The goal of this project is to demonstrate the feasibility of a fully implantable, battery-free biodegradable pacemaker for acute and chronic transient applications.

INTRODUCTION

Temporary pacemakers are implanted into patients for short-term pacing of the heart as a bridge to therapy or when arrhythmias are expected to be temporary. However, the standard hardware is often the focus for infection where bacteria form biofilms along wires or seed in the blood, resulting in pathological tissue reactions. Due to the short-term nature of these devices, the generator that powers the pacemaker is external, which increases chances of infection at the venous access sites of the hardware. Patients face physiological distress associated with re-operation and increased chances of infection during the removal of the temporary pacemaker leads. Few pacemakers can both deliver cardiac electrophysiology while also addressing the physiological complications of the removal of mechanical hardware. A biodegradable pacemaker would utilize more biocompatible materials to minimize adverse pathological reactions, and its biodegradable mechanism eliminates the need for device removal procedures.

METHODS

a) Ex vivo Optical Mapping of Electrical Pacing

b) In vivo Chronic Electrical Pacing of Rats

RESULTS

A. Schematic of the device

B. Device attachment

C. Wireless inductive power transfer

D. Device implantation

E. Histological analysis of fibrosis over 6 weeks

F. Fibrotic tissue fraction in myocardium over time

G. Scalable ex vivo Electrical Pacing

H. Chronic In vivo Electrical Pacing

CONCLUSIONS

These fully biodegradable pacemakers can deliver acute electrical stimulation with size scalability and can be fully implanted for chronic electrical stimulation for up to 4 days. The device is powered by wireless inductive power transfer and is therefore battery-free, thus allowing for its miniaturized nature. The full implantability minimizes complications such as infection that are common to external temporary pacemakers. The combination of the miniature geometry and the biodegradability make the device highly suitable for cases where temporary pacemakers and pediatric pacemakers are used because it eliminates the need for a second surgery to remove the device. This miniature biodegradable pacemaker serves as the basis for an alternative technology for temporary pacemakers.

ACKNOWLEDGEMENTS

• To the Efimov and Rogers labs, for their invaluable scientific input and dynamic scientific community.
• To the American Heart Association (AHA Predoctoral Fellowship 19PRE343B0781), the National Institutes of Health (grants R01 HL141470), and the Leducq Foundation (project RHYTHM) for their generous support.

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