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Evaluation of Lacrimal Sac Diameter in Different Age groups Using Ultrasound Biomicroscopy

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ABSTRACT

Background: Chronic dacryocystitis is the most frequent disorder in the lacrimal drainage system. The disease has been considered to be strongly associated with obstruction of the lacrimal duct, which creates a fertile environment for bacterial colonization and promotes lacrimal sac inflammation.

Objective: The aim of this work was to evaluate lacrimal sac diameter in different age groups using ultrasound biomicroscopy (UBM).

Patients and Methods: Twenty-four eyes of 24 normal individuals. They were divided according to age into 3 groups; group A: age ranging between 30 and 40 years, group B: age ranging between 40 and 50 years and group C: age above 50 years. Lacrimal sac diameter was assessed. Ocular examination and special tests were done for lacrimal drainage system (regurge test and fluorescein dye disappearance test) with imaging of lacrimal passages by ultrasound biomicroscopy.

Results: All patients had no symptoms of epiphora, negative both regurge test and dye disappearance test and clear contents of the lacrimal sac. There was no statistically significant difference between groups regarding either longitudinal or horizontal lacrimal sac diameter. **Conclusion:** UBM can be used for imaging and measuring lacrimal passages and thus can be useful as an adjunctive to clinical examination and surgical planning in cases with lacrimal system diseases.

Keywords: Chronic dacryocystitis, Lacrimal, UBM.

INTRODUCTION

Ultrasonography was first applied as a diagnostic tool for ophthalmology in 1956. A-mode was followed by B-mode ultrasonic imaging modalities that presented anatomical information in a distinctive display format [(1)]. Subsequently, further technological developments had a major impact on our ability to measure ocular dimensions, accurately confirm diagnoses, monitor ocular diseases, and visualize valuable characteristics of orbital lesions. Ultrasonography has evolved markedly in the past three decades with the era of digital image processing and development of very high frequency ultrasound that led to ultrasound biomicroscopy (UBM) [(2)].

UBM permits observation of living tissues at microscopic resolution using high ultrasound frequencies of 25 MHz or higher. The name is derived from its similarity to optical biomicroscopy, as it enables visualisation of living tissues in 20-60 mm resolutions depending upon its frequency [(3)]. Commercial 50 MHz ultrasound biomicroscopy became available in the early 1990s [(4)].

To evaluate human tissues, we need maximum resolution as well as deeper penetration of the ultrasound beam. The real challenge facing developers of the UBM was that resolution of the ultrasound increases with higher frequencies.

Meanwhile, all human tissues exhibit ultrasound attenuation coefficients that increase almost linearly with frequency, which results in less penetration [(5)]. The use of conventional frequency ultrasound has been reported in evaluation of the lacrimal sac (LS) tumours or diseases causing distention of the sac, but evaluation is difficult in the normal-sized sac and canalicular system [(6)]. Considering the superficial position and fine structure of the lacrimal duct system, the frequently used imaging techniques for the examination of the lacrimal duct, such as dacryocystography, B-scan ultrasound, computed tomography (CT), magnetic resonance imaging (MRI), and radioisotope scanning, cannot clearly display the lacrimal duct system [(7)]. The application of an imaging technique that can clearly display the structure of the lacrimal canaliculi would facilitate the diagnosis of lacrimal duct system diseases [(8)].

UBM is a non-invasive technique and has been widely applied in the evaluation of diseases of the anterior segment of the eye due to its high resolution. UBM has a potential to be an ideal technique for the imaging examination of the entire upper part of lacrimal drainage system particularly lacrimal puncta and canaliculi. UBM has been used in the examination of normal lacrimal canaliculus and in the detection of lacrimal canalicular diseases [(9)].

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The aim of this study was to evaluate lacrimal sac diameter in different age groups using ultrasound biomicroscopy.

PATIENTS AND METHODS

Patients were collected from the Outpatient Clinics of Ophthalmology Department, Faculty of Medicine, Zagazig University Hospitals. It was carried out on 24 normal individuals with their age ranging from 30 to 60 years in the period between September 2019 and September 2020.

Ethical approval:

The protocol of this study was approved by the Local Ethics and Research Committee of Faculty of Medicine, Zagazig University, and informed written consents were signed by all subjects before inclusion in the study after discussion to the whole study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Exclusion criteria: Patients with previously operated probing or DCR as well as those with lacrimal fistula were excluded from the study.

