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Research Article

Canaloplasty versus Trabeculectomy: A Systematic Review and Meta-Analysis

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Abstract

Objective: To assess the current evidence regarding the efficiency and safety of canaloplasty (CP) compared with trabeculectomy.

Methods: Controlled clinical trials comparing CP versus trabeculectomy were selected through extensive searches of the PubMed, Web of science and the Cochrane Library. The efficacy measures were the weighted mean differences (WMDs) for the percentage intraocular pressure reduction (IOPR%) and the reduction in glaucoma medications, the odds ratios (ORs) for success rates and postoperative surgical interventions. The safety measures were ORs for complications. All outcomes were reported with a 95% confidence interval (CI).

Results: Five studies involving 287 patients, 287 eyes were identified. Compared to CP, the values of IOPR% (12 months) and glaucoma medications reduction were statistically greater in trabeculectomy (WMD = -9.86, 95% CI = [-15.68, -4.04]; P < 0.001; WMD = -18.41, 95% CI = [-29.38, -7.45]; P = 0.001, respectively). Moreover, trabeculectomy had a significantly higher success rate (OR = 0.42, 95% CI = [0.2, 0.88]; P = 0.02). In combination with Phaco group, however, both of CP and trabeculectomy had the similar success rate (OR = 0.49, 95% CI = [0.17, 1.45]; P = 0.2). Hyphema was the most common complication in the CP group and its incidence was significantly higher than it in the trabeculectomy group (OR = 10.39, 95% CI = [3.77, 28.65]; P < 0.001). The incidences of hypotony, choroidal detachment, corneal erosion and scleral flap revision were significantly higher in the trabeculectomy group (OR = 0.18, 95% CI = [0.07,0.48]; P < 0.001; OR = 0.10, 95% CI = [0.03, 0.4]; P = 0.001; OR = 0.05, 95% CI = [0.01,0.27]; P < 0.001, OR = 0.14, 95% CI = [0.02, 0.83]; P = 0.03, respectively).

Conclusion: Compared to CP, trabeculectomy had better efficacy of reduction in intraocular pressure (IOP) and the number of glaucoma medications. Moreover, it had higher success rate. But it also was associated with higher incidence of adverse events except hyphema.

Keywords: *Canaloplasty; Trabeculectomy; Glaucoma; Hyphema; Lowering Intraocular Pressure (IOP)*

Introduction

Glaucoma is a major eye disease that can result in blindness [1]. Efficiently and safely lowering intraocular pressure (IOP) is the most important objective of glaucoma therapy. Currently, there are three methods available to reduce IOP: medication, laser, and surgery [2]. Trabeculectomy is the most common surgical approach. In order to reduce the IOP, it creates a communication between the anterior chamber and the sub-conjunctival space through a sclerostomy and requires full thickness penetration of the anterior chamber under a partial thickness scleral flap [3], then the aqueous humor can be drained to form an elevation which is called a filtering bleb. Although trabeculectomy is considered to be the standard procedure for lowering IOP in patients with glaucoma, its numerous complications associated with filtering bleb also cannot be ignored, such as hypotony with shallow or flat anterior chamber, choroidal detachment (effusions or hemorrhage), bleb leakage, scarring of the bleb or blebitis. In recent years, canaloplasty (CP), an interventional non-penetrating surgery, was developed to improve the safety of conventional glaucoma filtering surgery. Published studies have found that canaloplasty not only reduced adverse events rates but critically provided good IOP control [4-7]. The mechanism by which CP reduce IOP is that using a 360° microcatheter dilation of Schlemm canal and a tension suture to restore the normal aqueous outflow pathway through Schlemm canal and the collector channels [8]. This surgical procedure is minimal invasive and bleb formation is absent which may explain the low incidence of adverse events in theory. For the past few years, the efficacy and safety of CP and trabeculectomy have been examined in a number of comparative controlled trials; however, the results of these trials have been incompletely consistent or even conflicting. For example, several studies [9,10] have found that trabeculectomy was more efficient than CP at reducing IOP, whereas other studies [8,11,12] have concluded that similar IOP control is achieved by the two surgical approaches. These inconsistent results render it difficult to draw accurate conclusions. Therefore, it is necessary to systemically analyze the available literature to evaluate the efficacy and safety of CP compared with trabeculectomy for treating glaucoma.

