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Comparison between B-scan Ultrasonography and Optical Coherence Tomography in Evaluation of Macular Oedema

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ABSTRACT

Background: Optical Coherence Tomography is a very sensitive modality for detection of even subclinical macular edema and provides both qualitative and quantitative results used in monitoring and follow up of patients before and after treatment of ME. However, B-Scan Ultrasonography is a non-Invasive diagnostic tool that has the advantage of reliably imaging the posterior segment regardless of the ocular media status and it is less dependent on patient cooperation. **Aim of the Work:** To report sensitivity and specificity of B-scan Ultrasonography in detection of macular edema. **Patients and methods:** This observational case series was conducted on Forty eyes of 20 patients examined at the ophthalmology clinic of Cairo Fatimic Hospital. They were asked to participate and were enrolled in this study in the period from December 2017 to March 2018. **Results:** There was high degree of agreement between clinical diagnosis and echographic findings of macular thickening. The sensitivity and positive predictive value (PPV) of B-scan ultrasonography to detect ME were 91.7% (22/24) and 84.6% (22/26) respectively. The specificity and negative predictive value (NPV) of B-scan ultrasonography to detect ME were 75% (12/16) and 85.7% (12/14), respectively. And consequently, the diagnostic accuracy of B-scan ultrasonography to diagnose ME was found to be 85% (34/40). **Conclusion:** Optical Coherence Tomography is the most sensitive method to diagnose macular edema both qualitatively and quantitatively, but in certain circumstances when performing OCT would be difficult or even impossible, B-Scan Ultrasonography provides an acceptable method to qualitatively detect macular edema.

Key words: Macular oedema, B-scan ultrasonography, Optical coherence tomography

INTRODUCTION

Macular edema is a common phenomenon in various diseases where fluid accumulates in between the retinal cells. The fluid originates from the intravascular compartment. The focal, diffuse, and cystic forms are all characterized by extracellular accumulation of fluid, specifically in Henle's layer and the inner nuclear layer of the retina. The compartmentalization of the accumulated fluid is likely to be due in part to the relative barrier properties of the inner and outer plexiform layers [(1)].

The classic pattern of cystoid macular edema (CME) with the petaloid appearance originating from the fluorescein leakage from perifoveal capillaries may be seen in cases of advanced edema of various origins. This includes postsurgical CME as well as CME associated with one of the following conditions: diabetes, vascular occlusion, hypertensive retinopathy, epiretinal membranes, intraocular tumors (e.g., melanoma, choroidal hemangioma), intraocular inflammation (e.g., pars planitis), macroaneurysm, retinitis pigmentosa, choroidal neovascularization, and radiation retinopathy [(1)].

Cystoid macular edema may have severe implications for the function of the retina, including decreased visual acuity and contrast sensitivity. Acute or chronic edema causes anatomical disruption that may result in cellular dysfunction and death. Treatment of CME is important because chronic edema may result in degenerative changes in the macula and permanent loss of vision. In addition, large cystic changes in the retina may lead to thinning and loss of inner retinal tissue, or the formation of lamellar hole [(2)].

Early detection of CME is critical for diagnosis and management. Traditional methods of assessing macular edema include contact and noncontact slit lamp biomicroscopy, indirect ophthalmoscopy, fluorescein angiography (FA), and fundus stereo photography. However the interpretation of their results can be subjective, and subtle changes in retinal thickness in early CME may not be evident [(3)].

Optical coherence tomography (OCT) correlates well with retinal histology and can be used to quantitatively and qualitatively monitor retinal thickness over time. Compared to biomicroscopy and FA, OCT is more sensitive in detection of macular edema and subretinal fluid, and subclinical macular edema is often only detected by OCT [(4)].

Fluorescein angiography and OCT have limitations. Both tests require the ocular media to be of sufficient clarity to image the retina. Yet in certain patients, opacities in the ocular media limit biomicroscopy, FA, and OCT. Furthermore, a high degree of patient cooperation is required to ensure reliable and accurate testing. However, certain patients, such as children, often cannot tolerate a FA or follow the specific fixation instructions for OCT testing [(5)].

Ophthalmic ultrasonography is a well-accepted noninvasive diagnostic tool. Ultrasonography has the advantage of reliably imaging the posterior segment regardless of the ocular media status. Furthermore, ultrasonography is

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less dependent on patient cooperation for reliable testing compared to either FA or OCT [6].

