Optical coherence tomography angiography

- Type 2 diabetes abates retrograde collateral flow and promotes leukocyte adhesion following ischemic stroke
- Quantitative analysis of retinal and choroidal microvascular changes after endonasal endoscopic pituitary adenoma resection: An OCTA study
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Optical Coherence Tomography Angiography (OCTA) is a non-invasive imaging technique used to visualize and assess the microvasculature of various tissues, including the retina, choroid, and optic nerve head. It provides high-resolution, three-dimensional images of blood vessels without the need for the injection of contrast agents.

Here's how OCTA works:

Principle of OCTA: OCTA utilizes the principle of optical coherence tomography, which uses light waves to create cross-sectional images of tissues. By detecting changes in the reflected light, OCTA can create images of blood vessels.

Split-spectrum amplitude-decorrelation angiography (SSADA): One commonly used method in OCTA is SSADA. It involves acquiring a series of OCT images at the same location over time. The changes in intensity and phase of the reflected light between consecutive images are analyzed to detect the presence and flow of blood vessels.

Depth-resolved imaging: OCTA provides depth-resolved imaging, allowing the visualization of blood flow in different layers of the tissue. This enables the assessment of both superficial and deep vascular networks.

En face visualization: The acquired OCTA data is processed to create en face images, which represent the blood vessel network as a two-dimensional projection. These images provide detailed maps of the microvasculature, including capillaries and larger vessels.

Applications

Ophthalmology: OCTA has revolutionized the field of ophthalmology, particularly in the evaluation of retinal diseases such as diabetic retinopathy, age-related macular degeneration, retinal vascular occlusions, and glaucoma. It helps visualize alterations in retinal blood flow and detect abnormal vessel patterns, microaneurysms, neovascularization, and non-perfusion areas.

Neurology: OCTA has shown promise in the assessment of cerebral blood flow and the visualization of vessels in the optic nerve head and brain tissue. It may aid in the diagnosis and monitoring of conditions such as ischemic stroke, multiple sclerosis, and neurodegenerative disorders.

Dermatology: OCTA can be used to study cutaneous microvasculature and assess blood flow patterns in the skin. It has applications in dermatological conditions such as skin tumors, vascular malformations, and wound healing.

Cardiology: Although still under development, OCTA has potential applications in cardiology for assessing microvascular flow in the heart and evaluating coronary artery disease.

OCTA provides detailed information about the microvascular network in various tissues, helping clinicians in the diagnosis, monitoring, and management of numerous diseases. However, it is important to note that OCTA is a relatively new technology, and its interpretation requires expertise and correlation with clinical findings.

Ergn et al. assessed the potential retinal microcirculation alterations for postoperative visual recovery in sellar/paraseller tumor patients with Optical Coherence Tomography Angiography (OCT-A). Two hundred ten eyes with sellar/parasellar tumor for which preoperative and postoperative (3 months) MRI Scans, Visual Acuity Test, Optical Coherence Tomography (OCT), OCT-A and, Visual Field Test data were available, besides 92 healthy eyes were evaluated. In the preoperative phase, significant reductions were observed in retinal vascular densities in various regions, including the Superficial Retinal Capillary Plexus (SRCP) (whole: $p < 0.001$, fovea: $p = 0.025$, parafovea: $p < 0.001$), Deep Retinal Capillary Plexus (DRCP) (whole: $p < 0.001$, fovea: $p = 0.003$, parafovea: $p < 0.001$), Peripapillary Vascular Density (PVD) (whole: $p = 0.045$, peripapillary: $p < 0.001$, nasal: $p < 0.001$, inferior: $p < 0.001$, temporal: $p < 0.001$), and Retinal Nerve Fiber Layer (RNFL) (nasal: $p = 0.024$, inferior: $p < 0.001$, temporal: $p < 0.001$, superior: $p < 0.001$) compared to the healthy control group. After surgery, the postoperative data of patients without chiasmal distortion were compared to their preoperative data. In the postoperative evaluation, significant increases were observed in vascular densities in patients without chiasmal distortion in the SRCP (whole: $p < 0.001$, parafovea: $p = 0.045$), DRCP (whole: $p = 0.007$, fovea: $p = 0.006$, parafovea: $p = 0.040$), PVD (peripapillary: $p = 0.010$, inferior: $p < 0.001$, temporal: $p < 0.001$, superior: $p < 0.001$), and RNFL (nasal: $p = 0.011$, inferior: $p = 0.034$, temporal: $p = 0.046$, superior: $p = 0.011$). Furthermore, significant associations were observed in the ROC analysis between the postoperative Visual Field Mean Deviation (VFMD) and SRCP (whole AUC = 0.793, $p < 0.001$, cut-off = 51.45, parafovea AUC = 0.820, $p < 0.001$, cut-off = 53.95), DRCP (whole AUC = 0.818, $p < 0.001$, cut-off = 55.95, parafovea AUC = 0.820, $p < 0.001$, cut-off = 59.05), PVD (temporal AUC = 0.692, $p < 0.001$, cut-off = 55.10), and RNFL (whole AUC = 0.690, $p = 0.001$, cut-off = 119.5, inferior AUC = 0.712, $p < 0.001$, cut-off = 144.75). These findings indicate a potential role of pre and post-operative OCT-A measurements in the assessment of surgical timing and postoperative visual recovery in patients with or without optic chiasm distortion [1].

