ABSTRACT

THE RELATIONSHIP BETWEEN TUMOR-INFILTRATING LYMPHOCYTES AND MOLECULAR SUBTYPES OF BREAST CANCER USING IMAGEJ ANALYSIS

By

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Background: Breast cancer is the most common malignancy in women and remains a major global health burden. Its molecular subtypes, including Luminal A, Luminal B, HER2 positive, and Triple Negative Breast Cancer (TNBC), differ in biological behavior, prognosis, and therapeutic response. Tumor infiltrating lymphocytes (TILs) reflect the host antitumor immune activity and function as important prognostic and predictive biomarkers. Manual assessment often varies between observers, making digital image analysis using ImageJ a more objective alternative. This study aimed to evaluate the relationship between TIL levels and molecular subtypes of breast cancer using ImageJ.
Methods: An analytic observational study using secondary histopathology data. Stromal TILs were quantified on hematoxylin eosin slides through ImageJ using scale calibration, thresholding, and particle analysis. Subtypes were determined based on ER, PR, HER2, and Ki-67. Data were analyzed descriptively and through statistical tests.
Results: TIL levels differed according to molecular subtype. TNBC showed the highest infiltration, followed by HER2 positive, whereas Luminal B and Luminal A exhibited lower TIL percentages. A significant association was found between TIL percentage and molecular subtype.
Conclusions: : ImageJ based quantification demonstrated clear differences in TIL infiltration among breast cancer subtypes. Higher TIL levels in TNBC and HER2 positive groups reflect their more immunogenic characteristics. Digital image analysis offers an objective method for supporting prognostic evaluation.

Keywords: breast cancer, molecular subtype, tumor infiltrating lymphocytes, ImageJ, digital pathology

ABSTRAK

HUBUNGAN ANTARA *TUMOR-INFILTRATING LYMPHOCYTES* DENGAN SUBTIPE MOLEKULER KANKER PAYUDARA MENGGUNAKAN ANALISIS *IMAGEJ*

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Latar Belakang: Kanker payudara merupakan kanker tersering pada wanita dan menjadi masalah kesehatan global dengan angka morbiditas dan mortalitas yang tinggi. Subtipe molekuler seperti Luminal A, Luminal B, HER2 positif, dan *Triple Negative Breast Cancer* memiliki karakteristik biologis yang berbeda sehingga memengaruhi prognosis dan respons terapi. *Tumor-Infiltrating Lymphocytes* (TILs) mencerminkan aktivitas imun antitumor dan menjadi biomarker penting, terutama pada subtipe yang lebih agresif. Variasi penilaian secara manual mendorong penggunaan analisis citra digital seperti *ImageJ* untuk meningkatkan objektivitas. Penelitian ini bertujuan menilai hubungan TILs dengan subtipe molekuler kanker payudara menggunakan *ImageJ*.

Metode: Penelitian observasional analitik yang menggunakan data histopatologi. Stromal TILs diukur pada preparat hematoksilin eosin menggunakan *ImageJ* melalui kalibrasi skala, *thresholding*, dan *analyze particles*. Subtipe molekuler ditentukan berdasarkan ER, PR, HER2, dan Ki-67. Data dianalisis secara deskriptif dan bivariat.

Hasil: Persentase TILs bervariasi pada tiap subtipe. TNBC memiliki infiltrasi tertinggi, diikuti HER2 positif, sedangkan Luminal B dan Luminal A menunjukkan kadar lebih rendah. Terdapat hubungan bermakna antara persentase TILs dengan subtipe molekuler.

Kesimpulan: Analisis *ImageJ* menunjukkan perbedaan infiltrasi TIL yang signifikan antar subtipe. TNBC dan HER2 positif memiliki infiltrasi lebih tinggi. Metode digital ini memberikan pendekatan objektif untuk mendukung penilaian prognostik.

Kata Kunci: kanker payudara, subtipe molekuler, *tumor infiltrating lymphocytes*, *ImageJ*, patologi digital