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Original Article

Does 23-gauge vitrectomy decrease complications and operation time in treating retinal diseases? A meta-analysis

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Abstract: Objective: To compare the therapeutic effects and operation time of 23-G vitrectomy and conventional 20-G vitrectomy on complications (retinal breaks, retinal detachment). Methods: Related studies published prior to October 2014 were retrieved via exhaustive searching of English and Chinese scientific literature databases. High quality clinical cohort studies, focused on 23-G and 20-G vitrectomy in retinal diseases, were carefully selected according to our study inclusion criteria. Statistical analyses were also conducted by comprehensive Meta-analysis 2.0 (CMA 2.0) software. Results: Fifty-five published articles (47 in English and 8 in Chinese) were initially identified as relevant to our keyword search, of which 10 studies were included in this meta-analysis, including 1464 patients treated for retinal diseases (718 treated with 23-G vitrectomy, 746 treated with 20-G vitrectomy). Our meta-analysis showed that the incidence of retinal breaks in 23-G vitrectomy were lower than those in 20-G vitrectomy (P = 0.017). However, no such difference was found in the incidence of retinal detachment between these two surgical procedures (P = 0.467). As for operation time, our results showed that 23-G vitrectomy procedure was performed in less time compared with patients receiving 20-G vitrectomy (P < 0.001). Conclusions: The 23-G transconjunctival sutureless vitrectomy may be superior to conventional 20-G vitrectomy in reducing the incidence of retinal breaks and shortening operation time.

Keywords: 23-G vitrectomy, 20-G vitrectomy, retina, minimally invasive, complication, meta-analysis

Introduction

Poor final visual acuity often results from the treatment of retinal diseases, although new surgical and pharmacological modalities have been rapidly developed [1]. Pars plana vitrectomy (PPV), a surgical procedure initially reported in 1971 by Machemer *et al.*, has revolutionized retinal surgery since its advent, and is performed with 20-G instruments [2]. The first small caliber instrument was described in 2002, which used 25-G inserted through a 'port' and did not require suturing. Currently, 23-gauge (23-G), 25-gauge (25-G), and 27-gauge (27-G) techniques are available and transconjunctival sutureless pars plana vitrectomy (TSV) is considered safe for treating patients suffered from vitreoretinal pathologies, particularly macular disorders including preretinal membranes and macular holes [3-6]. Evidence has shown that the advantages of TSV included decreased operation time, increased patient comfort as well as decreased corneal astigmatism [7]. Nevertheless, similar to standard PPV, TSV has its inherent complications such as iatrogenic retinal breaks, cataract progression, lens touch and ocular hypertension [8]. Other complications include retinal breaks, postoperative retinal detachment, decompression retinopathy and intraoperative instrument breakage [8]. These procedures have been widely used by the vitreoretinal community, however, just as any new technique, they have encountered new surgical challenges and complications, including poor illumination of the retina and breakage of the instrument itself [9].

The 23-G vitrectomy was first reported by Eckardt in 2005 and since then it has emerged as an effective approach to minimize the disad-

vantages of 20-gauge (20-G) and 25-G vitrectomy, while maximizing the benefit to patients [3, 10]. In comparison to the conventional 20-G vitrectomy, 23-G vitrectomy can reduce trauma to sclera and conjunctiva, and save time at the beginning and at the end of the operation [11]. In addition, it has been manifested that the 23-G vitrectomy has a better safety profile and visual outcomes for a number of different posterior segment conditions [12]. In recent years, several studies have examined the difference between 20-G and 23-G vitrectomy in relation to the incidence of complications and the total operation time, some of which reported that 23-G TSV was superior to conventional 20-G vitrectomy [9, 13-16], while some other studies found no statistically significant difference between these two techniques [11, 17]. In view of the conflicting data from previous studies, we performed this meta-analysis to compare the incidence of complications and total operation times between 23-G vitrectomy and conventional 20-G vitrectomy.

