



# The better surgical timing and approach for orbital fracture: a systematic review and meta-analysis

Jian Zhang<sup>1#</sup>, Xin He<sup>2#</sup>, Yanxiu Qi<sup>1</sup>, Pingping Zhou<sup>1</sup>

<sup>1</sup>Department of Ophthalmology, The First Affiliated Hospital of Jiamusi University, Jiamusi, China; <sup>2</sup>Department of Ophthalmology, The Second Affiliated Hospital of Jiamusi University, Jiamusi, China

**Contributions:** (I) Conception and design: J Zhang; (II) Administrative support: P Zhou; (III) Provision of study materials or patients: X He; (IV) Collection and assembly of data: X He, Y Qi; (V) Data analysis and interpretation: Y Qi, P Zhou; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

<sup>#</sup>These authors contributed equally to this work.

**Correspondence to:** Pingping Zhou. Department of Ophthalmology, the First Affiliated Hospital of Jiamusi University, 348 Dexiang street, Xiangyang District, Jiamusi 154000, China. Email: 171843155@masu.edu.cn.

**Background:** A large number of empirical studies on the surgical timing and approach of orbital fracture have been published, but which surgical timing and approach is better is still a dispute. We use a systematic review and meta-analysis to solve this problem.

**Methods:** We performed a systematic search in the databases of PubMed, Cochrane Clinical Trials Database, Embase, and Web of Science for relevant literature. The search terms included those concerning or describing orbital fracture, timing, and approach, which are based on population, intervention, control, outcome, and study (PICOS) framework. The statistical software packages RevMan 5.4 and Stata 14.0 were used for data analysis. We sought to evaluate postoperative complications, and results were expressed as odds ratio (OR) with 95% confidence interval (CI). Forest plots, sensitivity analysis, funnel plots, Egger's test, and risk bias analysis were also performed on the included articles by using the Newcastle-Ottawa scale (NOS).

**Results:** A total of 7 trials involving 1,283 patients compared the surgical timing of  $\leq 14$  days versus  $> 14$  days, and another 14 trials involving 1,768 patients compared the surgical strategy of transconjunctival approach (TCA) with that of subciliary approach (SCA) for orbital fracture. The quality of all articles was higher than 7 points, which means all articles were at low risk of bias. Surgery conducted within 14 days significantly reduced the incidence of diplopia (OR: 0.53, 95% CI: 0.34 to 0.83,  $P=0.005$ ) and enophthalmos (OR: 0.32, 95% CI: 0.12 to 0.83,  $P=0.02$ ); TCA had a significantly lower incidence of ectropion (OR: 0.20, 95% CI: 0.10 to 0.38,  $P<0.00001$ ), scleral show (OR: 0.22, 95% CI: 0.12 to 0.38,  $P<0.00001$ ), and visible scar (OR: 0.15, 95% CI: 0.03 to 0.65,  $P=0.33$ ) compared to SCA, but had a significantly higher incidence of entropion (OR: 5.41, 95% CI: 1.83 to 15.96,  $P=0.002$ ). There was no significant publication bias among our included studies.

**Conclusions:** The operation in  $\leq 14$  days is better than that in  $> 14$  days. However, regarding the choice of surgical approach, TCA and SCA have their advantages and disadvantages, the exploration of which requires further research.

**Keywords:** Timing; approach; orbital fracture; meta-analysis

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## Introduction

Orbital fracture is a disease wherein an external force acting on the eye causes the orbital pressure to rise and the orbital bone wall to rupture (1,2). Safety accidents frequently occur in traffic or industrial production. In recent years, with the increasing economic development, the incidence of orbital fractures has also risen. Orbital fractures can lead to soft tissue herniation in the orbit and incarceration of extraocular muscles, with clinical manifestations such as entropion, eye movement disorders, and diplopia, which seriously affect the quality of life of patients (3,4). Surgery is the main treatment method to release the incarcerated extraocular muscles, incorporate soft tissue herniation into the paranasal sinuses, and repair orbital wall defects(5).

There are many factors affecting the results of surgery, including the timing of surgery, repair materials, and surgical approach (6-9). Most orbital fractures do not require immediate repair, depending on the severity and type of fracture. Some authors believe that repair of orbital fractures within 2 weeks is acceptable in the absence of an indication for urgent surgery (10,11). Some studies have even suggested that the earliest time to repair orbital fractures should be within 2 weeks, but there is insufficient evidence for how early surgical treatment of orbital fractures should start and how prognosis is influenced if surgical treatment is delayed (12,13).

The most classic surgical approaches are mainly divided into transconjunctival approach (TCA) and subciliary approach (SCA) (14,15). In 1921, Lynch first used a medial canthal skin incision to expose the inner orbital wall, and it has been widely used since (16). There are also many scholars who use a transconjunctival incision to treat orbital medial wall, inferior wall, or combined medial-inferior wall fractures to avoid visible skin scarring after surgery (17-19). However, for inferior orbital wall or intraorbital inferior wall combined fractures, exposure of the surgical field is not sufficient through the conjunctival incision, and there is interference of intraorbital fat (20). In the past, both the SCA and the TCA have been widely used for the treatment of orbital fractures. However, there is still controversy as to which is the best surgical approach for orbital fractures (21,22).

The key to the surgical treatment of orbital fractures lies in the incidence of postoperative complications. In this paper, through meta-analysis, with the more controversial 2 weeks as the threshold, the incidence of complications after surgery within 2 weeks and after 2 weeks of injury was

compared. In addition, we also compared the post-surgical complications of TCA and SCA. The purpose of this study was to determine the better surgery timing and approach for orbital fractures, and provide a reference for clinicians. We present the following article in accordance with the MOOSE reporting checklist (available at <https://atm.amegroups.com/article/view/10.21037/atm-22-1465/rc>).

## Methods

### *Literature search strategy*

We performed a systematic search for relevant studies from inception to December 2021 in the databases of PubMed, Cochrane Clinical Trials Database, Embase, and Web of Science (WOS). We used the following keywords: “orbital fractures”, “orbital fracture”, “orbital trauma”, “orbital injury”, “surgery”, “surgical”, “timing”, “14 days”, “2 weeks”, “approach”, “transconjunctival”, and “subciliary”. All these search words were combined using the Boolean operators “AND” or “OR”. The search strategies for all databases are presented in *Table 1*. Disagreements were resolved through consensus between the 2 reviewers (P Zhou and Y Qi).