Material and Methods

Search strategy and qualitative assessment

Two reviewers independently searched for related published articles up to December 2017 without restrictions to publication year, regions or languages. The primary sources were the electronic databases of PubMed, Web of science and the Cochrane Library. The following key terms and their combination were used for the search: canaloplasty OR iscience OR nonpenetrating surgery, trabeculectomy OR glaucoma surgery OR glaucoma filtration surgery. Manual search of additional trials from all the references of the original reports and review articles was supplemented.

All available randomized controlled clinical trials (RCTs) and retrospective comparative studies (cohort or case-control) comparing CP versus trabeculectomy for patients with glaucoma were considered eligible for inclusion. Their follow-up period must be at least six months. Reviews, case reports, editorial comments, letters, abstracts from conferences, full texts without raw data available for retrieval, or duplicate publications were excluded.

The quality assessment system reported by Downs and Blacks [13] was designed to evaluate both RCT and Non-RCT studies. The following 26 items of the pilot checklist including: reporting (9 items), external validity (3 items), bias (7 items), confounding (6 items), and power (1 item). Due to inadequate explanations of "power" in checklist, modified assessment method of "power" [14], that simplified to a score of 0 (no sample size calculation) or 1 (sample size calculation reported), was used in our study. Therefore, the total maximum score changed from 31 to 28. The following cut-off points have been reported to categorise studies by quality: excellent (26 - 28), good (20 - 25), fair (15 - 19) and poor (≤14) [15,16]. The trials were deemed to have adequate quality when a quality score was greater than or equal to 15. The quality assessment was performed independently by two reviewers. If different viewpoints could not be settled by discussion, the adjudicating senior reviewer would make decisions.

Data extraction and processing

Data from included studies were extracted and analyzed independently by two reviewers. The adjudicating senior reviewer would be involved if the disagreement could not be solved through discussion. The primary outcome was the IOPR% from preoperative to postoperative status; the secondary outcomes were success rate, postsurgical visual acuity, reduction in glaucoma medications, incurrence of adverse events and postoperative surgical interventions. The information on author, year of publication, study design, general characteristic of subjects (number of eyes, age, gender, country, combination with Phaco or not, type of glaucoma), and follow-up time were also extracted.

If the mean and standard deviation (SD) of the IOPR% were reported, they would be used directly, or they could be calculated as followed: $IOPR = IOP_{baseline} - IOP_{end\text{-}point}$ and $SD_{IOPR} = (SD^2_{baseline} + SD^2_{end\text{-}point} - SD_{baseline} \times SD_{end\text{-}point})^{1/2}$, then $IOPR\% = IOPR/IOP_{baseline}$ and $SD_{IOPR\%} = SD_{IOPR}/IOP_{baseline}$ [17-19]. Furthermore, the reduction in the number of glaucoma medications from pre-operation to post-operation was also assessed according to the methods mentioned above [20].

Success rate was defined as eyes with an IOP ≤ 18 mmHg with or without medications [21]. The rates of adverse events (hyphema, hypotony, choroidal detachment, descemet detachment, corneal erosion, conjunctival leak, shallow anterior chamber) and postoperative surgical interventions (conjunctival suturing, scleral flap revision, laser cyclophotocoagulation, trabeculotomy, express shunt, Ahmed glaucoma valve) were also evaluated.