Materials and methods

Search strategy

English and Chinese databases including PubMed (since 1966), Ovid (since 1948), Embase (since 1966), China National Knowledge Infrastructure (CNKI, since 1994), and Wanfang Data (since 1986) were electronically searched for related articles published prior to October 2014. Manual search was performed to identify additional studies from cross-references. The search terms which combined free text words with key words were: 23-G vitrectomy, 20-G vitrectomy, retinal detachment, retinal pigment epithelial detachment, and retinal breaks.

Selection criteria

Published studies were included if they met the following inclusion criteria: (1) Study design: Clinical cohort study; (2) Subject of study: Comparisons of complications and operation time between 23- and 20-G vitrectomy in treatment of retinal diseases; (3) Population: Patients histopathologically diagnosed with retinal diseases; (4) Outcomes: Reported complications in the operations or the operation time. Exclusion criteria were: (1) incomplete data; (2) repeat publications; (3) non-English or non-Chinese studies.

Data extraction and quality assessment

A standardized data-collection form was employed by two investigators to extract data independently from the eligible studies, mainly including the following aspects: first author's name, year of publication, country, ethnicity, language, disease, age, number of cases and controls, operation time, occurrence of retinal detachment and retinal breaks. Disagreement on any extracted item, if any, was resolved through the discussion with several other investigators. Two investigators performed the methodological quality assessment according to the Critical Appraisal Skills Programme (CASP) Checklists (http://www.casp-uk.net/), and a third investigator was involved when there was a disagreement. The CASP criteria as 12 items on the checklist as: 1) if a clearly focused issue was addressed (CASP01); 2) if the cohort were recruited in an acceptable way (CASP02); 3) if the exposure was accurately measured to minimize bias (CASP03); 4) if the outcome was accurately measured to minimize bias (CASP04); 5) if the confounding factors had been taken account in the design and/or analysis (CASP05); 6) if the follow up of subjects was complete and long enough (CASP06); 7) if the results of the study were complete (CASP07); 8) how precise are the results (CASP08); 9) if the results credible (CASP09); 10) if the results can be applied to the local population (CASP10); 11) if the results of this study fit with other available evidence (CASP11); 12) what are the implications of this study for practice (CASP12).

Statistical analysis

The software Comprehensive Meta-analysis 2.0 (Biostatic Inc., Englewood, New Jersey, USA) was utilized for statistical analysis in this meta-analysis. The standardized mean difference (SMD), Odds ratios (OR) with 95% confidence intervals (95% CI) were calculated by fixed-effects model or random effects model to assess the comparison of complications and operation time between 23-G and 20-G vitrectomy in the treatment of retinal diseases. Z test [18] was performed for assessing the significance of overall effect size; moreover, forest plots were conducted to display the values of SMD and OR with 95% CI between the 23-G group and the 20-G group. Heterogeneity was evaluated using Cochran's Q-statistic [18], which indicated the existence of heterogeneity

Table 1. Characteristics of included studies focused on 23-G vitrectomy and 20-G vitrectomy

First author	Year	Country	Ethnicity	Gender (M/F)		Age (years)		Patients		Total (eyes)		Total patients	Follow-up (day)	
				23-G	20-G	23-G	20-G	23-G	20-G	23-G	20-G		23-G	20-G
Pielen A [11]	2014	Germany	Caucasians	-	-	72 ± 9	72 ± 8	59	61	59	61	120	482 ± 294	997 ± 648
Liu SM [25]	2013	China	Asians	78/52		19~70	20~73	70	60	70	60	130	-	-
Cai WQ [24]	2012	China	Asians	32/20	40/23	72/43		52	63	52	63	115	> 365	> 365
Hikichi T [6]	2012	Japan	Asians	46/69	22/36	67 ± 9	68 ± 8	115	58	122	61	173	-	-
Gosse E [9]	2012	UK	Caucasians	21/29	16/34	57~85	48~88	50	50	50	50	100	-	-
Nakano T [15]	2011	Japan	Asians	80/96	65/88	70 ± 7.7	68.6 ± 9.3	176	153	176	153	329	> 730	> 730
Issa SA [14]	2011	UK	Caucasians	38/31	35/32	19~90	21~81	67	69	85	85	136	-	-
Albrieux M [17]	2011	France	Caucasians	20/15	20/15	63.4 ± 15.7	61.4 ± 16.6	35	35	35	35	70	-	-
Haas A [13]	2010	Austria	Caucasians	-	-	70.4 ± 9.7	69.9 ± 9.1	64	167	64	167	231	-	-
Narayanan R [16]	2010	USA	Caucasians	26/4	24/6	52.5 ± 14.5	50.5 ± 13.5	30	30	30	30	60	-	-

