

Comparison of Q-value-guided laser-assisted in situ keratomileusis and standard laser in situ keratomileusis for myopia

A meta-analysis

Kai-Ping Zhang, MD, Xiang Fang, MD, Yin Zhang, MD, Min Chao, MD*

Abstract

Background: Previous studies examining the safety and efficacy of *Q*-value-guided laser-assisted in situ keratomileusis (LASIK) for treating myopia have yielded inconsistent results. We, therefore, performed a meta-analysis to clarify this issue

Methods: Various databases were conducted up to November 21, 2018. All randomized controlled trials and cohorts that compared *Q*-value-guided LASIK with standard LASIK were selected. Mean differences (MDs) or odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to evaluate the strength of the correlations. Additionally, different subgroup analyses and publication bias tests were performed. Data were extracted including the number of postoperative uncorrected visual acuity (UCVA) of 20/20 or better, postoperative UCVA, preoperative and postoperative *Q*-value, postoperative refractive spherical equivalent (SE), the number of postoperative SE within ±0.5D, higher order aberration (HOA), coma-like aberration and spherical-like aberration.

Results: A total of seventeen studies with 2640 patients and 3,358 eyes were included. It has been shown that postoperative Q-value (MD=-0.42; 95% CI: -0.64, -0.21; P < .001), HOA (MD=-0.14; 95% CI: -0.23, -0.06; P=.001), spherical-like aberration (MD=-0.19; 95% CI: -0.32, -0.06; P=.004) rather than postoperative UCVA (MD=0.04; 95% CI: 0.01, 0.07; P=.012) were significantly better in the Q-value-guided LASIK than standard LASIK. However, the pooled results revealed that no significant differences were found between the 2 paired groups of postoperative UCVA of 20/20 or better (OR=1.09; 95% CI: 0.62, 1.92; P=.763), preoperative Q-value (MD=-0.00; 95% CI: -0.02, 0.02; P=.922), postoperative SE (MD=0.08; 95% CI: -0.09, 0.25; P=.336), coma-like aberration (horizontal: MD=-0.00; 95% CI: -0.03, 0.03; P=.966; vertical: MD=-0.01; 95% CI: -0.03, 0.01; P=.263) and postoperative SE within ±0.5 D (OR=1.06; 95% CI: 0.48, 2.33; P=.886). Likewise, similar results were detected in some corresponding subgroups.

Conclusion: *Q*-value-guided LASIK is a safe, effective and predictable surgical option for treating myopia, especially showing superiority over standard LASIK in postoperative *Q*-value, HOA and spherical-like aberration. However, more detailed studies are required to confirm our conclusions in advanced researches.

Abbreviations: CI = confidence interval, HOA = higher order aberration, I² = extent of inconsistency, LASIK = laser in situ keratomileusis, MD = mean difference, NOS = Newcastle-Ottawa Scale, OR = odds ratio, RCT = randomized controlled trials, SE = spherical equivalent, UCVA = uncorrected visual acuity.

Keywords: laser in situ keratomileusis, myopia, Q-value, meta-analysis

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The authors have no conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are publicly available.

Department of Urology, Anhui Provincial Children's Hospital and Children's Hospital of Anhui Medical University, Hefei, Anhui, P. R. China.

* Correspondence: Min Chao, Department of Urology, Anhui Provincial Children's Hospital and Children's Hospital of Anhui Medical University, Hefei, Anhui, P. R. China (e-mail: cm0654@sina.com).

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1. Introduction

Myopia is a common eye disease which increasingly recognized as a significant cause of visual impairment and blindness globally. Recent evidences from epidemiological studies suggested a increasing prevalence of myopia, causing a profound economic cost to the society.^[11] It has been reported that its prevalence among children and teenagers was as high as 50% in Taiwan,^[2] 67.3% in Chinese mainland,^[3] 70% in Singapore,^[4] and even 96.5% in Korea.^[5] It seriously affects the quality of vision of children and teenagers. Thus, there is an urgent need to develop effective treatment strategies for myopia.

Myopia is an ocular disease characterized by an abnormally elongated eyeball, which cannot be rescued by optical lenses or refractive surgeries. To date, laser in situ keratomileusis (LASIK) has been the standard refractive surgery for treating myopia owing to its safety and efficacy.^[6] However, conventional LASIK has the potential increase in corneal higher order aberrations (HOA) caused by an oblate central corneal surface, which may

cause postoperative halos, glare, and night vision difficulties. With the development of surgical instruments, the technique has gradually evolved accordingly. A better refractive outcome for improving vision quality has gradually being explored in clinical research. Recently, Q-value-guided LASIK is regarded as a relatively novel surgical option. It provides wavefront-guided corneal aspheric ablation to maintain preoperative and postoperative corneal shape, as evaluated by the Q-value. This device may be a promising tool to provide benefits in vision quality. Compared with conventional LASIK procedure, Q-value-guided LASIK also allows the surgeon to reduce the amount of tissue removal by approximately 30%.^[7,8] However, there were conflicting reports about the postoperative visual recovery and corneal stability of Q-value-guided LASIK. Meta-analysis can get a relatively precise and accurate estimation through incorporating all available data using statistical tool. Thus, the metaanalysis was to explore the safety and efficacy of Q-value-guided LASIK for treating myopia.

2. Materials and methods

2.1. Ethics statement

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines was used to perform the current metaanalysis.^[9] No patient's privacy or clinical sample was involved in this study, hence the ethical approval was not required.

2.2. Identification and eligibility of relevant studies

Literature resources including PubMed, Cochrane Library, Embase, China Biology Medicine disc and China National Knowledge Infrastructure were searched for eligible literatures. The search terms were composed of myopia (eg, myopia, shortsight and nearsighted), LASIK (eg, LASIK and Keratomileusis, Laser In Situ). Last search of current investigation was updated on November 21, 2018. The language was limited to English and Chinese. We identified other relevant articles according to scan all retrieved articles and reviews. We treated them independently if the different groups were found in a reported article.

2.3. Inclusion and exclusion criteria

Studies followed the 2 criteria could be identified:

(1) all randomized controlled trials (RCTs) and cohorts;

(2) The studies provided available data;

As per the exclusion criteria:

- (1) the available data was absent;
- (2) similar or duplicate study (When the same or similar cohort was applied, the most complete information was included);
- (3) other types of articles including reviews or abstracts.

2.4. Data extraction

In the light of inclusion and exclusion criteria, we extracted the relevant information from each eligible publication. If disagreements were noticed, we are clearly open to discussion by each other (Zhang Kaiping and Fang Xiang), or reviewed by a third author (Chao Min). The information on first author, publication year, study country, follow-up, laser Instrument, the number of patients and eyes, age, preoperative spherical equivalent (SE) and

study design was collected by 2 authors independently. We did not contact any authors of the original researches even though the essential information could not be available. Besides, country was divided into China and others. Number of eyes enrolled included ≥ 100 and < 100. Study design was stratified into 2 groups: RCT and cohort. The Newcastle-Ottawa Scale consisted of selection, comparability of the groups and ascertainment of exposure was introduced to evaluate the included publication's quality. The Newcastle-Ottawa Scale scores were 0 to 10 stars. If 1 included study obtained no less than 7 stars, it could be regarded as highquality.^[10]

2.5. Outcome measures

The outcome measures included the number of postoperative uncorrected visual acuity (UCVA) of 20/20 or better, postoperative UCVA, preoperative and postoperative *Q*-value, postoperative refractive SE, the number of postoperative SE within ± 0.5 D, HOA, coma-like aberration and spherical-like aberration.

