

**Arab American University
Faculty of Graduate Studies
Department of Health Sciences
Master Program in Clinical
Optometry**



**Relationship Between Steroid Induced Intraocular Pressure
and Central Corneal Thickness Pre and Post Compound
Myopic Astigmatism Photorefractive Keratectomy: Prospective
Study**

**Hadeel Ahmad Ismail Suliman
202216449**

Supervision Committee:

Dr. Khalil Ismaeel Yousef Huraibat

Dr. Ibrahim Abdullah Ibrahim Taha

Prof. Yazan Sultan Saad Gammoh

**This Thesis Was Submitted in Partial Fulfilment of the
Requirements for the Master Degree in Clinical Optometry**

Palestine, 2/2026

© Arab American University. All rights reserved.

**Arab American University
Faculty of Graduate Studies
Department of Health Sciences
Master Program in Clinical
Optometry**



Thesis Approval

Relationship Between Steroid-Induced Intraocular Pressure and Central Corneal Thickness Pre- and Post-Compound Myopic Astigmatism Photorefractive Keratectomy: Prospective Study

Hadeel Ahmad Ismail Suliman
202216449

This thesis was defended successfully on 12.2.2026 and approved by:

Thesis Committee Members:

Name	Title	Signature
1-Dr. Khalil Ismaeel Yousef Huraibat	Main Supervisor	
2- Dr. Ibrahim Abdullah Ibrahim Taha	Member of Supervision Committee	
3- Prof. Yazan Sultan Saad Gammoh	Member of Supervision Committee	

Palestine, 2/2026

Declaration

I declare that, except where explicit reference is made to the contribution of others, this thesis is substantially my own work and has not been submitted for any other degree at the Arab American University or any other institution.

Student Name: Hadeel Ahmad Suliman

Student ID: 202216449

Signature: Hadeel Ahmad Suliman

Date of Submitting the Final Version of the Thesis: 26.3.2026

Dedication

First, I want to thank God for His mercy and guidance that have been with me at every step of this journey. All praise and thanks be to God.

Secondly, to my beloved father, my role model and exemplar, I stand before you as you have always wished me to be. May God have mercy upon you and grant you mercy paradise.

To my mother and family, thank you from the bottom of my heart. Every difficult step became easier with your support, allowing me to overcome all challenges.

To my homeland, Palestine, the land we live in and pursuit, the land whose soil we love even though all hardships.

To my supervisors, thank you for your efforts, guidance and support in helping this thesis reach the great possible draft.

Hadeel Ahmad Esmail Suliman

Acknowledgements

First and foremost, I thank God for His guidance, blessings and grace throughout the process of completing this thesis.

My sincere gratitude to my supervisors for their continuous support, insightful guidance and invaluable assistance in analyzing and refining this thesis. Their expertise and encouragement were essential to completing this thesis.

My gratitude also goes to the Russian Eye Center in Hebron, where I work, for providing the clinical data and the facilities necessary to conduct this study. I am equally grateful to the technical team, colleagues and all who helped prepare the figures, images and materials used in this thesis

I also acknowledge the support of my department, college, program coordinator and committee members at the Arab American University for providing the academic environment and resources required to complete this work.

Relationship Between Steroid-Induced Intraocular Pressure and Central Corneal Thickness Pre- and Post-Compound Myopic Astigmatism Photorefractive Keratectomy: Prospective Study

Hadeel Ahmad Ismail Suliman

Supervision Committee: Dr. Khalil Ismaeel Yousef Huraibat, Dr.

Ibrahim Abdullah Ibrahim Taha and Prof. Yazan Sultan Saad Gammoh

Abstract:

Introduction: Photorefractive keratectomy (PRK) is a widely used laser refractive surgery for correcting refractive errors. PRK patients are advised to use steroid drops to minimize corneal haze and inflammation, but their use may decrease aqueous humor outflow and potentially increase the intraocular pressure (IOP) in some patients. Central corneal thickness (CCT) has traditionally been considered a potential predictor of postoperative IOP fluctuations.

Objectives: This study aimed to investigate whether preoperative CCT is associated with postoperative steroid-induced IOP elevation post PRK in patients with compound myopic astigmatism and to evaluate the clinical relevance of CCT as a predictor of postoperative steroid response.

Methods: A prospective observational study was conducted involving 100 eyes of 50 patients aged 18–35 years undergoing PRK at the Russian Eye Centre in Hebron, Palestine. Preoperative tests included comprehensive eye examinations, IOP measurement using air-puff tonometry and CCT measurement using the Pentacam. Postoperative care involved Moxifloxacin 5 mg/mL eye drops and Prednisolone Acetate 1% eye drops. Follow-ups at 10 days, one week and one month included measurements of IOP and CCT. Statistical analysis examined the relationship between preoperative CCT and changes in post-IOP.

Results: Postoperative data analysis showed a significant decrease in CCT ($p < 0.001$), but no significant change in IOP ($p > 0.05$). Differences in CCT pre- and post-operative were not significantly associated with postoperative IOP changes. Additionally, grouping patients by IOP elevation (≤ 2 mmHg vs. > 2 mmHg) showed no notable differences in age or baseline CCT.

Conclusion: CCT cannot predict the degree of IOP rise. An evaluation after surgery should consider more than just CCT: biomechanical parameters need to be included also. The risk of a rise in postoperative IOP might be reduced by using weaker steroids. Future research should use larger numbers of study participants and have more extended follow-up periods to give a complete biomechanical evaluation of the outcome of surgery.

Keywords: central corneal thickness, steroid-induced IOP, PRK, corneal biomechanics, myopic astigmatism.

Table of Contents

Declaration.....	I
Dedication.....	II
Acknowledgements.....	III
Abstract:.....	IV
list of Tables.....	VII
list of Figures	VIII
list of Definitions of Abbreviations	IX
Chapter One: Introduction	1
1.1 BACKGROUND.....	1
1.2 STUDY SIGNIFICANCE.....	8
1.3 RESEARCH PROBLEM.....	9
1.4 STUDY OBJECTIVES	9
1.5 RESEARCH QUESTION	9
Chapter Two: Literature Review	10
2.1 THE RESEARCH THEORIES AND TOPIC:	10
2.2 REFRACTIVE ERRORS AND PRK INDICATIONS:	11
2.3 PHOTOREFRACTIVE KERATECTOMY (PRK) AND CORTICOSTEROIDS:	12
2.4 STEROID-INDUCED GLAUCOMA MANAGEMENT STRATEGIES:.....	13
2.5 CENTRAL CORNEAL THICKNESS MANAGEMENT STRATEGIES:.....	15
2.6 RELATIONSHIP BETWEEN CCT AND STEROID-INDUCED IOP:	17
2.7 THE GAP IN KNOWLEDGE AND ITS SIGNIFICANCE	18
2.8 CONCEPTUAL FRAMEWORK:	19
Chapter Three: Methodology.....	21
3.1 STUDY DESIGN:	21
3.2 STUDY POPULATION:.....	21
3.3 INCLUSION CRITERIA:.....	23
3.4 EXCLUSION CRITERIA:.....	23
3.5 SAMPLE RECRUITMENT AND DATA COLLECTION:	24
3.6 STUDY PROCEDURES:	24
3.7 ETHICAL CONSIDERATIONS AND APPROVAL:	28
3.8 ANALYSIS PLAN:	28
Chapter Four: Results	28

4.1 SAMPLE CHARACTERISTICS	29
4.2 DESCRIPTIVE STATISTICS	30
4.3 COMPARISON OF PRE AND 10-DAY POST-PRK STUDY PARAMETERS.	31
4.4 CORRELATIONS OF STUDY PARAMETERS WITH POSTOPERATIVE IOP.	33
4.5 LINEAR REGRESSION ANALYSIS OF PREDICTORS OF POST-IOP.....	36
4.6 GROUP COMPARISON.....	37
Chapter Five: Discussion.....	38
5.1 CLINICAL IMPLICATIONS.....	41
5.2. LIMITATIONS AND RECOMMENDATIONS.....	42
5. 3. CONCLUSION.....	44
References:.....	46
الملخص باللغة العربية:	53

List of Tables

Table #	Title of Table	Page
Table 2.4	Patient Selection Criteria for Photorefractive Keratectomy Surgery.	11
Table 2.5	IOP Measurements Pre- and Post-Surgery Using GAT and Air-Puff Tonometry in LASIK and Epi-LASIK Patients.	14
Table 4.1	Demographic and Clinical Characteristics of Participants (N=50)	27-28
Table 4.2	Both eyes Ophthalmic Measurements: Preoperative - and 10-Day Postoperative	29
Table 4.3	Wilcoxon Signed-Rank Test for Preoperative vs. 10-Day Postoperative Ophthalmic Measurements.	30
Table 4.4	Spearman's Correlations of preoperative parameters with Post-IOP, Ablation Depth and Steroid-Induced IOP Rise (N=50).	32
Table 4.5	Pearson correlation between Δ CCCT and Δ IOP. (N=50).	34
Table 4.6	Linear Regression Results for (Pre_IOP)	34
Table 4.7	Mann-Whitney U Test Summary	35

List of Figures

Figures #	Title of Figure	Page
Figure 2.1	air puff tonometry (NCT).	14
Figure 2.2	Goldman applanation tonometry (GAT)	14
Figure 2.3	Pentacam	16
Figure 2.4	Orbscan	16
Figure 2.5	Ultrasonic Pachymetry	17
Figure 4.1	Comparison of Mean CCT: Pre vs. 10-Day Post-PRK (in microns)	31
Figure 4.2	Comparison of Mean IOP: Pre vs. 10-Day Post-PRK (in mmHg)	31
Figure 4.3	The Relationship between Pre-CCT and Post-IOP.	33

List of Definitions of Abbreviations

Abbreviations	Title
AAUP	Arab American University of Palestine
BCVA	Best Corrected Visual Acuity
BSS	Balanced Salt Solution
CC	Corneal Curvature
CCT	Central Corneal Thickness
CXL	Corneal Cross-linking
CH	Corneal Hysteresis
CRF	Corneal Resistance Factor
Corvis ST	Corneal visualization Scheimpflug technology
D	Diopters
DM	Diabetes Mellitus
Epi-LASIK	Epi- Laser-Assisted in Situ Keratomileusis
GAT	Goldman Applanation Tonometer
IOL	Intraocular lens implantation
IOP	Intraocular Pressure
IRB	Institutional Review Board
LASEK	Laser Epithelial Keratomileusis
LASIK	Laser-Assisted in Situ Keratomileusis
Max-K	Maximum Keratometry
Mean-K	Mean Keratometry
Min-K	Minimum Keratometry
MMC	Mitomycin-C
NCT	Non-contact tonometry
OD	Right eye
OS	Left eye
PKP	Penetrating keratoplasty
PRK	Photorefractive keratectomy
RA	Rheumatoid Arthritis
SE	spherical equivalent of refraction
SMILE	Small Incision Lenticule Extraction

Chapter One: Introduction

1.1 Background

Refractive surgeries are common laser procedures that correct refractive errors such as myopia (nearsightedness), hyperopia (farsightedness) and astigmatism. The defocus of light at the retina due to these refractive errors leads to a blurred image, which directly affects the clarity of vision. By reshaping the cornea, refractive surgeries aim to alter the focusing power and more accurately direct light onto the retina to compensate for the encountered refractive errors. Refractive error type and severity, corneal thickness and shape, patient age, lifestyle and general eye health all influence the choice of refractive surgery. Over the past few decades, refractive surgeries such as Laser-Assisted in Situ Keratomileusis (LASIK), Photorefractive Keratectomy (PRK), Small Incision Lenticule Extraction (SMILE) and Laser Epithelial Keratomileusis (LASEK) have become much safer, more predictable and produce better outcomes due to the advancements in laser technology and surgical techniques.

Photorefractive keratectomy (PRK) is still a widely used surgical procedure for correcting refractive errors, particularly myopic astigmatism, by removing the corneal epithelium, the outermost corneal layer and reshaping the corneal stroma using an excimer laser (M. Ang et al., 2021). PRK remains one of the most commonly performed refractive procedures (M.A Ahmad, 2014), especially in patients with compound myopic astigmatism. Despite its widespread use, PRK is associated with several postoperative complications, such as corneal haze and refractive errors regression being the most common (Moshirfar et al., 2023a). However, these complications can often be reduced with the postoperative use of topical steroid eye drops. In some patients, called steroid responder, steroid use may lead to increased IOP (Kaberi Feroze et al., 2024). A review of previous studies suggested a potential relationship between preoperative CCT and steroid-induced IOP elevation post PRK (Iglesias et al., 2020). Recognizing and confirming this relationship could facilitate early diagnosis and appropriate management, resulting in improved patient outcomes.

Topical corticosteroids are commonly prescribed after PRK to reduce inflammation and corneal haze; however, they may induce an IOP rise in susceptible individuals which can lead to steroid-induced glaucoma (Moshirfar, et al 2023). This increase in IOP can affect vision results. That's why understanding the link between CCT pre-surgery and steroid-related IOP rise post-surgery, as shown in previous studies, is important. It can help predict and prevent these side effects in advance. The main goal of this study is to see how CCT relates to steroid-induced IOP changes in patients with compound myopic astigmatism. Knowing this relationship can help improve patient care by planning treatment better, reducing complications and keeping a closer eye on IOP during recovery.

This study examines the tools used to collect and analyze the data that will form the results. The accuracy and reliability of the research depend on how precise this data is, mainly the CCT measured with the Pentacam and the IOP measured with the air-puff tonometer. That's why the study emphasizes the importance of using consistent measurement methods to ensure the data are correct and comparable. The goal is to see the relationship between CCT and IOP. Understanding this relationship can help improve patients' vision outcomes and quality of life since uncontrolled steroid-induced IOP post-surgery can affect vision quality.

1.1.1 Photorefractive keratectomy (PRK)

Photorefractive keratectomy (PRK) is widely used, common and the safest type of refractive surgery using an excimer laser. It is used to correct low refractive errors, such as myopia, hyperopia and astigmatism (Pidro et al., 2019) and has been successfully achieved for the past 30 years. During PRK the cornea outer layer called the epithelium is removed. After that the cornea inner layer called the stroma is exposed. Then the stroma is reshaped using a 193 nm excimer laser based on the patient's refractive errors type. This corrects refractive errors by changing the cornea's stromal curve to improve vision (Torricelli et al., 2024). The patient's refractive error is measured during preoperative assessments, which determine the treatment's ablation shape and depth. The laser reduces the central curvature in myopia and alters the peripheral curvature in hyperopia. and redistributes tissue along

specified meridians to correct astigmatism, with very little heating effect in the surrounding areas (Lau et al., 2019).

Laser in-situ keratomileusis (LASIK) and Transepithelial photorefractive keratectomy (Trans PRK) are common eye surgeries used to correct refractive errors (Curci et al., 2024). Both aim to change the cornea's shape to treat refractive errors. However, they have distinct methods and recovery times. LASIK may be unsuitable for patients with thin corneas or those predisposed to flap-related complications and side effect, Trans PRK is typically recommended for thinner corneas or contact sports players, PRK is particularly beneficial for individuals who are not good candidates for these types of refractive surgeries due to several reasons including thinner corneas, topographical pathology or epithelial basement membrane disease, as it does not require a flap. Compared to these two previous mentioned refractive techniques, (Torricelli et al., 2024). The most notable risk specific to PRK is corneal haze (M. Ang et al., 2021). Haze is a clouding of the cornea that can occur as part of the stromal healing response, particularly after higher corrections or in individuals prone to excessive wound healing (Hassanzadeh et al., 2025). It can range from mild, clinically insignificant haze to more severe opacities that can affect vision. Post-operative use of corticosteroid eye drops is crucial in minimizing haze formation.

