Incidence and Risk Factors of Refractive Regression following LASIK Surgery: A Systematic Review and Meta-Analysis

Abdulrahman Alamri, MD* Rayan Mohammed S. Almugharrid, Medical Student** Mohammed Saeed M Almousa, Medical Student** Saud Qasem A Alshabab, Medical Student** Fahad Yahya Ahmed Mushari, Medical Student** Fawaz Naif M AlQarni, Medical Student** Mohammed Abdulrahman H Ogran, Medical Student** Saif Tawfig M. Namri, Medical Student** Abdulmohsin Mohammed S. Alzuhairi, Medical Student** Faris Hatem A. Hejazi

ABSTRACT

Background: laser in situ keratomileusis (LASIK) is a widely used technique for myopia. However, regression of refraction is a common complication after long follow up periods. This study aims to evaluate the incidence and risk factors of refractor regression after LASIK surgery.

Methods: A systematic search on four databases (PubMed, Cochrane, Web of Science, and Scopus) retrieved all published articles till April 2024. The studies included if they were reported in English, assessing refractive regression after LASIK. Meta-analysis was conducted using OpenMeta analyst using the random effect model with 95% confidence interval (CI). Further meta regression analysis was conducted to test the correlation between the mean regression and some risk factors like spherical equivalent and age.

Results: The search yielded seven articles with 327 participants of 482 eyes. The analysis included 127 males and 159 females. The pooled analysis indicated significant regression occurs after refractive surgery P <0.001). additionally, the analysis indicated the significant association between the mean regression and spherical equivalent which mean that patients with higher degrees of myopia, more negative spherical equivalent, have higher regression of their nearsightedness following LASIK.

Conclusion: This systematic review and meta-analysis is the first to provide comprehensive assessment of myopic regression following LASIK surgery. Our analysis indicated a higher incidence of refractive regression following LASIK. Also, the spherical equivalent is a significant risk factor for regression after long follow-up. Further research with more standardized protocols, with control arm, and long follow-up periods are important to investigate a wider range of risk factors that might increase the susceptibility of regression occurrence.

Keywords: LASIK; laser in situ keratomileusis; refractive error; regression; myopia; eximer laser

INTRODUCTION

Globally, uncorrected refractive errors (REs) are considered the primary cause of visual impairment, with an estimation of more than 2.3 billion suffering from REs, of whom 670 million are visually impaired, 100 million with low vision and 67 million blind according to the World Health Organization (WHO) report 2021 [1, 2, 3.] This term refers to a set of visual conditions that are commonly associated with myopia, hyperopia, astigmatism and presbyopia4. These conditions affect the ability of the eye to focus light correctly on the retina, leading to blurred or distorted vision [4.] It can be corrected by glasses, contact lenses or even doing surgery with laser-assisted subepithelial keratectomy (LASEK) or laser-assisted in-situ keratomileusis (LASIK) [5, 6.] Laser has been used for decades to reshape the cornea and restore normal sight and is considered one of the most common elective procedure worldwide [7, 8.] It involves creating a corneal flap to allow a clear access before laser treatment of corneal stromal tissue which is more superficial and epithelial in LASEK and thicker with the include of some anterior stromal tissue in LASIK [6.]

Garamendi et al. used the Quality of Life Impact of Refractive Correction (QIRC) questionnaire to compare the quality of life (QoL) between people who did surgery and those stayed with glasses or lenses and found a greater improvement in favor of laser indicating the greater impact it has [9]. Gomel et al. proves the efficacy and safety of laser in myopia and correlates that with certain factors like younger age, and low myopia [10.] Despite the many advantages it has including efficacy, safety, quick visual recovery and patient satisfaction, frequent refractive regression is also reported [11, 12.] It means the tendency of the eye to regain partially or completely its previous refraction following a period of maintaining the desired one [1.]

Focusing on myopia or nearsightedness, the most prevalent RE with 1.4 billion people affection [13]. It happens when the light falls in front of the retina rather than on the retina itself causing distant objective to be blurry [14.] It can be caused by genetic or environmental factors 14. The incidence of regression after myopic LASIK have been varied between studies with a range of 5.5% to 27.7% [15, 16, 17]. low to moderate and high myopia is estimated to be associated with regression of 10% and 30% of eyes undergoing LASIK, respectively [18, 19]. The exact mechanism is still unclear but founding the corneal stroma clear along with the time frame of refractive changes after the operation have led the investigators to assume the involvement of corneal epithelium [20.]