2.6. Statistical analysis

RevMan software (version 5.3; Cochrane Collaboration, Oxford, United Kingdom) and STATA (version 12.0; Stata Corporation, College Station, Texas) were introduced to analyze the data in current meta-analysis. Odds ratio (ORs) with 95% confidence interval (CIs) were calculated for the dichotomous outcomes. For the continuous measures, mean difference (MDs) with 95% CIs were used, and a P < .05 was considered to be statistically significant difference. The heterogeneity has been assessed via chi-square-based Q and extent of inconsistency (I^2) test across studies (no heterogeneity $I^2 < 25\%$, moderate heterogeneity $I^2 = 25\%$ -50%, extreme heterogeneity $I^2 > 50\%$).^[11] In case of extreme heterogeneity ($I^2 > 50\%$ or P < .01 for Q test), we used random-effects (DerSimonian and Laird method) model.^[12] Otherwise, fixed-effects (Mantel-Haenszel method) model was introduced.^[13]

Subgroup analyses were performed on study design (RCTs versus cohorts), country (China versus Others) and number of eyes enrolled (\geq 100 versus < 100). Additionally, 1-way sensitivity analyses individually removed publications in meta-analysis were conducted to assess results' stability. Publication bias was estimated using Begg and Egger tests.^[14]

3. Results

3.1. Characteristics of Eligible Studies

A total of 17 studies with 2640 patients and 3358 eyes satisfied the eligible studies.^[15–31] Among them, Villa C et al study investigated 2 different case-control studies and we separated them independently into meta-analysis.^[20] Therefore, the current meta-analysis was established based on 18 studies (Fig. 1). Of these studies, 6 RCTs and twelve cohorts were included. The number of eyes ranged from 48 to 755. The main characteristics of the included studies were shown in Table 1.

3.2. Meta-analysis results

3.2.1. Postoperative UCVA of 20/20 or Better. Eight studies reported the postoperative UCVA of 20/20 or better of Q-value-guided LASIK and standard LASIK for myopia. No heterogeneity was found ($I^2 = 0.0\%$), so fixed effects model was used to



calculate the combined OR and 95% CI. As a result, the pooled result revealed that no significant difference was detected between the 2 paired groups (OR=1.09; 95% CI: 0.62, 1.92; P=.763) (Fig. 2)

3.2.2. Postoperative UCVA. Seven studies compared the postoperative UCVA between Q-value-guided LASIK and standard LASIK for myopia. Apparent heterogeneity was found ($I^2 = 76.9\%$), so random effects model was applied to calculate MD (95% CI). A statistically significant difference was found in postoperative UCVA (MD=0.04; 95% CI: 0.01, 0.07; P=.012) (Fig. 3).

3.2.3. Preoperative and postoperative Q-value. There are eleven studies to detect the preoperative and postoperative Q-value between 2 paired groups. An evident heterogeneity was detected among the study results ($I^2 = 68\%$ and 98.4%), so random effects model was applied to calculate the combined MD and 95% CI. No significant differences were found in preoperative Q-value (MD=-0.00; 95% CI: -0.02, 0.02; P = .922) (Fig. 4A). However, there was a statistically significant difference in postoperative Q values between 2 paired groups (MD=-0.42; 95% CI: -0.64, -0.21; P < .001) (Fig. 4B).

3.2.4. Postoperative refractive SE. Only 6 studies explored postoperative refractive SE of Q-value-guided LASIK and standard LASIK. Apparent heterogeneity was found ($I^2 = 95.4\%$), so random effects model was applied to calculate the

combined MD and 95% CI. There was no significant difference between 2 paired groups (MD=0.08; 95% CI: -0.09, 0.25; P=.336) (Fig. 5).

3.2.5. Postoperative SE within ± 0.5 D of Target Refraction. Only 3 studies were involved to explore the number of postoperative SE within ± 0.5 D. No heterogeneity was found ($I^2=0.0\%$), so fixed effects model was used to calculate the combined OR and 95% CI. The forest plot showed that no significant differences was found in postoperative SE within ± 0.5 D (OR=1.06; 95% CI: 0.48, 2.33; P=.886) (Fig. 6).

3.2.6. Postoperative aberration. Postoperative aberration included HOA, coma-like aberration and spherical-like aberration. Among them, coma-like aberration contained horizontal and vertical coma-like aberration. Ten and twelve studies explored HOA and spherical-like aberration, respectively. Apparent heterogeneity was found (I^2 =98.5% and 99.2%), so random effects model was applied to calculate the combined MD and 95% CI. Compared to the standard LASIK group, HOA (MD=-0.14; 95% CI: -0.23, -0.06; P=.001) (Fig. 7A) and spherical aberrations (MD=-0.19; 95% CI: -0.32, -0.06; P=.004) (Fig. 7B) increased more in the Q-value-guided LASIK group, and there were statistically differences. Additionally, there were 5 and 6 studies involved in horizontal and vertical coma-like aberration, respectively. No heterogeneity was found (I^2 =0.0%

Table 1 Characteristic	s of st	udias inc	Inded in the	, meta-analysis								
					Q-adjusted LASIK			Standard LASIK				
Authors	Year	Country	Follow-up (mo)	Laser Instrument	Eyes/Patients(n)	Age (yrs)	Preoperative SE (D)	Eyes/ Patients (n)	Age (yrs)	Preoperative SE (D)	Design	SON
Li et al ⁽¹⁵⁾	2012	China	e	Allegretto Wave Eye-Q 400 Hz (Wavelight AG, Germany)	32/32	21±2.50	DS: -4.38±-0.58 DC: -0.82	16/16	23±3.1	DS: -3.39±-0.82 DC: -0.61±-0.46	Cohort	9
Zheng et al ⁽¹⁶⁾	2011	China	>0	Technolas 217-z100 excimer	132/66	18-43	±-0.25	100/50	18–39	2	Cohort	7
Zhou et al ^[17]	2010	China		Allegretto Wave Eye-Q 400 Hz	27/27	22.6 (18–35)	-4.56 ± 1.69	27/27	22.6 (18–35)	-4.38 ± 1.80	RCT	2
Xin et al ^[18]	2010	China	36	Technolas 217-z100 excimer	367/189	NA	NA	194/100	NA	NA	RCT	9
Igarashi et al ^{r19}	2009	Japan	ç	laser (bausciri ariu curiu) Technolas 217-z100 excimer Isser (Bausch and Lomh)	28/15	36.4 ± 5.8	-5.13 ± 1.23	33/18	32.9±8.3	-5.63 ± 0.88	Cohort	9
Villa et al ^[20]	2009	Spain	С	Allegretto Wave Eye-Q 400 Hz	48/24 ^a 40/40 ^b	32.3 ^a 31.3 ^b	-3.4 ^a -4 ^b	76/38 ^a 40/40 ^b	35.2 ^a 31.3 ^b	-3.7 ^a -4 ^b	Cohort	ω
Liu et al ^[21] Mai at al ^[22]	2008 2008	China	-12	(wavengur Au, ucunauy) Astrascan XL 200 Hz (LaserSigh) MA	106/53 276/130	27.9±4.86 20.40±3.31	-6.57 ± 1.81	102/51 /79/2/1	25.4±5.85 22 70±4 42	-5.99 ± 2.53	RCT	~ ~
Ma et al ^[23]	2008	China	- ^	Allegretto Wave Eye-Q 400 Hz	86/43	NA	NA	86/43	AN	NA	Cohort	~ ∞
Zou et al ^[24]	2008	China	ო	Technolas 217-z100 excimer laser (Bausch and Lomb)	152/80	26.56±4.97	DS: -5.79±-2.18 DC: -0.79	181/100	25.4±5.17	DS: -5.21 ± -1.41 DC: -0.60 \pm -0.49	RCT	∞
Xu et al ^[25]	2008	China	e	Allegretto Wave Eye-Q 400 Hz	46/23	25.5 ± 6.02	± -0.41 -5.48 ± 2.38	44/22	24.7 ± 5.86	-5.62 ± 2.63	Cohort	7
Zhou et al ^[26] Cai et al ^[27]	2008 2008	China China	- 0	(warengun Ao, dennary) Mel 80 (Carl Zeis, Germany) Astrascan XL 200 Hz (LaserSigh)	38/38 64/32	27.1 ± 4.8 24.3 ± 7.2	-3.46±1.62 DS: -3.24±1.21 DC: -0.46±	41/41 64/32	26.4±6.1 25.1±6.7	-3.59±1.68 DS: -3.13±1.09 DC: -0.58±0.31	Cohort RCT	9 9
Huang et al ⁽²⁸⁾	2008	China	ę	Technolas 217-z100 excimer	43/43	23 土 4	0.29 -4.83±1.28	41/41	25 土 4	-5.01 ± 1.65	RCT	2
Chen et al ^[29] Liu et al ^[30]	2007 2007	China China	- 1 6	Astrascan XL 200 Hz (LaserSigh) Technolas 217-z100 excimer laser (Bausch and Lomb)	66/33 51/28	24.61±5.92 24.65±0.91	-5.18±1.62 DS: -6.71±0.91 DC: -0.68±	59/30 51/26	24.2±6.46 23.87±1.05	-5.26±1.65 DS: -6.62±0.21 DC: -0.64±0.07	Cohort Cohort	$\infty \infty$
Shen et al ^[31]	2005	China	9	Allegretto Wave Eye-Q 400 Hz (Wavelight AG, Germany)	64/32	NA	0.03 −6.22±2.22	58/29	NA	—6.19±2.17	Cohort	9

