ANALYSIS OF TEAR FILM PRE AND POST LASIK USING OCULUS KERATOGRAPH 5M IN A TERTIARY EYE CARE CENTER

Dissertation submitted to The Tamil Nadu Dr. M.G.R. Medical University in partial fulfilment of the requirements for the degree of

MS Ophthalmology

BRANCH - III

OPHTHALMOLOGY

Register No: 221713460

THE TAMIL NADU

DR. M.G.R. MEDICAL UNIVERSITY

CHENNAI –600032

MAY 2020

CERTIFICATE

This is to certify that this dissertation entitled **"ANALYSIS OF TEAR FILM PRE AND POST LASIK USING OCULUS KERATOGRAPH 5M IN A TERTIARY EYE CARE CENTER"** submitted to Tamil Nadu Dr MGR Medical University is a bonafide work done by **Dr.SRISHTI RAMAMURTHY** under the guidance and supervision in the department of Cornea, Aravind Eye Hospital and Post Graduate Institute of Ophthalmology in Madurai during her residency period from May 2017 to May to 2020.

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DECLARATION

I, **Dr. Srishti Ramamurthy** solemnly declare the dissertation titled **"ANALYSIS OF TEAR FILM PRE AND POST LASIK USING OCULUS KERATOGRAPH 5M IN A TERTIARY EYE CARE CENTER"** has been prepared by me. I also declare that this bonafide work or a part of this work was not submitted by me or any other for any award, degree, diploma to any other university board either in India or abroad. This dissertation is submitted to the **Tamil Nadu Dr.M.G.R. Medical University**, Chennai in partial fulfilment of the rules and regulation for the award of **M. S. Ophthalmology (BRANCH III)** to be held in May 2020.

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ACKNOWLEDGEMENT

I acknowledge with sincere gratitude to many people without whom this thesis would not have been a success.

At the outset, I take the opportunity to gratefully remember our founder and visionary, Late **Dr. G. Venkataswamy** and pay my respectful homage.

I extend my heartfelt gratitude to my guide **Dr. N. Venkatesh Prajna**, Director of Academics and Head of Cornea and Refractive services, Aravind Eye Hospital, Madurai for his able guidance and constant encouragement during the period of my thesis.

I am extremely grateful for my co-guide **Dr.Naveen Radhakrishnan**, Consultant, Cornea services, Aravind Eye Hospital for giving me the direction and support needed to complete my thesis.

My sincere gratitude to **Dr. P. Namperumalsamy**, Chairman Emeritus and Director of Research of the Aravind Eye Care system, **Dr. G. Natchiar**, Director Emeritus, **Dr. R.D. Ravindran**, Chairman of Aravind Eye Hospital, Madurai and **Dr R. Kim**, Chief Medical Officer of Aravind, Madurai who have enabled this thesis by providing an enriching environment and requisite facilities to complete the study.

I am very grateful to the paramedical staff of Cornea department who helped in counselling the patients and monitoring follow up visits, and the patients who agreed to be a part of this study.

My sincere thanks to **Mrs. Kumaragurupari**, Senior Librarian, **Mr. R. Govindarajan**, Assistant Librarian who played a key role in providing articles and academic support required to complete my thesis.

I would also like to thank biostatistician **Mr. Mohammed Sithiq** who helped with the task of statistical analysis and compilation of results.

I shall forever be thankful for the unconditional support of my family.

CONTENTS

PART-I

INTRODUCTION

Dry eye is one of the most commonly reported post-operative complications of keratorefractive surgery. (1) Studies have shown that the incidence of dry eye post LASIK was found to be 20% to 50%. (2) Occurrence of dry eye is a transient complication but chronicity of disease is reported in around 20% of patients. (3)

The pathophysiological mechanism of dry eye following LASIK is likely to be multifactorial. Flap creation in LASIK surgically disrupts the afferent sensory corneal nerves leading to neurotrophic epitheliopathy. (4) In addition, LASIK has been postulated to cause inflammatory desiccation of the corneal surface and a loss of conjunctival goblet cells, aggravating dry eye. (5)

Pre-operative assessment of tear film parameters would help predict the likelihood of developing post-operative dry eye and its severity. (6) Studies have shown that results of Schirmer's test when used alone may not be reliable for detecting mild to moderate dry eye. (7) Traditional tear film break up time use Fluorescein dye which destabilises the tear film. The Oculus Keratograph 5M uses imaging modalities to noninvasively measure tear film break up time and tear meniscus height. These non-

invasive measurements reduce reflex tearing and are established to have good repeatability.(8)

Validated questionnaires for dry eye help to assess the subjective symptoms of patients pre and post-operatively. Ocular Surface Disease Index (OSDI) is a Likert scale that assigns a numerical score which is higher in patients with dry eye. Studies have shown the OSDI questionnaire to have acceptable reliability in predicting dry eye. (9)

Some studies comparing Femtosecond Laser (FS) assisted LASIK and Mechanical Microkeratome (MK) have shown a lower occurrence and severity of post-operative dry eye in the former.(10) The study of the influence of intra-operative flap hinge location and flap thickness on development of dry eye post-operatively has been inconclusive.(11) Comparison between FS and MK assisted LASIK and the flap thickness used will be elucidated in this study.

BACKGROUND

TEAR FILM

Wolff proposed the model of tear film structure composed of three layers: a mucin layer produced by goblet cells of the conjunctiva covering the cornea and decreasing the hydrophobic nature of corneal epithelial cells, an aqueous layer secreted by the lacrimal glands which lubricates the ocular surface and provides appropriate osmolarity, and a lipid layer produced by the meibomian glands which prevents evaporation of the tear film. It is now understood that the tear film functions as a single unit. The mucin and aqueous layers of the tear film are considered as a single layer, referred to as the mucoaqueous layer. The lipid layer plays an important role in tear film stability and has an average thickness of 42 nm. (12)

Lacrimal glands have both sympathetic and parasympathetic innervation. Ocular surface stimulation carries impulses through the trigeminal nerve which is the afferent. Efferent parasympathetic supply via the facial nerve stimulates secretion from the lacrimal gland. (13)

Tear film secretion has been differentiated into four types. Basal secretion covers the ocular surface forming the stable pre-corneal tear film in the open eyes state. Reflex secretion occurs due to ocular stimulation of some sort. Emotional tears can occur in the presence of stimulation due to

emotions such as sadness. Closed eye tears are those produced by the lacrimal glands during sleep. (14)

Tear film osmolarity has a mean value ranging between 270 and 315 mOsm/l in normal individuals. Increased osmolarity of the tear film has been associated with severe dry eye. (15)

Tear film stability is also influenced by the rate of evaporation of tears. Higher rates of evaporation of tears result in symptoms of dry eye. Lower environmental humidity is associated with greater rate of evaporation of tear film leading to decreased lipid layer thickness and instability. (16)

Video display units (VDU) usage has been associated with dryness related symptoms. Reduction in blink rate, meibomian gland dysfunction, lipid layer instability and decreased TBUT values have been documented in VDU users. Ambient temperature, humidity levels and VDU usage are some of the environmental modifiers of tear film parameters. (17)

DRY EYE

The revised definition of dry eye according to TFOS DEWS II is:

"Dry eye is 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 etiologic roles."(18)

Patients with dry eye present with non-specific symptoms of ocular irritation, redness, mucoid discharge, photophobia and signs such as decreased tear film height and meibomian glands plugged with secretions.(19) Patients may also complain of reduced functional visual acuity. As dry eye symptoms are aggravated by cataract and refractive surgeries, it could potentially affect their visual outcomes. (20)

Epidemiology and risk factors

Female sex, old age and Asian ethnicity have been consistently associated with an increased risk of dry eye. Comparison among East Asian and Caucasian patients post LASIK has shown that the former are at a higher risk of developing chronic dry eye post-LASIK. (21) Meibomian gland dysfunction, connective tissue disorders such as Sjogren syndrome, and hormone replacement therapy are known to cause dry eye.

Occupational risk factors such as long hours of computer usage and contact lens wear result in tear film dysfunction. Topical antiglaucoma medications and other topical drops containing the preservative benzalkonium chloride over long term precipitate dry eye. Medications such as antihistamines, anxiolytics, antidepressants and isotretinoin can result in dry eye. Systemic conditions such as thyroid disorders, viral infections, Diabetes Mellitus and acne rosacea can potentiate dry eye.(22)

Pathophysiology

The two forms of dry eye disease; aqueous deficient and evaporative dry eye are now believed to exist in a continuum. Aqueous deficient dry eye alone contributes to a smaller proportion of the total cases of dry eye and occurs due to defective lacrimal gland function. Infiltration of the lacrimal gland that occurs in Sjogren syndrome is a more commonly reported cause of aqueous deficient dry eye in the western population. Other causes which may obstruct the lacrimal gland ducts include cicatricial conjunctivitis that is seen trachoma, ocular cicatricial pemphigoid and chemical burns. Topical anaesthetics, damage to trigeminal nerve and refractive surgery are also listed as causes of aqueous deficient dry eye. Meibomian gland dysfunction (MGD) is the most important cause of the hyper-evaporative state that occurs in evaporative form of dry eye. Meibomian gland drop out that occurs in old age and acne

vulgaris in younger population are common causes of MGD. MGD can be classified into cicatricial and non cicatricial. Cicatrising causes include trachoma, erythema multiforme and ocular pemphigoid. Atopic and seborrheic dermatitis and psoriasis can cause the non cicatricial form of MGD. Meibomian gland obstruction alters the oil composition of the tear film leading to hyperosmolarity of the tear film. This environment accelerates inflammation and release of cytokines, which incite the vicious cycle of dry eye. (23)

Diagnosis

The TFOS DEWS II report recommends triaging patients based on presence or absence of symptoms. Subjective questionnaires such as Ocular Surface Disease Index (OSDI) and Dry Eye Questionnaire-5 are used to rule out diseases that resemble dry eye. In addition to this, any one of: corneal or conjunctival staining, reduced non-invasive tear break up time and increased tear osmolarity or a disparity between the two eyes is considered to be conclusive dry eye disease. Assessment of tear film lipid layer and tear film volume aids in differentiation between aqueous deficient and evaporative dry eye. (24)

IATROGENIC DRY EYE

TFOS DEWS II includes a separate report on Iatrogenic Dry eye, which comprises proposed etiologies, pathophysiology and recommendations in management of dry eye induced by medications and surgery. (25)

a) Drug induced dry eye disease:

Topical eye drops affect the tear film by a multitude of mechanisms – toxic and inflammatory effects on the ocular surface, decrease aqueous secretion by the lacrimal glands, damage to the goblet cells, disruption of the lipid layer of the tear film, neurotoxic effects on the trigeminal nerve endings in the cornea and aggravation of meibomian gland dysfunction. (26) Preservatives such as benzalkonium chloride (BAK) have pro-inflammatory and detergent properties which disrupt the tear film and ocular surface. Studies have shown that patients using preservative free beta blocker preparations for glaucoma are less prone to dry eye disease. (27)

Studies have also shown that the occurrence of dry eye was directly influenced by the number of drops applied. Patient using a single anti-glaucoma medication were less prone to symptoms and signs of dry when compared to those using two to three different topical preparations. This

could be attributed to the additive effect of preservatives. Treating such a patient with a preservative containing lubricant will further aggravate symptoms of dry eye disease.(28)

Systemic medications which have anticholinergic properties block muscarinic receptors in the lacrimal gland acini, goblet cells of the conjunctiva and in the meibomian glands, thereby affecting the production of aqueous, mucin and lipid components of the tear film. Antipsychotics, antidepressants, decongestants and antihistamines are examples of drug groups that exert anticholinergic effects disrupting the tear film milieu. (29) Adrenergic drugs are also known to influence tear film quality. Drugs such as amiodarone, bisphosphonates and aspirin are hypothesised to cause evaporative dry eye.(30) Isotretinoin used in treatment of acne when administered in large doses, is known to cause dry eye disease. Isotretinoin gets secreted in tears and causes lacrimal gland atrophy and affects tear film stability. (31)

b) Contact lens induced dry eye disease

Contact lens wear induces structural alterations to the tear film. Studies have shown decrease in the lipid layer of the tear film, altered tear film spread, decreased tear break-up time (TBUT), decreased tear meniscus height and increased tear film osmolarity in contact lens wearers.

Contact lens wear has been established as an independent risk factor for dry eye and aggravates pre-existing dry eye disease. (32)(33)

c) Surgery induced dry eye disease

Corneal refractive surgery is known to worsen pre-existing dry eye. Patients undergoing Photorefractive keratectomy (PRK) are less prone to dry eye. PRK does not involve raising a flap thereby avoiding severing of corneal stromal nerves.(3) Small Incision Lenticule Extraction (SMILE) procedure has also been found to result in relatively less damage to the superficial corneal nerves, thereby preserving tear film parameters better in comparison to flap-based procedures. (34)

Cataract surgery is usually done in the senile age group who are generally predisposed to dry eye disease. Cataract surgery has been shown to aggravate dry eye and ocular surface inflammation. Diabetic patients are at a higher risk of dry eye disease post cataract surgery.(35) The pathophysiology of cataract surgery induced dry eye disease is multifactorial. Defective meibomian gland function, loss of goblet cells, light toxicity from prolonged exposure to the operating microscope, exposure related desiccation of the ocular surface and transection of nerve fibres has been attributed to cause dry eye disease. (36) Dry eye associated with older surgical techniques such intracapsular cataract extraction and extracapsular cataract extraction was found to be more severe and long

lasting when compared to Phacoemulsification and Femtosecond laser assisted cataract surgery. (37) Tear film parameters with newer techniques show initial worsening followed by a return to baseline within one to three months in a majority of the cases. (38)

LASIK FLAP

LASIK involves stromal ablation of the deep cornea after raising a corneal flap. One of the most critical steps involves the flap creation. The flap was originally raised with Mechanical microkeratome, followed by introduction of Femtosecond laser assisted flap creation.(39)

Mechanical Microkeratome creates shear force across the cornea with the help of an oscillating blade to raise an even flap. The blade penetrates the cornea at a pre-determined depth. A pneumatic suction ring aids in fixing the globe and creates an intraocular pressure of about 65 mm Hg to create a smooth even flap. The microkeratome head is mounted on grooves present on the surface of the suction ring. The surgeon controls a foot plate that permits movement of the blade till a hinge is created, after which it is reversed and the microkeratome is removed from the eye. (40)

Femtosecond laser used in LASIK has a wavelength of 1053 nm and has ultrafast pulse duration. Each pulse creates a small amount of microplasma and this coalesces to form microscopic gas bubbles within the interface which aids in flap creation, a process known as photodisruption. (41) The cornea is flattened during the procedure of laser application with a suction-applanation lens. A controlled application of laser application during the procedure avoids damage to the surrounding tissues resulting in higher flap predictability.(42)

Studies have shown similar results with both techniques with regards to safety and efficacy. Flap thickness was more predictable with usage of femtosecond laser. (43)

LASIK AND DRY EYE

Multiple factors have been implicated in causing dry eye that occurs following LASIK.

Pre-operative risk factors

Patients with pre-operative Schirmer's value of less than 10mm were found to be at a higher risk of post-operative tear dysfunction.(44) Patients with pre-existing dry eye were found to have greater corneal staining defects, delayed recovery of corneal sensation and prolonged duration of recovery from dry eye post-operatively.(45) Contact lens wear for prolonged duration was also associated with increased occurrence of dry eye. (46) Long term contact lens wear alters the tear film due to corneal warpage, alteration in corneal pachymetry, tear film protein composition and barrier function.(47) Diabetes causes corneal hypoesthesia posing a higher risk for dry eye.(48) Older age group and female sex are also at higher risk. Androgens which increase lacrimal gland secretion are lower in women leading to increased propensity for developing dry eye. [(1)] Allergic conjunctivitis increases risk of dry eye and has been listed as a contraindication for LASIK in studies. (49) Hyperopic LASIK and increased depth of ablation have also been postulated to increase risk of dry eye.(5) (15) Patients with mild Sjogren's syndrome who have undergone LASIK have progressed to severe/refractory forms.(50)

Intra-operative risk factors

Studies have shown that a nasal hinge flap has a lower risk of causing tear instability when compared to superior hinge flaps. The long posterior ciliary nerves which supply the cornea enter at 3 and 9 o' clock and both would be transected by a superior hinge flap which causes greater loss of corneal sensation potentiating dry eye. [11] Flap thickness has not been shown to alter risk significantly and requires further research. (46) High suction pressures while using the keratome leads to conjunctival goblet cell loss worsening tear film parameters. (51)

Pathophysiology

Nerve supply to cornea is from the ophthalmic and maxillary division of the trigeminal nerve. The nerve fibres lose their myelin sheath after entering the cornea and form a dense sub epithelial plexus. The nerves then penetrate the Bowman's layer to form the terminal fibres supplying the anterior cornea. The dense corneal stromal nerve plexus in the anterior two thirds of the cornea is damaged while creating the LASIK flap preserving only the deeper nerve fibre bundles.(52) This leads to loss of afferent corneal sensation disrupting the neurogenic reflex arc thereby affecting blink rate, tear production and clearance. (53) Decreased basal tear secretion and poor quality of lipid layer was documented in as many as half the patients post-LASIK although not all of them were

symptomatic. (54) Ocular surface denervation by the flap created masks the symptoms of dry eye. The symptoms of dry eye may be noticed by patients only when the nerves begin to regenerate thereby temporally dissociating the signs and symptoms of dry eye post LASIK.(55)

The term LASIK-induced neurotrophic epitheliopathy (LINE) was introduced by Wilson and Ambrosio to describe the defective functioning of the lacrimal gland and corneal surface as a neurogenic reflex arc. (56) Regeneration of intraepithelial and stromal nerves and restoration of function was found to occur between 3 to 6 months post-operatively in LASIK patients. (57)

Ablation of the central cornea with resultant flattening or steepening alters the spread of tear film across the ocular surface. The change in distribution of tear film leads to areas of stagnation of tears, non-wetting and desiccation. (58) Higher refractive errors particularly hyperopic corrections magnify this effect even further. (59)

LASIK induces an increase in tear film osmolarity which in turn leads to increased production of pro-inflammatory cytokines.(6) The inflammatory desiccation causes damage to the ocular surface aggravating the vicious cycle resulting in dry eye. (60)

DRY EYE EVALUATION

Subjective assessment

A detailed history for symptoms such as burning or foreign body sensation, excessive watering, redness, discomfort and photophobia might point towards dry eye disease.(61) Validated questionnaires help in detailed assessment of patient symptoms and can be repeated in subsequent reviews. McMonnies Dry eye questionnaire is used in screening patients and assays risk factors, occurrence of symptoms and environmental factors that impact dry eye.(62) The more reliable Ocular Surface Disease Index (OSDI) is a Likert scale containing three main headings under which patients are evaluated. It includes symptoms experienced by patients over the past week, assessment of functional visual acuity in terms of difficulty noticed in performing day to day tasks such as driving and environmental triggers. Air conditioning, dry or areas with low humidity and windy surroundings aggravate dry eye. (63)

Objective assessment

Ocular surface staining

Dyes used in testing the corneal and conjunctival surface include Fluorescein, Rose Bengal and lissamine green dyes.(64) 1-2% fluorescein strip is used in tear film and viewed using cobalt blue filter of slit lamp

after two minutes. Fluorescein stains area where epithelium has been disrupted. (65) Rose Bengal 1% stains conjunctiva more effectively than cornea and is viewed best with red-free filter. It stains areas lacking mucin coating and tear film debris. Rose Bengal dye is associated with maximum ocular irritation of the dyes used.(66) Staining patterns observed on the cornea/ conjunctiva can aid in diagnosis. Inferior cornea and bulbar conjunctival staining is commonly seen in lagophthalmos and MGD. Superior bulbar conjunctiva staining is classically suggestive of superior limbic keratoconjunctivitis. Diffuse interpalpebral staining usually seen in aqueous tear deficient dry eye. (67)

Tear break-up time test (TBUT)

TBUT helps to assess the stability of tear film by instilling fluorescein in the inferior tarsal conjunctiva. After a few blinks, the cornea is observed using cobalt blue filter and broad beam of the slit lamp. Time elapsed between the blink and appearance of first dark spot on the otherwise fluorescein tear film is the measure of TBUT. A TBUT value <10 seconds is abnormal and suggestive of dry eye disease. (68)

Non-invasive Keratograph tear break-up time (NIKBUT)

Conventional TBUT with fluorescein instillation alters the tear film dynamics and stability and therefore cannot be used as a reliable index.