Standing on the reality behind myopic regression is important for improving this procedure which make an impact in the life of millions of people. Conducting this study will provide the literature with up-to-date information regarding this topic.

* Department of Ophthalmology, College of Medicine , King Khalid University Saudi Arabia. E-mail: Am2mari@gmail.com
** Medical student College of Medicine, King Khalid University, Saudi Arabia

METHODS

This study is reported based on the Cochrane Handbook of Systematic Reviews on Interventions [21] and adheres the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement guidelines [22].

Search strategy

Our search included four electronic databases including PubMed, Cochrane, Web of science and Scopus from inception until April 2024. We used the following search strategy: for PubMed ((LASIK OR "laser" OR keratomileusis OR "Laser-Assisted Stromal in Situ Keratomileusis") AND (refractive regression)) No restrictions were applied regarding language, time and study design, the search strategy used in other databases are presented in supplementary file. To avoid missing any study, manual search was done on databases.

Eligibility criteria

We included English studies in which; population: patients diagnosed with refractive error and treated with laser-assisted in-situ keratomileusis (LASIK); Outcome: mean refractive regression; study design: observational studies including, cohort studies, case control studies, and case series. Other study designs were excluded. In contrast, non-English studies, case reports, conference proceeding studies, studies in which surgery not LASIK, or studies not presenting regression outcomes were excluded.

Screening and Study Selection

The retrieved articles were uploaded first to the Endnote software for duplicate removal [23], after that, Title and abstract screening were performed on Rayyan website followed by full-text screening. Finally, the retrieved articles are screened for full text for eligibility criteria.

Quality assessment

The risk of bias was assessed using the new castle Ottawa scale for cohort and case control studies [24]. While case series studies were evaluated using the JBI critical appraisal check list for case series [25].

Data extraction

Summary of included studies and baseline characteristics of the enrolled participants was extracted including: the study ID (last name of the first author and year of publication), study design, Excimer laser, number of eyes, follow up years, sample size, age, Gender, spherical equivalent D (D refers to diopter), sphere D and cylinder D.

Statistical analysis

We conducted our analysis using OpenMeta analyst software. We applied the pooled mean with the random effect model and the 95% confidence interval (CI) for the outcome, which is continuous variable, which is Mean regression of the refraction after LASIK and the correlation of age, gender either male or female and spherical equivalent was measured secondarily, Data were considered statistically significant if the p-value was below 5%. Assessment of statistical heterogenicity among the studies was done using the visual inspection of the forest plot, I-squared and (I^2) and chi-squared (Chi^2) statistics. For heterogenous results, sensitivity analysis (leave-one-out meta-analysis) were conducted in multiple scenarios, by excluding different study in each scenario, if the heterogeneity was not solved, meta-regression analysis was done to find any correlation between any variable that could influence the results. Further meta regression analysis was conducted to to test the assassinations between the mean regression and spherical equivalent, gender, and age. All analysis and its figures were generated by OpenMeta analyst software.

Results

Search and selection criteria

The search in the four databases revealed 2871 articles, 1355 records out of them removed for duplicate. 1237 article excluded form total of 1516 after title and abstract screening leaving 243 retrieved to full text screening. Of those 243 records, seven studies included in the systematic review and the meta-analysis. The selection process is shown in detail in **Figure 1**.

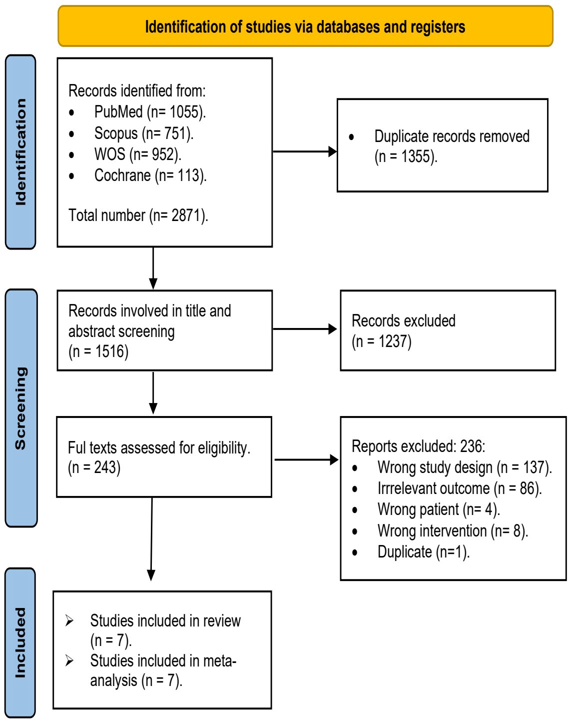

Figure 1. PRISMA flow diagram summarizing the selection process.