### *Study selection*

We considered studies eligible for inclusion if they met the following criteria: (I) inclusion only of patients diagnosed with orbital fracture; (II) the article involved the comparison of surgical timing or approach; and (III) there were at least 1 of the primary outcomes of interest. The exclusion criteria were as follows: (I) studies that did not meet the inclusion criteria; (II) relevant results that were not adequately reported or could not be used; and (III) studies were reviews, letters, abstracts, or duplicate publications.

### *Data extraction*

Data were extracted in duplicate by 2 investigators independently and inputted to a dedicated database. Prespecified data elements were extracted from each trial using a structured data form, including baseline characteristics, sample size, and related results of major complications.

### *Quality assessment*

Since the included studies were mainly retrospective or

**Table 1** Search strategies for each database

Search number	Queries
Queries in PubMed	
#1	Search “orbital fractures” [Mesh]
#2	Search (((orbital fractures [Title/Abstract]) OR orbital fracture [Title/Abstract]) OR orbital trauma [Title/Abstract]) OR orbital injury [Title/Abstract])
#3	#1 OR #2
#4	Search (((((((surgery [Title/Abstract]) OR surgical [Title/Abstract]) OR timing [Title/Abstract]) OR 14 days [Title/Abstract]) OR 2 weeks [Title/Abstract]) OR approach [Title/ Abstract]) OR transconjunctival [Title/Abstract]) OR subciliary [Title/Abstract])
#5	#3 AND #4
Queries in Cochrane	
#1	MeSH descriptor: (orbital fractures) explode all trees
#2	((orbital fractures*) OR (orbital fracture*) OR (orbital trauma*) OR (orbital injury*)): ti, ab, kw
#3	#1 OR #2
#4	MeSH descriptor: (surgery) explode all trees
#5	((surgery*) OR (surgical*) OR (timing*) OR (14 days*) OR (2 weeks*) OR (approach*) OR (transconjunctival*) OR (subciliary*)): ti, ab, kw
#6	#4 OR #5
#7	#3 AND #6
Queries in Embase	
#1	'orbital fractures'/exp OR 'orbital fracture' OR 'orbital trauma' OR 'orbital injury': ti, ab
#2	'surgery': ti, ab OR 'surgical': ti, ab OR 'timing': ti, ab OR '14 days': ti, ab OR '2 weeks': ti, ab OR 'approach': ti, ab OR 'transconjunctival': ti, ab OR 'subciliary': ti, ab
#3	#1 AND #2
Queries in WOS	
#1	TS = (orbital fractures OR orbital fracture OR orbital trauma OR orbital injury)
#2	TI = (surgery OR surgical OR timing OR 14 days OR 2 weeks OR approach OR transconjunctival OR subciliary)
#3	#1 AND #2

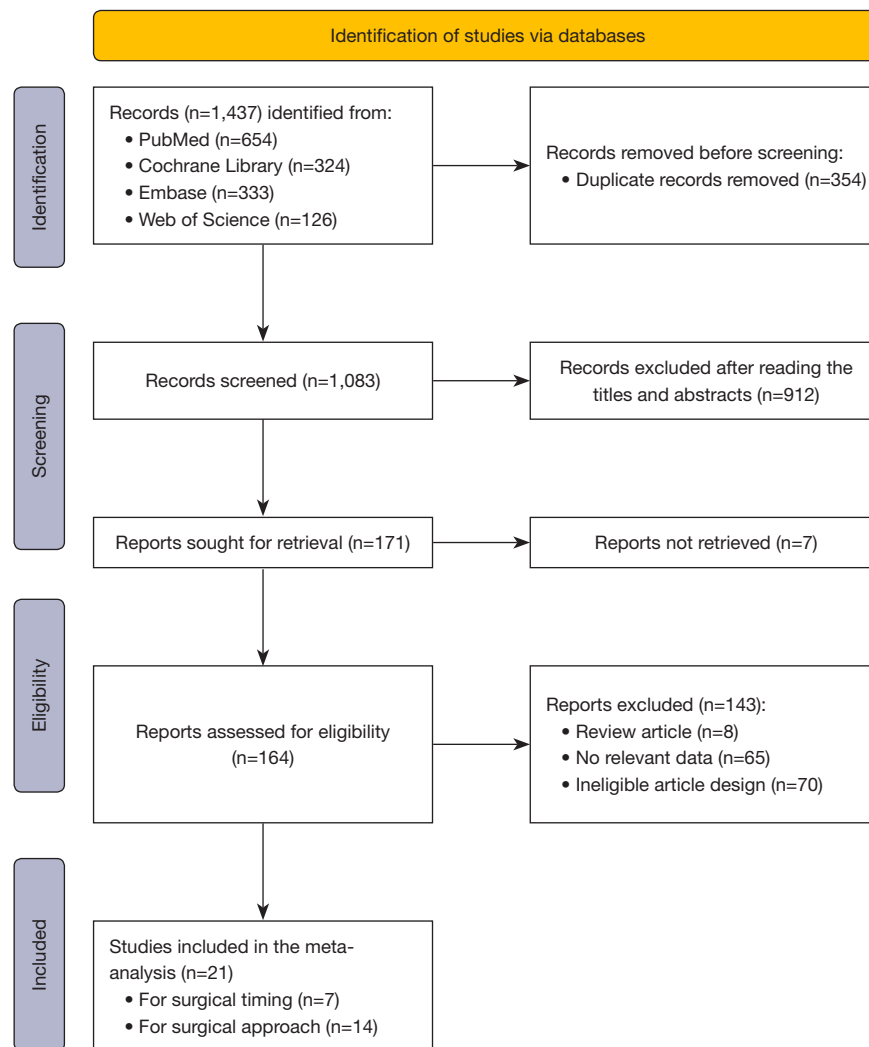
MeSH, Medical Subject Headings.

prospective cohort studies, we used the Newcastle-Ottawa scale (NOS) as the evaluation tool for methodological quality, which included adequacy selection of cohort, comparability of studies, and outcome assessment.

### **Statistical analysis**

Analyses were performed using Review Manager version 5.4 (RevMan 5.4; The Cochrane Collaboration, Copenhagen, Denmark, 2020), while Egger’s test was performed using

Stata version 14.0 (Stata Corp., College Station, TX, USA). As our outcome variables were dichotomous variables, we used the Mantel-Haenszel odds ratio (OR) model with 95% confidence interval (CI) for combined analysis. Heterogeneity between the studies in effect measures was assessed using both the chi-squared test and the  $I^2$  statistic with an  $I^2$  value >50%, indicative of substantial heterogeneity. The fixed-effects model was used in the absence of significant heterogeneity; otherwise, the random-effects model was applied. To further evaluate the



**Figure 1** Flow chart of literature search and study selection for systematic review and meta-analysis.

robustness of the final results, we conducted sensitivity analysis. Funnel plots and Egger's test were used to examine the publication bias among the included studies.