(69) NIKBUT is measured by observing the distortion of mires/ grid pattern projected on the pre-corneal tear film by a number of instruments such as Oculus Keratograph 5M, Fourier Domain OCT and Autorefractor-Keratometer devices overcomes the limitation of TBUT with acceptable reproducibility. (70), (71)

Schirmer Test

The Schirmer test is used to assess lacrimal gland function/ aqueous tear production. Results are often variable and it is therefore used along with a battery of other tests to establish a diagnosis of dry eye. The Schirmer test can be performed with and without topical anaesthesia. When performed with anaesthesia as in the Jones modification, it is used to assess the basal tear secretion. The amount of wetting of the standard 5*35mm Whatman No 41 filter strip placed at the lateral third of the lower lid in the inferior conjunctival fornix is measured at the end of 5 minutes. A value of less than 10mm at the end of 5 minutes points towards aqueous deficient dry eye disease.(72)

Fluorescein dye disappearance test/ Tear function index

The rate of turnover and clearance of tears is assessed by calculating the time taken for a measured volume of fluorescein instilled to disappear from the ocular surface. Schirmer II divided by tear clearance rate will give

the tear function index which is more reliable than Schirmer to detect dry eye. (73)

Tear osmolarity test

Tear osmalarity is measured using a commercially available, TearLab osmolarity system (TearLab, CA, USA). A value higher than 312 mOsms/L is considered abnormal and suggestive of dry eye. Tear osmolarity is altered early when the homeostasis is affected and might be useful in detecting early and milder forms of disease. (74), (75)

Tear film interferometry

Interferometry can be used in the assessment of the composition of the lipid layer of the tear film. This may be altered in MGD and can be used to detect evaporative dry eye. (76)

Tear film protein assay

Quantitative assessment of Matrix metalloproteinase-9 (MMP-9) can be of use in the diagnosis of dry eye. This has been done using commercially available Inflamma Dry device (Quidel corporation, USA). (77) Levels of lactoferrin, lipocalin and lysozyme can be used to assess tear film and lacrimal gland function.

OCULUS KERATOGRAPH 5M

The OCULUS Keratograph 5M uses high resolution Placido-based corneal topography. In addition to corneal topography, the instrument is now gaining popularity in the detection of dry eye disease.

The tear film parameters measured using OCULUS Keratograph 5M include:

Quantitative

Tear Meniscus Height (TMH)

Qualitative

1) Non-invasive Keratograph tear break-up time (NIKBUT)
2) Meibography
3) Lipid layer evaluation
4) Tear film dynamics

The Keratograph uses infrared wavelength 880nm for illumination which reduces the induced thermal changes brought about in the tear film. White diodes are used for tear film dynamics, blue diodes for fluorescein studies and infrared diodes for meibography(78).

Tear meniscus height (TMH) which is measured in this study is obtained by measuring the height of the inferior tear film along a perpendicular through the centre of the pupil and the lid margin.

Non-invasive keratography tear break-up time (NIKBUT) measured using the Keratograph is an automated technique that does not rely on the examiner skill for measurement. According to the report of DEWS I, NIKBUT was considered to have maximum sensitivity and specificity for detection dry eye disease. The pattern of illumination is in the form of a placido disc consisting of 22 rings projecting on the cornea. Each ring has 1000 points therefore a total of 22,000 points on the cornea are studied. Once the patient is comfortably seated, they are instructed to blink twice and this will automatically start the video recording and measurement by the Keratograph. The machine detects distortion of the mires and two values are obtained; NIKBUT first- which is the first point when tear film perturbation occurs and NIKBUT average- which is the average break up time of all the points analysed or 24 seconds from the blink, whichever occurs first. (79)

Studies have shown that K5M allows for non-invasive measurements with good repeatability and reproducibility. TMH and NIKBUT values showed significant difference between normal and patients with dry eye disease. It therefore serves as an effective alternative

to conventional invasive tear film studies such as Schirmer and TBUT. K5M has in-built software to record details of a patient and this serves for comparison and assessing response to treatment in subsequent review of patients with dry eye. Studies have also shown that K5M may pick up early changes in the pre-clinical stage of the disease. All these attributes make K5M an ideal device for the study of tear film in LASIK patients. (8)

REVIEW OF LITERATURE

Edward Y.W. et al conducted a prospective, non-randomised, interventional study among 58 consecutive patients who underwent bilateral myopic LASIK. Symptoms of dry eye along with objective tests such as Schirmer's, basal tear secretion and tear break up time were documented pre-operatively and post-operatively on day 1, 1 week and 1 month. Percentage of patients with symptoms of dry eye declined with each visit. Schirmer, Basal tear secretion and TBUT were significantly decreased on all post-operative visits. TBUT values recovered 1 month post-operatively. A pre-operative Schirmer of <10mm was significantly associated with increased risk of experiencing dry eye symptoms. As this study followed patients only till 1 month post-operatively, it was suggested that a longer follow up in future studies would elucidate the impact of LASIK on the development of dry eye in the long term. (44)

Chi-Chin Sun et al concluded that dry eye caused by corneal denervation resulting from flap based procedures is the most common complication following LASIK. They conducted a prospective, comparative study among 87 consecutive patients after assigning them to two non-randomized groups undergoing either Mechanical microkeratome or Femtosecond Laser assisted bilateral myopic LASIK. Objective outcome measures such as corneal sensitivity, Schirmer testing, tear break

up time (TBUT), corneal staining along with a subjective Ocular Surface Disease Index(OSDI) questionnaire were compared pre and 1 week, 1, 3 and 6 months post-operatively. Schirmer, corneal and conjunctival staining did not show a statistically significant difference post-operatively. OSDI scores were increased post-operatively in both MK and FS-assisted LASIK groups. Another notable result was that TBUT was higher post-operatively in FS assisted LASIK highlighting the need to investigate if the procedure decreased the risk developing dry eye. A drawback in the study was that most of the patients had chronic dry eye pre-operatively and there is a need for a similar study in a normal population to identify potential risk factors. (80)

Siganos et al studied 42 eyes of patients who underwent LASIK. They measured Schirmer 1 & 2, TBUT pre-operatively and post-operatively at 1,3 and 6 months. They could not establish a relationship between the depth of ablation and the tear film parameters. They concluded that tear secretion post-LASIK was decreased until 3 months post-operatively and returned to baseline levels by 6 months.(81)

Hidenga Kobashi et al conducted a meta-analysis to compare corneal innervation and other post operative ocular surface intergrity measures between patients who underwent Small incision Lenticule Excision (SMILE) with those who underwent Femtosecond assisted LASIK. The

results showed that the Schirmer test values and tear osmolarity were similar in both groups. Higher corneal sensitivity was observed among the SMILE group at 1 and 6 months post-operatively. Sub-basal nerve fibre bundle density was also higher in SMILE patients at 1 month post-operatively. Absence of a flap that disrupts the corneal innervation was postulated to explain the faster healing in SMILE patients. Tear break up time was higher in the SMILE group at 1 and 6 months post-operatively and OSDI scores were better in comparison. The study concluded the SMILE had superior outcomes on post-operative ocular surface integrity and had a reduced risk of dry eye disease. (2)

Perez-Santoja et al compared the recovery of corneal sensitivity between 17 patients who underwent LASIK and 18 patients who underwent Photorefractive Keratectomy (PRK). Cochet-Bonnet esthesiometer was used to obtain corneal sensitivity measurements pre-operatively and post-operatively at 1 week, 1,3 and 6 months. They found that the corneal sensitivity in the central zone of ablation was decreased significantly more in the LASIK group compared to the PRK group in the first 3 months post-operatively. At 6 months, the values between the two groups were similar.(82)

Batat et al evaluated a number of objective and subjective parameters in 48 patients who underwent LASIK. Corneal and conjunctival

sensitivity were decreased in all post-operative visits up until 16 months. Symptoms were assayed using a questionnaire which showed increased symptoms post-operatively. Schirmer 1 scores were decreased at 1 month post-operative visit. An increase in corneal fluorescein staining was noted which returned to baseline by 12 months post-operative visit. Corneal surface irregularity was also studied, which showed an increase at 1 month but normalised by 6 months. This study concluded that LASIK was accompanied by significant risk of tear film dysfunction. It highlighted the importance of counselling patients pre-operatively regarding the risk of developing ocular surface irritation post-operatively. (6)

Yesheng Xu et al conducted a comparative study among different variants of refractive surgery and the occurrence of post-operative dry eye. Dry eye parameters were studied among 4 groups of patients; SMILE, Femtosecond laser, Mechanical microkeratome thin flap 90 μm and 110 μm flap. Of the 176 patients (338 eyes) in the study, Schirmer values taken pre and post-operatively showed no significant difference in all groups. Tear break up time was decreased in all groups and persisted even 6 months post-operatively. The McMonnies subjective assessment was increased in all groups post-operatively and normalised by 6 months after surgery except in the Mechanical microkeratome group. The score was better in SMILE compared to the other groups. It was concluded that dry eye was

a transient post-operative complication. SMILE followed by Femto-LASIK and thin flap LASIK are acceptable alternatives to decrease post-operative tear dysfunction.(83)

Patel S. et al studied central corneal sensitivity and tear film lipid layer using optical interferometry. Results at 14 weeks post-operatively showed reduced corneal sensitivity and thin lipid layer which could explain the post-operative tear dysfunction in LASIK patients. (54)

Shen et al conducted a meta-analysis comparing SMILE (291 eyes) and Femto-LASIK (277 eyes). Schirmer I test was significantly decreased in both groups with no statistical significant difference between the two groups. OSDI at 6 months post-operatively was better in the SMILE group but TBUT and tear film osmolarity were similar in both groups and returned to normal by 6 months post-operatively. The study concluded that though SMILE patients may be subjectively more comfortable, Femto-LASIK had comparable results in decreasing risk of post-operative dry eye.(34)

Salomao et al compared the occurrence of dry eye among two groups of patients where flap was created either with IntraLase Femtosecond laser or Hansatome Manual Keratome. Patients in the Microkeratome group had a higher incidence (46%) of dry eye compared to the Femtosecond laser (8%) group. No significant association was found between the flap

thickness and occurrence of post-operative tear dysfunction. Overall, Femtosecond Laser assisted LASIK group has lower incidence and less severe form of dry eye post-operatively with a better response to treatment with cyclosporine A when compared to the Microkeratome group. (10)

Albietz M et al conducted a retrospective study among 566 eyes that underwent LASIK to analyse the possible relationship between chronic dry and regression after LASIK. Regression after LASIK occurred in 27% of patients previously diagnosed to have chronic dry eye compared to 7% in normal patients. Pre-operatively documented tear dysfunction and greater ablation depth were established as risk factors for regression after LASIK. (84)

Hovanesian et al conducted a prospective study to compare the occurrence of symptoms of dry eye and recurrent corneal erosions between patients who underwent LASIK and PRK. 231 PRK patients and 550 LASIK patients were requested to fill out questionnaires and occurrence of sharp pains, soreness to touch, and sticking sensation of eyeball to lid were analysed. Symptoms of dry eye occurred in both groups post-operatively but the severity was much higher in patients who underwent PRK, which translated to poorer patient satisfaction post-operatively.(85)

Tear Film and Ocular Surface Society (TFOS) Dry Eye Workshop (DEWS) II diagnostic methodology identified the battery of tests that

would be ideal to detect and monitor dry eye. Patients were initially triaged as symptomatic based on questionnaire such as OSDI. A significant score along with one of three: ocular surface staining, NITBUT (non-invasive tear break up time) and tear osmolarity were considered conclusive of dry eye disease. With a sensitivity between 82-84% and specificity of 76-94% using different devices, NITBUT is now recognised as a reliable marker and useful in early detection of dry eye disease. A cut off value of below 10 seconds was considered indicative of dry eye disease.(24)

N Best et al compared NITBUT measured by OCULUS Keratograph 5M with the same measured using Keeler tearscope. The objective measures were related to subjective symptoms using OSDI questionnaire. The Keratograph was found to detect very early tear film changes and NIKBUT values recorded were lower than subjective assessment. Instrument calibration would aid in establishing the value of Keratograph in the diagnostics of dry eye.(78)

Lei Tian et al studied the repeatability and reproducibility of non-invasive measurements obtained using Keratograph 5M among 42 healthy and 42 patients with dry eye. The inter-examiner repeatability and reproducibility was good in both groups. NIKBUT in dry eye patients was found to be a more reliable measure. The non-invasive measurements could serve as a method in diagnosis as well as follow up of patients. It was

concluded that a larger sample size would be needed to study if these measurements are more dependable than invasive measures such as Schirmer and fluorescein tear break up test. (8)

Pedro Arriola-Villalobos et al compared lower tear meniscus height measurements obtained using Keratograph 5M with those from Fourier domain optical-coherence tomography in 30 eyes of normal subjects. Intra and interobserver repeatability and reproducibility were studied. There was no statistical difference in the measurements obtained using the two devices.(71)

Lacunae in knowledge

- Tear film alterations pre and post LASIK in most studies have been quantified subjectively or using contact/invasive studies of tear film
- Oculus Keratograph 5M values correlated with subjective symptoms (OSDI in this study) would aid in establishing value of pre-operative non-invasive measurements in predicting occurrence and severity of dry eye postoperatively
- Oculus Keratograph 5M studies of tear film have not been done in a similar population demographic in the past

Figure 1.1: OCULUS Keratograph 5M console (OculusOptikgerate GmbH, Wetzlar, Germany)

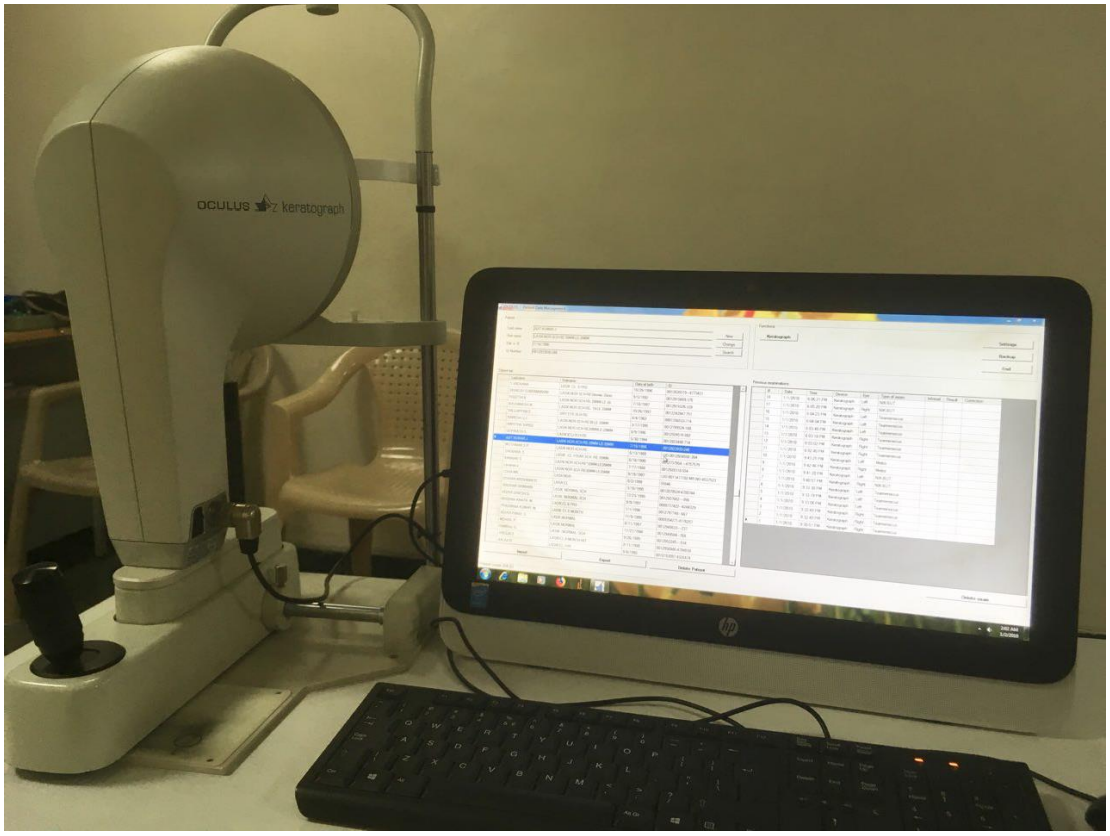


Figure 1.2: Data entry in OCULUS Keratograph. Individual patient data can be opened up during follow up visits enabling easy monitoring of patients.

