RESEARCH TOPIC MEM18
Applications of Low intensity pulsed ultrasound (LIPUS) in medicine for therapeutic purposes
Curriculum MEM

Laboratory name
Laboratory of Gastrointestinal Immunopathology

Research Supervisor
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Abstract
Low-intensity pulsed ultrasound (LIPUS) is a developing non-invasive approach consisting of non-ionizing mechanical waves emitted in a pulsed manner. LIPUS is currently being explored for a variety of therapeutic applications such as regeneration of soft tissue and inflammation inhibition in multiple medical fields. Recently, our laboratory has been explored for the first time the use of precisely controlled LIPUS dosage as a method of gut liquid biopsy through the modulation of tissue-contained miRNAs in the short term by transiently enhancing extracellular release. This project aims at exploring immunomodulatory and regenerative properties of LIPUS in different abdominal organs (stomach, intestine, fat, spleen), skin and bone; and its impact on gut microbiota in health, and diseases (inflammation and cancer). By 3-dimentionally re-construction of the abdominal cavity and acoustic simulation framework we will be able to model LIPUS propagation through abdominal tissues estimating the real ultrasound energy reaching the different organs and assess its immunomodulatory and regenerative effects.

Main technical approaches
- Ultrasound technology (setting, procedure and validation); Cell biology;
- Isolation and analysis of Extracellular vesicles;
- Omics technologies (RNA sequencing, metabolomics; metagenomics);
- Molecular biology techniques (FACS, RNA scope);
- Data analysis and bioinformatics;
- In vivo mouse models.

Scientific references

- Tran, F., et al. Sci Rep 14, 10925 (2024).
- G. Baldi, A. Cafarelli*, R. Bisogno, S. Vetrano and L. Ricotti. 2021 IEEE International Ultrasonics Symposium (IUS), Virtual Symposium, 12-16 September, 2021.
- Vetrano S, et al., Front Immunol. 2022 Nov 9;13:1002629.
- Petti L, et al. J Exp Clin Cancer Res. 2020 Nov 23;39(1):253.
- E Sala, et al. Gastroenterology. 2015 Jul;149(1):163-176.e20

Brief description of the coherence of the project in relation to the PNRR objectives

The project promotes innovation and diffusion of LIPUS as non-based imaging technique to improve diagnosis and monitoring disease progression for inflammatory and cancer diseases; and therapeutic properties. Approved by the FDA in orthopedics and rehabilitation for aiding fracture healing, LIPUS is currently being explored for a variety of therapeutic applications such as regeneration of soft tissue and inflammation inhibition in multiple medical fields. However, despite the evidence of its beneficial effects, most of the available LIPUS studies today exploit uncontrolled, and often unknown, ultrasound stimulation protocols without correlating a precise LIPUS dosage to bioeffects achieved, implying a 700% uncertainty overall in the ultrasound dose delivered. The experimental setup here designed will allow an accurate and precise stimulation, associating LIPUS parameters, such as frequency, intensity and time lapse, with the consequential biological effects. This is a unique opportunity to work in a multidisciplinary manner close to the device manufacturer to optimize its use in a wide range of diseases in benefit of patients and healthcare systems.

N. of months abroad

6 months, at Institute of Clinical Molecular Biology, University Medical Center Schleswig-Holstein, Christian Albrecht University Kiel, Campus Kiel, Rosalind-Franklin-Strasse 12, 24105, Kiel, Germany

N. of months at the company

6 months, at BAC Technology

Type of contract

PhD scholarship of € 21.000 gross per year awarded by Humanitas University on institutional funds and cofounded with PNRR funds under M.D.M. D.D. N. 630/2024 and BAC technology.
This sum is exempt from IRPEF income tax according to the provisions of art. 4 of Law no. 476 of 13th August 1984, and is subject to social security contributions according to the provisions of art. 2, section 26 and subsequent sections, of Law no. 335 of 8th August 1995 and subsequent modifications.

Borsa di dottorato pari a € 21.000 annui lordi erogata da Humanitas University su fondi istituzionali e fondi da D.M. 630/2024 e BAC Technology. Importo non soggetto a tassazione IRPEF a norma dell'art. 4 della L. 13 agosto 1984 n. 476 e soggetto, in materia previdenziale, alle norme di cui all'art. 2, commi 26 e segg., della L. 8 agosto 1995, n. 335 e successive modificazioni.