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Comparison between B scan ultrasonography, immersion UBM and contact UBM techniques in evaluation of the lens area

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Abstract
Purpose: The aim of our work is to compare between B Scan Ultrasonography, Immersion UBM and Contact UBM Techniques In evaluation of the Lens Area.
Methods: A prospective observational case series study was performed on thirty eyes for patients suffering from lens pathology examined by B Scan Ultrasonography, Immersion UBM and Contact UBM at the Ophthalmology Department in Tanta University Hospitals from January 2021 till June 2021 and performed by Sonomed Escalon ophthalmic ultrasound Vupad, U.S.A.
Results: The mean age was 59.67±5.80 with peak incidence between the ages of 60 to 69 years. 43.3% cases were males and 56.7% cases were females. The mean value of the depth of the anterior chamber by immersion UBM and contact UBM was 2.565±0.292 mm (range from 2.11 mm to 3.04 mm) and 2.183±0.457 mm (range from 1.52 mm to 2.99 mm) respectively and underestimated by contact UBM with statistically significant difference between the values that measured by the two methods (p value <0.001). The mean value of the anterior chamber angle by immersion UBM and contact UBM was 26.30 °±9.61° (range from 0° to 40.7°) and 22.41°±7.95° (range from 0° to 34.8°) respectively and underestimated by contact UBM with statistically significant difference between the values that measured by the two methods (p value <0.001).
Conclusion: Anterior chamber depth and angle are shallower and narrower respectively by contact UBM rather than immersion UBM. Contact UBM is an alternative to immersion UBM in general with more comfortability for patient and confidently about safety for physician but especially with recent repaired ocular wounds or surgeries and irregular ocular surface such as anterior staphyloma or severe corneal ectasia.

Keywords: B Scan ultrasonography, immersion UBM, moving nub, contact UBM, imaging of the anterior segment, open shell

Introduction

Conventional B Scan ultrasonography uses a probe with frequency from 7.5 till 12 Mega Hertz. B scan ultrasonography introduced in ophthalmic specialty in 1958 by Greenwood and Baum. It is a non-ionizing, non-expensive, non-invasive and so easily performed imaging technique. It is useful in showing soft tissue abnormalities of the eye and orbit in presence of media opacity and detecting intraocular foreign bodies (IOFB) [1].

Ultrasound Biomicroscopy (UBM) is a technique used for imaging of the ocular anterior segment. It was first introduced by Pavlin and Foster in the early 1990's to obtain cross-sections of the ocular tissues at microscopic resolution [2].

Compared to regular ultrasound modalities such as B scan which uses a frequency (10 MHz), UBM uses a much higher frequency transducer (35-100 MHz) [5]. This leads to get resolutions up to 20um axially and 50um laterally and depth of tissue penetration is about 8mm. UBM can be used for imaging much of the anatomy of the anterior segment and associated pathologies [3].

Physicians found immersion UBM technically challenging because they were concerned about using an open shell with a moving nub and they couldn't directly visualize where the corneal surface was located. They were worried about sterility especially after recent operations and the shell was uncomfortable for the patient. The contact UBM changed all that, Now a plastic bag that connects to UBM probe protects the cornea from the moving nub during examination. The physician is more confident about safety and doesn't have to worry about the probe touching the eye during examination and the patient is more comfortable.

Contact UBM delivers images with resolutions near to immersion UBM with advantage of sterility for patients with recent operations [4].

Subjects and methods

This prospective observational case series study was performed on thirty eyes for patients suffering from lens pathology examined by B Scan Ultrasonography, Immersion UBM and Contact UBM at the Ophthalmology Department in Tanta University Hospitals from January 2021 till June 2021.

Inclusion criteria

Patients who were candidates for cataract surgery.

Exclusion criteria: only for immersion UBM

- Open ruptured globe or recently closed rupture globe.
- Recent operations (cataract surgeries, corneal surgeries…).
- Uncooperative patients without anesthesia.

B Scan Ultrasonography, Immersion UBM and Contact UBM Techniques performed to evaluate the lens area. Measurement of central corneal thickness, anterior chamber depth, anterior chamber angle and lens thickness by Immersion UBM and Contact UBM for comparison between both methods.

Equipment and technique

B Scan Ultrasonography, Immersion UBM and Contact UBM Techniques performed by Sonomed Escalon ophthalmic ultrasound Vupad, U.S.A (Fig).