One of the primary refractive errors treated mainly by PRK is the compound myopic astigmatism (Peyman et al., 2017), affecting about 13% of the total individuals having refractive errors (Schiefer et al., 2016). Compound myopic astigmatism occurs when the eye's two principal meridians are both myopic (nearsighted), though to different degrees. Because the excimer laser can be set to deliver a customized ablation profile that simultaneously corrects the cylindrical astigmatic component and the spherical myopic component, PRK is especially appropriate for the correction of compound myopic astigmatism (Somani et al., 2025a). To ensure precise retinal focus across both principal meridians, the laser reshapes the corneal stroma, the middle layer of the cornea. Therefore, to create a more uniform corneal curvature, the ablation pattern for astigmatism is usually toric, which removes more tissue along the steeper corneal meridian and less along the flatter meridian (R. E. T. Ang, 2025). To address the myopic component, the entire treatment zone

is subjected to spherical correction after the astigmatic correction. The accuracy of today's excimer lasers enables this complex, non-uniform ablation, which is necessary for effectively treating compound astigmatism on the corneal surface.

1.1.2 Central corneal thickness (CCT)

Central Corneal Thickness (CCT) refers to the thickness of the cornea at its center, an important parameter that has a big impact on ocular biomechanics (Vestergaard, 2014). The measurement of IOP is impacted by corneal thickness, which also influences its rigidity and resistance to deformation. Through the removal of corneal tissue, refractive procedures such as PRK reshape the cornea (Somani et al., 2025a). A decrease in CCT is the direct consequence of this tissue removal. There is a significant relationship between CCT and IOP measurement. The most common method for measuring IOP, Goldmann applanation tonometry (Zeppieri & Gurnani, 2025), relies on the principle of applanation, where a particular part of the cornea is flattened. However, corneal thickness affects this method's accuracy. Goldmann tonometry has an ability to underestimate the true IOP in corneas with decreased CCT (Zeppieri & Gurnani, 2025), such as those following PRK. An artificially low-pressure reading results from the thinner cornea's higher susceptibility to distortion. As a result, post-PRK thinning complicates clinical decision-making by changing both the actual and perceived IOP. When interpreting IOP measurements in patients who have had refractive surgery, this requires the clinicians to take certain considerations and adopt some changes.

Preoperative evaluation for PRK includes measurement of (CCT) and assessment of the degree of refractive error (Vestergaard, 2014). CCT measurement is a critical parameter for both the diagnosis and management of some ocular conditions, as well as in the planning and monitoring of refractive surgery outcomes such as PRK and LASIK. The Pentacam and Orbscan are two of the most widely used instruments for this purpose because of their portability and common usage in clinical and research settings (Jabbarv and et al., 2017a). Accurate and precise CCT measurements are obtained using the Pentacam because of its advanced features. It employs a rotating Scheimpflug camera to capture detailed three-dimensional images of 356 degrees of the anterior segment of the eye and the anterior

chamber angle, allowing for the study of both the anterior and posterior corneal surfaces (Al-Ageel & Al-Muammar, 2009 & Jabbarvand et al., 2017a). Unlike that, the Orbscan only gives a 2D image of the front surface of the cornea and doesn't show extra details. This can sometimes lead to wrong diagnoses because it relies on the front surface map using slit scanning technology (Matsuda et al., 2008a). Compared to the conventional contact ultrasound pachymetry, which touches the cornea directly and can be uncomfortable and less consistent, both the Pentacam and Orbscan don't touch the eye, which makes them easier and better in that sense (Kawana et al., 2004).

Current studies support using the Pentacam to measure CCT, especially pre-refractive surgeries (Al-Ageel & Al-Muammar, 2009 & Jabbarvand et al., 2017a). In the past, Orbscan was commonly used as the standard instrument for measuring CCT (Jabbarvand et al., 2017b; Kumar et al., 2021). In clinical practice, ophthalmologists prefer the Pentacam both pre- and post-surgery to obtain accurate measurements and to assess the corneal status precisely, thanks to its ability to offer comprehensive data analysis and high-resolution imaging. As shown in previous studies, the Pentacam provides reliable and valid corneal thickness measurements after LASIK surgery, particularly when evaluating thin corneas pre and post the procedure (Al-Ageel & Al-Muammar, 2009). Corneal Surface irregularities affect Orbscan reliability, which tends to decrease in post-surgical eyes and increase following procedures such as PRK or LASIK. The Pentacam Scheimpflug imaging technology appears to be less affected by these corneal distortions though. This is clinically significant, particularly when assessing patients for ectasia risk or retreatment. Many eye care specialists now view Pentacam as the gold standard for CCT measurement in post-refractive surgery examinations (Kumar et al., 2021). For these reasons, Pentacam CCT measurements will be used for this work.

1.1.3 Steroid-induced intraocular pressure (IOP)

In PRK, certain patients may experience complications like regression in myopia and corneal haze (M. Ang et al., 2021). To correct vision, these complications may require multiple procedures or additional interventions. Topical steroid application has

been demonstrated in earlier research to remove subepithelial haze and, in certain situations, prevent myopic regression. (Moshirfar et al., 2023a). It was also confirmed that topical steroids cause an increase in the IOP in steroid-responsive patients (Kaberi Feroze et al., 2024), with approximately one-third of the patients showing a moderate increase in the IOP after using steroids (Pattih Prima Sakti et al., 2025). This increased IOP results from decreased aqueous humor outflow at the trabecular meshwork (Javadi et al., 2008a). Importantly, to prevent steroid-induced glaucoma requires identifying patients who are "steroid responders" those who experience significant rises in IOP after using steroids.

After PRK, careful and regular monitoring of IOP is essential for controlling symptoms and protecting the optic nerve and other ocular structures that may be affected by elevated IOP. Moreover, corticosteroid eye drops, including fluorometholone, dexamethasone and prednisolone (Pleyer et al., 2013), play an important role in managing common post-operative symptoms such as inflammation. However, although effective in preventing inflammation, these medications can significantly contribute to IOP post-PRK elevation. Therefore, healthcare professionals must be cautious when choosing the appropriate steroid and ensure a short period for monitoring of the patient during and after treatment starts. In this context, fluorometholone is considered a relatively low potency option with fewer IOP-elevation, while dexamethasone is regarded as one of the most effective agents for reducing post-surgical inflammation (Fung et al., 2020), with higher potency for IOP elevation.

To reduce the occurrence of these complications, many measures should be performed. First, While the peak rise typically happens within 3-6 weeks, some studies recommend monitoring IOP no later than 10 to 14 days after beginning steroid treatment. especially post procedures like PRK (Manzoor et al., 2020a). Second, an accurate measurement device that is not affected by post-surgical CCT changes, which may influence the reliability and accurate of IOP readings, should be used. Different methods exist for measuring IOP, though some might be inappropriate post-refractive surgeries. These include the Goldmann Applanation Tonometer (GAT) (Zeppieri & Gurnani, 2025), non-contact tonometry (NCT), the Tono-Pen, iCare rebound tonometry and Pascal Dynamic Contour Tonometry. The air-puff

tonometer is a non-contact device (NCT) used to measure IOP. It works by sending a jet air to the center of the cornea, causing it to flatten briefly. The device then measures how long the cornea takes to return to its normal shape and this time is used to estimate the IOP (Farhood, 2012). This method is easy to use, safe and does not require touching the eye cornea which makes it more comfortable for patients during eye examinations. On the other hand, the Goldmann applanation tonometer (GAT) is influenced by CCT. Post refractive surgery corneal thinning and increased corneal flattening can cause GAT to underestimate the true IOP values (Javadi et al., 2008a).

When considering the GAT as the gold standard for measuring IOP (Ajazaj et al., 2018), it is important to note that the device may become less accurate post-refractive surgery. This can result in an underestimation of normal IOP readings due to CCT thinning and flattening. In contrast, the air-puff tonometer helps reduce errors related to postoperative changes in CCT (Javadi et al., 2008b). Therefore, the air-puff tonometer was chosen to measure IOP in this study.

1.1.4 Corneal biomechanical

The viscoelastic behavior of the cornea is complex and depends on the arrangement of collagen fibers, rather than the CCT. The biomechanics of the cornea, including Corneal Hysteresis (CH), reflect the cornea's ability to accommodate and dissipate energy (Komninos et al., C.E.) and these factors have been shown to affect the accuracy of IOP measurements. Post-PRK, changes in corneal architecture may alter corneal biomechanics, potentially affecting IOP measurement accuracy and steroid response (Hsia et al., 2023). CH, as measured by the Ocular Response Analyzer (ORA) (Long et al., 2015), reflects the difference in pressure needed for inward and outward movements of the applanation probe, indicating the cornea's viscoelastic damping ability (Aoki et al., 123 C.E.). Similarly, the Corvis ST uses high-speed Scheimpflug imaging to assess the cornea's deformability through dynamic parameters (Eun Kim et al., 2020). Post-PRK changes in collagen fiber thickness and

organization may compromise the corneal biomechanical strength, potentially affecting IOP measurement and reactions to steroid treatment.

1.2 Study significance

Understanding the relationship between steroid-induced IOP elevation and CCT pre- and post-compound myopic astigmatism PRK is essential for many key reasons. It enables timely medical interventions for patients when postoperative complications and side effects arise. Topical steroid eye drops, used to reduce corneal haze and prevent refractive errors regression post-surgery (Moshirfar et al., 2023a), play an essential role in reaching these advantages. However, these drops are also the leading cause of elevated IOP in steroid-responsive patients (Kaberi Feroze et al., 2024), as previous studies have shown, with about 3% of cases addressing an increase in IOP (Dada et al., n.d.). Therefore, a thorough understanding of the mechanisms that correlate steroid use with IOP and CCT changes is essential for improving postoperative patient care and reducing potential complications.

The medical and clinical importance of this study is that it helps ophthalmologists better manage post-surgical side effects and complications by understanding the relationship studied here. This knowledge helps doctors predict how a patient might perform post-surgery using pre-surgery data, which can help prevent steroid-related increases in IOP and their negative effects on vision and comfort. When doctors can clearly see how steroid eye drops affect the eye understand the link between post-surgery steroid-related IOP increases and pre-surgery CCT, they can make personalized follow-up plans for each patient. This allows closer monitoring for patients who are more likely to have complications. Also, there is a clear gap in previous research that has specifically looked at using both air-puff tonometry and Pentacam in patients with compound myopic astigmatism having PRK to see how steroids affect IOP and CCT.

1.3 Research problem

Topical corticosteroids are commonly used to reduce and prevent corneal haze and inflammation post PRK for compound myopic astigmatism. Yet they can also cause steroid-induced IOP elevation (Moshirfar et al., 2023a). For this reason, this study aims to understand how steroid use, IOP, and visual outcomes interact in a standard refractive surgery procedure. By optimizing steroid regimens to reduce IOP-related complications and enhance patient safety and visual outcomes, this research may help guide clinical practice. Additionally, this research's novelty could have a significant impact on the field of refractive surgery, as, to our knowledge, no previous study has specifically examined the relationship between steroid-induced IOP elevation and CCT in patients undergoing PRK for compound myopic astigmatism.

1.4 Study objectives

1.4.1 Primary objective

The primary aim of this work is to determine the relationship between pre-PRK CCT and steroid-induced IOP elevation.

1.4.2 Secondary objectives

- 1- Assess whether refractive errors and ablation depth degrees predict IOP response.
- 2- To evaluate pre-PRK CCT and baseline IOP as predictors of post-PRK steroid-induced IOP elevation.
- 3- Baseline demographic, refractive and visual characteristics of the study population.

1.5 Research Question

What kind of relationship is presented between central corneal thickness (CCT) pre- and post-compound myopic astigmatism, PRK and steroid-induced IOP elevation? and is it possible to forecast it pre-surgically so we can manage the elevation in steroid-induced IOP before it happens?

Chapter Two: Literature Review

2.1 The research theories and topic:

Several theories are relevant to understanding the relationship between central corneal thickness (CCT) and steroid-induced intraocular pressure (IOP), especially pre- and post-compound myopic astigmatism photorefractive keratectomy (PRK). Therefore, this chapter will focus on giving a structural review and a summary of the core concepts of this research work: PRK, IOP, CCT and their interplay theories. Additionally, the following subsection of this chapter will highlight the rationale for each topic area to support the research hypothesis.

One important theory is the steroid response theory, which suggests that corticosteroids may increase intraocular pressure (IOP) by altering the dynamics of aqueous humor, which results in a decreased outflow capacity and an increase in resistance at the trabecular meshwork (Goel et al., 2010). This is essential to understanding how steroids could impact IOP post-surgery. The corneal biomechanics theory which suggests that variations in CCT may affect IOP readings (Zarei et al., 2022). is another important theory, because of their anatomical characteristics, thicker corneas typically result overestimated IOP readings, whereas thinner corneas may underestimate true IOP readings (Marjanović et al., 2010). Therefore, surgical changes can have significant effects on both CCT and IOP therefore, making measurements in an appropriate way is essential when evaluating patients undergoing PRK.

The ophthalmologist needs to adapt the treatment post-surgery correctly, watch for any possible complications and determine, monitor the appropriate steroid dose (Chen Cardenas et al., 2023), including how to start and tapering it safely until end of use it. So, understanding the relationship between CCT and IOP, as this study looks at, is important to get the best results for patients post PRK. After reviewing previous studies and their results, we'll highlight the ones most relevant to our topic and explain the best ways to manage these related factors post-surgery, with a focus on methods used in recent research. According to our study idea, there's a positive relationship between CCT measured by the Pentacam and IOP measured by the air-puff tonometer, both pre and post PRK.

2.2 Refractive errors and PRK indications:

Blurred vision commonly results from refractive errors, which are conditions where the eye cannot focus light accurately onto the retina. These errors are usually classified into three types: myopia (nearsightedness), hyperopia (farsightedness) and astigmatism. In myopia, light focuses in front of the retina causing blurry vision at a far distance. In hyperopia light focuses behind the retina causing blurry vision at near distances. Astigmatism occurs when the cornea or lens becomes irregularly shaped causing blurry vision at all distances. Another complex refractive error is compound myopic astigmatism because, here, an individual suffers from both myopia and astigmatism or astigmatism only. In this condition the principal meridians of an individual's eyes are myopic but dissimilar in refractive power, causing blurry nearsighted vision in two directions with different levels of intensity. Therefore, blurry vision occurs at all distances with the extent of blurry vision directly proportional to the combined severity of both astigmatism and myopia.

Globally, the prevalence of refractive errors varies and is impacted by environmental factors, age and ethnicity (Vitale et al., 2008). The prevalence of myopia is rising globally especially in East Asia. and significantly increased in recent decades (Grzybowski et al., 2020). According to estimates of prevalence and associated population figures, 52% (4949 million) and 10.0% (925 million) of the world's population, respectively, would suffer from myopia and high myopia by 2050. As a result, myopia is predicted to affect 52% of people globally by 2050, up from 27% in 2010 (Ali Nouraeinejad et al, 2021). Another standard refractive error that varies in prevalence depending on the population under study is astigmatism (J. Zhang et al., 2023). Uncorrected refractive errors can significantly impact quality of life and productivity (Németh et al., 2023). In the case of compound myopic astigmatism, the blurred vision is present at all distances, making it particularly debilitating.

