Regulation of Dental Pulp Stem Cells in Fibrotic Hydrogels

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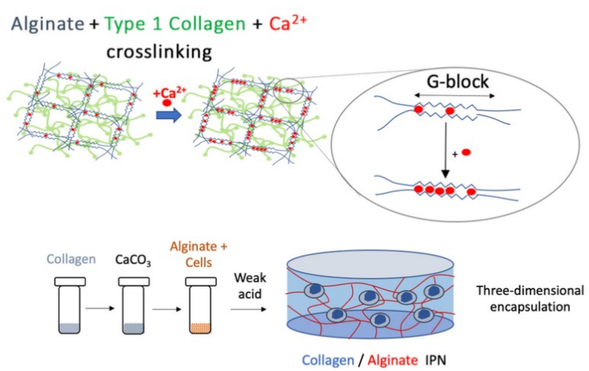
ABSTRACT

- Dental disease affects over 2.5 billion people worldwide, causing pain, infection, and loss of teeth. Regenerative dentistry aims to promote dental pulp stem cells (DPSCs) to repair and heal damaged tooth tissue. We hypothesize inflammation and fibrosis negatively impact DPSCs in dental disease. We will examine the effect of inflammatory white blood cells on DPSCs in fibrotic hydrogels with defined biochemical and mechanical cues. DPSCs will be encapsulated in collagen-alginate interpenetrating network hydrogels with tunable mechanical properties. The gene expression of DPSCs will be determined in hydrogel conditions treated with conditioned media of inflammatory white blood cells or control.

METHODS

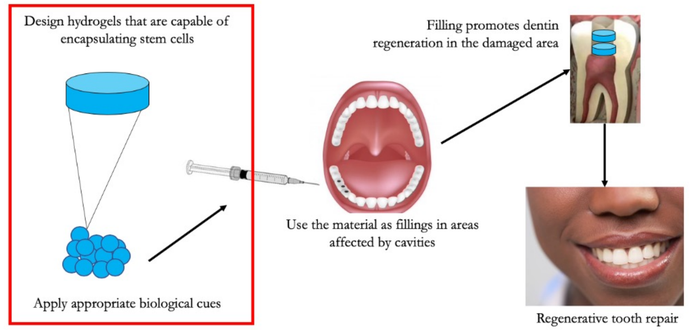
Procedures Performed:
- Generating collagen-alginate hydrogels and encapsulating DPSCs
- Cell culture of DPSCs and Mycoplasma Detection Protocol
- Achieving variable stiffness with gel IPNs

Next Steps:
- Co-culture of monocytes and DPSCs in fibrotic hydrogels
- Analyze effect of the inflammatory factors produced by monocytes that will regulate the gene expression of encapsulated DPSCs (BMP4, DSPP, MSX2, RUNX2)

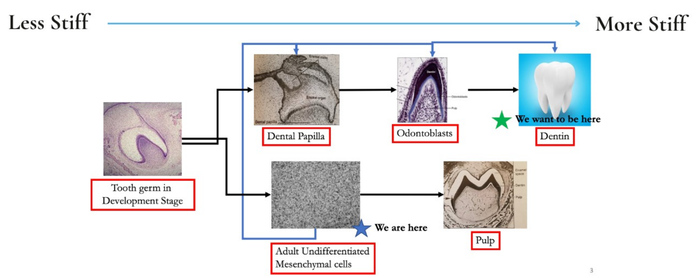


BACKGROUND

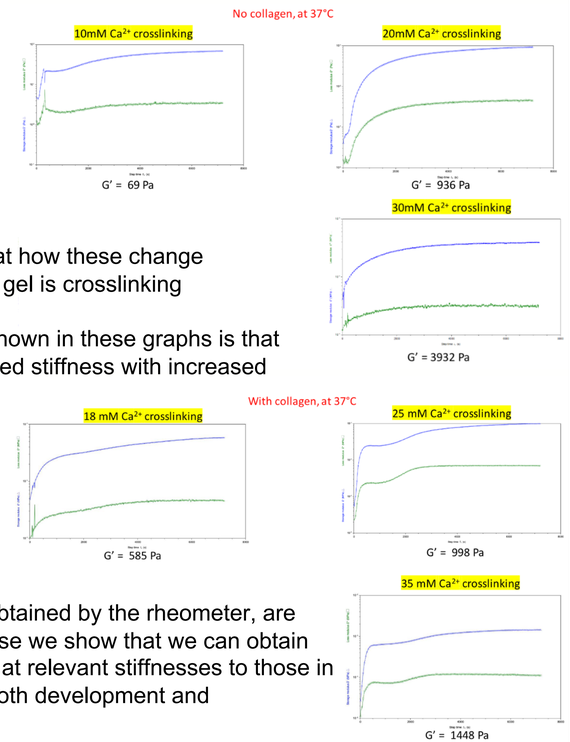
- In our approach to address this issue of permanent tooth damage, we aim to design a material capable of mimicking the environment of the tooth during development.
- We have developed a hydrogel for the encapsulation of dental pulp stem cells, featuring precise stiffness modulation. After applying appropriate biological cues, our objective is to engineer a dental filling material that facilitates dentin regeneration, thereby contributing to the advancement of tooth repair methodologies.



So put simply, development stems off into two paths, beginning at the tooth germ:
1. One path goes toward Undifferentiated Mesenchymal Cells; in our experiments, the Undifferentiated stem cells are the Dental Pulp Stem Cells harvested from third molars, and these cells typically make up the pulp within the tooth.
2. The other path leads to the dental papilla, this condensed area below the enamel organ, which then gives rise to odontoblasts and then dentin.



RESULTS



We are looking at how these change over time as the gel is crosslinking

The key result shown in these graphs is that we have increased stiffness with increased calcium.

These results, obtained by the rheometer, are important because we show that we can obtain these hydrogels at relevant stiffnesses to those in the context of tooth development and inflammation.

STATEMENT OF IMPORTANCE

The specific aim of this project is to advance the repair and healing of damaged tooth tissue by utilizing dental pulp stem cells (DPSCs). The overarching objective is to foster collaboration among researchers, clinicians, and industry professionals to develop next-generation fillings that facilitate healing and regeneration within the tooth. The final goal is to eliminate the need for root canals by promoting the natural healing capacity of DPSCs and enabling the restoration of damaged tooth structures. By achieving this, the project aims to revolutionize dental treatments and improve patient outcomes in the field of oral healthcare.