

OPTICAL COHERENCE TOMOGRAPHY: N VIVO HUMAN HAND EXPLORER

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The hand palm is an important human body part primarily for physical manipulation of the environment. For example, palmar hyperhidrotics report a low quality of life due to excessive palmar sweating disrupting normal palm use¹. As a body part in frequent contact with the environment, proper palm care should include routine checks to identify and localize surface and internal abnormalities at an early stage when chance for health recovery is particularly high. Effective intervention on palm care can benefit from a hand palm explorer device for in situ morphometry. High result reliability can be achieved if the device affords non-invasive, non-destructive, and non-contact operation to avoid disturbing normal functioning of the palm during assessment. The hand palm hosts micron-size organs, for example, a dense network of blood vessels, sweat glands, ducts, and pores. When observed functioning in situ they are good indicators of an individual's health state.² Because of their micron-dimensions, spatial resolution is another important performance specification parameter of the in vivo explorer device. We demonstrate the potential applicability of an optical coherence microscope operating on the well-known principle of optical coherence tomography³ (OCT). Briefly, this type of microscope, originally developed for human eye imaging, operates by illuminating a biologic sample with a safe dose of tissue-penetrating near-infrared light of low-coherent length through an amplitude-division interferometer. Sample back-reflection is collected and analysed interferometrically and at video-rate into a 2-D or 3-D spatial map of tissue microstructure reflectivity.

Typical OCT cross-section images of the in vivo finger pad and palm microstructure of a young African male volunteer are shown in Fig. 1 and 2 respectively. Surface landmarks such as ridges (R) and valleys (V) which in combination form the fingerprint are clearly visible. Internal micron-sized landmarks, for example, dermis-epidermis junction (DEJ), sweat glands (SG), and ducts (SD) could be resolved. V and R alternate positions giving the palm skin its wavy shape which also is the normal DEJ shape (Figs. 1 and 2). Sweat secreting ducts appear whiter due to enhanced reflectivity as a result of the relatively high refractive index of sweat. Blood vessels (BV) appear as low-signal regions.

An image of a damaged palm site is shown in Fig. 3. Crude identification of this site involved running a finger on the human subject palm to identify sites which felt hard or bumpy under touch before interrogating such sites with the OCT microscope. As can be clearly seen on Fig. 3 there is striking difference in the relative dermis-to-epidermis junction distance (compare between DEJ1 and DEJ2) while the DEJ shape departs from the anticipated wavy shape. Also, the

sweat ducts under the area of damage appear long and stretched out.

Optical microscopes based on the OCT principle would be useful as in situ human hand explorer devices, for example, in occupational health and safety.

References

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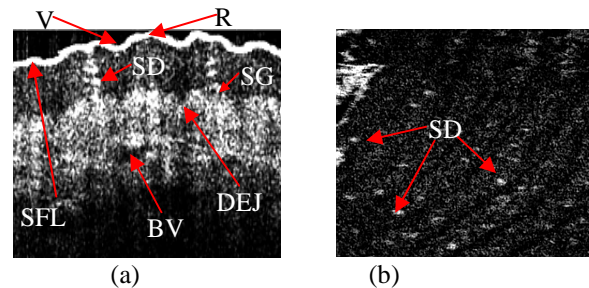


Fig. 1: In vivo human finger. (a) XZ plane and (b) en-face single frame images. SFL is sweat film layer; R is ridge; V is valley; DEJ is dermis-epidermis junction; SD is sweat filled duct; SG is sweat gland; BV is blood vessel.

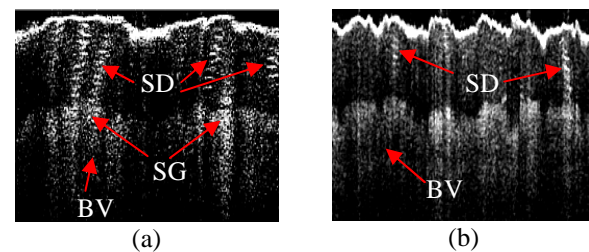


Fig. 2: In vivo human palm. (a) XZ plane and (b) YZ plane single frame images. Symbols have the same meaning as in figure 1.

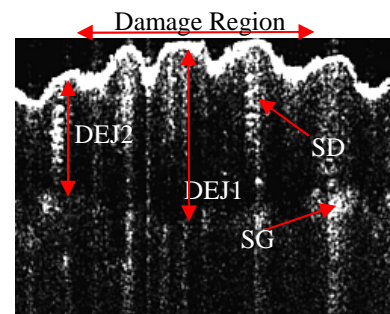


Fig. 3: Image frame for the damaged site showing large DEJ value ($DEJ1 > DEJ2$).

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