M: Male; F: Female.

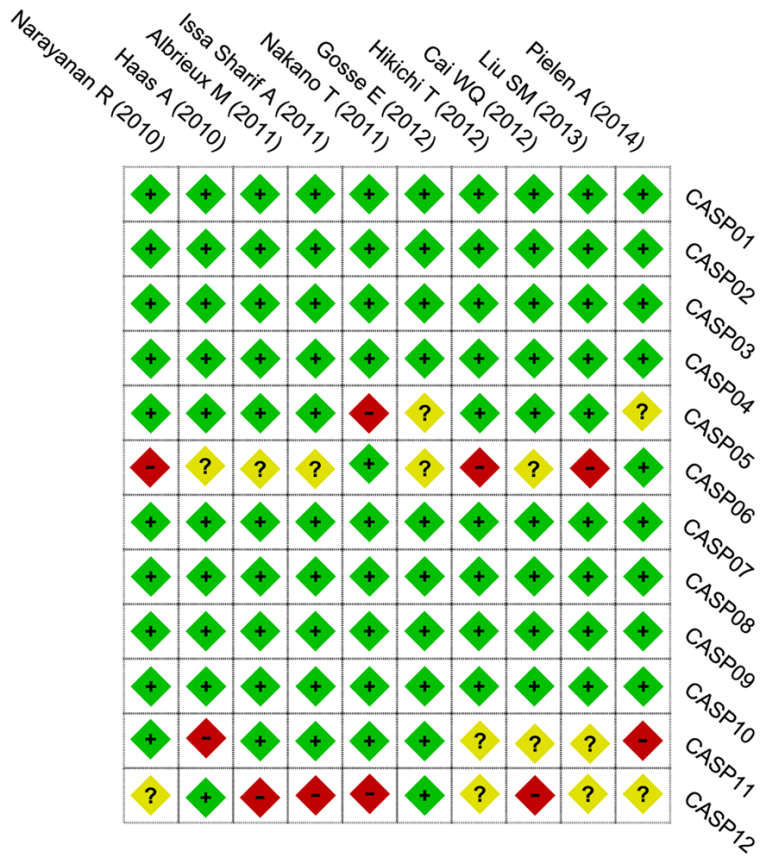

Figure 1. Critical Appraisal Skills Programme assessments for each included study.

with P_h < 0.05. For quantifying the degree of heterogeneity, I-squared (I^2) statistic [19] was calculated with higher values (ranging from 0%~100%) indicating higher degree. A P_h < 0.05 or I^2 > 50% suggested that the studies were heterogeneous, thus a random effects model was applied, otherwise a fixed-effects model was used [20]. With the sensitivity analysis of variables, the impact on the overall results by removing one single study was evaluated. Funnel plots, classic fail-safe N [21, 22] as well as Egger regression analyses were performed for the assessment of publication bias to evaluate the reliability of the results [23]. All these bilateral tests were conducted with P < 0.05 implying a statistical significance.

