In Vivo High-Definition Optical Coherence Tomography: A Bedside Diagnostic Aid for Morphea

Optical coherence tomography (OCT) is a noninvasive imaging technique that allows real-time high-definition cross-sectional visualization of tissues. Conventional OCT was introduced in dermatology in 1997 and has shown benefit in evaluating malignant neoplasms and inflammatory skin disorders.\(^1\)\(^2\) High-definition OCT (HD-OCT) scanners have recently been developed; they provide a higher resolution than conventional OCT and horizontal, in additional to vertical, sectional imaging, which conventional OCT does not provide.

Abignano et al\(^3\) previously demonstrated the use of OCT in quantifying skin fibrosis in systemic sclerosis. In the present report, we illustrate how HD-OCT may be used to aid the bedside diagnosis of morphea.

**Report of a Case** | A middle-aged man presented with a 1-year history of worsening itchy eruptions over his lower limbs and back. Examination revealed indurated brown patches over his lower limbs (Figure 1). Inflamed patches were noted over his hips, abdomen, and back. Systemic findings were normal; specifically, there was no arthralgia, dysphagia, or Raynaud phenomenon. Test results for antinuclear and extractable nuclear antigen antibodies were negative.

A lesional skin biopsy over his right shin revealed histological features consistent with morphea. In vivo HD-OCT imaging (SkinTell; Agfa HealthCare) was performed at sites of indurated skin (including skin adjacent to the biopsy site), inflamed patches, and normal skin. The patient was treated with psoralen bath phototherapy with UV-A twice weekly. By 4 months after treatment, the inflamed plaques had resolved and the indurated skin had markedly softened.

In vivo HD-OCT imaging was repeated over the same sites as previously performed. In the HD-OCT images, the dermis of indurated skin appeared homogeneously darker than normal skin and had fewer and smaller blood vessels (Figure 2). Between inflamed and normal skin, no clear differences could be visualized. Software analysis of dermal pixel brightness was subsequently performed (ImageJ, version 1.48; National Institutes of Health) of 30 equidistant vertical slices in each image. Before treatment, evaluated on an 8-bit gray scale of 0 to 255 (lower number representing darker pigment), the indurated dermis was darker and more homogeneous than normal skin (mean [SD] gray score, 56.7 [35.0] for indurated vs 105.9 [53.2] for normal skin). Four months after treatment, this difference was still evident, but brightness in the indurated dermis had increased (mean [SD] gray score, 70.0 [25.4]).

**Discussion** | In HD-OCT, the comparative uniform darkness (hyporefractiveness) in the dermis of indurated skin, evident visually and reflecting a lower gray score with smaller SD in image analysis, denotes homogeneity of the dermal components. This was correlated with the histological findings of thickening and hyalinization of the collagen in the dermis with associated decrease in adnexal structures, blood vessels, and inflammatory infiltrate. In contrast, there was marked heterogeneity in the dermis of both inflamed and normal skin in which variations in refractile indexes manifested as nonuniform brightness. With treatment, induration of affected skin was clinically markedly reduced, and there was a corresponding increase in dermal brightness on HD-OCT imaging.

Imaging techniques can enable the detection of certain features of skin diseases to support their clinical diagnosis. These can be performed at the bedside to provide immediate information to aid clinical decision making. In vivo HD-OCT can image skin to a depth of 570 μm and is therefore appropriate for conditions affecting the deeper dermis, such as morphea.\(^4\) It has a resolution of 3 μm in both the slice and en face planes and is thus capable of detecting the structures and cells affected in morphea, namely the collagen bundles, blood vessels, and inflammatory infiltrates.\(^4\) In addition, each image acquisition takes only 2 to 3 seconds, enabling it to be practically used in clinical practice.

In this case study, we found the in vivo HD-OCT features of indurated skin in morphea to manifest as homogeneous darkness of the dermis, which reduced after effective treatment. Subsequent studies may be performed to validate the utility of in vivo HD-OCT in the diagnosis and management of morphea.

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Figure 2. High-Definition Optical Coherent Tomography and 3-Dimensional Reconstruction Images

A-C, High-definition optical coherent tomography images. A, Indurated skin at the right shin (adjacent to biopsy site). B, An inflamed patch on the right hip. C, Normal-appearing skin on the chest. D and E, Three-dimensional reconstructions of 2 of the tomography images (asterisks indicate blood vessels). D, Indurated skin at the right shin. E, Normal-appearing skin on the chest. A-E, Comparatively, the indurated dermis (A and D) appears homogeneously darker and shows fewer and smaller blood vessels than the inflamed (B) or normal-appearing skin (C and E).