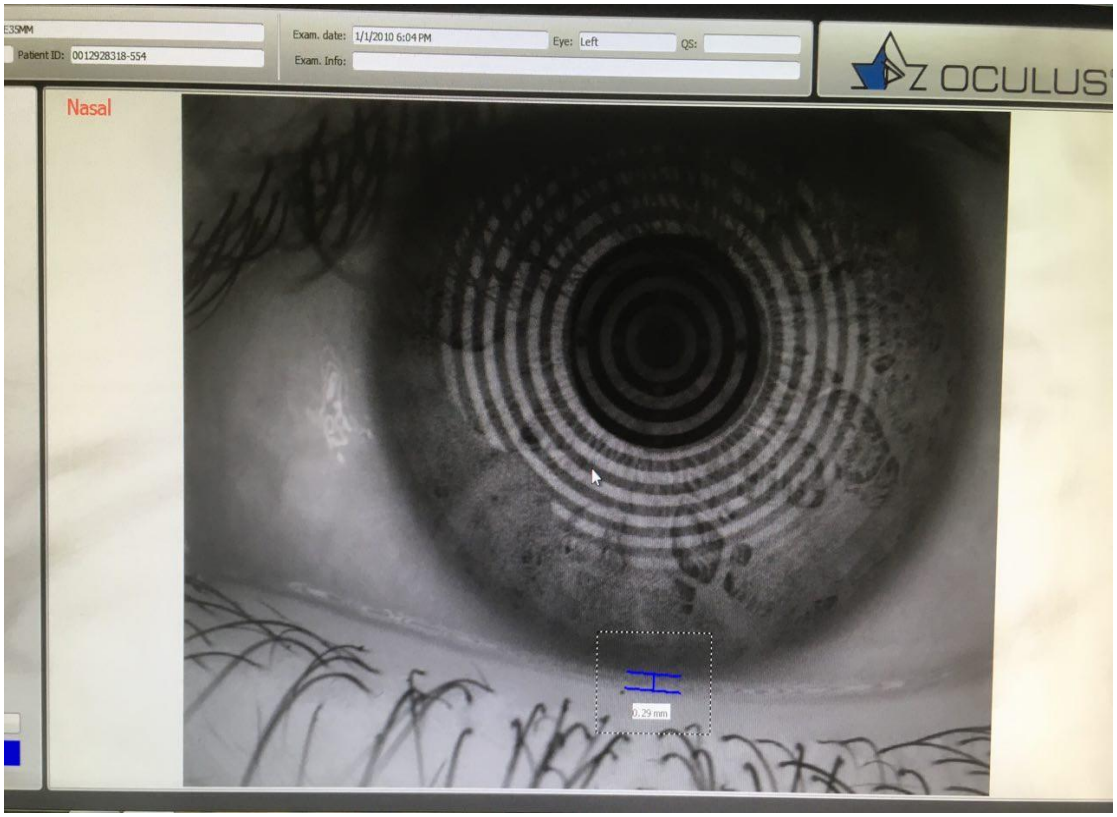


Figure 1.3: Measurement of Tear Meniscus Height (TMH) on OCULUS Keratograph 5M

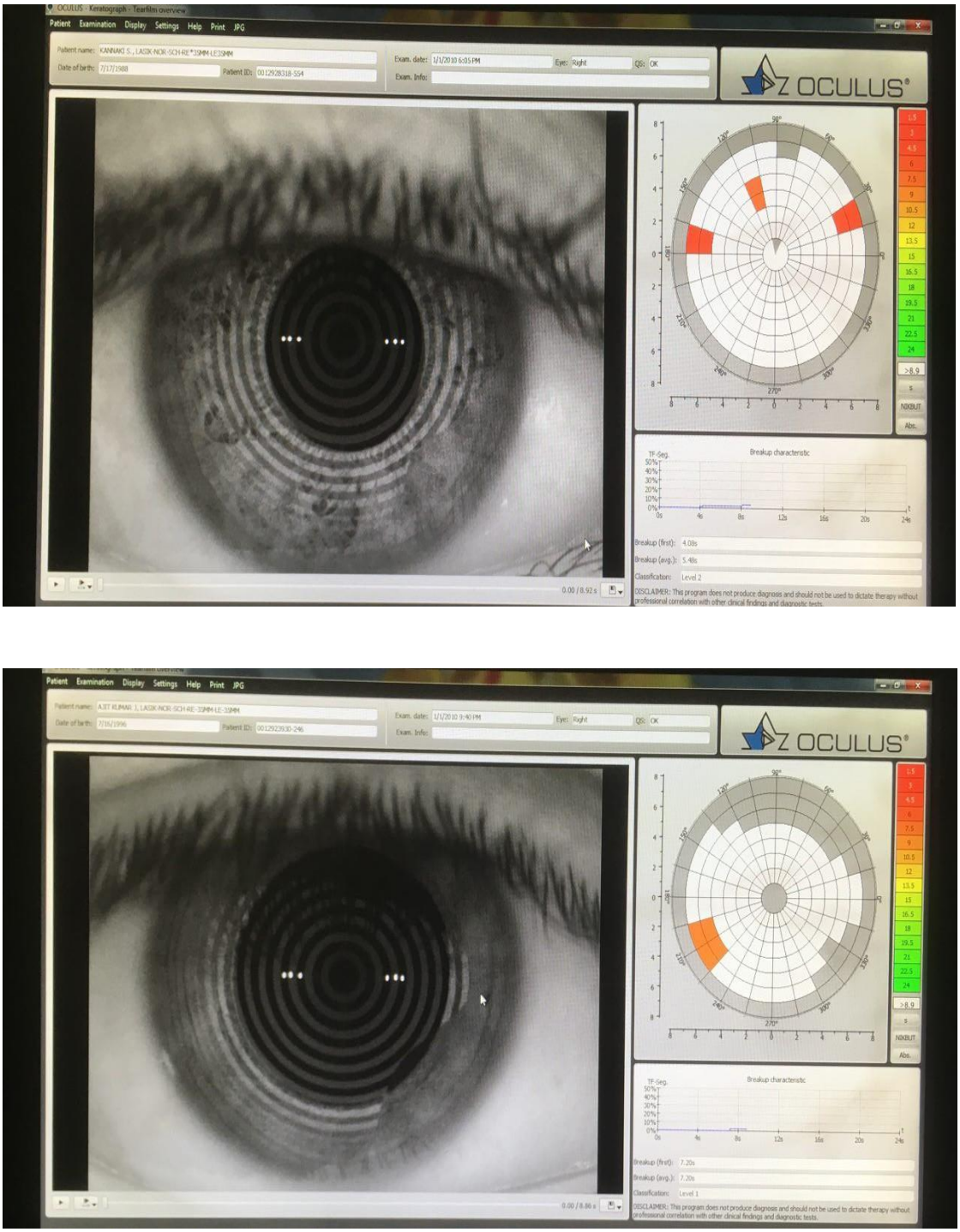


Figure 1.4, 1.5: Non-invasive Keratograph tear break-up time (NIKBUT) which utilises infrared rays to map out areas of tear film break-up.

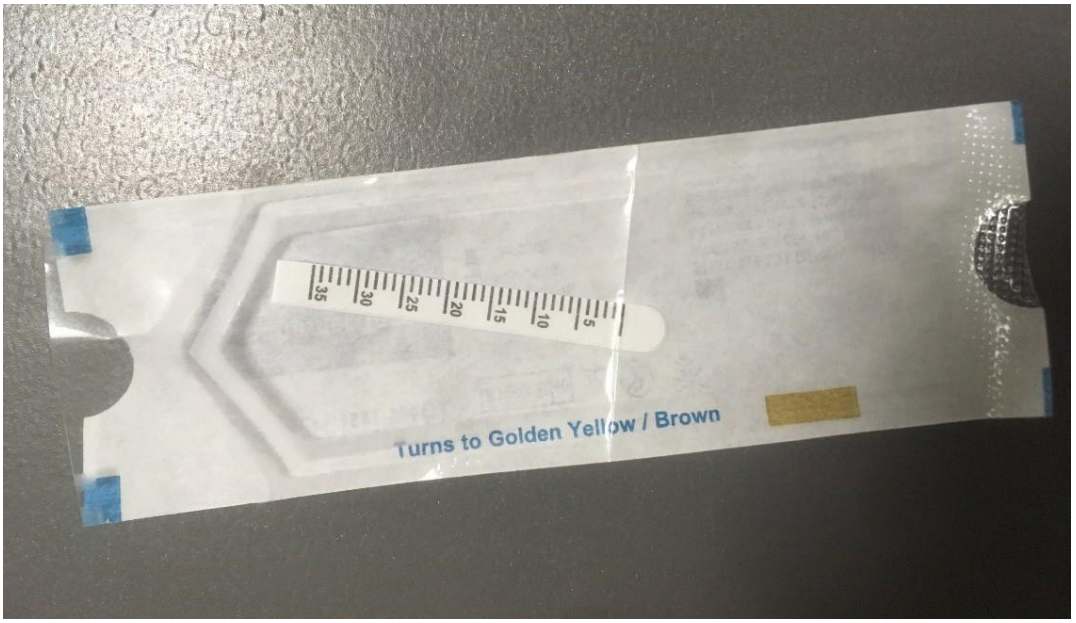


Figure 1.6, 1.7: Schirmer tear test strips: Whatman filter paper no 41

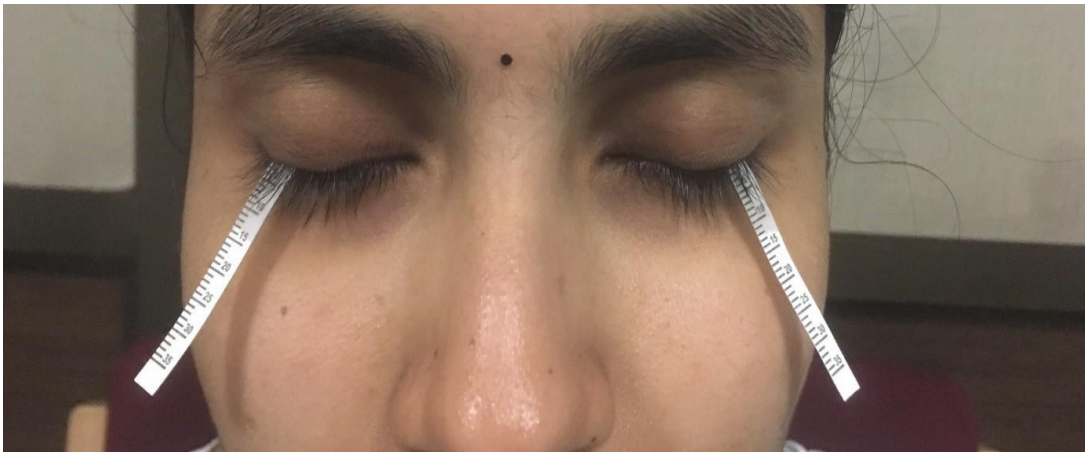


Figure 1.8: Schirmer test strip placed at junction of lateral 1/3rd and medial 2/3rd of lower eye lid.

Figure 1.9: TECHNOLAS ZYOPTIX® XP for microkeratome flap creation (Technolas Perfect Vision, Munich, Germany)

Figure 1.10: Intralase femtosecond laser for flap creation - iFS 150 kHZ (Abbott Medical Optics Inc, Santa Ana, CA, USA)

Figure 1.11: Excimer laser for stromal ablation- STARS4 IR Excimer laser (Abbott Medical Optics Inc, Santa Ana, CA, USA)

PART-II

AIM AND OBJECTIVES

Primary objective

1) To study the tear film (NIKBUT and TMH) preoperatively and postoperatively (1 month follow up visit) using Oculus Keratograph 5M in all patients undergoing LASIK (Mechanical microkeratome and Femtosecond laser) during the time period of the study in the Cornea department, Aravind Eye hospitals, Madurai

Secondary objectives

1) To analyse tear film preoperatively and postoperatively using Schirmer's test

2) To correlate aforementioned objective values with subjective symptoms of dryness assessed using Ocular Surface Disease Index (OSDI) questionnaire pre and post-operatively

3) To compare tear film changes in patients undergoing Femtosecond laser vs Mechanical microkeratome LASIK

4) To compare the tear film parameters between contact lens wearers and non-contact lens wearers who underwent LASIK surgery.

MATERIALS AND METHODS

Study design: Prospective non-randomized observational study

Study population: Patients attending the Cornea and Refractive services clinic at Aravind Eye Hospitals, Madurai who fulfil the inclusion criteria

Study period: 1.5 years

Recruitment period- 01/01/2018-31/12/2018

Total study duration- 01/01/2018-30/06/2019

Sampling technique: Non probability consecutive sampling

Sample size calculation:

$$n = \frac{z^2_{1-\alpha/2}\sigma^2}{\varepsilon^2\mu^2}$$

Where,

σ : Standard deviation

ε : Relative precision

μ : mean

1-α/2 : Desired confidence level

Sample size- A sample of 130 patients is needed to analyse the tear film pre and post LASIK using Oculus keratograph 5M. The mean (standard deviation) of average NIKBUT which is 10.35 (4.22) is taken as reference with 7% precision and 95% confidence interval.(8)

Inclusion criteria

1) Patients undergoing bilateral myopic LASIK (Mechanical microkeratome and Femtosecond Laser)
2) Age > 18 years
3) Patients who are willing to participate in the study and return for 1 month follow up visit

Exclusion criteria

1) Patients previously diagnosed to have dry eye
2) Pregnant women
3) Age </= 18 years
4) Patients with prior history of using topical ocular medications
5) Patients with prior history of surgery to the eye
6) Patients with allergic eye disease
7) Patients who have intraoperative complications

Data collection

Pre-operative data collection for all patients recruited in the study included demographic data such as name, age and sex. Relevant history pertaining to dry eye is detailed such as prior contact lens use, duration and type. Systemic history of Diabetes Mellitus, collagen vascular disease, Hormonal therapy, pregnancy, lactation and thyroid disorder was collected. Previous ocular history of dry eye, glaucoma, chronic uveitis,

allergic eye disease and history of laser treatment or prolonged use of topical ocular medications was collected.

Pre-operative

Evaluation parameters

1) Age
2) Sex
3) Contact lens history
4) Type of LASIK- a) Mechanical microkeratome b) Femtosecond laser assisted
5) Tear Meniscus height (TMH) using Oculus Keratograph 5M
6) Non-invasive keratograph tear break up time (NIKBUT) using Oculus Keratograph 5M
7) Schirmer's type II
8) Ocular surface disease index questionnaire (OSDI)

Oculus Keratograph 5M

Oculus Keratograph is a topography based analysis system that also has proven value in dry eye assessment including tear film quantity and quality, meibography.

Assessing quantity of tear film

Tear Mensicus Height (TMH)

Inferior TMH values were obtained perpendicular to the lid margin at a point relative to the center of the pupil. The normal TMH value is between 0.2-0.35 mm.

TMH readings were obtained 3 times in each eye and average taken to avoid intraobserver variability.(86)

Assessment of tear film quality

Non-invasive Keratograph Breakup time(NIKBUT)

Keratograph uses an infrared illumination system – wavelength 880 nm. The relatively small quantity of heat emitted in this system reduces thermally induced effects on tear film quality. An illuminated ring pattern consisting 22 mires in the form of a placido disc is projected onto the cornea. After aligning the patient correctly, the patient is prompted to blink twice. The second blink triggers the beginning of the video and the timer that will be recorded for measurement. During the test, the software detects distortion of mires. The measurement finishes at the time of the third blink or at the end of 24 seconds. A legend will show the time of tear breakup at different areas. 2 values are obtained. NIKBUT first – the time at which

first break up of tear film occurs and NIKBUT average- average time of all breakup incidents.(87) (78)

Each measurement is repeated three times and an average is taken to circumvent intraobserver variability.

Classification based on NIKBUT

Level	NIKBUT (seconds)
0=Stable tear film	>/= 14
1=short breakup time	>/= 7 <14
2=very short breakup time	<7

Schirmer II

The test was conducted under similar environmental conditions with eyes closed in all patients. A drop of local anaesthetic is instilled. A standard 5x35 mm Schirmer test strip is placed at the junction of the middle and lateral one third of the lower lid. The test was done in all patients with eyes closed and under similar environmental conditions. The amount of wetting at the end of 5 minutes is assessed. < 10mm wetting at the end of 5 minutes is considered abnormal.(88)

OSDI- Ocular Surface Disease Index

The Ocular Surface Disease Index (OSDI) is a Likert scale with five categories that can assess

- Symptoms
- Visual disturbance
- Environmental triggers

OSDI can be used to assess the potential of K5M to study occurrence of dry eye post LASIK.(63)

Intraoperative

Flap creation in the microkeratome group was carried out using Technolas, ZYOPTIX XP. A superior hinged flap was created in all patients

I) Flap thickness

Based on the pre-operative evaluation of the patient, the flap thickness was chosen

1) 120 µm

or

2) 140 µm

Intralase femtosecond laser - iFS 150 kHZ femtosecond laser in the raster mode was used in flap creation in the femtosecond group. A superior hinged flap was made in all patients.

The flap thickness used in Femtosecond laser assisted LASIK was:

1) 110 µm

or

3) 120 µm

Postoperative

All patients were given topical Gatifloxacin and Dexamethasone combination eye drops QID for 10 days following LASIK. None of the patients were given topical lubricants in the immediate post-operative period.

Additional medication prescribed, if any, was noted.

Follow up

1 month follow up visit – data collected included the same parameters measured pre-operatively; TMH, NIKBUT, Schirmer II, OSDI.

Statistical analysis

- Descriptive variables will be given with Frequency (Percentage) and continuous variables with Mean (Standard Deviation) or Median (IQR) based on parametric and non parametric distribution.
- The pre and post measurements will be compared with Paired t test or Wilcoxon Sign rank test.

- Comparison between parameters in Mechanical microkeratome and Femtosecond laser assisted Lasik was done with independent t test and Mann-Whitney U test.
- The correlation between the variables will be found using Pearson correlation coefficient or Intra class correlation coefficient.
- P value less than 0.05 will be considered as statistically significant.
- All the statistical analysis will be done using statistical software STATA 14.1 (Texas, USA).

RESULTS

The total number of participants in the study was 130.

Demographic data

Age

Mean (SD) of age of patients in the study was 23.74(3.20) years and it ranged from 19 to 39 years.

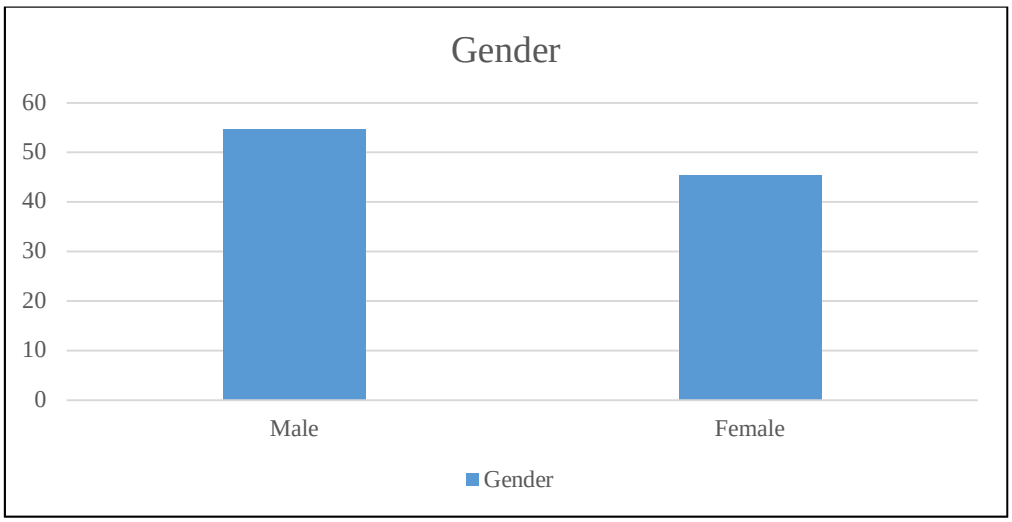
Gender

Table 1: Gender distribution

Gender	n	%
Male	71	54.6
Female	59	45.4
Overall	130	100

The study participants included 54.6% males (n = 71) and 45.4% females (n = 59).

