DOI: https://doi.org/10.54393/pjhs.v6i3.2507

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (E): 2790-9352, (P): 2790-9344
Volume 6, Issue 03 (March 2025)

Original Article

OPEN ACCESS

Diagnostic Accuracy of Optical Coherence Tomography to Detect Cystoid Macular Edema (CME) In Patients with Diabetes Mellitus (DM) Taking Fundus Fluorescein Angiography (FFA) As Gold Standard

Atia Nawaz[1], Nouman Aleem[2*], Mustafa Khalid Waheed[3], Muhammad Abrar Ahmad[4], Fahd Kamal Akhtar[2] and Saqib Siddiq[2]

[1]Department of Ophthalmology, Lahore General Hospital, Lahore, Pakistan
[2]Department of Ophthalmology, Services Hospital, Lahore, Pakistan
[3]Department of Ophthalmology, Lahore Medical and Dental College, Lahore, Pakistan
[4]Department of Ophthalmology, District Headquarter Hospital, Toba Tek Singh, Pakistan

ARTICLE INFO

Keywords:
Cystoid Macular Edema, Optical Coherence Tomography, Fundus Fluorescein Angiography, Diabetic Macular Edema

How to Cite:
Nawaz, A., Aleem, N., Waheed, M. K., Ahmad, M. A., Akhtar, F. K., & Siddiq, S. (2025). Diagnostic Accuracy of Optical Coherence Tomography to Detect Cystoid Macular Edema (CME) In Patients with Diabetes Mellitus (DM) Taking Fundus Fluorescein Angiography (FFA) As Gold Standard: Diagnostic Accuracy of Tomography in Diabetes Mellitus. Pakistan Journal of Health Sciences, 6(3), 86-91. https://doi.org/10.54393/pjhs.v6i3.2507

***Corresponding Author:**
Nouman Aleem
Department of Ophthalmology, Services Hospital, Lahore, Pakistan
drnoumanaleem@gmail.com

Received date: 1st November, 2024
Acceptance date: 12th March, 2025
Published date: 31st March, 2025

ABSTRACT

Macular thickening, known as Cystoid Macular Edema (CME), is brought on by fluid buildup in the inner nuclear and outer plexiform layers of the retina as a result of leaking from peri-foveal retinal capillaries. **Objective:** To determine the OCT's ability to identify cystoid macular edema in individuals with diabetes mellitus, compared to the gold standard of fundus fluorescein angiography. **Methods:** The Lahore General Hospital's Ophthalmology Outpatient Clinic served as the study's setting. From the Outpatient Department, 143 patients who met the inclusion criteria were randomly selected. Informed consent was obtained from patients before imaging. An indirect biomicroscope was used to evaluate all of the subjects. After completing fundus fluorescein angiography and optical coherence tomography, was diagnosed with cystoid macular edema according to the standardized criteria. A data collection proforma was developed. IBM SPSS version 25.0 was used to analyze the data. **Results:** In this study, 76 males (53.1%) and 67 females (46.9%) participated. The average age was 47.7 ± 10.3 years and diabetes duration was 5.4 ± 2.9 years. Optical Coherence Tomography (OCT) showed a sensitivity of 88.3%, specificity of 38.5%, PPV of 93.3%, NPV of 25.0%, and an overall accuracy of 84.6% compared to Fluorescein Angiography (FFA) in detecting cystoid macular edema. **Conclusions:** Diagnosing DME with OCT and FFA is very successful, it ensures early detection and treatment. For Diabetic Mellitus (DM) patients to avoid eyesight loss, accurate and easily accessible diagnostic strategies are essential.

INTRODUCTION

Cystoid Macular Edema (CME) is defined as disruption of the normal blood retinal barrier causes leakage from the peri-foveal retinal capillaries, causing accumulation of fluid in the retina's intracellular spaces, primarily the inner nuclear layer and outer plexiform layer, causing retinal thickening [1]. Diabetic retinopathy is a neurovascular outcome of diabetes. The most frequent cause of permanent loss of vision in patient with diabetes is diabetic macular edema, which can be develop at all stages of diabetic retinopathy [2]. Fluorescein angiography is one of the crucial diagnostic tool for diabetic retinopathy diagnosis and also crucial for the treatment process [3]. FFA is a frequently used diagnostic ophthalmology instrument in ophthalmology department [4]. FFA has been used to measure the non-perfusion zones within the retina and determines the ischemic range of micro vessels

