

# **Multi-Parametric OCT Angiography for Assessing Therapeutic Response in Port-Wine Stains**

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## **Abstract**

Port Wine Stains (PWS) are congenital capillary malformations characterized by ectatic dermal microvasculature that often demonstrate variable and heterogeneous responses to laser and vascular-targeted therapies. Conventional clinical assessment methods, such as visual inspection and colorimetric evaluation, provide limited quantitative insight into microvascular remodeling following treatment. To address this limitation, this study proposes a multi-parametric Optical Coherence Tomography Angiography (OCTA)-based analytical framework to quantitatively assess and characterize heterogeneous therapeutic responses in PWS lesions. The proposed system integrates longitudinal OCTA-derived vascular and perfusion biomarkers, including vessel density (VD), vessel length density (VLD), vessel diameter index (VDI), tortuosity index (TI), fractal dimension (FD), branchpoint density (BPD), flow index (FI), perfusion density (PD), capillary dropout index (CDI), and intra-lesion heterogeneity metrics such as perfusion heterogeneity (PH) and flow heterogeneity (FH). By computing delta changes between baseline and follow-up sessions, the framework captures dynamic vascular remodeling patterns induced by therapy. A composite response score is formulated using weighted multi-parametric deltas to reflect improvements in perfusion enhancement, vascular normalization, and reduction in heterogeneity.