## Results

### Search process

A total of 1,473 relevant articles were identified through a primary literature search using the described search strategy and inclusion/exclusion criteria. After duplicate elimination, 1,083 studies underwent title and abstract screening, resulting in 171 studies considered suitable for inclusion. Following full paper review, 21 articles met the criteria for inclusion, of which 7 were included in the meta-analysis of

surgical timing for orbital fracture (23-29), and the other 14 were included in the meta-analysis of surgical approach for orbital fracture (30-43). The results of the search process, which followed the Meta-analyses of Observational Studies in Epidemiology (MOOSE) checklist, including reasons for exclusion of studies, are illustrated in *Figure 1*.

### Characteristics of the included studies

The detailed characteristics of the 7 studies included for surgical timing analysis and 14 studies included for surgical approach analysis are summarized in *Tables 2,3*, respectively.

All of the 7 studies included in the meta-analysis of surgical timing were retrospective studies. The total number

**Table 2** Characteristics of studies included in the meta-analysis for surgical timing

Study	Study design	Country	Gender (M/F)	Age (years)	No. of patients		No. of diplopia		No. of enophthalmos		Follow-up	Duration
					≤14 days	>14 days	≤14 days	>14 days	≤14 days	>14 days		
Dal Canto 2008	Retrospective study	USA	NR	5–68	36	22	3	1	1	0	24 weeks	September 1994 to December 2006
Brucoli 2011	Retrospective study	Italy	29/11	47.7 [30–60]	36	4	13	4	7	4	39 months	January 2001 to December 2007
Hosal 2002	Retrospective study	USA	30/12	32 [12–74]	25	12	2	5	1	2	11 months	1992 to 1998
Shin 2011	Retrospective study	Korea	433/148	NR	485	106	23	6	3	1	6 months	May 2000 to December 2007
Hwang 2012	Retrospective study	Korea	NR	33.4 [6–77]	228	14	5	0	2	0	12 months	March 2006 to February 2011
Poeschl 2012	Retrospective study	Austria	38/22	36 [4–48]	43	17	–	–	1	0	14 months	NR
Yu 2016	Retrospective study	China	181/74	27.6 [7–74]	167	88	31	26	–	–	14.2 months	July 2003 to December 2014

NR, no reported.

of patients was 1,283, including 1,020 patients in the ≤14 days group and 263 patients in the >14 days group. The main complications were diplopia and enophthalmos, with 119 patients (9.28%) and 22 patients (1.72%), respectively. The included studies were published between 2008 and 2016.

The 14 studies included in the meta-analysis of surgical approach contained 10 retrospective studies and 4 prospective studies. The total number of patients was 1,768, including 856 patients in the TCA group and 912 patients in the SCA group. The main complications were ectropion, entropion, scleral show, canthal malposition, and visible scar, with 53 patients (3.00%), 23 patients (1.30%), 67 patients (3.79%), 6 patients (0.34%), and 45 patients (2.55%), respectively. The included studies were published between 1993 and 2021.

### Results of quality assessment

After identifying the trials, abstracts and full texts were carefully read and risk of bias was screened and evaluated according to the NOS. *Table 4* shows a summary of all kinds of bias in each study included in the surgical timing meta-analysis, while *Table 5* shows the bias in each study included in the surgical approach meta-analysis. The results showed that the quality of all articles was higher than 7 points, and some articles were only deducted in terms of comparability and outcome evaluation.

### Results of the meta-analysis for surgical timing

#### Diplopia

In 1,223 patients across 6 studies, surgical timing in the ≤14 days group indicated a lower incidence of diplopia than in the >14 days group (OR: 0.53, 95% CI: 0.34 to 0.83,  $P=0.005$ ), without significant heterogeneity ( $I^2=23\%$ ,  $P=0.26$ ) (*Figure 2*). Sensitivity analysis showed that the results were relatively stable (*Figure S1*). Nonsignificant publication bias was found according to the funnel plot or Egger's test ( $P=0.536$ ) (*Figure S2*).

#### Enophthalmos

Enophthalmos was reported in 6 studies involving 1,028 patients. The ≤14 days group also showed a lower incidence of enophthalmos compared to the >14 days group (OR: 0.32, 95% CI: 0.12 to 0.83,  $P=0.02$ ), there was no significant heterogeneity ( $I^2=0\%$ ,  $P=0.44$ ) (*Figure 3*). We performed sensitivity analysis and the results showed that there was no

**Table 3** Characteristics of studies included in the meta-analysis for surgical approach

Study	Study design	Country	Gender (M/F)	Age	No. of patients			No. of ectropion			No. of entropion			No. of scleral show			No. of canthal malposition			No. of visible scar	Follow-up	Duration
					TCA	SCA	SCA	TCA	SCA	TCA	SCA	TCA	SCA	TCA	SCA	TCA	SCA	TCA	SCA			
Appling 1993	Retrospective study	USA	41/18	11-60	36	27	0	3	-	-	1	7	3	0	-	-	4 months	March 1987 to February 1992				
Ridgway 2009	Retrospective study	USA	72/28	39 [16-90]	45	56	0	7	2	0	-	-	-	-	0	2	6 months	1998 to 2008				
Salgarelli 2010	Retrospective study	Italy	169/105	37.1 [16-78]	32	219	0	0	-	-	0	3	-	-	1	38	48 months	2000 to 2007				
Giraddi 2012	Prospective study	India	19/1	28.4 [12-45]	10	10	1	3	3	0	-	-	-	-	-	-	3 months	NR				
Raschke 2012	Prospective study	Germany	171/50	44.76±19.15	129	92	2	6	-	-	11	29	-	-	-	-	9 months	September 2006 to September 2011				
Ishida 2016	Retrospective study	Japan	NR	NR	179	29	1	2	6	0	0	2	1	0	-	-	12 months	1992 to 2012				
Kesseling 2016	Retrospective study	USA	NR	37.5 [4-83]	26	47	0	1	0	0	-	-	-	-	-	-	NR	2011 to 2011				
Pausch 2016	Retrospective study	Germany	248/98	42.7 [5-89]	121	225	0	8	3	0	-	-	-	-	-	-	6 months	January 2001 to December 2010				
Vaibhav 2016	Prospective study	India	36/4	20-60	20	20	0	0	1	0	-	-	-	-	0	4	3 months	NR				
Haghighat 2017	Retrospective study	Italy	NR	26.7 [17-44]	17	17	0	3	-	-	-	-	-	-	-	-	4 weeks	2015				
Neovius 2017	Retrospective study	Sweden	249/68	41 [8-88]	91	37	2	3	0	0	4	4	2	0	-	-	6 months	June 2005 to December 2012				
Bronstein 2020	Retrospective study	USA	151/33	35.1±12.1	102	82	2	2	4	1	-	-	-	-	-	-	6 months	2005 to 2016				
Mohamed 2020	Prospective study	Egypt	20/10	35.5±11.8	15	15	1	3	3	0	2	4	-	-	-	-	6 months	August 2017 to April 2019				
Trevisiol 2021	Retrospective study	Italy	53/16	42 [6-78]	33	36	0	3	0	0	-	-	-	-	-	-	35 months	January 2013 to September 2018				