Medicine

D = diopter. DC = diopter of cylindrical power, DS = diopter of spherical power, LASIK = Laser *in situ* keratomileusis, NA = Not available, NOS = Newcastle-Ottawa Scale, RCT = Randomized controlled trial, SE = Spherical equivalent.

4



Figure 2. Forest plot of postoperative UCVA of 20/20 or better between Q-value-guided LASIK and standard LASIK for myopia. LASIK=Laser in situ keratomileusis, UCVA=uncorrected visual acuity.

and 0.0%). Consequently, no significant differences were found in coma-like aberration between 2 paired groups (horizontal: MD=-0.00; 95% CI: -0.03, 0.03; P=.966; vertical: MD=-0.01; 95% CI: -0.03, 0.01; P=.263) (Fig. 7C-7D).

3.2.7. Subgroup-analysis results. Subgroup analyses were performed according to the study design (RCTs versus cohorts), country (China versus Others) and number of eyes enrolled $(\geq 100 \text{ versus} < 100)$. As shown in Table 2, significant statistically difference were found in sub-analyses regarding postoperative Qvalue (RCTs: MD = -0.48; 95% CI: -0.77, -0.18; P = .002; cohort: MD=-0.41; 95% CI: -0.68, -0.14; P=.003), HOA (RCTs: MD = -0.10; 95% CI: -0.17, -0.03; P = .006; cohort: MD = -.16; 95% CI: -0.26, -0.05; P=.004) and spherical-like aberration (cohort: MD=-0.16; 95% CI: -0.25, -0.07; P=.001). As for subgroup of country, similar results were found in postoperative Q-value (country: MD=-0.30; 95% CI: -0.51, -0.10; P=.003; other: MD=-0.75; 95% CI: -1.12, -0.38; P=.000), HOA (country: MD=-0.10; 95% CI: -0.14, -0.05; P=.000; other: MD = -0.22; 95% CI: -0.37, -0.07; P = .004) and spherical-like aberration (other: MD=-0.22; 95% CI: -0.43, -0.01; P=.039) (Table 3). Likewise, we also detected similar results via subgroup analysis on study eye sizes. Postoperative UCVA (≧100: MD= 0.05; 95% CI: 0.01, 0.08; P=.006), postoperative Q-value $(\geq 100; MD = -0.46; 95\% CI: -0.73, -0.18; P = .001), HOA$ (<100: MD = -0.12; 95% CI: -0.20, -0.05; P = .001) and spherical-like aberration (≥ 100 : MD=-0.36; 95% CI: -0.64, -0.08; P = .011) in Q-value-guided LASIK group exhibited statistically significant differences compared to control (Table 4).

3.3. Sensitivity analysis and publication bias

Each study here was deleted at a time to assess the specific effect of the individual data on the pooled results, and one-way sensitivity analysis suggested the results were relatively stable. The Begg test (P=.06 to 1.000) and Egger test (P=.021 to .735) were applied to all of the outcome measures. No publication bias was found in all outcome measures rather than postoperative refractive SE (Egger: P=.021).

4. Discussion

Q-value-guided LASIK is new technology now approved for clinical use. However, there were controversial reports about its postoperative visual recovery and corneal stability. Metaanalysis could get a relatively precise estimation from different inconsistent studies. We tried to explore its safety and efficacy in current research. As a result, Q-value-guided LASIK is a safe, effective and predictable surgical options for treating myopia. Meanwhile, Q-value-guided LASIK shows obvious superiority in postoperative Q-value, HOA and spherical-like aberration. It could provide benefits for improvement of vision quality, and have a relatively smaller increase in the differential postoperative Q-value after surgery. Generally, the outer surface of the human



Figure 3. Forest plot of postoperative UCVA between Q-value-guided LASIK and standard LASIK for myopia. LASIK=Laser in situ keratomileusis, UCVA= uncorrected visual acuity.