AIM OF THE WORK

To report sensitivity and specificity of B-scan Ultrasonography for the detection of macular edema.

PATIENTS AND METHODS

Forty eyes of 20 patients examined at the ophthalmology clinic of Cairo Fatimic Hospital were asked to participate and were enrolled in this study in the period from December 2017 to March 2018.

This study was designed as an observational case series to report sensitivity and specificity of B-scan ultrasonography to detect macular edema. It was conducted in accordance with the ethical standards stated by the ethical committee of Ain Shams University hospitals.

Inclusion criteria: Patients were randomly selected to participate in this study.

Exclusion criteria: Criteria that prevent from performing OCT to the examined eye: Uncooperative patients as children. Central corneal opacity. Dense Cataract. Vitreous hemorrhage. Retinal detachment. High myopic patients (chorioretinal atrophy).

Ophthalmological examination:

B-scan Ultrasonography:

Patients underwent B-scan Ultrasonography by the same masked operator, and was performed before the history or examination had been revealed to the masked operator in an attempt to minimize any bias.

B-scan Ultrasonography using a 10-MHz probe on VuPADTM diagnostic ophthalmic ultrasound (Sonomed Escalon Inc., 2014, Lake Success, NY, USA) was performed.

The patient was placed in a supine position and A Coupling agent (Aquasonic 100 Ultrasound Transmission Gel, Parker Laboratories, Fairfield, NJ, USA) is applied to the tip of the probe or to the closed eyelids. Evaluation of the vitreous and macula were performed using various probe positions: horizontal axial and transverse directed temporally. In certain instances, longitudinal scans through the macula were also used to assess thickening.

Gain settings were adjusted accordingly to maximize detection of macular pathology (55-75 dB) [7].

In our study, macular thickening was graded as 0 (none), 1 (subtle), or 2 (pronounced) (qualitative grading system).

Full history fulfilling the following data: name, age, residence, special habits of medical importance (example: smoking), systemic diseases (example: DM, HTN), history of ocular trauma or any previous ocular surgery, drugs used previously or currently, history of spectacle correction and if yes, the type of correcting lenses (convex, concave and/or cylinder) and history of any visual complaints including decreased VA, metamorphopsia or scotomas.

Careful ocular examination including:

a) Best corrected visual acuity (BCVA) using tumbling (illiterate) E eye chart (Good-Lite Co.). The patient was seated 6 meters away from the chart, and each eye is tested separately while the fellow eye is occluded. When the patient could not see the largest letter (6/60), he was asked to move slowly meter by meter towards the chart until he could see the largest letter. If he was only one meter away from the chart and still could not see the largest letter (1/60), he was asked to count fingers (CF) at progressively shorter distance. If CF could not be achieved, the patient was checked if he could see hand motion (HM). If less than this, light perception (PL) is tested with a bright light. If PL is present, all four quadrants are tried, and the patient was asked to point to which quadrant the light was perceived as arising from (accurate projection). In our study, patients included were of VA 1/60 or better to facilitate fixation during OCT testing.

b) Intra ocular pressure (IOP) measurement was carried out using Goldman Applanation Tonometer (Haag-Streit, AT 900).

c) Anterior segment examination was done by slit lamp Biomicroscopy (Haag-Streit, BM 900) for detection of any pathology including corneal opacity, lens opacity and anterior chamber activity.

d) Examination of the pupil for relative afferent pupillary defect (RAPD) before dilation of the pupil to detect optic nerve disease and severe retinal damage as retinal detachment and major retinal vascular occlusion.

e) Posterior segment examination after dilation of pupil with tropicamide eye drops 1% using 1) indirect ophthalmoscope (Keeler Ltd. Windsor, UK) (using handheld +20D lens) for thorough examination of peripheral fundus for Degenerations, breaks, retinal detachment hemorrhage, exudate, pigmentary retinopathy, chorioretinal scars 2) slit lamp Biomicroscopy using handheld +90D lens (Volk Optical, Mentor, OH) for thorough examination of macula whether it is flat or elevated, if there is hemorrhage, exudate, drusen, atrophy or angioid streaks.