Summary of included studies and quality assessment.

We included seven studies with 327 participants of 482 eyes. The analysis included 127 males and 159 females 26, 27, 28, 29, 30, 31, 32. The majority of studies used the VISK 20/20 eximer laser while each of MEL 60 and Keracor eximer laser was used in one study. The details of included studies are shown in **Table 1**. The risk of bias assessment of the included studies are described in detail in **supplementary table 1 and 2**.

Clinical outcomes

The pooled analysis of mean myopic regression was statistically significant after LASIK surgery in the seven studied reporting it with the following values (mean = -1.879; 95% CI: -2.725, -1.033; P <0.001), as shown in (**Figure 2**). This indicates that patients experienced a return of myopia (nearsightedness) after LASIK. A significant heterogeneity was detected between the pooled studies (P <0.001; I^2 = 96.407). To solve the heterogeneity, sensitivity analysis was conducted but did not solve it. We observed the variation of pre-operative spherical equivalent that may influence the results so, a meta-regression analysis was conducted between them and was found to have a strong correlation between spherical equivalent and mean regression P < 0.001 as shown in (**Figure 4.a)**.

Further subgroup analysis based on the follow up was conducted. For follow-up (three months to 10 years), The mean pooled mean in

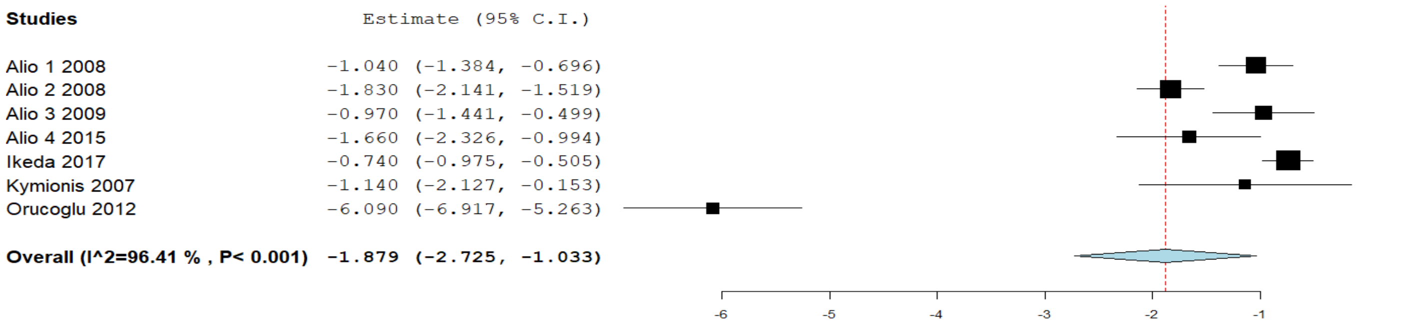

Figure 2. Forest plot of mean myopic regression after LASIK surgery. This figure visualizes the pooled mean based on random effect model with 95% confidence interval (CI) Each horizontal line represents an individual study, and the Square represents the study's pooled mean. The size of the square reflects the study's weight (typically based on sample size).