	Q-adju	isted LA	SIK	Stand	ard LA	SK		Mean Difference	Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Tota	Weight	N. Random, 95% Cl	IV, Random, 95% Cl
Chen SH 2007	-0.172	0.121	66	-0.162	0.118	59	9.7%	-0.01 [-0.05, 0.03]	
Huang GF 2008	-0.17	0.08	43	-0.16	0.1	41	10.4%	-0.01 [-0.05, 0.03]	
Igarashi A 2009	-0.13	0.09	28	-0.16	0.11	33	8.1%	0.03 [-0.02, 0.08]	
LIJ 2012	-0.18	0.17	32	-0.18	0.16	16	3.2%	0.00 F0.10, 0.10	
LUB 2008	-0.14	0.15	106	-0.16	0.14	102	10.3%	0.02 [-0.02, 0.06]	
LUL 2007	-0.12	0.01	51	-0.13	0.02	51	17.5%	0.01 [0.00, 0.02]	+
Shen ZW 2005	-0.33	0.11	64	-0.25	0.09	58	11.1%	-0.08 [-0.12, -0.04]	
Vila C-1 2009	-0.23	0.18	48	-0.29	0.21	76	5.4%	0.06 [-0.01, 0.13]	
Villa C-2 2009	-0.34	0.23	40	-0.38	0.24	40	2.9%	0.04 [-0.08, 0.14]	
Xin BL 2010	-0.17	0.12	367	-0.16	0.14	194	14.2%	-0.01 [-0.03, 0.01]	
Xu K 2008	-0.27	0.12	46	-0.28	0.15	44	7.1%	0.01 (-0.05, 0.07)	
Total (95% CI)			891			714	100.0%	-0.00 [-0.02, 0.02]	•
Heteropeneity: Tau? =	0.00 CH	= 31.25	df= 10	P=0	0005): F	= 69%			
Test for overal effect:	Z = 0.10 (P = 0.92)						-0.1 -0.05 0 0.05 0.1 Favours (Q-adjusted) Favours (Standard)
A									
	0 atia	Instad1 A	SBC	Stan	Athel	SIK		Maan Difference	Maan Difference
Study or Subaroup	Q-adj Mean	usted LA SD	SIK	Stans	lard LA	SIK	Mainht	Mean Difference IV. Random, 95% Cl	Mean Difference
Study or Subgroup	Q-adju Mean	SD 0.221	SIK Total	Stans Mean	SD	SIK Total	Weight	Mean Difference IV. Random, 95% Cl -0.30 L0 38 -0.221	Mean Difference IV, Random, 95% Cl
Study or Subgroup Chan SH 2007 Huang GE 2008	0-adj Mean 0.107	0.231	SIK Total 66	Stane Mean 0.41 0.82	ard LA SD 0.214	SIK Total 59 41	Weight 9.3% 9.0%	Mean Difference IV. Random, 95% Cl -0.30 [-0.38, -0.22] -0.32 [-0.47, -0.17]	Mean Difference IV, Random, 95% Cl
Study or Subgroup Chen SH 2007 Huang GF 2008 Ingrachi & 2009	0-adj Mean 0.107 0.5	0.231 0.28 0.44	SIK Total 66 43 28	Stans Mean 0.41 0.82 0.74	lard LA SD 0.214 0.4 0.3	SIK Total 59 41 33	Weight 9.3% 9.0% 8.7%	Mean Difference IV. Random, 95% CI -0.30 [-0.38, -0.22] -0.32 [-0.47, -0.17] -0.24 [-0.43, -0.05]	Mean Difference IV, Random, 95% Cl
Study or Subgroup Chan SH 2007 Huang GF 2008 Igarashi A 2009 LLL 2012	0-adj Mean 0.107 0.5 0.5 0.18	0.231 0.28 0.44 0.38	58K Total 66 43 28 32	Stane Mean 0.41 0.82 0.74 0.41	lard LA SD 0.214 0.4 0.3 0.34	SIK Total 59 41 33 18	Weight 9.3% 9.0% 8.7% 8.6%	Mean Difference IV, Random, 95% CI -0.30 [-0.38, -0.22] -0.32 [-0.47, -0.17] -0.24 [-0.43, -0.05] -0.23 [-0.44, -0.02]	Mean Difference IV, Random, 95% Cl
Study or Subgroup Chan SH 2007 Huang GF 2008 Igarashi A 2009 Li J 2012 Li J 2008	0-adj Mean 0.107 0.5 0.5 0.18 0.2	0.231 0.23 0.44 0.38 0.4	SIK Total 66 43 28 32	Stane Mean 0.41 0.82 0.74 0.41 0.53	lard LA SD 0.214 0.4 0.3 0.34 0.45	SIK Total 59 41 33 16 102	Weight 9.3% 9.0% 8.7% 8.6% 9.1%	Mean Difference IV, Random, 95% CI -0.30 [-0.38, -0.22] -0.32 [-0.47, -0.17] -0.24 [-0.43, -0.05] -0.23 [-0.44, -0.02] -0.28 [-0.48, -0.24]	Mean Difference IV, Random, 95% Cl
Study or Subgroup Chan SH 2007 Huang GF 2008 Igarashi A 2009 Li J 2012 Liu B 2008 Li Li L 2007	0-adj Mean 0.107 0.5 0.5 0.18 0.2 1.3	0.231 0.23 0.44 0.38 0.4 0.1	SIK Total 66 43 28 32 106 51	Stane Mean 0.41 0.82 0.74 0.41 0.56 1.38	lard LA SD 0.214 0.4 0.3 0.34 0.45 0.14	SIK Total 59 41 33 16 102 51	Weight 9.3% 9.0% 8.7% 8.6% 9.1% 9.3%	Mean Difference IV. Random, 95% CI -0.30 [-0.38, -0.22] -0.32 [-0.47, -0.17] -0.24 [-0.43, -0.05] -0.23 [-0.44, -0.02] -0.36 [-0.48, -0.24] -0.08 [-0.13, -0.03]	Mean Difference IV, Random, 95% Cl
Study or Subgroup Chan SH 2007 Huang GF 2008 Igarashi A 2009 Li J 2012 Liu B 2008 Liu L 2007 Ma YN 2008	0-adj Mean 0.107 0.5 0.5 0.18 0.2 1.3 0.113	0.231 0.23 0.44 0.38 0.4 0.1 0.287	SIK Total 66 43 28 32 106 51 86	Stane Mean 0.41 0.82 0.74 0.41 0.56 1.38 0.48	ard LA SD 0.214 0.4 0.3 0.34 0.45 0.14 0.269	SIK Total 59 41 33 16 102 51 88	Weight 9.3% 9.0% 8.7% 8.6% 9.1% 9.3% 9.2%	Mean Difference IV. Random, 95% CI -0.30 [-0.38, -0.22] -0.32 [-0.47, -0.17] -0.24 [-0.43, -0.05] -0.23 [-0.44, -0.02] -0.36 [-0.48, -0.24] -0.08 [-0.13, -0.03] -0.37 [-0.45, -0.28]	Mean Difference IV, Random, 95% Cl
Study or Subgroup Chan SH 2007 Huang GF 2008 Igarashi A 2009 Li J 2012 Li J B 2008 Li L 2007 Ma YN 2008 Vila C1 2008	0-adj Mean 0.107 0.5 0.5 0.5 0.18 0.2 1.3 0.113 -0.26	0.231 0.23 0.44 0.38 0.4 0.1 0.287 0.19	SIK Total 66 43 28 32 106 51 86 48	Stane Mean 0.41 0.82 0.74 0.41 0.56 1.38 0.48 0.48	lard LA SD 0.214 0.4 0.3 0.34 0.46 0.14 0.269 0.31	SIK Total 59 41 33 18 102 51 88 78	Weight 9.3% 9.0% 8.7% 8.6% 9.1% 9.3% 9.2% 9.2%	Mean Difference IV, Random, 95% CI -0.30 [-0.38, -0.22] -0.32 [-0.47, -0.17] -0.24 [-0.43, -0.05] -0.23 [-0.44, -0.02] -0.36 [-0.48, -0.24] -0.08 [-0.13, -0.03] -0.37 [-0.45, -0.28] -0.91 [+ 1.00, -0.82]	Mean Difference IV, Random, 95% Cl