Optical coherence tomography:

The same examiner performed all OCT measurements. OCT measurements for macular

thickness was performed using the same device Optos SD-OCT (Spectral OCT SLO, Optos Instrumentation, Hialeah, FL, USA). It uses light generated from an infrared broadband Super Luminescent Diode (SLD) source with a center wavelength frequency of 830nm. It has an Axial Resolution <10 micron, Digital on-screen <6 micron. Transverse Resolution 20 micron (in tissue).

Macular thickness measurements:

After pupillary dilation using tropicamide eye drops 1%, the patient was asked to fixate on an internal fixation target during the scanning process so that the scanning area is central over the macula.

The 3D Retinal Topography was used as the scanning mode. The system collects a set of sequential stacks of B-Scan OCT images and provides the user with a three dimensional (3D) reconstructed OCT image and a Topographic Map of the captured volume. The topographic map can be displayed on top of the SLO image, which provides an accurate display of orientation and registration of the topographic map, in relation to the SLO image of the fundus.

The 3D Topography covers an area of 9.0 x 9.0mm. The "Analyze" 3D Topography displays 3D Topographic Map with Retinal Thickness (measured between Vitreo-Retinal interface and the Mid RPE reflectance).

With Zones analysis under Regular Topographic Map covering an area of 9.0mm x 9.0mm, the software analyzes the retinal thickness and volume through nine different regions (zones) of the retina which were divided into the following groups: Center circle (1mm. diameter circle), the second (inner) circle/zone covers an area from 1.0mm diameter to 3.0mm diameter and the third circle/zone covers a ring with inner diameter of 3.0mm and outer diameter of 6.0mm. The second and third circle/zones were also divided to sub-regions marked as: Superior Inner, Temporal Inner, Inferior Inner, Nasal Inner, Superior Outer, Temporal Outer, Inferior Outer and Nasal Outer region. Each of the regions and sub-regions displays average thickness and volume.

The final assessment of macular thickening was based on slit lamp Biomicroscopy findings (by using a thin slit beam, ideally at a 45° angle, and a Biomicroscopic lens with high magnification +90D. The inner aspect of the beam was directed at the surface of the retina and retinal vessels, the outer aspect at the RPE. The distance between the inner and outer aspects was recognized as the thickness of the retina. Once the normal thickness of the retina is known for a given location within the macula, abnormal thicknesses may be evaluated in other area ***(Friberg, 2008)*** combined with OCT.

The presence or absence of macular thickening as determined by B-scan ultrasonography was compared with the final clinical assessment and OCT measurements. Eyes that underwent Ultrasonography, but could not otherwise be assessed with biomicroscopy and OCT, were excluded from the final data analysis.

Statistical Analysis

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 23 (SPSS Inc., 2017 South Wacker Drive, Chicago, USA). The quantitative data were presented as mean, standard deviations and ranges when their distribution found parametric. Also qualitative data were presented as number and percentages.

The comparison between two independent groups with qualitative data was done by using Chi-square test and/or Fisher exact test only when the expected count in any cell found less than 5.

The comparison between two independent groups with quantitative data and parametric distribution was done by using Independent t-test.

Pearson correlation coefficients were used to assess the correlation between two quantitative parameters in the same group.

Receiver operating characteristic curve (ROC) was used to assess the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of U/S grading in prediction of final clinical determination results.

The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following: $P > 0.05$: Non significant. $P < 0.05$: Significant. $P < 0.01$: Highly significant.

RESULTS

This study included 40 eyes of 20 patients, (12 males and 8 females) with age ranging from 32 to 68 years. A single masked operator performed B-scan ultrasonography for all eyes, and graded macular thickening in to grade 0 (none), grade 1 (subtle) and grade 2 (pronounced). The final assessment of macular thickness was based on biomicroscopy and OCT. B-scan ultrasonography findings were compared to final clinical assessment and OCT measurements.

Demographic data

The mean age for the 20 patients was 53.55 ± 11.16 ranging from 32-68 years.

Among the 20 patients enrolled in this study, 12 patients (60.0%) were males and 8 patients (40.0%) were females. 20 eyes (50%) were right and 20 eyes (50%) were left.

Using B-scan ultrasonography, 14 eyes (35%) were found to have no macular edema (grade 0), 12 eyes (30%) with subtle macular edema (grade 1) and 14 eyes (35%) with pronounced macular edema (grade 2).

