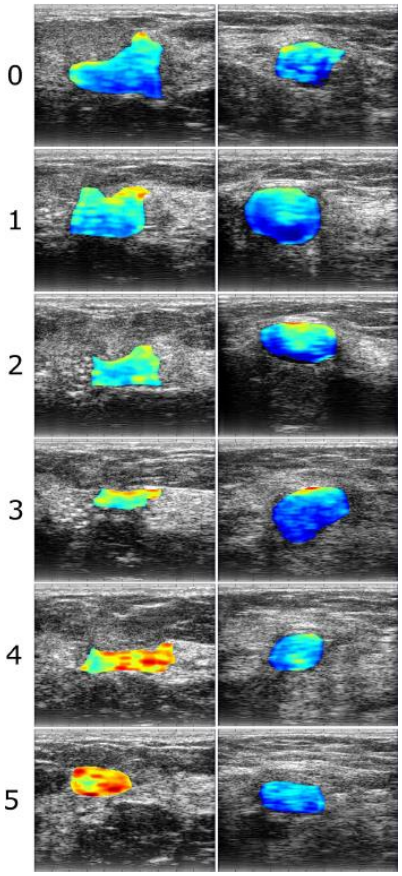
Quantitative analysis of ultrasound scattered in the tissue. Application in assessing tumor response to chemotherapy in patients with breast cancer

The properties of the tissues change during the disease, which can be used to assess the severity of the disease process. Measuring and learning about the properties of tissues is a particular challenge for living human tissue. The methods used must be safe and should not affect biological processes in the tissue. The aim of the project is to determine in vivo the properties of soft tissue using ultrasonic waves. We want to use ultrasonic methods because they are non-invasive and at the same time enable the determination of mechanical and structural properties of the tested materials. We are particularly interested in the tissue of breast cancer tumors and tissue response to chemotherapy. Currently, nearly a quarter of oncological diagnoses among Polish women are breast cancer. Nearly 70,000 people live in Poland with this cancer diagnosed in the last 5 years. Before surgery for tumor removal, preoperative therapy (neoadjuvant chemotherapy- NAC) is increasingly used, resulting in reduced tumor size, less risk of local recurrence, and less likely metastasis and, consequently, less patient mortality. About 12% of tumors are resistant to NAC treatment. We would like to detect tumors resistant to the chemotherapy after the first doses of chemotherapy, so as not to expose the patient to side effects of the treatment unnecessarily or to quickly change the treatment method. Our goal is also to identify tumors that respond very well to therapy, which would lead to breast-conserving treatment.

Data will be collected from patients qualified for NAC by means of a research ultrasound scanner, with the option of registering RF signals, before starting therapy, after each dose of the drug and before surgery.



Based on the analysis of ultrasound data (RF and B mode), histopathological data and data measured using a scanning acoustic microscope, and modeling the signal backscattered in tissue, we will determine the characteristics of the changes caused by chemotherapy and their effect on the signal received by ultrasound scanner. This will allow us to determine what signal parameters are associated with tissue changes caused by chemotherapy. Next, we will determine quantitative parameters describing the tissue structure measurably from ultrasound signals. These parameters, together with the results obtained from modeling, will be used to build markers / classifiers enabling early capture of tumors that do not respond to chemotherapy and markers that allow for the indication of fully cured tumors before mastectomy. The chemotherapy impact assessment scheme is planned according to the processes at the cell and tissue level that occur during successful therapy. In the first phase, parameters sensitive to cellular changes will be used and will be repeated in the second phase if the result is negative in the first phase. In the case of a positive result, in the second phase parameters sensitive to stromal changes and extracellular matrix will be used.

Parametric images (distribution of scattering parameter in tumor) before (0) and after subsequent NAC doses (1-5) for responding (left) and non-responding (right) tumor.

The far-reaching medical goal of the project is to provide the physician with additional and objective information about the tumor response to chemotherapy that can be used in medical practice. We also plan to create a database containing tumor images, RF data and histopathology results, which will later be shared with other researchers after the project.