

EVALUATION OF OCULAR BIOMETRY IN PATIENTS WITH EVAPORATIVE DRY EYES

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DISCLAIMER

I hereby certify that the work in this dissertation is my own except for the quotations and summaries which have been duly acknowledged.

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Abbreviations

DED	Dry Eye Disease
TBUT	Tears Break Up Time
DEWS	Dry eye workshop
TFOS	Tear film and ocular surface society
MGD	Meibomian gland disease
D	Diopetre
IOL	Intraocular lens
OCT	Optical Coherence Tomography
SS-OCT	Swept source optical coherence tomography
HUSM	Hospital Universiti Sains Malaysia
OSDI	Ocular Surface Disease Index
AXL	Axial length
K	Keratometry
ACD	Anterior chamber depth
T2DM	Type 2 Diabetes Mellitus
SD	Standard Deviation
NI BUT	Non-invasive break up time

Abstrak

Pengenalan

Pengukuran biometri okular yang tepat adalah penting untuk memastikan hasil pembedahan yang baik. Interferometri laser ialah kaedah pengukuran biometri okular yang tidak berbahaya yang biasa digunakan. Ia bergantung kepada filem air mata yang stabil dan permukaan kornea yang licin untuk mendapatkan bacaan yang tepat. Ini adalah faktor yang terjejas dalam pesakit mata kering .

Objektif

Untuk menilai parameter biometri okular, termasuk seperti panjang paksi, bacaan keratometri dan kedalaman ‘anterior chamber’ di kalangan pesakit mata kering.

Methodologi

Kajian keratan rentas telah dijalankan di klinik oftalmologi Hospital Melaka dan Hospital Universiti Sains Malaysia daripada Ogos 2019 hingga Jun 2021. Sampel dipilih dengan kaedah persampelan mudah . Peserta yang memenuhi kriteria inklusi akan dipilih. Peserta menjalani penilaian mata kering dan dibahagikan kepada kumpulan mata kering dan kumpulan tiada mata kering. Para peserta daripada kedua-dua kumpulan kemudian menjalani ukuran panjang paksi, keratometri dan kedalaman ‘anterior chamber’ menggunakan IOLMaster 700.

Keputusan

Seramai 115 peserta dengan purata umur 64.58 telah disertakan (64 mempunyai mata kering manakala 51 tiada mata kering). Purata bacaan keratometri dalam kumpulan mata kering adalah lebih tinggi (-1.45D) daripada kumpulan tiada mata kering, (-0.59D) dan perbezaannya adalah ketara ($p < 0.01$). Purata panjang paksi dan kedalaman 'anterior chamber' adalah lebih pendek dalam kumpulan mata kering. Walau bagaimanapun, perbezaan ini tidak ketara. Apabila menilai perhubungan antara parameter mata kering dengan biometri okular pesakit mata kering, terdapat perhubungan positif yang ketara antara kedalaman 'anterior chamber' dengan 'tears break up time' (TBUT) ($p = 0.021$). Panjang paksi dengan 'cornea fluorescein staining' mempunyai perhubungan negatif ($p = 0.042$), dan keputusan ini adalah ketara. Tiada perhubungan antara bacaan keratometri dengan OSDI, TBUT dan 'cornea fluorescein staining'.

Kesimpulan

Perbezaan purata bacaan keratometri antara kumpulan mata kering dan kumpulan tiada mata kering adalah ketara. Walau bagaimanapun, tiada perhubungan antara parameter mata kering dengan bacaan keratometri dalam kalangan pesakit mata kering. Walaupun perbezaan purata panjang paksi dan kedalaman 'anterior chamber' tidak ketara, pengukuran-pengukuran ini didapati mempunyai perhubungan dengan parameter mata kering. Oleh itu, penilaian untuk mata kering sebelum pembedahan katarak adalah wajar untuk meningkatkan ketepatan pengukuran biometri okular dan pemilihan kuasa IOL.

Abstract

Introduction

Accurate ocular biometry measurements is essential in ensuring good post-operative outcome. Laser interferometry is a commonly applied, noninvasive method of ocular biometry measurements which relies on stable tear film and smooth corneal surface for accurate readings. These are factors which are affected in patients with evaporated dry eye disease.