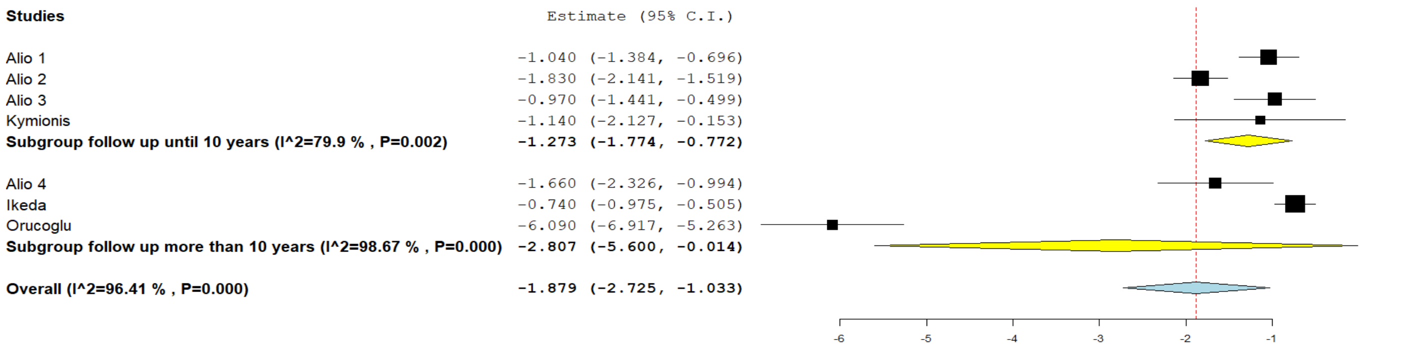

Figure 3. Forest plot of subgroup analysis means myopic regression after LASIK surgery based on follow up points. The data in the top of graph represents the data of studies of follow-up until 10 years, while data in the lower side of the graph represents the data of studies of follow up points more than 10 years until 15 years. This figure visualizes the pooled mean based on random effect model with 95% confidence interval (CI) Each horizontal line represents an individual study, and the Square represents the study's pooled mean. The size of the square reflects the study's weight (typically based on sample size).

Table 1. Summary and baseline characteristics of included studies

Study ID	Study design	Excimer laser	Eyes	Sample population	Follow up years	Age years, mean ± sd	Gender, n (%)		spherical equivalent, D, mean ± sd	sphere D, mean ± sd	cylinder D, mean ± sd
							Male	Female			
Alio 2008	retrospective, interventional case series	VISX 20/20	97	70	10	33.2 ± 9.9	33 (47)	36 (51)	-7.27 ± 1.94	-6.53 ± 1.82	-1.44 ± 1.07
Alio 2008	retrospective, interventional case series	VISX 20/20	196	118	10	32.9 ± 9.3	52 (44.06)	66 (55.93)	-13.95 ± 2.79	-13.10 ± 2.83	-1.70 ± 1.09
Alio 2009	A retrospective, control-matched study	VISX 20/20	34	32	10	29.44 ± 6.8	14 (43.75)	18 (56.25)	-8.30 ± 1.21	-7.70 ± 1.23	-1.10 ± 0.79
Alio 2015	Retrospective–prospective case series	VISX 20/20	40	40	15	51.08 ± 6.67	-	-	-10.37 ± 3.19	-9.47 ± 3.26	-1.79 ± 1.10
Ikeda 2017	Retrospective Cohort	VISX STAR S2	68	37	12	34.4 ± 9.5	14 (37.8)	23 (63.2)	-6.70 ± 2.52	-	0.76 ± 0.67
Kymionis 2007	Retrospective Cohort	MEL 60	11	7	11	41.7 ± 6.5	2 (28.57)	5 (71.42)	-12.96 ± 3.17	-	-
Oruçoğlu 2012	Prospective Cohort	Keracor	36	23	10 to 15	-	12 (52.17)	11 (47.82)	-20.38 ± 5.16	-	-

