INTRODUCTION

- Myocardial infarction (MI) is a condition that is caused by blood vessel obstructions that prevent sufficient levels of blood and oxygen from reaching the heart, which is known as coronary heart disease.
- Cardiac cells are deprived of the materials needed to sustain them and they quickly die off, which results in excess scar tissue developing on the heart’s surface.
- The heart loses its proper shape and elasticity, preventing it from pumping blood as effectively as it should.
- In this research project, the potential of a hydrogel-based cardiac patch was investigated.
- This study focused on the implantation of this multilayer patch on an in vivo test subject and determining the ability of the device to record various cardiac parameters.

METHODS

- The cardiac patch was designed as a T-shaped, four-armed device.
- The main structure was comprised of a UV laser-cut, bilayer structure consisting of gold film and polyimide (PI).
- Temperature, strain, and ECG pacing sensors were attached to the patch and covered with a protective parylene coating.
- The PNIPAM hydrogel was made from a mixture of the following solutions: N-isopropylacrylamide (NIPAM), N,N'-Methylenebisacrylamide (BIS), Ammonium persulfate (APS), Tetramethylene (TMEDA).
- The hydrogel was cured, cut, and glued onto each cardiac patch arm with biocompatible glue (Fig. 1A).
- Preliminary and in vitro tests were conducted to confirm the general functionality of the patch.
- In vivo tests were performed on a live mouse heart (both healthy and post-MI), where strain, temperature, and ECG readings were collected and analyzed (Fig. 1B).

RESULTS

- For a healthy heart, each arm of the cardiac patch had short, less clearly defined peaks for strain except for S4 (Fig. 4).
- For a post-MI heart, there were tall, distinct peaks for strain for all arms except for S3 (Fig. 5).
- The pacing electrodes were stimulated at around 0.2 s, the ECG waveform immediately following this event was completely functional with the following features:
- It quickly adapted to the temperature of the mouse's body, as reflected by the way it folded onto its surface.
- The patch also showed how it could influence heart rate with the use of pacing electrodes and electrical stimuli.
- Most importantly, the device was able to discern and visualize the key differences between the strain rates of a normal and post-MI heart.
- The ability of the cardiac patch to provide real-time information about heart activities from different perspectives allows one to better understand the changes that the heart undergoes after being subjected to sizeable trauma.

CONCLUSION

- From the results, this cardiac patch prototype shows promise as the foundation of a new MI treatment.
- It quickly adapted to the temperature of the mouse’s heart, as reflected by the way it folded onto its surface.
- The patch also showed how it could influence heart rate with the use of pacing electrodes and electrical stimuli.
- Most importantly, the device was able to discern and visualize the key differences between the strain rates of a normal and post-MI heart.
- The ability of the cardiac patch to provide real-time information about heart activities from different perspectives allows one to better understand the changes that the heart undergoes after being subjected to sizeable trauma.

REFERENCES