A Novel Polymer Platform for Drug Delivery Applications in Oncology

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SUMMARY

UCLA researchers in the Departments of Head and Neck Surgery and Bioengineering have developed a novel implantable platform to treat tumors in patients with advanced or recurrent Head and Neck Squamous Cell Carcinoma (HNSCC).

BACKGROUND

Head and neck squamous cell carcinoma (HNSCC) is the sixth most common cancer in the world, affecting 50,000 Americans and more than 600,000 individuals annually worldwide. Surgical resection and chemoradiation therapy (CRT) are the dominant treatment modalities that often negatively impact patient quality of life and in some cases cause severe disfiguration and loss of facial mobility. Unfortunately, even the most aggressive surgical resection and CRT often cannot remove all cancerous tissues due to the proximity of numerous vital structures in the head and neck. The resultant high cancer recurrence rate (40-50%) and low survival rates, with less than 50% of patients surviving beyond 5 years, has spurred the development of new approaches to improve elimination of malignant cells not targeted by CRT or surgery.

INNOVATION

UCLA researchers have developed a novel implantable drug delivery device that reproducibly reduces tumor growth in vivo. The technology combines biocompatible polymer sheets with anti-tumor drugs and immune-boosting proteins that can be implanted to the surgical bed after debulking of the tumor. Importantly, the polymers possess high adherence and adaptation to the patient’s tissue contours, maximizing efficacy, safety, comfort and limiting systemic side effects of pharmacological agents. These layers of sheets are highly customizable, as they can incorporate multiple drugs at different concentrations and release rates. Furthermore, the polymer sheets can be linked to immune-activating proteins like cytokines and chemokines that attract more immune cells with potent anti-tumor responses, redirecting and restimulating the body to attack the malignant cancer cells. Therefore, this device represents a new therapeutic modality for patients with HNSCC by maximizing the therapeutic index, minimizing systemic adverse effects, and enhancing postoperative radiation therapy.

APPLICATIONS

▶ Attachment of anti-tumor drugs, e.g. cisplatin, tumor targeting peptides, or other therapeutic small molecules to the polymer sheets for cancer therapy with tunable pharmacokinetics against surgically unresectable regions of HNSCC or other solid tumors
▶ Conjugation of immunomodulators that are known to stimulate immune cell proliferation and survival to the implantable polymer,
▶ Imaging; label the chemotherapeutic layer of polymers to enhance radiopacity and facilitate visualization with CT scan for monitoring and diagnostic purposes

ADVANTAGES

▶ Biocompatible: polymers consist of materials that are currently used in medical devices with known characteristics in terms of toxicity, hypersensitivity, mutagenesis, and inflammatory response
▶ Controlled release of drugs and/or chemokines, dependent on polymer backbone linkage
▶ Facile application: flexible, strong, modifiable if necessary, reliable
▶ Minimal degradation from irradiation (tested in vivo and in vitro)
▶ Modular platform: drugs linked to the device can be altered for personalized treatment, dependent on stage and type of HNSCC in the patient.
▶ Radiopacity: facilitates visualization of the ‘at risk’ tumor bed with CT
▶ Potentially lower radiation dose

STATE OF DEVELOPMENT

To test the invention, cisplatin, which is widely used in combination with radiation as a radiosensitizer, was added to the polymer and implanted into mice after partial tumor resection. The implanted cisplatin polymer significantly reduced tumor growth by more than 16-fold compared with control mice and mice given cisplatin as an intratumoral bolus injection. This platform also synergized with traditional radiation therapy to reduce tumor burden.

RELATED MATERIALS

PATENT STATUS

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ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- An Improved Cast for Bone Fracture Healing
- Atomized Bioactive Spiral Coil Coating
- 3D Scaffolds For Mesoderm Differentiation