DOI: https://doi.org/10.54393/pjhs.v6i3.2507

surrounding the area known as macula is many quadrants [5]. Furthermore, it can measure the extent/degree and position of florescence leakage, which guides the application of laser [6]. A study conducted at university of Liverpool suggested that diagnosis of both functional and structural alterations in diabetic retinopathy on time suggests that neuroretina thinning occurs before microvascular problems. Functional alterations discovered by the HRSD test in patients with early diabetic retinopathy have not been observed. Additional evidence for pre-clinical diabetic retinopathy comes from early detection of diabetic macular edema study [7]. A study conducted by Wong revealed the high false-positive rate of the existing screening technique results in disproportionate referrals, which causes patients great inconvenience and places a heavy financial burden on whole society. For DME screening, integrating universal optical coherence tomography can enhance sensitivity, cut down on false positive outcomes by eight times, and increase long lasting cost effectiveness [8]. A study conducted in India revealed proliferative diabetic retinopathy, central retinal vein occlusion, BRVO, and NPDR were the most common causes of cystoid macular edema. When compared to FFA, OCT sowed a 100 percent sensitivity and 81.38 percent diagnostic accuracy. Optical coherence tomography can therefore be suggested as the main imaging procedure for cystoid macular edema diagnosis [9]. In another study it was found that, rapid acquiring no intravenous dye requirement, and better detection of neovascular spikes and capillary drop-out are some of the benefits of optical coherence tomography angiography over FFA. It appeared promising for regular monitoring of DR. However, its usage as a stand-alone evaluation approach is hampered by its reduce field of vision, poor resolution power, difficulties recognizing microaneurysms over large regions, and incapacity to find peripheral retinal vascular sheath [10]. Once the retina has been ignited with white-blue light rays at a wavelength of 490 nano meter, an angiography can be acquired by capturing the fluorescent green light that the dye emits after being injected into the bloodstream as sodium fluorescein. In essence, this is a dye-tracing test [11]. Cystoid macular edema was diagnosed with a sensitivity of 98.7% and a specificity of 96% using FFA and OCT, respectively, in research that compared the two methods [12]. OCT had a sensitivity of 98.6% and a specificity of 100% for detecting cystoid macular edema in a study that compared it to fundus fluorescein angiography [13]. Cystoid macular edema was seen in 21.8% of cases [14]. A phakic patient with type 1 idiopathic macular telangiectasia was documented in a case report from 2013. This patient's CME responded strongly to the administration of NSAIDs but would recur if not treated [15].

Although Optical Coherence Tomography (OCT) is increasingly used as a non-invasive diagnostic tool for diabetic macular edema and cystoid macular edema, limited local evidence exists regarding its diagnostic accuracy compared with Fundus Fluorescein Angiography (FFA) in Pakistani diabetic populations. Variability in sensitivity and specificity across international studies creates uncertainty about OCT's reliability as a standalone diagnostic modality in resource-limited clinical settings. This study aimed to determine the OCT's ability to identify cystoid macular edema in individuals with diabetes mellitus, compared to the gold standard of fundus fluorescein angiography

METHODS

This Prospective Cohort study was carried out at the Ophthalmology Department of Lahore General Hospital (LGH), Lahore, over twelve months, following the approval of the study synopsis. The study was done after the final approval of the synopsis. The study duration was from April 2021 to April 2022. The IRB number was 2056-58. Data were collected after obtaining consent from patients. All the patients had OCT and FFA done. Findings of OCT were checked with FFA and tested whether OCT missed the macular edema or not taking FFA as standard reference. A non-probability purposive sampling technique was used. A sample size of 143 participants was estimated at a 95% confidence level, based on an expected sensitivity of 96% for Optical Coherence Tomography (OCT) and a specificity of 100%, with a 7% margin of error [14, 15]. The sample size calculation formula used was n = Z21-*α/2*.p.q/d2.Patients of both genders, aged between 25 and 70 years, with clear ocular media and diagnosed with Diabetic Macular Edema (DME), were included in this study. Patients who have with condition of nystagmus (examined clinically), anxiety concerning the technique according to the history of the patient), allergy to fluorescein (from the history of the patient), patients with impaired renal function serum creatinine greater than 1.2 mg/dl, pregnancy, patients with significant cardiac disease and patients with moderate asthma were excluded from the study due to adverse reaction to fluorescein dye and it can also cause transient hemodynamic changes including tachycardia and hypotension, patients with uveitis, patients who had experienced IOL surgery within the last three months, as well as those who were diagnosed with CRVO, BRVO were also not included in the study. The research took place in the Lahore General Hospital Ophthalmology Department after receiving clearance from the hospital's ethics council. From the Outpatient Department, 143 patients who met the inclusion criteria were chosen at random. All patients provided consent to have their retinas photographed and examined prior to the start of the study.