Final clinical determination using biomicroscopy, 16 eyes (40%) were found to have no macular edema. The final diagnoses for these eyes included normal examination (8 eyes), dry ARMD (2 eyes) and DR (6 eyes). 24 eyes (60%) had macular edema, the final diagnoses for these eyes included DME (12 eyes), BRVO (3 eyes), HRVO (2 eyes), active CNV (2 eyes), ERM (2 eyes), CRVO (1 eye), uveitis (1 eye) and CSR (1 eye).

Central macular thickness measured by OCT ranged from 150-1010, with a mean of 422.43 ± 229.03.

Table (1): Description of data for the studied cases.

		No. = 40
Age	Mean±SD	53.55 ± 11.16
	Range	32 – 68
Sex	Male	24 (60.0%)
	Female	16 (40.0%)
Eye	Right	20 (50.0%)
	Left	20 (50.0%)
UlS grade of thickening	No	14 (35.0%)
	Subtle	12 (30.0%)
	Pronounced	14 (35.0%)
OCT central thickness (µm)	Mean±SD	422.43 ± 229.03
	Range	150 – 1010
Final clinical determination	ME absent	16 (40.0%)
	ME present	24 (60.0%)
Final diagnosis	Normal	8 (20.0%)
	ERM	2 (5.0%)
	DME	12 (30.0%)
	DR	6 (15.0%)
	BRVO	3 (7.5%)
	HRVO	2 (5.0%)
	CRVO	1 (2.5%)
	CNV	2 (5.0%)
	Dry ARMD	2 (5.0%)
	CSR	1 (2.5%)
	Uveitis	1 (2.5%)

Relation between U/S grade of thickening and the studied parameters

Studying the relation between US grade of thickening and patients' age (P-value 0.835), sex (P-value 0.919) and laterality (P-value 0.414) revealed statistically non-significant difference.

There was a statistically highly significant relation between US grade of thickening and OCT central macular thickness (P-value o.ooo). For eyes with grade 0 ME, mean central OCT thickness (+/- SD) was (246.64 ± 84.56). Eyes with grade 1 ME, mean central OCT was (326.42 ± 93.93) and eyes with grade 2 ME, mean central OCT was 680.5 ± 170.99.

The relation between US grade of thickening and final clinical determination was found to be statistically highly significant (P-value 0.000). for eyes with grade 0 ME, using biomicroscopy 85.7% of those eyes had no ME and 14.3% of eyes had ME. For eyes with grade 1 ME, 33.3% of eyes had no ME, and 66.7% of eyes had ME using biomicroscopy. Eyes with grade 2 ME, 100% of eyes had ME on biomicroscopy examination.

Table (2): Relation between Ultrasound grade of macular thickening and the studied parameters.

		U/S grade of thickening			**Test value**	**P-value**	**Sig.**
		No	**Subtle**	**Pronounced**			
		No. = 14	**No. = 12**	**No. = 14**			
Age	Mean±SD	52.07 ± 12.44	54.33 ± 8.17	54.36 ± 12.60	0.181•	0.835	NS
	Range	32 – 68	40 – 66	32 – 68			
Sex	Male	8 (57.1%)	7 (58.3%)	9 (64.3%)	0.169*	0.919	NS
	Female	6 (42.9%)	5 (41.7%)	5 (35.7%)			
Eye	Right	8 (57.1%)	7 (58.3%)	5 (35.7%)	1.762*	0.414	NS
	Left	6 (42.9%)	5 (41.7%)	9 (64.3%)			
OCT central thickness (µm)	Mean±SD	246.64 ± 84.56	326.42 ± 93.93	680.5 ± 170.99	47.886•	0.000	HS
	Range	150 – 513	163 – 453	453 – 1010			
Final clinical determination	ME absent	12 (85.7%)	4 (33.3%)	0 (0.0%)	21.746*	0.000	HS
	ME present	2 (14.3%)	8 (66.7%)	14 (100.0%)			
Final diagnosis	Normal	7 (50.0%)	1 (8.3%)	0 (0.0%)	12.396	0.002	HS
	ERM	0 (0.0%)	1 (8.3%)	1 (7.1%)	1.153	0.561	NS
	DME	2 (14.3%)	5 (41.7%)	5 (35.7%)	2.642	0.266	NS
	DR	4 (28.6%)	2 (16.7%)	0 (0.0%)	4.519	0.104	NS
	BRVO	0 (0.0%)	0 (0.0%)	3 (21.4%)	6.023	0.049	S
	HRVO	0 (0.0%)	0 (0.0%)	2 (14.3%)	3.91	0.141	NS
	CRVO	0 (0.0%)	0 (0.0%)	1 (7.1%)	1.905	0.385	NS
	CNV	0 (0.0%)	1 (8.3%)	1 (7.1%)	1.153	0.561	NS
	Dry ARMD	1 (7.1%)	1 (8.3%)	0 (0.0%)	1.153	0.561	NS
	CSR	0 (0.0%)	1 (8.3%)	0 (0.0%)	2.393	0.302	NS
	Uveitis	0 (0.0%)	0 (0.0%)	1 (7.1%)	1.905	0.385	NS