Objective

To evaluate ocular biometry parameters, which includes axial length, keratometry reading and anterior chamber depths among patients with evaporative dry eyes

Methodology

A cross-sectional study was conducted in ophthalmology clinic of Hospital Melaka and Hospital University Sains Malaysia from August 2019 till June 2021. The samples were selected with the convenience purposive sampling method. The participants who fulfilled the inclusion criteria were recruited. Participants were subjected to evaporative dry eye assessment, whereby they were divided into dry eye group and no dry eye group. The participants in both groups then undergo axial length, keratometry and anterior chamber depth measurements using IOLMaster 700.

Result

A total of 115 participants with mean age of 64.58 were recruited (64 had evaporative dry eye and 51 had no dry eye). Mean keratometry reading in the evaporative dry eye group was higher(-1.45D) than the no dry eye group (-0.59D) and the difference was statistically significant ($p<0.01$). Mean axial length and anterior chamber depth were shorter in the evaporative dry eye group. However, this was not statistically different. When assessing the correlation between individual dry eye parameters with ocular biometry of subjects with evaporative dry eye, there was a statistical significant positive correlation between anterior chamber depth with TBUT($p=0.021$) and a statistically significant negative correlation between axial length with cornea fluorescein staining ($p=0.042$). There were no correlations between keratometry reading with OSDI, TBUT and cornea fluorescein staining grading.

Conclusion

There was a statistically significant difference in the mean keratometry reading between evaporative dry eye group and no dry eye group. However, there were no correlations between the individual dry eye parameter with keratometry reading among subjects with evaporative dry eye. Though differences in the mean axial length and anterior chamber depth were not statistically significant, correlations with the individual dry eye parameters were present. Therefore, assessment for evaporative dry eye during cataract operation pre-clerking is warranted to improve the accuracy of ocular biometry measurements and IOL power selection.

Chapter 1

Introduction

1. INTRODUCTION

1.1 BACKGROUND OF STUDY

Dry eye disease (DED) is a disorder of the tears and ocular surface which results in eye discomfort, disturbances in vision due to hyperosmolarity and inflammation of the ocular surface.(Lemp *et al.*, 2007) It can be broadly categorized into aqueous tear-deficient dry eye and evaporative dry eye. Evaporative dry eye occurs due to excessive tear loss from ocular surface in a presence of normal lacrimal secretory function. However, the boundaries between these two causes are often overlapped. (Messmer, 2015)

A survey conducted by the American Academy of Ophthalmology showed that 30% of patients seeking treatment from ophthalmologist have symptoms consistent with DED. Globally, the prevalence of dry eye is about 17.0%, while other studies showed a higher prevalence of approximately 30.0% among people of Asian descent. (Shah & Jani, 2015; Han *et al.*, 2011) Locally, a few hospital and population- based dry eye studies have been conducted. (Mohd-Ali *et al.*, 2011; Din *et al.*,2013; Jamaliah & Fathilah, 2005) These studies showed a prevalence of 14% of their sample population with DED. However, there is a higher prevalence of DED among the elderly, with an increase of prevalence from 2.7% in those 18- to 34 years old versus 18.6% in those older than 75 years. Older patients are prone to have a reduction in tear production, tear film instability and increased meibomian gland anomalies. (Muna'aim *et al.*, 2016)

In evaporative dry eye, excessive evaporation of the tear film layer leads to ocular surface damage, triggering the ocular inflammatory cascade. This results in corneal epithelial injury which stimulates sensorial corneal nerve endings leading to symptoms of discomfort, increased

blinking and compensatory reflex lacrimal tear secretion. Loss of normal mucin layer which is the innermost part of tear film layer that normally adhere on the corneal epithelial cells contributes to gritty and foreign body sensation by increasing frictional resistance between lids and globe. (Lemp *et al.*, 2007) In severe cases, vision may also be compromised. As a result of these signs and symptoms, patients' ocular health, general well-being and quality of life may greatly affected.

Ocular biometry is the anatomical measurement of the eye, which includes axial length, measurement of the cornea power (keratometry) and anterior chamber depth. (Dong *et al.*, 2018) These parameters are incorporated into basic formulas used in calculation of intraocular lens(IOL) power which will be placed during cataract surgery to replace the opaque crystalline lens removed intraoperatively. Therefore, measurement of these parameters are essential and crucial in determining the precision of IOL power calculation and greatly determine the refractive outcome of the cataract operation. There are few methods of measurements available, however the most commonly used methods are ultrasound and optical biometry, also known as the laser interferometry method. Laser interferometry is a non-contact method of biometry, which allows measurements of axial length, anterior chamber depth, keratometry and a few other parameters.