Lee et al. investigated the differences in peripapillary vessel density (VD) between compressive optic neuropathy (CON) and normal-tension glaucoma (NTG).

They compared patients with chronic CON and NTG, particularly after strictly controlling the mean extent of macular damage by the area of the ganglion cell-inner plexiform layer (GCIPL) loss in optical coherence tomography (OCT). We compared retinal nerve fiber layer (RNFL) and GCIPL thickness from OCT and peripapillary and macular VD from OCT angiography (OCTA) between the CON and NTG groups.

From the initial 184 patients with CON and 443 patients with OAG, we included 41 patients with CON (57 eyes) and 64 patients with NTG (75 eyes) with a comparable extent of macular GCIPL thinning. Under similar mean macular involvement, the peripapillary VD was significantly lower in the CON group than in the NTG group after considering the effects of age, spherical equivalent, visual field sensitivity, peripapillary RNFL (pRNFL) thickness, GCIPL thickness, and image quality scores ($P < 0.001$). Marked loss of VD in the temporal and nasal sectors in CON was notable, attributing to the significantly lower peripapillary VD compared to NTG.

Conclusions: Patients with CON had a significantly lower peripapillary VD than those with NTG under similar mean degrees of pRNFL thickness and GCIPL damage. Our results reveal the potential utility of OCTA VD besides OCT pRNFL thickness, in relation to different topographic patterns of pRNFL loss, and possible differences in the pathogenesis of microvascular compromise between CON and NTG [2)]

Optical coherence tomography angiography has been used to evaluate the posterior segment in a wide variety of pathologies because it is a noninvasive image technique, but its role in the evaluation of the retina in a case of carotid-cavernous fistula has not been described yet.

Del Mar Schilt-Catafal et al. present a patient who consulted with spontaneous left superior eyelid hematoma and was diagnosed with left indirect carotid cavernous sinus fistula. In this study, optical coherence tomography angiography was used to evaluate the different macular capillary plexuses in a patient with carotid cavernous sinus fistula and a clinical situation of secondary local venous stasis before and after percutaneous embolization. Augmented vessel density was seen in superficial and deep capillary plexuses and in choriocapillaris before the percutaneous embolization, and a decrease of the parameters was seen after the treatment.

All macular capillary plexuses presented with augmented vessel density levels that normalized after treatment. These findings were previously undescribed, and they suggest that optical coherence tomography angiography may be useful to initially evaluate patients with carotid cavernous sinus fistula who are planned to undergo embolization and to follow them up until normalization of the vascular structures is reported [3)].

Quality control

Wicklein et al.aimed to develop criteria for OCTA quality assessment through (1) extensive literature review on OCTA artifacts and image quality to generate standardized and easy-to-apply OCTA QC criteria, (2) application of OCTA QC criteria to evaluate interrater agreement, (3) identification of reasons for interrater disagreement, revision of OCTA QC criteria, development of OCTA QC scoring guide and training set, and (4) validation of QC criteria in an international, interdisciplinary multicenter study.

Results: We identified 7 major aspects that affect OCTA quality: (O) obvious problems, (S) signal strength, (C) centration, (A) algorithm failure, (R) retinal pathology, (M) motion artifacts, and (P) projection artifacts. Seven independent raters applied the OSCAR-MP criteria to a set of 40 OCTA scans from people with MS, Sjogren syndrome, and uveitis and healthy individuals. The interrater kappa was substantial (κ 0.67). Projection artifacts were the main reason for interrater disagreement. Because artifacts can affect only parts of OCTA images, we agreed that prior definition of a specific region of interest (ROI) is crucial for subsequent OCTA quality assessment. To enhance artifact recognition and interrater agreement on reduced image quality, we designed a scoring guide and OCTA training set. Using these educational tools, 23 raters from 14 different centers reached an almost perfect agreement (κ 0.92) for the rejection of poor-quality OCTA images using the OSCAR-MP criteria.

They propose a 3-step approach for standardized quality control: (1) To define a specific ROI, (2) to assess the occurrence of OCTA artifacts according to the OSCAR-MP criteria, and (3) to evaluate OCTA quality based on the occurrence of different artifacts within the ROI. OSCAR-MP OCTA QC criteria achieved high interrater agreement in an international multicenter study and is a promising QC protocol for application in the context of future clinical trials and studies [4).

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2)

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3)

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4)

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