> 0.05 NS: Non significant; < 0.05 S: Significant; < 0.01 HS: Highly significant
*:Chi-square test; •: One Way ANOVA test

Relation between final clinical determination and the studied parameters

Mean patients' age for eyes with no ME and eyes with ME using biomicroscopy was 52.13 ± 11.85 and 54.50 ± 10.83 respectively, with no statistically significant difference (P-value 0.517).

There was a statistically non-significant difference regarding gender distribution (P-value 0.792) and eye laterality (P-value 1.000).

There was a statistically highly significant relation between final clinical determination and US grade of thickening. For eyes with no ME on biomicroscopy, 75% of them were grade 0, 25% of

them were grade 1 and none with grade 2. For eyes with ME on biomicroscopy, only 8.3% were grade 0, 33.3% were grade 1 and 58.3% were grade 2.

Mean OCT central macular thickness (+/- SD) for eyes with no ME and eyes with ME on biomicroscopy was 224.50 ± 38.12 and 554.38 ± 206.34 respectively, showing a highly significant statistical relation (P-value 0.000).

Table (3): Relation between final clinical determination using Biomicroscopy and the studied parameters.

		Final clinical determination		Test value	P-value	Sig.
		ME absent	ME present			
		No. = 16	No. = 24			
Age	Mean±SD	52.13 ± 11.85	54.50 ± 10.83	-0.654•	0.517	NS
	Range	32 – 68	32 – 68			
Sex	Male	10 (62.5%)	14 (58.3%)	0.069*	0.792	NS
	Female	6 (37.5%)	10 (41.7%)			
Eye	Right	8 (50.0%)	12 (50.0%)	0.000*	1.000	NS
	Left	8 (50.0%)	12 (50.0%)			
UlS grade of thickening	No	12 (75.0%)	2 (8.3%)	21.746*	0.000	HS
	Stable	4 (25.0%)	8 (33.3%)			
	Pronounced	0 (0.0%)	14 (58.3%)			
OCT central thickness (µm)	Mean±SD	224.50 ± 38.12	554.38 ± 206.34	-6.297•	0.000	HS
	Range	150 – 286	235 – 1010			
Final diagnosis	Normal	8 (50.0%)	0 (0.0%)	15.000	0.000	HS
	ERM	0 (0.0%)	2 (8.3%)	1.404	0.236	NS
	DME	0 (0.0%)	12 (50.0%)	11.429	0.001	HS
	DR	6 (37.5%)	0 (0.0%)	10.588	0.001	HS
	BRVO	0 (0.0%)	3 (12.5%)	2.162	0.141	NS
	HRVO	0 (0.0%)	2 (8.3%)	1.404	0.236	NS
	CRVO	0 (0.0%)	1 (4.2%)	0.684	0.408	NS
	CNV	0 (0.0%)	2 (8.3%)	1.404	0.236	NS
	Dry ARMD	2 (12.5%)	0 (0.0%)	3.158	0.076	NS
	CSR	0 (0.0%)	1 (4.2%)	0.684	0.408	NS
	Uveitis	0 (0.0%)	1 (4.2%)	0.684	0.408	NS

NS: Non significant; S: Significant; HS: Highly significant
*:Chi-square test; •: Independent t-test

For eyes that were found to have no macular edema using biomicroscopy, 8 eyes (50%) were normal, 6 eyes (37.5%) had diabetic retinopathy and 2 eyes (12.5%) had dry ARMD.