Astigmatism, hyperopia and myopia are among the clinical indications for PRK (Somani et al., 2025a). It works exceptionally well to correct refractive errors of low to moderate size. The following patient selection criteria (Table 2.4) are essential for successful outcomes.

Table 2.4: Patient Selection Criteria for Photorefractive Keratectomy Surgery.

Criterion	Description
Age	Patients must be at least 18 years old(Jacobs et al., 2023).
Refractive Stability	The refractive error should be stable for a minimum of one year before surgery(Jacobs et al., 2023).
Corneal Thickness	Sufficient corneal thickness is required to allow for laser ablation without compromising corneal integrity(Djodeyre et al., 2016).
Corneal Topography	The cornea should be free of significant irregularities or abnormalities(Ramamurthy et al., 2020).
Overall Eye Health	Patients should be free from other eye diseases like cataracts, glaucoma and significant dry eye(Somani et al., 2025a).

2.3 Photorefractive keratectomy (PRK) and Corticosteroids:

PRK involves the removal of the corneal epithelium, followed by the reshaping of the corneal stroma using an excimer laser (Somani et al., 2025a). This process corrects refractive errors by changing how light is focused on the retina. PRK has been used for many years and progress in technology and techniques are evident every day. Corticosteroids are often used to control inflammation, decrease corneal haze and support epithelial recovery and healing (Fung et al., 2020). The inflammatory response following PRK can lead to corneal haze, which can impair visual outcomes. Corticosteroids, such as prednisolone acetate or dexamethasone, are typically prescribed as topical eye drops.

After PRK, the effectiveness of corticosteroids and the patient's safety regarding side effects have been the focus of many research studies. A 2020 study published in the Journal of Refractive Surgery (Pakbin et al., 2020) evaluated the use of topical steroids post PRK for myopia and found that these medications significantly helped reduce side effects particularly corneal haze and improved visual acuity and quality of life for patients (Moshirfar et al., 2023b). Many previous studies have examined the outcomes of PRK (Tahzib, 2008), including patient satisfaction and visual improvement, comparing these results with postoperative data from LASIK, which shows similar effects (Almutairi et al., 2025). Both procedures are effective in correcting refractive errors and achieving optimal results; however, PRK remains a better option in cases of thin corneas (Zhao et al., 2010). Another study published in Clinical Ophthalmology in 2023 investigated the impact of corticosteroid dosing protocols and monitoring, demonstrating that tapered steroid use after refractive surgery helps reduce corneal haze and improve visual acuity. while, in

some cases PRK may still be the perfect option for patients with thin corneas or those at higher risk of flap complications (Somani et al., 2025b).

2.4 Steroid-Induced Glaucoma Management Strategies:

The GAT is considered the gold standard for measuring IOP and has been widely compared with NCT especially the air-puff tonometer. Many studies have examined the differences between these devices including a study by Osman et al. (2018), which evaluated variations in IOP measurements between the two methods as illustrated in Figures 2.1 and 2.2. These comparisons are important for determining which device is more suitable in certain cases, particularly post-refractive surgery (Vincent et al., 2012). The study reported some statistical differences with the air-puff tonometer showing slightly higher IOP readings than GAT in the right eye while similar readings were observed in the left eye ($P = 0.93$). Although differences were noted they were not statistically significant enough to affect the overall accuracy of the measurements. However, a previous study conducted at Shaheed Beheshti Medical University in Tehran, Iran (Javadi et al., 2008b), found that GAT has certain limitations when measuring IOP post PRK surgery. These limitations primarily relate to postoperative changes in corneal biomechanics. Reducing in CCT and corneal rigidity post-surgery may cause GAT to underestimate the true IOP which could hide conditions such as elevated IOP or glaucoma.

Non-contact tonometry (NCT), such as the air-puff tonometer, is commonly used after refractive surgery because it may be less influenced by postoperative corneal changes. Although no tonometry method is entirely independent of corneal properties, NCT provides a practical and non-invasive option for IOP assessment in post-PRK patients. A study by Ahmad M.A et.al 2014) examined the relationship between CCT, corneal curvature (CC) and IOP pre and post PRK for simple myopia. Conducted at the Department of Ophthalmology in Iraq from August 2011 to August 2012, the study used NCT to measure

IOP. A key finding was a negative correlation between CCT and steroid-induced IOP, showing that thicker corneas were linked to lower IOP readings when steroids were used prior to the procedure. Another study by (Manzoor et al., 2020b).assessed the relationship between post-operative CCT and steroid-induced IOP post myopic PRK. This longitudinal study involved 50 patients of both genders, aged 20 to 40, who underwent myopic PRK at the Department of Ophthalmology, Madina Teaching Hospital, Faisalabad, from July 2019 to May 2022. The results of using GAT for IOP measurement were a positive correlation between CCT and IOP (Manzoor et al., 2020a). Refractive surgery causes a significant lowering of IOP as measured using Goldman applanation tonometry or air puff tonometry (Shousha et al., 2013a). A prospective comparative clinical study was conducted between February and September 2011 by Shousha et al. on 30 eyes divided into four groups, comparing different intraocular pressure measurement techniques in normal eyes, post-surface and post-lamellar refractive surgery. Results show that the IOP values are different pre- and post-surgery in patients undergoing LASIK and epi-LASIK (Shousha et al., 2013b). In conclusion, many studies confirmed that refractive surgeries affect the accuracy of the Goldman tonometer, causing it to underestimate IOP (Faucher et al., 1997; De Moraes et al., 2008). Therefore, most studies advocate for the use of multiple tonometry devices in clinical practice to ensure accurate IOP assessment, especially in patients with thinner or structurally altered corneas post-refractive surgery.

Table 2.5: IOP Measurements Pre- and Post-Surgery Using GAT and Air-Puff Tonometry in LASIK and Epi-LASIK Patients.

Variables		IOP-LASIK (mmHg)	IOP-EpiLASIK (mmHg)
GAT	Pre-Surgery	18(8-28)	14(12-16)
	Post-Surgery	12(6-16)	12(10-14)
NCT	Pre-Surgery	20(10-28)	15(12-18)
	Post-Surgery	13.5(10-18)	12.5(10-16)



(Figure 2.1): air puff tonometry (NCT).

(Non-Contact Tonometer NT-530/510 | NIDEK, n.d.)



(Figure 2.2): Goldman applanation tonometry (GAT)

(Applanation Tonometer 900 & 870, n.d.)

2.5 Central Corneal Thickness Management Strategies:

Accurate measurement of CCT is critical for diagnosing and managing ocular conditions, as well as for planning and monitoring outcomes in refractive surgeries such as PRK and LASIK. Two of the most widely used devices for CCT measurement in clinical and research settings are Pentacam and Orbscan, as shown in Figures 2.3 and 2.4 below. Pentacam uses a

rotating Scheimpflug camera system to capture detailed, three-dimensional images of the cornea, while Orbscan utilizes scanning slit technology combined with Placido disk-based topography. Ultrasonic Pachymetry is a technique for measuring CCT with ultrasonic waves. The device assesses corneal thickness by positioning a probe on the eye and recording the time it takes for ultrasonic waves to reflect from the corneal surfaces, as shown in Figure 2.6. Anterior Segment Optical Coherence Tomography (AS-OCT) is a non-contact, high-resolution technique for imaging the cornea and anterior segment of the eye. AS-OCT helps accurately measure CCT (Komninou et al., 123 C.E.).

Several studies have examined the changes in CCT pre- and post-refractive surgery. A notable 2008 study compared Pentacam and Orbscan in patients who had undergone LASIK and PRK (Matsuda et al., 2008b). It found that Pentacam provides more accurate and reliable CCT measurements especially in thin corneas. In contrast Orbscan's accuracy declined because it depends on the anterior corneal surface which changes significantly post-refractive surgery. Pentacam which is equipped with Scheimpflug imaging technology is less affected by post-refractive surgical corneal surface changes, making it the preferred choice for precise measurement unaffected by refractive surgery (Journal et al., 2019). Regarding other devices, such as ultrasonic pachymetry, a 2017 retrospective case series by (Busool et al., 2017) followed patients who underwent PRK from 2000 to 2015 for at least three months, measuring CCT with ultrasound. This study reported higher CCT values with ultrasound, but overall, Pentacam remains the most effective and accurate tool, especially post-refractive surgery. Using the most precise device improves data interpretation. Compared to studies like (Manzoor et al., 2020a), which also used Pentacam for CCT measurement, that study explored the relationship between postoperative CCT and steroid-induced IOP elevation after PRK. It involved 50 patients and provided valuable insights into how corneal changes post-surgery influence IOP, with Pentacam ensuring measurement accuracy and enhancing the validity of its findings.



(Figure2.3): Pentacam
(OCULUS Pentacam HR - Ophthalmic Mart, n.d.)



(figure2.4): Orbscan
(Bausch & Lomb's Orbscan IIz Topographer - Vision Equipment Inc., n.d.)



(Figure 2.5): Ultrasonic Pachymetry
(Pachymeter - PacScan Plus - Sono med Escalon - Ultrasound Pachymetry / Tabletop, n.d.)

2.6 Relationship Between CCT and Steroid-Induced IOP:

Several studies have been conducted on the relationship between CCT and steroid-induced elevation of IOP. Steroid-induced glaucoma is a condition in which the use of steroids, whether topical, systemic, or periocular, causes an increase in intraocular pressure

in those who are susceptible. The ability of CCT to predict this response has been examined in several studies. In related prospective randomized clinical trial study done by Brand t et al. (2004), showed that thinner CCT was associated with increased risk of steroid-induced IOP elevation. This means that individuals with thinner CCT are possibly more affected by steroids induced IOP elevation more than others because of this longitudinal analytical study done by Manzoor et al. (2020b). On the other hand, a study by Wei et al. (2014), discovered that a higher IOP response to topical steroids was associated with thicker CCT. The contrasting findings show how complicated this relationship is and how much more research is required to understand how CCT fully predicts steroid response.

Generally, the relationship between CCT steroid-induced IOP elevation and refractive surgery outcomes is complicated and often variable. However, it can be said that thinner CCT are more strongly linked to an increased risk of steroid-induced IOP elevation post refractive surgery. Conversely, the success of refractive surgery mainly depends on the level of refractive error degree and the amount of corneal tissue removed. Regional studies offer valuable insights into patients' individual traits and their postoperative results. Still, there is a need for larger and more thorough studies to better predict steroid responsiveness based on corneal thickness measurements, thereby achieving high-quality outcomes after refractive surgery.

2.7 The gap in knowledge and its significance

There are clear research gaps that justify the start of this study. Although previous research has provided valuable and accurate data about the relationship between CCT and steroid-induced IOP elevation, these studies did not adequately control for all related factors and influential variables. These include age, history of ocular diseases, the specific type of steroid used and the lack of long-term follow-up to monitor postoperative changes over different time periods. As shown in the reviewed studies (Javadi et al., 2008d)•they mainly focus on short-term postoperative outcomes without addressing the long-term effects that require extended follow-up periods. Similarly, the study by (Manzoor et al., 2020d). concentrated mainly on preoperative measurements and data, without considering

the potential influence of patient-related factors that could impact the accuracy of the findings. A thorough literature review that fills these gaps by using a larger sample size and longer follow-up periods will improve earlier research findings. In this study, we will compare pre-PRK CCT and post-PRK IOP elevation measurements while accounting for factors such as age and eye health history. This study focuses on compound myopic astigmatism, which has not been thoroughly studied in the existing PRK literature. Therefore, the aim of this research is to describe the relationship over time and provide better recommendations for managing postoperative side effects and optimizing steroid use in this patient population.

2.8 Conceptual Framework:

The conceptual framework of this study is based on a few main points in eye care. First, it's important to understand how steroids can raise IOP. Glucocorticoids increase IOP in sensitive individuals, primarily by slowing fluid flow within the eye through changes in the trabecular meshwork. Second, IOP readings are influenced by the cornea's biomechanical properties, particularly the CH and CCT measured using various methods and devices. For example, thinner corneas usually give lower pressure readings, while thicker corneas often give higher readings than the actual pressure. Third, PRK is a type of eye surgery in which part of the cornea is removed using an excimer laser to correct vision. This naturally changes corneal thickness pre- and post-surgery, which, as mentioned before, also affects eye pressure readings.

The framework specifies the following variables:

1.2.8 Independent Variables:

- Steroid management: The use of topical corticosteroids post-PRK.
- Photorefractive Keratectomy (PRK): The surgical intervention itself.

2.2.8 Dependent Variables:

- IOP: Measured at the same time pre- and post-PRK and steroid drop use PRK, using air puff tonometry.
- CCT: Measured at different times pre- and post-PRK by using Pentacam.

The relationships among these variables are illustrated as follows:

PRK causes a reduction in CCT, which naturally leads to lower IOP readings after the surgery. Although, the use of steroids postoperatively, which is important for recovery and healing, can cause an increase in IOP in individuals susceptible to steroid-induced IOP. Additionally, an individual's history of steroid responsiveness affects how steroid use impacts IOP.

This framework was chosen because it examines how steroid medication, eye anatomy, corneal biomechanics and surgery interact in complex ways. It provides a clear plan for understanding these connections and helps develop research questions and ideas to test. It also guides how to collect and look at the data correctly. Using this framework helps determine the best ways to measure IOP and CCT, when to take these measurements and which statistical methods to use to analyze the data.

Chapter Three: Methodology

3.1 Study design:

To analyze the influence of CCT, preoperative refractive error and ablation depth on postoperative Steroid-induced IOP we conducted a prospective observational study from Jan. 8, 2024 to Jan. 6, 2025 (one of several observational studies). The data we collected for this study include multiple outcomes for the same subjects measured at several time points, hence the definitions of CCT, preoperative refractive error and ablation depth in the text above. Because we are measuring all outcomes from this study at the same site, we will maintain a high level of control over the testing environment across all sites. Additionally, the prospective design allows us to examine relationships among these variables within our sample.

3.2 Study population:

The sample size was identified using an equation that considers data variability and comparisons with equivalent studies (Charan & Biswas, 2013). By applying a calculation approach aligned with established examples in the literature, it was concluded that an appropriate sample size for this investigation is 50 ± 5 patients (100 ± 5 eyes). Data were collected through a prospective review of 50 male and female patients (100 eyes), aged 18-35 years, undergoing PRK surgery for compound myopic astigmatism at the Russian Eye Centre in Hebron, Palestine. The participants had a spherical equivalent of refraction (SE) greater than -0.25 diopters (D) and astigmatism less than -5.00 diopters (D).

3.2.1 Calculation approach:

An Adequate sample size calculation is an important methodological requirement to ensure scientific rigor, statistical validity, and reliability of clinical research findings. In the current study, the sample size was calculated using the standard formula for estimating a population mean:

$$\bullet \text{ sample size} = \frac{(Z_{1-\alpha/2})^2 * SD^2}{D^2}$$

Based on previously published studies, the following values were adopted.

$$Z_{1-\alpha/2} = 1.96 \text{ (from Charan \& Biswas, 2013)}$$

$$SD = 19 \text{ (from Brand t et al., 2004)}$$

$$D = 5 \text{ (from Charan \& Biswas, 2013).}$$

$$(Z_{1-\alpha/2})^2 = (1.96)^2 = 3.8416$$

$$SD^2 = (19)^2 = 361$$

$$D^2 = (5)^2 = 25$$

$$\text{sample size} = \frac{3.8416 * 361}{25}$$

$$\text{Sample size} = 3.8416 * 361 = 1386.9176$$

$$\text{Sample size} = \frac{1386.9176}{25} = 50 \pm 5 \text{ patients.}$$

As a result, the minimum sample size needed was around 50-55 patients. This estimate was deemed sufficient to ensure adequate statistical power, along with acceptable precision and confidence in the study outcomes.

