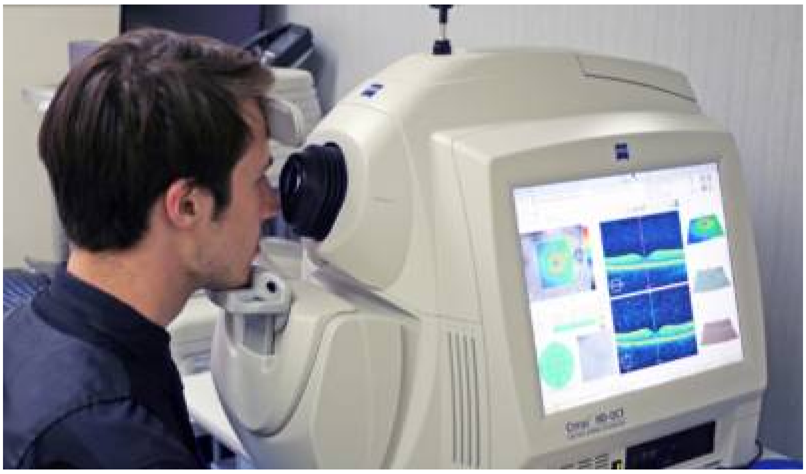
Optical coherence tomography



Optical coherence tomography (OCT) is an established medical imaging technique that uses light to capture micrometer-resolution, three-dimensional images from within optical scattering media (e.g., biological tissue). Optical coherence tomography is based on low-coherence interferometry, typically employing near-infrared light. The use of relatively long wavelength light allows it to penetrate into the scattering medium. Confocal microscopy, another optical technique, typically penetrates less deeply into the sample but with higher resolution.

Depending on the properties of the light source (superluminescent diodes, ultrashort pulsed lasers, and supercontinuum lasers have been employed), optical coherence tomography has achieved sub-micrometer resolution (with very wide-spectrum sources emitting over a ~100 nm wavelength range)[citation needed].

Optical coherence tomography is one of a class of optical tomographic techniques. A relatively recent implementation of optical coherence tomography, frequency-domain optical coherence tomography, provides advantages in signal-to-noise ratio, permitting faster signal acquisition. Commercially available optical coherence tomography systems are employed in diverse applications, including art conservation and diagnostic medicine, notably in ophthalmology and optometry where it can be used to obtain detailed images from within the retina. Recently it has also begun to be used in interventional cardiology to help diagnose coronary artery disease.

The standard OCT protocol generates two quantitative RGC measures. The retinal nerve fiber layer (RNFL) thickness represents the number of axons, and the ganglion cell–inner plexiform layer thickness reflects the number of cell bodies and dendrites of RGCs.

Optical coherence tomography angiography

Optical coherence tomography angiography

Optical Coherence Tomography Indications

Optical coherence tomography (OCT) is a noninvasive high-resolution ocular imaging modality routinely used in ophthalmology clinics for qualitative and quantitative analysis of optic nerve and retinal structures, including the retinal ganglion cells. By demonstrating structural loss of the retinal ganglion cells whose axons form the optic nerve before decussating in the optic chiasm, OCT imaging of the optic nerve and retina provides an excellent tool for the detection and monitoring of compressive optic neuropathies and chiasmopathies due to sellar and parasellar tumors. Recent studies have highlighted the role of OCT imaging in the diagnosis, follow-up, and prognostication of visual outcomes in patients with chiasmal compression. OCT parameters of the optic nerve and macular scans such as peripapillary retinal nerve fiber layer thickness and macular ganglion cell thickness are correlated with the degree of visual loss; additionally, OCT can detect clinically significant optic nerve and chiasmal compression before visual field loss is revealed on automated perimetry. Preoperative values of OCT optic nerve and macular parameters represent a prognostic tool for postoperative visual outcome. This review provides a qualitative analysis of the current applications of OCT imaging of the retina and optic nerve in patients with anterior visual pathway compression from sellar and parasellar masses. They also review the role of new technologies such as OCT-angiography, which could improve the prognostic ability of OCT to predict postoperative visual function [1)].

Automated classification of brain metastases and healthy brain tissue is feasible using OCT imaging, extracted texture features, and machine learning with principal component analysis (PCA) and support-vector machines (SVM). The established approach can prospectively provide the surgeon with additional information about the tissue, thus optimizing the extent of tumor resection and minimizing the risk of local recurrences [2)].

Optical coherence tomography can differentiate brain regions with intrinsic contrast and at a micron-scale resolution. Such a device can be particularly useful as a real-time neurosurgical guidance tool. Felts Almog et al. presented, the first full-field swept-source optical coherence tomography system operating near a wavelength of 1310 nm. The proof-of-concept system was integrated with an endoscopic probe tip, that is compatible with deep brain stimulation keyhole neurosurgery. Neuroimaging experiments were performed on ex vivo brain tissues and in vivo in rat brains. Using classification algorithms involving texture features and optical attenuation, images were successfully classified into three brain tissue types [3)]

The pathophysiology of extracranial traumatic aneurysm formation has not been fully elucidated. Intraarterial optical coherence tomography (OCT), was used to evaluate patients presenting with saccular traumatic aneurysms of the internal carotid artery (ICA). Two consecutive trauma patients diagnosed with saccular traumatic aneurysms of the cervical ICA, per the institutional screening protocol for traumatic cerebrovascular injury, underwent digital subtraction angiography (DSA) with OCT. Optical coherence tomography demonstrated disruption of the intima with preservation and stretching of the more peripheral layers. In 1 patient the traumatic aneurysm was associated with thrombus formation and a separate, more proximal dissection not visible on CT angiography (CTA) or

DSA. Imaging with OCT indicates that saccular traumatic aneurysms may develop from disruption of the intima with at least partial preservation of the media and adventitia. This provides in vivo evidence that saccular traumatic aneurysms result from a partial arterial wall tear rather than complete disruption. Interestingly, OCT was also able to detect arterial injury and thrombi not visible on CTA or DSA [4].

Retinal Optical coherence tomography (OCT), is a promising tool to be considered as a screening or follow-up test in children with optic pathway glioma OPG, and further multicenter research is encouraged [5].

Semyachkina-Glushkovskaya et al. clearly show how the brain clears dextran after it crosses the BBB via the meningeal lymphatic vessels. They first demonstrate successful application of optical coherence tomography (OCT) for imaging of the lymphatic vessels in the meninges after opening of the BBB, which might be a new useful strategy for noninvasive analysis of lymphatic drainage in daily clinical practice. Also, we give information about the depth and size of the meningeal lymphatic vessels in mice. These new fundamental data with the applied focus on the OCT shed light on the mechanisms of brain clearance and the role of lymphatic drainage in these processes that could serve as an informative platform for a development of therapy and diagnostics of diseases associated with injuries of the BBB such as stroke, brain trauma, glioma, depression, or Alzheimer disease [6].

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