Fig 1: Sonomed Escalon ophthalmic ultrasound Vupad, U.S.A

Immersion UBM

Preparation of the patient

It was important to explain to the patient that the examination didn't take long and generally caused minimal irritation because of using the eye cup and solution.

Positioning the Patient

The patient was examined in a supine position with looking up at the ceiling. The operator sat at the bed head and approached the eye at a comfortable level. The monitor was at a comfortable height where could be observed by the operator. The hand controller was in an easily accessible position. The probe controlled with the right hand and the foot pedal was in a comfortable position.

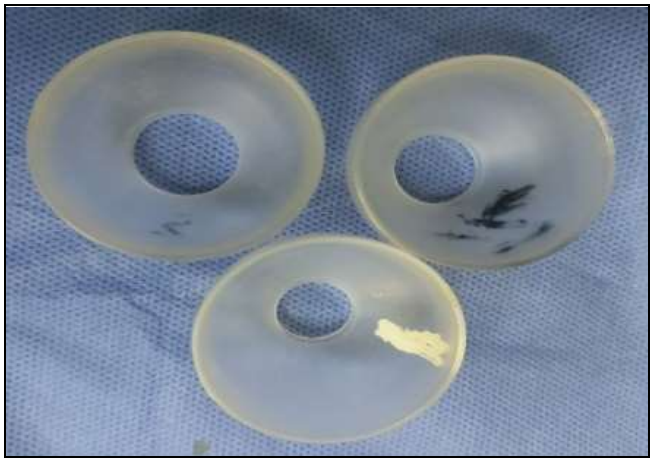

Fig 2: Eye cups

Fig 1: Positioning the patient during Immersion UBM

Procedure

Topical anesthetic Benoxinate Hcl 0.4% (Benox, Eipico, 10th of Ramadan, Egypt) was instilled. Eye cup with a proper size placed on the patient's eye. Cups with diameters of 24 and 22 mm used for adult eyes.

The upper lip of the eye cup was placed under the upper lid with the patient asked to look down. Maintaining upward pressure on the eye cup to keep it in place under the upper lid, the lower lid was pulled down with a finger and placed over the inferior lip. A tissue could be used to grip the lower lid and place it in position.

Then the eye cup was filled with fluid and the examination began. Saline used to fill the cup after using a small amount of 2.5% methyl cellulose to seal the base of the cup and prevent fluid loss. The transducer tip was placed in the fluid opposite the pathology of interest after clearing of bubbles because air bubbles in the fluid or on the tip of the transducer could lead to attenuation of sound. Radial sections of the globe performed where the probe marker designated the left side of the image.

If the probe was placed at the limbus in a radial manner with the marker on the scleral side, the left side of the picture on the screen would correspond to the scleral side and the right side of the screen would correspond to the corneal side and the probe position was designated in clock hours transverse sections of the globe performed where the

marker of the probe on the counterclockwise side when defining the lateral extent of lesions.

Contact UBM

Patient preparation

The examination didn't take long and the advantage over immersion UBM was that the eye cup and direct instilled solution were not used, so no irritation was expected.

Positioning the patient

The patient was examined in a sitting position with looking straight or in a supine position with looking up at the ceiling.

Procedure

Topical anesthetic Benoxinate Hcl 0.4% (Benox, Eipico, 10th of Ramadan, Egypt) was instilled. Speculum could be placed especially for patients with narrow palpebral fissure. The probe connected with a membrane filled with fluid through any of the followings:

A. We made a ring from Teflon material connected to plastic membrane and covered by rubber ring to fix it (Fig).

Fig 4: A ring from Teflon material connected to plastic membrane

Fig 5: A ring from Teflon material was covered by rubber ring to fix it

B. Thumb of glove size 8 (Figure 6).

Fig 6: Thumb of glove size 8

C. A single used cap kit offered by Sonomed Escalon company which consisted of carton ring connected to plastic membrane and covered by rubber ring to fix it (Fig)

Fig 7: A single used cap kit offered by Sonomed Escalon company which consisted of carton ring connected to plastic membrane and covered by rubber ring to fix it

D. Cap kit offered by Sonomed Escalon company which consisted of piece of tube covered by plastic membrane surrounded by rubber band

Fig 8: Cap kit offered by Sonoma Escalon company which was consisted of piece of tube covered by plastic membrane surrounded by rubber band

2.5% methyl cellulose was placed on the patient's eye then examination begun as before.