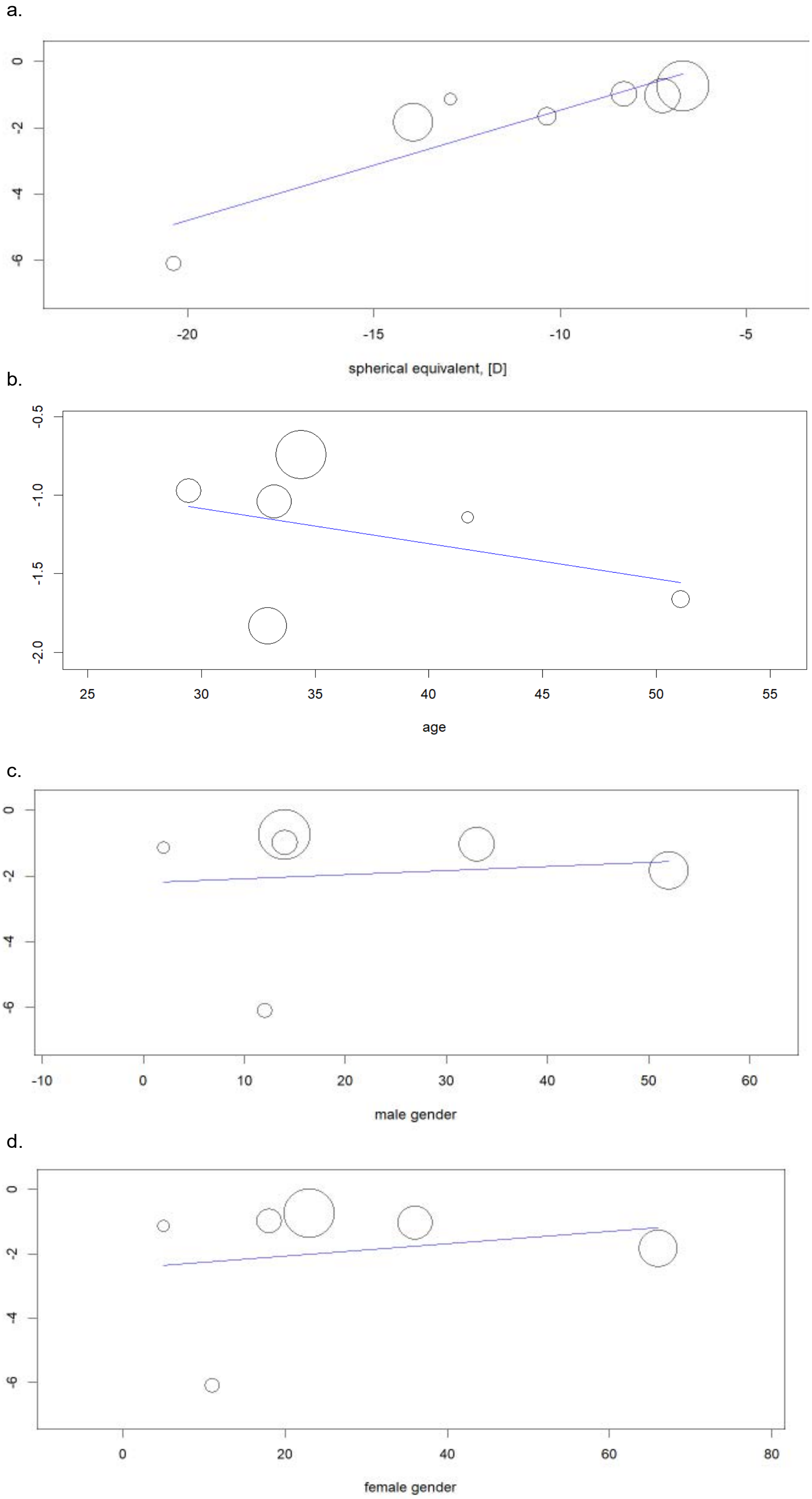

Figure 4. The plots visualize the meta-regression analysis investigating the correlation between mean regression and a) spherical equivalent, b) age, c) male, and d) female, across multiple studies included in the meta-analysis.

regression was -1.273 diopters, with a statistically significant p-value ($p < 0.001$). This indicates a significant average regression in this group. (mean = -1.273; 95% CI: -1.774, -0.772; P <0.001), as shown in (**Figure 5**).

For follow-up (> 10 years): The pooled mean was -2.807 diopters, with a borderline significant p-value ($p = 0.049$). This suggests a trend towards greater regression in patients followed for more than 10 years compared to the 3–10-year group (mean = -2.807; 95% CI: -5.6, -0.014; P =0.049), as shown in (**Figure 3**). Overall, the analysis strengthens the evidence for myopic regression after LASIK surgery, with a possible link between the degree of regression and the length of follow-up. However, the limitations of a single-arm analysis and potential heterogeneity need further research with control group for a more conclusive picture.

Table 1. summarizing the summary and baseline characteristics of included studies. Quantitative data are presented in frequency and percentages n (%), while quantitative data are presented in mean and standard deviation mean (sd). D, Diopter.Risk factors

Spherical equivalent

There's a statistically significant correlation between pre-operative spherical equivalent (a measure of myopia severity) and myopic regression (0.333 -0.211, 0.455; P < 0.001). This suggests that patients with higher degrees of myopia might experience greater regression after LASIK, as shown in (**Figure 4.a)**.

Age and gender

The meta-regression analysis revealed that age and gender either male or female are not statistically associated with the degree of myopic regression in this analysis with the following values respectively (0.022 -0.075, 0.03; P =0.398), (0.013 -0.075, 0.101; P =0.778) and (0.019 -0.052, 0.09; P =0.598), as shown in (**Figure 4.b,c,d**).