Results

Database search results

Fifty-five articles were initially retrieved, of which 6 duplicates, 8 letters or reviews, 2 non-human studies and 11 articles not related to the research topics were screened out. Additionally, 14 studies were excluded through overall assessment of the 28 remaining studies, and another 4 articles were further removed for partially related data. Thus, 10 cohort studies published between 2010 and 2014 [6, 9, 11, 13-17, 24, 25] met our inclusion criteria and were enrolled in this meta-analysis. These 10 literatures included 1464 patients with retinal diseases, with a sample size range of 60~329. In relation to the subjects investigated, 6 studies were performed in Caucasian population and 4 studies in Asian population. The baseline characteristics of studies included in the meta-analysis are presented in **Table 1**. Results of CASP assessment for each included study are shown in **Figure 1**.

Meta-analysis results

Seven of the included studies reported the difference in the incidence of intraoperative retinal breaks between 23-G TSV and 20-G vitrectomy. No heterogeneity was found according to the results of Cochran's Q-statistic test (P > 0.05), therefore a fixed-effects model was carried out. Results of our meta-analysis suggested that the incidence of retinal breaks during 23-G vitrectomy was lower than during 20-G vitrectomy (OR = 0.557, 95% CI = 0.343~0.902, P = 0.017) (**Figure 2B**). Subgroup analyses by ethnicity demonstrated that the incidence of retinal breaks between these two operations was statistically significant in Caucasians (OR = 0.432, 95% CI = 0.210~0.887, P = 0.022), while no such significance was observed in Asians (OR = 0.684, 95% CI = 0.357~1.312, P = 0.254) (**Figure 3**). As for retinal detachment, three of the included studies compared the incidence of retinal detachment during 23-G and 20-G vitrectomy. No heterogeneity was found (P > 0.05), therefore a fixed-effects model was carried out. Meta-analysis revealed no statistically significant difference in the incidence of retinal detachment between these