Study or Subgroup Chan SH 2007 Huang GF 2008 Igarashi A 2009 Li J 2012 Li B 2008 Li L 2007 Ma YN 2008 Vila C-1 2009 Vila C-2 2009	0.adjj <u>Mean</u> 0.107 0.5 0.18 0.2 1.3 0.113 -0.26 -0.37	usted LA <u>SD</u> 0.231 0.23 0.44 0.38 0.4 0.1 0.287 0.19 0.21	SIK Total 66 43 28 32 106 51 86 48 48	Stans Mean 0.41 0.82 0.74 0.41 0.56 1.38 0.48 0.48 0.65 0.71	lard LA SD 0.214 0.4 0.3 0.34 0.45 0.14 0.269 0.31 0.28	SIK Tetal 59 41 33 16 102 51 86 78 40	Weight 9.3% 9.0% 8.7% 8.6% 9.1% 9.3% 9.2% 9.2% 9.2%	Mean Difference IV, Random, 95% CI -0.30 [-0.38, -0.22] -0.32 [-0.47, -0.17] -0.24 [-0.43, -0.05] -0.23 [-0.44, -0.02] -0.36 [-0.48, -0.24] -0.08 [-0.13, -0.03] -0.37 [-0.45, -0.28] -0.91 [-1.00, -0.82] -1.08 [-1.19, -0.97]	Mean Difference IV, Random, 95% Cl
Study or Subgroup Chan SH 2007 Huang GF 2008 Igarashi A 2009 LJ 2012 LJ B 2008 LJ L 2007 Ma YN 2008 Vila C-1 2009 Vila C-2 2009 Vila C-2 2009 Xin BL 2010	0-adj <u>Mean</u> 0.107 0.5 0.5 0.18 0.2 1.3 0.113 -0.26 -0.37 0.14	sted LA SD 0.231 0.23 0.44 0.38 0.4 0.1 0.287 0.19 0.21 0.287 0.19	SIK Total 66 43 28 32 106 51 86 48 40 367	Stans Mean 0.41 0.82 0.74 0.41 0.56 1.38 0.43 0.48 0.65 0.71 0.87	ard LA SD 0.214 0.4 0.3 0.34 0.45 0.14 0.269 0.31 0.29 0.4	SIK Total 59 41 33 18 102 51 88 78 40 194	Weight 9.3% 9.0% 8.7% 9.1% 9.3% 9.2% 9.1% 9.3%	Mean Difference IV, Random, 95% CI -0.30 [-0.38, -0.22] -0.32 [-0.47, -0.17] -0.24 [-0.43, -0.05] -0.23 [-0.44, -0.02] -0.36 [-0.48, -0.24] -0.08 [-0.13, -0.03] -0.37 [-0.45, -0.28] -0.91 [-1.00, -0.82] -1.08 [-1.19, -0.97] -0.73 [-0.79, -0.67]	Mean Difference IV. Random, 95% Cl
Study or Subgroup Chan SH 2007 Huang GF 2008 Igarashi A 2009 Li J 2012 Liu B 2008 Liu L 2007 Ma YN 2008 Vila C-1 2008 Vila C-2 2009 Xin BL 2010 Xu K 2008	0-adj <u>Mean</u> 0.107 0.5 0.5 0.18 0.2 1.3 0.113 -0.26 -0.37 0.14 0.23	0.231 0.231 0.28 0.44 0.38 0.4 0.1 0.287 0.19 0.21 0.08 0.27	SIK Total 66 43 28 32 106 51 86 48 40 387 46	Stans Mean 0.41 0.82 0.74 0.41 0.56 1.38 0.43 0.65 0.71 0.87 0.26	ard LA SD 0.214 0.4 0.3 0.34 0.45 0.14 0.269 0.31 0.29 0.4 0.27	SIK Tetal 59 41 33 16 102 51 88 78 40 194 44	Weight 9,3% 9,0% 8,7% 8,6% 9,1% 9,2% 9,2% 9,2% 9,1% 9,3% 9,1%	Mean Difference IV. Random, 95% CI -0.30 [-0.38, -0.22] -0.32 [-0.47, -0.17] -0.24 [-0.43, -0.05] -0.23 [-0.44, -0.02] -0.36 [-0.48, -0.24] -0.08 [-0.13, -0.03] -0.37 [-0.45, -0.28] -0.91 [-1.00, -0.82] -1.08 [-1.19, -0.97] -0.73 [-0.79, -0.67] -0.03 [-0.14, -0.08]	Mean Difference IV, Random, 95% Cl
Study or Subgroup Chan SH 2007 Huang GF 2008 Igarashi A 2009 Li J 2012 Liu B 2008 Liu L 2007 Ma YN 2008 Villa C-1 2009 Villa C-2 2009 Xin BL 2010 Xu K 2008 Total (95% CI)	0-adj Mean 0.107 0.5 0.5 0.18 0.2 1.3 0.18 0.2 1.3 0.113 -0.26 -0.37 0.14 0.23	0.231 0.23 0.44 0.38 0.4 0.1 0.287 0.19 0.21 0.08 0.27	SIK Total 66 43 28 32 106 51 86 48 40 387 46 913	Stane Mean 0.41 0.82 0.74 0.41 0.56 1.38 0.48 0.65 0.71 0.87 0.25	ard LA SD 0.214 0.4 0.3 0.34 0.46 0.14 0.269 0.31 0.29 0.4 0.27	SIK Tetal 59 41 33 16 102 51 86 78 40 194 44 742	Weight 9,3% 9,0% 8,7% 8,6% 9,1% 9,3% 9,2% 9,2% 9,2% 9,1% 9,3% 9,1%	Mean Difference IV, Random, 95% CI -0.30 [-0.38, -0.22] -0.32 [-0.47, -0.17] -0.24 [-0.43, -0.05] -0.23 [-0.44, -0.02] -0.36 [-0.48, -0.24] -0.08 [-0.13, -0.03] -0.37 [-0.45, -0.28] -0.91 [-1.00, -0.82] -1.08 [-1.19, -0.97] -0.73 [-0.79, -0.67] -0.03 [-0.14, -0.08] -0.42 [-0.64, -0.21]	Mean Difference IV. Random, 95% Cl
Study or Subgroup Chan SH 2007 Huang GF 2008 Igarashi A 2009 Li J 2012 Li B 2008 Li L 2007 Ma YN 2008 Vila C-1 2009 Vila C-2 2009 Xin BL 2010 Xu K 2008 Total (95% CI) Heteropenelly: Tou ^a =	0-adj <u>Mean</u> 0.107 0.5 0.5 0.18 0.2 1.3 0.113 -0.26 -0.37 0.14 0.23 0.13 Chi	sted LA <u>SD</u> 0.231 0.23 0.44 0.38 0.4 0.1 0.287 0.19 0.21 0.08 0.27 = 633 0	Total 66 43 28 32 106 51 86 48 40 367 46 913 40 df =	Stans Mean 0.41 0.82 0.74 0.41 0.56 1.38 0.45 0.74 0.45 0.71 0.87 0.26	and LA SD 0.214 0.4 0.3 0.34 0.46 0.34 0.269 0.31 0.269 0.4 0.27	SIK <u>Total</u> 59 41 33 16 102 51 86 76 40 194 44 742 1° = 6	Weight 9,3% 9,0% 8,7% 8,6% 9,1% 9,2% 9,2% 9,2% 9,2% 9,2% 9,3% 9,3% 9,1% 100,0%	Mean Difference IV, Random, 95% CI -0.30 [-0.38, -0.22] -0.32 [-0.47, -0.17] -0.24 [-0.43, -0.05] -0.23 [-0.44, -0.02] -0.36 [-0.48, -0.24] -0.08 [-0.13, -0.03] -0.37 [-0.45, -0.28] -0.91 [-1.09, -0.82] -1.08 [-1.19, -0.97] -0.73 [-0.79, -0.87] -0.03 [-0.14, -0.21]	Mean Difference IV. Random, 95% Cl
Study or Subgroup Chan SH 2007 Huang GF 2008 Igarashi A 2009 Li J 2012 Li B 2008 Li L 2007 Ma YN 2008 Vila C-1 2009 Vila C-2 2009 Xin BL 2010 Xu K 2008 Total (95% CI) Hoterogenelly: Tau ^a = Test for overall effect:	0.adj <u>Mean</u> 0.107 0.5 0.5 0.18 0.2 1.3 0.113 -0.26 -0.37 0.14 0.23 0.13, Chi Z = 3.89	sted LA <u>SD</u> 0.231 0.23 0.44 0.38 0.4 0.1 0.287 0.19 0.21 0.08 0.27 = 633.0 P = 0.00	SIK <u>Total</u> 66 43 28 32 106 51 86 48 40 367 46 913 46 913 46 913	Stans Mean 0.41 0.82 0.74 0.41 0.56 1.38 0.48 0.48 0.48 0.65 0.71 0.25	ard LA SD 0.214 0.4 0.3 0.34 0.46 0.34 0.269 0.31 0.269 0.4 0.27 0.20001	Silk <u>Total</u> 59 41 33 16 102 51 86 76 40 194 44 742 (), I ^a = 9	Weight 9,3% 9,0% 8,7% 8,6% 9,3% 9,2% 9,2% 9,2% 9,2% 9,3% 9,3% 9,1% 9,3% 9,1%	Mean Difference IV, Random, 95% CI -0.30 [-0.38, -0.22] -0.32 [-0.47, -0.17] -0.24 [-0.43, -0.05] -0.23 [-0.44, -0.02] -0.36 [-0.48, -0.24] -0.08 [-0.13, -0.03] -0.37 [-0.45, -0.28] -0.91 [-1.00, -0.82] -1.08 [-1.19, -0.97] -0.73 [-0.79, -0.67] -0.03 [-0.14, -0.21] -0.42 [-0.64, -0.21]	Mean Difference IV. Random, 95% Cl