Figure 2.1 : Gender distribution



Systemic comorbidity

Table 2: Systemic comorbidities in study population

Systemic comorbidity	n	%
Diabetes	1	0.8
Nil	129	99.2
Overall	130	100

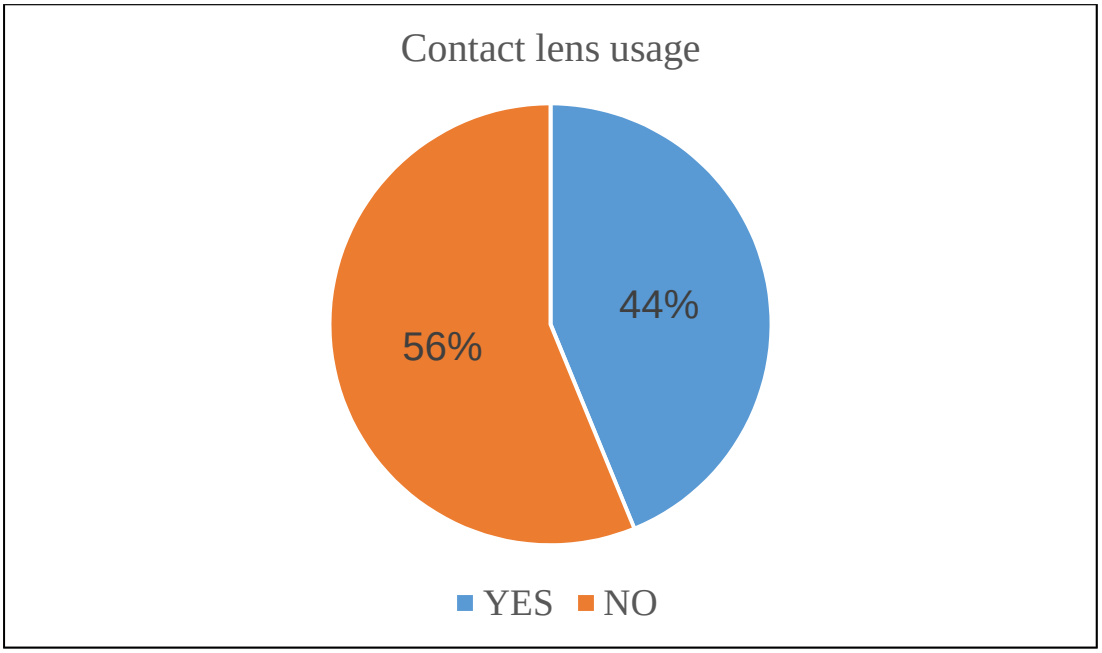
There were no significant systemic comorbidities in our study group. Only 1 patient had Polycystic ovarian syndrome with Diabetes Mellitus.

Contact lens usage history amongst participants

Table 3: Contact lens usage

Contact lens usage	n	%
Yes	57	43.8
No	73	56.2
Overall	130	100

Figure 2.2: % of contact lens wearers and non contact lens wearers



History of contact lens use was present among 57 (43.8%) of the study participants.

Contact lens type

Table 4: Contact lens type

Contact lens type	n	%
Soft	56	96.5
RGP	1	3.5
Overall	57	100

Most of the contact lens wearers used soft contact lens with only 1 patient who used a Rigid Gas Permeable contact lens.

Monthly vs yearly disposable

Table 5: Contact lens monthly vs yearly use distribution

Type	n	%
Monthly	46	80.7
Yearly	11	19.3
Overall	57	100

Majority of the contact lens wearers in the study used monthly disposable contact lens.

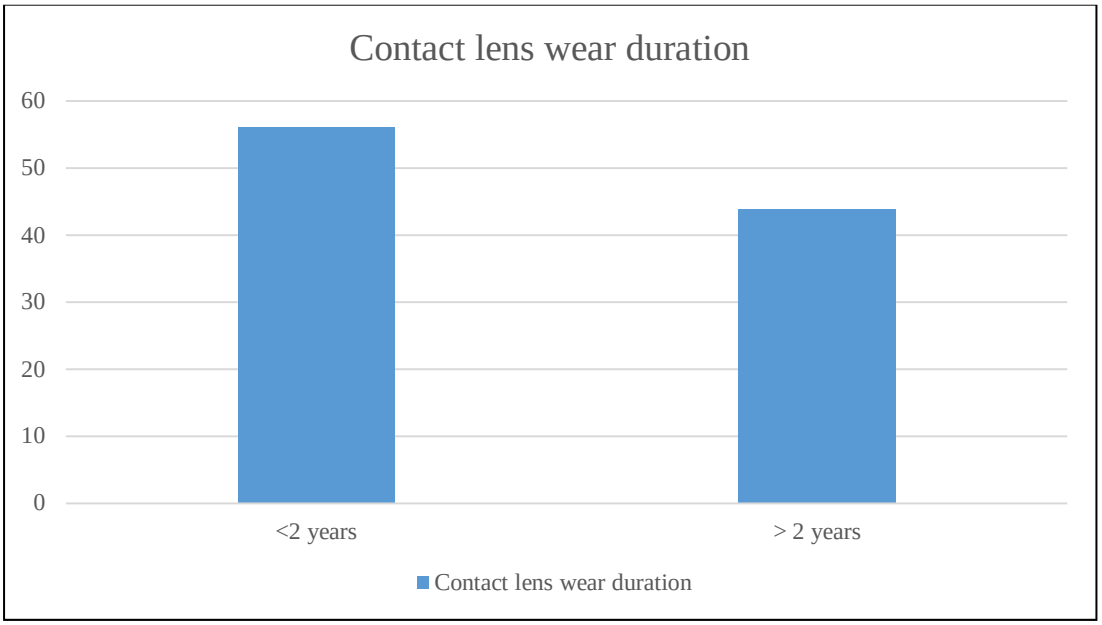
Contact lens duration

Table 6: Duration of contact lens wear

Contact lens duration	n	%
≤ 2 years	32	56.1
>2 years	25	43.9
Overall	57	100

25 patients (43.9%) had a history of contact lens usage for more than 2 years.

Figure 2.3: Duration of contact lens wear

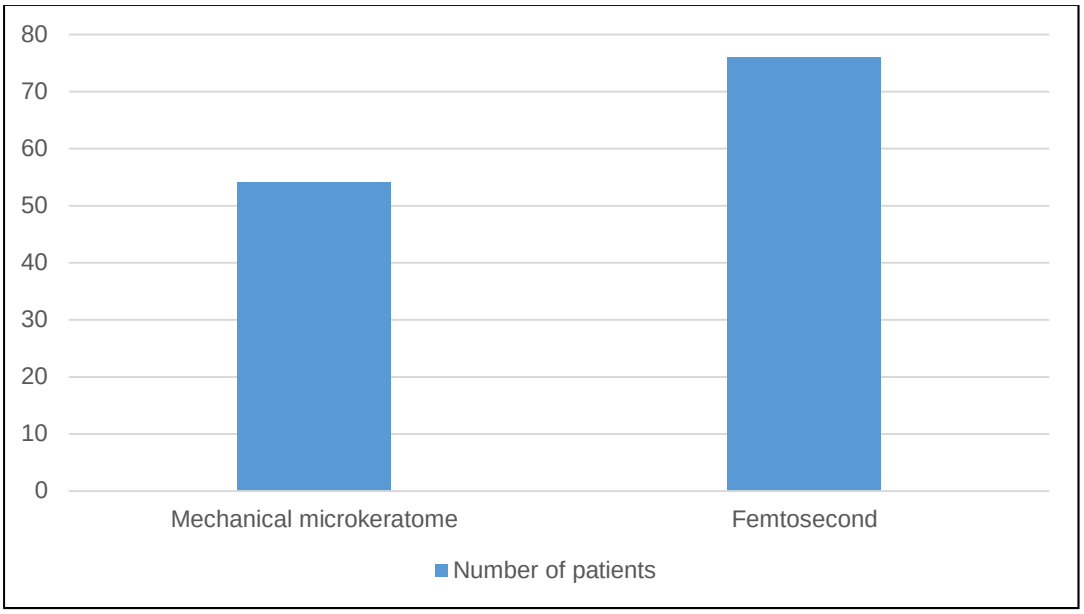


Mechanical microkeratome vs Femtosecond laser assisted LASIK

Table 7: Percentage distribution of Mechanical Microkeratome and Femtosecond LASIK

	n	%
Manual keratome	54	41.5
Femtosecond	76	58.5
Overall	130	100

Figure 2.4: Percentage distribution of Mechanical Microkeratome and Femtosecond LASIK



Flap thickness

Microkeratome

Table 8: Flap thickness in Microkeratome patients

Flap thickness	n	%
120 µ	7	12.96
140 µ	47	87.04
Total	54	100

Majority of the patients who underwent Microkeratome Lasik in our study had an intraoperative flap thickness of 140 µ (n = 47, 87%)

Femtosecond laser assisted LASIK

Table 9: Flap thickness in Femtosecond LASIK patients

Flap thickness	n	%
110 µ	71	93.42
120 µ	5	6.58
Total	76	100

Majority of the patients who underwent Femto LASIK in our study had an intraoperative flap thickness of 110 µ (n=71, 93%)

Tear meniscus height average

Tear meniscus height (TMH) values measured using Oculus Keratograph 5M pre and post-LASIK surgery

Table 10: TMH average pre and post-operatively

	TMH
Pre op Median IQR	 0.30 0.26 – 0.36
Post op Median IQR	 0.29 0.24 – 0.34
p value	**0.002**

*Wilcoxan sign rank test

There was a statistically significant difference between pre-op and 1 month post-operative TMH values. (p value 0.002)

TMH in Microkeratome LASIK group

Table 11: TMH average pre and post-operatively in Microkeratome LASIK

TMH	**Microkeratome LASIK**
Pre op Median IQR	 0.31 0.27 – 0.37
Post op Median IQR	 0.29 0.25 – 0.33
p value	**0.003**

*Wilcoxan sign rank test

p value (0.003) showed that there was a statistically significant decrease in 1 month post-operative TMH value compared to baseline in patients who underwent Microkeratome assisted LASIK.

TMH in Femtosecond laser assisted LASIK group

Table 12: TMH average pre and post-operatively in FemtoLASIK

TMH	**Femtosecond LASIK**
Pre op	
Median	0.30
IQR	0.26 – 0.36
Post op	
Median	0.29
IQR	0.24 – 0.36
p value	**0.025**

*Wilcoxan sign rank test

p value (0.025) showed that there was a significant decrease in 1 month post-operative TMH value in Femtosecond laser assisted LASIK patients compared to baseline.

The post-operative TMH value was also compared between patients undergoing Mechanical microkeratome and Femtosecond laser assisted LASIK

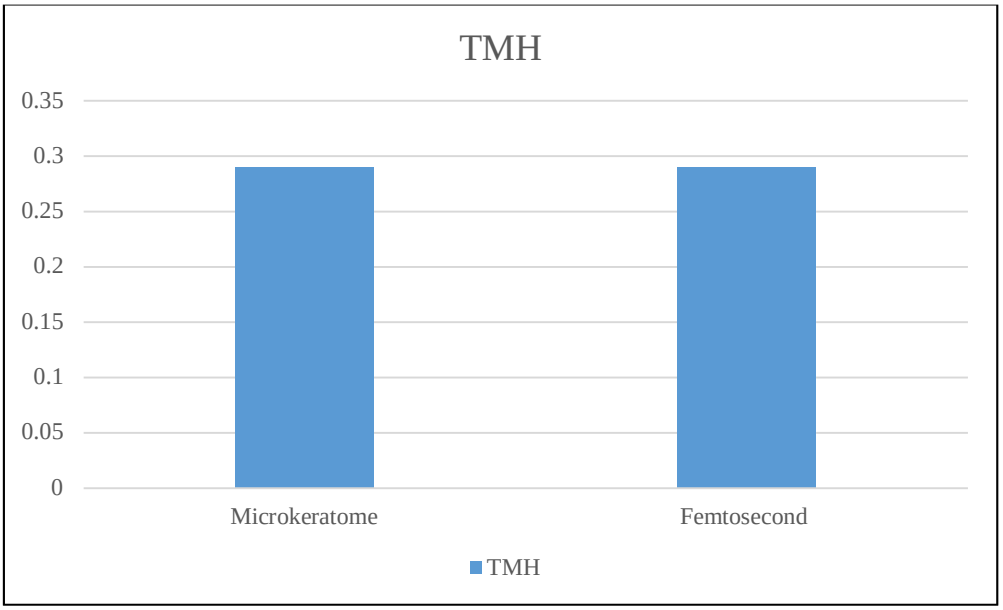
Table 13: TMH average comparison between Microkeratome and Femtosecond LASIK

TMH	Post-operative value
Manual keratome	Median - 0.29 IQR – 0.25-0.33
Femtosecond	Median – 0.29 IQR – 0.25 – 0.36
P value	0.884

*Mann-Whitney U test

There was no significant difference (p value 0.884) between Average TMH value between the two procedures.

Figure 2.5: TMH average comparison between Microkeratome and Femtosecond LASIK



Non-invasive keratograph tear break up time (NIKBUT) average

The NIKBUT average measured using Oculus Keratograph 5M showed the following results

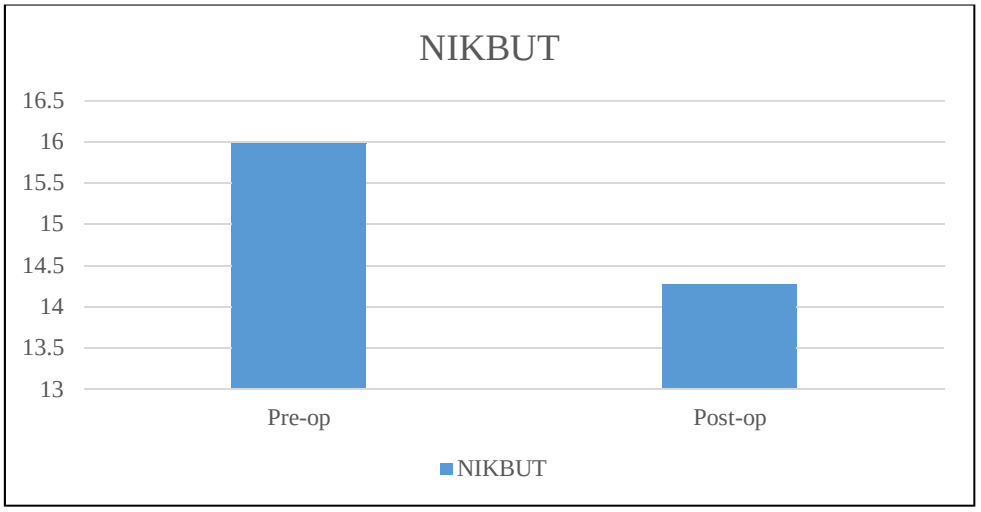
Table 14: NIKBUT Average pre and post-operatively

	NIKBUT Average
Pre-op Mean (SD) Min – Max	 15.95 (5.70) 2.45 to 27.48
Post-op Mean (SD) Min - Max	 14.27 (5.47) 1.56 to 26.70
p value	**0.0005**

*paired-t test

The pre-op mean of NIKBUT Average was 15.95 and post-op mean of NIKBUT Average was 14.27. There was a significant decrease noted in NIKBUT Average values post-operatively at 1 month follow up. (p value 0.0005)

Figure 2.6: NIKBUT Average pre and post-operatively



NIKBUT average in patients undergoing Microkeratome LASIK

Table 15: NIKBUT Average pre and post-operatively in Microkeratome LASIK

Microkeratome keratome	NIKBUT Average
Pre-op Mean (SD) Min – Max	 15.50 (5.85) 2.45 to 23.96
Post-op Mean (SD) Min - Max	 14.06 (5.01) 3.86 to 24.02
p value	**0.025**

*paired t-test

In patients who underwent Microkeratome assisted LASIK, pre-op mean NIKBUT Average was 15.50 and post-op mean of NIKBUT Average was 14.06. There was a significant decrease in post-operative NIKBUT Average (p value 0.025) in patients who underwent Microkeratome assisted LASIK.

NIKBUT Average in Femtosecond laser assisted LASIK patients

Table 16: NIKBUT Average pre and post-operatively in FemtoLASIK

Femtosecond LASIK	NIKBUT Average
Pre-op Mean (SD) Min – Max	 16.27 (5.58) 3.08 to 27.48
Post-op Mean (SD) Min - Max	 14.41 (5.78) 1.56 to 26.70
p value	**0.003**

*paired t-test

In patients who underwent Femtosecond laser assisted LASIK, the pre-operative mean of NIKBUT Average was 16.27 and post-operatively, the mean value was found to be 14.41.There was a significant decrease in post-operative NIKBUT Average in patients who underwent Femtosecond assisted LASIK. (p value 0.003)

NIKBUT Average in Microkeratome vs Femtosecond Laser assisted LASIK

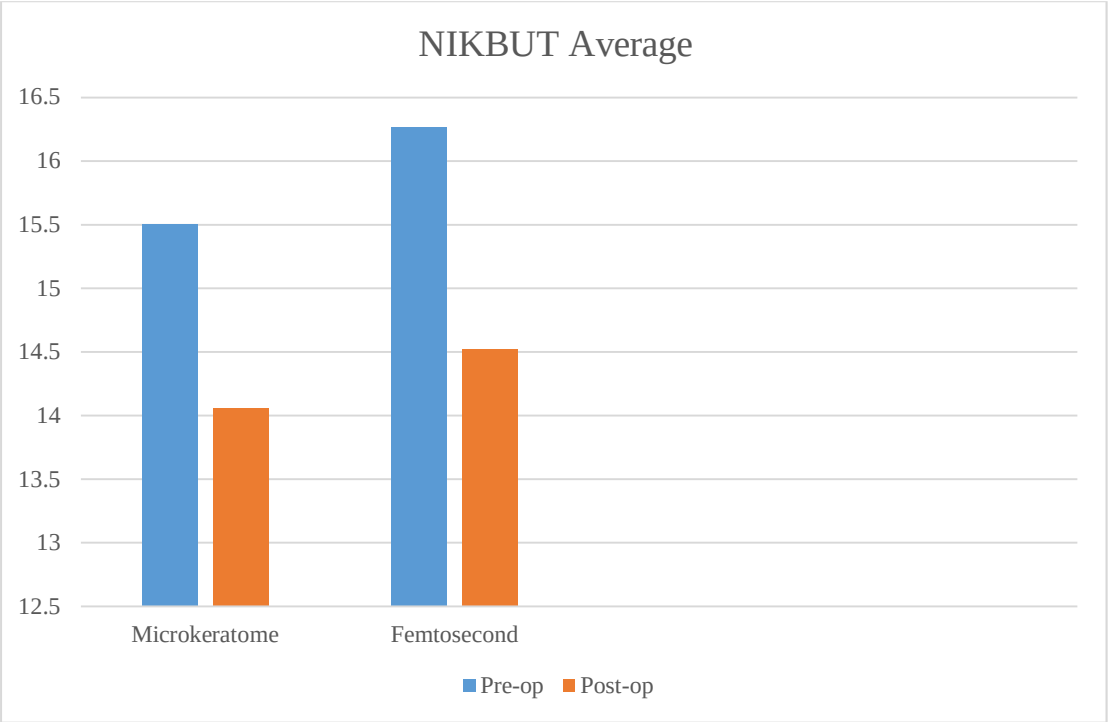
Table 17: Comparison between NIKBUT Average in Microkeratome and FemtoLASIK

	NIKBUT Average
Microkeratome	
Mean (SD)	14.06 (5.01)
Min – Max	3.86 to 24.02
Femtosecond laser	
Mean (SD)	14.41 (5.78)
Min - Max	1.56 to 26.70
p value	0.607

*independent t-test

The post-operative mean of NIKBUT Average was 14.06 in Microkeratome assisted LASIK patients and 14.41 in Femtosecond laser assisted LASIK patients. There was no significant difference (p value 0.607) in the post-operative NIKBUT Average between patients undergoing Microkeratome and Femtosecond LASIK.

