Characterization of the Eyes in Pre-operative Cataract Saudi Patients by Using Medical Diagnostic Ultrasound

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ABSTRACT

Objective: This study was designed with an aim to visualize the status of the posterior portion of the eye globe of adult Saudi cataract patients with brightness mode (B-mode) ultrasound, to find out any posterior segment lesions in such pre-operative cases.

Methods: A prospective study was performed between May 2014 and May 2015. A 375 pre-operative cataract (184, 49.1%) males and (191, 50.9%) females between the ages from 18 to 90 years; mean age of 54 ± 0.5 years were scanned at two Radiology departments. Patients were divided into non-traumatic cataract (n = 346; 92.3%) and post-traumatic cataract (n = 29; 7.7%) groups. B-scan ophthalmic ultrasound was performed using a Hitachi (HI Vision AVIUS) ultrasound machine. The statistical package for the social sciences (SPSS) was used to analyse the results.

Results: Ultrasound revealed that vitreous haemorrhage (110, 29.3%) was the main cause of non- and post-traumatic form of cataract in pre-operative adult Saudi patients. In contrast, intra-ocular tumours (6, 1.7%) and posterior vitreous detachment (1, 3.5%) were the least causes of non- and post-traumatic cataract, respectively. Pre-operative adult Saudi females are more subjective to the causes of non-traumatic cataract rather than males in the same age, while males are able to develop post-traumatic cataract due to the abundance of aetiologies in comparison to females.

Conclusion: Ocular ultrasound examination in pre-operative cataract patients is a useful part of ophthalmic examination for detection, evaluation and follow-up of posterior segment pathologies that may influence the surgical strategy and the postoperative visual prognosis.

Keywords: Amplitude mode (A-Mode), brightness mode (B-Mode), cataract, intra-ocular tumours, prospective cohort study, vitreous haemorrhage

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INTRODUCTION

A cataract is defined as the opacity of any portion of the lens, regardless of visual acuity (1). There are 31 million blind patients in the world and 15 million more with reduced vision. Eighty per cent of these are patients with treatable conditions; that is, reversible blindness, and the primary cause is the cataract (2, 3). The World Health Organization (WHO) estimated that there were 161 million persons worldwide with visual impairment, in the year 2002 (4, 5). The majority of them resided in developing countries, including Saudi Arabia (6).

Few studies have been conducted in Saudi Arabia to estimate the prevalence of visual impairment and its causes. In a stratified geographic cluster sample of 14 577 persons representing the settled population of Saudi Arabia. A non-statistical sample of 2233 bedouins was also examined. The survey revealed that 1.5% of the population are blind and another 7.8% are visually impaired. The most common causes of blindness include cataract, trachoma, nontrachomatous corneal scars, refractive errors, congenital anomalies, failed medical or surgical treatment and glaucoma. About 7% of all Saudi Arabians and 42% of those older than 40 years, have a cataract or its sequel (7). The main medical causes of visual impairments among Saudi adults attending primary healthcare centers in northern Saudi Arabia were refractive errors (36.0%) followed by cataract (29.1%) and diabetic retinopathy (20.9%), and the least leading cause was glaucoma (5.8%) (8). In addition, Hajar *et al* 2015, found that cataract was the leading cause of blindness in a 58.6% of Saudi patients, who are randomly selected from the population of $\geq$ 50 years of age in Jazan district, Southern Saudi Arabia (9).

Medical diagnostic ultrasound has developed significantly and is an important diagnostic method if visualization of the posterior eye segment is reduced and when pathology is clinically visible for monitoring of the disease progression (10). High resolution ultrasound imaging can be used in the presence of optical opacities and allows evaluation of

deeper tissue structures (10). Ultrasonography can provide highly accurate (up to 96%) clinically confirmed diagnosis in the evaluation of posterior eye segment pathology (11). First use of ultrasound in ophthalmology was in 1956 by Mundt and Hughes, who used Amplitude mode (A-mode) to evaluate an intra-ocular tumour (12), while Baum and Greenwood were first to introduce a brightness mode (B-mode) into the ophthalmology (13). In 1979 the standardized echography was introduced to ophthalmology as a term that refers to the combined use of contact B-mode and standardized A-mode for evaluation of ocular and orbital pathology (14). Both A-mode and B-mode scanning techniques are important for the diagnosis of posterior segment lesions. A-mode is useful for a better demonstration of the shape and the topographic relationship of lesions in the posterior segment. While B-mode provides a cross sectional display of diseased tissues and is valuable in detecting unsuspected posterior segment diseases (15). Imaging of the eye and orbit is facilitated by the use of the high frequency sound [8–10 MHz, 20 MHz and 50–100 MHz] (16).