For eyes that were found to have macular edema using biomicroscopy, 2 eyes (8.3%) had ERM, 12 eyes (50%) had diabetic macular edema, 3 eyes (12.5) had BRVO, 2 eyes (8.3%) had HRVO, 1 eye (4.2%) had CRVO, 2 eyes (8.3%) had active CNV, 1 eye (4.2%) had CSR and 1 eye (4.2%) had uveitis.

Relation between OCT central thickness and the studied parameters

Studying the relation between OCT central thickness and age, we found that there was no statistically significant value (P-value 0.359).

Mean OCT central thickness for eyes of male patients was (419.21 ± 225.28) and that of eyes of female patients was (427.25 ± 241.91) with no statistically significant difference (P-value 0.915).

Mean OCT central thickness for studied right eyes was (361.80 ± 169.95) and that of studied left eyes was (483.05 ± 266.55) with no statistically significant difference (P-value 0.094).

Table (4): Relation between mean OCT central thickness (± SD) and the studied parameters.

		OCT central thickness (µm)		Test value	P-value	Sig.
		Mean±SD	Range			
Sex	Male	419.21 ± 225.28	150 – 1010	-0.107•	0.915	NS
	Female	427.25 ± 241.91	163 – 976			
Eye	Right	361.80 ± 169.95	150 – 760	-1.715•	0.094	NS
	Left	483.05 ± 266.55	213 – 1010			
Final diagnosis	Normal	229.63 ± 21.08	193 – 260	8.760••	0.000	HS
	ERM	451.50 ± 43.13	421 – 482			
	DME	461.58 ± 156.75	235 – 734			
	DR	233.50 ± 51.15	150 – 286			
	BRVO	602.67 ± 153.64	453 – 760			
	HRVO	743.00 ± 83.44	684 – 802			
	CRVO	1010.00 ± 0.0	1010 – 1010			
	CNV	688.00 ± 407.29	400 – 976			
	Dry ARMD	177.00 ± 19.80	163 – 191			
	CSR	453.00 ± 0.0	453 – 453			
	Uveitis	730.00 ± 0.0	730 – 730			

NS: Non significant; S: Significant; HS: Highly significant
*:Chi-square test; •: Independent t-test; ••: One Way ANOVA test

Table (5): Correlation between OCT central thickness and age of the studied cases.

	OCT central thickness (µm)	
	r	P-value
Age	0.149	0.359

Diagnostic accuracy of U/S in prediction of final clinical determination results

There was a high degree of agreement between clinical diagnosis and echographic findings of macular thickening. The sensitivity and positive predictive value (PPV) of B-scan ultrasonography to detect ME were 91.7% (22/24) and 84.6% (22/26) respectively.

The specificity and negative predictive value (NPV) of B-scan ultrasonography to detect ME were 75% (12/16) and 85.7% (12/14), respectively.

And so the diagnostic accuracy of B-scan ultrasonography to diagnose ME was found to be 85% (34/40).

Table (6): Diagnostic accuracy of ultrasound in prediction of final clinical determination results.

U/S	ME absent		ME present		Test value	P-value	Sig.
	No.	%	No.	%			
Negative	12	75.0%	2	8.3%	18.755	0.000	HS
Positive	4	25.0%	22	91.7%			
Total	16	100.00%	24	100.00%			

	Sensitivity	Specificity	PPV	NPV	Accuracy
U/S	91.7%	75.0%	84.6%	85.7%	85.0%

DISCUSSION

Cystoid macular edema is a common phenomenon in various disease that may lead to severe implications on visual functions including decreased visual acuity and decreased contrast sensitivity [3]. It is considered a leading cause of central visual loss in the developed world and therefore has an enormous medical and socioeconomic importance [8].

Traditional methods used to detect macular edema include contact and noncontact slit lamp Biomicroscopy, indirect ophthalmoscopy, fluorescein angiography (FA), and fundus stereo photography, these are subjective methods. On the other hand, Optical coherence tomography on the other hand is an objective method and it is the most sensitive to detect even subtle macular edema both qualitatively and quantitatively [4].

However, there are certain occasions when performing Biomicroscopy and OCT would be difficult or even impossible. Both require the ocular media to be sufficiently clear for good fundus visualization and imaging. Moreover both need a high level of patient cooperation to ensure accurate examination and to follow the specific instructions for eye fixation during OCT testing. And so if these conditions are not met in any certain patient, B-scan ultrasonography may be the only method available to detect macular edema [9].