TCA, transconjunctival approach; SCA, subciliary approach; NR, no reported.

**Table 4** Risk of bias of included studies for surgical timing

Study	Selection				Comparability of cohorts	Outcomes			Score*
	Representativeness of cohort	Selection of nonexposed cohort	Ascertainment of exposure	Outcome lacking at the beginning		Outcome assessment	Sufficient follow-up time	Follow up adequacy	
Dal Canto 2008	★	★	★	★	★★	☆	★	★	8
Brucoli 2011	★	★	★	★	★☆	★	★	★	8
Hosal 2002	★	★	★	★	★☆	★	★	★	8
Shin 2011	★	★	★	☆	★★	★	★	★	8
Hwang 2012	★	★	★	★	★☆	☆	★	★	7
Poeschl 2012	★	★	★	★	★☆	★	★	★	8
Yu 2016	★	★	★	☆	★★	★	★	★	8

\*, the total score of NOS evaluation is 9 points; ★ represents that the item has obtained the score, ☆ represents that the item has not been scored.

obvious change (Figure S1). Neither funnel plot nor Egger's test ( $P=0.641$ ) revealed any publication bias (Figure S2).

### Results of the meta-analysis for surgical approach

#### Entropion

In 14 studies involving 1,763 patients, TCA was associated a significantly lower incidence of entropion compared to SCA (OR: 0.20, 95% CI: 0.10 to 0.38,  $P<0.00001$ ), without significant heterogeneity ( $I^2=0\%$ ,  $P=0.96$ ) (Figure 4). Sensitivity analysis showed that the results were robust (Figure S3). Although the funnel plot was not symmetrical, the results of Egger's test showed no significant publication bias ( $P=0.319$ ) (Figure S4).

#### Entropion

A total of 10 studies involving 1,199 patients contributed to the analysis of entropion, wherein TCA showed a significantly higher incidence of entropion compared to SCA (OR: 5.41, 95% CI: 1.83 to 15.96,  $P=0.002$ ), without significant heterogeneity ( $I^2=0\%$ ,  $P=0.97$ ) (Figure 5). No significant change was found after the sensitivity analysis (Figure S3). The funnel plot showed some evidence of asymmetry, but Egger's test indicated no significant publication bias ( $P=0.254$ ) (Figure S4).

#### Scleral show

A total of 6 studies reported the incidence of scleral show, and TCA was associated with a significantly lower incidence compared to SCA (OR: 0.22, 95% CI: 0.12 to 0.38,  $P<0.00001$ ). We used the fixed-effects model to perform the pooled analysis because of the low heterogeneity ( $I^2=0\%$ ,  $P=0.49$ ) (Figure 6). The result did not change after the sensitivity analysis (Figure S3). There was no significant publication bias according to the Egger's test ( $P=0.428$ ) (Figure S4).

#### Canthal malposition

Data was available in 3 studies to assess canthal malposition. The meta-analysis showed that there was no difference between TCA and SCA regarding the incidence of canthal malposition (OR: 2.36, 95% CI: 0.42 to 13.40,  $P=0.33$ ), and the heterogeneity among included studies was not significant ( $I^2=0\%$ ,  $P=0.53$ ) (Figure 7). The result of sensitivity analysis indicated that it was stable (Figure S3). The funnel plot was roughly asymmetric; however, Egger's test indicated that there was no publication bias ( $P=0.382$ ) (Figure S4).

#### Visible scar

There was a total of 392 patients enrolled in 3 studies

**Table 5** Risk of bias of included studies for surgical approach

Study	Selection				Comparability of cohorts	Outcomes			Score*
	Representativeness of cohort	Selection of nonexposed cohort	Ascertainment of exposure	Outcome lacking at the beginning		Outcome assessment	Sufficient follow-up time	Follow up adequacy	
Appling 1993	★	★	★	★	★★	☆	★	★	7
Ridgway 2009	★	★	★	★	★★	★	★	★	8
Salgarelli 2010	★	★	★	★	★★	☆	★	★	7
Giraddi 2012	★	★	★	★	★★	★	★	★	9
Raschke 2012	★	★	★	★	★★	★	★	★	9
Ishida 2016	★	★	★	★	★★	★	★	★	8
Kesselring 2016	★	★	★	★	★★	☆	★	★	7
Pausch 2016	★	★	★	★	★★	☆	★	★	7
Vaibhav 2016	★	★	★	★	★★	★	★	★	9
Haghighat 2017	★	★	★	★	★★	★	★	★	8
Neovius 2017	★	★	★	★	★★	★	★	★	8
Bronstein 2020	★	★	★	★	★★	★	★	★	8
Mohamed 2020	★	★	★	★	★★	★	★	★	9
Trevisiol 2021	★	★	★	★	★★	☆	★	★	7