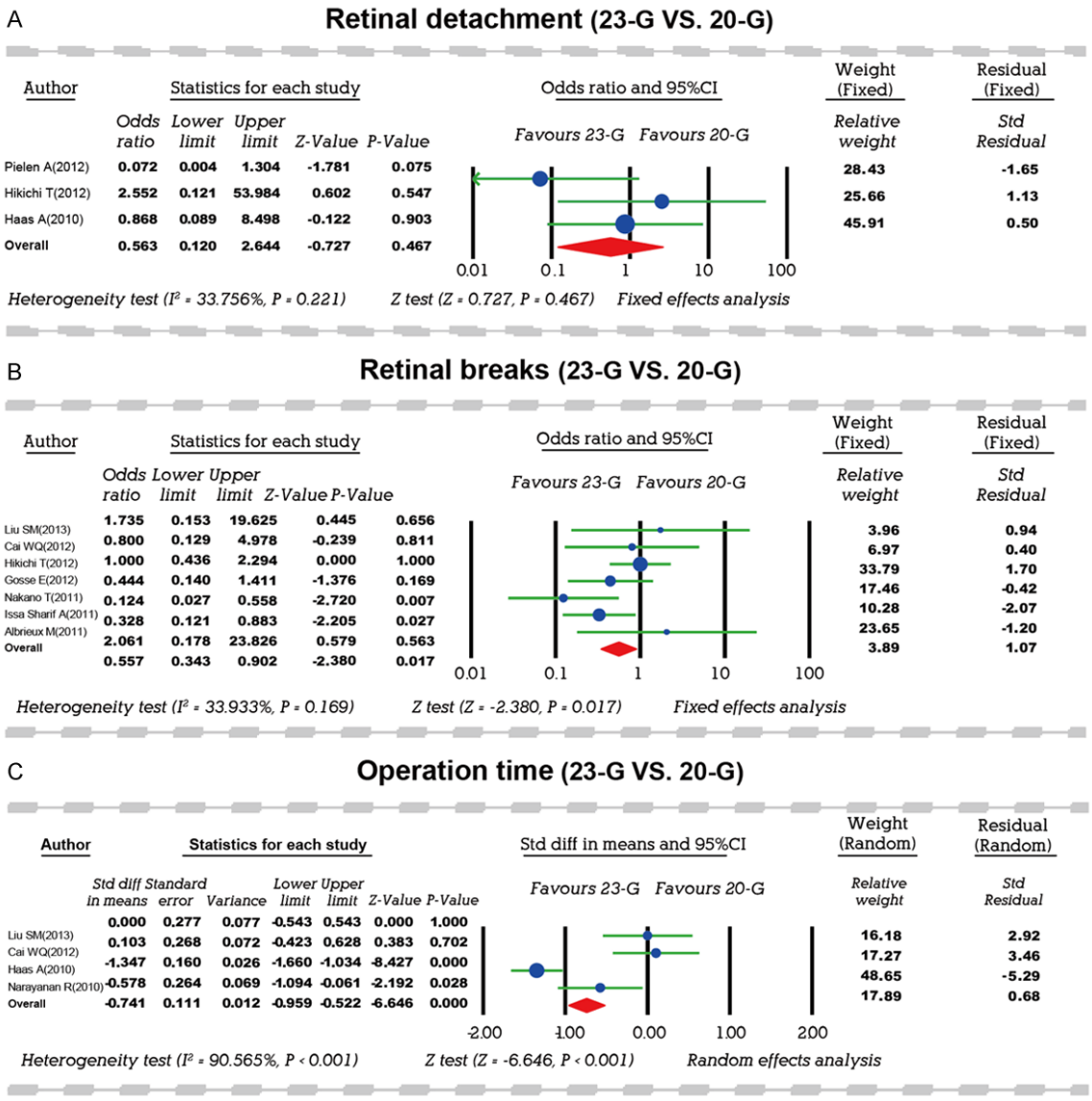

Figure 2. Forest plots: the difference of complications and operation time between 23-G and 20-G vitrectomy.

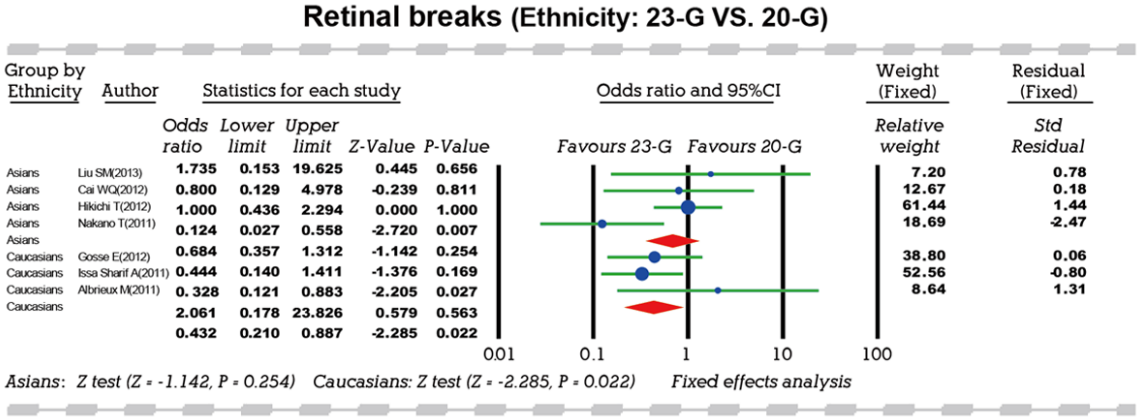

Figure 3. Forest plots: the subgroup analyses by ethnicity on the difference of retinal breaks between 23-G and 20-G vitrectomy.