In evaporative dry eye, there is an instability of the precorneal tear film. With tear film instability, the quality of the refractive surface is unpredictable, often changing dramatically between blinks. Aside from unstable tear film, evaporative dry eye is often associated with irregular cornea surface and increased surface asymmetry index.(Huang *et al.*, 2002) These are factors that will be greatly affected in biometers which rely on the reflections of smooth and

regular cornea surfaces to obtain an accurate ocular biometry measurement. Many ocular biometry methods have been known to adhere to this principle of reflection from corneal surfaces to obtain measurements, including keratometers and corneal topography. Keratometry readings affected by DED have been demonstrated by various studies.

In our study, ocular biometry is performed using the IOLMaster 700. IOLMaster 700 is a non-contact biometer which uses laser interferometry to obtain ocular biometry measurements. A signal is produced as a result of the interference between light reflected by the tear film and that reflected by the retinal pigment epithelium. The IOLMaster 700 also incorporates a newer swept-source optical coherence tomography (SS-OCT) technology to obtain ocular biometry parameters. Swept source technology is a laser with a tunable wavelength centered on 1055nm. Swept-source OCT scans sequentially through a series of wavelengths to enhance the interference pattern from the reflected light. A scan and B scan images are then built to allow measurements of the desired parameters. (Bullimore *et al.*,2019) Current trend favors measurement of biometry using optical method as compared to immersion method, due to its increased precision, though both are almost comparable.

Tear film instability resulted in interference of the reflectivity from the corneal surfaces. This will cause scattering of light. When scanning with IOLMaster 700, if a measuring mark is projected onto this area, the otherwise circular or ellipsoid image of the measuring mark will become irregular and may result in inability to get a precise measurement. (Zeiss, 2018)

We believe this non-invasive study will help to determine if there are any differences in the ocular biometry measurements in evaporative dry eye patients using laser interferometry optical biometer. This will facilitate for a more accurate measurement and to subsequently allow for early treatment if required.

1.2 DRY EYE DISEASE (DED)

International Dry Eye Workshop (DEWS) published by Tear Film and Ocular Surface Society (TFOS) defined DED as a multifactorial disease of the ocular surface characterized by a loss of homeostasis of the tear film, and accompanied by ocular symptoms, in which tear film instability and hyperosmolarity, ocular surface inflammation and damage, and neurosensory abnormalities play etiological roles. TFOS emphasized on the importance of definition to aid in diagnosis and treatment of DED. (Craig *et al.*, 2017)

1.2.1 PREVELANCE OF DED

Global epidemiological studies have shown a prevalence of DED ranging from five to 50% . (Stapleton *et al.*, 2017) The National Health and Wellness Survey showed 6.8% of the United States adult population being diagnosed with DED (Farrand *et al.*, 2017) In Asia, China reported prevalence of 17.0 %, (Liu *et al.*, 2014) Indonesia reported 27.5% (Lee *et al.*, 2002) and India had the highest with 29.3% of dry eye prevalence. (Gupta *et al.*,2010)

1.2.2 CLASSIFICATION OF DED

The Asia Dry Eye Society classification report suggest definition, diagnostic criteria and classification system should be practical and simple enough to be integrated into daily practice. (Tsubota *et al.*, 2019) DED can be broadly categorized into aqueous deficient dry eye and evaporative dry eye. Aqueous deficiency occurs due to reduction on aqueous production from