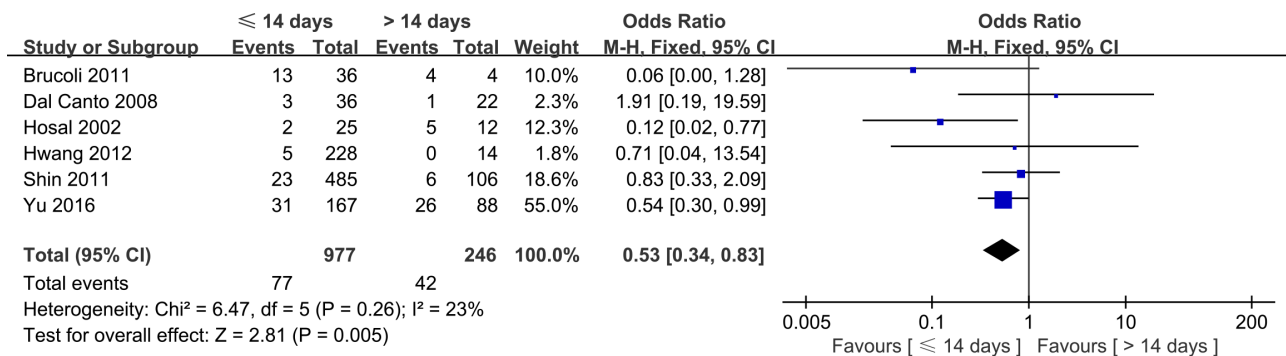
\*, the total score of NOS evaluation is 9 points; ★, represents that the item has obtained the score; ☆, represents that the item has not been scored.

which compared the incidence of visible scar. The pooled analysis showed that TCA had a significantly lower incidence of visible scar than SCA (OR: 0.15, 95% CI: 0.03 to 0.65,  $P=0.01$ ), without significant heterogeneity ( $I^2=0\%$ ,  $P=0.90$ ) (Figure 8). The result of sensitivity analysis showed no obvious change, suggesting that it was reliable (Figure S3). The funnel plot appeared symmetric, and the Egger's test was nonsignificant ( $P=0.486$ ) (Figure S4).

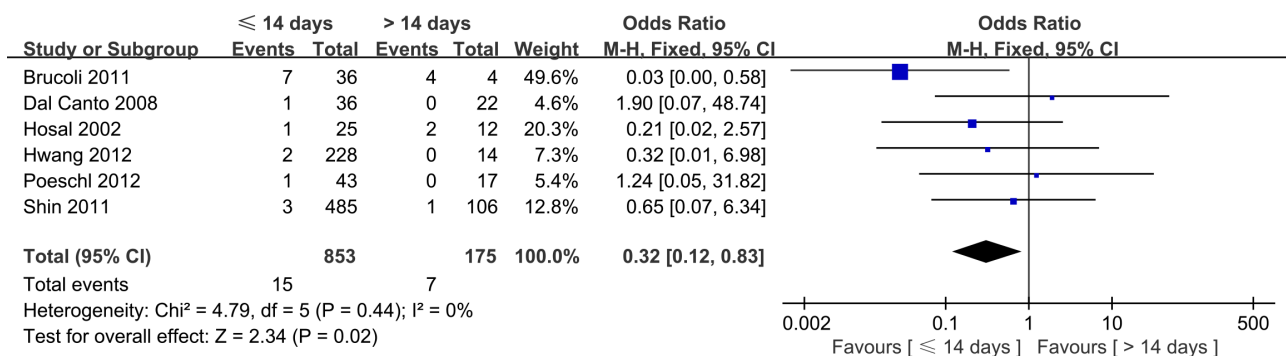
## Discussion

As the orbit is an important aesthetic component of the face, fracture repair surgery faces certain challenges, and its complications often cause aesthetic and functional concerns (44,45). The timing and approach of surgery for orbital fractures has been widely debated, with some authors suggesting that conservative management is more beneficial than early surgical intervention (46). Isolated





**Figure 2** Forest plot: ≤14 versus >14 days for diplopia. CI, confidence interval; df, degrees of freedom.



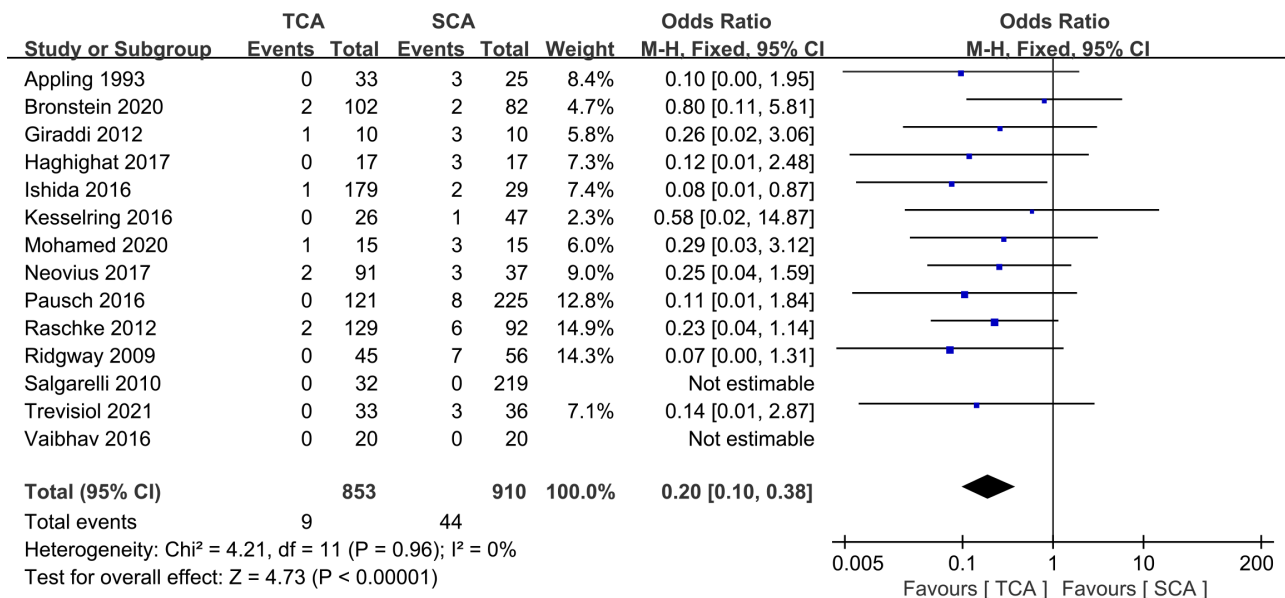
**Figure 3** Forest plot: ≤14 versus >14 days for enophthalmos. CI, confidence interval; df, degrees of freedom.

orbital floor fractures do not require urgent surgical intervention in the absence of specific indications such as muscle entrapment and/or visual threat. Orbital edema or hematoma can also improve significantly after several weeks without intervention (47). However, when symptoms persist, surgery may be required, and there is no clear consensus on the optimal timing of orbital fractures in these cases (48). For the surgical procedure, orthopedic surgery usually requires adequate exposure of the bone. The SCA takes the most direct route through the soft tissue to the bone, and in doing so, scars are easily produced. Making an incision through the TCA can effectively conceal scarring, but because the bones cannot be sufficiently exposed, it may occasionally lead to functional and aesthetic complications, such as eyelid asymmetry, scleral show, and so on (49,50).