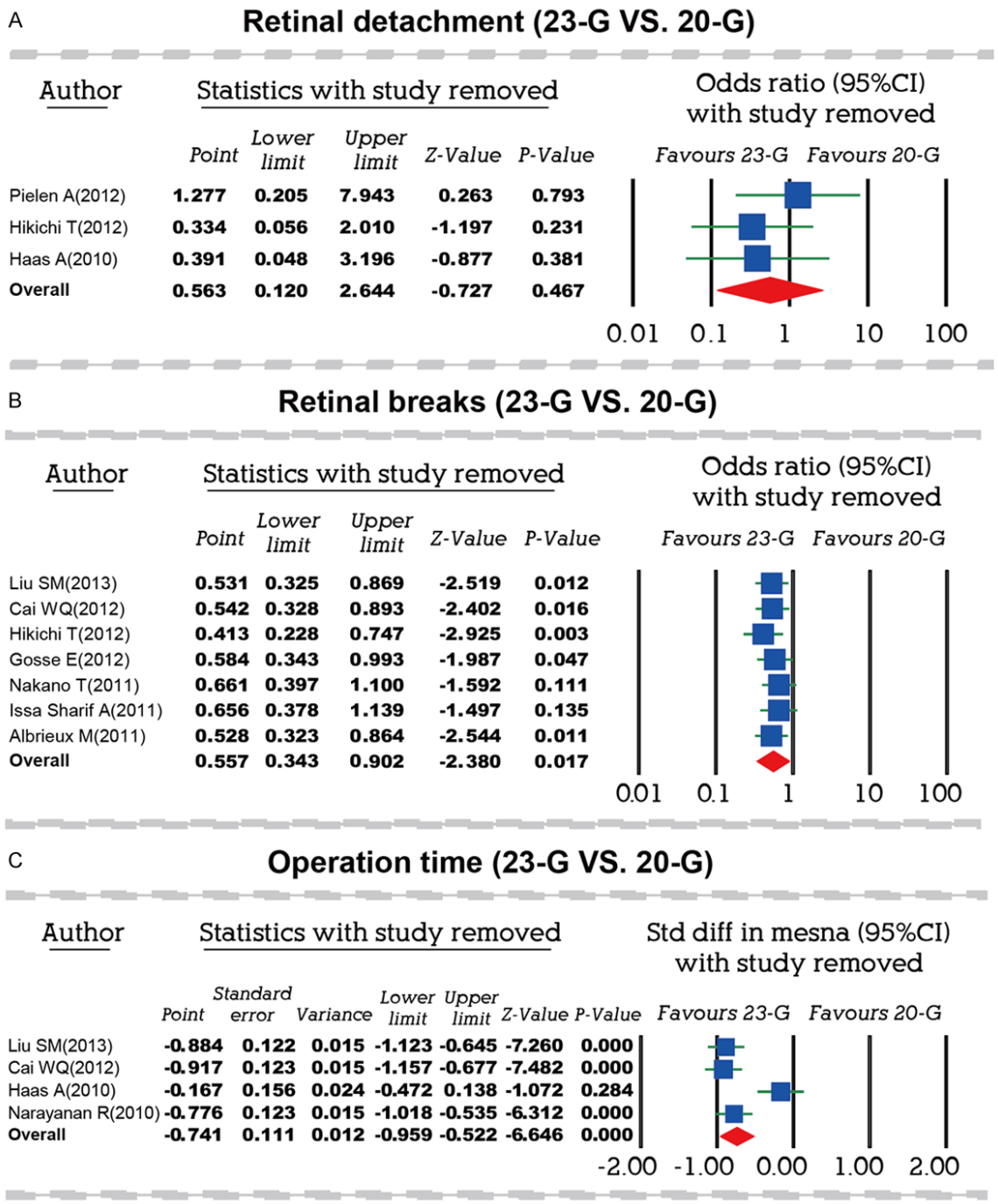

Figure 4. Sensitivity analysis on the difference of complications and operation time between 23-G and 20-G vitrectomy.

two operations (OR = 0.563, 95% CI = 0.120~2.644, P = 0.467) (**Figure 2A**). A total of 4 studies documented the difference in operation times between 23- and 20-G vitrectomy. Heterogeneity (P < 0.05) was observed among the three studies and a random effects model was utilized for analysis. Meta-analysis results showed that the 23-G TSV was performed in markedly less time than the conventional 20-G vitrectomy (SMD = -0.741, 95% CI = -0.959~-0.522, P < 0.001) (**Figure 2C**).