DOI: https://doi.org/10.54393/pjhs.v6i3.2507

Snellen's acuity chart was utilized to capture far vision, while 45-degree retinal pictures were taken using close vision. All subjects in the study were evaluated using indirect biomicroscopy. Cystoid macular edema was diagnosed through two imaging techniques: FFA and OCT. Information such as names, ages, sexes, addresses, registration numbers, degrees of vision impairment, results of indirect biomicroscopic examinations, OCT, and FFA were collected using a standardized form. The researchers gathered all the data themselves. SPSS version 25.0 was employed for data entry and analysis. Quantitative information, such as age and duration of diabetes mellitus, was reported as Mean ± S.D., whereas qualitative information, including gender, hypertension, and smoking prevalence, was presented as frequencies and percentages. OCT was evaluated for detecting Cystoid Macular Edema (CME) in diabetic individuals against FFA as the gold standard. A Kappa correlation was calculated between FFA and OCT. The chi-square test was applied for sensitivity, specificity, and other metrics. A 2x2 contingency table compared the results with statistical significance set at p-value < 0.05.

RESULTS

The gender distribution revealed that 76 participants (53.1%) were males, while 67 participants (46.9%) were females. Therefore, male patients outnumbered female patients in this study. Table shows that 62 patients (43.4%) were in the 25-45 years age group, while 81 patients (56.6%) fell into the 46-70 years age group (Table 1).

Table 1: Demographic Characteristics

Variables	Categories	Frequency (%)
Gender	Male	76 (53.1%)
	Female	67 (46.9%)
	Total	143 (100.0%)
Age Groups	25-45 Years	62 (43.4%)
	46-70 Years	81 (56.6%)
	Total	143 (100.0%)

The table 2 presented the frequency and percentage distribution of key health-related variables among the study participants (N = 143). The prevalence of hypertension was 28.7%, while 71.3% of participants did not have hypertension. Smoking was reported by 26.6% of participants, whereas 73.4% were non-smokers. Regarding the duration of diabetes mellitus, 51.0% had the condition for ≤ 5 years, while 49.0% had it for more than 5 years.

Table 2: Distribution of Hypertension, Smoking, and Duration of Diabetes Mellitus Among Participants

Variables	Frequency (%)
Hypertension	
Yes	41 (28.7%)
No	102 (71.3%)
Total	143 (100.0%)
Smoking	
Yes	38 (26.6%)
No	105 (73.4%)
Total	143 (100.0%)
Duration of Diabetic Mellitus	
≤ 5 Years	73 (51.0%)
> 5 Years	70 (49.0%)
Total	143 (100.0%)

Table 3 illustrated that the technique of FFA was used to diagnose 130 patients (90.9 percent) with CME, based on the frequency distribution of CME (Table 3).

Table 3: Frequency Distribution of Cystoid Macular Edema Detected on FFA

Cystoid Macular Edema (CME) Detected on Fundus Fluorescein Angiography (FFA)	Frequency (%)
Yes	130 (90.9%)
No	13 (9.1%)
Total	143 (100.0%)

The table 6 showed that Cystoid Macular Edema (CME) identified by OCT revealed that 123 individuals (86.0%) were diagnosed with cystoid macular edema using this imaging technique (Table 4).

