The Feasibility of utilizing Vascularity Characteristics in Three-Dimensional Power Doppler Ultrasonography to Predict Complete Responses in Patients Undergoing Neoadjuvant Chemotherapy

Wei-Chung Shia1 PhD, Dar-Ren Chen1,2*, MD, Yu-Len Huang2 PhD, and Hwa-Koon Wu4 MD and Fang-Rong Hsu5

1Cancer Research Center, Changhua Christian Hospital, Taiwan
2Comprehensive Breast Cancer Center, Changhua Christian Hospital, Taiwan
3Department of Computer Science, Tunghai University, Taiwan
4Department of Medical Imaging, Changhua Christian Hospital, Taiwan
5Department of Information Engineering and Computer Science, Feng Chia University, Taiwan

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Abstract
Pathological complete response (pCR) is most significantly associated with the likelihood of benefit in neoadjuvant chemotherapy (NAC) treatment. Tumor vascularity and morphology is shown has correlated with the degree of malignancy and prognosis, therefore the change of the vascularity and morphology may help predict the pCR of neoadjuvant chemotherapy for breast cancer. Two new studies which published recently represent that utilized the 3D-HDF ultrasound (US) to quantify vascularity characteristics and identify differences associated with varying levels of chemotherapeutic response is possible.

Keywords: Neoadjuvant chemotherapy, 3D-HDF ultrasound, Breast cancer, Pathological complete response

Introduction
To increase the chances of successful breast-conserving surgery, neoadjuvant chemotherapy is aimed at reducing the tumor size and stage [1]. Pathological complete response (pCR) is most significantly associated with the likelihood of benefit, as measured by disease-free and overall survival together with the lymph node status at surgery [2]. In the past studies, tumor vascularity and morphology has shown strongly correlated with the degree of malignancy [3,4] and prognosis [5]; therefore, changes in this vascularity and morphology may predict pCR to neoadjuvant chemotherapy for breast cancer. The challenge is how to classify patients with a good and poor response after treatment based on the changes in vascular flow indices. Predicting which patients will experience pCR will help identify patients who are likely to benefit from treatment.

Two new studies which published recently represent that utilized the 3D-HDF US to quantify vascularity characteristics and identify differences associated with varying levels of chemotherapeutic response is possible [6,7]. These studies were focus to patients were stage T2 (tumor size 2 cm to 5 cm) under the estimate within tumor, node and metastasis (TNM) staging system according to the 6th AJCC [8], and receiving anthracycline-based therapies (FEC). These studies results show that the vascular variations within sonography was provide sufficient information to directly improve the observation of the chemotherapy response.

If the analysis was simply based on the variation of fundamental vascular flow indices, over 83% of pCR patients (AUC ≈ 0.7) can be distinguished before the initiation of chemotherapy approximately. Over 87% of pCR patients can be distinguished before the third cycle of chemotherapy approximately (AUC ≈ from 0.75 to 0.82). After combine the variation of vascular flow indices and morphological features, over 89% of pCR patients can be distinguished before the initiation of chemotherapy (AUC = 0.8788). Over 93% of pCR patients was observed before the
The feasibility of utilizing vascularity in breast cancer. The preliminary results of recent studies show it can aid in the evaluation of the chemotherapy response biases, the variations of vascularity in sonography on lesion still experienced by experts and is associated with several unavoidable factors. The accuracy (AUC = 0.8247) before the first chemotherapy administration (AUC = 0.8247, patients), over 75% of the pCR patients were distinguished to 76 patients (include 41 pCR patients and 16 HER2-positive patients). After improving the size of case group, evidence that may conclusion of this study is also applicable to the CR patients who administrated with ECT. This preliminary result has already represented the potential of using the vascularity information of sonography as the characteristic and predict the response of NAC. After obtaining the larger dataset in the future, how to make the model optimizes and having the good performance in distinguishing pCR patients becomes the new challenge, and the feasibility and how to aid the decision-making of physicians in NAC will be revealed finally.

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