Figure 4. Forest plot of preoperative and postoperative Q-value between Q-value-guided LASIK and standard LASIK for myopia. A: preoperative Q-value; B: postoperative Q-value. LASIK=Laser in situ keratomileusis.



Figure 5. Forest plot of postoperative refractive SE between Q-value-guided LASIK and standard LASIK for myopia. LASIK=Laser in situ keratomileusis, SE= spherical equivalent.



Figure 6. Forest plot of postoperative SE within ±0.5 D of target refraction between Q-value-guided LASIK and standard LASIK for myopia. LASIK=Laser in situ keratomileusis, SE=spherical equivalent.

	Q-adju	isted LA	SIK	Stand	ard LAS	SIK		Mean Difference	Mean Difference	
Study or Subgroup	Mean	SD	Tota	Mean	SD	Tota	Weight	IV. Random, 95% CI	IV. Random, 95% Cl	
Cai FR 2008	0.16	0.03	64	0.21	0.05	64	10.6%	-0.05 [-0.06, -0.04]	•	
Huang GF 2008	0.541	0.167	43	0.95	0.518	41	7.5%	-0.41 [-0.58, -0.24]		
Igarashi A 2009	0.15	0.06	28	0.18	0.19	33	9.9%	-0.03 [-0.10, 0.04]	+	
Li J 2012	0.35	0.11	32	0.49	0.08	16	10.1%	-0.14 [-0.19, -0.09]		
Villa C-1 2009	0.422	0.051	48	0.802	0.093	76	10.5%	-0.38 [-0.41, -0.35]	·	
Villa C-2 2009	0.501	0.06	40	0.741	0.062	40	10.5%	-0.24 [-0.27, -0.21]	-	
Kin BL 2010	0.74	0.13	367	0.85	0.25	194	10.4%	-0.11 [-0.15, -0.07]		
Ku K 2008	0.329	0.115	46	0.334	0.158	44	10.1%	-0.01 [-0.06, 0.05]		
Zhou J 2008	0.571	0.024	38	0.706	0.062	41	10.5%	-0.14 [-0.16, -0.11]	-	
Zhou L 2010	0.306	0.145	27	0.309	0.098	27	9.9%	-0.00 [-0.07, 0.06]		
Total (95% CI)			733			576	100.0%	-0.14 [-0.23, -0.06]	•	
Heterogeneity: Tau ² =	0.02; Ch	"= 608.	.83, df =	9 (P < 0	0.00001); P= 9	9%		de ale ale	
Test for overall effect	Z= 3.40	(P = 0.0	007)	22		1			-0.5 -0.25 0 0.25	
١		•							Favours (experimental) Favours (control	
	Q-adjusted LASIK		SIK	Stand	lard LA	SIK		Mean Difference	Mean Difference	
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	N, Random, 95% Cl	IV, Random, 95% Cl	
Cai FR 2008	01	0.08	64	0.24	012	64	8.6%	-0.14 6-0.18 -0.10	-	
Huana GE 2008	-0 265	0 156	43	-0 497	0 159	41	8 4%	0 22 10 15 0 20		
agrachi & 2000	0.06	0.02	20	0.407	0.100	22	0.44	0.0410.06 .0.03	-	
garasin A 2009	0.00	0.03	20	0.00	0.00	33	0.0%	-0.04 [-0.06, -0.02]		
JJ 2012	0.22	0.12	32	0.32	0.00	10	8.3%	-0.10 -0.15, -0.05	-	
LIU L 2007	0.76	0.07	51	0.87	0.09	51	8.6%	-0.11 [-0.14, -0.08]		
Shen 200 2005	1.9	0.75	64	2.26	0.85	58	6.1%	-0.36[-0.65, -0.07]		
/illa C-1 2009	0.286	0.071	48	0.47	0.09	76	8.6%	-0.18 [-0.21, -0.16]	-	
/illa C-2 2009	0.265	0.051	40	0.702	0.114	40	8.6%	-0.44 [-0.48, -0.40]	-	
(u K 2008	0.157	0.166	46	0.201	0.203	44	8.4%	-0.04 [-0.12, 0.03]	-1	
Zhou J 2008	0.203	0.071	38	0.302	0.059	41	8.6%	-0.10[-0.13, -0.07]	-	
Zhou L 2010	0.107	0.091	27	0.128	0.074	27	8.5%	-0.02 [-0.07, 0.02]	-	
Zou GC 2008	1.53	0.17	152	2.54	0.32	181	8.5%	-1.01 [-1.06, -0.96]	-	
Total (95% CI)			633			672	100.0%	-0.19 [-0.32, -0.06]	•	
Heterogeneity, Tau ^a =	0.05; Ch	= 1461	1.62. df	= 11 (P	< 0.000	01); P=	99%	Section Section	+ + + +	
Test for overall effect	Z= 2.85	(P = 0.00	04)						-1 -0.5 0 0.5	
3									Favours [experimental] Favours [control	
54	Q-adj	isted LA	SIK	Stan	dard LA	SIK		Mean Difference	Mean Difference	
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV. Fixed, 95% CI	IV. Fixed, 95% Cl	
Cal FR 2008	-0.043	0.15	64	-0.047	0.15	64	42.9%	0.00 [-0.05, 0.06]	_	
Huang GF 2008	-0.06	0.21	43	-0.04	0.26	41	11.3%	-0.02 -0.12, 0.081		
LI J 2012	0.01	0.27	32	0.06	0.18	16	7.0%	-0.05 [-0.18, 0.08]		
Ku K 2008	0.018	0.177	46	0.02	0.142	44	26.5%	-0.00 [-0.07, 0.06]		
Zhou L 2010	-0.023	0.187	27	-0.054	0.176	27	12.3%	0.03 [-0.07, 0.13]		
fotal (95% CI)			212			192	100.0%	-0.00 [-0.03, 0.03]	· · · ·	
Heterogeneity: Chi ² =	1.15, df=	= 4 (P = 1	0.89); P	= 0%					-0.2 -0.1 0 0.1	
Tool for autorall affast	Z = 0.04	(P = 0.9	7)						Favours (experimental) Favours (control	
rest for overall ellect.					area a constante	Contract of			. create (expensional) i arears (control	
C	-	000000						Magan Dilloronga	Hoon Difference	
)))	Q-adju	isted L/	SIK	Stan	dard LA	SIK		Mean Difference	Mean Diriel ence	
Study or Subgroup	Q-adju Mean	isted L/ SD	SIK Total	Stan Mean	dard LA SD	Total	Weight	IV, Fixed, 95% Cl	IV, Fixed, 95% Cl	
Study or Subgroup Cal FR 2008	Q-adju Mean -0.051	sted LA SD 0.12	Total 64	Stan Mean -0.046	dard LA SD 0.12	Total 64	22.4%	IV. Fixed, 95% Cl -0.00 [-0.05, 0.04]	IV. Fixed, 95% Cl	
Study or Subgroup Cai FR 2008 Huang GF 2008	Q-adju Mean -0.051 0.22	0.12 0.25	Total 64 43	Stan Mean -0.046 0.28	dard LA SD 0.12 0.37	Total 64 41	22.4%	IV. Fixed, 95% Cl -0.00 [-0.05, 0.04] -0.06 [-0.20, 0.08]	IV. Fixed, 95% Cl	
Study or Subgroup Cai FR 2008 Huang GF 2008 Igarashi A 2009	Q-adju Mean -0.051 0.22 0.13	0.12 0.25 0.06	Total 64 43 28	Stan Mean -0.046 0.28 0.14	dard LA SD 0.12 0.37 0.03	Total 64 41 33	Weight 22.4% 2.1% 64.6%	N. Fixed, 95% Cl -0.00 [-0.05, 0.04] -0.06 [-0.20, 0.08] -0.01 [-0.03, 0.01]	IV. Fixed, 95% Cl	
Study or Subgroup Cai FR 2008 Huang GF 2008 garashi A 2009 Li J 2012	Q-adju Mean -0.051 0.22 0.13 0.01	0.12 0.25 0.06 0.27	Total 64 43 28 32	Stan Mean -0.046 0.28 0.14 0.1	dard LA SD 0.12 0.37 0.03 0.21	Total 64 41 33 16	Weight 22.4% 2.1% 64.6% 2.0%	Image: Non-Section Content of Co	IV. Fixed, 95% Cl	
Study or Subgroup Cai FR 2008 Huang GF 2008 Igarashi A 2009 Li J 2012 Ku K 2008	Q-adju Mean -0.051 0.22 0.13 0.01 0.024	15ted L/ SD 0.12 0.25 0.06 0.27 0.184	Total 64 43 28 32 46	Stan Mean -0.046 0.28 0.14 0.1 0.025	dard LA SD 0.12 0.37 0.03 0.21 0.194	Total 64 41 33 16 44	22.4% 2.1% 64.6% 2.0% 6.3%	Interence IV. Fixed, 95% CI -0.00 [-0.05, 0.04] -0.06 [-0.20, 0.08] -0.01 [-0.03, 0.01] -0.09 [-0.23, 0.05] -0.00 [-0.08, 0.08]	Near Difference IV. Fixed, 95% Cl	
Study or Subgroup Cai FR 2008 Yuang GF 2008 garashi A 2009 Li J 2012 (u K 2008 Zhou L 2010	Q-adju Mean -0.051 0.22 0.13 0.01 0.024 -0.263	0.12 0.25 0.06 0.27 0.184 0.238	Total 64 43 28 32 46 27	Stan Mean -0.046 0.28 0.14 0.14 0.125 -0.243	dard LA SD 0.12 0.37 0.03 0.21 0.194 0.213	Total 64 41 33 16 44 27	Weight 22.4% 2.1% 64.6% 2.0% 6.3% 2.7%	IV. Fixed, 95% Cl -0.00 [-0.05, 0.04] -0.06 [-0.20, 0.08] -0.01 [-0.03, 0.01] -0.09 [-0.23, 0.05] -0.00 [-0.08, 0.08] -0.02 [-0.14, 0.10]		
Study or Subgroup Cai FR 2008 Huang GF 2008 Igarashi A 2009 Li J 2012 Ku K 2008 Zhou L 2010 Total (95% CI)	Q-adju Mean -0.051 0.22 0.13 0.01 0.024 -0.263	sted L/ SD 0.12 0.25 0.06 0.27 0.184 0.238	Total 64 43 28 32 46 27 240	Stan Mean -0.046 0.28 0.14 0.1 0.025 -0.243	dard LA SD 0.12 0.37 0.03 0.21 0.194 0.213	Total 64 41 33 16 44 27 225	Weight 22.4% 2.1% 64.6% 2.0% 6.3% 7 2.7% 100.0%	Image: Construction of the system IV. Fixed, 95% CI -0.00 [-0.05, 0.04] -0.06 [-0.20, 0.08] -0.01 [-0.03, 0.01] -0.09 [-0.23, 0.05] -0.00 [-0.08, 0.08] -0.02 [-0.14, 0.10] -0.01 [-0.03, 0.01]	N. Fixed, 95% Cl	
Study or Subgroup Cai FR 2008 Huang GF 2008 Igarashi A 2009 Li J 2012 Xu K 2008 Zhou L 2010 Total (95% CI) Heterogeneity: Chi ^p =	Q-adju Mean -0.051 0.22 0.13 0.01 0.024 -0.263	sted LA SD 0.12 0.25 0.06 0.27 0.184 0.238 0.238	Total 64 43 28 32 46 27 240 0.86): P	Stan <u>Mean</u> -0.046 0.28 0.14 0.1 0.025 -0.243 = 0%	dard LA SD 0.12 0.37 0.03 0.21 0.194 0.213	Total 64 41 33 16 44 27 225	Weight 22.4% 2.1% 64.6% 2.0% 6.3% 2.7% 100.0%	Interferce IV, Fixed, 95% CI -0.00 [-0.05, 0.04] -0.06 [-0.20, 0.08] -0.01 [-0.03, 0.01] -0.09 [-0.23, 0.05] -0.00 [-0.08, 0.08] -0.02 [-0.14, 0.10] -0.01 [-0.03, 0.01]	N. Fixed, 95% Cl	