Figure 2.7: NIKBUT Average in Microkeratome and FemtoLASIK



Schirmer's test

Table 18: Schirmer values pre and post-operatively

	Schirmer value
Pre-op Mean (SD) Min – Max	 24.25(8.12) 10 to 35
Post-op Mean (SD) Min - Max	 23.00 (7.40) 5 to 36
p value	**0.003**

*paired t-test

The pre-operative mean Schirmer value was 24.25 and post-operative mean was 23. There was a statistically significant difference between pre and postoperative Schirmer's in the patients who underwent LASIK. (p value 0.003)

Schirmer's test in Microkeratome LASIK group

Table 19: Schirmer values in Microkeratome LASIK

	Schirmer value
Pre-op Mean (SD) Min – Max	 25.03(7.17) 10 to 35
Post-op Mean (SD) Min - Max	 23.98 (7.46) 10 to 35
p value	0.112

*paired t-test

The mean pre-operative and post-operative Schirmer value in Microkeratome assisted LASIK patients were 25.03 and 23.98 respectively. There was no significant difference (p value 0.112) between pre and post-operative Schirmer's in patients who underwent Microkeratome assisted LASIK

Schirmer's test in Femtosecond LASIK group

Table 20: Schirmer values pre and post-operatively

	Schirmer value
Pre-op Mean (SD) Min – Max	 23.69 (8.70) 5 to 35
Post-op Mean (SD) Min - Max	 22.31 (7.30) 5 to 36
p value	**0.013**

*paired t-test

In Femto-LASIK patients, the pre-operative and post-operative Schirmer values were 23.69 and 22.31 respectively. There was a statistically significant difference (p value 0.013) between pre and post-operative Schirmer's in patients who underwent Femtosecond laser assisted LASIK.

Schirmer's test in Microkeratome vs Femtosecond LASIK group

Table 21: Comparison of Schirmer values between Microkeratome and FemtoLASIK

	Schirmer value
Manual Keratome Mean (SD) Min – Max	 23.98 (7.46) 10 to 35
Femtosecond Mean (SD) Min - Max	 22.31 (7.30) 5 to 36
p value	0.073

*independent t-test

The post-operative mean Schirmer value was 23.98 in Microkeratome assisted LASIK patients and 22.31 in Femtosecond LASIK patients. There was no significant difference (p value 0.073) on comparing post-operative Schirmer's between patients who underwent Microkeratome and Femtosecond LASIK.

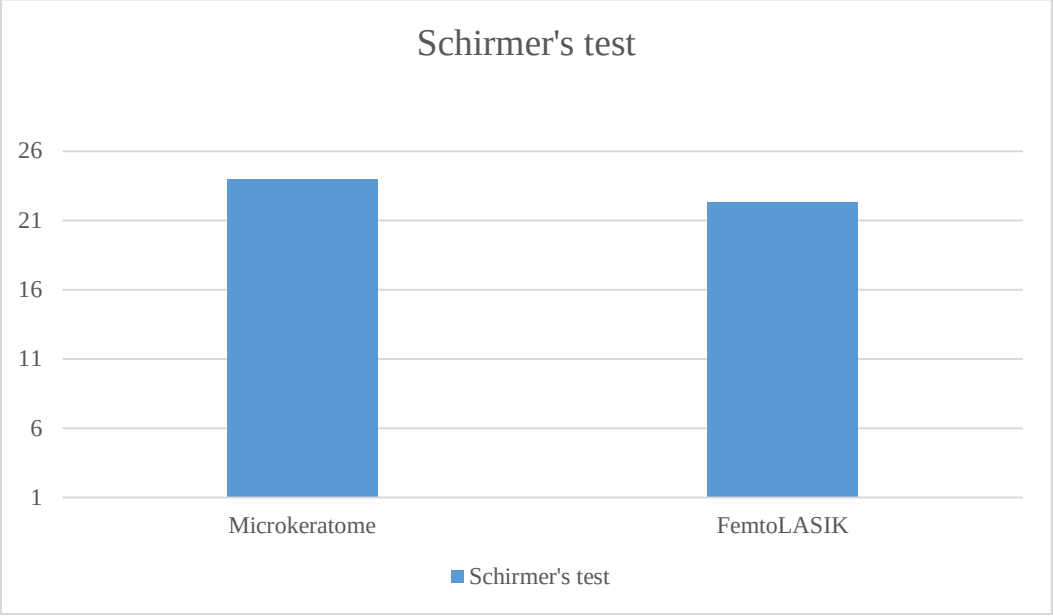


Figure 2.8: Comparison of Schirmer values between Microkeratome and FemtoLASIK

Ocular Surface Disease Index (OSDI) Score

Table 23: OSDI pre and post-operatively

	OSDI score
Pre-op Mean (SD) Min – Max	 0.91 (2.40) 0 to 12.50
Post-op Mean (SD) Min – Max	 0.68 (1.97) 0 to 12.50
p value	0.959

*Wilcoxan sign rank test

There was no significant difference (p value 0.959) in the OSDI score pre and 1 month post-operatively in patients who underwent both Microkeratome and Femtosecond LASIK.

OSDI in Microkeratome vs Femtosecond LASIK group

Table 24: OSDI comparison between Manual Keratome and FemtoLASIK

	OSDI score
Microkeratome Mean (SD) Min – Max	 0.84 (2.58) 0 to 12.50
Femtosecond Mean (SD) Min – Max	 0.57 (1.41) 0 to 6.35
p value	0.744

*Mann-Whitney U test

There was no significant difference (p value 0.744) in the post-operative OSDI scores of Microkeratome and Femtosecond LASIK groups.

Contact lens and tear film parameters

Tear meniscus height (TMH)

Table 25: TMH in contact lens and non contact lens wearers

	Contact lens wearers (n = 57)	**Non contact lens wearers (n = 73)**
Baseline		
Median	0.30	0.31
IQR	0.26 – 0.36	0.26 – 0.37
Post-operative		
Median	0.28	0.30
IQR	0.23 – 0.33	0.25 – 0.36
p value	**0.0002**	0.147

*Wilcoxan sign rank test

There was a significant difference (p value 0.0002) between baseline and post-op TMH among the contact lens wearers group. There was no significant difference between baseline and post-operative TMH among non-contact lens wearers (p value 0.147).

Non-invasive Keratograph tear break-up time (NIKBUT)

Table 26: NIKBUT in contact lens and non contact lens wearers

Average NIKBUT	**Contact lens wearers (n = 57)**	**Non contact lens wearers (n = 73)**
Baseline		
Mean (SD)	15.25(5.84)	16.50(5.54)
Min - Max	2.45 to 27.48	2.80 to 24.09
Post-op		
Mean (SD)	12.90(5.49)	15.33(5.23)
Min - Max	1.78 to 26.70	1.56 to 24.15
p value	**0.005**	**0.038**

*paired t-test

There was a statistically significant difference (p = 0.005) between baseline and post-operative NIKBUT among the contact lens wearers group and in the non-contact lens wearers group. (p value = 0.038)

Schirmer

Table 27: Schirmer values in contact lens and non contact lens wearers

Schirmer	**Contact lens wearers (n = 57)**	**Non contact lens wearers (n = 73)**
Baseline		
Mean(SD)	24.15(8.91)	24.32(7.46)
Min - Max	5 – 35	5 – 35
Post-op		
Mean(SD)	22.70(8.12)	23.24(6.81)
Min - Max	9 - 36	5 - 35
p-value	**0.040**	**0.037**

*paired t-test

There was a statistically significant difference in the Schirmer values pre and post-operatively in both contact lens wearers (p value 0.040) and non contact lens wearers groups (p value 0.037).

OSDI

Table 28: OSDI in contact lens wearers and non contact lens wearers

OSDI score	Contact lens wearers (n = 57)	Non contact lens wearers (n = 73)
Baseline		
Mean(SD)	0.80(1.87)	0.99(2.76)
Median	0	0
Min - Max	0 to 8.3	0 to 12.5
Post-op		
Mean(SD)	0.83(2.32)	0.56(1.66)
Median	0	0
Min - Max	0 to 12.5	0 to 8.3
p value	0.836	0.762

*Wilcoxan sign rank test

There was no significant difference in OSDI pre and post-operatively in the contact lens wearers group (p value 0.836) and non contact lens wearers. (p value 0.762)

DISCUSSION

This is a prospective observational study done to analyse the tear film parameters pre-operatively and post-operatively, using Oculus Keratograph 5M in patients who underwent LASIK. Dry eye is one of the most common complications post refractive surgery, although usually transient. (89) Denervation of the cornea secondary to raising a flap in LASIK results in disruption of the tear film surface. This makes it vital to screen patients pre-operatively and identify those at risk of post-operative dry eye. (56) No single test can provide conclusive evidence of dry eye. A combination of tests along with a subjective questionnaire is thus a suitable approach as signs often do not correlate with symptoms in patients with dry eye disease. (90)

Demographic data

The total number of participants in this study was 130. The mean age of participants in the study was 23.74 years with a range between 19 and 39 years. Yu et al conducted a similar study to evaluate the tear film stability post LASIK which included 38 patients with an age range of 21 to 47 with a mean age of 31.(44) Salomao et al studied dry eye after LASIK among 183 patients with a mean age of 43, ranging between 20 to 72 years of age.(10) The older age of the population demographic in western

countries could contribute to the higher incidence of dry eye post LASIK in those studies.

71 patients (54%) were male and 59 patients (45%) were female. History of contact lens usage was present among 57 patients (43.8%) of the participants in the study. Prolonged usage of contact lens has been shown to affect the corneal sensitivity and decrease tear secretion in the study conducted by Benitez et al. (91) Our study showed a significant decrease in TMH among contact lens wearers when compared to the non-contact lens wearers. NIKBUT and Schirmer values were statistically significant in both contact lens and non-contact lens wearers.. There was no significant difference based on the duration of contact lens usage (>2 years).

Tear Meniscus Height (TMH)

Tao et al studied the tear meniscus height using OCT in LASIK patients pre-operatively and post-operatively at 1 week, 1 month and 20 months after surgery. Both upper and lower tear meniscus height showed decrease 1 month post-operatively but normalised by 20 months post-op. (92) Patel et al compared the tear meniscus height in patients who underwent LASIK pre-operatively and 1, 3 and 6 months post-operatively. They concluded that the differences in average tear meniscus height were not statistically significant post-LASIK surgery. (93) Our study showed a

statistically significant difference in average TMH measured using Oculus Keratagraph 5M between pre-operative and 1 month post-operative values. However a long term follow up is needed to assess if this difference post-operatively is transient. There was no significant difference in TMH values on comparing between Manual Keratome and Femtosecond LASIK groups.

Non-invasive Keratograph tear break-up time (NIKBUT)

Yu et al studied the tear film stability post-LASIK. Their TBUT measurements showed a decrease 1 day and 1 week post-operatively but normalised by 1 month post-operatively.(44) Toda et al studied the occurrence of dry eye post LASIK using a combination of tear film parameters. TBUT measurements were decreased 1 and 3 months post-operative follow up but returned to baseline by 6-9 months post-operatively. They concluded that compromised tear film surface was present for atleast 1 month post-operatively. (45) Conventional TBUT uses fluorescein that could potentially destabilise the tear film.(78) In our study, we used the Oculus Keratograph to non-invasively assess the tear break-up time. Our study showed a significant difference between pre-operative and post-operative NIKBUT in LASIK patients measured at 1 month follow up. There was no significant difference between patients who underwent Manual Keratome or Femtosecond Laser assisted LASIK. Sun et al showed

that TBUT values were higher in patients who underwent Femtosecond assisted LASIK when compared to Manual Keratome. (80)

Schirmer's test

A pre-operative Schirmer value of less than 10 mm has been shown to significantly increase the occurrence of dry eye post-LASIK. (3) (94) Hassan et al conducted a study where they studied a number of tear film parameters in LASIK patients pre-operatively and post-operatively at day 1, 1 month and 3 months post-operatively. Their study found no significant difference in Schirmer's test. (95) Shahzad et al studied tear film parameters following Femtosecond assisted LASIK. A statistically significant difference was found in Schirmer's, more so in patients where a thicker (130 µm) flap was raised. (46) Our study showed a significant difference between baseline and post-operative Schirmer values. There was no significant difference in post-operative Schirmer values between Mechanical Microkeratome and Femtosecond LASIK groups.

OSDI

Hassan et al evaluated OSDI in 15 LASIK patients and found that it was increased on post-operative day 1, 1 month but returned to baseline by 2 months post-operatively. (95) In a study conducted by Sun et al among 43 patients, OSDI was found to be increased 1 week post-operatively but

did not return to baseline even 6 months post-operatively. (96) Jung et al compared 60 controls with 60 patients who underwent LASIK, which showed a worsening of OSDI and TBUT in the LASIK group, however the difference in Schirmer was not statistically significant. (97) Our study showed no significant difference between OSDI values pre and post-operatively in LASIK patients.

The results obtained from subjective OSDI questionnaire showed a discrepancy from the objective tear film parameters such as TMH, NIBUT and Schirmer's in our study. Although the results of the aforementioned objective tests showed a statistically significant difference pre and post-operatively, it was not found to be clinically significant as the patients were asymptomatic, as supported by the results obtained from the OSDI questionnaire. TFOS DEWS II Epidemiology report found that there has not been any detailed population survey in dry eye in the southern hemisphere over the past decade. Such a study could potentially map out environmental, socioeconomic and geospatial influences of dry eye. These factors could contribute to the explanation of the relatively lower occurrence of subjective symptoms of dry eye post LASIK in our population demographic.(22)

Microkeratome vs Femtosecond laser assisted LASIK

Salomao et al conducted a retrospective study among 183 patients who underwent LASIK, of which 113 had femto-LASIK and 70 had Microkeratome assisted LASIK. They found that the occurrence of LASIK induced neurotrophic epitheliopathy (LINE), punctate epithelial erosions and subjective symptoms were significantly higher in the Microkeratome group. (10) Barequet et al retrospectively studied the dry eye parameters among 38 patients who underwent Femtosecond Lasik with a thin flap. They found that the thin, uniform flap raised using femtosecond laser did not significantly affect Schirmer, TBUT, corneal sensitivity and staining 6 months post LASIK. (98) Sun et al found no significant difference in Schirmer, corneal surface staining, sensitivity and subjective symptoms at 1 week, 1 month, 3 and 6 months post LASIK on comparing Femtosecond group with Microkeratome. The only significant finding was TBUT which was higher in patients who underwent femtosecond assisted LASIK. (80) Our study found no significant difference in tear film parameters and subjective symptoms on comparing the Microkeratome group with Femtosecond laser assisted LASIK.

LIMITATIONS

1) Dry is known to be a transient complication of LASIK which requires a longer follow up of LASIK patients post-operatively until 9 months or further, to study the course of dry eye disease and to detect the occurrence of chronicity.
2) In spite of developing a protocol to maintain a 10 minute time interval between individual tests, each test is capable of inducing reflex tearing which could influence the final results.
3) Our study did not evaluate the effect of location of flap hinge on the occurrence of dry eye, as all cases had a superiorly hinged flap.

CONCLUSION

1) Tear film parameters measured using Oculus Keratagraph 5M showed a decrease post-LASIK, in both Mechanical Microkeratome and Femtosecond laser assisted LASIK groups.
2) Schirmer values showed a decrease post-operatively in LASIK patients.
3) These objective results, however, were not substantiated by subjective OSDI questionnaire, as patients in our population demographic were asymptomatic. This could also be attributed to the fact that symptoms and signs of dry eye disease do not always correlate.
4) There was no significant difference in the post-operative tear film parameters on comparing Microkeratome and Femtosecond LASIK patients in our study.
5) Post-operative tear film parameters were similar in contact lens and non-contact lens wearers.

RECOMMENDATIONS

1) Longer follow up period of 3 to 9 months post-operatively would aid in understanding the course of dry eye post-LASIK and to study occurrence of chronicity of dry eye.
2) Inclusion of PRK and SMILE in subsequent cohorts would help in comparison of tear film parameters among different keratorefractive procedures.

ANNEXURE

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ABBREVIATIONS

LASIK	-	Laser assisted in-situ keratomilieusis
MK	-	Mechanical Microkeratome
FS	-	Femtosecond laser
TMH	-	Tear Meniscus Height
NIKBUT	-	Non-invasive Keratograph Tear break-up time
OSDI	-	Ocular Surface Disease Index
TBUT	-	Tear break-up time
PRK	-	Photorefractive keratectomy
SMILE	-	Small Incision Lenticule Extraction
TFOS DEWS II	-	Tear Film and Ocular surface Society- Dry Eye Workshop II
MGD	-	Meibomian gland dysfunction
BAK	-	Benzalkonium chloride
mm	-	millimetre
nm	-	nanometer
p value	-	Probability value
IQR	-	Interquartile range

PROFORMA - ANALYSIS OF TEAR FILM PRE AND POST LASIK

Name: Age: Sex: ☐ M ☐ F

MR No: ☐☐☐☐☐☐☐ Study No: ☐☐☐

UID No: ☐☐☐☐☐☐☐☐☐☐

H/O contact lens use: ☐ Yes ☐ No If yes, duration: ☐ years

Type of contact lens: ☐ RGP ☐ Soft

☐ Monthly ☐ Yearly ☐ Disposable

Systemic history: ☐ Diabetes ☐ Collagen vascular disease

☐ Hormonal therapy ☐ Pregnancy

☐ Lactation ☐ Thyroid disorder ☐ Nil

Previous Ocular history: ☐ Dry eye ☐ Glaucoma

☐ RD ☐ Laser done

☐ Chronic uveitis ☐ Allergic eye disease

☐ Nil

Refractive surgery advised: LASIK:

☐ Manual Keratome

☐ Femtosecond laser

PRE OP

TMH

	RIGHT EYE	**LEFT EYE**
R1		
R2		
R3		
Average		

NIKBUT:

	RIGHT EYE	**LEFT EYE**
First		
Average		

Schirmer's: (Measured 5 min after instillation of topical anaesthetic)

RIGHT EYE (mm)	**LEFT EYE (mm)**

PRE OP

OCULAR SURFACE DISEASE INDEX (OSDI)

Have you experienced any of the following *during the last week?*	**All of the time**	**Most of the time**	**Half of the time**	**Some of the time**	**None of the time**
1)Eyes that are sensitive to light?	4	3	2	1	0
2) Eyes that feel gritty?	4	3	2	1	0
3) Painful or sore eyes?	4	3	2	1	0
4) Blurred vision?	4	3	2	1	0
5) Poor vision?	4	3	2	1	0

Subtotal score for answers 1 to 5 (A): ☐

Have problems with your eyes limited you in performing ant of the following *during the last week?*	**All of the time**	**Most of the time**	**Half of the time**	**Some of the time**	**None of the time**
6) Reading?	4	3	2	1	0
7) Driving at night?	4	3	2	1	0
8) Working with a computer or a bank machine (ATM)?	4	3	2	1	0
9) Watching TV?	4	3	2	1	0