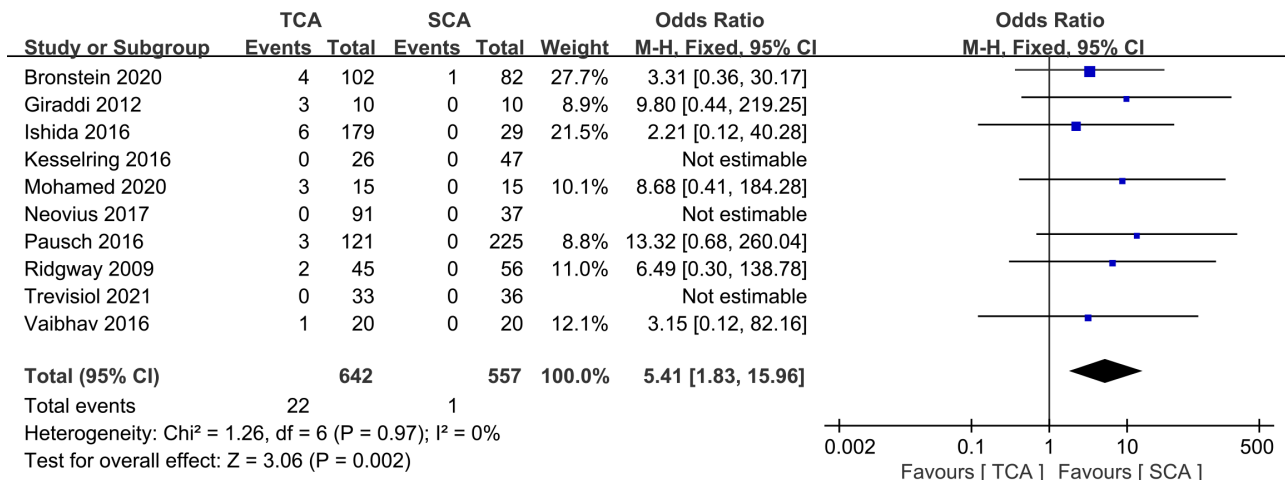
In this meta-analysis, we used the 14 days surgical margin as a threshold for optimal timing of surgery and compared the incidence of complications between the TCA and the SCA to determine the optimal surgical approach. The results showed that surgery with 14 days after injury significantly reduced the incidence of diplopia (OR: 0.53,

95% CI: 0.34 to 0.83, P=0.005) and enophthalmos (OR: 0.32, 95% CI: 0.12 to 0.83, P=0.02). The incidence of ectropion (OR: 0.20, 95% CI: 0.10 to 0.38, P<0.00001), scleral show (OR: 0.22, 95% CI: 0.12 to 0.38, P<0.00001), and visible scar (OR: 0.15, 95% CI: 0.03 to 0.65, P=0.33) in the TCA group decreased significantly when compared with the SCA group, but the incidence of entropion (OR: 5.41, 95% CI: 1.83 to 15.96, P=0.002) increased significantly, in addition, there was no significant difference in the incidence of canthal malposition (OR: 2.36, 95% CI: 0.42 to 13.40, P=0.33) between the 2 approaches.

Regarding the timing of surgery, this study demonstrated better outcomes when surgery was performed within 14 days after injury, and other reports have shown that early intervention may lead to better postoperative outcomes, with lower incidences of diplopia and entropion (51). For example, Jazayeri *et al.* found that the cut-off point of 14 days or 28 days showed a significant improvement in the results of early intervention (52); Byeon's study confirmed that the effect of correcting intraocular lesions within 1 month after injury was significantly better, while delayed



**Figure 4** Forest plot: TCA versus SCA for ectropion. TCA, transconjunctival approach; SCA, subciliary approach; CI, confidence interval; df, degrees of freedom.

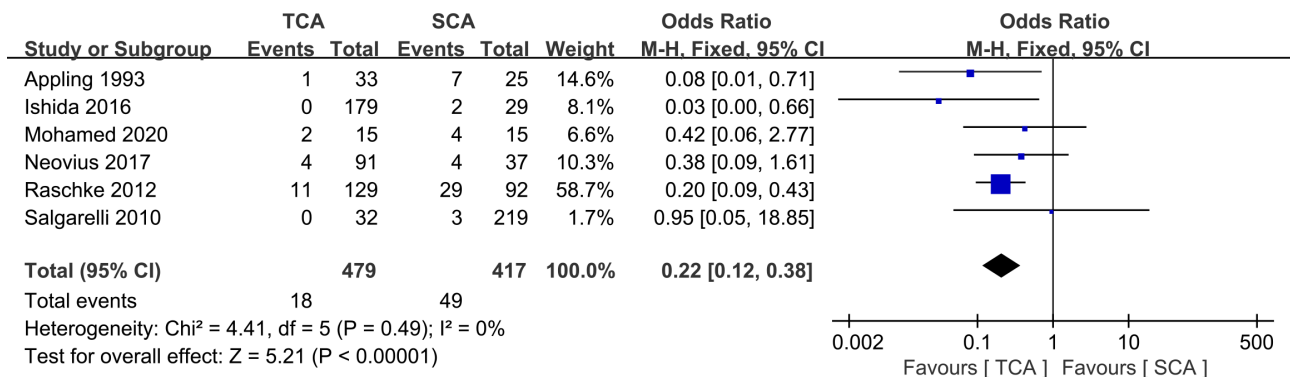


**Figure 5** Forest plot: TCA versus SCA for entropion. TCA, transconjunctival approach; SCA, subciliary approach; CI, confidence interval; df, degrees of freedom.