B-Scan Ultrasonography

Patient preparation

The examination generally didn't take long and the advantage over immersion UBM was that the eye cup and direct instilled solution weren't used, so no irritation expected**.**

Positioning the patient

The patient examined in a sitting position with looking at 1 o'clock by the right eye or at 10 o'clock by the left eye.

Procedure

B-scan could be performed by directly placing the probe on the surface of the cornea after adequate anesthesia or by placing it over the eyelids using adequate coupling jelly agent then examination begun. To get lens scan by using the vitreous as a coupling gel medium. Patient has to look at 1 o'clock by the right eye or at 10 o'clock by the left eye.

Data analysis was done by using SPSS program v22.0 (SPSS Inc, Chicago, USA). Qualitative data was presented as number and percent. Quantitative data was presented as mean ±SD. Paired Student t-test was used to compare between two methods of UBM. P value < 0.05 was considered to be statistically significant.

Mean value: The sum of all observations divided by the number of observations measured by two methods of UBM.

Standard deviation (SD): It measures the degree of scatter of individual varieties around their means.

Paired T-test: Paired Student T-test was used to compare between each parameter for same patient measured by two methods of UBM.

Results

Demographic data: The data of the patients could be summarized in Table 1.

Table 1: The demographic data

Character	(n = 30 patients)
	No. (%)
Age of the patients in years:	
Mean±SD	59.67±5.80
Range	44-67
Peak incidence	60-69
Sex	
Male	13(43.3)
Female	17(56.7)

UBM measurements

A. Central corneal thickness: The mean value of the central corneal thickness by immersion UBM and contact UBM was 0.589±0.037 mm (range from 0.5 mm to 1.5 mm) and 0.596±0.042 mm (range from 0.48 mm to 1.57 mm) respectively with statistically insignificant difference between the values that measured by the two methods (p value = 0.231).

B. Table ; Figure 9

Table 2: Central corneal thickness (CCT) by immersion UBM and contact UBM

CCT	Mean	Std. Deviation	P value
Immersion UBM	0.589	0.037	0.231
Contact UBM	0.596	0.042	

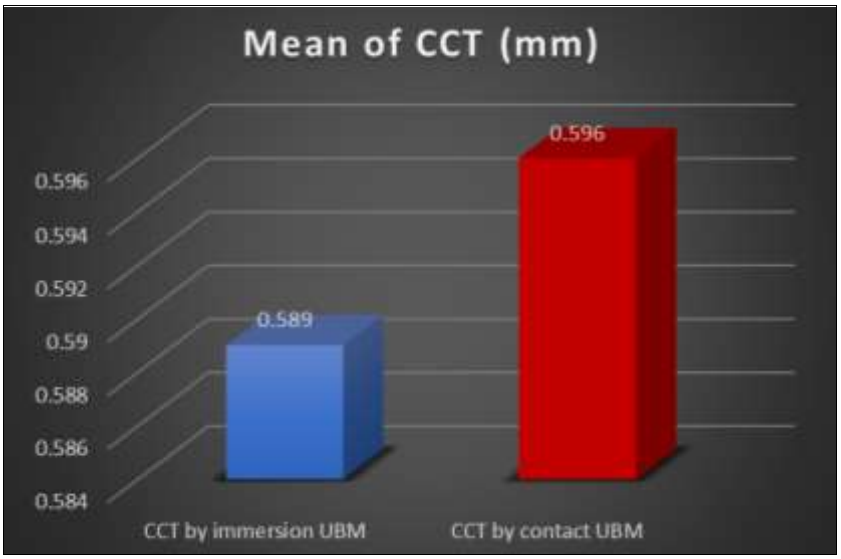

Fig 9: Mean of CCT by immersion and contact UBM

C. Anterior chamber depth: The mean value of the depth of the anterior chamber by immersion UBM and contact UBM was 2.565±0.292 mm (range from 2.11 mm to 3.04 mm) and 2.183±0.457 mm (range from 1.52 mm to 2.99 mm) respectively with statistically significant difference between the values that measured by the two methods (p value <0.001).[

D. Table ;Fig]

Table 3: Anterior chamber depth (ACD) by immersion UBM and contact UBM.