Subtotal score for answers 6-9 (B): ☐

Have your eyes felt uncomfortable in any of the following situations *during the last week?*	**All of the time**	**Most of the time**	**Half of the time**	**Some of the time**	**None of the time**
10) Windy conditions?	4	3	2	1	0
11) Places or areas with low humidity/very dry?	4	3	2	1	0
12) Areas that are air conditioned?	4	3	2	1	0

Subtotal scores for answers 10-12 (C): ☐

Sum of subtotals A, B and C: (D) ☐

Total number of questions answered: (E) ☐

OSDI: D/E X 25 = ☐

POST OP:

Flap thickness:

If Manual keratome: ☐ 120 µm ☐ 140 µm

If Femtosecond laser: ☐ 110 µm ☐ 120 µm

Post-op medication: ☐ Gatilox DM QID X 10 days

Any other, specify: _____

TMH

	RIGHT EYE	**LEFT EYE**
R1		
R2		
R3		
Average		

NIKBUT

	RIGHT EYE	**LEFT EYE**
First		
Average		

Schirmer's: (Measured 5 min after instillation of topical anaesthetic)

RIGHT EYE (mm)	**LEFT EYE (mm)**

POST OP

OCULAR SURFACE DISEASE INDEX (OSDI)

Have you experienced any of the following *during the last week?*	**All of the time**	**Most of the time**	**Half of the time**	**Some of the time**	**None of the time**
1)Eyes that are sensitive to light?	4	3	2	1	0
2) Eyes that feel gritty?	4	3	2	1	0
3) Painful or sore eyes?	4	3	2	1	0
4) Blurred vision?	4	3	2	1	0
5) Poor vision?	4	3	2	1	0

Subtotal score for answers 1 to 5 (A): ☐

Have problems with your eyes limited you in performing ant of the following *during the last week?*	**All of the time**	**Most of the time**	**Half of the time**	**Some of the time**	**None of the time**
1) Reading?	4	3	2	1	0
7) Driving at night?	4	3	2	1	0
8) Working with a computer or a bank machine (ATM)?	4	3	2	1	0
9) Watching TV?	4	3	2	1	0

Subtotal score for answers 6-9 (B): ☐

Have your eyes felt uncomfortable in any of the following situations *during the last week?*	**All of the time**	**Most of the time**	**Half of the time**	**Some of the time**	**None of the time**
10) Windy conditions?	4	3	2	1	0
11) Places or areas with low humidity/very dry?	4	3	2	1	0
12) Areas that are air conditioned?	4	3	2	1	0

Subtotal scores for answers 10-12 (C): ☐

Sum of subtotals A, B and C: (D) ☐

Total number of questions answered: (E) ☐

OSDI: D/E X 25 = ☐

INFORMED CONSENT FORM TO PARTICIPATE IN THE STUDY

STUDY: ANALYSIS OF TEAR FILM PRE AND POST LASIK USING OCULUS KERATOGRAPH 5M IN A TERTIARY EYE CARE CENTER

Protocol Number:

Subject's Name:_____Subject's Initials: _____

Subject ID No: _____

Date of Birth / Age: _____

I confirm that I have understood the information about the study, procedures and treatments for the above study and have had the opportunity to ask questions and I received satisfactory answers to all of my questions. I have been given a copy of the informed consent form to take home	[ ]
I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected. However, this is may not be possible for certain surgical procedures	[ ]
I understand that the Investigator of the study can access my health records for the research purpose. However, I understand that my identity will not be revealed in any information released to third parties or published.	[ ]
I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s)	[ ]
I agree to take part in the above study.	[ ]

Signature (or Thumb impression) of the Subject: _____

Date:_____/_____/_____

Subject's Name: _____

Signature (or Thumb impression) of Legally Acceptable Representative (LAR):

_____ Date: _____

Signature of the Investigator: _____

Date:_____/_____/_____

Investigator's Name: _____

Signature of the Witness _____

Date:_____/_____/_____

Name of the Witness: _____

ARAVIND MEDICAL RESEARCH FOUNDATION
Institutional Ethics Committee
(REGISTRATION NO. ECR/182/INST/TN/2013 DATED 20.04.2013)

20th December 2017

To
Dr.Srishti Ramamurthy
MS Resident
Aravind Eye Hospital
Madurai

Dear Dr. Srishti Ramamurthy,

Thesis Title: Analysis of tear film Pre and Post-LASIK (Manual Keratome and Femtosecond Laser assisted) using Oculus Keratograph 5M in a tertiary eye care center

IEC Code: IEC201800250

Thank you for submitting your thesis and seeking the approval from the ethics committee. The documents provided by you for consideration which include the thesis protocol and informed consent forms were reviewed for the research methodology and scientific content. The Ethical committee did not find any correction and has recommended the thesis to go ahead in the present form.

Thanking you

Yours Sincerely,

Dr.R.Sharmila
Member Secretary
Institutional Ethics Committee

MEMBER SECRETARY
INSTITUTIONAL ETHICS COMMITTEE
ARAVIND MEDICAL RESEARCH FOUNDATION
No.1, Anna Nagar, Madurai-625 020

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E-mail: amrf@aravind.org; www.aravind.org

URKUND Report

URKUND

Urkund Analysis Result

Analysed Document: Analysis of tear film pre and post LASIK using Oculus Keratograph 5M.docx (D56444677)
Submitted: 10/3/2019 8:22:00 PM
Submitted By: srishti.ramamurthy@gmail.com
Significance: 1 %

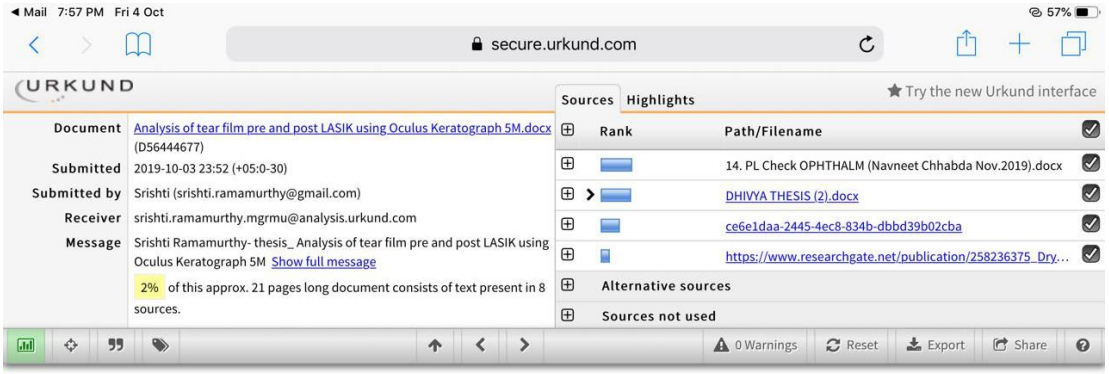
Sources included in the report:

DHIVYA THESIS (2).docx (D31792446)
14. PL Check OPHTHALM (Navneet Chhabda Nov.2019).docx (D55543235)
https://www.researchgate.net/publication/258236375_Dry_Eyes_in_Patients_Undergoing_Refractive_Surgery
ce6e1daa-2445-4ec8-834b-dbbd39b02cba

Instances where selected sources appear:

5

URKUND Analysis screenshot



Introduction

Dry eye is one of the most commonly reported post-operative complications of Refractive surgery. (1) Studies have shown that the incidence of dry eye post LASIK was found to be 20% to 50%. (2) Occurrence of dry eye is a transient complication but chronicity of disease is reported in around 20% of patients. (3)

The pathophysiological mechanism of dry eye following LASIK is likely to be multifactorial. Flap creation in LASIK surgically disrupts the afferent sensory corneal nerves leading to neurotrophic epitheliopathy. (4) In addition, LASIK has been postulated to cause inflammatory desiccation of the corneal surface and a loss of conjunctival goblet cells, aggravating dry eye. (5)

Pre-operative assessment of tear film parameters would help predict the likelihood of developing post-operative dry eye. (6) Studies have shown that results of Schirmer's test when used alone may not be reliable for detecting mild to moderate dry eye. (7) Traditional tear film break up time use Fluorescein dye which destabilises the tear film. The Oculus Keratograph 5M uses imaging modalities to noninvasively measure tear film break up time and tear meniscus height. These non-invasive measurements reduce reflex tearing and are established to have good