DISCUSSION

In this systematic review and meta-analysis of observational studies assessing the refractive regression after LASIK surgery, we found significant regression occurs after long-follow-up to 10 years from the time of surgery. Also, our analysis revealed the significant association between pre-operative spherical equivalent and regression at which the higher preoperative values play as a significant risk factor for developing regression after surgery.

Regarding to our search, there is no previous literature examined the regression after LASIK surgery, our study is the first of its kind to investigate the regression after LASIK and potential risk factors associated with refractive regression following LASIK. While there in no prior research, existing research offers potential areas for exploration, the existing analysis revealed that, patients with higher degrees of myopia, more negative spherical equivalent, have higher regression of their nearsightedness following LASIK. as

shown in Ikeda et al, [26-31] that included patients with mean spherical equivalent -6.70 ± 2.52 D which is the lowest spherical equivalent among studies included as shown in (Table 1) resulted in -0.74 mean regression after 12 year of follow up. In contrast, significant higher myopic regression -6.09 resulted after 10 to 15 years of follow up of patients having higher pre-operative spherical equivalent values greater than -14 D (-20.38 ± 5.16) as reported by Oruçoğlu et al, [32]. This association could be explained and supported by the corneal weakness that induced by flap and corneal tissue ablation as reported by Khamar et al, [33.] Additionally, multiple studies reported that the LASIK surgery can affect the biomechanical parameters of the cornea and affect its strength depending on the degree of myopia and connective tissue ablation [34, 35, 36]. This finding highlights the importance of not choosing patients with higher myopia for LASIK surgery due to the higher risk of regression.

The current analysis revealed a negative association between myopic regression and gender or Age, but these results are disputed. Zhou et al, [37] reported resulted differ from that findings, they found that female patients have higher risk of myopic regression. The hormonal change during menstrual cycle or during pregnancy may lead to variations in the central corneal thickness and corneal biomechanical parameters [38.] This variation may make the cornea more susceptible to shape changes after LASIK surgery. Additionally, Zhang et al [39] reported different results from this study which indicated the susceptibility of refractive regression with younger patients. It is important to acknowledge the heterogeneity present in the current study. Variations were observed among the included studies in demographics. The most important variable is the pre-operative spherical equivalent that represents the degree of myopia and we have previously explained how it impacts the total effect estimate. Additionally, the age of patients included in the current studies are not comparable as Alio et al, [29] included patients with mean age of 51.08 ± 6.67, which is older than rest of studies. Variation in sample size was observed also, as the participants and eye included for surgery was vary among studies. Overall, this meta-analysis highlights the importance of considering spherical equivalent and other risk factors that have higher susceptibility of developing refractive regression.

As this first systematic review on regression following LASIK surgery, all these potential cofounders and heterogeneity among studies may influence the evidence and affect the generalizability of the results. Also, the heterogeneity of included study resulted from the pooled analysis and the heterogeneity of included studies regarding study designs and follow-up durations necessitated the need for further research with more restricted and standardized protocols. Additionally, the absence of prior literature limits our ability to draw more definitive conclusion. Additionally, the current evidence based on observational studies limits the comparability with control arm which limits its generalizability.

CONCLUSION

In conclusion, this systematic review and meta-analysis is the first to provide comprehensive assessment of myopic regression following LASIK surgery and identified significant factors influencing this outcome. The current analysis indicated clear association between pre-operative spherical equivalent and regression, patients with spherical equivalent exceeding -14 D had the higher substantial regression. The current study acknowledges the persistence of limitations arising from heterogeneity among the includes studies. Therefore, further research with more standardized protocols, with control arm, and long follow-up periods are important to investigate a wider range of risk factors that might increase the susceptibility of regression occurrence.

Authorship Contribution: All authors share equal effort contribution towards (1) substantial contributions to conception and design, acquisition, analysis and interpretation of data; (2) drafting the article and revising it critically for important intellectual content; and (3) final approval of the manuscript version to be published. Yes.