ACD	Mean	Std. Deviation	P value
Immersion UBM	2.565	0.292	< 0.001
Contact UBM	2.183	0.457	

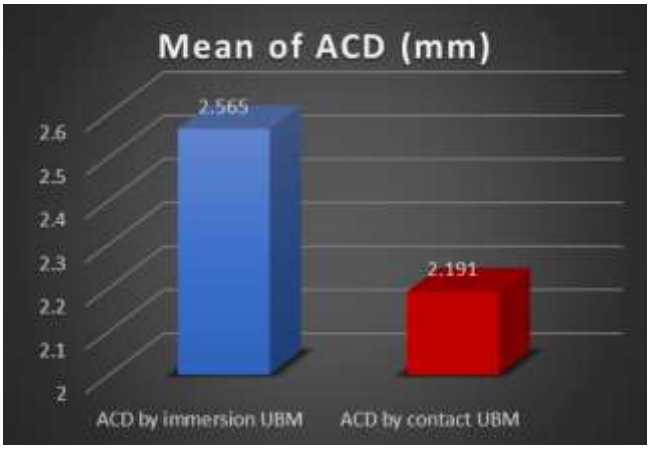

Fig 10: Mean of ACD by immersion and contact UBM

E. Anterior chamber angle: The mean value of the anterior chamber angle by immersion UBM and contact UBM was 26.30°±9.61° (range from 0° to 40.7°) and 22.41°±7.95° (range from 0° to 34.8°) respectively with statistically significant difference between the values measured by the two methods (p value <0.001). [Table 4;Fig]

Table 4: Anterior chamber angle (A.C angle) by immersion UBM and contact UBM.

A.C angle	Mean	Std. Deviation	P value
Immersion UBM	26.30	9.61	< 0.001
Contact UBM	22.41	7.95	

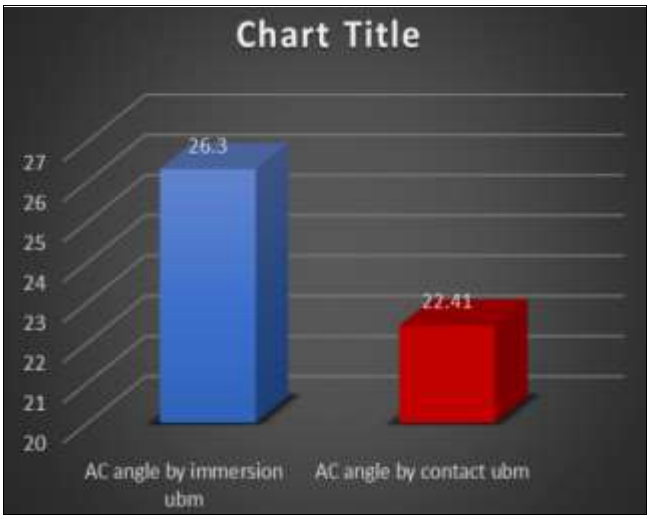

Fig 11: Mean of A.C angle by immersion and contact UBM

F. Lens thickness: The mean value of the lens thickness by immersion UBM and contact UBM was 3.697±0.101 mm (range from 3.06 mm to 5.06 mm) and 3.697±0.108 mm (Range from 3.02 mm to 5.22 mm) respectively with statistically insignificant difference between the values measured by the two methods (p value = 0.981).

Table 5: Lens thickness by immersion UBM and contact UBM

Lens thickness	Mean	Std. Deviation	P value
Immersion UBM	3.697	0.101	0.981
Contact UBM	3.697	0.108	

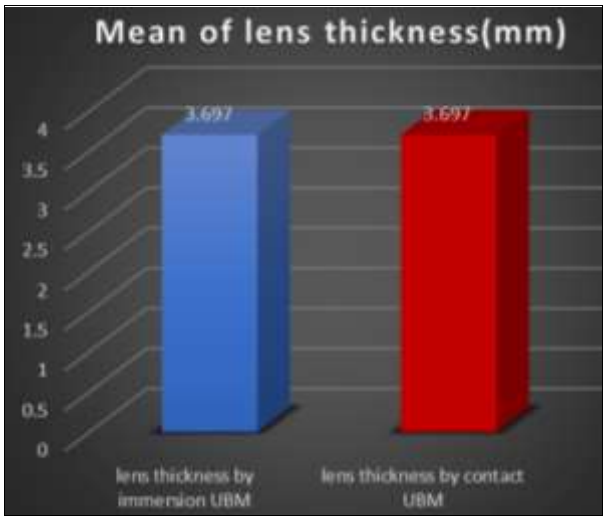

Fig 12: Mean of ACD by immersion and contact UBM

B scan ultrasonography didn't give us information about corneal thickness, anterior chamber depth and angle or lens thickness but only gave us information about the presence of crystalline lens and if cataractous or not and insitu or not. B scan ultrasonography had only advantage that it could evaluate and assess posterior segment where UBM couldn't.