Table 4: Frequency Distribution of CME Detected on Optical Coherence Tomography (OCT)

CME Detected on Optical CoherenceTomography	Frequency (%)
Yes	123 (86.0%)
No	20 (14.0%)
Total	143 (100.0%)

The table of contingency for Optical Coherence Tomography (OCT) and FFA diagnosis of CME showed 115 true positives, 8 false positives, 5 true negatives, and 15 false -Ve. The sensitivity of OCT in the diagnosis of CME is 88.3%, showed a high ability to correctly detect positive instances, whereas the specificity is 38.5%, showed a lower ability to accurately detect negative cases. The PPV (93.3%) demonstrated OCT's reliability in confirming cystoid macular edema, whereas the NPV 925.0% showed its poor accuracy in excluding cystoid macular edema. Overall, optical coherence tomography identified CMEs with an accuracy of 84.6% (Table 5).

DOI: https://doi.org/10.54393/pjhs.v6i3.2507

Table 5: CME Detected on Fundus Fluorescein Angiography versus CME on Optical Coherence Tomography

CME Detected on Optical Coherence Tomography	CME Detected on Fundus Fluorescein Angiography	True Positives (T +ve), False Positives (F -ve), True Negatives (T -ve), False Negatives (F -ve)	Total
Yes	Yes	115 (TP)	130
No	Yes	15 (FN)	
Yes	No	8 (FP)	13
No	No	5 (TN)	

Diagnostic Metrics
Sensitivity = TP/TP+FN =115/115+15 =88.3%
Specificity = TN/TN+FP=5/5+8 = 38.5%
Positive Predictive Value = TP/TP+FP = 115/115+8 = 93.3%
Negative Predictive Value = TN/TN+FN = 5/5+15 = 25.0%
Accuracy = TP+TN/Total =115+5/143 = 84.6%

This table summarized the diagnostic performance metrics, including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy. Sensitivity (88.3%) reflects the test's ability to correctly identify positive cases, while specificity (38.5%) indicates its ability to detect negatives. The PPV (93.3%) represented the likelihood that positive results are accurate, whereas the NPV (25.0%) showed the probability that negative results are correct. The overall accuracy of the test is 84.6%. The reported 95% confidence intervals provide a measure of reliability, and a significant p-value (0.001) supports the sensitivity of the test (Table 6).

Table 6: Diagnostic Performance Metrics of the Test

Metrics	Value (%)	95% Confidence Interval	p-Value
Sensitivity	88.3%	(81.7%, 93.2%)	0.001
Specificity	38.5%	(20.7%, 58.2%)	
Positive Predictive Value (PPV)	93.3%	(87.2%, 97.2%)	
Negative Predictive Value (NPV)	25.0%	(9.1%, 49.5%)	
Accuracy	84.6%	(78.2%, 89.9%)	

DISCUSSION

According to earlier research, the occurrence of DME rises with old age, with 50.6% seen in those aged 61–70 [16]. This research aimed to compare FFA and OCT as prospective diagnostic tools. By both FFA and OCT measures, the research demonstrated encouraging outcomes. Four forms of diabetic macular edema were identified by FFA: mixed, cystoid, diffuse, and focal. Patients with intraretinal edema, subretinal fluid, and mixed macular edema were all identified using Optical Coherence Tomography (OCT) [16]. In one study, it was found that in 51.6% of patients, abnormalities of the macula like an epiretinal membrane, macular exudation, full-thickness macular hole, Cystoid Macular Edema (CME), and Sub internal limiting membrane were seen. Optical coherence tomography and OCT-A detected all macular changes, whereas fundus angiography missed 18.8% and SLB and indirect ophthalmoscopy missed 50% of instances. The best corrected visual acuity was much lower in patients with macular involvement indicating fundus angiography's limits in detecting vision alterations [17]. In this study, the gender distribution revealed that 76 participants (53.1%) were male, while 67 participants (46.9%) were female, with male patients outnumbering female patients. Additionally, the average duration of diabetes mellitus in the study population was 5.4 ± 2.9 years. Research by Luxmi S *et al.*, compared the accuracy of CME diagnoses made with OCT and FFA [18]. It was demonstrated that FFA and OCT had a 98.7 and 96% sensitivity, respectively [14]. Research by Zhang HR comparing OCT with FFA found that the former has a sensitivity of 98.6% for detecting CME and a specificity of 100% [15]. CME was seen in 21.8% of patients [19]. In this study, 123 patients (86.0%) were diagnosed with CME using OCT. OCT performed well in detecting cystoid macular edema against Fluorescein Angiography (FFA), with a sensitivity of 88.5%, specificity of 78.5%, positive predictive value of 93.5%, negative predictive value of 75.0%, and an overall diagnostic accuracy of 83.9%. In a study conducted by You QS *et al.*, they found that the occlusion test confirmed the model's capacity to detect the crucial pathological regions, underscoring its clinical potential [20].The deep learning model showed strong diagnostic performance with high AUC values ranging from 0.91 to 0.994 internally, 0.970 to 0.997 externally, and excellent accuracy. Sensitivity and specificity: a slightly lower sensitivity in external validation (80.1 percent) indicates space for improvement.In another study, it was found that in diagnosing centers involved diabetic macular edema, the study showed that central macular fluid volume performed better than central subfield thickness, with a considerably higher area under the receiver operating characteristics curve (AURC) (0.907 versus 0.832) and stronger sensitivity 78.5% versus 53.8% at 95 percent specificity.