Potential Conflicts of Interest: None

Competing Interest: None

Acceptance Date: 27-08-2024

REFERENCES

1. M. K. Yan, J. S. Chang, and T. C. Chan, "Refractive regression after laser in situ keratomileusis," Clin. Experiment. Ophthalmol., vol. 46, no. 8, pp. 934–944, 2018, doi: 10.1111/ceo.13315.
2. K. S. Naidoo and J. Jaggernath, "Uncorrected refractive errors," Indian J. Ophthalmol., vol. 60, no. 5, pp. 432–437, 2012, doi: 10.4103/0301-4738.100543.
3. S. Resnikoff, D. Pascolini, S. P. Mariotti, etal. "Global magnitude of visual impairment caused by uncorrected refractive errors in 2004," Bull. World Health Organ., vol. 86, no. 1, pp. 63–70, Jan. 2008, doi: 10.2471/blt.07.041210.
4. V. Galvis, A. Tello, P. A. Camacho, etal., "Definition of refractive errors for research studies: Spherical equivalent could not be enough," J. Optom., vol. 14, no. 2, pp. 224–225, 2021, doi: 10.1016/j.optom.2020.10.003.
5. "Refractive Errors | National Eye Institute." Accessed: Apr. 09, 2024. Online. Available: https://www.nei.nih.gov/learn-about-eye-health/eye-conditions-and-diseases/refractive-errors
6. J. Kuryan, A. Cheema, and R. S. Chuck, "Laser-assisted subepithelial keratectomy (LASEK) versus laser-assisted in-situ keratomileusis (LASIK) for correcting myopia," Cochrane Database Syst. Rev., vol. 2017, no. 2, p. CD011080, Feb. 2017, doi: 10.1002/14651858.CD011080.pub2.
7. M. Moshirfar, Ali hassan , Edward F et al., "Laser-Assisted In Situ Keratomileusis (LASIK) Enhancement for Residual Refractive Error after Primary LASIK," J. Clin. Med., vol. 11, no. 16, p. 4832, Aug. 2022, doi: 10.3390/jcm11164832.
8. Meidani, C. Tzavara, C. Dimitrakaki, etal."Femtosecond laser-assisted LASIK improves quality of life," J. Refract. Surg. Thorofare NJ 1995, vol. 28, no. 5, pp. 319–326, May 2012, doi: 10.3928/1081597X-20120403-01.
9. E. Garamendi, K. Pesudovs, and D. B. Elliott, "Changes in quality of life after laser in situ keratomileusis for myopia," J. Cataract Refract. Surg., vol. 31, no. 8, pp. 1537–1543, Aug. 2005, doi: 10.1016/j.jcrs.2004.12.059.
10. Zigmond AS, Snaith RP, The Hospital Anxiety and Depression Scale. Acta Psychiatr Scand. 1983, 67,361- 370. 10.1111/j.1600-0447.1983.tb09716.x.
11. M. Moshirfar, P. Bennett, and Y. Ronquillo, "Laser In Situ Keratomileusis (LASIK)," in StatPearls, Treasure Island (FL): StatPearls Publishing, 2024. Accessed: Apr. 09, 2024. Online. Available: http://www.ncbi.nlm.nih.gov/books/NBK555970/
12. Law M, Naughton MT, Dhar A, Barton D, Dabscheck E, Validation of two depression screening instruments in a sleep disorders clinic. J Clin Sleep Med. 2014, 10,683-688. 10.5664/jcsm.3802
13. Iber C, Ancoli-Israel S, Chesson A, Quan S, American Academy of Sleep Medicine, The AASM Manual for the Scoring of Sleep and Associated Events, Rules, Terminology and Technical Specifications. American Academy of Sleep Medicine, Westchester; 2007.
14. Bjorvatn B, Rajakulendren N, Lehmann S, etal.Increased severity of obstructive sleep apnea is associated with less anxiety and depression. J Sleep Res. 2018, 27,12647. 10.1111/jsr.12647
15. J. M. Albietz, L. M. Lenton, and S. G. McLennan, "Chronic dry eye and regression after laser in situ keratomileusis for myopia," J. Cataract Refract. Surg., vol. 30, no. 3, pp. 675–684, Mar. 2004, doi: 10.1016/j.jcrs.2003.07.003.
16. Lee S-A, Yoon H, Kim H-W, Is severe obstructive sleep apnea associated with less depressive symptoms? . J Psychosom Res. 2019, 122,6-12. 10.1016/j.jpsychores.2019.04.017
17. W. A. Lyle and G. J. Jin, "Retreatment after initial laser in situ keratomileusis," J. Cataract Refract. Surg., vol. 26, no. 5, pp. 650–659, May 2000, doi: 10.1016/s0886-3350(00)00319-9.
18. "Regression After LASIK for the Treatment of Myopia: The Role of the Corneal Epithelium: Seminars in Ophthalmology: Vol 13, No 2." Accessed: Apr. 09, 2024. Online. Available: https://www.tandfonline.com/doi/abs/10.3109/08820539809059822