3.3 Inclusion criteria:

- 1- Adults over 18 years with compound myopic astigmatism who have had a stable refraction for at least 12 months.
- 2- IOP lower than 21 mm Hg(Eun Kim et al., 2020).
- 3- CCT greater than 450 microns(Busool Abu-Eta et al., 2021).
- 4- A period without wearing contact lenses (more than 2 weeks for rigid contact lenses and more than 4 days for soft contact lenses) (Du et al., 2023).pre-surgical protocol.
- 5- The participants' astigmatism was less than -5.00 diopters (D)and their spherical equivalent of refraction (SE) was greater than -0.25 diopters (D).

3.4 Exclusion criteria:

Exclusion Criteria

1. Corneal Diseases•Keratoconus•Corneal dystrophies or degenerations•Severe dry eye disease.
2. History of Ocular Surgery :Penetrating keratoplasty (PKP)•Phacoemulsification with intraocular lens implantation (IOL)•Corneal cross-linking (CXL).
3. Ocular Trauma :Any history of ocular injury or trauma.
4. Congenital or acquired corneal opacities :Infectious keratitis (e.g., adenoviral keratitis). Cataract •Glaucoma.
5. Systemic or Autoimmune Diseases Affecting Corneal Healing :Autoimmune disorders (e.g., Rheumatoid Arthritis, RA) •Diabetes Mellitus (DM).
6. IOP > 21 mmHg, which is in line with the current definition of ocular hypertension and baseline CCT ≤ 450 μm were excluded with the goal to preserve corneal biomechanical stability and lower the possibility of error caused by thickness-related IOP overestimation or underestimation.

3.5 Sample recruitment and Data Collection:

Participants were recruited at the ophthalmology center and were undergoing a comprehensive eye examination in preparation for PRK between January 8, 2024 and January 6, 2025. Oral and written consent was obtained after explaining the study objectives and procedures, followed by a formal request for their participation. Data were collected at three different stages:

- 1- The preoperative demographic data collected included age, gender, date of surgery, dominant eye, CCT measured with Pentacam (Oculus Pentacam HR), IOP measured by air puff tonometry (Topcon CT-80 noncontact tonometer), preoperative spherical equivalent (SE) and cylinder, mean keratometry (mean-K) power, minimum and maximum keratometry (min-K and max-K), CCT, IOP and corrected distance visual acuity.
- 2- The intraoperative data registrar included operating room humidity, temperature, optical zone, maximum ablation depth and mitomycin-C (MMC) exposure time.
- 3- Postoperative data sharing measurements of IOP, CCT and the dose of topical steroids prescribed post PRK.

3.6 Study procedures:

The surgical technique known as PRK was created to improve visual acuity by correcting a variety of refractive errors in patients' eyes. This method effectively altered the cornea's curvature by precisely using an excimer laser to ablate and reshape the stromal tissue. PRK was employed to treat conditions such as astigmatism (irregular corneal curvature), hyperopia (farsightedness) and myopia (nearsightedness), by modifying the corneal surface to improve how light rays focus onto the retina. Patients seeking to lessen their dependence on corrective soft contact lenses achieved the best results. This technique was regularly performed by experienced or qualified optometrists and ophthalmologists (Bamdad et al., 2022).

3.6.1 pre-PRK surgery:

3.6.1.1 Visual acuity and refraction:

Refraction was measured using an autorefractor keratometry (Topcon KR-8000PA) (User Manual, n.d.). The patient seated themselves directly in front of the device, resting their chin on the designated support and aligning their head as directed by the examiner. They are then instructed to focus on a red target within the device, keeping a steady gaze. and refraining from blinking or eye movements for approximately three seconds per eye until the necessary measurements are obtained by automatically averaging three measurements taken at the central 3 mm of the visual axis. Visual acuity was assessed using a proper Snellen chart with the patient seated at 3 meters. The examination was conducted under normal room lighting conditions using a trial frame. Visual acuity was tested for each eye individually and the best corrected visual acuity was recorded as sphere, negative cylinder and cylinder axis.

3.6.1.2 IOP measurement by Air puff tonometry.

Patients were asked to sit in front of the device on a chair adjusted to the appropriate height. They then placed their chin on the designated rest. They were instructed not to blink and to focus on the green dot. Three readings were averaged to determine the intraocular pressure (IOP) values for each eye, taken between 8 AM and 1 PM, both before and after PRK surgery. The examination was performed AR Ard room lighting. Air-puff tonometry, using the Topcon CT-80 model (Topcon Corporation, Tokyo, Japan) (CT-80, n.d.), an applanation method that used a standardized puff of air to flatten the cornea, was employed. This technique has the benefit of not requiring a topical anesthetic and carries no risk of corneal abrasion. Intraocular pressure above 21 mm Hg was considered elevated for this study(Eun Kim et al., 2020).

3.6.1.3 CCT measurement by Pentacam:

Both eyes of each patient were scanned using the Pentacam HR (Type 70900, Pentacam, Oculus GmbH, Wetzlar, Germany)(HR OCULUS, n.d.). A skilled optometrist performed all procedures. The patient was asked to sit in a chair adjusted to the proper height and to rest their chin on the designated support. The patient was instructed to blink immediately before each assessment and to focus on the red dot. The scans were completed in a slightly dimmed room within 10 minutes. Only high-quality automatic Scheimpflug scans that passed the Pentacam software's quality check were accepted. A central corneal thickness of 450 microns or more is considered normal. We take the CCT in the thinnest location from the Pentacam report.

3.6.1.4 Slit lamp, Fundus exam and cycloplegic refraction:

Pharmacologic pupil dilation was achieved by administering Mydramide (tropicamide 5%) eye drops. Three drops were instilled into the conjunctival sac over 45 minutes, with a 15-minute interval between each drop, to induce mydriasis. This regimen resulted in transient visual blurring that lasted up to 4 hours. Patients were advised to bring an accompanying person on the day of the exam and to avoid driving for at least 4 hours after the procedure. Post the pupils dilated, the patient sat in front of the slit lamp and was told to sit properly so the eye could be checked correctly, following the ophthalmologist's instructions. First, the anterior segment of the eye was carefully examined, then the posterior segment, including the retina, was checked using a +78-diopter lens. This gave a complete examination at the eye's overall health. The refractive errors were also measured under pupil dilation using an autorefractor to assess refractive error degrees post mydriatic test (Topcon KR-8000PA)(User Manual, n.d.). Refractive data were recorded as spherical equivalent, negative cylinder and cylinder axis to accurately identify the patient's refractive state.

3.6.2 During PRK surgery:

To reduce the risk of postoperative endophthalmitis, preoperative antisepsis is crucial. The ocular surface was prepared by instilling a solution of iodine dissolved in water (1:2 povidone-iodine to normal saline), followed by careful scrubbing of the eyelashes and eyelid margins,

then cleaning the periocular skin performed by an experienced nurse. The final refractive error values are entered into the device by a licensed, trained medical engineer, who then signals the surgeon to begin the procedure. During PRK, the surgeon administers local anesthesia with Localin (oxybuprocaine hydrochloride 0.4%) eye drops, applying three drops to the conjunctival sac at 5-minute intervals. A speculum is used to prevent blinking in the right eye while the left eye is covered; the process is then repeated for the left eye. Eyes are washed by Balanced Salt Solution (BSS). The epithelium is removed using a ring by applying an alcohol solution for 30 seconds. (Shapira et al., 2015). The laser device tracks the time required for alcohol application and alarms with an audible signal when it's time to wash the eye using BSS and remove the ring. The ring size depends on the patient's corneal curvature and treatment zone. The outer layer of the cornea, the epithelium, is removed with the alcohol solution and the cornea is rinsed again with BSS. After removing the epithelium, the ophthalmologist uses an excimer laser (Bausch and Lomb Technolas Teneo 317) (TENE0 TM 317 Technical Specifications, 2017) to reshape the cornea. The laser exposure duration depends on the refractive error. After the laser procedure, Mitomycin C, a chemotherapeutic drug that inhibits DNA synthesis and wound healing, should be applied with a wet sponge. The application period for Mitomycin C depends on the amount of refractive error. Finally, at the end of the surgery, the bandage contact lens Johnson & Johnson Vision Care (Oasys)will be applied to reduce irritation during the healing period, which lasts one week. Antibiotic eye drops Moxifloxacin at a dosage of five mg/mL are applied every two hours for one week, together with Steroid eye drops Prednisolone acetate 1%, which are also applied every two hours.

3.6.3 Post PRK surgery:

After surgery, follow-up appointments were scheduled at one week, 10 days and one month. Patients attended an examination during the first week to check the health of their corneas and to remove the band age contact lens (Oasys) with forceps, a slit lamp and fluorescein dye, which stains the lens and helps in its removal. At 10 days, the Pentacam was used to measure Stand air-puff tonometry was used to measure IOP between 10 am and 2 pm for every patient at the time of his or her surgery. All comprehensive eye exams were repeated at the one-month mark to track the patients' recovery.

3.7 Ethical considerations and approval:

In the present study, the principles of the Declaration of Helsinki were followed. The procedures received approval from the Institutional Review Board (IRB) at the Arab American University of Palestine under approval number "R-2024/A/124/N." After have all necessary approvals and documents, the participants agreed to the procedures by both verbal and written consent before the operation. The data collected in this study were handled carefully by the researcher and are safely stored in the center's electronic system and can be accessed if needed.

3.8 Analysis plan:

Since the data we collected did not meet normality assumptions, we used a non-parametric test called the Wilcoxon signed-rank test to compare the differences in IOP and CCT pre and post PRK. Due to the violation of the normality assumption, using a paired t-test would not be appropriate; therefore, the Wilcoxon signed-rank test was chosen as an appropriate alternative. Additionally, we examined the correlation between IOP and CCT pre- and post-surgery using Spearman's rank correlation for ordinal data. The significance level for both tests was set at $P < 0.05$. Because measurements obtained from the right and left eyes of the same participant are not statistically independent and to avoid violation of independence assumptions, analyses were conducted separately for right and left eyes. Results are therefore presented independently for each eye

Chapter Four: Results

4.1 Sample Characteristics

The study sample included 50 participants. Their clinical traits were measured pre and post PRK surgery. Table 4.1 shows the demographic and clinical characteristics of the participants. The gender distribution indicated an even split, with 26 females and 24 males. Ocular dominance was mostly OD in 37 participants, while 13 had OS dominance. The average age of the participants was 25.3 years, showing that most were young adults close to this average. The mean cylinder values which measure astigmatism were -1.21D for OD and -1.48D for OS. This indicates moderate astigmatism with no notable difference between the eyes. BCVA was excellent post-surgery, with mean values of 0.99 in OD and 0.98 in OS. There were no significant differences in the following parameters between OD and OS: SE ($p=0.65$), cylinder ($p=0.06$) and BCVA ($p=0.45$).

Table 4.1: Demographic and Clinical Characteristics of Participants (N=50)

Variable	Category	N
Gender	Female	26 (52%)
	Male	24(48.0%)
Dominant eye	OD (Right Eye)	37(74.0%)
	OS (Left Eye)	13(26.0%)
Age	Mean	25.3
	Median	25.0
	SD	4.5
SE (OD, OS)	Mean	-2.76, -2.66
	Median	-2.63, -2.38
	SD	1.48, 1.52
Cylinder (OD, OS)	Mean	-1.21, -1.48
	Median	-1.00, -1.00
	SD	0.78, 0.89
BCVA (OD, OS)	Mean	0.99, 0.98
	Median	1.00, 1.00
	SD	0.08, 0.07

4.2 Descriptive Statistics

Table 4.2 shows the preoperative and 10-day postoperative eye measurements for both eyes (OD and OS). It highlights the key eye parameters of the study participants. The results show a significant reduction in CCT post PRK. The average pre-CCT was 534.56 microns for the OD and 536.90 microns for the OS. Postoperative measurements showed a substantial decrease, with CCT at 427.78 microns for the OD and 427.52 microns for the OS. This indicates effective tissue removal during PRK. IOP showed a slight increase post PRK, averaging 15.46 mmHg for the OD and 15.70 mmHg for the left eye. IOP variability was elevated, with a range from 8 to 29 mmHg in the right eye. This suggests an early steroid response. Overall, the findings show significant changes in CCT, highlighting the effectiveness of the surgical procedure while keeping normal IOP levels. The reduction in CCT indicates successful tissue removal during PRK. Additionally, the slight rise in IOP post PRK may reflect an early steroid response, although the values remain within the normal range. It is important to note the wide range of IOP readings (8 to 29 mmHg), as it indicates variability in individual responses to the procedure.

Table 4.2: Both eyes Ophthalmic Measurements: Preoperative - and 10-Day Postoperative

Variable	Eye	Mean	Median	Stand Ard Deviation	Minimum	Maximum
Pre_CCT_	OD	534.56	534.00	29.86	451.00	595.00
	OS	536.90	538.00	25.99	487.00	598.00
Pre_IOP	OD	14.12	15.00	3.24	6.00	20.00
	OS	14.80	15.00	2.94	8.00	20.00
Post_CCT	OD	427.78	434.00	32.57	359.00	492.00
	OS	427.52	426.50	30.06	369.00	483.00
Post_IOP	OD	15.46	14.00	5.26	8.00	29.00
	OS	15.70	14.50	5.19	9.00	27.00

Δ CCT		-108.08	-105.50	22.28	-155.50	-54.50
Δ IOP		1.12	-1.00	5.01	-6.50	13.50

4.3 Comparison of Pre and 10-Day Post-PRK Study Parameters.

The Wilcoxon Signed-Rank test in Table 4.3 was used to examine changes in CCT and IOP from pre- to 10-day post-PRK measurements. A significant reduction in CCT was found for both OD and OS ($Z = -6.155$, $p < 0.001$). A negative Z-value shows that the sum of ranks for the positive and negative differences is significant, with all 50 participants showing a decrease in CCT post-PRK (see Figure 4.1). On the other hand, no significant change in IOP was observed ($p > 0.05$). These results indicate a notable thinning of the CCT post PRK, while IOP did not show significant changes (see Figure 4.2). For the OD, 27 participants (54 eyes) had a decrease in IOP (Negative Ranks $N=27$, Mean Rank=19.93, Sum of Ranks=538.00), while 22 participants (44 eyes) had an increase (Positive Ranks $N=22$, Mean Rank=31.23, Sum of Ranks=687.00), with one draw. The calculated Z-statistic was -0.745, yielding an asymptotic p-value of 0.456. Similarly, for the OS, 26 participants showed a decrease (Negative Ranks $N=26$, Mean Rank=19.73, Sum of Ranks=513.00), 20 experienced an increase (Positive Ranks $N=20$, Mean Rank=28.40, Sum of Ranks=568.00) and a total of 44 participants were observed. The Z-statistic for OS was -0.302, with an asymptotic p-value of 0.763. Since both p-values ($p=0.456$ for OD and $p=0.763$ for OS) are greater than the standard significance level of 0.05, these findings indicate that the variations in IOP were not statistically significant and were likely due to random fluctuations rather than a direct consequence of the procedure.

