Evaluation of the Histotripsy-Induced Sonochemical Reactions

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ABSTRACT & BACKGROUND

- Current cancer treatments are associated with caustic side effects, significant failure rate, or cannot be implemented for critically ill patients. Histotripsy is a form of therapeutic ultrasound that lyases cells mechanically via bubble cloud formation (Fig. 1).

- The inertial collapse of a bubble can sonochemically generate reactive oxygen species (ROS) capable of inducing cell death; light emissions are also a byproduct of the sonochemical reaction (Fig. 2).

- Assessing and accentuating ROS generation during histotripsy is a promising therapeutic candidate to treat cancer.

HYPOTHESIS/OBJECTIVE

- The central hypothesis of this study is that histotripsy can be utilized to generate in situ sonochemical reactions.

- The objective of this study is to quantify the degree of ROS formation and light emissions from histotripsy-induced bubble cloud activity in vitro.

MATERIALS AND METHODS

- Conversion of terephthalic acid (TA) to hydroxylxerephthalic acid (HTA) via ROS formation quantified with spectrophotometric assay
- Light emissions were recorded with a photomultiplier tube (PMT)
- Bubble cloud activity was assessed with passive cavitation imaging (PCI)

RESULTS

- Fig. 3: Diagram of experimental set up
- Fig. 4: Overview of potential sonochemical processes during histotripsy insonation
- Mapping of Bubble Activity
- Detection of Light Emissions
- RESULTS (CONT.)

- Fig. 7: Dependence of ROS-induced TA to HTA conversion on the histotripsy pulse peak negative pressure. The pulse was 5 cycles in duration and 1-MHz fundamental frequency pulse.
- Fig. 8: Correlation of ROS-induced HTA and bubble cloud activity assessed with PCI. The peak negative pressure of the histotripsy pulse is noted in the legend.

FUTURE DIRECTIONS

- The presence of both light emissions and ROS indicate histotripsy induces sonochemical reactions
- The total ROS production was an order of magnitude lower than previous studies, but ROS production rate 25-fold greater
- Future study of histotripsy-induced ROS include optimizing insonation parameters and combining histotripsy with sonosensitizers
- Utilizing histotripsy for cell lysis and the generation of toxic ROS levels is an innovative method to treat cancer.

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LITERATURE CITATIONS

5. Hanworth et al., IEEE UFFC, 64(1):177-191, 2017

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