

The outcome of breast chemotherapy based on Gray Relational Coefficient of ultrasound images

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Breast cancer is the most common malignancy in women and the second most common cause of cancer-related death of women in Poland [1]. One of the treatment modalities used is neoadjuvant chemotherapy (NAC), which aims to reduce tumor mass, limit metastases and enable surgical treatment. The tumor response to NAC is variable. Detection of tumors that respond well to NAC prior to surgery allows for breast-saving surgery. Current methods of monitoring therapy are based primarily on assessing changes in tumor size. Techniques for measuring tumor size are subject to significant error, and a change in tumor size does not always yield a good response rate to treatment [2].

In the presented study, we analyzed the ultrasound data from 38 breast tumors collected before the NAC therapy and after each of the six subsequent treatment cycles. An ultrasound scanner with a research option was used, allowing for the recording of RF data. Gray Relational Coefficient (GRC) was used to evaluate the therapy. The parameter was determined for three data types (for RF images, envelope images and envelope after log compression) and for four areas of interest (including both tumor tissue and surrounding tissue). The tumor sizes were also recorded. The usefulness of GRC and tumor size changes in predicting the effects of NAC was statistically evaluated based on the area under the ROC curve (AUC) and the post-mastectomy histopathology result was used as a reference.

Considering all the results of the prediction of treatment effects obtained, the highest AUC values were obtained when using RF data after envelope detection. After the first dose of NAC, data collected from the entire tumor and its surroundings predicted a good tumor response with AUC not less than 0.85. Only the data from the inside of the tumor gave a worse result = 0.81. For subsequent NAC doses, data collected from the tumor margin and surrounding tissues turned out to be the best. After the fifth dose, by far the best response to NAC was obtained using data from the tumor alone and strict center of the tumor, AUC > 0.93. The results of the classification of tumors by GRC have always been significantly better than by their size (Figure 1).

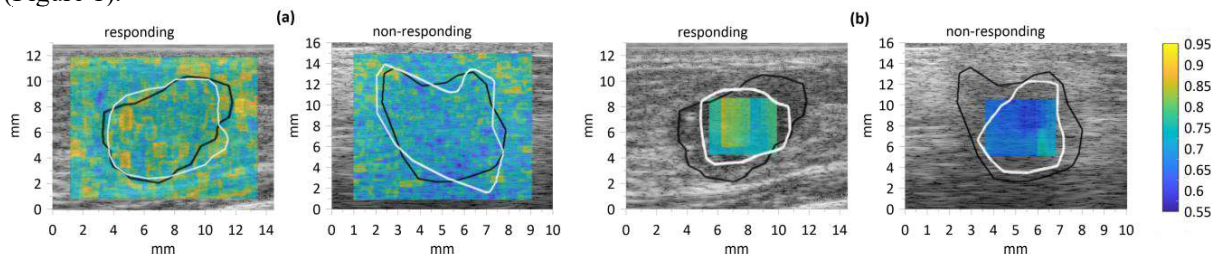


Figure 2. Parametric images of the responding and non-responding breast tumor after the first (a) and fifth (b) NAC cycle. The color scale shows the values of the GRC parameter. The lines represent the border of the lesion before chemotherapy (black line) and after the first/fifth cycle (white line)

The number of cases considered is insufficient to draw more general conclusions. However, our results indicate that the values of the GRC parameter may reflect the changes in tumor tissue structure as a result of chemotherapy. Thus, it may support the physician in evaluating the effects of NAC and contribute to an increase in the number of breast-saving procedures.

References:

- [1] Nowotwory złośliwe w Polsce w 2018 roku. *Krajowy Rejestr Nowotworów*, Ministerstwo Zdrowia 2020
- [2] Reig B., et al. Role of MRI to assess response to neoadjuvant therapy for breast cancer, *Journal of Magnetic Resonance Imaging*, 2020, vol. 52, no. 6, pp. 1587–1606