Case presentation

- **Case no. 1**
  - Female pt aged 53 years old complaining from right gradual progressive painless diminution of vision.

Clinical examination

- **Cornea:** Clear.
- **Anterior chamber:** Within normal depth and no abnormal contents.
- **Lens:** Cataractous.
- **Fundus examination:** normal.

Immersion UBM

Fig CCT: 0.52 mm.

- **A.C depth:** 2.11mm.
- **Angle:** Open all around with 26.5° at 2 o'clock.
- **Lens thickness:** 4.53 mm with cataractous lens and intact zonules.

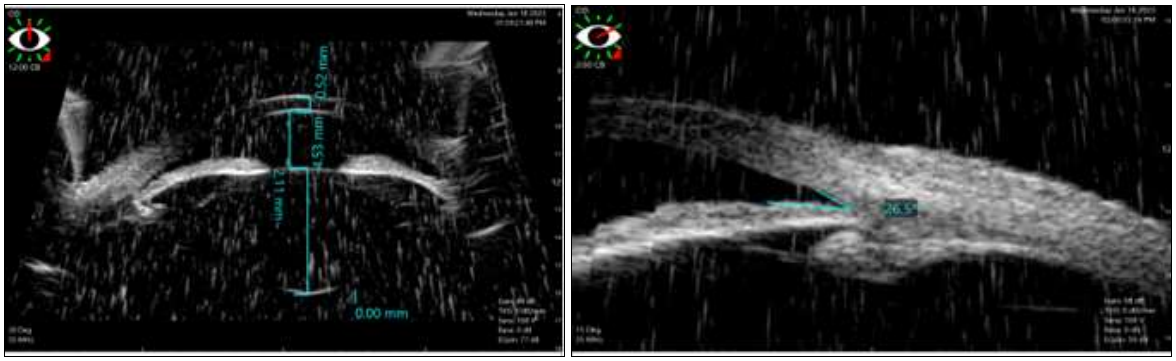

Fig 13: Immersion UBM represents CCT: 0.52 mm, A.C depth: 2.11 mm, open angle all around with 26.5° and lens thickness: 4.53 mm with cataracts lens and intact zonules

Contact UBM: CCT: 0.55 mm.

- **A.C depth:** 1.59 mm (shallower than immersion UBM due to pressure of the cornea by the probe).
- **Angle:** open all around with 21.7° at 2 o'clock (narrower than immersion UBM due to pressure of the cornea by the probe).
- **Lens thickness:** 4.58 mm with cataractous lens and intact zonules.

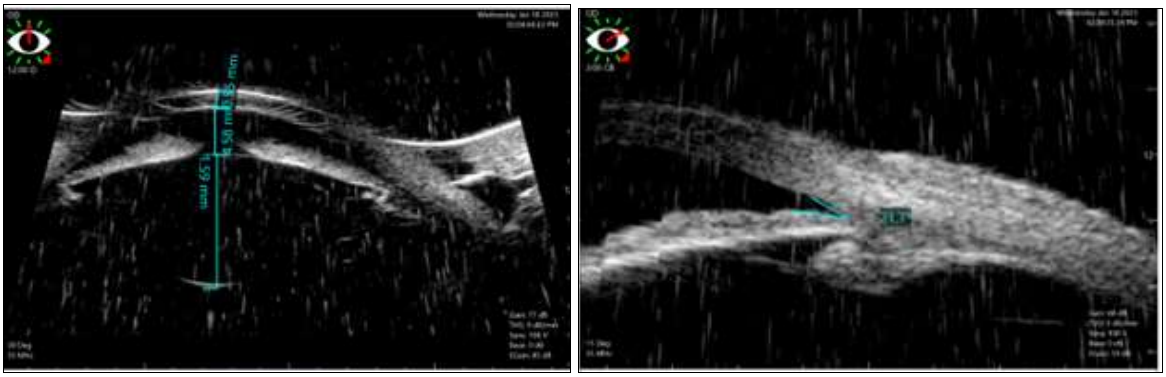

Fig 14: Contact UBM represents CCT: 0.55 mm, A.C depth: 1.59 mm, open angle all around with 21.7° (narrower than immersion UBM due to pressure of the cornea by the probe) and Lens thickness: 4.58 mm with cataractous lens and intact zonules

B scan ultrasonography

Minimal vitreous floaters.