S No	MR No	UID No	Name	Age	Sex 1-M 2-F	Contact lens use: 1- Yes 2- No	IFYES-Duration:	Type: 1-RGP 2-Soft	1-Monthly 2-Yearly 3-Disposable	Systemic: 1- Diabetes 2- Collagen vascular disease 3-HRT 4-Pregnancy 5-Lactation 6- Thyroid disorder 7-Nil	Ocular: 1-Dry eye 2-Glaucoma 3-RD 4-Laser done 5-Chronic uveitis 6-Allergic eye disease 7-Nil	LASIK: 1-Manual Keratome 2-Femtosecond laser	RE TMH: R1	RE TMH: R2	RE TMH: R3	RE Average TMH	LE TMH R1	LE TMH R2	LE TMH R3	LETMH Average	RE NIKBUT First	RE NIKBUT Average	LE NIKBUT First	LE NIKBUT Average	RE Schirmer	LE Schirmer	Pre op OSDI	Flap thickness- MK: 1-120 2-140	Flap thickness- FS: 1-110 2-120	Intra-op complications: 1-yes 2-no	Post op medication: 1- Gatilox DM 2- Lubricants 3- Others	1 month post -op visit: 1- attended 2-not attended	Post op RE TMHR1	RE TMH R2	RE TMH R3	RE TMH Avg	LE TMH R1	LE TMH R2	LE TMH R3	LE TMH Avg	RE NIKBUT First	RE NIKBUT Avg	LE NIKBUT First	LE NIKBUT Avg	RE Schirmer	LE Schirmer	Post op OSDI
1	4697022	12366263	Manikandan	27	1	2		-	-	7	7	2	0.26	0.3	0.3	0.29	0.3	0.26	0.3	0.29	23.6	23.7	23.71	23.82	18	22	12.5		1	2	2	1	0.26	0.28	0.28	0.27	0.27	0.27	0.24	0.26	20.3	21.45	23.22	23.22	20	20	0.00
2	4658867	12138934	Azhagarsamy	25	1	2		-	-	7	7	2	0.3	0.31	0.31	0.31	0.34	0.43	0.35	0.37	8.16	20.7	8.66	20.65	30	28	0		2	2	1	1	0.24	0.31	0.24	0.26	0.2	0.22	0.24	0.22	14.3	20.54	22.75	22.75	30	25	0.00
3	4685957	12303920	Keerthi	26	2	1	1 y	2	1	7	7	2	0.24	0.22	0.2	0.22	0.24	0.23	0.28	0.25	20.1	22.6	20.14	23.17	5	5	0			2	1	1	0.34	0.27	0.31	0.31	0.34	0.36	0.34	0.35	6.5	13.64	6.5	13.64	20	14	0.00
4	4701061	12590834	S.S Deepu	23	2	1	2 y	2	1	7	7	2	0.32	0.42	0.35	0.36	0.38	0.42	0.34	0.38	4.14	12.6	5.54	19.23	10	12	0		1	2	1	1	0.2	0.21	0.23	0.21	0.25	0.26	0.26	0.26	10.9	12.8	11.2	12.4	20	16	0.00
5	4694123	12674369	Haifa	27	2	1	4 y	2	1	7	7	1	0.23	0.23	0.25	0.24	0.26	0.27	0.28	0.27	12.1	13.2	11.2	14.1	13	18	0	2		2	1	1	0.23	0.25	0.26	0.25	0.22	0.24	0.27	0.24	11.2	13.5	14.2	15.1	11	15	0.00
6	4709287	12443640	Suresh	20	1	1	1 y	2	1	7	7	1	0.31	0.24	0.26	0.27	0.36	0.36	0.32	0.35	15.2	16	11.85	16.97	35	32	0	2		2	1	1	0.29	0.39	0.46	0.38	0.36	0.48	0.41	0.42	8.22	10.04	3.24	13.91	16	32	0.00
7	4702133	12387139	Vignesh Prabhu	29	1	1	2 y	2	1	7	7	2	0.36	0.36	0.36	0.36	0.36	0.38	0.38	0.37	12.5	13.9	11.48	14.9	26	29	0		1	2	1	1	0.31	0.36	0.44	0.37	0.4	0.29	0.26	0.32	6.75	8.15	6.37	13.01	35	35	0.00
8	4698921	10985643	Kalaimurugan gandhi	22	1	2				7	7	2	0.35	0.33	0.36	0.35	0.35	0.3	0.25	0.30	12.9	21	2.8	12.01	26	28	0		1	2	1	1	0.3	0.32	0.33	0.32	0.28	0.29	0.28	0.28	11.1	12.2	12.8	13.1	28	24	0.00
9	4633710	11390876	Swetha sri	22	2	1	2 y	2	1	7	7	2	0.47	0.19	0.19	0.28	0.31	0.3	0.31	0.31	12.3	14.1	13.45	17.22	32	35	0		1	2	1	1	0.3	0.26	0.38	0.31	0.17	0.26	0.24	0.22	3.12	6.48	10.2	11.13	35	35	2.83
10	4704728	12413248	V.Jeyaram	27	1	1	1 y			7	7	1	0.29	0.31	0.29	0.30	0.34	0.31	0.29	0.31	7.9	9.72	10.2	12.34	16	15	0	1		2	1	1	0.27	0.31	0.29	0.29	0.34	0.27	0.29	0.30	2.68	6.14	2.36	8.74	10	11	12.50
11	4705593	11114598	Arun Shankar	27	1	1	3 y	2		7	7	1	0.26	0.31	0.22	0.26	0.39	0.37	0.43	0.40	22.1	22.1	9.9	10.35	35	35	0	2		2	1	1	0.23	0.24	0.29	0.25	0.3	0.32	0.33	0.32	11	12.34	5.6	6.32	20	24	0.00
12	4827957	13177615	Nithyapriya	32	2	1	3 y	2	1	7	7	1	0.28	0.29	0.31	0.29	0.33	0.34	0.36	0.34	17.2	19.6	15.45	17.65	20	24	0	2		2	1	1	0.25	0.24	0.21	0.23	0.27	0.24	0.29	0.27	10.2	11.69	8.83	8.83	16	18	0.00
13	4716406	12489062	Priyadarshini A	21	1	2				7	7	2	0.26	0.27	0.31	0.28	0.27	0.38	0.43	0.36	6.75	7.9	9.18	13.11	35	35	0		1	2	1	1	0.2	0.21	0.24	0.22	0.22	0.24	0.26	0.24	5.67	7.65	8.34	10.2	19	17	0.00
14	4714143	7481111	Dinesh Raja K	25	1	1	2 y	2	1	7	7	1	0.29	0.24	0.41	0.31	0.31	0.36	0.36	0.34	24	24	18.8	19.13	25	20	2	2		2	1	1	0.25	0.26	0.27	0.26	0.24	0.25	0.26	0.25	10.9	12.2	11.3	12.65	18	19	0.00
15	4680457	12270887	Shivaranjini L	21	2	1	3 y	2	1	7	7	2	0.31	0.31	0.28	0.30	0.43	0.34	0.35	0.37	5.04	12.5	6.82	7.12	35	35	0		1	2	1	1	0.23	0.24	0.25	0.24	0.19	0.2	0.21	0.20	18.9	20.34	16.32	18.22	21	23	0.00
16	4709995	12327755	Gunasekaran	23	1	1	1 y	2	1	7	7	2	0.28	0.24	0.4	0.31	0.33	0.32	0.22	0.29	3.5	15.9	6.56	6.56	32	33	6.25	2		2	1	1	0.14	0.24	0.31	0.23	0.35	0.31	0.38	0.35	5.42	17.45	11.15	13.68	22	33	6.35
17	4697642	12370022	Arshad Aarif	25	1	1	1 y	2	1	7	7	2	0.26	0.21	0.32	0.26	0.4	0.32	0.37	0.36	20.9	20.9	21.86	22.11	35	35	0		1	2	1	1	0.39	0.36	0.38	0.38	0.36	0.39	0.38	0.38	20.5	22.66	10.4	20.19	25	35	0.00
18	4718991	12505658	Palinivel Rajan	26	1	2				7	7	1	0.31	0.26	0.33	0.30	0.5	0.65	0.61	0.59	19.8	20.1	18.9	19.8	22	30	8.3	2		2	1	1	0.19	0.19	0.19	0.19	0.19	0.21	0.2	0.20	23.6	23.96	14.66	16.38	35	35	8.30
19	4719969	12511520	Sheik Abdulla	26	1	1	2 y	2	1	7	7	1	0.33	0.38	0.33	0.35	0.47	0.31	0.41	0.40	5.67	7.27	8.335	9.285	14	13	2.08	2		2	1	1	0.2	0.21	0.22	0.21	0.19	0.2	0.21	0.20	8.8	9.8	9.9	10.1	20	20	0.00
20	4691479	12330979	Madhuvadhana	21	1	2			-	7	7	1	0.34	0.31	0.39	0.35	0.39	0.39	0.39	0.39	21.3	21.5	21.49	22.535	23	15	10.42	2		2	1	1	0.18	0.23	0.24	0.22	0.2	0.22	0.24	0.22	10.3	12.1	10.2	13.1	18	15	0.00
21	3579227	2000802	Manimozhi	21	2	1	2 y	2	1	7	7	2	0.26	0.32	0.29	0.29	0.43	0.34	0.31	0.36	20.8	21.2	23.4	23.4	15	33	0		1	2	1	1	0.23	0.23	0.26	0.24	0.24	0.22	0.25	0.25	11.4	12.3	9.8	10.5	12	14	0.00
22	4561585	11553202	Ezhil vannan	23	1	2		-	-	7	7	2	0.34	0.34	0.27	0.32	0.26	0.28	0.41	0.32	20.1	22.3	19.8	21.2	5	11	12.5		1	2	1	1	0.31	0.39	0.34	0.35	0.31	0.38	0.45	0.38	24.2	24.15	3.9	12.15	5	10	0.00
23	4655162	13098746	S.Balamurugan	22	1	2		-	-	7	7	1	0.26	0.34	0.41	0.34	0.38	0.28	0.26	0.31	18.9	20.1	17.2	19.2	27	23	7.75	2		2	1	1	0.24	0.25	0.25	0.25	0.23	0.24	0.27	0.25	15.8	16.9	17.2	18.9	10	12	0.00
24	4481000	11089131	Gurukrishna	21	1	1	3 y	1	1	7	7	2	0.29	0.19	0.33	0.27	0.39	0.29	0.36	0.35	20.8	21.7	13.4	16.7	35	35	8.3	2		2	1	1	0.24	0.22	0.27	0.24	0.37	0.22	0.29	0.29	10.1	12.35	13.6	14.7	14	24	0.00
25	4728995	12560583	Ishwarya Rajalaksmi d	24	2	2				7	7	2	0.26	0.39	0.26	0.30	0.27	0.43	0.22	0.31	18.8	19.1	17.8	18.9	16	22	4.16		1	2	1	1	0.39	0.48	0.41	0.43	0.38	0.38	0.31	0.36	15.1	19.15	20.65	23.45	25	35	0.00
26	4289255	2518574	Vanmathi	20	2	2		-	-	7	7	2	0.29	0.27	0.24	0.27	0.3	0.29	0.2	0.26	23.6	23.6	24.09	24.09	18	21	0		1	2	1	1	0.21	0.22	0.16	0.20	0.23	0.21	0.19	0.21	1.47	1.56	4.84	16.99	20	13	0.00
27	4770698	12815622	Vidhya Radha	20	1	2		1	1	7	7	2	0.22	0.26	0.31	0.26	0.27	0.33	0.31	0.30	14.9	15	15.01	16.03	15	18	0		1	2	1	1	0.17	0.19	0.16	0.17	0.36	0.36	0.31	0.34	2.29	2.29	4.08	18.63	18	13	0.00
28	4519475	11319238	Saranya	21	2	2				7	7	1	0.24	0.22	0.26	0.24	0.26	0.31	0.22	0.26	9.8	11.3	10.4	12.2	18	25	2.08	2		2	1	1	0.31	0.26	0.34	0.30	0.29	0.26	0.29	0.28	7.01	7.01	9.8	10.9	13	28	0.00
29	4767520	12797032	Keerthana	22	2	1	5 y	2	2	7	7	2	0.25	0.26	0.31	0.27	0.24	0.22	0.39	0.28	9.2	10.5	14.21	15.55	18	16	2.08		1	2	1	1	0.34	0.74	0.39	0.49	0.37	0.38	0.34	0.36	8.9	10.1	19.82	21.85	9	9	4.16
30	4537165	11415119	K. Revathi	24	2	2				1	7	2	0.22	0.24	0.26	0.24	0.28	0.29	0.27	0.28	6.95	6.95	10.26	16.68	31	30	0		1	1	1	1	0.22	0.22	0.19	0.21	0.26	0.22	0.27	0.25	10.3	11.1	14.1	15.1	32	30	2.08
31	4774791	1287643	Mathana sri	25	2	1	1 y	2	2	7	7	1	0.27	0.33	0.21	0.27	0.17	0.27	0.22	0.22	3.25	11.4	10.13	13.56	20	18	2.08	1		2	1	1	0.31	0.43	0.34	0.36	0.34	0.29	0.31	0.31	3.31	19.87	4.21	14.56	18	19	0.00
32	4753751	12242947	Bhuvanesh	20	1	2				7	7	1	0.46	0.5	0.43	0.46	0.29	0.48	0.39	0.39	20.5	20.8	3.44	5.39	18	35	0		2	2	1	1	0.37	0.59	0.27	0.41	0.28	0.32	0.38	0.33	4.21	10.73	5.99	15.88	20	35	0.00
33	4767667	12747748	Krishnakanth	21	1	1	2 y	2	2	7	7	1	0.31	0.26	0.33	0.30	0.29	0.31	0.34	0.31	11.7	13	13.56	14.78	15	26	2.08	2		2	1	1	0.31	0.29	0.34	0.31	0.37	0.19	0.29	0.28	2.86	3.86	10.3	11.1	20	23	0.00
34	4791956	12937662	Sridhar srimaan	22	1	2				7	7	1	0.26	0.34	0.48	0.36	0.41	0.51	0.43	0.45	14.8	16	15.68	18.23	35	30	0	2		2	1	1	0.27	0.13	0.29	0.23	0.58	0.84	0.71	0.71	7.14	14.95	22.81	23.39	20	35	0.00
35	4794454	12953805	Aswin Vairamani	28	1	2				7	7	2	0.29	0.24	0.24	0.26	0.19	0.24	0.2	0.21	15.6	15.9	8.03	9.87	13	18	0			2	1	1	0.39	0.32	0.32	0.34	0.34	0.35	0.29	0.33	11.5	11.53	17.8	17.8	20	22	0.00
36	4789892	12924516	Amirthashree	21	2	2				7	7	2	0.24	0.28	0.27	0.26	0.24	0.34	0.31	0.30	9.43	11.8	1.34	4.44	15	13	0		1	2	1	1	0.23	0.2	0.21	0.21	0.43	0.55	0.42	0.47	9.43	11.82	3.89	9.99	20	28	0.00
37	4752190	12706375	Logeshkumar	25	1	2				7	7	2	0.41	0.32	0.31	0.35	0.27	0.29	0.29	0.28	10.1	12.3	11.1	13.4	11	6	4.16		2	2	1	1	0.32	0.32	0.27	0.30	0.32	0.56	0.34	0.41	9.8	10.2	9.81	13.64	15	20	0.00
38	4557590	13249081	J. Nandhini	22	2	1	2 y	2	2	7	7	1	0.24	0.24	0.27	0.25	0.36	0.29	0.31	0.32	15.7	18.7	11.28	13.1	35	30	0	2		2	1	1	0.32	0.26	0.39	0.32	0.37	0.31	0.39	0.36	10.4	10.39	8.48	13.97	20	35	0.00
39	4755597	12726047	Preethi	23	2	1	4 y	2	2	7	7	2	0.19	0.27	0.22	0.23	0.34	0.31	0.41	0.35	12.9	14.6	11.78	13.59	15	20	0		1	2	1	1	0.43	0.44	0.38	0.42	0.41	0.48	0.48	0.46	1.27	5.18	4.56	6.89	20	20	0.00
40	4765460	12785263	Meera	22	2	2				7	7	1	0.2	0.26	0.26	0.24	0.27	0.31	0.46	0.35	13.3	15.2	18.99	21.67	25	20	0	1		2	1	1	0.34	0.34	0.24	0.31	0.46	0.36	0.31	0.38	15.9	21.58	5.35	14.88	20	23	0.00
41	4757579	12737954	Shobana	27	2	1	1 y	2	1	7	7	2	0.26	0.24	0.22	0.24	0.19	0.24	0.22	0.22	7.26	11.4	7.52	13.56	17	15	4.16	2		2	1	1	0.31	0.32	0.26	0.30	0.26	0.27	0.26	0.26	5.61	5.61	7.46	8.78	20	13	0.00
42	4769699	12808824	Nagalakshmi	24	2	1	2 y	2	2	7	7	2	0.31	0.31	0.33	0.32	0.34	0.36	0.29	0.33	25.3	27.5	7.58	13.26	35	35	2.08		1	2	1	1	0.34	0.31	0.21	0.29	0.34	0.31	0.31	0.32	2.48	3.93	1.78	1.78	35	35	0.00
43	4755873	12728718	Thamiyon infant	26	1	2				7	7	1	0.59	0.62	0.6	0.60	0.59	0.67	0.69	0.65	2.8	2.8	6.78	9.45	30	30	0	1		2	1	1	0.33	0.41	0.41	0.38	0.33	0.45	0.37	0.38	20.7	22.9	3.5	12.75	35	35	0.00
44	2424406	1289700	Manoj Kumar	23	1	1	3 y	2	1	7	7	2	0.36	0.26	0.29	0.30	0.36	0.44	0.43	0.41	23.3	23.3	3	3.08	32	32	0		1	2	1	1	0.41	0.31	0.43	0.38	0.43	0.32	0.32	0.36	19.6	21.81	11.79	19.47	35	34	0.00
45	4784445	12893019	Harshitha T	19	2	1	1 y	2	1	7	7	2	0.29	0.44	0.34	0.36	0.26	0.43	0.63	0.44	12.1	17.9	14.91	16.91	35	35	0		1	2	1	1	0.32	0.39	0.39	0.37	0.27	0.27	0.3	0.28	12.9	20.29	16.7	26.7	36	32	0.00
46	4786147	12902057	Aarthy DR	22	2	1	2 y	2	1	7	7	1	0.36	0.58	0.58	0.51	0.44	0.46	0.45	0.45	17.5	17.9	17.91	21.99	30	30	0	2		2	1	1	0.22	0.26	0.32	0.27	0.37	0.3	0.29	0.32	16.7	16.8	15.8	15.8	30	30	0.00
47	4784336	12892467	Murali Krishna	23	1	2				7	7	1	0.27	0.31	0.29	0.29	0.27	0.33	0.33	0.31	3.5	8.57	12.51	13.51	25	25	0	2		2	1	1	0.26	0.24	0.26	0.25	0.27	0.36	0.33	0.32	4.5	5.67	10.1	11.1	20	20	0.00
48	4765390	10588027	Karthik Ramanathan	28	1	2				7	7	2	0.21	0.17	0.19	0.19	0.29	0.17	0.27	0.24	21.1	21.1	7.9	7.9	28	35	0		1	2	1	1	0.21	0.21	0.17	0.20	0.15	0.17	0.21	0.18	19.3	21.37	12.68	12.68	20	18	0.00
49	4778623	12885755	A Gowri	28	1	2				7	7	2	0.1	0.17	0.19	0.15	0.24	0.21	0.29	0.25	20.6	22.7	12.81	15.4	25	28	0		2	2	1	1	0.27	0.21	0.27	0.25	0.32	0.22	0.24	0.26	16.9	19.76	7.52	14.81	23	20	0.00
50	4798189	12978562	P Arunpandi	24	1	1	1 y	2	2	7	7	1	0.29	0.24	0.17	0.23	0.27	0.33	0.22	0.27	19.9	20.7	18.76	19.71	10	12	0	2		2	1	1	0.22	0.25	0.22	0.23	0.25	0.29	0.27	0.27	2.8	7.52	13.45	15.25	11	18	0.00
51	4742727	12647004	Sampath Kumar	25	1	2				7	7	2	0.34	0.36	0.32	0.34	0.33	0.33	0.33	0.33	4.59	6.71	22.88	22.88	30	30	0		1	2	1	1	0.43	0.43	0.38	0.41	0.42	0.41	0.35	0.39	3.82	17.56	9.43	17.37	35	25	0.00
52	4742836	12647659	Lokkesh	24	1	1	3 y	2		7	7	2	0.36	0.34	0.36	0.35	0.26	0.29	0.27	0.27	7.33	7.33	22.75	22.75	10	10	0		1	2	1	1	0.38	0.36	0.49	0.41	0.4	0.4	0.39	0.40	23.8	23.96	14.47	14.7	15	12	0.00
53	4371872	10461319	Praveen Kumar	23	1	1	2 y	2	1	7	7	1	0.29	0.24	0.33	0.29	0.39	0.31	0.36	0.35	3.06	12.8	21.41	21.41	20	24	0	2		2	1	1	0.24	0.26	0.28	0.26	0.26	0.24	0.24	0.25	11.5	15.36	15.23	20.46	20	20	0.00
54	4706071	12422013	V Priyanka	24	2	1	3 y	2	1	7	7	1	0.26	0.31	0.24	0.27	0.26	0.24	0.24	0.25	9.08	12.1	11.41	12.89	10	20	8.3	1		2	1	1	0.33	0.29	0.26	0.29	0.29	0.22	0.29	0.27	11	17.17	13.8	13.8	13	12	8.30
55	4725730	7222236	amirthashree	20	2	2				7	7	2	0.38	0.34	0.34	0.35	0.34	0.38	0.36	0.36	21.1	21.1	21.09	21.09	25	26	0		1	2	1	1	0.32	0.31	0.38	0.34	0.39	0.38	0.4	0.39	10.2	11.64	9.56	13	26	24	2.08
56	4706724	1245499	Hemasree MS	23	2	1	2 y	2	1	7	7	1	0.22	0.2	0.33	0.25	0.26	0.26	0.24	0.25	2.28	2.45	22.88	22.88	25	30	0	2		2	1	1	0.29	0.27	0.39	0.32	0.33	0.32	0.36	0.34	8.09	15.26	5.61	12.88	30	30	0.00
57	4244329	9727422	Veera Dinesh	26	1	2				7	7	1	0.27	0.43	0.32	0.34	0.21	0.15	0.19	0.18	18.3	18.3	9.56	10.79	16	13	0	2		2	1	1	0.25	0.27	0.22	0.25	0.29	0.37	0.25	0.30	4.01	5.89	18	15	20	22	0.00
58	4793237	12945633	Veerapandi	20	1	2				7	7	2	0.15	0.1	0.22	0.16	0.22	0.27	0.22	0.24	21.9	21.9	19.3	20.25	13	10	0		1	2	1	1	0.17	0.15	0.2	0.17	0.17	0.15	0.27	0.20	15.6	16.78	10	8	27	24	0.00
59	4780744	12870524	Viswakrishnan	24	1	1	1y	2	1	7	7	1	0.24	0.2	0.2	0.21	0.2	0.19	0.22	0.20	20.3	21.7	16.8	18	30	32	0	2		2	1	1	0.27	0.27	0.25	0.26	0.3	0.37	0.37	0.35	12.9	13.01	9.34	10.21	20	18	2.08

