Optical Coherence Tomography

Optical coherence tomography (OCT) is a technique that is used to peer inside a body noninvasively. Tissue structure defined by tissue absorption and scattering coefficients, and the speed of blood flow, are derived from the characteristics of light remitted by the body. Singly backscattered light detected by partial coherence interferometry (PCI) is used to synthesize the tomographic image coded in false colors. A prerequisite of this technique is a low time-coherent but high space-coherent light source, for example, a superluminescent diode or a supercontinuum source. Alternatively, the imaging technique can be realized by using ultrafast wavelength scanning light sources. For tissue imaging, the light source wavelengths are restricted to the red and near-infrared (NIR) region from about 600 to 1300 nm, the so-called therapeutic window, where absorption (μa ≈ 0.01 mm⁻¹) is small enough. Transverse resolution in OCT is diffraction limited, as in conventional imaging; depth resolution is limited by the coherence length of the light. Both figures are of the order of micrometers. Velocity resolution is of the order of 0.1 mm s⁻¹. Several instruments are commercially available. At present, OCT is mainly used in the medical field, in particular, in ophthalmology. Owing to the high transmissivity of ocular media, the depth penetration is considerable. Corresponding applications in dermatology are somewhat hindered by the strong scattering of epidermic tissue (μs ≈ 10² mm⁻¹). As OCT provides images with a resolution comparable to conventional histology, but in real time, it can be used as a biopsy technique in a wide range of biological systems to detect diseases. These include the tomographic imaging of the internal microstructure of in vivo atherosclerotic plaques, the tomographic real-time diagnostics for intraoperative monitoring, and in microsurgical intervention. Optical biopsy based on OCT also provides diagnostic information by differentiating the architectural morphology of urological tissue, gastrointestinal tissue, and respiratory tissue.

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