- Cataractous lens in place.
- Retina in place.

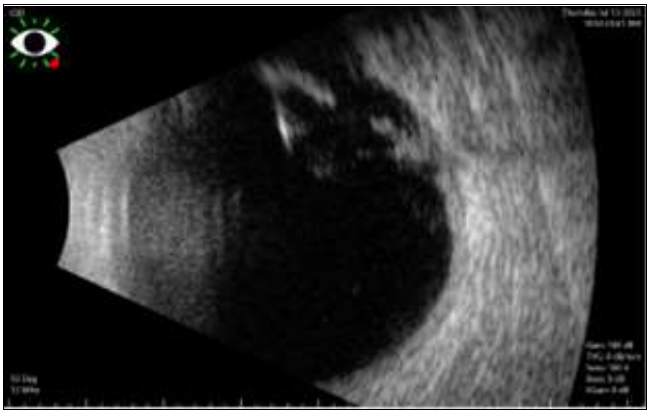

Fig 15: B scan ultrasonography represents minimal vitreous floaters, cataractous lens in place and retina in place

- Male pt aged 61 years old complaining from right gradual progressive painless diminution of vision.

Clinical examination

- **Cornea:** Clear.
- **Anterior chamber:** within normal depth and no abnormal contents
- **Lens:** cataractous.
- **Fundus examination:** normal.

Immersion UBM:

- **CCT:** 0.59 mm.
- **A.C depth:** 2.97 mm.
- **Angle:** Open all around with 28.6° at 2 o'clock.
- **Lens thickness:** 3.33 mm with cataractous lens and intact zonules.

Case no. 2

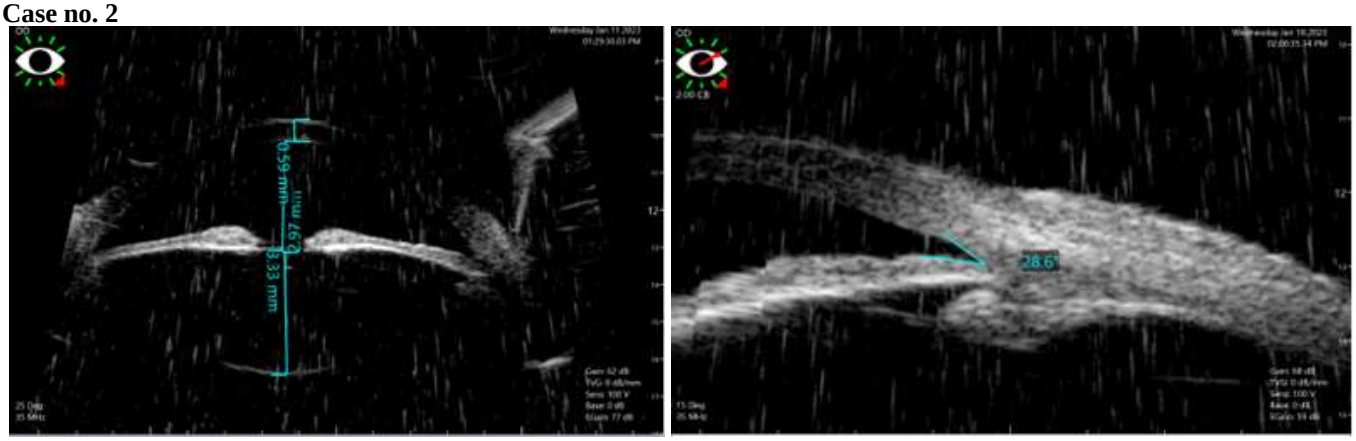

Fig 16: Immersion UBM represents CCT: 0.59 mm, A.C depth: 2.97 mm, angle: open all around with 28.6° and lens thickness: 3.33mm with cataractous lens and intact zonules

Contact UBM

- **CCT:** 0.57 mm.
- **A.C depth:** 2.91 mm (shallower than immersion UBM due to pressure of the cornea by the probe).
- **Angle:** Open all around with 21.6° at 2 o'clock (narrower than immersion UBM due to pressure of the cornea by the probe).
- **Lens thickness:** 3.33 mm with cataracts lens and intact zonules.