Ultrasonography is an important tool for evaluating the posterior segment in eyes with opaque media and provides a method of assessing the structural changes in the posterior segment of the eye in such patients (17, 18). The most frequent findings of posterior segment lesions associated with perforating and blunt trauma and also without trauma were recorded on B-scan ultrasound, like retinal detachment, vitreous haemorrhage, intra-ocular foreign body, neoplasia and posterior vitreous detachment (19).

This study was designed with an aim to visualize the status of the posterior portion of the eye globe of adult Saudi cataract patients with B-mode ultrasound, to find out any posterior segment lesion in such pre-operative cases.

MATERIAL AND METHODS

Selection and description of participants

After receiving approval from the local ethics committee, a total of 375 pre-operative cataract patients were recruited for a period of twelve months between May 2014 and May 2015 in this prospective cohort study. Pre-operative cataract males were scanned at the ultrasound clinic of the Radiology and Medical Imaging Department of Prince Sattam bin Abdulaziz University in Al-Kharj province. While pre-operative cataract females were examined in the ultrasound clinic of the King Khalid Hospital and Prince Sultan Center in the same province. All patients were provided a written informed consent before participation in accordance with institutional guidelines.

Depending on the previous history of ocular trauma, patients were divided into two groups either non-traumatic and post-traumatic. Detailed history and complete pre-operative eye examination protocol, including slit lamp examination, visual acuity tests, intra-ocular pressure, pupillary reaction, biomicroscopy, fundoscopy and tonometry were done in both groups of patients. Exclusion criteria were patients with known presence of posterior segment pathology in the eyes to be operated, afferent pupillary conduction defect and previous history of ocular surgery. In inclusion participants recruitment, according to their Saudi nationality, area of location in Saudia Arabia, gender difference either males or females, ages and ethnicities.

Ultrasound equipment

Diagnostic B-mode of scanning was performed using a Hitachi (HI vision Avius) ultrasound unit, equipped with a high frequency direct contact 10 MHz linear array ultrasound probe. Initial examination was performed under high gain (80 dB to 90 dB) and low gain (60 dB to 70 dB) sensitivity for more detailed inspection during ultrasonography.

Minims tetracaine hydrochloride 0.5% eye drops were used for local anaesthesia and Aquasonic 100 Ultrasound Gel as the coupling material. Hard copies of eye sonograms were obtained using an ultrasound digital graphic printer, 100 V; 1.5 A; and 50/60 Hz, with the serial number of 3-619-GBI-01 and made by Sony Corporation, Japan.

Technique

The examinations were conducted by the same sonologist in the two areas of the study, to avoid any bias or faulty results. B-scans were performed with the patient lies in the supine position. The transverse probe position was used to demonstrate the lateral extent of the pathology (Fig. 1).