Sensitivity analysis and publication bias

Results of sensitivity analysis indicated that except for studies reported by Nakano *et al.*

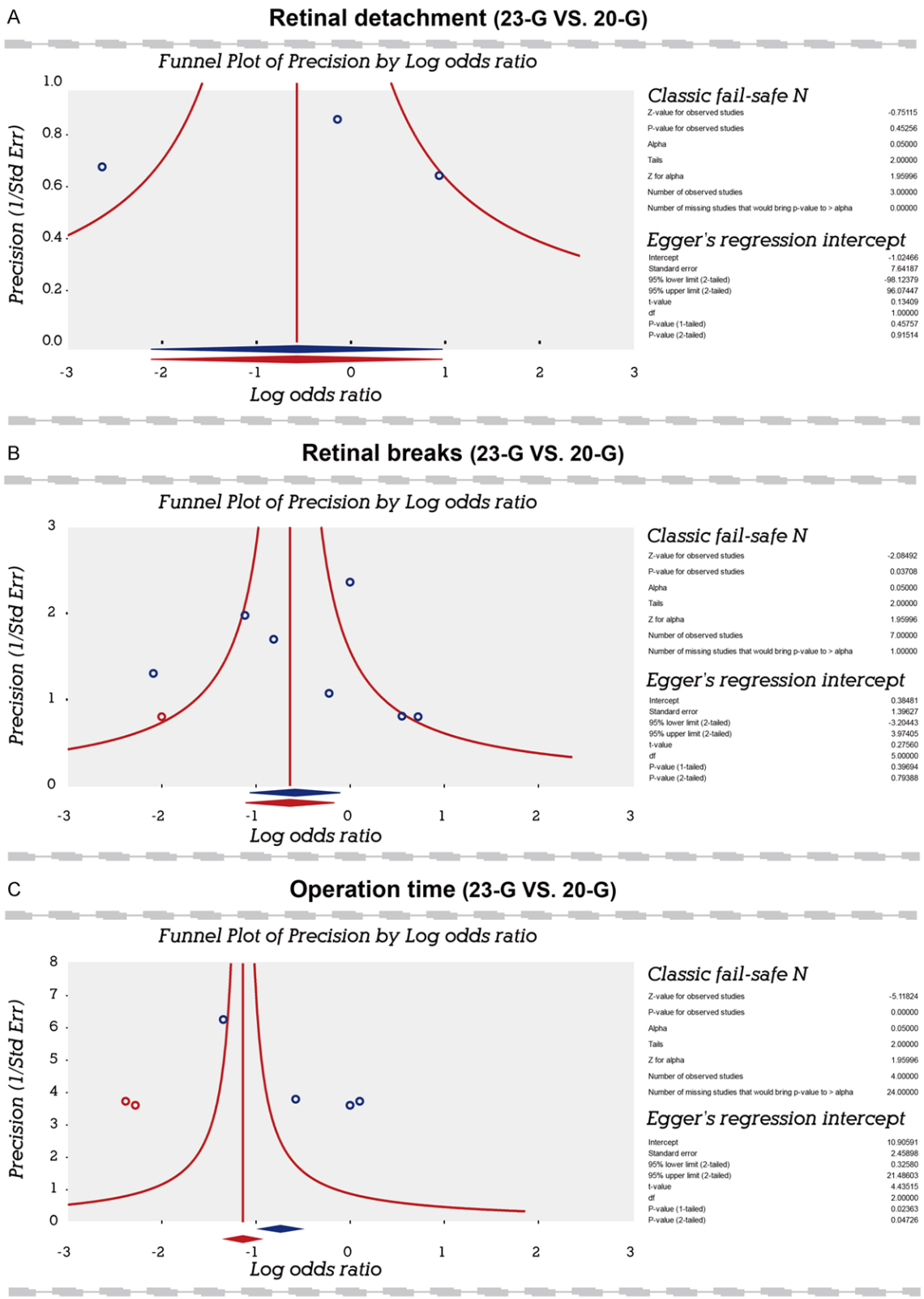

Figure 5. Funnel plots: publication biases on the difference of complications and operation time between 23-G and 20-G vitrectomy.