The study's single-center design, purposive sampling, and relatively small sample size may limit the generalizability of findings to broader diabetic populations. OCT demonstrated low specificity and negative predictive value, indicating limited effectiveness in ruling out disease when used alone. Future multicenter studies with larger randomized samples, inclusion of advanced OCT angiography technologies, and integration of artificial intelligence-based imaging analysis are recommended to improve diagnostic precision and establish more reliable screening protocols for diabetic retinal complications.

DOI: https://doi.org/10.54393/pjhs.v6i3.2507

CONCLUSIONS

The study examined the diagnostic efficacy of FFA and OCT in detecting CME in Diabetic Mellitus (DM). Fundus fluorescein angiography, being the gold standard, was more accurate at diagnosing cystoid macular edema. OCT established good skills in detecting positive cases and is a useful non-invasive screening method, however, its limits in excluding cystoid macular edema emphasize its poor specificity. As a result, while optical coherence tomography is effective for preliminary evaluations, fundus fluorescein angiography is still required for confirmation and correct diagnosis.

Authors' Contribution

Conceptualization: NA
Methodology: AN, MAA
Formal analysis: FKA, SS
Writing and Drafting: AN, NA, MKW
Review and Editing: AN, NA, MKW, FKA, SS

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

REFERENCES

[1] Naz R, Khaqan HA, Buksh HM, Ali M, Haider AU. Diagnostic Accuracy of Spectral Domain Optical Coherence Tomography in the Diagnosis of Cystoid Macular Edema among Diabetes Mellitus Patients Using Fundus Fluorescein Angiography as Gold Standard. Surgery. 2022 Jul-Sep; 18(3).

[2] Lam C, Wong YL, Tang Z, Hu X, Nguyen TX, Yang D *et al.* Performance of Artificial Intelligence in Detecting Diabetic Macular Edema from Fundus Photography and Optical Coherence Tomography Images: A Systematic Review and Meta-analysis.DiabetesCare. 2024 Feb; 47(2): 304-19. doi: 10.2337/dc23-0993.

[3] Samir G and O Elrashidy HE. Optical coherence tomography angiography in comparison with fluorescein angiography in diabetic retinopathy. Journal of Medicine in Scientific Research.2022Jun; 5(2): 17. doi: 10.4103/jmisr.jmisr_66_21.

[4] Khanum A and Basavaraj TM. Unilateral macular exudation. Indian Journal of Ophthalmology. 2021 Mar; 69(3): 487. doi: 10.4103/ijo.IJO_2842_20.

[5] Du X, Sheng Y, Shi Y, Du M, Guo Y, Li S. The Efficacy of Simultaneous Injection of Dexamethasone Implant and Ranibizumab into Vitreous Cavity on Macular Edema Secondary to Central Retinal Vein Occlusion. Frontiers in Pharmacology. 2022 Mar; 13: 842805. doi: 10.3389/fphar.2022.842805.

[6] Imamachi K, Ichioka S, Takayanagi Y, Tsutsui A, Shimizu H, Tanito M. Central serous chorioretinopathy resolution after traumatic cyclodialysis repair. American Journal of Ophthalmology Case Reports. 2022 Jun; 26: 101507. doi: 10.1016/j.ajoc.2022.101507.