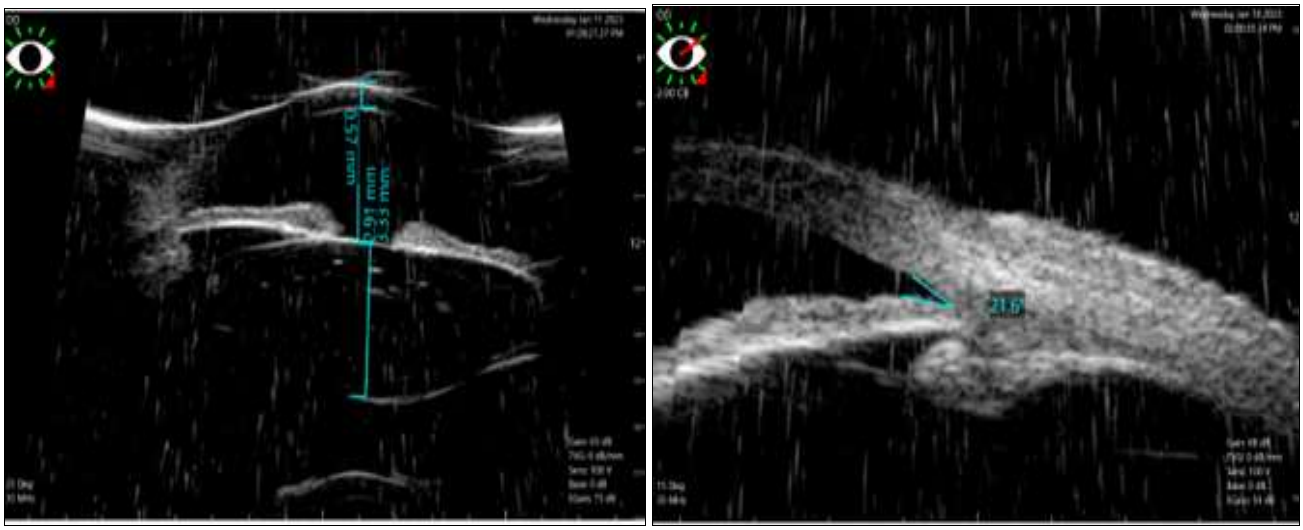

Fig 17: Contact UBM represents CCT: 0.57 mm, A.C depth: 2.91 mm (shallower than immersion UBM due to pressure of the cornea by the probe), open angle all around with 21.6° and lens thickness: 3.33 mm with cataracts lens and intact zonules

B scan ultrasonography

Minimal vitreous floaters.

- Cataractous lens in place.
- Retina in place.

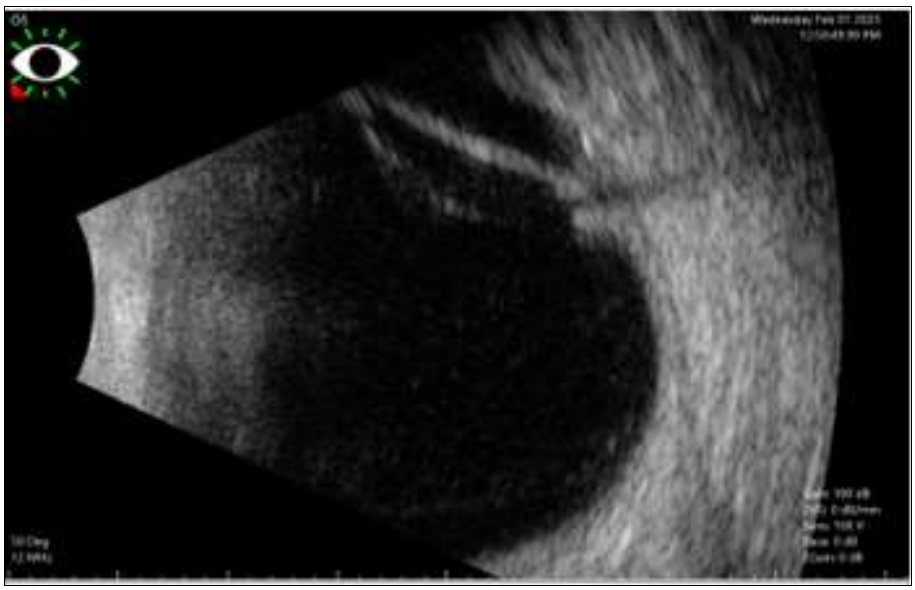

Fig 18: B scan ultrasonography represents minimal vitreous floaters, cataractous lens in place and retina in place

Discussion

This study agreed with Kaushik S *et al*. [4], who found immersion UBM technically challenging because they were concerned about using an open shell with a moving nub and they couldn't directly visualize where the corneal surface was located. They were worried about sterility especially after recent operations and the shell was uncomfortable for the patient. The contact UBM changed all that, Now a plastic bag that connects to UBM probe protects the cornea from the moving nub during examination. The physician is more confident about safety and doesn't have to worry about the probe touching the eye during examination and the patient is more comfortable. Contact UBM delivers images with resolutions near to immersion UBM with advantage of sterility for patients with recent operations [4].