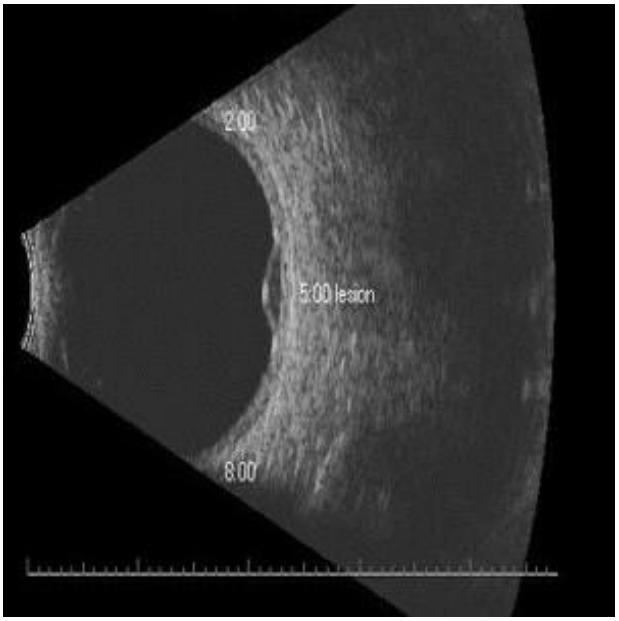

Fig. 1. Transverse scan of a choroidal melanoma. This is a lateral slice through the lesion centered at the 5:00 position left eye, with 3 O'clock hours represented both above and below the lesion.

With the eye anaesthetized, the patient should be instructed to look in the direction of the area of interest. The probe face is coated in ultrasound gel and positioned on the opposite conjunctival surface parallel to the limbus, regardless of probe location around the globe, with the marker aimed either superiorly or nasally (20).

Consequently, the marker is oriented superiorly when examining the nasal or temporal globe (3 O'clock or 9 O'clock positions) and toward the nose when examining the superior or inferior globe (12 O'clock or 6 O'clock positions). When the probe is aimed at an oblique clock hour, such as 10:30 or 5:00, the marker should be oriented in the superior portion of the oblique angle (20).

B-scans with longitudinal probe positions were also used to represent the radial extent (Fig. 2).

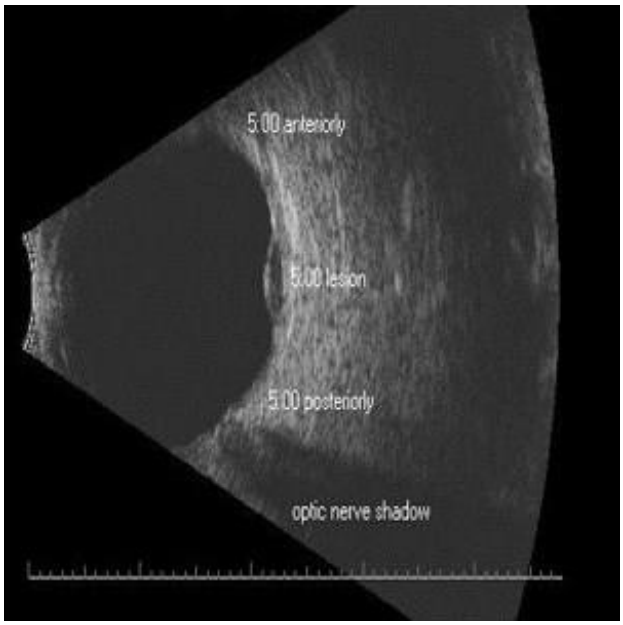

Fig: 2. Longitudinal scan of the same choroidal melanoma. This is a radial slice through the lesion, with 1 O'clock hour being represented from the optic nerve and posterior pole outward to the anterior meridian.

As with transverse scans, the patient is instructed to look in the direction of the area of interest, and the probe face is placed on the opposite conjunctival surface. However, in longitudinal scanning, the probe face is rotated so that it is perpendicular to the limbus, with the marker directed toward the limbus, or to the area of interest, regardless of the clock hour being examined. This results in the optic nerve shadow being represented at the bottom on the

right-side of each longitudinal echogram, and the posterior pole just above the nerve shadow. The anterior portion of the clock hour is represented at the top of the right side (20).

If any posterior pathology is detected during basic screening, it should be centered on the right-side of the echogram to achieve greater resolution. This is accomplished by determining the clock hour represented in the center, top, and bottom of the right side on the transverse scan where it was discovered, and then determining where this pathology lies in relation to those clock hours. Once determined, the patient should be instructed to redirect his or her gaze to that meridian, with the probe then placed on the opposite scleral surface.

Perpendicularity to the pathology is achieved when it is centered and when the vertex of the pathology is a brighter white. The gain is now reduced until the greatest resolution is achieved, and photographic documentation is produced with proper labeling (20).

