

ANALYSIS OF NEOADJUVANT CHEMOTHERAPY TREATMENT RESPONSE IN BREAST DCE MRI PATIENTS BASED ON ESTROGEN RECEPTOR STATUS AND GABOR FILTER DERIVED ANISOTROPY INDEX

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ABSTRACT

Estrogen Receptor (ER) is a molecular biomarker that plays an important role in evaluating the Neoadjuvant Chemotherapy (NAC) treatment response of breast cancer patients. ER (-) breast cancer patients have better tumor response rates than ER (+) patients due to NAC and the result of ER status could change after NAC. However, there are limited studies on the analysis of NAC treatment response using ER status. Further, manual quantification of treatment response is challenging and inconsistent across raters. In this work, an attempt has been made to objectively quantify the radiological differences of Dynamic Contrast Enhanced (DCE) MR images in ER (-) and ER (+) patients due to NAC using Gabor filter derived Anisotropy Index (AI). The images (113 subjects at 4 visits of NAC treatment) used in this study are obtained from the publicly available I-SPY1 dataset. Gabor filter bank is designed with 5 scales and 7 orientations, and AI is calculated from each Gabor energy within the patient group. Results show that AI values can statistically ($p < 0.05$) differentiate the radiological differences in ER (-) and ER (+) patients due to NAC. The percentage difference in the mean AI values of Visit 1 Vs Visit 4, Visit 1 Vs Visit 3, and Visit 2 Vs Visit 4 is high in ER (-) compared to ER (+) patients. Thus, Gabor filter derived AI could be used as an objective measure in evaluating NAC treatment response in ER (-) and ER (+) patients.

Keywords: Anisotropy Index, Breast Cancer, DCE MRI, Estrogen Receptor, Gabor Filter Bank, Neoadjuvant Chemotherapy

INTRODUCTION

Female breast cancer is the most commonly diagnosed cancer worldwide and 2.3 million new cases were estimated in 2020 [1]. Though breast cancer mortality has been declined over time, it still accounts for the major cancer deaths in women [2]. Early diagnosis and effective treatment planning of breast cancer are the most precise approaches to reduce mortality.

Breast cell growth and proliferation are controlled by estrogen and progesterone hormones since it is a sexual hormone-dependent organ. As a result, estrogen and progesterone are key endocrine hormones that play a major role in both the normal growth and disease progression of breast cancer. Immunohistochemistry (IHC) determines Estrogen Receptor (ER) protein as a significant predictive and diagnostic biomarker that must be evaluated in all invasive occurrences. ER positive (ER (+)) is the most common type which accounts for 60-80% of all breast cancer cases. The decision of treatment plan and prognosis are heavily influenced by ER (+) breast cancers molecular type. Clinical studies have shown that ER negative (ER (-)) has a better prognosis for Neoadjuvant Chemotherapy (NAC) treatment, while ER (+) is notorious for deprived response [3], [4]. These studies help to determine overall patient condition, but they don't reveal the individual outcomes