Participants were subjected to the following:

1. Full history taking: personal history (age, sex), past history of previous ocular surgery or trauma.
2. Best corrected visual acuity (BCVA) on Landolt chart.
3. Ocular examination: slit lamp biomicroscopy for examination of the anterior segment and fundus examination by indirect ophthalmoscopy.
4. Regurge test: It is done by pressure over the lacrimal sac. The flow of sac material from the puncta will confirm the presence of a nasolacrimal duct obstruction.
5. Fluorescein dye disappearance test and Imaging of lacrimal passages by UBM.

Fluorescein dye disappearance test (DDT):

Fluorescent dye was dropped in the conjunctival sac and the results of the DDT were recorded as follows:

- Negative (if the dye disappeared or if there was faint dye in the tear film after 5 min)
- Delayed (if the dye partially disappeared after 5 min or there was a lightly stained conjunctival cul-de-sac after 10– 15 min)
- Positive (if there was a thick meniscus of fluorescein-tinted tears with a deeply stained conjunctival cul-de-sac after 5 min).

Imaging of the lacrimal passage:

All subjects involved in the study were subjected to imaging by the Accutome UBM Plus *(Keeler Co., Malvaren, PA., USA)* for the upper lacrimal drainage system. The shape and dimensions of lacrimal sac were evaluated with special attention paid to anteroposterior and vertical sac diameters, with qualitative assessment of the content. The findings were recorded and correlated with clinical examination.

The technique for lacrimal passage imaging involved examining each subject in a supine position using an immersion technique; swimming goggles were fixed in place with the front eye piece removed. This cavity was then filled with normal saline as a coupling medium after instillation of local anesthesia (Benoxinate hydrochloride). Goggles were used to overcome surface irregularity problems at the area harboring lacrimal passages. The rubber frame with the elastic head band holds the artificial large cup in place while covering the entire area without distortion. Lacrimal passages were observed with 48 MHz ultrasound probe.

Statistical analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Walk test. Qualitative data were represented as frequencies and relative percentages. Chi square test ($\chi 2$) to calculate difference between two or more groups of qualitative variables. Quantitative data were expressed as mean ± SD (Standard deviation). Independent samples t-test was used to compare between two independent groups of normally distributed variables (parametric data). P value ≤ 0.05 was considered significant.

RESULTS

24 normal studies patients (8 males and 16 females) were evaluated for the lacrimal sac diameter (Longitudinal and horizontal) using UBM. They were then divided according to age into 3 groups; Group A: age ranging between 30 and 40 years, group B: age ranging between 40 and 50 years and group C: age above 50 years.

Lacrimal sac diameter was assessed using UBM among the studied group with no significant difference between the studied groups (table 1). Figure (1) showed no difference in longitudinal sac diameter among the studied groups. Figure (2) showed no difference in horizontal sac diameter among the studied groups.

Table (1): Lacrimal sac diameter assessed using UBM among the studied group

Variables	Mean ± SD			F	P-value
	Group A N=5	Group B N=8	Group C N=11		
Longitudinal diameter	**2.2 ± 0.6**	**1.8 ± 0.3**	**1.9 ± 0.3**	1.098	0.352 NS
Horizontal diameter	**7.2 ± 0.6**	**6.8 ± 0.3**	**6.95 ± 0.6**	**0.776**	**0.473 NS**

F: One way Anova test NS; Non significant

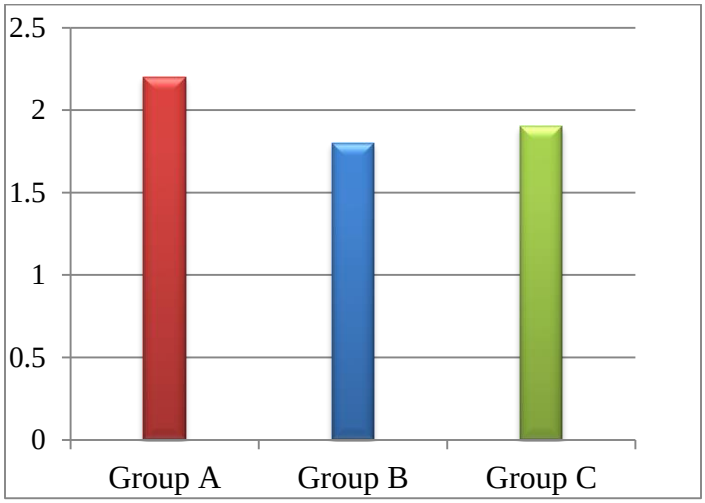

Figure (1): Difference in longitudinal sac diameter among both studied groups.