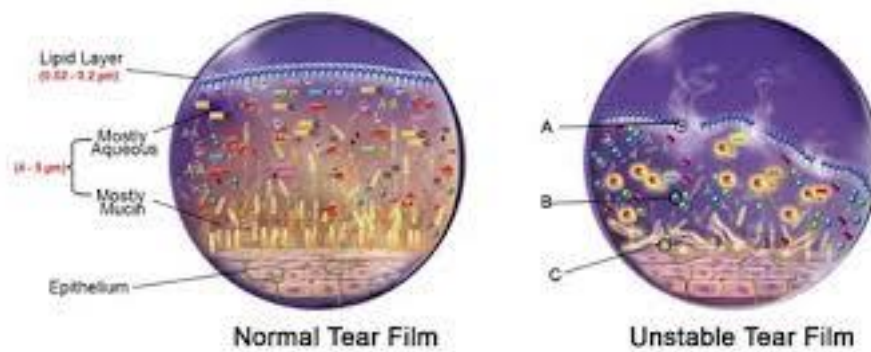
lacrimal glands. It account for a tenth of DED.(Findlay *et al.*, 2018) Evaporative dry eye disease occurs due to excessive tear evaporation resulting in deficient tear film lipid layer. It is the most common form of DED. (Findlay *et al.*, 2018)

Differentiation of the subtype is important to classify the disease. However, TFOS DEWS mentioned that DED is a spectrum of disease, involving both evaporative and aqueous deficient subtypes, with overlapping of the pathophysiological entities. Identification of the main etiology is deemed most useful in guiding and deciding on treatment plans.

1.3 EVAPORATIVE DRY EYE DISEASES

Evaporative dry eye comprises of over 85% of DED. It occurs due to excessive tear loss from ocular surface as a result of deficient lipid layer in the tear film, in presence of normal lacrimal secretory function. Causes include meibomian gland dysfunction and blepharitis. (Findlay *et al.*, 2018) The causes can be divided into intrinsic and extrinsic. In evaporative dry eye, excessive evaporation of the tear film layer leads to ocular surface damage, triggering the ocular inflammatory cascade. This results in corneal epithelial injury which stimulates sensorial corneal nerve endings leading to symptoms of discomfort, increased blinking and compensatory reflex lacrimal tear secretion. Loss of normal mucin layer which is the innermost part of tear film layer that normally adhere on the corneal epithelial cells contributes to gritty and foreign body sensation by increasing frictional resistance between lids and globe. In severe cases, vision may also be compromised. As a result of these signs and symptoms, patients' ocular health, general well-being and quality of life may greatly affected.

Figure 1: Illustration of unstable tear film



1.3.1 Assessment of evaporative DED

In regards to evaporative dry eye, diagnosis is usually made through history, ocular and systemic examination. There are particular diagnostic tools which assesses the specific components of evaporative dry eye. For example, meibomian gland assessment allows us to ascertain the presence of meibomian gland disease (MGD). Healthy meibomian glands usually produce clear, oily discharge when there is gentle pressure applied at lid margin. In contrast, abnormal meibomian gland would produce thick, turbid discolored discharge. The gland orifices at the lid margin may appear to be ‘pouting’ as well. Cornea and conjunctival fluorescein staining determines the presence of ocular surface disease. The increased shedding of cornea and conjunctival cells, results in loss of protective glycocalyx barrier. This area of epithelial loss is readily visible using fluorescein strips placed on the cornea and conjunctival against cobalt blue light at the slit lamp. Similarly, TBUT allows the assessment of tear film stability using fluorescein strips and cobalt blue light at the slit lamp. It is known that TBUT is reduced in DED. Questionnaire assessment determines presence of symptoms attributed to

evaporative dry eye, which is important as mentioned above as a combination with other tests in DED diagnosis. (Findlay *et al.*, 2018)

Other test such as tear hyperosmolarity analysis, and tear analysis for cytokine MMP-9 marker can be done (Messmer, 2015) However these tests are not widely available and not easily accessible to the general ophthalmologists.