Figure 7. Forest plot of different postoperative aberration between Q-value-guided LASIK and standard LASIK for myopia. A: HOA; B: spherical aberrations; C: horizontal coma-like aberration; D: vertical coma-like aberration. LASIK=Laser in situ keratomileusis.

Table 2 Subgroup analyses on study design

Study design (RCTs versus Cohorts)	Studies	Eyes	OR or MD (95%CI)	Р	l ²
Postoperative UCVA of 20/20 or better	8	1397	OR 1.09 (0.62, 1.92)	.763	0.0%
RCT	3	699	OR 0.61 (0.08, 4.70)	.633	0.0%
Cohort	5	698	OR 1.15 (0.64, 2.06)	.647	0.0%
Postoperative UCVA	7	1645	MD 0.04 (0.01, 0.07)	.012	76.9%
RCT	3	595	MD 0.03 (-0.02, 0.08)	.180	56.2%
Cohort	4	1050	MD 0.04 (-0.00, 0.09)	.070	86.0%
Preoperative Q-value	11	1605	MD -0.00 (-0.02, 0.02)	.922	68.0%
RCT	3	853	MD -0.00 (-0.02, 0.01)	.668	0.0%
Cohort	8	752	MD 0.00 (-0.03, 0.03)	.935	75.0%
Postoperative Q-value	11	1655	MD -0.42 (-0.64, -0.21)	.000	98.4%
RCT	3	853	MD -0.48 (-0.77, -0.18)	.002	96.0%
Cohort	8	802	MD -0.41 (-0.68, -0.14)	.003	98.5%
Postoperative refractive SE	6	1627	MD 0.08 (-0.09, 0.25)	.336	95.4%
RCT	3	1002	MD 0.19 (-0.17, 0.54)	.299	98.0%
Cohort	3	625	MD -0.00 (-0.06, 0.05)	.897	0.0%
НОА	10	1309	MD -0.14 (-0.23, -0.06)	.001	98.5%
RCT	4	827	MD -0.10 (-0.17, -0.03)	.006	89.4%
Cohort	6	482	MD -0.16 (-0.26, -0.05)	.004	98.4%
Horizontal coma-like aberration	5	404	MD -0.00 (-0.03, 0.03)	.966	0.0%
RCT	3	266	MD 0.00 (-0.04, 0.05)	.816	0.0%
Cohort	2	138	MD -0.01 (-0.07, 0.05)	.688	0.0%
Vertical coma-like aberration	6	455	MD -0.01 (-0.03, 0.01)	.263	0.0%
RCT	3	266	MD -0.01 (-0.05, 0.03)	.577	0.0%
Cohort	3	189	MD -0.01 (-0.03, 0.01)	.331	0.0%
Spherical-like aberration	12	1305	MD -0.19 (-0.32, -0.06)	.004	99.2%
RCT	4	599	MD -0.24 (-0.69, 0.22)	.308	99.7%
Cohort	8	706	MD -0.16 (-0.25, -0.07)	.001	97.9%

CI = confidence interval, HOA = higher order aberration, I² = extent of inconsistency, MD = mean difference, OR = odds ratio, RCT = randomized controlled trials, SE = spherical equivalent, UCVA = uncorrected visual acuity.

cornea is physiologically conical rather than a sphere. A significant variation of physiologic asphericity is shown ranging from mild oblate to moderate prolate.^[32] Therefore, it is necessary to introduce a shape factor to characterize the amount of asphericity of the cornea numerically, the so-called *Q*-factor. The *Q* value is negative for most eyes and not related to the degree of myopia.^[33,34]*Q* value mathematically reflects corneal asphericity, which can be defined to variations in radius of curvature from apex to periphery.^[35,36]

To date, LASIK is a common corneal surgery for myopia and astigmatism.^[37] It makes the cornea undergo a anatomical change, from its initially prolate shape (Q < 0) with a steeper central area and flat peripheral area to an oblate shape (Q > 0) with a flat center and steep periphery.^[38–40] LASIK can reduce refractive error and improve uncorrected visual acuity, but several problems still must be resolved regarding postoperative visual function and contrast sensitivity.^[41] Increased higher-order optical aberrations after laser refractive surgery was found

Table 3

Subgroup analyses on country.