60	4788906	12918692	K. Sindhuja	23	2	2				7	7	2	0.24	0.21	0.22	0.22	0.27	0.24	0.22	0.24	7.01	9.83	10.45	10.45	35	30	0		1	2	1	1	0.34	0.32	0.3	0.32	0.32	0.27	0.28	0.29	21.2	21.22	7.78	9.07	35	30	0.00
61	4604950	11811344	Muthulakshmi	21	2	1	2 y	2	1	7	7	1	0.3	0.29	0.28	0.29	0.36	0.34	0.33	0.34	5.35	6.21	7.8	8.9	30	35	0	2		2	1	1	0.25	0.24	0.29	0.26	0.34	0.34	0.34	0.34	2.55	12.66	9.3	14.48	33	35	0.00
62	4804488	13017021	Tharagai	23	1	2				7	7	2	0.31	0.27	0.29	0.29	0.2	1.22	0.29	0.57	11.2	11.2	23.36	23.26	24	35	0		1	2	1	1	0.22	0.17	0.14	0.18	0.17	0.22	0.24	0.21	15.6	21.82	23.37	22.56	20	32	0.00
63	4184011	9397199	Indhu SR	23	2	2				7	7	2	0.24	0.34	0.2	0.26	0.31	0.22	0.32	0.28	12.1	13.4	10.9	12.37	20	28	0		1	2	1	1	0.36	0.37	0.36	0.36	0.36	0.37	0.42	0.38	12.4	13.1	11.9	13.45	23	20	2.08
64	4799891	11209875	Arjun Govind	22	1	1	3 y		1	7	7	2	0.26	0.24	0.24	0.25	0.43	0.28	0.23	0.31	3.89	3.27	19.56	20.09	18	12	0		1	2	1	1	0.26	0.26	0.22	0.25	0.33	0.25	0.27	0.28	3.44	4.5	16.4	17.1	16	18	0.00
65	4638287	12011967	P.Gunaseelan	26	1	2				7	7	1	0.31	0.34	0.43	0.36	0.51	0.51	0.43	0.48	9.87	11.5	10.9	14.33	18	18	0	1	1	2	1	1	0.42	0.54	0.42	0.46	0.42	0.34	0.58	0.45	17.7	21.86	17.46	17.46	26	22	0.00
66	4790264	12924558	Muthaiah SP	29	1	2				7	7	1	0.26	0.22	0.26	0.25	0.26	0.31	0.21	0.26	2.17	3.64	11.85	11.85	25	33	0	2	1	2	1	1	0.24	0.32	0.26	0.27	0.26	0.27	0.35	0.29	10.6	11.4	11.8	12.2	30	25	0.00
67	4796503	14809764	Saravana	22	1	2				7	7	1	0.2	0.24	0.15	0.20	0.36	0.36	0.29	0.34	23.6	23.6	23.71	23.78	25	30	0	2	1	2	1	1	0.32	0.25	0.25	0.27	0.37	0.29	0.36	0.34	20.5	21.99	4.84	7.49	28	32	0.00
68	4789714	12928498	Gopinath	24	1	1	2 y	2	2	7	7	2	0.76	0.86	0.81	0.81	0.99	0.7	0.92	0.87	13.3	13.3	24.35	22.08	35	35	0		1	2	1	1	0.5	0.66	0.65	0.60	0.74	0.85	0.57	0.72	7.01	7.01	4.08	8.28	35	35	0.00
69	4778510	12857968	Syed Sheik Abdullah	21	1	2				7	7	2	0.24	0.19	0.3	0.24	0.24	0.29	0.35	0.29	12.1	13.3	22.75	22.75	20	18	0	1	1	2	1	1	0.28	0.32	0.31	0.30	0.37	0.34	0.34	0.35	2.36	13.06	21.41	22.65	30	16	0.00
70	4786806	3029118	Abirami Sundari	24	2	1	1 y	2	1	7	7	2	0.15	0.15	0.15	0.15	0.26	0.24	0.22	0.24	11	11.2	11.28	13.28	10	12	2.08		1	2	1	1	0.23	0.26	0.22	0.24	0.19	0.31	0.29	0.26	14.3	19.7	19.75	21.82	18	20	0.00
71	4802515	11209876	Ajitha	22	2	2				7	7	2	0.24	0.24	0.27	0.25	0.24	0.2	0.27	0.24	11	11.9	11.02	12.65	35	14	0		1	2	1	1	0.24	0.24	0.24	0.24	0.2	0.24	0.24	0.23	16.7	21.88	8.67	17.2	30	18	0.00
72	4752322	12707271	Baneetha Banu	24	2	2				7	7	2	0.21	0.27	0.19	0.22	0.43	0.52	0.39	0.45	8.35	14.5	23.39	23.67	20	25	0		1	2	1	1	0.32	0.29	0.29	0.30	0.29	0.35	0.35	0.33	15.7	18.1	14.34	19.84	21	30	0.00
73	4804167	13015571	Akilesh	20	1	2				7	7	1	0.36	0.21	0.29	0.29	0.2	0.24	0.29	0.24	5.16	14.2	2.17	15.93	26	22	0	2		2	1	1	0.22	0.17	0.17	0.19	0.21	0.26	0.29	0.25	11.7	13.99	10.2	13.1	20	26	0.00
74	4806439	13030760	Yashwanth Kumar	21	1	2				7	7	2	0.34	0.47	0.31	0.37	0.37	0.34	0.37	0.36	6.89	11.2	12.09	13.08	25	28	0		1	2	1	1	0.24	0.26	0.25	0.25	0.32	0.39	0.24	0.32	8.99	8.99	9.24	11.84	23	25	0.00
75	4776668	12848201	Rekka R	24	2	1	2 m	2	1	7	7	1	0.39	0.38	0.51	0.43	0.25	0.25	0.34	0.28	4.84	17.6	9.5	9.66	35	30	0	2		2	1	1	0.17	0.19	0.2	0.19	0.29	0.26	0.23	0.26	9.05	10	13.19	20.08	35	35	0.00
76	4746168	12668314	Gangavithya	24	2	1	4 y	2	1	7	7	1	0.26	0.26	0.22	0.25	0.26	0.24	0.26	0.25	6.44	17.5	16.7	18.99	18	12	0	2		2	1	1	0.29	0.3	0.27	0.29	0.34	0.25	0.37	0.32	4.27	18.64	22.94	22.94	25	33	0.00
77	4843677	13287072	Navaneetha Krishnan	31	1	2				7	7	1	0.37	0.37	0.42	0.39	0.57	0.31	0.32	0.40	11	15	4.01	9.99	35	35	0	2		2	1	1	0.38	0.31	0.22	0.30	0.27	0.19	0.22	0.23	2.87	15.47	8.6	15.91	35	35	0.00
78	2780276	1393910	Sharmila S	22	2	2				7	7	2	0.14	0.17	0.26	0.19	0.2	0.29	0.32	0.27	7.46	17.8	19.95	19.95	18	30	0		1	2	1	1	0.29	0.29	0.19	0.26	0.17	0.22	0.2	0.20	18.6	20.92	5.8	13.49	13	20	0.00
79	4811290	13064884	Jeyashree	23	2	1	6 y	2	1	7	7	2	0.32	0.44	0.42	0.39	0.39	0.35	0.3	0.35	8.9	10.2	7.01	10.36	28	13	0		1	2	1	1	0.35	0.35	0.3	0.33	0.28	0.3	0.34	0.31	6.7	8.2	7.2	8.9	28	13	0.00
80	4124847	9080215	Shri Aathmikka	22	2	1	1 y	2	1	7	7	2	0.31	0.49	0.44	0.41	0.64	0.76	0.44	0.61	20.8	22.2	15.36	20.38	18	13	2.08		1	2	1	1	0.44	0.56	0.36	0.45	0.49	0.32	0.34	0.38	6.31	13.85	15.74	17.65	15	10	0.00
81	4864784	13427305	GokulRamdas	23	1	2				7	7	2	0.34	0.3	0.34	0.33	0.47	0.44	0.32	0.41	22.1	22.1	23.01	23.01	23	25	0		1	2	1	1	0.27	0.34	0.32	0.31	0.42	0.39	0.37	0.39	6.59	16.26	12.24	20.65	25	23	0.00
82	4840605	13263994	Sivakumar	25	1	2				7	7	1	0.26	0.29	0.31	0.29	0.34	0.27	0.37	0.33	11.6	13	13.89	13.89	18	16	0	2		2	1	1	0.24	0.31	0.36	0.30	0.34	0.3	0.29	0.31	21.9	23.08	4.65	7.59	20	18	0.00
83	4862634	13414673	Nandhagopal	21	1	2				7	7	2	0.25	0.2	0.36	0.27	0.29	0.38	0.33	0.33	13.1	15.1	6.44	16.76	35	35	0		1	2	1	1	0.32	0.29	0.44	0.35	0.31	0.24	0.32	0.29	19	18.99	18.42	20.01	35	35	0.00
84	4861439	13405722	V Gayathri	26	2	2				7	7	1	0.35	0.31	0.3	0.32	0.34	0.27	0.31	0.31	14	19.1	10.01	10.01	18	13	0	2		2	1	1	0.31	0.22	0.27	0.27	0.54	0.53	0.49	0.52	10.6	16.23	5.99	13.56	13	16	0.00
85	4747209	12673444	Fathima	22	2	2				7	7	2	0.31	0.22	0.24	0.26	0.27	0.24	0.29	0.27	11.4	19.4	11.1	12.2	12	12	0		1	2	1	1	0.3	0.27	0.25	0.27	0.27	0.26	0.3	0.28	22.8	22.94	7.01	17.98	14	19	0.00
86	4030257	7226551	T Udhayanand	23	1	1	2 y	2	1	7	7	1	0.22	0.15	0.27	0.21	0.32	0.36	0.39	0.36	23.4	23.5	20.33	21.63	30	25	0	2		2	1	1	0.21	0.22	0.24	0.22	0.28	0.23	0.26	0.26	8.7	9.5	10.11	10.11	20	25	0.00
87	4847482	13313922	Bala ganesh	23	1	1	2 y	2	2	7	7	1	0.46	0.39	0.27	0.37	0.24	0.24	0.26	0.25	19.1	19.1	3.25	6.16	25	23	0	2		2	1	1	0.29	0.25	0.25	0.26	0.34	0.34	0.35	0.34	13.8	13.83	7.52	7.52	28	29	0.00
88	4074301	8651223	Sreemeena N	21	2	1	3 y	2	1	7	7	1	0.2	0.22	0.19	0.20	0.22	0.22	0.31	0.25	18.3	20.7	14.28	19.21	20	18	0	2		2	1	1	0.39	0.34	0.4	0.38	0.54	0.6	0.61	0.58	13.8	13.83	6.56	8.09	35	35	0.00
89	4800444	12991437	Adrin	35	1	1	3 y	2	1	7	7	1	0.31	0.32	0.35	0.33	0.47	0.34	0.45	0.42	15	15	13.57	16.76	35	35	0	2		2	1	1	0.3	0.38	0.48	0.39	0.48	0.46	0.56	0.50	9.43	16.45	20.46	22.74	35	35	0.00
90	3777927	3180462	Arun Kumar	23	1	2				7	7	2	0.26	0.27	0.39	0.31	0.32	0.2	0.29	0.27	5.67	5.67	5.48	5.48	23	16	0		1	2	1	1	0.21	0.19	0.21	0.20	0.21	0.2	0.17	0.19	5.54	13.84	6.37	6.37	18	16	0.00
91	4861126	13463690	Nanthini	22	2	2				7	7	2	0.52	0.41	0.49	0.47	0.51	0.46	0.4	0.46	4.08	12.6	16.44	16.73	35	35	0	2		2	1	1	0.36	0.42	0.42	0.40	0.39	0.37	0.46	0.41	4.33	5.17	5.54	9.3	35	35	0.00
92	3384596	1800984	Sowmiya	25	2	1	5 y	2	1	7	7	2	0.36	0.27	0.45	0.36	0.44	0.49	0.42	0.45	7.33	7.33	10.2	10.2	35	35	0	2		2	1	1	0.32	0.27	0.27	0.29	0.29	0.27	0.29	0.28	4.84	4.84	5.42	5.42	23	25	0.00
93	4869498	12060731	Priyanka	23	2	1	3 y	2	2	7	7	2	0.34	0.36	0.35	0.35	0.46	0.47	0.46	0.46	21.8	21.8	7.33	9.23	35	35	0	2		2	1	1	0.52	0.47	0.56	0.52	0.67	0.62	0.59	0.63	3.19	15.47	4.33	19.16	35	35	0.00
94	4852902	13349154	Yuvasri J	23	2	1	4 y	2	1	7	7	2	0.41	0.37	0.57	0.45	0.63	0.24	0.29	0.39	3.09	7.05	10.77	10.96	30	28	0		1	2	1	1	0.24	0.26	0.19	0.23	0.19	0.25	0.24	0.23	8.29	9.21	6.69	6.88	26	20	0.00
95	4881073	13535969	Niveditha G	25	2	1	8 m	2	1	7	7	2	0.39	0.37	0.41	0.39	0.52	0.86	0.51	0.63	22.4	22.4	22.05	23.07	35	35	0		1	2	1	1	0.24	0.26	0.3	0.27	0.29	0.41	0.37	0.36	3.31	14.82	3.7	5.95	18	16	0.00
96	4909774	13735360	Jenovaf	21	2	1	1 y	2	1	7	7	2	0.24	0.24	0.17	0.22	0.29	0.27	0.32	0.29	5.04	9.43	10.96	10.96	16	13	0		1	2	1	1	0.24	0.29	0.33	0.29	0.2	0.22	0.19	0.20	1.98	1.98	2.08	2.08	18	15	0.00
97	4894983	11289564	Maheswari S	25	2	2				7	7	1	0.27	0.2	0.25	0.24	0.29	0.34	0.34	0.32	22.9	22.9	22.23	22.24	35	35	0	2		2	1	1	0.25	0.2	0.2	0.22	0.29	0.29	0.19	0.26	4.84	9.97	9.43	15.74	35	35	0.00
98	4865017	13428616	Divya M	23	2	1	5 y	2	1	7	7	2	0.26	0.34	0.37	0.32	0.42	0.49	0.34	0.42	14.9	19.3	5.8	14.41	29	26	0		1	2	1	1	0.41	0.32	0.43	0.39	0.38	0.33	0.46	0.39	16.3	20.96	4.97	12.57	26	26	4.16
99	4809559	13051821	Vigneshkumar	23	1	2				7	7	1	0.4	0.47	0.48	0.45	0.34	0.22	0.32	0.29	23.9	23.9	20.2	21.34	25	25	0		2	2	1	1	0.2	0.22	0.27	0.23	0.21	0.27	0.19	0.22	5.67	5.99	16.57	20.52	20	24	2.08
100	4051016	7307846	G. Aarthy	20	2	2				7	7	1	0.32	0.3	0.22	0.28	0.48	0.42	0.5	0.47	16.4	19.9	9.62	9.25	26	28	0	2		2	1	1	0.19	0.2	0.24	0.21	0.32	0.24	0.34	0.30	4.46	8.26	7.97	7.97	26	23	0.00
101	4883191	13551655	Madhumitha	21	2	1	3 m	2	1	7	7	2	0.27	0.39	0.32	0.33	0.34	0.52	0.47	0.44	14.5	14.5	11.6	15.54	25	30	0		1	2	1	1	0.27	0.27	0.3	0.28	0.3	0.34	0.34	0.33	14.2	14.75	6.58	8.38	20	26	0.00
102	4898817	10977757	Akash	19	1	2				7	7	1	0.39	0.24	0.39	0.34	0.37	0.49	0.49	0.45	6.88	12.3	9.43	9.43	26	30	0	2		2	1	1	0.39	0.34	0.34	0.36	0.46	0.51	0.57	0.51	19.8	23.24	18.04	22.92	28	33	0.00
103	4896206	13642556	Ruso Saimon	21	1	2				7	7	2	0.41	0.37	0.35	0.38	0.25	0.3	0.29	0.28	18.5	20	18.54	15.9	20	26	0		1	2	1	1	0.22	0.25	0.32	0.26	0.3	0.41	0.39	0.37	24	23.96	23.96	23.96	23	26	0.00
104	4897924	13655049	Rajesh Ram	25	1	2				7	7	1	0.39	0.29	0.37	0.35	0.27	0.39	0.39	0.35	22.1	22.1	3.76	5.36	26	20	0		1	2	1	1	0.34	0.37	0.29	0.33	0.25	0.36	0.25	0.29	3.25	15.52	12.43	18.18	20	21	0.00
105	4547581	11470588	RR Meenupriya	24	2	2				7	7	2	0.24	0.26	0.38	0.29	0.24	0.24	0.19	0.22	16.7	16.7	19.4	19.85	18	13	0		1	2	1	1	0.28	0.36	0.32	0.32	0.34	0.34	0.31	0.33	6.25	7.49	3.89	17.52	18	10	0.00
106	4803935	13014042	Anandhuvijayam	21	1	2				7	7	1	0.41	0.32	0.34	0.36	0.37	0.36	0.39	0.37	17.2	18.3	20.33	21.09	35	26	0	2		2	1	1	0.29	0.24	0.25	0.26	0.3	0.31	0.36	0.32	24	24.02	10.32	15.54	35	20	0.00
107	3451758	13002367	Karthikeyan	22	2					7	7	1	0.34	0.41	0.39	0.38	0.41	0.36	0.36	0.38	2.74	5.27	22.5	22.59	35	35	0	2		2	1	1	0.26	0.17	0.26	0.23	0.34	0.26	0.29	0.30	23.3	23.26	21.2	22.2	35	35	0.00
108	3564715	1985069	Sujitha R	24	1	1	5 y	2	1	7	7	2	0.24	0.24	0.31	0.26	0.39	0.46	0.42	0.42	17.6	19.9	4.01	4.01	18	20	2.08		1	2	1	1	0.41	0.43	0.29	0.38	0.3	0.17	0.24	0.24	22.2	23.32	24.08	24.08	16	21	4.16
109	3542781	12085647	Rajalakshmi	22	2	1	3 y	2	2	7	7	1	0.24	0.32	0.31	0.29	0.41	0.46	0.32	0.40	3	3.33	21.99	21.99	26	20	0	2		2	1	1	0.32	0.36	0.31	0.33	0.29	0.37	0.3	0.32	9.75	14.72	3.89	8.38	26	23	2.08
110	4290359	9984158	Mohamed Farooq	27	1	2				7	7	2	0.24	0.21	0.26	0.24	0.26	0.27	0.29	0.27	19.3	19.3	17.34	18.01	18	13	0	2		2	1	1	0.2	0.22	0.23	0.22	0.24	0.22	0.19	0.22	18.1	18.1	10.31	10.2	20	20	0.00
111	4408435	10669698	Benitha Edwin	25	2	1	3 y	2	1	7	7	1	0.24	0.29	0.34	0.29	0.22	0.25	0.24	0.24	9	13	10.71	13.9	18	28	0	2		2	1	1	0.22	0.2	0.21	0.21	0.18	0.18	0.19	0.18	9	10	8.9	12	16	20	0.00
112	4527852	13177221	Aseera Banu	20	2	2				7	7	2	0.29	0.24	0.26	0.26	0.26	0.26	0.29	0.27	21.5	22.1	20.98	20.98	25	28	0		1	2	1	1	0.24	0.25	0.24	0.24	0.23	0.22	0.25	0.23	16.7	17.8	19.2	19.2	20	27	0.00
113	4746098	12668062	Ranjith Kumar	21	1	2				7	7	2	0.19	0.19	0.22	0.20	0.2	0.26	0.29	0.25	20.4	20.4	19.8	20.9	25	25	2.08		1	2	1	1	0.19	0.18	0.17	0.18	0.16	0.19	0.2	0.18	17.8	18.9	18.8	20	23	24	4.16
114	4699309	12379263	Madhumitha K	21	2	2				7	7	2	0.14	0.14	0.2	0.16	0.24	0.19	0.18	0.20	15.6	18.5	15.65	17.75	8	20	0		1	2	1	1	0.13	0.14	0.14	0.14	0.18	0.16	0.17	0.17	12.3	12.44	13.45	14	7	15	0.00
115	4766100	12789085	R Sidharth	24	1	1	3 y	2	1	7	7	2	0.25	0.21	0.27	0.24	0.37	0.27	0.41	0.35	5.61	6.45	9.62	13.1	19	23	0		1	2	1	1	0.2	0.21	0.23	0.21	0.27	0.26	0.28	0.27	5.5	5.5	8.9	8.9	14	18	0.00
116	4266180	12789524	Ramesh G J	22	1	2				7	7	1	0.29	0.41	0.41	0.37	0.38	0.47	0.41	0.42	6.95	6.95	6.93	6.95	30	35	0	2		2	1	1	0.28	0.26	0.27	0.27	0.31	0.3	0.27	0.29	7.9	7.9	6.5	6.5	28	27	0.00
117	4832927	13214300	Nazeer Sultan	27	1	1	4 y	2	1	7	7	2	0.32	0.37	0.49	0.39	0.49	0.49	0.36	0.45	14.5	14.5	16.51	18.99	25	23	0		1	2	1	1	0.32	0.37	0.38	0.36	0.4	0.42	0.44	0.42	12.3	13.5	15.3	16	21	20	0.00
118	4870042	13460197	Kavitha	23	2	1	3 y	2	1	7	7	2	0.26	0.32	0.29	0.29	0.43	0.34	0.31	0.36	10.1	11.2	9.8	10.3	14	13	0		1	2	1	1	0.23	0.24	0.25	0.24	0.3	0.31	0.28	0.30	7.8	9.9	8.8	10.8	12	11	0.00
119	4746171	12668322	Aravin N	22	1	2				7	7	1	0.31	0.31	0.31	0.31	0.31	0.36	0.31	0.33	16.4	17.8	17.2	18.9	20	33	0	2		2	1	1	0.28	0.29	0.29	0.29	0.25	0.28	0.3	0.28	14.3	15.5	16.2	16.5	18	22	0.00
120	4225374	9624560	Ananthakumar	25	1	2				7	7	1	0.26	0.26	0.29	0.27	0.29	0.24	0.32	0.28	5.9	6.47	22.75	23.4	20	26	0	2		2	1	1	0.24	0.26	0.26	0.25	0.18	0.22	0.22	0.21	10.8	10.8	20.3	21.7	18	23	0.00
121	4857889	13349114	Prem Kumar	39	1	2				7	7	2	0.34	0.29	0.32	0.32	0.34	0.37	0.39	0.37	3.7	10.5	10.96	21.45	34	32	0		1	2	1	1	0.32	0.31	0.3	0.31	0.32	0.33	0.35	0.33	4.5	10.1	7.8	10.22	20	22	0.00
122	4806070	13028574	Dinesh Babu	27	1	2				7	7	2	0.29	0.27	0.27	0.28	0.26	0.22	0.32	0.27	19.6	19.6	20.23	22.1	25	25	2.08		1	2	1	1	0.26	0.24	0.25	0.25	0.26	0.24	0.3	0.27	13.2	14.5	16.2	16.8	21	23	4.16
123	4764976	12781938	Naga Raju	19	1	2				7	7	2	0.29	0.19	0.24	0.24	0.21	0.2	0.3	0.24	18.5	19.1	17.8	18.44	15	23	0		1	2	1	1	0.22	0.25	0.22	0.23	0.19	0.15	0.2	0.18	16.7	17.1	17.25	18.21	18	20	0.00
124	4908023	13722634	D Kannan	27	1	2				7	7	1	0.37	0.44	0.42	0.41	0.42	0.46	0.49	0.46	10.8	13.6	14.4	18.31	35	35	4.16	2		2	1	1	0.28	0.29	0.3	0.29	0.3	0.35	0.35	0.33	9.8	10.3	13.4	13.56	24	23	8.33
125	3997357	7088148	T Muniyarajan	30	1	2				7	7	2	0.36	0.35	0.44	0.38	0.44	0.56	0.53	0.51	19.3	19.5	18.8	18.8	32	32	0		1	2	1	1	0.3	0.29	0.29	0.29	0.33	0.31	0.32	0.32	15.5	16.2	13.4	14.5	20	25	0.00
126	4876048	13501807	Seenivasan	33	1	2				7	7	2	0.19	0.2	0.22	0.20	0.27	0.27	0.3	0.28	14.8	17.8	6.95	13.33	28	33	0		1	2	1	1	0.18	0.19	0.19	0.19	0.24	0.25	0.23	0.24	12.2	13.1	5.6	10.45	20	24	2.08
127	4807242	13035889	Janani S	24	2	2				7	7	1	0.27	0.26	0.32	0.28	0.34	0.24	0.27	0.28	12.1	13.5	18.9	19.23	25	25	0	2		2	1	1	0.22	0.25	0.26	0.24	0.28	0.29	0.3	0.29	10.3	13.2	16.7	19.1	20	20	0.00
128	4707951	13089578	Makesh	30	2	2				7	7	2	0.34	0.48	0.41	0.41	0.41	0.34	0.41	0.39	17	19.6	18.16	20.33	18	20	2.08		1	2	1	1	0.3	0.31	0.32	0.31	0.34	0.33	0.32	0.33	15.4	16.77	17.91	18.6	16	18	4.16
129	4755080	18130789	Suganya	22	2	2				7	7	2	0.31	0.27	0.22	0.27	0.26	0.22	0.21	0.23	15.6	17.2	16.7	17.45	20	16	0		1	2	1	1	0.28	0.24	0.28	0.27	0.23	0.24	0.25	0.24	16.7	17.1	143	15.6	18	19	0.00
130	4767848	12798623	Kiruthika	21	2	2				7	7	2	0.21	0.24	0.22	0.22	0.26	0.23	0.24	0.24	14.7	15.6	4.08	13.71	30	30	0		1	2	1	1	0.2	0.21	0.22	0.21	0.22	0.24	0.26	0.24	13.8	15.1	12.1	12.45	28	26	0.00