Additional B-scans may be required, such as axial scans (Fig. 3) to centering the posterior lens curve to the left of the echogram, positioning the optic nerve shadow to the right of the echogram rather than the macula, and to document the location of the pathology of the optic nerve (20).

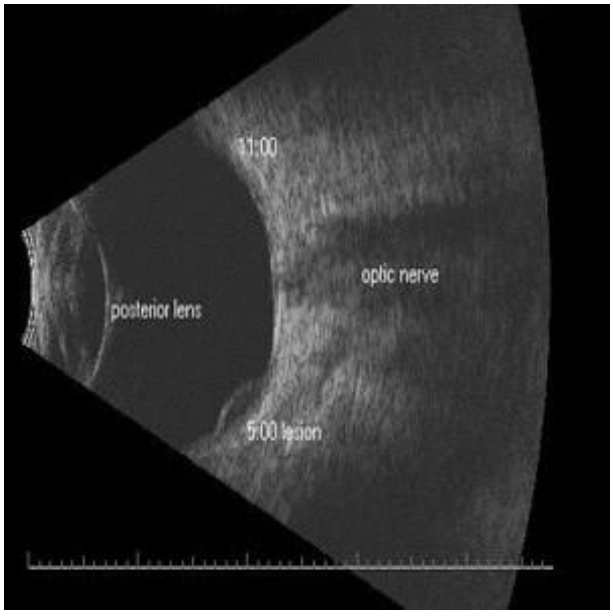

Fig: 3**.** Axial scan of the same melanoma. The posterior lens surface is seen centrally to the left of the scan, and the optic nerve shadow is seen centrally on the right.

Statistics

Data were initially summarized as mean ± SD in a form of comparison tables and graphs. Statistical analysis was performed using the standard Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) version 20 for windows.

RESULTS

The study population comprised a total of 375 pre-operative cataract patients made up of (184, 49.1%) males and (191, 50.9%) females. Their ages ranged from 18 to 90 years, with a mean age of 54 ± 0.5 years. Patients were divided into two groups in which (n = 346; 92.3%) were of non-traumatic cataract and (n = 29; 7.7%) were post-traumatic cataract patients (Table 1 and Table 2).

Table. 1: Distribution of non-traumatic cataract in different ages and genders of patients.

Age ranges (years)	**Non-traumatic cataract patients**		**Total (n, %)**
	Male (n, %)	**Female (n, %)**	
18–28	1, 0.3%	1, 0.3%	2, 0.6%
29–39	2, 0.6%	4, 1.2%	6, 1.8%
40–50	21, 6%	28, 8%	49, 14%
51–61	90, 26%	95, 27.5%	185, 53.5%
62–72	25, 7.2%	29, 8.4%	54, 15.6%
73–83	13, 3.8%	17, 4.9%	30, 8.7%
84–94	8, 2.3%	12, 3.5%	20, 5.8%
Total (n, %)	**160, 46.2%**	**186, 53.8%**	**346, 100%**

Table. 2**:** Distribution of post-traumatic cataract in different ages and genders of patients.

Age ranges (years)	Post-traumatic cataract patients		Total (n, %)
	Male (n, %)	Female (n, %)	
18–28	2, 6.9%	1, 3.4%	3, 10.3%
29–39	18, 62.1%	3, 10.4%	21, 72.5%
40–50	3, 10.4%	1, 3.4%	4, 13.8%
51–61	1, 3.4%	0, 0%	1, 3.4%
62–72	0, 0%	0, 0%	0, 0%
73–83	0, 0%	0, 0%	0, 0%
84–94	0, 0%	0, 0%	0, 0%
Total (n, %)	**24, 82.8%**	**5, 17.2%**	**29, 100%**

The majority of patients (185, 53.5%) either males or females, were affected by non-traumatic cataract at the age of 51 to 61 years (Table 1 and Fig. 4). Females of 29 years and older, are more subjective to non-traumatic form of cataract rather than males as presented in the above results (Table 1 and Fig. 4). Non-traumatic cataract is considered as a rare pathological condition that could be developed in Saudi adults before the age of forty (Table 1 and Fig. 4).