Statistical analysis

All analysis was conducted using the RevMan software package (version 5.3, Information Management Systems Group, Cochrane Collaboration, and Oxford, United Kingdom). The WMD with a 95% confidence interval (CI) and OR with a 95% CI were used to compare continuous and dichotomous variables. $P < 0.05$ was considered statistically significant for the overall effect. Statistical heterogeneity between studies was analyzed using the I^2 test and $P \leq 0.10$ was considered significant statistical heterogeneity [22]. If $P > 0.10$, fixed effect model would be applied; if $P \leq 0.10$, random effect model would be used [20].

Result

Literature search

Three hundred and ninety-two publications were identified using the predefined search strategy. Two hundred and eighty were excluded because of duplications from multiple databases. After title and abstract review, 84 irrelevant studies were also excluded. The remaining 28 studies were fully reviewed, of these, 23 were excluded for various reasons (reviews, letter, non-comparative studies, German language). Subsequently, five articles with full texts which published between 2011 and 2017 were assessed and included in the meta-analysis [8-12]. Figure 1 provides a flow diagram of the search results.

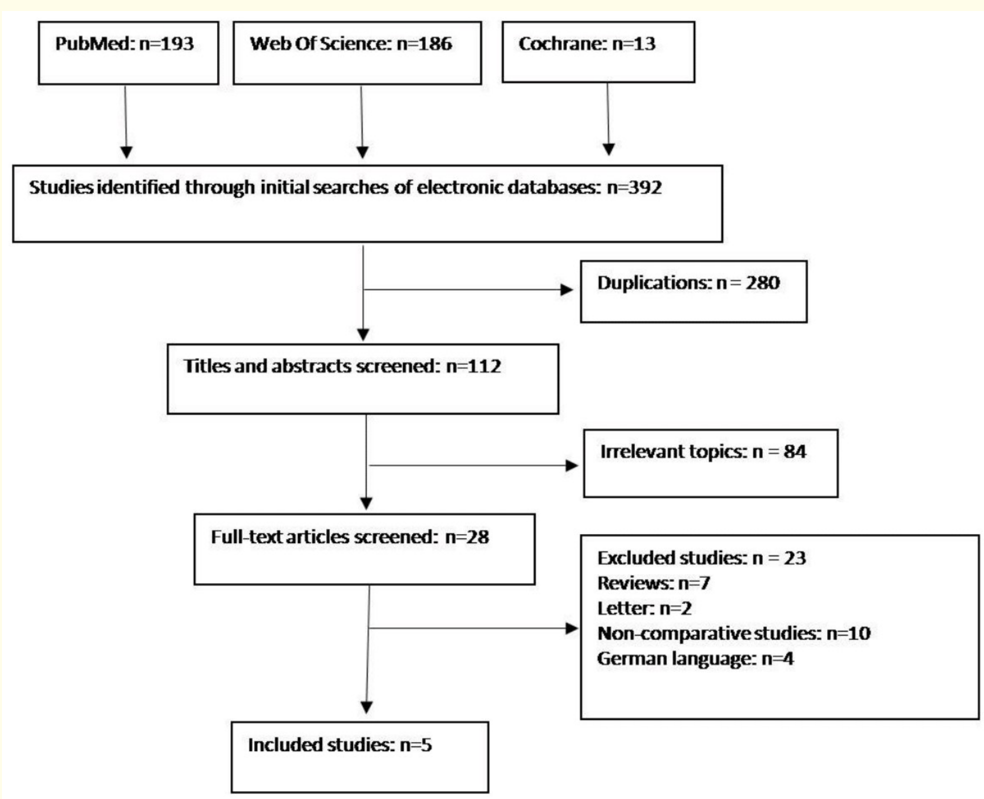

Figure 1: *Flow diagram of studies identified, included, and excluded.*

Characteristics of included studies

Among the eligible studies, there were 1RCTs and 4 retrospective comparative controlled trials. They were conducted in USA and Germany. In total, 287 eyes from 287 patients were analyzed in this meta-analysis, 133 eyes were included in the CP group and 154 eyes in the trabeculectomy group. The mean ages ranged from 66.5 to 72.9 years in the CP group and 64.5 to 73.6 years in the trabeculectomy group. Two of the included retrospective comparative studies concurrently performed Phaco [8,10]. The mean duration of follow up ranged from 12 to 24 months in both groups. Seven types of glaucoma were included in these studies. The baseline characteristics of the eligible studies are summarized in table 1.

