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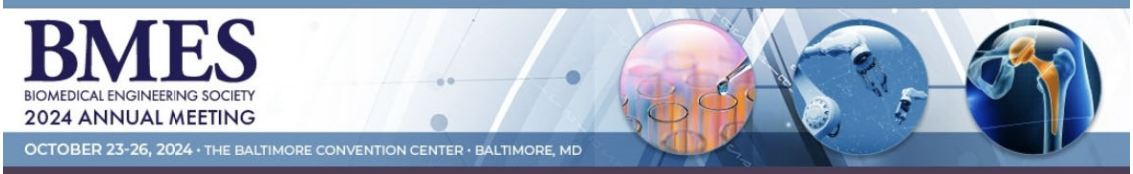

Drug Delivery

Thursday, October 24

10:00 AM - 11:00 AM

Room: Exhibit Hall E, F & G

Session: Drug Delivery - Poster Session A

(Poster W13) 3D Printed Multi-layered Local Drug Delivery Patch for Preventing Implant Induced Capsular Contracture

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3D Printed Multi-layered Local Drug Delivery Patch for Preventing Implant Induced Capsular Contracture

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Introduction (50-250 words)

Capsular contracture is one of the major concerns of implant surgery. The cause of capsular contracture is known to be bacterial infection and immune response during healing process. When the fibrosis capsule form around the implant, causing pain and deformation. Fibrosis capsule can be removed by the replacement surgery, but it can recur. Thus, the non-invasive strategies for preventing implant fibrosis are needed. Some of the drugs such as antibiotics and immunosuppressant are studied to be effective. However, this approach is still limited due to low delivery rate. Thus, drug releasing patch to deliver antibiotics and immunosuppressant temporally at local site is needed.

Materials and Methods (50-250 words)

Tracheal mucosa and vessel decellularized extracellular matrix (tmdECM and vdECM) were used as the basal material. Composite biomaterial ink was prepared by optimizing the mixing ratio of decellularized extracellular matrix (dECM), hyaluronic acid (HA) and methacrylated hyaluronic acid (HAMA). The molecular weight (MW) and mixing ratio of HA was optimized to control the drug release. A multi-layered drug releasing patch was fabricated using 3D bioprinting system. Biomaterial inks loaded with two different drugs were printed onto 3 or 5 layers using a multi-head 3D printing system.

Animal study was designed to mimic the implant-based breast reconstruction by inserting small size silicon breast implant into rat and rabbit model. The experimental design of animal study divided into four groups. S. epidermidis were inoculated after implantation to recapitulate the bacterial infection. The dual drug-releasing patch was placed at both sides of the implant before the inoculation of S. epidermidis. The tissue samples were collected 8 weeks after implantation and stained using H&E, α-SMA, and TGF-β to evaluate the formation of fibrosis capsule.

Results (20-120 words)

The sequential release of dual drugs was controlled by applying the designed multi-layered structure. The three-layered patch (the first version) was fabricated using vdECM, HAMA, gentamicin and triamcinolone acetonide. Antibiotics was verified to be released at early stage and immunosuppressant released slowly until the late stage as we inteded.

The five-layered patch (the second version) was fabricated using tmdECM, HA, cefazolin and triamcinolone acetonide. HA with high molecular weight (MW) was adopted to retain the drug for longer period. The MW and mixing ratio of HA was optimized to improve printability and to control the speed of the drug release. The five-layered drug patch was developed to regulate the burst release of the drugs at the very beginning. The additional outer layer alleviated the burst release of drugs.

The tissue sample of rat model, where the three-layered patch was implanted, was and harvested after 8 weeks and stained using H&E, α-SMA, and TGF-β. The evaluation of stained samples verified that the 3D printed multi-layered sequential drug releasing patch effectively reduced inflammation and capsule formation by delivering antibiotics and immunosuppressant locally and temporally. The tissue sample with drug releasing patches showed thinner capsules, lower levels of myofibroblast and inflammation, indicating better tissue integration and less foreign body response.

Conclusions (20-120 words)

The 3D printed multi-layered sequential drug releasing patch effectively reduced inflammation and capsule formation in the rat model by delivering antibiotics and immunosuppressant locally and temporally. The suggested drug patch demonstrated its therapeutic potential as a novel treatment for preventing capsular contracture while reducing concerns about systemic side effects.

Discussions (20-120 words)

A 3D printed multi-layered drug patch demonstrated its therapeutic potential as an efficient strategy for preventing capsular contracture. Furthermore, the 3D-printed local drug delivery system offers a new medical application and potential for the development of therapeutic agents to prevent capsular contracture caused by various implant-based surgeries. To meet the goal, further studies are needed to optimize the range and concentration of the drugs released from the patch over time. Biodistribution study of composite biomaterial and PK/PD of the drugs are also necessary to be accomplished.