Post-PRK surgery, 21 patients showed IOP elevation. IOP was higher in 10 OS and 11 OD than in baseline measurements. This increase, however, was not statistically significant (OS: $p = 0.763$; OD: $p = 0.456$). After surgery, IOP was elevated in at least one eye in about 21% of patients. Conservative management was used for all cases with elevated IOP. Topical corticosteroids were gradually tapered off as part of the treatment. When necessary, topical anti-glaucoma medications were applied. Sequential IOP monitoring and close follow-up showed that IOP was effectively controlled without requiring surgery.

Table 4.3. Wilcoxon Signed-Rank Test for Preoperative vs. 10-Day Postoperative Ophthalmic Measurements.

Eye	Variable Pair	N (Negative Ranks)	N (Positive Ranks)	N (Ties)	Mean Rank (Negative)	Mean Rank (Positive)	Z-statistic	Sig. (2-tailed)
OD	Pre, Post CCT	50	0	0	25.5	0	-6.155	< 0.001*
OS		50	0	0	25.5	0	-6.155	< 0.001*
OD	Pre, Post IOP	27	22	1	19.93	31.23	-0.745	0.456
OS		26	20	4	19.73	28.4	-0.302	0.763

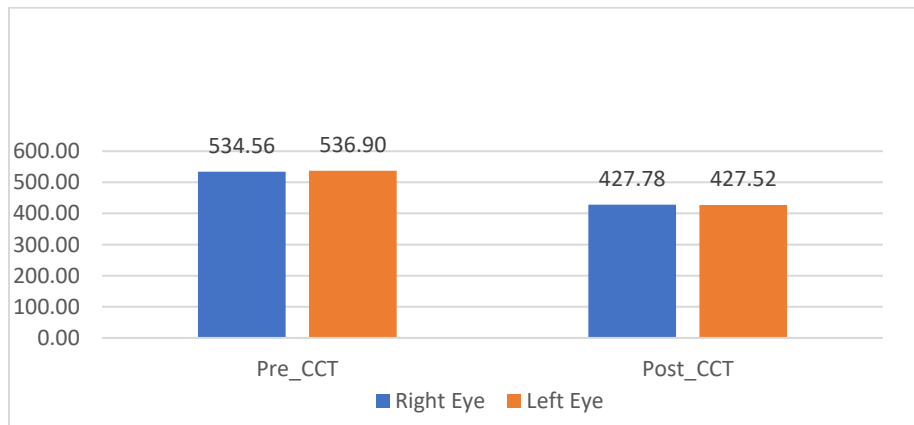


Figure 4.1: Comparison of Mean CCT: Pre vs. 10-Day Post-PRK (in microns)

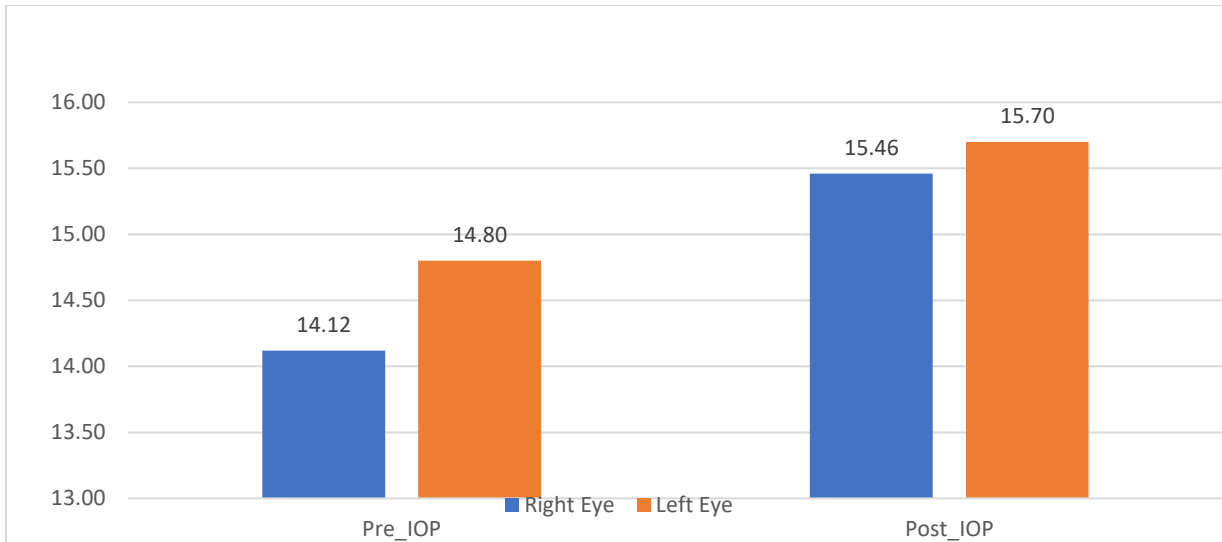


Figure 4.2: Comparison of Mean IOP: Pre vs. 10-Day Post-PRK (in mmHg)

4.4 Correlations of Study Parameters with Postoperative IOP.

Spearman's correlation analysis is shown in Table 4.4. It investigates various pre- and postoperative measurements. Most correlations between preoperative parameters and post-IOP, ablation depth and steroid-induced IOP rise were weak and not statistically significant. Notably, the correlation between pre-CCT and Post-IOP was very weak and not statistically significant in either the OD or the OS ($r = 0.136$, $p = 0.346$ for OD; $r = 0.079$, $p = 0.583$ for OS). This indicates that pre-CCT does not reliably predict post-IOP. Similarly, cylinder measurements for both eyes showed no significant association with post-IOP, as all p-values were greater than 0.05.

Table 4.4. Spearman's Correlations of preoperative parameters with Post-IOP, Ablation Depth and Steroid-Induced IOP Rise (N=50).

Spearman's rho	Post - IOP	Correlation Coefficient Sig. (2-tailed)	Ablation	Steroid-Induced IOP Rise	SE
			_Depth		
Cylinder_OD	Post_IOP OD	-0.119	0.082	-0.015	0.198
		0.411	0.57	0.34	0.167

Spearman's rho	Post - IOP	Correlation Coefficient Sig. (2-tailed)	Ablation	Steroid-Induced IOP Rise	SE
			_Depth		
Cylinder_OS	Post_IOP OS	-0.066 0.651	-0.175	-0.015	0.059
			0.225	0.851	0.684
BCVA_OD	Post_IOP OD	0.055 0.704	0.169	0.222	0.194
			0.241	0.183	0.176
BCVA_OS	Post_IOP OS	-0.068 0.637	-.317*	-0.060	-.298*
			0.025	0.810	0.036
Pre_CCT OD	Post_IOP OD	0.136 0.346	0.249	-0.044	-0.095
			0.081	0.675	0.511
Pre_CCT OS	Post_IOP OS	0.079 0.583	0.194	-0.044	-0.126
			0.178	0.238	0.385
Pre_IOP OD	Post_IOP OD	.377** 0.007	-0.05	-0.077	-0.115
			0.729	0.224	0.426
Pre_IOP OS	Post_IOP OS	.408** 0.003	0.14	0.043	-0.085
			0.334	0.482	0.556

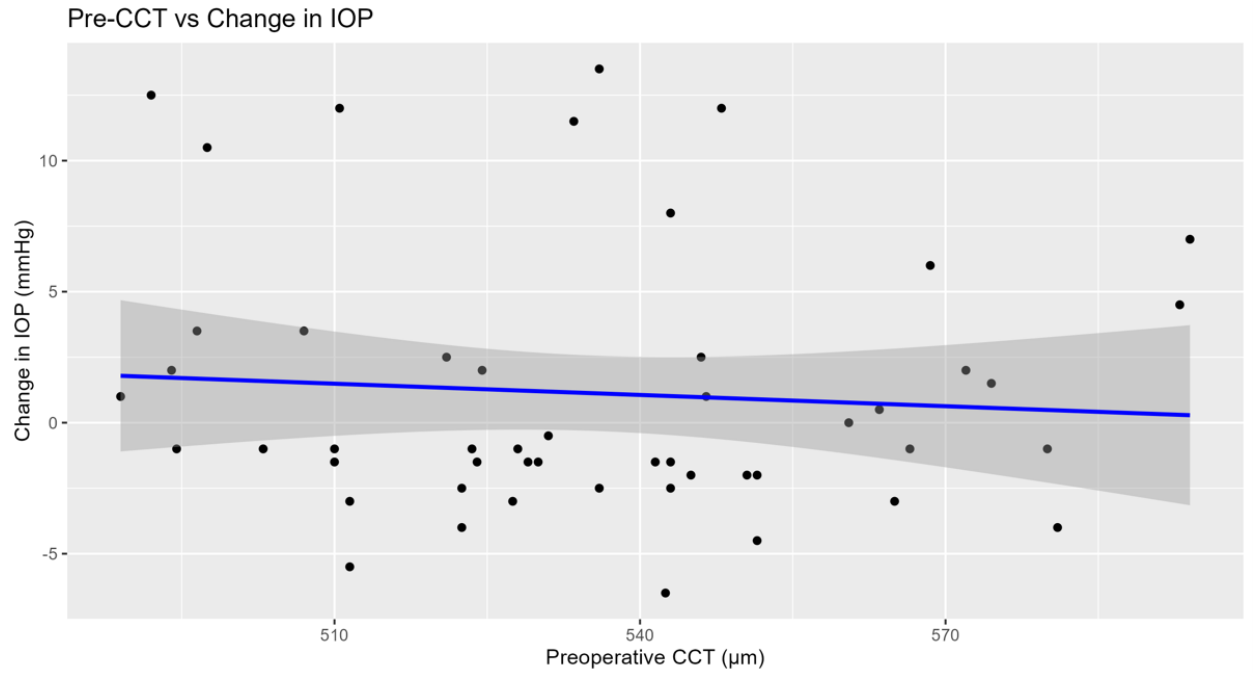


Figure 4.3: The Relationship between Pre-CCT and Post-IOP.

The scatterplot in Figure 4.3 illustrates the relationship between pre-CCT and post- IOP changes. It shows a broad distribution of data points, highlighting considerable variability in IOP change that appears to be independent, mainly of pre-CCT values. The blue regression line is nearly flat, indicating a weak or no relationship between the two variables. This suggests that pre-CCT is not a dependable predictor value for IOP change postoperatively. The shaded area around the line shows the confidence interval, representing the uncertainty in the estimated regression parameters. The observed relationship can be statistically represented by a linear regression model: $IOP_{change} = \beta_0 + \beta_1 \cdot CCT_{pre} + \epsilon$, where IOP_{change} is the change in IOP, CCT_{pre} is the pre-CCT value, β_0 is the intercept, β_1 is the regression coefficient and ϵ is the error term. The arithmetic mean of the OD and OS measurements for these variables was calculated.

4.4.1 Correlations between Δ CCT and Δ IOP.

A correlation analysis was performed to evaluate the linear relationship between changes in Δ CCT and Δ IOP. Results show no statistically significant correlation between Δ CCT and Δ IOP ($p=0.706$). In this sample of 50 patients (100 eyes), variations in CCT do not seem to be linearly linked to changes in IOP, as shown in Table 4.5.

Table 4.5: Pearson correlation between Δ CCT and Δ IOP. (N=50).

		Pearson Correlation	Sig. (2-tailed)
Δ CCT	Δ IOP	-.055	.706
Δ IOP	Δ CCT	-.055	.706

4.5 Linear Regression Analysis of Predictors of Post-IOP.

A stepwise linear regression was performed to identify the factors that best predict pre-IOP levels. The results showed that the only predictor for pre-IOP was pre-CCT. The model was statistically significant ($F(1,48) = 5.805, p = 0.020$). It explained about 10.8% of the variation in pre-IOP (Adjusted $R^2 = 0.089$). The analysis indicated that increasing pre-CCT by 1 unit raised pre-IOP by 0.033 units (up standardized $B = 0.033, SE = 0.014$). This effect was positive and statistically significant, with a moderate effect size, as shown in Table 4.6. Age and Gender failed to demonstrate statistically significant predictive power for pre-IOP ($p=0.461$ and $p=0.417$).

Table 4.6: Linear Regression Results for (Pre_IOP)

Variable	up standardized B	Std. Error	Stand radioed β	T	Sig. (p)	Adjusted R2	F	Sig. (p ANOVA)
(Constant)	-3.023	7.265	-	-0.416	0.679			
Pre_CCT	0.033	0.014	0.328	2.409	0.02	0.089	5.805	0.02

4.6 Group comparison

4.6.1 IOP rise (> 2 vs ≤ 2) mmHg

Participants were divided into two groups—those with IOP post-PRK elevation of more than two mmHg versus those with two mmHg or less—and compared to their status pre-PRK CCT. This study aimed to examine differences in younger patients with thinner corneas, considering age and Gender. The Mann-Whitney U test compared the distribution of Age and (Pre_CCT) between the two groups. The analysis found no statistically significant difference between the groups for either variable: Age ($Z=-1.684$, $p=0.092$); Pre-CCT ($Z=-0.649$, $p=0.516$), see table 4.7.

Table 4.7. Mann-Whitney U Test Summary

Variable	Group (IOP Rise)	Sample Size (N)	Mean Rank	Mann-Whitney U	Z	Asymp. Sig. (p)	Interpretation
Age	≤ 2	21	29.55	219.5	-1.684	0.092	Not Significant
	> 2	29	22.57				
Pre_CCT	≤ 2	21	27.07	271.5	-0.649	0.516	Not Significant
	> 2	29	24.36				

Chapter Five: Discussion

Photorefractive keratectomy (PRK) is widely performed to correct refractive errors (Akrobetu & Pineda, 2025). Postoperative corticosteroids are routinely prescribed to manage inflammation and reduce the risk of corneal haze (Moshirfar et al., 2023). Nevertheless, steroid use is associated with a recognized risk of increasing IOP. Over 3.2% of individuals experience an increase in IOP post PRK surgery (Rajendrababu et al., 2021), which if left unmonitored may result in steroid-induced ocular hypertension or glaucomatous damage (Varshney et al., 2023). Patients may exhibit symptoms such as blurred vision, halos, ocular discomfort, headaches, or tearing (Drugs in Ophthalmology, 2019). Considering these clinical considerations this study aims to assess whether preoperative CCT; a parameter commonly used in refractive surgery, correlates with steroid-induced postoperative elevations in IOP. Creating this relationship could improve how we assess and manage postoperative complications. This is important because corticosteroids post-PRK may cause steroid-induced IOP elevation in some patients (Rajendrababu et al., 2021). CCT is widely considered an essential parameter for understanding IOP, particularly in glaucoma management.