Trial (year)	Desigh	Location	Eyes*	Patients*	SexΔ		Age*# (year)	Combination with phacoemulsification	Follow up (mon)*	Type of glaucoma*
					CP	Trab				
Ramesh S (2011)	Non-RCT	USA	33/46	33/46	17/16	26/20	68.3 (10)/64.5 (11.7)	No	12/12	1/1
Juliane (2013)	Non-RCT	Germany	19/20	19/20	9/10	6/14	72.9 (5.7)/73.6 (7.5)	Yes	12/12	2,3,4/2,3,4
Evan D (2015)	Non-RCT	USA	36/41	36/41	24/12	10/31	66.8 (8.5)/70.2 (9.8)	Yes	12/12	1/1
Anne (2013)	Non-RCT	Germany	15/15	15/15	5/10	5/10	69.1 (33-86)/66.0 (33-84)	No	12/12	2,4,5/2,4,5
Juliane (2015)	RCT	Germany	30/32	30/32	18/12	11/21	66.5 (11.3)/67.9 (9.3)	No	24/24	2,4,6,7/2,4,6

Table 1: *Baseline Characteristics of included studies.*

**Canaloplasty/Trabeculectomy*

Δ: Male/Female

#Values are mean(SD) or median (interquartile range)

Abbreviations: *CP: Canaloplasty; Trab: Trabeculectomy; RCT: Randomized Controlled Trail; 1: Open Angle Glaucoma; 2: Primary Open Angle Glaucoma; 3: Primary Angle Closure Glaucoma; 4: Pseudoexfoliation Glaucoma; 5: Low-Tension Glaucoma; 6: Pigmentary Glaucoma; 7: Preperimetricprimary Open Angle Glaucoma.*

Methodological quality of included studies

According to the modified Downs and Black quality assessment scale, all of the included studies were classified as 'fair'. Table 2 shows the quality evaluation of each clinical trial.

Author (year)	Quality Score					Score
	Reporting	External validity	Bias	Confounding	Power	
Ramesh S (2011)	10	1	5	2	0	18
Juliane (2013)	10	1	4	1	0	16
Evan D (2015)	10	1	5	2	0	18
Anne (2013)	9	1	5	1	0	16
Juliane (2015)	9	1	5	3	1	19

Table 2: *Quality Assessment of included studies.*

IOP reduction

The detail data of IOPR% in different follow up phase are shown in table 3. All of the included studies assessed the IOP before and after operation at various follow up time points. IOP at 1 month after surgery was reported in three studies. Results showed that the IOPR% in trabeculectomy was greater than CP (WMD = -13.86, 95% CI = [-20.95, -6.76]; P < 0.001). However, significant heterogeneity was observed (P = 0.1, I^2 = 57%). In sensitivity analysis, no statistical heterogeneity was noted (P = 0.72, I^2 = 0%) after the removal of data from Ramesh S., *et al.* [9] and the results were consistent with the previous ones (WMD = -10.25, 95% CI = [-18.09, -2.41]; P = 0.01). At 3 months, no statistical heterogeneity was observed between three studies (P = 0.36, I^2 = 1%) and the IOPR% in the two groups had no significant difference (WMD = -6.32, 95% CI = [-13.19, 0.55]; P = 0.07). At 6 months (four studies) or 12 months (five studies), the differences in pooled IOPR% between the CP group and the trabeculectomy group were all significant and no statistically significant heterogeneity was noted (6 months: P = 0.81, I^2 = 0%, WMD = -9.1, 95% CI = [-15.4, -2.81]; P = 0.005; 12 months: P = 0.5, I^2 = 0%,WMD = -9.86, 95% CI = [-15.68, -4.04]; P < 0.001). Only one study reported the IOP at 24 months. No difference in the IOPR% was observed between the two groups (WMD = -9.27, 95% CI = [-20.16, 1.62]; P = 0.1).

