Liposomal nanoparticles enhance contrast of fluorescence, specklecontrast imaging, and ultrasound measurements in phantoms and murine model

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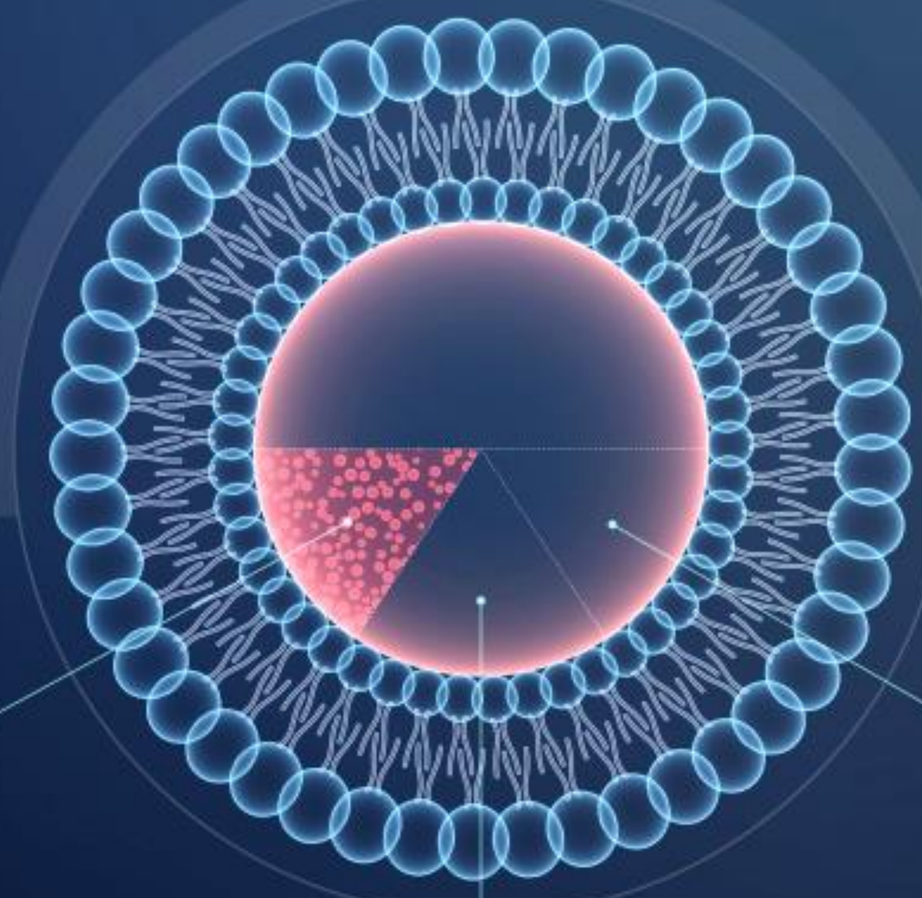
Introduction

Liposome particles are used as a tool for drug delivery and fluorescent labels. Due to its properties, liposome particles can be used as a contrast agent in fluorescence imaging, laser speckle-contrast imaging, and in ultrasound diagnostics. The use of a contrast agent for LSCI with fluorescence and ultrasound control of particle distribution plays a vital role in preclinical studies.

Experimental method

For this task, multilayer liposomes were synthesized using lecithin and sunflower cholesterol by phase inversion. For fluorescence spectroscopy, liposomes with an encapsulated fluorescent dye eosin-Y were used. Air-filled liposomes were used in ultrasound spectroscopy and LSSI. Passive inclusion was carried out at the stage of hydration of the lipid film.

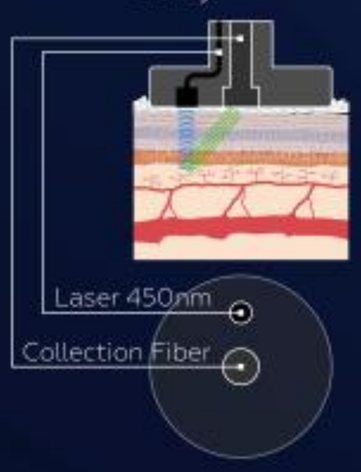


The aim

This work aimed to obtain particles for multi-use in LSCI, fluorescence spectroscopy and ultrasound diagnostics.