Figure 2: Assessment of Evaporative DED

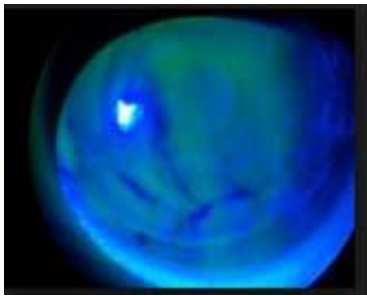


Figure 2a: Abnormal TBUT

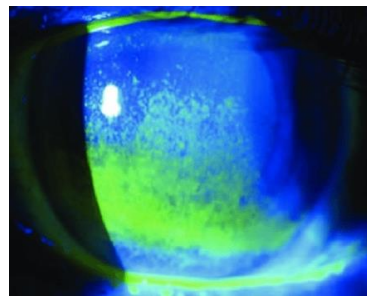


Figure 2b Cornea Fluorescein Staining

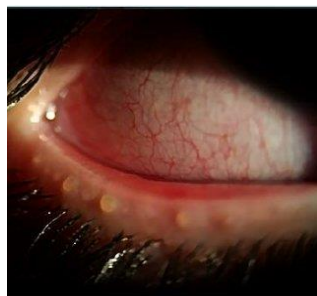


Figure 2c Abnormal meibomian gland

1.3.2 Management of Evaporative DED

Management of evaporative DED is fairly similar to general DED, whereby a stepwise approach is applicable. Aside from that, targeted treatment of the cause of DED is crucial especially to prevent recurrences.

Artificial tears drops as supplements are usually the first line in treatment of both subtypes of DED. However, newer preparation with 'lipid' tear supplements such as propylene glycol, emulsified mineral oil (Sytane Balance) , soya lechithin (Optrex ActiMist) and Perfluorehexyloctane (NovaTears) are preferred in evaporative dry eye, as they act to replenish and supplement the lipid layer loss in evaporative DED.

Treatment of meibomian gland dysfunction is a crucial step in treatment of evaporative DED. Traditional treatments include intensive lid hygiene, warm compression, frequent expression of the glands, lid wipes or foam cleansers and oral antibiotics such as doxycycline. Other more advanced and targeted therapies have become available in the recent years. Thermal pulsation therapy is also currently being used to treat meibomianitis. Terpinen-4-ol is an effective treatment in reducing demodex counts. Blood derived products such as autologous serum tears have been shown to be effective.

Figure 3: Treatment of Evaporative DED



Figure 3a: Expression of meibomian gland



Figure 3b Thermal Pulse Therapy



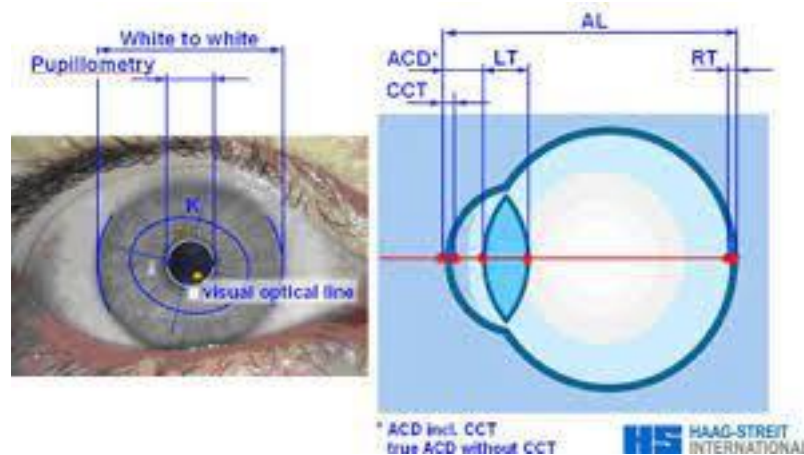
Figure 3c Lipid based artificial tears

1.4 OCULAR BIOMETRY

The term biometry is the application of mathematics to biology. (Astubury *et al.*, 2006) Ocular biometry is the anatomical measurements of the eye. (Dong *et al.*, 2018) The ocular refractive power derives mainly from the cornea, lens, ocular media and axial length of the eye. In cataract surgery, the opaque crystalline lens is removed and replaced with an artificial intraocular lens . The required power of the IOL is calculated using various formulas whereby ocular biometry measurements are included.(Atsubury *et al.*, 2006) IOL formula from first generation such as the SRK formula to the fourth generation such as Holladay formula have included the basic parameters of axial length, keratometry reading and anterior chamber depth. Therefore, measurement of these parameters are essential and crucial to determine the precision of IOL

power calculation and greatly determine the refractive outcome of the cataract operation regardless of which formula of choice.