Study design	Studies (n)	NO. eyes	WMD (95% CI)	Heterogeneity		Over Effect	
		CP/Trab		P	I^2%	Z	P
IOP reduction (1 month)							
Total	3	74/93	-13.86 [-20.95, -6.76]	0.1	57%	3.83	< 0.001
Sensitivity analysis	2	46/52	-10.25 [-18.09, -2.41]	0.72	0%	2.56	0.01
Non-RCT	2	45/61	-18.6 [-39.54, 2.33]	0.04	77%	1.74	0.08
RCT	1	29/32	-11.74 [-23.02, -0.46]			2.04	0.04
IOP reduction (3 months)							
Total	3	71/93	-6.32 [-13.19, 0.55]	0.36	1%	1.8	0.07
Non-RCT	2	45/61	-5.83 [-14.88, 3.23]	0.16	50%	1.26	0.21
RCT	1	26/32	-6.99 [-17.53, 3.55]			1.3	0.19
IOP reduction (6 months)							
Total	4	84/106	-9.1 [-15.4, -2.81]	0.81	0%	2.83	0.005
Non-RCT	3	60/74	-8.58 [-16.46, -0.7]	0.63	0%	2.13	0.03
RCT	1	24/32	-10.03 [-20.51, 0.45]			1.88	0.06
Combination with Phaco	1	17/20	-10.51 [-20.62, -0.4]			2.04	0.04
No combination with Phaco	3	67/86	-8.21 [-16.26, -0.17]	0.66	0%	2	0.05
IOP reduction (12 months)							
Total	5	117/147	-9.86 [-15.68, -4.04]	0.5	0%	2.32	< 0.001
Non-RCT	4	94/116	-9.98 [-16.95, -3.02]	0.34	11%	2.81	0.005
RCT	1	23/31	-9.58 [-20.19, 1.03]			1.77	0.08
Combination with Phaco	2	51/60	-12.13 [-28.21, 3.95]	0.1	62%	1.48	0.14
No combination with Phaco	3	66/87	-10.49 [-18.61, -2.38]	0.72	0%	2.53	0.01
IOP reduction (24 months)							
Total (RCT)	1	23/31	-9.27 [-20.16, 1.62]			1.66	0.1

Table 3: *Comparison of percentage IOP reduction from baseline between canaloplasty group and trabeculectomy group.*

Abbreviations: *IOP: Intraocular Pressure; CP: Canaloplasty; Trab: Trabeculectomy; Phaco: Phacoemulsification; RCT: Randomized Controlled Trail; WMD: Weighted Mean Difference, CI: Confidence Interval*

According to different study design and combination with Phaco or not, subgroup analysis was performed. In Non-RCT group, heterogeneity was statistically significant at 1 or 3 months (1 month: P = 0.04, I^2 = 77%; 3 months: P = 0.16, I^2 = 50%). Random effect models showed that the IOPR% in two groups had no significant differences (1 month: WMD = -18.6, 95% CI = [-39.54, 2.33]; P = 0.08; 3 months: WMD = -5.83, 95% CI = [-14.88, 3.23]; P = 0.21). At 6 or 12 months, however, a higher percentage reduction in IOP was present in trabeculectomy than CP (6 month: WMD = -8.58, 95% CI = [-16.46, -0.7]; P = 0.03; 12 months: WMD = -9.98, 95% CI = [-16.95, -3.02]; P = 0.005). No statistically significant heterogeneity were observed (6 month: P = 0.63, I^2 = 0%; 12 months: P = 0.34, I^2 = 11%). Only one RCT study reported IOP from 1 to 24 months after surgery. The results showed that the differences in the IOPR% between two groups were not significant at 3, 6, 12 or 24 months. In combination with Phaco, the values of IOPR% were statistical greater in trabeculectomy with Phaco group at 6 months (WMD = -10.51, 95% CI = [-20.62, -0.4]; P = 0.04). At 12 months, they were similar with the values of IOPR% in CP with Phaco group (WMD = -12.13, 95% CI = [-28.21, 3.95]; P = 0.14) and significant heterogeneity was observed (P = 0.1, I^2 = 62%). The result of no combination with Phaco group showed that the difference in IOPR% between the two groups was not significant at 6 months (WMD = -8.21, 95% CI = [-16.26, -0.17]; P = 0.05), however, it was significant at 12 months (WMD = -10.49, 95% CI = [-18.61, -2.38]; P = 0.01) and heterogeneities were not significantly different (6 month: P = 0.66, I^2 = 0%; 12 months: P = 0.72, I^2 = 0%).