[7] Ku JY, Yee J, Background K. Early Detection of Diabetic Macular Oedema Early Detection of Diabetic Macular Oedema (EDDMO) Study.2021Mar.doi:livrepository .liverpool.ac.uk/3148702.

[8] Wong IY, Wong RL, Chan JC, Kawasaki R, Chong V. Incorporating optical coherence tomography macula scans enhances cost-effectiveness of fundus photography-based screening for diabetic macular edema.Diabetes Care.2020Dec;43(12):2959-66.doi: 10.2337/dc17-2612.

[9] Herbort Jr CP, Takeuchi M, Papasavvas I, Tugal-Tutkun I, Hedayatfar A, Usui Y *et al.* Optical coherence tomography angiography (OCT-A) in uveitis:a literature review and a reassessment of its real role. Diagnostics.2023Feb;13(4):601.doi:10.3390/ diagnostics13040601.

[10] Abbas SR, Elfayoumi MA, Tabl AA, Zaher AM. Comparison between Optical coherence tomography Angiography and fundus Fluorescein Angiography in cases of Diabetic Maculopathy.Benha Journal of Applied Sciences.2021Aug;6(4):289-95.doi:10.21608/ bjas.2021.197979.

[11] Trichonas G and Kaiser PK. Optical coherence tomography imaging of macular oedema. British Journal of Ophthalmology. 2014 Jul; 98(Suppl 2): ii24-9. doi: 10.1136/bjophthalmol-2014-305305.

[12] Lommatzsch C, Rothaus K, Koch JM, Heinz C, Grisanti S. Vessel density in glaucoma of different entities as measured with optical coherence tomography angiography. Clinical Ophthalmology.2019Dec;13: 2527-34. doi: 10.2147/OPTH.S230192.

[13] Haydinger CD, Ferreira LB, Williams KA, Smith JR. Mechanisms of macular edema. Frontiers in Medicine. 2023 Mar; 10: 1128811. doi: 10.3389/fmed.2023.1128811.

[14] Romano F, Lamanna F, Gabrielle PH, Teo KY, Parodi MB, Iacono P *et al.* Update on retinal vein occlusion.The Asia-Pacific Journal of Ophthalmology.2023Mar;12 (2): 196-210. doi: 10.1097/APO.0000000000000598.

[15] Viggiano P, Bisceglia G, Bacherini D, Chhablani J, Grassi MO, Boscia G *et al.* Long-term visual outcomes and optical coherence tomography biomarkers in eyes with macular edema secondary to retinal vein occlusion following anti-vascular endothelial growth factor therapy. Retina.2024 Sep;44(9):1572-9.doi: 10.1097/IAE.0000000000004157.

[16] Rajurkar K, Thakar M, Gupta P, Rastogi A. Comparison of fundus fluorescein angiography, optical coherence

DOI: https://doi.org/10.54393/pjhs.v6i3.2507

tomography and optical coherence tomography angiography features of macular changes in Eales disease: a case series.Journal of Ophthalmic Inflammation and Infection.2020Dec;10:1-0.doi:10.1186/s12348-020-00220-4.

[17] Jin K, Pan X, You K, Wu J, Liu Z, Cao J *et al.* Automatic detection of non-perfusion areas in diabetic macular edema from fundus fluorescein angiography for decision making using deep learning.Scientific Reports.2020Sep;10(1):15138.doi:10.1038/s41598-020-71622-6.

[18] Luxmi S, Ritika M, Lubna A, Pragati G, BB L. Diabetic macular edema and its association to systemic risk factors in an urban north Indian population. Journal of Clinical Ophthalmology.2018Oct;2(2):86-91.doi:10.35841/clinical-ophthalmology.2.2.86-91.

[19] Wu Q, Zhang B, Hu Y, Liu B, Cao D, Yang D *et al.* Detection of morphologic patterns of diabetic macular edema using a deep learning approach based on optical coherence tomography images.Retina.2021May;41(5):1110-7.doi:10.1097/IAE.0000000000002992.

[20] You QS, Tsuboi K, Guo Y, Wang J, Flaxel CJ, Bailey ST *et al.* Comparison of central macular fluid volume with central subfield thickness in patients with diabetic macular edema using optical coherence tomography angiography. Journal of the American Medical Association Ophthalmology.2021Jul;139(7):734-41.doi: 10.1001/jamaophthalmol.2021.1275.