Concept

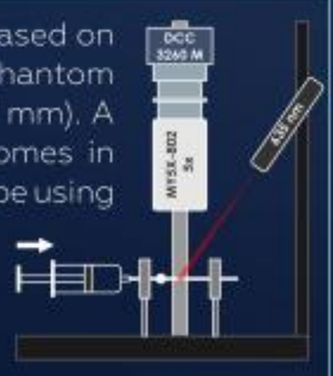
1 Fluorescence spectroscopy was used to study the effectiveness of the penetration of eosin-Y liposome capsules with a fluorescent label in the circulatory system when administered orally.



The maximum intrinsic fluorescence of the tested fluorescent dye (eosin-Y) lies in the region of 520 ± 5 nm. As measuring equipment, a fluorescent channel with a series of fibre probes of the LAKK-M multifunctional laser non-invasive diagnostic system (LAZMA LLC, Russia) was used.

Experimental studies were performed on clinically healthy mice of outbred initial CD-1 at the age of 5 months 11 (n = 6 in the group).

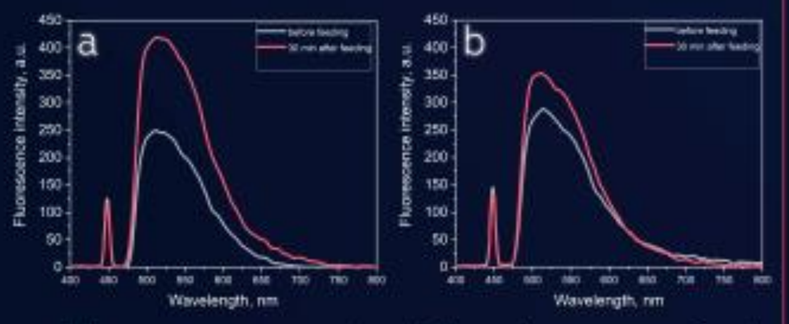
2 For research on an experimental setup based on LSCI, a phantom setup was used. The phantom consisted of a capillary tube (diameter 1 mm). A suspension of Intralipid 20% and liposomes in water was pumped through a capillary tube using a syringe. Changes in the speed of movement of intralipids / liposomes in a test tube were recorded using a camera, then frame sequences were processed.



3 For ultrasound examination, an Esaote MyLab 50 ultrasound apparatus with a frequency of 1-8 MHz was used. In the course of the study, experiments were conducted on phantom units to check the increase in the contrast properties of the synthesized particles.

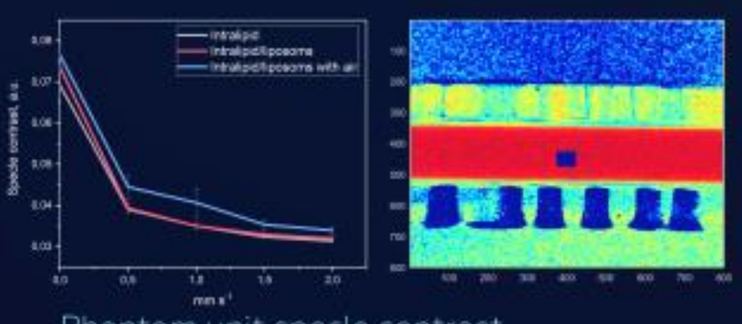
The study was conducted on a phantom setup with elastic tubes placed in an agar-agar gel, through which an isotonic solution was passed at a speed of 0 to 20 cm / s.

Results and Discussion



Fluorescence spectra of the: a) group received fluorescent dye; b) group received liposome with incorporated fluorescent dye.

Twelve mice of outbred initial CD-1 were divided into two groups: treated with eosin-Y (n = 6) and control dye without liposomes (n = 6). The maximum fluorescence intensity, 140% of the initial level, was recorded 30 minutes after oral administration. In the group of animals that received a fluorescent dye without a liposome membrane, fluorescence did not exceed 110% of the initial level. Experimental results show that the obtained multilayer liposome particles can increase the efficiency of the transported material entering the bloodstream through the gastrointestinal tract after oral administration.



Phantom unit specle contrast

The contrast level increased by 57% of the initial concentration in the control. The circulation time in a closed system at a speed of 20 cm / s was 11 minutes until an ultrasonic wave utterly destroyed the particles.

Phantom unit sonographic image: a) saline; b) saline after administration liposome with air.

Analyzing the data obtained, we can conclude that the proposed gas-filled liposome particles can increase the contrast level by 16%.

Conclusion

These results indicate that liposome particles can be used in fluorescence spectroscopy, in ultrasound diagnostics, and in LSCI. Using a single dose of particles will provide a wide range of information and suggest fewer invasive procedures.

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