Country (China versus Others)	Studies	Eyes	OR or MD (95%Cl)	Р	ŕ
Preoperative Q-value	11	1605	MD -0.00 (-0.02, 0.02)	.922	68.0%
China	8	1340	MD -0.01 (-0.03, 0.01)	.398	74.7%
Others	3	265	MD 0.04 (0.00, 0.08)	.019	0.0%
Postoperative Q-value	11	1655	MD -0.42 (-0.64, -0.21)	.000	98.4%
China	8	1390	MD -0.30 (-0.51, -0.10)	.003	97.9%
Others	3	265	MD -0.75 (-1.12, -0.38)	.000	96.4%
НОА	10	1309	MD -0.14 (-0.23, -0.06)	.001	98.5%
China	7	1044	MD -0.10 (-0.14, -0.05)	.000	92.4%
Others	3	265	MD -0.22 (-0.37, -0.07)	.004	98.3%
Vertical coma-like aberration	6	455	MD -0.01 (-0.03, 0.01)	.263	0.0%
China	5	404	MD -0.01 (-0.05, 0.02)	.424	0.0%
Others	1	51	MD -0.01 (-0.03, 0.01)	.423	/
Spherical-like aberration	12	1305	MD -0.19 (-0.32, -0.06)	.004	99.2%
China	9	1040	MD -0.18 (-0.37, 0.00)	.055	99.3%
Others	3	265	MD -0.22 (-0.43, -0.01)	.039	99.3%

CI=confidence interval, HOA=higher order aberration, P = extent of inconsistency, MD=mean difference, OR=odds ratio, RCT=randomized controlled trials.

Table 4

Subgroup analyses on study eye sizes.

Eye sizes (\geq 100 versus < 100)	Studies	Eyes	OR or MD (95%CI)	Р	f
Postoperative UCVA of 20/20 or better	8	1397	OR 1.09 (0.62, 1.92)	.763	0.0%
≥100	4	1090	OR 1.16 (0.55, 2.44)	.697	0.0%
	4	307	OR 1.00 (0.42, 2.38)	.991	0.0%
Postoperative UCVA	7	1645	MD 0.04 (0.01, 0.07)	.012	76.9%
≧100	5	1543	MD 0.05 (0.01, 0.08)	.006	82.8%
<100	2	102	MD -0.01 (-0.09, 0.07)	.839	0.0%
Preoperative Q-value	11	1605	MD -0.00 (-0.02, 0.02)	.922	68.0%
≧100	6	1242	MD -0.01 (-0.03, 0.02)	.678	82.9%
<100	5	363	MD 0.01 (-0.02, 0.03)	.547	0.0%
Postoperative Q-value	11	1655	MD -0.42 (-0.64, -0.21)	.000	98.4%
≧100	6	1292	MD -0.46 (-0.73, -0.18)	.001	98.9%
<100	5	363	MD -0.38 (-0.83, 0.06)	.093	97.9%
Postoperative refractive SE	6	1627	MD 0.08 (-0.09, 0.25)	.336	95.4%
≧100	5	1543	MD 0.11 (-0.11, 0.33)	.315	96.3%
<100	1	84	MD -0.02 (-0.10, 0.06)	.621	/
HOA	10	1309	MD -0.14 (-0.23, -0.06)	.001	98.5%
≧100	3	813	MD -0.18 (-0.40, 0.04)	.109	99.6%
<100	7	496	MD -0.12 (-0.20, -0.05)	.001	94.6%
Horizontal coma-like aberration	5	404	MD -0.00 (-0.03, 0.03)	.966	0.0%
≧100	1	128	MD 0.00 (-0.05, 0.06)	.880	/
<100	4	276	MD -0.00 (-0.05, 0.04)	.851	0.0%
Vertical coma-like aberration	6	455	MD -0.01 (-0.03, 0.01)	.263	0.0%
≧100	1	128	MD -0.00 (-0.05, 0.04)	.814	/
<100	5	327	MD -0.01 (-0.04, 0.01)	.253	0.0%
Spherical-like aberration	12	1305	MD -0.19 (-0.32, -0.06)	.004	99.2%
≧100	5	809	MD -0.36 (-0.64, -0.08)	.011	99.6%
<100	7	496	MD -0.08 (-0.20, 0.05)	.238	98.6%

CI = confidence interval, HOA = higher order aberration I² = extent of inconsistency, MD = mean difference, OR = odds ratio, RCT = randomized controlled trials, SE = spherical equivalent, UCVA = uncorrected visual acuity.

to be a potentially major factor in visual quality.^[42] A further study is required to determine the exact *Q*-values after surgery. With the development and maturation of refractive surgery, relatively high surgical efficacy based on *Q*-value has been introduced for treating myopia. *Q*-value guided surgery aims to minimize changes of the corneal anterior surface asphericity in order to reduce corneal ablation depth, which impacts mostly on visual quality.^[43-45] However, there were conflicting reports about the postoperative visual recovery and corneal stability of *Q*-value-guided LASIK. Thus, to explore its safety and efficacy, we performed the current meta-analysis to compare *Q*-valueguided LASIK with standard LASIK.

Due to significant heterogeneity of the current meta-analysis, careful interpretation and search for influencing factors were required. LASIK for the correction of myopia is primarily concerned with production of refractive changes by corneal flattening in relation to the amount of refractive error. The Technolas was gradually approved for clinical use in China. It features a new algorithm with preoperative assessment of the Q-value together with subjective refraction. In presented research, the included studies mainly focused on Chinese and English literatures, which may influence the ultimate results. Additionally, differences in the study design should be considered as potential sources of heterogeneity. Sample size also have an impact on heterogeneity. The differences in the baseline, such as age or gender, are likely to be significant factors contributing to the results.

Actually, there are several important limitations. Firstly, only published studies may not provide sufficient evidences. Secondly, only English and Chinese literatures were explored, which may influence the ultimate results. Meanwhile, the extreme heterogeneity suggested there are potential or undiscovered factors. The impact of those factors could not be formally explored through subgroup analysis. Whereas, in spite of aforementioned limitations, it also has been proven that Q-value-guided LASIK is a safe, effective and predictable surgical options for treating myopia.

Author contributions

Conceptualization: Kai-Ping Zhang.

- Data curation: Kai-Ping Zhang.
- Formal analysis: Kai-Ping Zhang, Xiang Fang.
- Investigation: Xiang Fang, Yin Zhang.
- Methodology: Xiang Fang, Yin Zhang.
- Project administration: Kai-Ping Zhang, Min Chao.
- Resources: Kai-Ping Zhang.
- Software: Kai-Ping Zhang,
- Supervision: Kai-Ping Zhang, Min Chao.
- Validation: Kai-Ping Zhang, Yin Zhang, Min Chao.
- Visualization: Min Chao.
- Writing original draft: Yin Zhang, Min Chao.
- Writing review & editing: Kai-Ping Zhang, Xiang Fang, Yin Zhang, Min Chao.

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