Success rate

Success rate of CP and trabeculectomy in the treatment of glaucoma was summarized in table 4. In total analysis, five studies reported success rate and no statistical heterogeneity was noted (P = 0.19, I^2 = 34%). It was found that trabeculectomy had a significantly higher success rate than CP (OR = 0.42, 95% CI = [0.2, 0.88]; P = 0.02). In subgroup analysis, the results of four Non-RCT studies which had no significant heterogeneity (P = 0.32, I^2 = 14%) showed that the difference between the two groups was not significant (OR = 0.61, 95% CI = [0.27, 1.38]; P = 0.23). However, in RCT group, the result was consistent with the total analysis (OR = 0.09, 95% CI = [0.01, 0.76]; P = 0.03). In combination with Phaco group, both of CP and trabeculectomy had the similar success rate (OR = 0.49, 95% CI = [0.17, 1.45]; P = 0.2) and heterogeneity was not significantly different (P = 0.35, I^2 = 0%). In no combination with Phaco group, the result was consistent with the above(OR = 0.38, 95% CI = [0.14, 1.02]; P = 0.06), however, significant heterogeneity was observed (P = 0.08, I^2 = 61%). Sensitivity analysis showed that a higher success rate was present in trabeculectomy after removing the study of Anne., *et al.* [12] because of a smaller sample size (OR = 0.17, 95% CI = [0.05, 0.65]; P = 0.009) and heterogeneity was not significantly different (P = 0.35, I^2 = 0%).

Study design	Studies (n)	Rate, n/N		OR (95% CI)	Heterogeneity		Over Effect	
		CP	Trab		P	I^2 %	Z	P
Total	5	110/133	142/154	0.42 [0.2, 0.88]	0.19	34%	2.29	0.02
Non-RCT	4	88/103	111/122	0.61 [0.27, 1.38]	0.32	14%	1.2	0.23
RCT	1	22/30	31/32	0.09 [0.01, 0.76]			2.21	0.03
Combination with Phaco	2	45/55	55/61	0.49 [0.17, 1.45]	0.35	0%	1.29	0.2
No combination with Phaco	3	65/78	87/93	0.38 [0.14, 1.02]	0.08	61%	1.92	0.06
Sensitivity analysis	2	51/63	75/78	0.17 [0.05, 0.65]	0.35	0%	2.6	0.009

Table 4: *Comparison of success rate (12 months)of canaloplasty versus trabeculectomy in the treatment of glaucoma.*

Abbreviations: *CP: Canaloplasty; Trab: Trabeculectomy; Phaco: Phacoemulsification; RCT: Randomized Controlled Trail; OR: Odds Ratio; CI: Confidence Interval.*

Postoperative visual acuity and reduction of glaucoma medications

Four studies reported the postoperative visual acuity (Table 5). The difference between CP and trabeculectomy was not significant (WMD = -0.11, 95% CI = [-0.23, 0.02]; P = 0.09). In subgroup analysis, all of the results were consistent with the previous one. Three studies reported the mean number of reduction of glaucoma medications (Table 5). Compared to CP, the reduction of glaucoma medications was significantly more in trabeculectomy (WMD = -18.41, 95% CI = [-29.38, -7.45]; P = 0.001). But in combination with Phaco group, both of CP and trabeculectomy had the similar reduction of medications (WMD = -27.71, 95% CI = [-56.26, 0.84]; P = 0.06). No significant heterogeneity was observed in all of the groups.