Many recent studies have examined how CCT influences steroid-induced IOP elevation post-refractive surgery. In our review, we included studies that examined how CCT affects steroid-induced IOP in patients. Many of these studies compared data immediately post-surgery so we used them as supporting evidence for our conclusions. Although people with thinner corneas tend to have steroid-induced IOP elevation, newer research indicates that the relationship between CCT and IOP is more complicated. For example, Naderi and colleagues found that it's safe to perform surface ablation procedures on patients with corneas thinner than 500 microns (Naderi et al., 2016). Additionally, having a thin cornea is not an absolute problem and does not reliably predict IOP-related complications. In a study involving patients with keratoconus (a condition that thins the cornea) and those treated with dexamethasone, patients with keratoconus had a higher risk of steroid-induced IOP elevation than normal patients (Kanellopoulos et al. 2016). The study also demonstrated that in keratoconus it's the biomechanical weakness of the cornea not just its CCT that makes it more sensitive to IOP elevation. This shifts the understanding of the connection between CCT and IOP from focusing

solely on thickness to also considering corneal biomechanics. Yamaguchi and his team also advised caution when thinning the corneal surface post PRK, as thinner corneas may increase the risk of steroid-induced IOP. underestimation of IOP when measured with GAT, thereby obscuring steroid-induced IOP increase (Yamaguchi et al., 2008). This initially supported the concept that thinner corneas might predict elevated IOP responses. However, more recent research indicates that biomechanical indices like corneal hysteresis (CH) and resistance factor (CRF) are more accurate predictors of IOP changes and steroid responses than CCT alone. (Nossair et al., 2021). Overall, CCT appears to be an incomplete and weak indicator of steroid-induced IOP (Manzoor et al., 2019). Additionally, Nossair et al. found that factors not directly related to corneal thinning include male gender, higher preoperative CCT, the severity of myopia, the presence of corneal haze and steroid potency particularly dexamethasone. That steroid responsiveness could not be determined by stromal thickness alone is befittingly hypothesized by the comprehensive study conducted by Manzoor et al., in which no significant correlation was found between preoperative CCT and postoperative IOP elevation in patients undergoing PRK. Physiological and demographic factors further complicate this relationship. Changes with age, such as decreased viscoelasticity and increased stromal solidity, can lead to an overestimation of IOP readings in older patients, particularly when using NCT (Svedberg et al., 2005). However, younger people may be more fragile to steroid-induced IOP due to a more responsive trabecular meshwork and effective aqueous humor production (Vajaranant et al., 2010). Hormonal variations related to gender may also affect corneal biomechanics and steroid responses; on the other hand, research findings in this area are varying and need further investigation. (Reddy Korpole et al., 2022). This regional study looked at patients with compound myopic astigmatism. We used Pentacam and air-puff tonometry to measure CCT and IOP pre and post PRK. While CCT has often been considered a key predictor of steroid-induced changes in IOP post PRK, our findings indicate that corneal biomechanics, individual patient factors and corticosteroid strength play a greater role. This highlights the need for a thorough, personalized assessment post-PRK that considers more than just CCT.

Current evidence suggests that corneal hysteresis (CH) measurements provide more complete and clinically relevant information about the cornea's mechanical properties and response than CCT (Nossair et al., 2021). Corneal hysteresis reflects the cornea's viscoelastic properties post refractive surgery. This includes its ability to absorb and dissipate energy and how tissue rigidity changes over time. Studies show that CH is a more reliable indicator than CCT for predicting IOP changes and glaucoma risk (Sit et al., 2023). Since PRK alters the cornea's structure and mechanical properties, CH will also change. This affects how the cornea responds to applied forces and influences topographic measurements (Jacobs et al., 2023). CH may fluctuate post refractive surgeries which impacts how the cornea reacts to appplanation forces and influences topographic readings (Čulina et al., 2024). Our study indicates that relying just on CCT is not useful for predicting steroid-induced IOP elevation postoperatively, as there was no statistical relationship between CCT and steroid-related IOP increase (Zhou et al., 2025). Future studies using CH may reveal important connections between steroid-induced IOP and CCT that CCT cannot detect. This could enhance our understanding of why IOP can rise even when CCT decreases post refractive surgery.

We further examined whether preoperative refractive error (SE and Cylinder) predicts the response of IOP steroid-induced elevation. Our analysis indicated that there was no statistically significant effect for preoperative SE and Cylinder on steroid-induced IOP response post-PRK. This finding aligns with several studies that have found magnitude SE and cylinder (less than five diopters) to be a poor predictor of steroid responder status (Busool et al., 2017), suggesting that the individual's position and ocular characteristics, rather than the magnitude of their SE and cylinder (B. Zhang et al., 2025), play a more dominant role in their susceptibility to steroid-induced IOP elevation. Similarly, ablation depth did not demonstrate a significant association with postoperative IOP increase. Given that deeper ablations cause greater thinning, a positive correlation would be expected if corneal thickness strongly influenced steroid responsiveness. The absence of such a correlation further supports the idea that other mechanisms, possibly related to the trabecular meshwork's steroids, are more influential than the biomechanical changes caused by PRK in determining the status of steroid responders (Javadi et al., 2008). Thinner corneas tend to cause an underestimation of IOP by GAT, while

thicker corneas lead to an overestimation, with an average measurement error of approximately 0.7 mmHg for every 10 μm deviation from the standard CCT value of 520 μm on which GAT calibration is based (Javadi et al., 2008). When these findings are compared with non-contact tonometry, it becomes evident that GAT is more sensitive to variations in CCT. This suggests that the differences between GAT and NCT measurements are primarily due to a corneal thickness-related bias, rather than reflecting actual differences in IOP. NCT-like air puff tonometry may offer more precise IOP measurements in eyes with thin corneas or those undergoing post-PRK treatment.

5.1 Clinical Implications

5.1.1. Implications for Risk Stratification

The implications of this research work for post-PRK risk analysis have been significant. It has been indicated that, based on results of this research work, a lack of predictive value regarding pre-operative refractive errors, astigmatism and ablation depths, as well as a non-statistically significant relationship between steroid-induced IOP values measured by air puff tonometry and CCT values measured by Pentacam, indicate that these elements cannot be used to predict steroid-induced IOP increase risks post-PRK surgery effectively. It has consequently been confirmed that individual biological susceptibility to IOP increase during steroid treatment remains a dominant parameter, as supported by previous studies in this field (Fakhraie et al., 2021). As a direct result, greater attention of clinicians in this area should be paid to individual-specific, biological and mechanical aspects of steroid sensitivity. These aspects include individual experiences regarding IOP steroid-induced increase, glaucoma family history and individual biological and mechanical characteristics of a specific eye, primarily providing aqueous humor drainage. Compared with biological eye anatomy these elements have a dominant effect on the development of steroid-induced glaucoma.

5.1.2. Implications for Monitoring

From a medical monitoring viewpoint, these findings emphasize the need for regular IOP checks in all PRK patients who use steroids post PRK, no matter their CCT or the specifics of their ablation. It is crucial to take repeated early postoperative measurements and to keep monitoring late responders. This is because steroid-induced IOP rises within 10 days to four weeks. (Dada et al.,2022). Clinicians should also consider the biomechanical and structural changes caused by PRK when assessing IOP. GAT as a gold standard for IOP measurement, except post-refractive surgery because GAT underestimates IOP, while non-contact tonometers are less affected for these changes (Farhood, 2012). Air-puff tonometry, as used in this study, or biomechanically adjusted tools, like the Ocular Response Analyzer or Corvis ST (Corneal Visualization Scheimpflug Technology) is an advanced ophthalmic device by Oculus that utilizes a high-speed camera and air puff to analyze corneal biomechanics, enhancing accuracy and minimizing the risk of missing significant pressure increases (Naderi et al., 2025).

5.1.3 Implications for Steroid Choice

Surgical decision-making regarding steroid usage is dependent on the study's findings. If the patient exhibits risk factors (e.g., previous steroid reactions; family history of Glaucoma; Optic Nerve Cupping), then the use of softer steroids (e.g., Loteprednol; Fluorometholone) may be more beneficial than high-potency steroids (e.g., Dexamethasone; Prednisolone) initially (Sherif & Pleyer, 2002). In extreme cases, tapering earlier and initiating an IOP-lowering agent immediately after elevated IOP protects against optic nerve damage and potential visual field loss (Csorba et al., 2019; Shroff et al., 2018). This tiered treatment approach based on individual risk factors aligns with current methods for managing IOP steroid-induced elevation and optimizing recovery safety.

5.2. Limitations and Recommendations

5.2.1 Limitations

This study offers a new view and findings that support recent research, but it also has several limitations that future studies can address and improve. First the small sample size limits our ability to apply the results generally, so future research should include more participants. Also,

the follow-up period post-surgery should be longer to track changes over time. In this study, the short follow-up might have missed cases of late IOP steroid-induced increases in some patients. Lastly, this study only included patients with myopia even though the anatomical features of the eye vary among myopia, hyperopia and astigmatism. Therefore, future studies should consider these differences, as variations in eye structure due to refractive errors could affect how patients respond to steroids.

5.2.2. Recommendations for Future Research

To thoroughly understand steroid-induced IOP elevation post-PRK, future research should focus on these three key areas.

1. Short-Term Clinical Studies

Larger multicenter studies can be employed in future clinical research to enhance predictive accuracy and statistical strength. Standardization of the potency, timing and duration of current postoperative steroid regimens can reduce variations in clinical protocols, allowing for more straightforward comparisons across patient groups. This approach can also improve the ability to predict steroid-induced IOP elevations both pre- and post-PRK.

2- Mechanistic studies

To identify reliable biological markers of how patients respond to steroids, more extensive theoretical studies are necessary. A thorough assessment of corneal mechanical properties using advanced imaging techniques, Corvis ST dynamic response parameters, CH and trabecular meshwork structure can improve the understanding of why some individuals respond differently to steroids. Examining biochemical and molecular markers, such as MYOC gene variations and glucocorticoid receptor types, may also enhance prediction accuracy and help create personalized treatment plans for each patient postoperatively.

3- Comparative Treatment Studies

This study helps in planning an effective strategy for using steroids postoperatively in a way that prevents steroid-induced high IOP while still being effective in controlling

inflammation and reducing its occurrence. Therefore, randomized controlled trials comparing lower-potency steroids such as loteprednol and fluorometholone with high-potency steroids like dexamethasone and prednisolone will help clarify the safety and effectiveness of each option.

6.3 Conclusion

This study investigated whether CCT measured by Pentacam, pre- and post-PRK, can predict steroid-induced IOP elevation measured by air-puff tonometry post-PRK among patients with compound myopic astigmatism. The results of this study showed no statistically significant relationship between CCT pre-PRK and the steroid-induced IOP elevation post-PRK. This means that CCT cannot be considered a reliable indicator for predicting steroid-induced IOP elevation post-surgery. These findings support new research confirming that corneal biomechanics, particularly CH and individual biological factors are more influential than CCT in affecting postoperative IOP trends. Additionally, current literature recommends shifting the approach to predicting IOP post-PRK from CCT to corneal biomechanics. On the other hand, previous hypotheses suggested that thinner pre CCT might predispose patients to greater postoperative steroid-induced IOP elevation; our results, together with the latest studies, demonstrate that CCT reflects only structural properties and does not account for dynamic tissue responses. The lack of significant associations between postoperative CCT changes, cylinder or ablation depth, refractive error and postoperative IOP increase highlights the importance of trabecular meshwork sensitivity, pharmacogenomic differences and biomechanical factors in steroid response. A main clinical implication is the need to learn how select postoperative steroids. Since steroid-induced ocular hypertension is primarily caused by individual biological predisposition rather than CCT, using lower-potency corticosteroids such as loteprednol or fluorometholone may be a safer option post-surgery for patients with risk factors such as previous steroid response, family history of glaucoma, or optic nerve cupping. Several protocols exist for using steroids post-PRK, including the use of softer steroids that do not raise IOP while maintaining their importance in preventing inflammation. This approach

helps prevent steroid-induced IOP elevation while protecting the patient from side effects. The specific protocol varies depending on each patient's risk factors.

This study explains several key points. First, relying only on CCT values to estimate IOP post-refractive surgeries is not enough. Regular and systematic monitoring of IOP post refractive surgery should be done for all patients who have refractive surgeries. Additionally, choosing steroid eye drops carefully is important, based on each patient's individual risk factors. CH values should also be considered when available, as they help improve and support the development of customized postoperative follow-up and treatment plans for each patient. Furthermore, larger studies on this topic are needed, incorporating standardized protocols for steroid use and longer follow-up periods. In the end, these steps aim to achieve the best clinical outcomes while reducing postoperative complications and side effects from steroids.

References:

- Ajazaj, V., Kačaniku, G., Asani, M., Shabani, A., & Dida, E. (2018). Intraocular Pressure After Corneal Refractive Surgery. *Medical Archives (Sarajevo, Bosnia and Herzegovina)*, 72(5), 341–343. <https://doi.org/10.5455/medarh.2018.72.341-343>
- Akrobetu, D., & Pineda, R. (2025). Laser-based Refractive Surgery: A Review of Select Clinical Challenges and Future Directions. *International Ophthalmology Clinics*, 65(3), 1–7. <https://doi.org/10.1097/IIO.0000000000000568>
- Al-Ageel, S., & Al-Muammar, A. M. (2009). Comparison of central corneal thickness measurements by Pentacam, noncontact specular microscope and ultrasound pachymetry in normal and post-LASIK eyes. *Saudi Journal of Ophthalmology*, 23(3–4), 181–187. <https://doi.org/10.1016/j.sjopt.2009.10.002>
- Almutairi, M. N., Alshehri, A. M., Alhoumaily, A. Y., Alnahdi, O., Taha, M. A., & Gangadharan, S. (2025). SYSTEMATIC REVIEW Open Access Meta-analysis: clinical outcomes of laser-assisted in situ keratomileusis (LASIK) and photorefractive keratectomy (PRK) in hyperopia. *BMC Ophthalmology*, 25, 140. <https://doi.org/10.1186/s12886-025-03956-6>
- Ang, M., Gatinel, D., Reinstein, D. Z., Mertens, E., Alió del Barrio, J. L., & Alió, J. L. (2021). Refractive surgery beyond 2020. In *Eye (Basingstoke)* (Vol. 35, Issue 2, pp. 362–382). Springer Nature. <https://doi.org/10.1038/s41433-020-1096-5>
- Ang, R. E. T. (2025). Transepithelial Versus Conventional PRK: A Randomized Controlled Study. *Ophthalmology and Therapy*. <https://doi.org/10.1007/s40123-025-01167-2>
- Applanation Tonometer 900 & 870*. (n.d.). Retrieved August 29, 2025, from <https://uk.haag-streit.com/products/categories/general-diagnostics/tonometry/goldmann-applanation-tonometer>
- Bamdad, S., Momeni-Moghaddam, H., Abdolalian, M., & Piñero, D. P. (2022). Agreement of wavefront-based refraction, dry and cycloplegic autorefractometry with subjective refraction. *Journal of Optometry*, 15(1), 100–106. <https://doi.org/10.1016/j.optom.2020.08.008>
- Bausch & Lomb's Orbscan IIz Topographer - Vision Equipment Inc.* (n.d.). Retrieved August 29, 2025, from <https://visionequipmentinc.com/product/bausch-lombs-orbscan-ii-z-topographer/>
- Brandt, J. D., Beiser, J. A., Gordon, M. O., & Kass, M. A. (2004a). Central corneal thickness and measured IOP response to topical ocular hypotensive medication in the ocular hypertension treatment study. *American Journal of Ophthalmology*, 138(5), 717–722. <https://doi.org/10.1016/j.ajo.2004.07.036>
- Brandt, J. D., Beiser, J. A., Gordon, M. O., & Kass, M. A. (2004b). Central corneal thickness and measured IOP response to topical ocular hypotensive medication in the ocular hypertension treatment study. *American Journal of Ophthalmology*, 138(5), 717–722. <https://doi.org/10.1016/j.ajo.2004.07.036>
- Busool, Y., Mimouni, M., Vainer, I., Levartovsky, S., Sela, T., Munzer, G., & Kaiserman, I. (2017a). Risk factors predicting steroid-induced ocular hypertension after photorefractive keratectomy. *Journal of Cataract and Refractive Surgery*, 43(3), 389–393. <https://doi.org/10.1016/J.JCRS.2016.12.030>
- Busool, Y., Mimouni, M., Vainer, I., Levartovsky, S., Sela, T., Munzer, G., & Kaiserman, I. (2017b). Risk factors predicting steroid-induced ocular hypertension after