B-scan ultrasonography is a well-accepted noninvasive diagnostic tool that can image posterior segment of the eye regardless of the presence or absence of media opacity. For example, in diabetic patients with dense cataracts that preclude fundus visualization and OCT, B-scan ultrasonography may be the only available method to detect the presence of macular edema, the presence of which changes the whole treatment plan. Furthermore B-scan ultrasonography is less dependent on patient cooperation compared to OCT, and so more suitable for uncooperative patients as young children [6].

In this study, we tested the accuracy of B-scan ultrasonography to detect macular edema compared to Biomicroscopy and OCT, which is the most sensitive test to measure macular edema. Our study results revealed statistically highly significant relation between B-scan ultrasound and Biomicroscopy findings (P-value 0.000). The sensitivity of B-scan US to detect ME was 91.7% (22/24). B-scan ultrasonography didn't detect ME in 2 eyes diagnosed with ME using Biomicroscopy. One eye had diabetic macular edema which was confirmed by OCT (central thickness, 513µm). The other eye had diabetic maculopathy and was suspected to have mild ME using Biomicroscopy, but OCT showed non thickening (central thickness, 235µm).The specificity of B-scan ultrasound to detect ME was 75% (12/16). B-scan ultrasonography falsely detected ME in 4 eyes. One eye had dry ARMD with central thickness, 163µm. Two eyes had DR with central thickness, 260µm and 240µm. The last eye was clinically normal with central thickness 223µm.

The relationship between B-scan ultrasonography findings and OCT measurements of central macular thickness was tested and was found to be statistically highly significant (P-value 0.000). Using B-scan ultrasonography, 14 eyes were found to have no ME (grade 0), 12 eyes were diagnosed with subtle ME (grade 1) and 14 eyes diagnosed with pronounced ME (grade 2). Those eyes with grade 0 ME had mean OCT central thickness (± SD) 246.64 ± 84.56µm, those with grade 1 ME had mean central thickness (± SD) 326.42 ± 93.93µm and those with grade 2 ME had mean central thickness (± SD) 680.5 ± 170.99µm.

The accuracy of B-scan ultrasonography in the detection of macular thickening has been previously described in a single Observational case series study that included Seventy-three eyes of 40 consecutive patients (age range, 7–80 years). The final assessment of macular thickening was based on either Biomicroscopy, FFA or OCT. The study showed that Ultrasonographic diagnosis correlated with OCT measurements and there was a high degree of agreement between Ultrasonographic findings and clinical assessment with B-scan ultrasound sensitivity 91% which is almost comparable with our results, and specificity 96% which is higher than results in our study (75%) [10].

The accuracy and intra/interobserver reproducibility of OCT measurements of retinal thickness have been tested and confirmed by many authors. Retinal mapping software of OCT allows reproducible measurement of retinal thickness in both healthy subjects and diabetic patients with macular edema. Moreover macular thickness measurements and reproducibility using various OCT instruments was tested. Macular thickness absolute value differs for each device. For this reason, the devices are not interchangeable [11,12,13,14,15]. Comparing Macular Thickness Measurements in Patients with Diabetic Macular Edema with the Optos Spectral OCT/SLO and Heidelberg Spectralis HRA + OCT, which is considered the gold standard for macular thickness measurements, proposed that whilst it is not possible to transfer absolute measurements between the devices, there is a very good correlation between the measurements from both devices. This suggests that the

Optos Spectral OCT/SLO could reliably be used for SD-OCT in patients as long as the patient continues to be monitored with this same device during the management of their condition [16].

B-scan ultrasonography does have limitations regarding detecting macular edema. It is not as accurate as OCT and does not quantify macular edema, and so whenever possible, OCT must be the first option to detect, measure and follow up ME. Furthermore its accuracy is completely dependent on the examiner's technique and experience (subjective method).

A potential design limitation in our study is the small sample size. Moreover the reported accuracy of B-scan ultrasonography in diagnosing macular edema reflects the experience of single masked operator. We recommend further studies with larger sample size and using different ultrasonography instruments and higher frequency probes (20MHz).

CONCLUSION

Optical Coherence Tomography is the most sensitive method to diagnose macular edema both qualitatively and quantitatively, but in certain circumstances when performing OCT would be difficult or even impossible, B-Scan Ultrasonography provides an acceptable method to qualitatively detect macular edema.

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