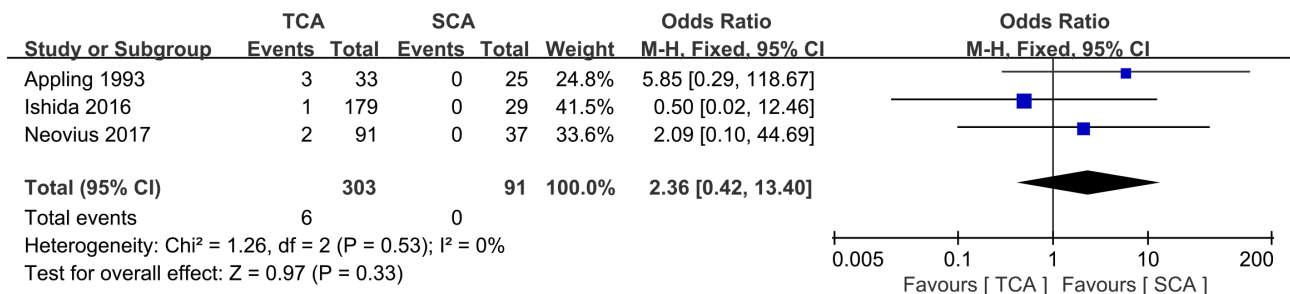
surgical intervention lead to more serious complications such as tissue fibrosis and atrophy (53). The feasible reason is that early intervention can significantly reduce periorbital soft tissue scarring, and early reversal of persistent tissue compression, stretching, and displacement may limit advanced fibrosis, especially in the presence of massive soft tissue swelling (54,55).

For the surgical approach, both the TCA and the SCA

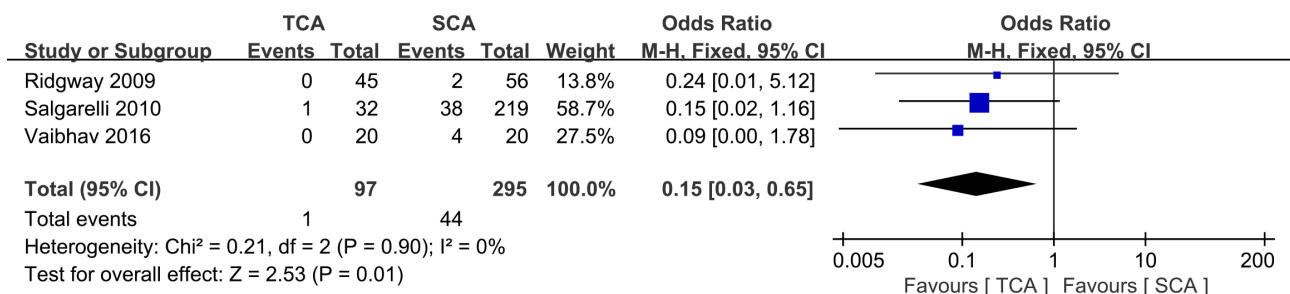
seem to have their own advantages and disadvantages. With SCA, although the fracture area is fully exposed and it is easy to perform surgical repair operations, skin scars may easily form, and it carries a higher risk of damaging the muscle tissue at the incision site, resulting in increased ectropion and sclera exposure and other complications (56,57). With TCA, combined lateral canthotomy may be required, which will easily increase the surgical duration



**Figure 6** Forest plot: TCA versus SCA for scleral show. TCA, transconjunctival approach; SCA, subciliary approach; CI, confidence interval; df, degrees of freedom.



**Figure 7** Forest plot: TCA versus SCA for canthal malposition. TCA, transconjunctival approach; SCA, subciliary approach; CI, confidence interval; df, degrees of freedom.



**Figure 8** Forest plot: TCA versus SCA for visible scar. TCA, transconjunctival approach; SCA, subciliary approach; CI, confidence interval; df, degrees of freedom.

and tissue damage, and may also lead to conjunctival edema, entropion, foreign body sensation, and eyelid tearing. Although the complication rate of the TCA is not high, it often requires secondary surgery (34,40).

This study had certain limitations. There were large differences in fracture types, repair materials, methods of assessing complications, and follow-up time among all included studies, and we were unable to classify, which may

have reduced the accuracy of the evidence. In addition, the 21 studies included were all cohort studies, and most of the studies were retrospective studies, which may have involved selection bias and retrospective bias; no randomized controlled trials were included, which may have reduced the strength of the conclusions. Finally, the timing of surgery may interact with the surgical approach, resulting in differences in the complications analyzed separately. We

hope that more robust articles will assist the validation of our stratified analysis in the future.

## Conclusions

In conclusion, this study confirmed that early surgical intervention can achieve better clinical outcomes. When considering the surgical approach, the TCA and SCA have their own advantages and disadvantages. The literature and related evidence levels included in this study were limited, so more research should be performed to confirm the optimal surgical timing and approach for orbital fractures.

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## Footnote

*Reporting Checklist:* The authors have completed the MOOSE reporting checklist. Available at <https://atm.amegroups.com/article/view/10.21037/atm-22-1465/rc>