(2011) and Issa *et al.* (2011), showing difference in the retinal breaks between 23-G and 20-G vitrectomy and the study by *Haas et al.* (2010) presenting the operation time difference (a reverse outcome existed after their removal), the other 7 publications had no significant influence on the OR and SMD in relation to the incidence of complications and operation time between these two operations (**Figure 4**). Symmetrical funnel plots showed that there was no publication bias in the difference of complications between 23- and 20-G vitrectomy, which was further verified by the results of classic fail-safe N and Egger regression analyses (all $P > 0.05$) (**Figure 5**). However, funnel plots demonstrating the difference in operation time was asymmetric, which indicated the existence of publication bias; further identification of publication bias was obtained from the results of classic fail-safe N and Egger regression analyses (all $P < 0.05$) (**Figure 5**).

Discussion

TSV, including 23-G vitrectomy, is widely utilized by retinal surgeons for its advantages such as patient comfort, reduced operation time and earlier postoperative recovery than conventional 20-G vitrectomy [26]. However, 23-G vitrectomy may also cause complications such as retinal breaks, postoperative retinal detachment, decompression retinopathy and intraoperative instrument breakage [8]. We performed this meta-analysis to investigate the difference in the incidence of complications and total operation time between 23-G vitrectomy and conventional 20-G vitrectomy.

Specifically, we studied two complications, retinal breaks and retinal detachment, in relation to these two operative methods. The results of our meta-analysis clearly revealed that the incidence of retinal breaks during 23-G vitrectomy were significantly lower than during 20-G vitrectomy. According to previous publications, the incidence of retinal breaks triggered by standard 20-G vitrectomy was between 4% and 17% [27-30]. For small-incision vitrectomy, the incidence of retinal breaks ranged from 0% to 15.8% [31-34]. Nakano *et al.* argued that these broad-ranged results could be caused by the methods used for identification of retinal breaks or due to variations in the surgical indications for vitrectomy [15]. Moreover, a cannulated entry system, which might decrease vitreous base traction upon instrument insertion, is used in TSV. Angled scissors, which is often used for delamination during 20-G surgery, cannot be used during cannulated entry systems, and the insertion of curved or straight instruments is likely to reduce traction in TSV surgery [14]. In addition, the cutter mouth in 23-G vitrectomy is closer to the end of the cutter compared to 20-G vitrectomy, which causes less risk of breaks by allowing more controlled segmentation of fibrovascular tissue [35].

With respect to retinal detachment, the results of our meta-analysis revealed no statistically significant difference in the incidence of retinal detachment between these two operations. The 23-G vitrectomy is a relatively new procedure, with its own unique surgical challenges and complications. According to Albrieux *et al.*, although the scleral indentation of 23-G vitrectomy was more delicate, its self-sealing nature of the incisions may pose theoretical concerns of increased risk of vitreous incarceration, hypotony and postoperative endophthalmitis [17].

To better compare the advantages of 20-G and 23-G vitrectomy, we also conducted meta-analysis on the operation times of these two surgeries. Our results demonstrated that 23-G vitrectomy was performed in markedly lesser time than the conventional 20-G vitrectomy, indicating that 23-G vitrectomy was superior to 20-G vitrectomy in reducing total operation time. The potential reason could be that the air/fluid exchange and the dye in 20-G vitrectomy requires 2 minutes, while in 23-G vitrectomy, the dye can be injected onto the macula directly without the need of air/fluid exchange [36].

There are limitations in this meta-analysis. First, only English and Chinese databases were searched and only 10 studies were enrolled, which might not be comprehensive enough for this meta-analysis. Second, as with other meta-analyses, lack of original data of enrolled studies may limit our evaluation of the results. These features may have resulted in a publication bias and affected the overall outcomes.

In summary, our meta-analysis results revealed that the 23-G vitrectomy is superior to the conventional 20-G vitrectomy in reducing the incidence of retinal breaks and operation time.

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Disclosure of conflict of interest

None.

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