19. Pan Q, Gu YS, Wang J et al. Differences between regressive eyes and non-regressive eyes after LASIK for myopia in the time course of corneal changes assessed with the Orbscan. Ophthalmologica 2004; 218: 96–101.
20. Roberts C. Biomechanics of the cornea and wavefront-guided laser refractive surgery. J Refract Surg 2002; 18: S589–92
21. Reinstein DZ, Silverman RH, Raevsky T et al. Arc-scanning very high-frequency digital ultrasound for 3D pachymetric mapping of the corneal epithelium and stroma in laser in situ keratomileusis. J Refract Surg 2000; 16: 414–30.
22. Reinstein DZ, Archer TJ, Gobbe M. Change in epithelial thickness profile 24 hours and longitudinally for 1 year after myopic LASIK: three-dimensional display with artemis very high-frequency digital ultrasound. J Refract Surg 2012; 28: 195–201.
23. Kanellopoulos AJ, Asimellis G. Longitudinal postoperative lasik epithelial thickness profile changes in correlation with degree of myopia correction. J Refract Surg 2014; 30: 166–71.
24. Kamiya K, Oshika T. Corneal forward shift after excimer laser keratorefractive surgery. Semin Ophthalmol 2003; 18: 17–22.
25. PD, Lobo L, Ibrahim J, Tyrer J, Marshall J. Interferometric technique to measure biomechanical changes in the cornea induced by refractive surgery. J Cataract Refract Surg 2005; 31: 175–84.
26. Qi H, Hao Y, Xia Y, Chen Y. Regression-related factors before and after laser in situ Keratomileusis. Ophthalmologica 2006; 220: 272–6.
27. Chan TCY, Liu D, Yu M, Jhanji V. Longitudinal evaluation of posterior corneal elevation after laser refractive surgery using swept-source optical coherence tomography. Ophthalmology 2015; 122: 687–92.
28. Reinstein DZ, Archer TJ, Gobbe M, Silverman RH, Coleman DJ. Epithelial thickness after hyperopic LASIK: three-dimensional display with Artemis very high-frequency digital ultrasound. J Refract Surg 2009; 26: 555–64.
29. Kermani O, Schmeidt K, Oberheide U, Gerten G. Hyperopic laser in situ keratomileusis with 5.5-, 6.5-, and 7.0-mm optical zones. J Refract Surg 2005; 21: 52–8.
30. Kato T, Nakayasu K, Hosoda Y, Watanabe Y, Kanai A. Corneal wound healing following laser in situ keratomileusis (LASIK): a histopathological study in rabbits. Br J Ophthalmol 1999; 83: 1302–5.
31. de Ortueta D, Arba Mosquera S. Topographic stability after hyperopic LASIK. J Refract Surg 2010; 26: 547–54.
32. Li T, Zhou X, Chen Z, Zhou X. Corneal thickness profile changes after femtosecond LASIK for hyperopia. Eye Contact Lens 2017; 43: 297–301.
33. Baldwin HC, Marshall J. Growth factors in corneal wound healing following refractive surgery: a re. Acta Ophthalmol Scand 2002; 80: 238–47.
34. Qazi MA, Roberts CJ, Mahmoud AM, Pepose JS. Topographic and biomechanical differences between hyperopic and myopic laser in situ keratomileusis. J Cataract Refract Surg 2005; 31: 48–60.
35. Zhou X, Li T, Chen Z, Niu L, Zhou X, Zhou Z. No change in anterior chamber dimensions after femtosecond LASIK for hyperopia. Eye Contact Lens 2015; 41: 160–3.

36. Kanellopoulos AJ, Kahn J. Topography-guided hyperopic LASIK with and without high irradiance collagen cross-linking: initial comparative clinical findings in a contralateral eye study of 34 consecutive patients. J Refract Surg 2012; 28: S837–40.
37. Alió JL, Muftuoglu O, Ortiz D et al. Ten-year follow-up of laser in situ keratomileusis for myopia of up to −10 diopters. Am J Ophthalmol 2008; 145: 46–54.
38. Sekundo W, Bönicke K, Mattausch P, Wiegand W. Six-year follow-up of laser in situ keratomileusis for moderate and extreme myopia using a first-generation excimer laser and microkeratome. J Cataract Refract Surg 2003; 29: 1152–8.
39. Jaycock PD, O'Brart DPS, Rajan MS, Marshall J. 5-year follow-up of LASIK for hyperopia. Ophthalmology 2005; 112: 191–9.