Figure 4: Ocular biometry



1.4.1 Keratometry

Keratometry is the measurement of corneal power based on its steepness. The cornea is assumed to be a perfect convex mirror, forming a virtual image target. From the size of the reflected image, the radius of the curvature can be determined, which is then converted to power in diopter or mm. Keratometry can be measured manually or automated. An error of 0.75D in the keratometry will result in a similar IOL power error, while a 1mm difference in axial length will result in 2.5D in error in IOL power. (Norrby *et al.*, 2008)

1.4.2 Axial Length

Axial length is the distance from anterior corneal surface to the retinal pigment epithelium. Various methods have been used to measured axial length, such as indentation, immersion and optical biometers, each to its advantage. Therefore, combination of technique has been shown

to give better results. It changes the IOL power by nearly 2.5 to 3 times, more so in short eyes than in longer ones.(Sahin *et al.*, 2012)

1.4.3 Anterior Chamber depth

Anterior chamber depth represents the distance between the corneal endothelium and the anterior capsule of the crystalline lens. It is an established biometric parameter of the anterior segment. Latest generations of the IOL power formulas are increasingly emphasizing on the role of ACD measurements. Feng *et al.*, (2011) reported that 42% of refractive error after IOL implantation was found to be due to inaccuracies in ACD measurements, more than axial length (36%) and keratometry (22%).

1.5 METHODS OF OCULAR BIOMETRY MEASUREMENTS

1.5.1 Applanation biometry

Applanation biometry is achieved by direct contact of a handheld probe with the cornea of the patient. Sound beam is then directed through visual axis. It is most accurately performed with patient in a reclined position, placing the patient's head in front of the biometer display screen. Inaccuracies is much higher due to indentation of the globe caused by the direct contact and also accurate position of the head position. Therefore, this technique has been abandoned by many in favor of more accurate non-contact instruments. (Ronda *et al.*, 2016)

1.5.2 Immersion biometry

The immersion technique biometry is performed by placing a scleral shell between patient's lids. This scleral shell is filled with saline and the probe is then immersed in this, creating a distance between the probe and the cornea. Due to absence of direct contact, is it more accurate

than applanation method. Eyes measure with immersion method are 0.1-0.3mm longer than measured with indentation method. (Ronda *et al.*,2016)

Figure 5: Contact method of ocular biometry



Figure 5a: Applanation method

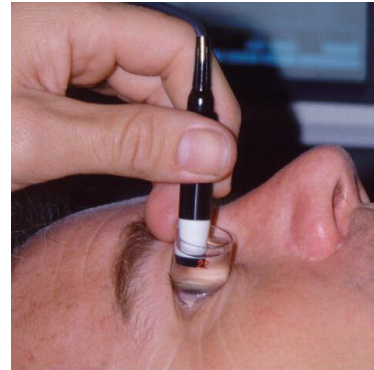


Figure 5b: Immersion method

1.5.3 Optical biometry

For many years, ultrasound-based devices have been the standard practice in measuring ocular biometry. However, contact method of measurement poses many problems, including risk of infection and it is highly operator dependent. With the technology advancement in recent years, an array of non-contact biometers using the principals of laser interferometry have become widely available. In 1999, IOLMaster 500 was first introduced. Since then, several new devices have also been introduced, for example Lenstar LS900, Aladdin, AL-Scan, Tomey OA-2000 biometer etc. IOLMaster 700 has also been recently introduced which incorporates swept source technology into its optical biometer. Aside from its non-contact nature, optical biometers have been proven to be more accurate than ultrasound based biometers, resulting in an improved final refractive outcome post cataract surgery. (Levison *et al.*,2011; Kunaivisarut *et al.*, 2012; Gopi *et al.*, 2017)

Figure 6: Optical Biometry



1.5.4 Principles of ocular biometry using IOLMaster

The IOLMaster 500 uses partial coherence interferometry to measure axial length. A signal is produced as a result of the interference between light reflected by the tear film and that reflected by the retinal pigment epithelium. (Bullimore *et al.*, 2019) A newer model, which is the IOLMaster 700 was introduced. IOLMaster 700 incorporates a newer swept-source optical coherence tomography(SS-OCT) technology to obtain ocular biometry parameters, which includes axial length, anterior chamber depth, corneal thickness and lens thickness.