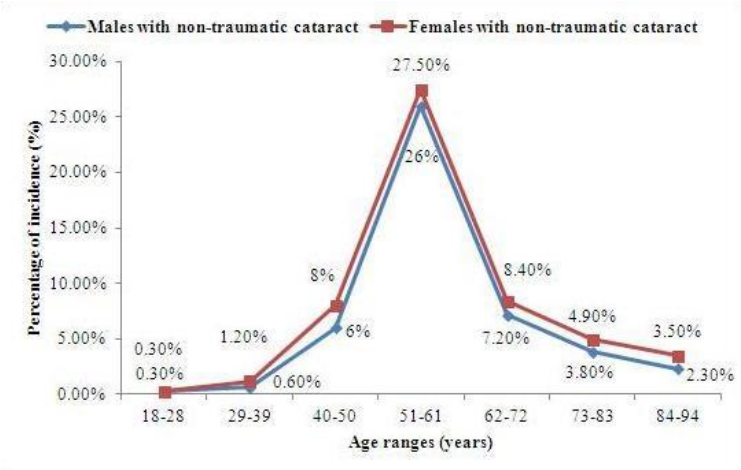

Fig. 4. Incidence of non-traumatic cataract cases in males *versus* females among different age groups of patients.

Post-traumatic cataract is most frequently occurs (21, 72.5%) in the age of 29 years up to 39 years old (Table 2 and Fig. 5) in both sexes. The results of the current study did not present any patient affected by traumatic form of cataract in the age of 62 years and older (Table 2 and Fig. 5).

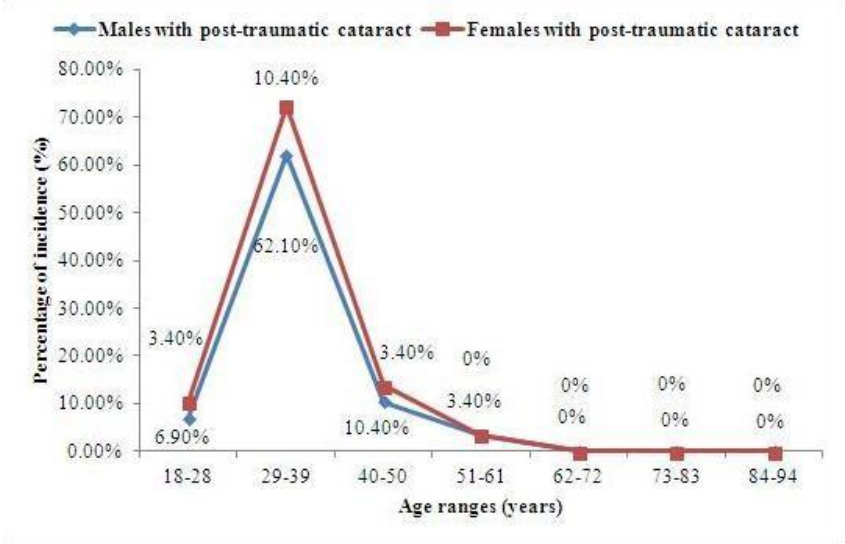

Fig: 5. Incidence of post-traumatic cataract cases in males *versus* females among different age groups of patients.

Ocular ultrasound revealed that vitreous haemorrhage (98, 28.4%) was the main cause of non-traumatic cataract in pre-operative patients, while intra-ocular tumours were the least cause (6, 1.7%) of such disease (Table 3 and Fig. 6). Other diagnosed causes of non-traumatic cataract, were asteroid hyalosis (79, 22.9%), retinal detachment (73, 21%), choroidal detachment (57, 16.5%), posterior vitreous detachment (30, 8,6%), and enlargement of optic nerve [excavation] (3, 0.9%), respectively (Table 3 and Fig. 6).

Table. 3: Ocular ultrasound findings in non-traumatic cataract patients.