This study agreed with Abdolrazaghnejad A *et al*., [5] who found that B Scan ultrasonography is relatively contraindicated in the presence of rupture globe to avoid further trauma and contamination of the wound, so primary closure should be performed previous to ultrasound examination [2]. If ultrasound examination has to be performed prior to primary closure, it should be performed with caution to prevent possible trauma to the eye. Sterility is necessary when the globe is open or a recent repaired rupture globe. The probes should be sterile or they may be kept in sterile rubber sleeves [5].

An observational case series study by Marchini G *et al*. [6] who compared between three groups (patients with acute/intermittent PACG, patients with chronic PACG and normal subjects). 54 white patients with PACG were included: ten cases with acute, twenty two cases with intermittent and twenty two cases with chronic types of PACG. 42 normal white subjects were performed as control subjects. Only one eye was considered in each patient. Standardized A scan ultrasound and UBM (immersion technique) were examined in each patient during the same session or within 1 to 3 days.

Marchini G *et al*. [6] concluded that the anterior segment in patients with PACG was more crowded because of the presence of increased lens thickness and further anteriorly located lens. The UBM confirms this crowding of the ocular anterior segment with showing the anterior rotation of the ciliary processes. A gradual progressive change in anatomic parameters is noticed on passing from normal to chronic PACG and then to acute/intermittent PACG eyes. We agreed with that by immersion UBM but with contact UBM showed more crowdedness and shallower anterior segment with narrower angle [6].

A prospective study by Helal J *et al*. [7] which performed on twenty eyes of twenty different patients suffering from primary angle-closure glaucoma and in need for LPI. Patients underwent a complete clinical ophthalmic examination. UBM was examined pre and 1 week post LPI. Quantitative parameters included thickness of iris, trabecular iris angle, angle opening distance (AOD), trabecular ciliary process distance, iridocorneal angle recess area (ICA), iris lens contact distance (ILCD). The aim of this study was to assess the changes in anterior segment by ultrasound biomicroscopy after laser peripheral iridotomy (LPI) in eyes suffering from narrow angle glaucoma. The mean age for the patients was 55±9.6 years (range: 40–80 years), and 12 patients were females. LPI was performed in the supero-temporal quadrant in twelve eyes and in the supero-nasal quadrant in eight eyes. On gonioscopy, the angle structures weren't observed on primary gaze in the four quadrants in two eyes, in three quadrants in eight eyes and in two quadrants in ten eyes. After LPI, ILCD noticed to be significantly increased in ten eyes (*P value* <0.001), whereas AOD and ICA widened significantly in all eyes (*P*<0.0001). Most of the AOD widening was noticed in the temporal quadrant followed by the superior quadrant. ICA increase was the largest in the temporal quadrant [7]. ILCD increased significantly with flattening of the iris convexity. There wasn't significant change in the depth of the anterior chamber, lens thickness, trabecular-ciliary process distance, or iris thickness after LPI. Helal J *et al.* [7] concluded that LPI significantly changed the morphology and parameters of anterior segment in eyes with narrow angles with clear widening of the drainage angle. Unlike gonioscopy, these changes could be quantified accurately and objectively highlighted by UBM.

Conclusion

Anterior chamber depth and angle are shallower and narrower respectively by contact UBM rather than immersion UBM. Contact UBM is an alternative to immersion UBM in general with more comfortability for patient and confidently about safety for physician but especially with recent repaired ocular wounds or surgeries and irregular ocular surface such as anterior staphyloma or

severe corneal ectasia.

Recommendations
Contact UBM can be used with caution in patients suffering from narrow angle glaucoma and lens-induced glaucoma because anterior chamber depth and angle are shallower and narrower due to pressure on the cornea by the probe.

Declaration of conflicting interests
The author(s) declared that no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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