*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at <https://atm.amegroups.com/article/view/10.21037/atm-22-1465/coif>). The authors have no conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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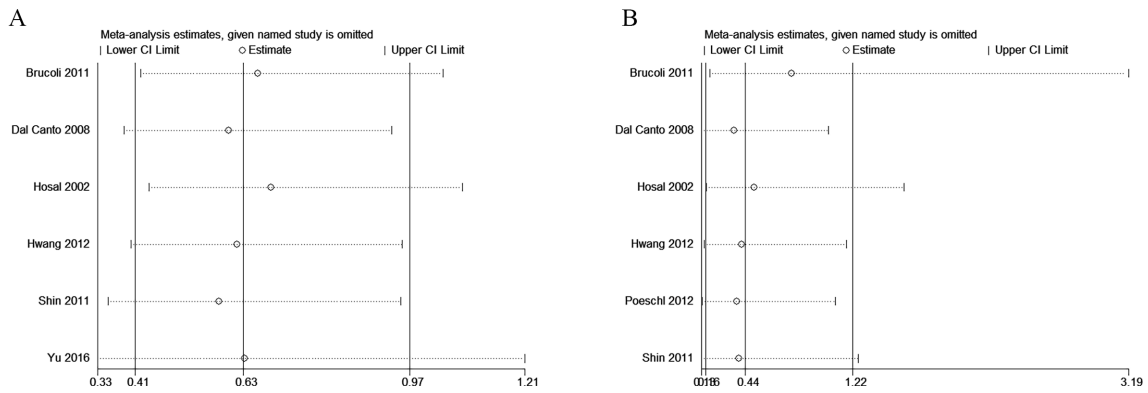
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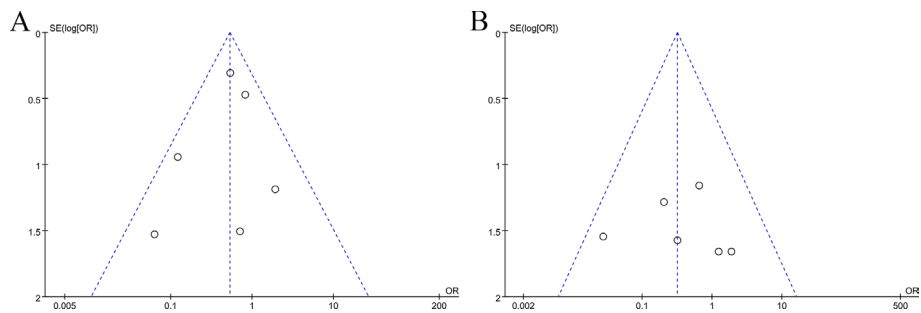
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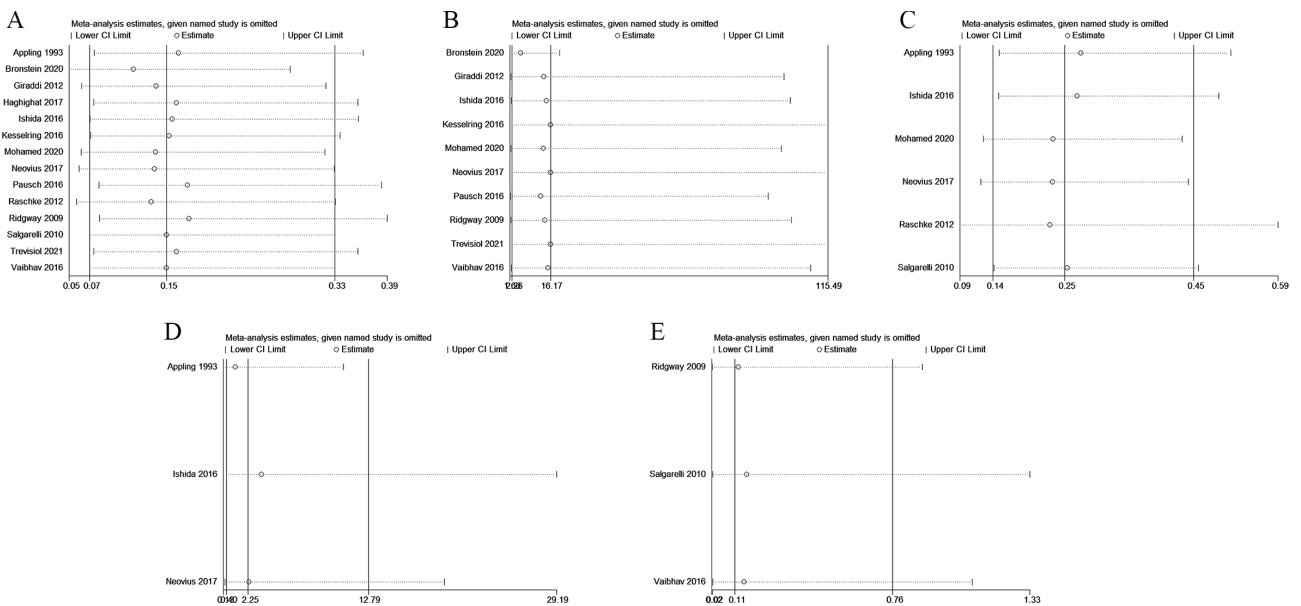
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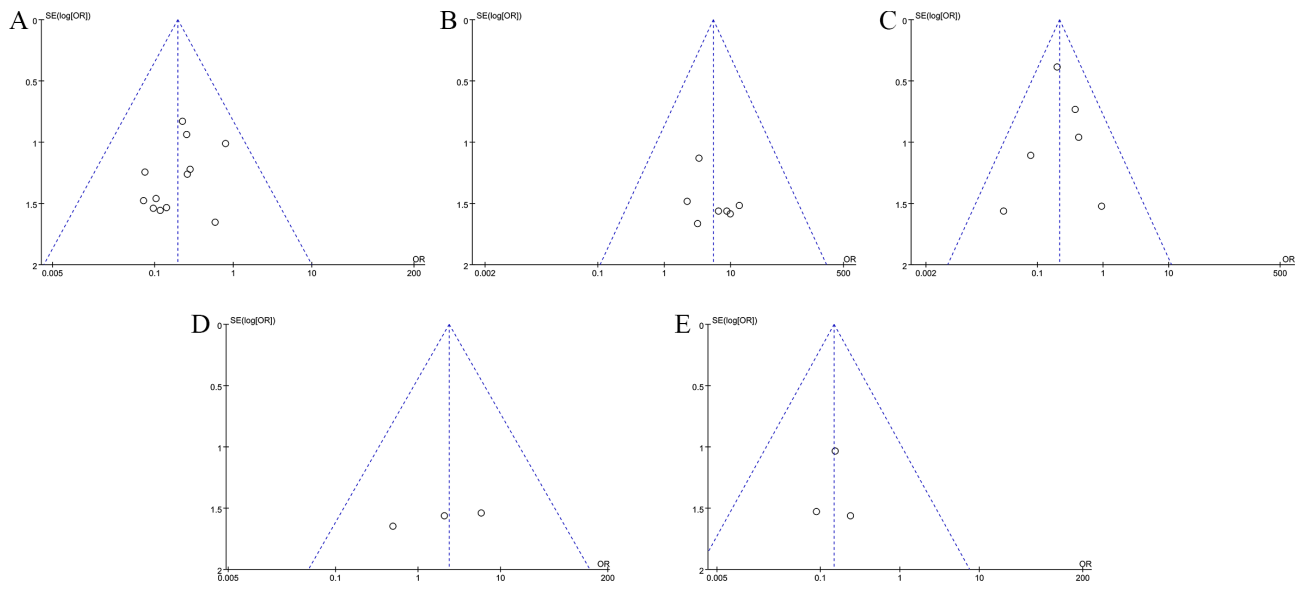
**Figure S1** Sensitivity analysis of (A) diplopia and (B) enophthalmos. The 3 vertical lines represent the overall effect size and its 95% CI. Each circle and horizontal line represent the effect size and 95% CI after removing each indicated study. CI, confidence interval.



**Figure S2** The funnel plots of (A) diplopia and (B) enophthalmos.



**Figure S3** Sensitivity analysis of (A) ectropion, (B) entropion, (C) scleral show, (D) canthal malposition, and (E) visible scar. The 3 vertical lines represent the overall effect size and its 95% CI. Each circle and horizontal line represents the effect size and 95% CI after removing each indicated study. CI, confidence interval.



**Figure S4** The funnel plots of (A) ectropion, (B) entropion, (C) scleral show, (D) canthal malposition, and (E) visible scar.