Ocular ultrasound findings	Non-traumatic cataract patients		Total (n, %)
	Male (n, %)	Female (n, %)	
Posterior vitreous detachment	11, 3.2%	19, 5.4%	30, 8.6%
Retinal detachment	35, 10%	38, 11%	73, 21%
Choroidal detachment	27, 7.8%	30, 8.7%	57, 16.5%
Vitreous haemorrhage	47, 13.6%	51, 14.8%	98, 28.4%
Enlargement of optic nerve (excavation)	1, 0.3%	2, 0.6%	3, 0.9%
Asteroid hyalosis	38, 11%	41, 11.9%	79, 22.9%
Intra-ocular foreign body	0, 0%	0, 0%	0, 0%
Intra-ocular tumours	1, 0.3%	5, 1.4%	6, 1.7%
Total (n, %)	**160, 46.2%**	**186, 53.8%**	**346, 100%**

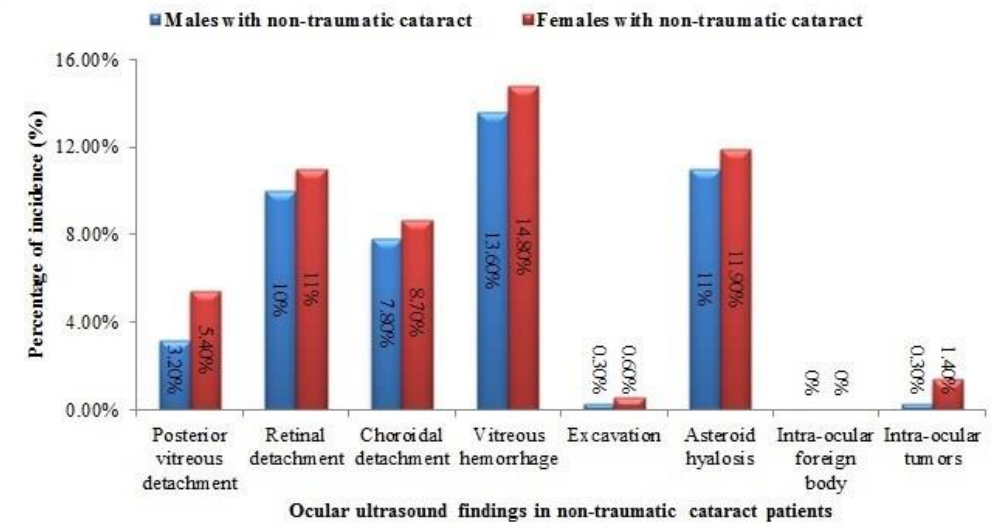

Fig: 6. Ocular ultrasound findings in pre-operative non-traumatic cataract patients; comparing the incidence of causes between adult males and females Saudi patients.

In contrast to the previous results, adult Saudi males are more subjective to post-traumatic form of cataract rather than females in the same age (Table 2 and Table 4). Also, vitreous haemorrhage (12, 41.4%) was the most common cause of post-traumatic cataract in pre-operative patients. Other causes of post-traumatic cataract were retinal detachment (9, 31%), intra-ocular foreign body (5, 17.2%), and choroidal detachment (2, 6.9%) respectively (Table 4 and Fig. 7). Posterior vitreous detachment (1, 3.5%) was the least cause of post-traumatic cataract in pre-operative Saudi adults (Table 4 and Fig. 7).

Table. 4: Ocular ultrasound findings in post-traumatic cataract patients.

Ocular ultrasound findings	**Post-traumatic cataract patients**		**Total (n, %)**
	Male (n, %)	**Female (n, %)**	
Posterior vitreous detachment	1, 3.5%	0, 0%	1, 3.5%
Retinal detachment	7, 24.1%	2, 6.9%	9, 31%
Choroidal detachment	2, 6.9%	0, 0%	2, 6.9%
Vitreous haemorrhage	10, 34.5%	2, 6.9%	12, 41.4%
Enlargement of optic nerve (excavation)	0, 0%	0, 0%	0, 0%
Asteroid hyalosis	0, 0%	0, 0%	0, 0%
Intra-ocular foreign body	4, 13.8%	1, 3.4%	5, 17.2%
Intra-ocular tumours	0, 0%	0, 0%	0, 0%
Total (n, %)	**24, 82.8%**	**5, 17.2%**	**29, 100%**

