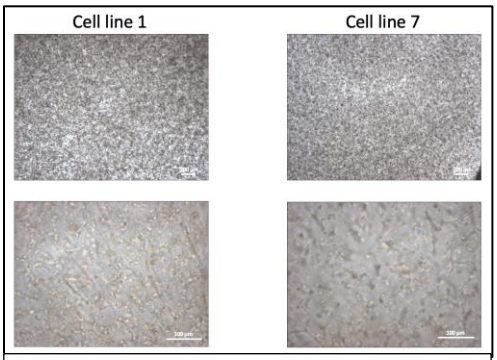

Figure 2. Bright field- GelMA Day 14

12/2019 – 02/2020 Waiting for the driver software from the MIT group

02/2020 – 03/2020 Problem shooting of the 3D Mechanical Stimulation Machine

03/2020 – 3/31/2021 Research stopped because of the COVID-19 outbreak.

11/2020 The primary study and literature review were presented at NESO (Northeastern Society of Orthodontists) Conference 2020

Since December 2019, we have been waiting to continue active cell work in the lab because the 3D mechanical stimulation machine (Yelick Lab) doesn't work. The machine was designed and fabricated by the Yelick Lab and a student group at the Massachusetts Institute of Technology (MIT). We were first waiting for the driver software. Dr. Yelick got the software

from the MIT group in early February, but the machine still has mechanical problems. We have tried several times to run the machine but failed till the research has been stopped in March because of the outbreak of COVID-19. The machine has not been repaired during the pandemic.

Beside the research, the following OFDFA goals have been accomplished:

Educational Plan:

2019 ADEA Summer Program For Emerging Academic Leaders- July 17-20

2020 AAO, 2020 AAO, 2020 NESO-Con, 2020 Yankee Dental Conference, The international caries detection and assessment system (ICDAS) training, Seminars, workshops at Tufts School of Dental Medicine

Teaching Plan:

Tufts CELT Fellow

Developed and co-director, Pre-doctoral Integrated Craniofacial Biology

Co-director, Orthodontic Initial/Progress/Final Case Seminar

Director, Contemporary Literature Review in Orthodontics, Orthognathic Case Seminar , Orthodontic Topics and Skills

Lecturer, Orthognathic Surgery, Pre-doctoral Orthodontic Theory, Growth and Development, Management of Patients with Craniofacial Anomalies, Interdisciplinary Management of Complex Cases, American Board of Orthodontics Literature Review, Introduction to Dental Patient III

Clinical Skills Plan:

American Board of Orthodontics Certification, Clinical Instructor Clinical Orthodontic Practice, Orthodontist at Faculty Practice clinic, Attending Orthodontist at Cleft Lip / Craniofacial Anomalies Team

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