Swept source technology is a laser with a tunable wavelength centered on 1055nm. Swept-source OCT scans sequentially through a series of wavelengths to enhance the interference pattern. This is then decoded with Fourier transformation into an A-scan trace. B-scan image is then formed by combination of multiple adjacent A-scans. These B-scans are displayed as a full-length OCT image showing anatomical details on longitudinal sections of the entire eye. With the newer swept-source OCT, deeper range of imaging, less sensitivity reduction with depth and faster scanning speeds can be obtained. (Bullimore *et al.*, 2019)

Cornea curvature is determined by measuring the distance between reflected light spots projected onto the cornea. The axial length, anterior chamber depth, lens thickness measurements are based on the laser interferometry method, which require reflected light from the corneal surface. (Zeiss, 2018)

Many studies have demonstrated the repeatability and accuracy of IOLMaster 700 in measuring the ocular biometry parameters. Bullimore *et al.*, (2019) showed good agreement between IOLMaster 700 and IOLMaster 500 and Lenstar 900, with superior or equivalent precision. Similar results were shown by Shi *et al.*, (2021) and Huang *et al.*, (2020). Where-else Cho *et al.*, (2018) showed good agreement between IOLMaster 700 with immersion method, automated refractor and manual keratometry.

1.6 THE EFFECT OF EVAPORATIVE DRY EYE ON OCULAR BIOMETRY MEASUREMENTS

It is known that dry eye affects millions of people worldwide, the prevalence being higher among older subjects. Patients undergoing cataract surgery are majority of the older age group, and therefore more susceptible to DED. (Sanchis-Gimeno *et al.*, 2005) The hallmark of DED is tear hyperosmolarity, which in turn results in an unstable tear film. Ocular biometry measurements which rely on a good reflection from the corneal surface are affected when the ocular surface is compromised, especially in evaporative dry eye patients.

IOLMaster 700 is a non-contact biometer which uses laser interferometry to obtain ocular biometry measurements. A signal is produced as a result of the interference between light reflected by the tear film and that reflected by the retinal pigment epithelium. Therefore, a

smooth corneal surface is required to allow proper interference to take place. Any corneal surface irregularities which is especially observed in evaporative dry eye disease is postulated to have an effect on the ocular biometry parameters obtained with IOLMaster 700. (Zeiss, 2018)

Tear film instability results in interference of the reflectivity from the corneal surfaces. This will cause scattering of light. When scanning with IOLMaster 700, if a measuring mark is projected onto this area, the otherwise circular or ellipsoid image of the measuring mark will become irregular and may result in inability to get a precise measurement.

Keratometry readings affected by DED have been demonstrated by a few studies. Epitroupoulas *et al.*, (2012) demonstrated that patients with greater tear osmolarity have a more variable keratometry reading. The keratometry readings were obtained using IOLMaster 500 and automated keratometer. Hong *et al.*, (2016) too demonstrated a higher keratometry reading among dry eye patients when measured using IOLMaster, which in turn affected the refractive outcome post-operatively. Chantra *et al.*, (2018) have shown cornea parameters accuracy, in particular astigmatism calculations, were affected by DED when measured using the VERION™ image guided system, which is an intraoperative imaging device. By using optical coherence tomography(OCT) , Dienema *et al.*, (2017) found that tear hyperosmolarity significantly affects the corneal reflectivity and central cornea thickness (CCT) of individuals with DED. In a study done by Sanchis-Gimeno *et al.*, (2005), CCT measured using Orbscan topography system 2 showed a significant difference between dry eye individuals when compared to non-dry eye. study by Liu *et al.*, (1999) also showed similar changes in CCT among dry eye individuals with measurements performed with Orbscan corneal topography system.

However, other parameters such as axial length and anterior chamber depth measured using the immersion method (Sanchis-Gimeno *et al.*, 2006) showed no significant difference among the two groups. Hong *et al.*, (2016) too did not demonstrate statistically significant differences in the axial length and anterior chamber depth among dry eye and no dry eye patients.

Lin *et al.*, (2016) demonstrated changes in the corneal wavefront aberrations in dry eye patients after treatment with artificial lubricant drops. Roggla *et al.*, (2021) and Chen *et al.*, (2021) too have demonstrated improvement in keratometry readings with the use of artificial lubricant tears to stabilize the cornea surface in dry eye patients.

1.7 STUDY RATIONALE

Accurate ocular biometry measurements including axial length, keratometry and anterior chamber depth are essential for ophthalmologist performing cataract surgery. These parameters will be incorporated into calculations of IOL power calculations and this IOL will be implanted during cataract surgery. Any minute error or discrepancy in these parameters will result in refractive errors post cataract surgery leading to poor and unsatisfactory visual outcomes.