- photorefractive keratectomy. *Journal of Cataract and Refractive Surgery*, 43(3), 389–393. <https://doi.org/10.1016/j.jcrs.2016.12.030>
- Charan, J., & Biswas, T. (2013). How to calculate sample size for different study designs in medical research? In *Indian Journal of Psychological Medicine* (Vol. 35, Issue 2, pp. 121–126). <https://doi.org/10.4103/0253-7176.116232>
- Chen Cardenas, S. M., Santhanam, P., Morris-Wiseman, L., Salvatori, R., & Hamrahian, A. H. (2023). Perioperative Evaluation and Management of Patients on Glucocorticoids. In *Journal of the Endocrine Society* (Vol. 7, Issue 2). Endocrine Society. <https://doi.org/10.1210/jendso/bvac185>
- Csorba, A., Soproni, A., Maneschg, O., Nagy, Z. Z., & Szamosi, A. (2019). Application of corticosteroid eye drops for allergic eye diseases in children. *Orvosi Hetilap*, 160(9), 329–337. <https://doi.org/10.1556/650.2019.31265>
- Čulina, K., Tomić, M., Bulum, T., Medić, A., Šoša, I., Ivanišević, K., Jukić, T., Čulina, K., Tomić, M., Bulum, T., Medić, A., Šoša, I., Ivanišević, K., & Jukić, T. (2024). Corneal Biomechanics and Other Factors Associated with Postoperative Astigmatism after Cataract Surgery. *Life* 2024, Vol. 14, 14(6). <https://doi.org/10.3390/LIFE14060655>
- Curcă, P. F., Tătaru, C. I., Sima, G., Burcea, M., & Tătaru, C. P. (2024). Advances in Transepithelial Photorefractive Keratectomy versus Laser-Assisted in Situ Keratomileusis. *Diagnostics*, 14(5). <https://doi.org/10.3390/diagnostics14050481>
- Dada, T., Nair, S., & Dhawan, M. (n.d.). *Steroid-induced Glaucoma. Diagnosis20of20Steroid-induced20Glaucoma20After20PRK*. (n.d.).
- Djodeyre, M. R., Beltran, J., Ortega-Usobiaga, J., Gonzalez-Lopez, F., Ruiz-Rizaldos, A. I., & Baviera, J. (2016). Long-term evaluation of eyes with central corneal thickness <400 μm following laser in situ keratomileusis. *Clinical Ophthalmology*, 10, 535–540. <https://doi.org/10.2147/OPHTH.S100690>
- Drugs in Ophthalmology*. (2019). Scholars Portal.
- Du, H., Zhang, B., Wang, Z., & Xiong, L. (2023). Quality of vision after myopic refractive surgeries: SMILE, FS-LASIK and ICL. *BMC Ophthalmology*, 23(1). <https://doi.org/10.1186/s12886-023-03045-6>
- Fakhraie, G., Hospital, F. E., Vahedian, Z., Farabi, R. Z., Hospital, E., Eslami, Y., Hadi, A., & Fakhraie, A. (2021). *Intraocular Pressure Trend Following Myopic Photorefractive Keratectomy*. <https://doi.org/10.21203/rs.3.rs-891473/v1>
- Farhood, Q. K. (2012). Comparative evaluation of intraocular pressure with an air-puff tonometer versus a Goldmann applanation tonometer. *Clinical Ophthalmology*, 7(1), 23–27. <https://doi.org/10.2147/OPHTH.S38418>
- Faucher, A., Gregoire, J., & Blondeau, P. (1997). Accuracy of Goldmann tonometry after refractive surgery. *Journal of Cataract and Refractive Surgery*, 23(6), 832–838. [https://doi.org/10.1016/S0886-3350\(97\)80239-8](https://doi.org/10.1016/S0886-3350(97)80239-8)
- Fung, A. T., Tran, T., Lim, L. L., Samarawickrama, C., Arnold, J., Gillies, M., Catt, C., Mitchell, L., Symons, A., Buttery, R., Cottee, L., Tumuluri, K., & Beaumont, P. (2020). Local delivery of corticosteroids in clinical ophthalmology: A review. In *Clinical and Experimental Ophthalmology* (Vol. 48, Issue 3, pp. 366–401). Blackwell Publishing. <https://doi.org/10.1111/ceo.13702>
- Goel, M., Picciani, R. G., Lee, R. K., & Bhattacharya, S. K. (2010). Aqueous Humor Dynamics: A Review. In *The Open Ophthalmology Journal* (Vol. 4).

- Grzybowski, A., Kanclerz, P., Tsubota, K., Lanca, C., & Saw, S. M. (2020). A review on the epidemiology of myopia in school children worldwide. In *BMC Ophthalmology* (Vol. 20, Issue 1). BioMed Central. <https://doi.org/10.1186/s12886-019-1220-0>
- Hassanzadeh, S., Fereydouni, F., & Bakhtiari, E. (2025). Visual and refractive outcomes of photorefractive keratectomy in hyperopia and hyperopic astigmatism: A systematic review and meta-analysis. In *Photodiagnosis and Photodynamic Therapy* (Vol. 53). Elsevier B.V. <https://doi.org/10.1016/j.pdpdt.2025.104604>
- Iglesias, M., Yebra, F., Kudsieh, B., Laiseca, A., Santos, C., Nadal, J., Barraquer, R., & Casaroli-Marano, R. P. (2020). New applanation tonometer for myopic patients after laser refractive surgery. *Scientific Reports*, *10*(1). <https://doi.org/10.1038/s41598-020-64013-4>
- Jabbarvand , M., Askarizadeh, F., Sedaghat, M. R., Ghadimi, H., Khosravi, B., Amiri, M. A., & Narooie-Noori, F. (2017a). Comparison between Pentacam HR and Orbscan II after hyperopic photorefractive keratectomy. *Journal of Ophthalmic and Vision Research*, *12*(4), 374–379. https://doi.org/10.4103/jovr.jovr_47_17
- Jabbarvand , M., Askarizadeh, F., Sedaghat, M. R., Ghadimi, H., Khosravi, B., Amiri, M. A., & Narooie-Noori, F. (2017b). Comparison between Pentacam HR and Orbscan II after hyperopic photorefractive keratectomy. *Journal of Ophthalmic and Vision Research*, *12*(4), 374–379. https://doi.org/10.4103/jovr.jovr_47_17
- Jacobs, D. S., Lee, J. K., Shen, T. T., Afshari, N. A., Bishop, R. J., Keenan, J. D., & Vitale, S. (2023). Refractive Surgery Preferred Practice Pattern®. *Ophthalmology*, *130*(3), P61–P135. <https://doi.org/10.1016/j.ophtha.2022.10.032>
- Javadi, M.-A., Mirbabaei-Ghafghazi, F., Mirzade, M., Yazdani, S., & Yaseri, M. (2008a). Ocular Hypertension after PRK; Javadi et al Steroid Induced Ocular Hypertension Following Myopic Photorefractive Keratectomy. In *JOURNAL OF OPHTHALMIC and VISION RESEARCH* (Vol. 3, Issue 1).
- Javadi, M.-A., Mirbabaei-Ghafghazi, F., Mirzade, M., Yazdani, S., & Yaseri, M. (2008b). Ocular Hypertension after PRK; Javadi et al Steroid Induced Ocular Hypertension Following Myopic Photorefractive Keratectomy. In *JOURNAL OF OPHTHALMIC and VISION RESEARCH* (Vol. 3, Issue 1).
- Javadi, M.-A., Mirbabaei-Ghafghazi, F., Mirzade, M., Yazdani, S., & Yaseri, M. (2008c). Ocular Hypertension after PRK; Javadi et al Steroid Induced Ocular Hypertension Following Myopic Photorefractive Keratectomy. In *JOURNAL OF OPHTHALMIC and VISION RESEARCH* (Vol. 3, Issue 1).
- Javadi, M.-A., Mirbabaei-Ghafghazi, F., Mirzade, M., Yazdani, S., & Yaseri, M. (2008d). Ocular Hypertension after PRK; Javadi et al Steroid Induced Ocular Hypertension Following Myopic Photorefractive Keratectomy. *JOURNAL OF OPHTHALMIC and VISION RESEARCH*, *3*(1), 42–46.
- Journal, O., Motlagh, M. N., Majid Moshirfar,;, Murri, M. S., David,;, Skanchy, F., Hamed Momeni-Moghaddam,;, Yasmyne,;, Ronquillo, C., Phillip,;, & Hoopes, C. (2019). Medical Hypothesis, Discovery & Innovation Pentacam® Corneal Tomography for Screening of Refractive Surgery Candidates: A Review of the Literature, Part I. In *Med Hypothesis Discov Innov Ophthalmol* (Vol. 8, Issue 3).
- Kaberi Feroze, A. B., Zeppieri, M., & Khazaeni Affiliations, L. (2024). *Steroid-Induced Glaucoma Continuing Education Activity*.

- Kanellopoulos, A. J., Cruz, E. M., Ang, R. E. T., & Asimellis, G. (2016). Higher incidence of steroid-induced ocular hypertension in keratoconus. *Eye and Vision*, 3(1). <https://doi.org/10.1186/s40662-016-0035-9>
- Kawana, K., Tokunaga, T., Miyata, K., Okamoto, F., Kiuchi, T., & Oshika, T. (2004). Comparison of corneal thickness measurements using Orbscan II, non-contact specular microscopy and ultrasonic pachymetry in eyes after laser in situ keratomileusis. *British Journal of Ophthalmology*, 88(4), 466–468. <https://doi.org/10.1136/bjo.2003.030361>
- KR-8000_UserManual. (n.d.).
- Kumar, K., Prakash, A., Neeraja, T., Adappa, K., Prabha, T., & Gangasagara, S. (2021). To compare central corneal thickness measurements obtained by Pentacam with those obtained by IOLMaster 700, Cirrus anterior segment optical coherence tomography and Tomey specular microscopy in normal healthy eyes. *Indian Journal of Ophthalmology*, 69(7), 1713–1717. https://doi.org/10.4103/ijoj.IJO_3364_20
- Lau, Y. T. Y., Shih, K. C., Tse, R. H. K., Chan, T. C. Y., & Jhanji, V. (2019). Comparison of Visual, Refractive and Ocular Surface Outcomes Between Small Incision Lenticule Extraction and Laser-Assisted in Situ Keratomileusis for Myopia and Myopic Astigmatism. *Ophthalmology and Therapy*, 8(3), 373–386. <https://doi.org/10.1007/S40123-019-0202-X>
- Ahmad. (2014). relationship between corneal thickness corneal curvature and intraocular pressure before and after laser treatment for simple myopia. *Eye Science*, (.),.-.
- Manzoor, H., Batool, A., Akram, S., Khalil, I., & Affi, A. (2019). Relationship between post-op central corneal thickness and steroid-induced ocular hypertension following myopic photorefractive keratectomy. <https://doi.org/10.15406/aovs.2020.10.00398>
- Manzoor, H., Batool, A., Akram, S., Khalil, I., & Affi, A. (2020a). Relationship between post-op central corneal thickness and steroid-induced ocular hypertension following myopic photorefractive keratectomy. *Advances in Ophthalmology & Visual System*, 10(5), 132–135. <https://doi.org/10.15406/aovs.2020.10.00398>
- Marjanović, I., Kantić, D., Hentova-Senćanić, P., Marković, V., & Božić, M. (2010). Correlation between central corneal thickness and intraocular pressure in various age groups. *Srpski Arhiv Za Celokupno Lekarstvo*, 138(5–6), 279–286. <https://doi.org/10.2298/SARH1006279M>
- Matsuda, J., Hieda, O., & Kinoshita, S. (2008a). Comparison of central corneal thickness measurements by Orbscan II and Pentacam after corneal refractive surgery. *Japanese Journal of Ophthalmology*, 52(4), 245–249. <https://doi.org/10.1007/s10384-008-0550-x>
- Matsuda, J., Hieda, O., & Kinoshita, S. (2008b). Comparison of central corneal thickness measurements by Orbscan II and Pentacam after corneal refractive surgery. *Japanese Journal of Ophthalmology*, 52(4), 245–249. <https://doi.org/10.1007/S10384-008-0550-X>
- More Than Fifty Percent of the World Population Will Be Myopic by 2050. (2021). <https://doi.org/10.14744/bej.2021.27146>
- Moshirfar, M., Wang, Q., Theis, J., Porter, K. C., Stoakes, I. M., Payne, C. J., & Hoopes, P. C. (2023a). Management of Corneal Haze After Photorefractive Keratectomy. In *Ophthalmology and Therapy* (Vol. 12, Issue 6, pp. 2841–2862). Adis. <https://doi.org/10.1007/s40123-023-00782-1>
- Moshirfar, M., Wang, Q., Theis, J., Porter, K. C., Stoakes, I. M., Payne, C. J., & Hoopes, P. C. (2023b). Management of Corneal Haze After Photorefractive Keratectomy. In

- Ophthalmology and Therapy* (Vol. 12, Issue 6, pp. 2841–2862). Adis.
<https://doi.org/10.1007/s40123-023-00782-1>
- Moshirfar, M., Wang, Q., Theis, J., Porter, K. C., Stoakes, I. M., Payne, C. J., & Hoopes, P. C. (2023c). Management of Corneal Haze After Photorefractive Keratectomy. *Ophthalmology and Therapy*, 12(6), 2841. <https://doi.org/10.1007/S40123-023-00782-1>
- Naderi, M., Ghadamgahi, S., & Jadidi, K. (2016a.) Original Article Medical Hypothesis. In *Discovery & Innovation Ophthalmology Journal* (Vol. 5, Issue 2).
- Naderi, M., Jadidi, K., Mosavi, S. A., Mohammadi, A. H., Farahani, M., & Karimi, F. (2025). Comparison of three measurement methods of intraocular pressure in patients with keratoconus undergoing MyoRing implantation. *Malaysian Journal of Ophthalmology*, 7(1). <https://doi.org/10.35119/myjo.v7i1.374>
- Nagy, Z. Z., Szabó, A., & Krueger, R. R. (2001). *Treatment of intraocular pressure elevation after photorefractive keratectomy*.
- Németh, J., Daiki, T., Sándor, G. L., Keve, H., Szabó, D., Tóth, G., Dankovics, G., Barna, I., Limburg, H., & Nagy, Z. Z. (2023). Uncorrected refractive errors are important causes of avoidable visual impairment in Hungary: re-evaluation of two existing national data sets. *Int J Ophthalmol*, 16(6). <https://doi.org/10.18240/ijo.2023.06.19>
- Non-Contact Tonometer NT-530/510 / NIDEK*. (n.d.). Retrieved August 29, 2025, from <https://www.nidek-intl.com/items/non-contact-tonometer-nt-530-510-2/>
- Nossair, A., Kassem, M., Eltanamly, R., & Alahmadawy, Y. (2021). Corneal hysteresis, central corneal thickness and intraocular pressure in rheumatoid arthritis and their relation to disease activity. *Middle East African Journal of Ophthalmology*, 28(3), 174–179. https://doi.org/10.4103/meajo.meajo_434_20
- OCULUS Pentacam HR - Ophthalmicmart*. (n.d.). Retrieved August 29, 2025, from <https://www.ophthalmicmart.com/product/pentacam-hr/>
- Osman, E. A., Gikandi, P. W., Al-Jasser, A.-R. A., Alotaibi, M., & Mousa, A. (2018). *Comparison of Goldmann Applanation, Noncontact Air Puff and Tono-Pen XL Tonometry in Normal Controls versus Glaucoma Patients at a University Hospital in Riyadh, Saudi Arabia*. <https://doi.org/10.4103/meajo>
- Pachymeter - PacScan Plus - Sonomed Escalon - ultrasound pachymetry / tabletop*. (n.d.). Retrieved August 29, 2025, from <https://www.medicalexpo.com/prod/sonomed-escalon/product-70674-961328.html>
- Pakbin, M., Khabazkhoob, M., Pakravan, M., Fotouhi, A., Jafarzadehpour, E., Aghamirsalim, M., Seyedian, M. A., & Hashemi, H. (2020). Duration of topical steroid application after photorefractive keratectomy with mitomycin C. In *Journal of Cataract and Refractive Surgery* (Vol. 46, Issue 4, pp. 622–632). Lippincott Williams and Wilkins. <https://doi.org/10.1097/j.jcrs.0000000000000060>
- Pattih Primasakti, Lucyana, Fitratul Ilahi, & Hendriati. (2025). Clinical Characteristics and Management of Steroid-Induced Glaucoma. *Bioscientia Medicina: Journal of Biomedicine and Translational Research*, 9(5), 7439–7450. <https://doi.org/10.37275/bsm.v9i5.1285>
- Pentacam ® Pentacam ® HR OCULUS*. (n.d.). www.oculus.de
- Peyman, A., Dastborhan, Z., & Peyman, M. (2017). Astigmatic treatment with photorefractive keratectomy: Investigations of non-keratometric ocular astigmatism. *Journal of Current Ophthalmology*, 29(2), 98–102. <https://doi.org/10.1016/j.joco.2016.12.001>

