Controlled-Release Delivery of Ovarian Anticancer Paclitaxel via Vortex Ring, Donut-Shaped Hydrogels

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Ovarian cancer affects countless women worldwide. Unfortunately, systemic chemotherapy for treatment of ovarian cancer necessitates one-time super dosing, leading to the onset of severe side effects, and like radiation therapy, causes the destruction of neighboring, healthy cells. A method where chemotherapy is temporarily implanted at the cancer and subsequently time-released would be preferred, to adhere the drug to the tumor, and minimize side effects associated with immediate overdosing. Here, such a device is engineered, via donut-shaped hydrogel vortex rings that are formed and loaded with a chemotherapy agent. Specifically, 750μg of paclitaxel (PAC) is dissolved in 1ml aqueous 2% sodium alginate, a droplet of which is then injected into a 5mM $CaCl_2$ and 95mM $MgCl_2$ buffer to create a 1mm vortex ring hydrogel, with a 7.5μg drug load. Under simulated ovarian conditions, each sticky, PAC-loaded vortex ring steadily releases its chemotherapy, so that 50% is released in 4hours, with up to 5.4μg delivered in a maximum of 20hours (72% release), post-application. Simulation of pointed placement of the PL-VRH donuts, their adherence to a cancerous tumor in the ovarian cavity, resistance to movement due to aqueous conditions, and subsequent release of the paclitaxel, was carried out using a porcine intestine membrane model. For delivery of a localized PAC dosage that concurs current IP-injection (342μg for a typical 57cm^2 ovary), it was determined that ~60 hydrogel vortex rings can be directly delivered to the ovarian site via 600μl injection of medicated precursor, ensuring direct and extended interaction of the chemotherapy and cancer.