The focus of this study is to determine whether ocular biometry measurements when performed using laser interferometry, which in our study, IOLMaster 700, will be affected by dry eye disease. If a significant discrepancy in ocular biometry is detected from our study between evaporative dry eye disease patients and their no dry eye counterpart, identification of these patients will be imperative at the pre-operative stage. This will allow ophthalmologists to administer prompt treatment to the dry eye group of patients prior to ocular biometry measurements. This will lead to a more accurate ocular biometry measurements and

subsequently an improved refractive outcome of the cataract surgery. Dry eye patients undergoing cataract surgery are then be able to benefit from an equally accurate refractive outcome as their no dry eye counterparts. This will improve their post operative satisfaction, especially with the increased availability of premium lenses, whereby IOL power calculations need to be highly accurate to yield a good post operative outcome.

Moreover, evaporative dry eye disease is prevalent among the elderly (Muna'aim *et al.*, 2016), They comprised of the majority of patients undergoing cataract surgery. With the results of this study, we hope to aid in improving the refractive outcome and visual satisfaction post cataract surgery.

Chapter 2

Study Objectives

2.1 RESEARCH QUESTION

1. Is there a difference between the ocular biometry parameters (axial length, keratometry, anterior chamber depth) using non-contact laser interferometry between evaporative dry eye and no dry eye group?
2. Is there a correlation between ocular biometry (axial length, keratometry, anterior chamber depth) with dry eye parameters (OSDI, TBUT, corneal fluorescein staining, conjunctival injection, meibomian gland grading) among patients with evaporative dry eye.

2.2 RESEARCH HYPOTHESIS

1. There is a difference between the ocular biometry parameters (axial length, keratometry, anterior chamber depth) using non-contact laser interferometry between evaporative dry eye and no dry eye group
2. There is a correlation between ocular biometry (axial length, keratometry, anterior chamber depth) with dry eye parameters (OSDI, TBUT, corneal fluorescein staining, conjunctival injection, meibomian gland grading) among patients with evaporative dry eye.

2.3 GENERAL OBJECTIVE

To evaluate ocular biometry parameters using non-contact laser interferometry in patients with evaporative dry eye.

2.4 SPECIFIC OBJECTIVE

- i. To compare ocular biometry parameters (axial length, keratometry, anterior chamber depth) between evaporative dry eye and no dry eye group.
- ii. To correlate between ocular biometry parameters (axial length, keratometry, anterior chamber depth) with dry eye parameters (OSDI, TBUT, corneal fluorescein staining, conjunctival injection, meibomian gland grading) among patients with evaporative dry eye.

Chapter 3

Methodology

3.1 STUDY DESIGN

Type of study : Comparative cross-sectional study

3.2 STUDY POPULATION, PLACE OF STUDY AND STUDY DURATION

3.2.1 Study Population

Evaporative dry eye patients attending Ophthalmology Clinic, Hospital Universiti Sains Malaysia (HUSM) and Ophthalmology Clinic, Hospital Melaka during study duration and fulfilling selection criteria

3.2.2. Place of Study

1. Ophthalmology Clinic, HUSM
2. Ophthalmology Clinic, Hospital Melaka

3.2.3 Study duration

August 2019 until June 2021

3.3 SAMPLING AND SAMPLE SIZE

3.3.1 Sampling Method

Convenience sampling method will be applied for both evaporative dry eye subjects and non-dry eye subjects. Patients attending Ophthalmology Clinic, HUSM and Ophthalmology Clinic, Hospital Melaka from August 2019 to June 2021 that fulfill the criteria will be recruited in the study.

3.3.2 Sample Size

This study will involve 2 group of subjects; the evaporative dry eye and control group. Sample size for each group is calculated accordingly.

Objective 1: To compare ocular biometry parameters (axial length, keratometry, anterior chamber depth) between evaporative dry eye and no dry eye group.

Sample size calculation was determined using G Power 3.1 software.

The calculation is done based on the 2 independent mean formula (2 groups).

Level of significance (α) = 0.05

Power of study = 0.8

Sample Size in each group, n= 51

Total sample size +10% dropout = 51(2) +10%

$$= 112$$