- Pidro, A., Biscevic, A., Pjano, M. A., Mravicic, I., Bejdic, N., & Bohac, M. (2019). Excimer lasers in refractive surgery. *Acta Informatica Medica*, 27(4), 278–283. <https://doi.org/10.5455/aim.2019.27.278-283>
- Pleyer, U., Ursell, P. G., & Rama, P. (2013). Intraocular Pressure Effects of Common Topical Steroids for Post-Cataract Inflammation: Are They All the Same? *Ophthalmology and Therapy*, 2(2), 55–72. <https://doi.org/10.1007/s40123-013-0020-5>
- Reddy Korpole, N., Kurada, P., & Reddy Korpole, M. (2022). *Gender Difference in Ocular Diseases, Risk Factors and Management with Specific Reference to Role of Sex Steroid Hormones*. https://doi.org/10.4103/jmh.jmh_28_22
- Schiefer, U., Kraus, C., Baumbach, P., Ungewiß, J., & Michels, R. (2016). Refractive errors - Epidemiology, effects and treatment options. *Deutsches Arzteblatt International*, 113(41), 693–701. <https://doi.org/10.3238/arztebl.2016.0693>
- Shapira, Y., Mimouni, M., Levartovsky, S., Varssano, D., Sela, T., Munzer, G., & Kaiserman, I. (2015). Comparison of three epithelial removal techniques in PRK: Mechanical, alcoholassistedand transepithelial laser. *Journal of Refractive Surgery*, 31(11), 760–766. <https://doi.org/10.3928/1081597X-20151021-05>
- Sherif, Z., & Pleyer, U. (2002). Corticosteroids in Ophthalmology: Past – Present – Future. *Ophthalmologica*, 216(5), 305–315. <https://doi.org/10.1159/000066189>
- Shousha, S. M. A., Steit, M. A. H. A., Hosny, M. H. M., Ewais, W. A., & Shalaby, A. M. M. (2013a). Comparison of different intraocular pressure measurement techniques in normal eyes, post surface and post lamellar refractive surgery. *Clinical Ophthalmology*, 7(1), 71–79. <https://doi.org/10.2147/OPHTH.S37978>
- Shousha, S. M. A., Steit, M. A. H. A., Hosny, M. H. M., Ewais, W. A., & Shalaby, A. M. M. (2013b). Comparison of different intraocular pressure measurement techniques in normal eyes, post surface and post lamellar refractive surgery. *Clinical Ophthalmology*, 7(1), 71–79. <https://doi.org/10.2147/OPHTH.S37978>
- Shroff, S., Thomas, R. K., D’Souza, G., & Nithyanand an, S. (2018). The effect of inhaled steroids on the intraocular pressure. *Digital Journal of Ophthalmology: DJO*, 24(3), 6–9. <https://doi.org/10.5693/djo.01.2018.04.001>
- Sit, A. J., Chen, T. C., Takusagawa, H. L., Rosdahl, J. A., Hoguet, A., Chopra, V., Richter, G. M., Ou, Y., Kim, S. J., & Wudunn, D. (2023). Ophthalmic Technology Assessment Corneal Hysteresis for the Diagnosis of Glaucoma and Assessment of Progression Risk a Report by the American Academy of Ophthalmology. *Ophthalmology*, 130, 433–442. <https://doi.org/10.1016/j.ophtha.2022.11.009>
- Somani, S. N., Moshirfar, M., & Patel, B. C. (2025a). *Photorefractive Keratectomy Continuing Education Activity*.
- Somani, S. N., Moshirfar, M., & Patel, B. C. (2025b). *Photorefractive Keratectomy Continuing Education Activity*.
- Somani SN, Moshirfar M, Patel BC. *Photorefractive Keratectomy*. [Updated 2023 Jul 18]. In: *StatPearls [Internet]*. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK549887>. (n.d.).
- Svedberg, H., Chen, E., & Hamberg-Nyström, H. (2005). Changes in corneal thickness and curvature after different excimer laser photorefractive procedures and their impact on intraocular pressure measurements. *Graefe’s Archive for Clinical and Experimental Ophthalmology*, 243(12), 1218–1220. <https://doi.org/10.1007/s00417-005-0072-x>

- Tahzib, N. G. (2008). *Visual outcome and patient satisfaction after corneal and refractive surgery* [maastricht university]. <https://doi.org/10.26481/dis.20081010nt>
- TECHNOLAS® TENEQ TM 317 MODEL 2 (M 2) Technical Specifications. (2017). www.bausch.com
- Toricelli, A. A. M., Giglio, V. B., Garcia, R., Santhiago, M. R., Bechara, S. J., Wilson, S. E., & Monteiro, M. L. R. (2024). Photorefractive Keratectomy: Technical Evolution, Refractive Outcomes, Corneal Wound Healing Response and Complications. In *Journal of refractive surgery (Thorofare, N.J.: 1995)* (Vol. 40, Issue 10, pp. e754–e767). <https://doi.org/10.3928/1081597X-20240826-05>
- Vajaranant, T. S., Nayak, S., Wilensky, J. T., & Joslin, C. E. (2010). Gender and glaucoma: What we know and what we need to know. In *Current Opinion in Ophthalmology* (Vol. 21, Issue 2, pp. 91–99). <https://doi.org/10.1097/ICU.0b013e3283360b7e>
- Varshney, T., Dudani, P., & Gupta, V. (2023). Steroid-Induced Glaucoma. *Childhood Glaucoma: A Case Based Color and Video Atlas*, 235–243. https://doi.org/10.1007/978-981-19-7466-3_22
- Vestergaard, A. H. (2014). Past and present of corneal refractive surgery. *Acta Ophthalmologica*, 92(thesis2), 1–21. <https://doi.org/10.1111/aos.12385>
- Vincent, S. J., Vincent, R. A., Shields, D., & Lee, G. A. (2012). Comparison of intraocular pressure measurement between rebound, non-contact and Goldmann applanation tonometry in treated glaucoma patients. *Clinical and Experimental Ophthalmology*, 40(4). <https://doi.org/10.1111/j.1442-9071.2011.02670.x>
- Vitale, S., Ellwein, L., Cotch, M. F., Ferris, F. L., & Sperduto, R. (2008). Prevalence of refractive error in the United States, 1999–2004. *Archives of Ophthalmology*, 126(8), 1111–1119. <https://doi.org/10.1001/archoph.126.8.1111>
- Wei, W., Fan, Z., Wang, L., Li, Z., Jiao, W., & Li, Y. (2014). Correlation analysis between central corneal thickness and intraocular pressure in juveniles in Northern China: The Jinan City eye study. *PLoS ONE*, 9(8). <https://doi.org/10.1371/journal.pone.0104842>
- Zarei, Er. R., Zamani, M. H., Eslami, Y., Fakhraei, Gh. H., Tabatabaei, M., & Esfandiari, A. R. (2022). Comparing corneal biomechanics and intraocular pressure between healthy individuals and glaucoma subtypes: A cross-sectional study. *Annals of Medicine and Surgery*, 82. <https://doi.org/10.1016/j.amsu.2022.104677>
- Zeppieri, M., & Gurnani, B. (2025). *Applanation Tonometry Continuing Education Activity*.
- Zhang, B., Zhou, C., Lai, Y., Zhang, C., & Zhang, Y. (2025). Associated factors for steroid-induced ocular hypertension in children with systemic lupus erythematosus. *Visual Neuroscience*, 42, 20. <https://doi.org/10.48130/vns-0025-0022>
- Zhang, J., Wu, Y., Sharma, B., Gupta, R., Jawa, S., & Bullimore, M. A. (2023). *Epidemiology and Burden of Astigmatism: A Systematic Literature Review*. www.optvissci.com *Optom Vis Sci*, 100(3), 218–231. <https://doi.org/10.1097/OPX.0000000000001998>
- Zhao, L. Q., Wei, R. L., Cheng, J. W., Li, Y., Cai, J. P., & Ma, X. Y. (2010). Meta-analysis: Clinical Outcomes of Laser-Assisted Subepithelial Keratectomy and Photorefractive Keratectomy in Myopia. *Ophthalmology*, 117(10), 1912–1922. <https://doi.org/10.1016/J.OPHTHA.2010.02.004>
- Zhou, X., Xu, J., & Duan, X. (2025). Bidirectional Causal Relationships between Corneal Biomechanics and Glaucoma or Intraocular Pressure. *Ophthalmology Science*, 5(4), 100742. <https://doi.org/10.1016/J.XOPS.2025.100742>

العلاقة بين ضغط العين الستيريود وسماكة منتصف القرنيه قبل وبعد عملية تصحيح النظر لمرضى قصر وانحراف النظر المجمع باستخدام الليزر السطحي : دراسه مستقبليه.
اسم الطالب الرباعي: هديل احمد إسماعيل سليمان
أسماء لجنة الاشراف: الدكتور. خليل إسماعيل يوسف حريبات . الدكتور. إبراهيم عبدالله إبراهيم طه. الدكتور الأستاذ. يزن سلطان سعيد قموه.

الملخص باللغة العربية:

المقدمة:

يُعدّ استئصال القرنية بالليزر السطحي (Photorefractive Keratectomy – PRK) أحد أنواع جراحات تصحيح الأخطاء الانكسارية، حيث يعتمد على استخدام ليزر الإكس يمر لتصحيح الأخطاء الانكسارية. يُصحح المرضى الخاضعون لعملية PRK باستخدام القطرات الستيريودية لمدة شهر بعد الجراحة. وقد تؤدي القطرات الستيريودية إلى تقليل تصريف السائل الزجاجي الامامي، مما قد يسبب ارتفاعاً في ضغط العين الداخلي (Intraocular Pressure – IOP) لدى بعض المرضى. تقليدياً، اعتُبر سُمك القرنية المركزي (Central Corneal Thickness – CCT) عاملاً محتملاً للتنبؤ بتقلبات ضغط العين بعد الجراحة. تهدف هذه الدراسة إلى استكشاف العلاقة بين سُمك القرنية المركزي قبل العملية وارتفاع ضغط العين الستيريودي بعد عملية PRK لتصحيح قصر وانحراف النظر المركب.

الأهداف:

هدفت الدراسة إلى تحديد ما إذا كان سُمك القرنية المركزي قبل PRK مرتبطاً بارتفاع ضغط العين الستيريودي بعد PRK، وتقييم الأهمية السريرية لـ CCT كعامل تنبؤي للاستجابة الستيريودية بعد الجراحة.

المنهجية:

أُجريت دراسة رصدية مستقبلية شملت 50 مريضًا تتراوح أعمارهم بين 18 و35 عامًا يعانون من قصر وانحراف النظر المركب، وخضعوا لعملية PRK في المركز الروسي لطب العيون في الخليل، فلسطين. شملت التقييمات قبل الجراحة فحصًا عينيًا شاملاً، وقياس ضغط العين باستخدام جهاز قياس ضغط العين غير التلامس (Air-puff tonometry)، وتقييم سُمك القرنية المركزي باستخدام جهاز الـ Pentacam. بعد الجراحة تلقى جميع المرضى قطرات موكسيفلوكساسين بتركيز 5 ملغ/مل وقطرات أسيتات البريد يزولون 1% كل ساعتين لمدة أسبوع واحد. أُجريت زيارات المتابعة بعد 10 أيام، وبعد أسبوع واحد، وبعد شهر واحد، حيث تم خلالها إعادة قياس ضغط العين وسُمك القرنية المركزي. تم تحليل البيانات باستخدام برنامج SPSS لدراسة العلاقة بين سُمك القرنية المركزي والزيادة في ضغط العين الستيرويدي.

النتائج:

لوحظ انخفاض ملحوظ في سُمك القرنية المركزي بعد 10 أيام من عملية PRK لدى جميع المشاركين ($p < 0.001$)، مما يعكس الترقق في سماكة القرنية المتوقع بعد الجراحة. بقي ضغط العين مستقرًا دون حدوث تغيرات ذات دلالة إحصائية بعد العملية. ($p > 0.05$) كما أظهر التحليل أن التغيرات في سُمك القرنية المركزي، سواء قبل الإجراء الجراحي أو بعده، لم تكن مرتبطة بشكل احصائي بالتغيرات في ضغط العين بعد الجراحة. إضافة إلى ذلك، فإن تقسيم المرضى إلى مجموعتين بناءً على مقدار ارتفاع ضغط العين (>2 مم زئبق مقابل ≥ 2 مم زئبق) لم يُظهر فروقًا ملحوظة في العمر أو في سُمك القرنية المركزي الأساسي. وبشكل عام، تشير النتائج إلى أن سُمك القرنية المركزي لا يؤثر في التغيرات اللاحقة في ضغط العين المرتبطة باستخدام الستيرويد.

الاستنتاج:

تُشير نتائج هذه الدراسة إلى أن سماكة القرنية المركزية ليست مؤشرًا موثوقًا للتنبؤ بارتفاع ضغط العين الاستيرويدي بعد عملية PRK. لذلك، ينبغي على الأطباء إجراء تقييم شامل بعد الجراحة يأخذ بعين الاعتبار الخصائص البيو ميكانيكية للقرنية بدلاً من الاعتماد على سُمك القرنية فقط. كما أن استخدام ستيرويد أقل قوة قد يساهم في تقليل خطر ارتفاع ضغط العين بعد الجراحة. توصي الدراسة بإجراء أبحاث مستقبلية تشمل عينات أكبر، وفترات متابعة أطول، وتحليلاً أكثر تفصيلاً للعوامل البيو ميكانيكية، بهدف تحديد مؤشرات أكثر موثوقية للتنبؤ بارتفاع ضغط العين الاستيرويدي.

الكلمات المفتاحية:

سماكة القرنية المركزية، ارتفاع ضغط العين الاستيرويدي، استئصال القرنية الانكساري الضوئي (PRK) ، الميكانيكا الحيوية للقرنية، انحراف وقصر النظر المركب.