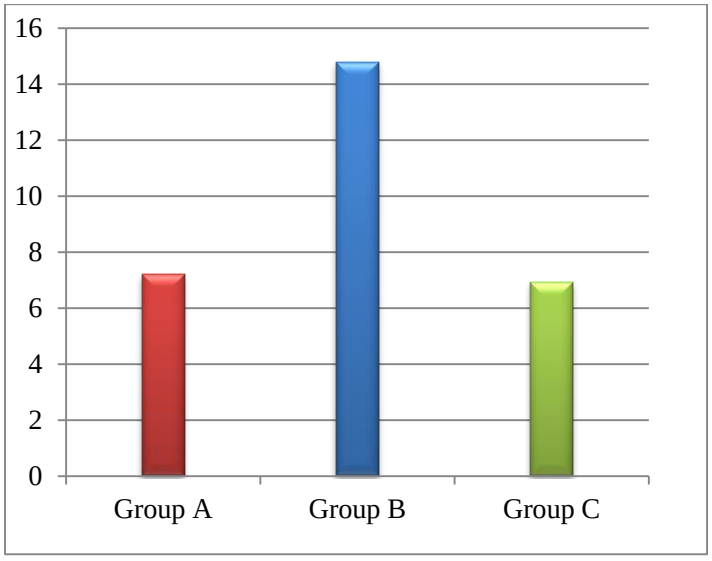

Figure (2): Difference in Horizontal sac diameter among both studied groups.

DISCUSSION

In general, any fluid-filled structure and any accessible adnexal structure that can be approached through the surface are amenable to UBM examination. A fluid immersion technique is required for UBM examination to provide an adequate standoff from the structures being examined as the transducer of high frequency UBM is constantly moving and lacks a membrane covering to avoid excessive sound attenuation [(10)]. Consequently, maintenance of coupling media during examination is essential. The lacrimal drainage system (LDS) is readily accessible through the skin and designed to contain fluid (tears) during the process of drainage and is therefore ideal for UBM. However, some obstacles facing LDS evaluation with UBM can include keratinized epithelium of the skin coverage, which causes significantly more attenuation than conjunctival or corneal epithelium, and the irregularities of the medial canthus area, which can result in difficulties keeping the eye cup in place and avoiding leakage of filling solution. These limitations have minimized the number of reports regarding the use of UBM in the evaluation of LDS [(11)].

Pertaining to skin covering attenuation effect, UBM has been used to evaluate normal upper eyelid structures, eyelid lesions and levator aponeurosis (in congenital and aponeurotic ptosis) with a high correlation between UBM, normal anatomy, aponeurotic abnormalities and histopathology characteristics of lesions [(12-14)]. The structure of the eyelid is fairly similar to the lacrimal drainage system area with respect to covering skin and underlying orbicularis, which attenuate ultrasound. Nevertheless, visualisation of deeper levator aponeurosis, Muller-conjunctival complex, and tarsus or eyelid lesions is possible. The skin coverage over the lacrimal sac is slightly thicker than the eyelid skin, but UBM has been used successfully for establishing giant cell arteritis via examination of the superficial temporal artery through the skin of the scalp, which is much thicker than the skin covering of the lacrimal sac [(15)]. There are only limited data in the literatures describing normal LDS evaluation with UBM or even low-frequency ultrasound [(16)].

In the present study, 24 normal individuals (8 males and 16 females) were evaluated for the lacrimal sac diameter (Longitudinal and horizontal) using UBM. They were then divided according to age into 3 groups; Group A: age ranging between 30 and 40 years, group B: age ranging between 40 and 50 years and Group C: age above 50 years. All patients had no symptoms of epiphora; negative both regurge test and dye disappearance test and clear contents of the lacrimal sac. There was no statistically significant difference between groups regarding either longitudinal or horizontal lacrimal sac diameter. We found no significant differences across age groups. Regardless of the small sample size, the levels of

the p value may indicate that most likely, even if we increase the sample size, differences will maintain insignificant levels. Similarly, **Al-Faky** [17] stated that UBM is a valuable tool in the assessment of both normal and diseased LDS. It is a valuable tool in the evaluation of LDS distal to the site of complete obstruction.

In summary, the UBM is a valuable tool for the assessment of both normal and diseased LDS. Despite its inability to evaluate the bony NLD, the UBM is able to evaluate the canalicular system and LS distal to the site of complete obstruction, which otherwise cannot be assessed with other investigative modalities.

CONCLUSION

UBM can be used for imaging and measuring lacrimal passages and thus can be useful as an adjunctive to clinical examination and surgical planning in cases with lacrimal system diseases.

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