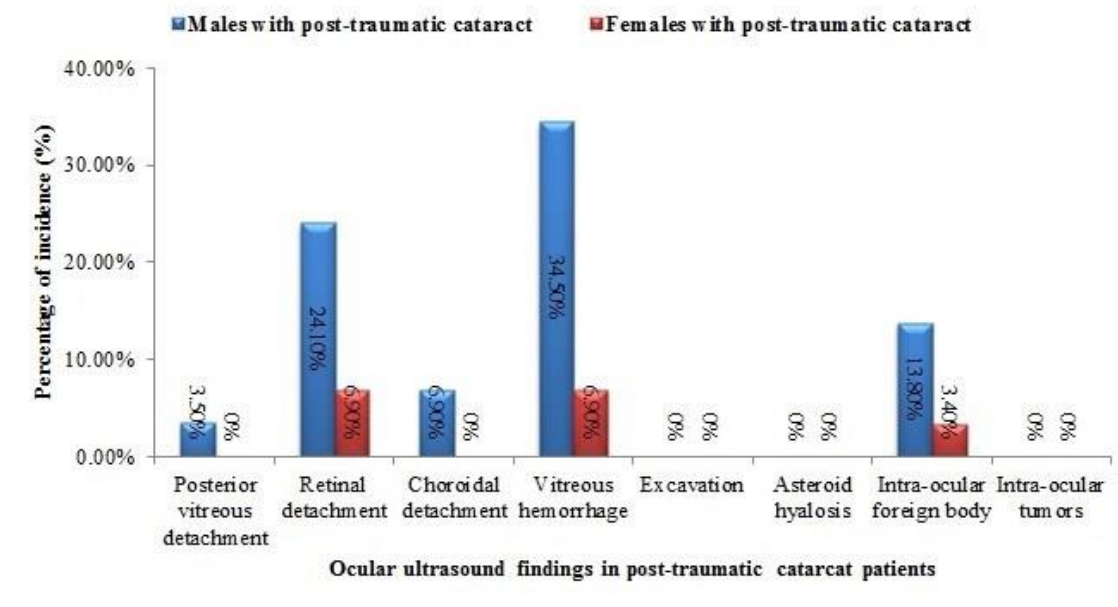

Fig: 7. Ocular ultrasound findings in pre-operative post-traumatic cataract patients; comparing the incidence of causes between adult males and females Saudi patients.

Ophthalmic ultrasound findings showed that, adult Saudi females are more subjective to the causes of non-traumatic form of cataract rather than males in the same age (Table 1 and Table 3). In addition, the adult Saudis males are able to develop post-traumatic cataract due to the abundance of etiologies when compared with the females (Table 2 and Table 4).

DISCUSSION

Cataract is a one of the leading cause of treatable blindness in developing countries. Many of these cases have advanced cataracts that preclude visualization of fundus prior to cataract surgery. Such visualization is considered important to provide accurate prognosis for vision after cataract surgery (21). Ultrasonography is essential when visualization of posterior eye segment structures is difficult. These conditions include lid tarsorrhaphy, lid severe oedema, corneal opacities, keratoprosthesis, hyphaema, hypopyon, refractory miosis, different papillary membranes, various vitreous opacities and dense cataracts (18, 22, 23).

Ultrasonography is used for diagnostic purposes when ocular pathology is clinically visible, while it can accurately image and measure intra-ocular structures. These conditions include ruling out a detachment of the ciliary body, differentiation of intra-ocular tumours, differentiation of the iris or the ciliary body lesions, serous *versus* haemorrhagic choroidal detachments, rhegmatogenous *versus* exudative retinal detachments and papilledema *versus* optic nerve nerve drusen (18, 22–24).

However, it should be remembered that although facilities and personnel for performing cataract extraction with intra-ocular lens implantation are widely available in developing countries, facilities for more sophisticated tests such as ultrasonography are less commonly available. Even in centers where ultrasonography is possible, routine evaluation of all patients with advanced cataracts by ultrasonography is time consuming and of questionable cost-effectiveness. A recent study showed that the results of ultrasonography influenced surgical management in only 7% of eyes with cataract as compared with 17% of eyes with non-cataract media opacities (25).

Age range of adult Saudi patients in this study was 18 to 90 years; mean age of 54 ± 0.5 years. Most of the patients (49.6%) with non- or post-traumatic cataract were in the range of 51–61 years of age (Table 1 and Table 2). This is the age where senile cataract is more common (26). Also, this finding is less than the study mentioned in American Academy of Ophthalmology (AAO), which shows that the prevalence of cataracts is 50% in people between the ages of 65 and 74 years (27).

These age related in non-traumatic cataract showed that the incidence of this lesion was more common in females (53.8%) than in males (46.2%) (Table 1 and Fig. 4). Such finding was supported by Bourne *et al* 2013, in a study about the prevalence and causes of vision loss in high income countries and in Eastern and Central Europe, where women were generally more affected than men with cataract (28). Trauma, either blunt or penetrating, not

only damages the anterior segment, but can also cause damage to the posterior segment of the eye (29, 30). In post-traumatic cataract group (Table 2 and Fig. 5), almost (72.5%) of the patients were 29–39 years old, which is the age range when adults are more active and involved in outdoor work and further life activities (29, 30).

In this study, the aim was to visualize the status of the posterior portion of the eye globe in pre-operative adult Saudi cataract patients with brightness mode (B-mode) ultrasound, to find out any posterior segment lesions and to identify the retinal pathologies requiring further management. This enabled surgeons to deduce a protocol and strategy in planning cataract surgery with adjunctive treatments for the posterior segment pathologies.

The most frequent disclosed abnormality was vitreous haemorrhage in both non- (28.4%) and post-traumatic (41.1%) cataract groups as demonstrated in (Table 3 and Table 4). In contrast to these results, the findings of Qureshi and Laghari, 2010 in their study about the role of B-scan ultrasonography in pre-operative Pakistani non- and post-traumatic cataract patients, where retinal detachment was the most frequent disclosed abnormality (15). Also Shaikh *et al* 2009, demonstrate in non-traumatic cataract patients, that posterior staphyloma was the most common finding in (3.52%) followed by vitreous haemorrhage in (1.32%), intravitreal membrane, chorioretinal thickening, retinal detachment each was in (0.9%) eyes and (0.45%) had optic nerve oedema (26). According to Correa *et al* 2002, posterior vitreous detachment was most commonly found (26.1%) by using ultrasonography, followed by retina detachment (9.7%) and vitreous haemorrhage (8.6%) (31). Similarly, Anteby *et al* 1998, reported that posterior staphyloma was more frequent in the posterior segment of the eyes of cataract patients [7.2%] (32).

Furthermore, results about pre-operative cataract patients revealed that intra-ocular foreign (0%) body was not a cause of cataract in non-traumatic group (Table 3 and Fig. 6). Also, intra-ocular tumours (0%) was not detected by ultrasound in post-traumatic cataract

group (Table 4 and Fig. 7). Such findings could be compared with the results of Haile and Mendistu, 1996 where intra-ocular foreign body was found in more traumatic cataract patients rather than in non-traumatic ones (33). In addition, intra-ocular tumours were found in almost twice as many non-traumatic cataract patients as reported by Ali and Rehman, 1997 (34).

A limitation of this study, however, was the small sample size (n = 375). Further study with a larger sample size is suggested for more accurate results. Another limitation of this study was that disorders such as central and branch retinal vein occlusion, diabetic maculopathy, optic atrophy and macular hole could not be diagnosed pre-operatively as proved by Shaikh *et al* 2009 (26). Thus, it is advisable that patients undergoing cataract surgery should be warned of these limitations of ultrasonography.

In conclusion, two dimensional (2D) B-mode ultrasound is a simple, non-invasive, reproducible, and quick investigative technique which proves an accurate and beneficial evaluation to characterize the posterior segment of the eyes in pre-operative adult Saudi patients; either affected with non- or post-traumatic form of cataract. Ophthalmic ultrasound should be performed routinely in the pre-operative assessment of cataract patients to diagnose pathologies of posterior segment of the eye, that may influence the surgical strategy and postoperative visual prognosis of patients after cataract surgery.

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