Study design	Studies (n)	WMD (95% CI)	Heterogeneity		Overall effect	
			P	I^2 (%)	Z	P
Postoperative visual acuity						
Total	4	-0.11 [-0.23, 0.02]	0.72	0%	1.71	0.09
Non-RCT	3	-0.11 [-0.26, 0.04]	0.51	0%	1.45	0.15
RCT	1	-0.10 [--0.32, 0.12]			0.91	0.36
Combination with Phaco	2	-0.17 [--0.36, 0.01]	0.81	0%	1.84	0.07
No combination with Phaco	2	-0.06 [--0.22, 0.1]	0.54	0%	0.68	0.5
Reduction of glaucoma medications						
Total	3	-18.41 [-29.38, -7.45]	0.65	0%	3.29	0.001
Non-RCT	2	-17.03 [-29.72, -4.34]	0.41	0%	2.63	0.009
RCT	1	-22.5 [-44.3, -0.7]			2.02	0.04
Combination with Phaco	1	-27.71 [-56.26, 0.84]			1.9	0.06
No combination with Phaco	2	--16.81 [-28.69, -4.92]	0.54	0%	2.77	0.006

Table 5: *Analysis of postoperative visual acuity and reduction of glaucoma medications.*

Abbreviations: *RCT: Randomized Controlled Trail; WMD: Weighted Mean Difference; CI: Confidence Interval.*

Adverse events and postoperative surgical interventions between canaloplasty and trabeculectomy

The postoperative complications were summarized in table 6. Hyphema was the most common complication in the CP group and its incidence was significantly higher than it in the trabeculectomy group (OR = 10.39, 95% CI = [3.77, 28.65]; P < 0.001). The incidences of hypotony, choroidal detachment and corneal erosion, however, were significantly lower in the CP group (OR = 0.18, 95% CI = [0.07, 0.48]; P < 0.001; OR = 0.10, 95% CI = [0.03, 0.4]; P = 0.001; OR = 0.05, 95% CI = [0.01, 0.27]; P < 0.001, respectively). No significant heterogeneity was observed in all of the above groups. Of the three studies that reported the scleral flap revision (Table 7), however, significant heterogeneity was observed (P = 0.03, I^2 = 73%). In sensitivity analysis, the study of Evan D., *et al.* [10] was removed because its results was contrary to the other two studies, then no statistical heterogeneity was noted (P = 0.82, I^2 = 0%). After removing the study, the results showed that more patients in trabeculectomy group underwent scleral flap revision (OR = 0.14, 95% CI = [0.02, 0.83]; P = 0.03).

Adverse events	Studies (n)	Crude event rate, n/N		OR (95% CI)	Heterogeneity		Over Effect	
		CP	Trab		P	I^2 (%)	Z	P
Hyphema	5	32/133	4/154	10.39 [3.77, 28.65]	0.85	0%	3.52	< 0.001
Hypotony	4	6/118	26/139	0.18 [0.07, 0.48]	0.97	0%	3.47	< 0.001
Choroidal detachment	4	1/97	21/113	0.10 [0.03, 0.4]	0.84	0%	3.3	0.001
Descemet detachment	4	4/114	0/134	3.56 [0.70, 18.01]	1.00	0%	1.53	0.13
Corneal erosion	2	1/49	20/52	0.05 [0.01, 0.27]	0.89	0%	3.46	< 0.001
Conjunctival leak	2	3/49	4/52	0.81 [0.19, 3.49]	0.53	0%	0.28	0.78
Shallow anterior chamber	2	0/49	3/52	0.25 [0.03, 2.32]	0.82	0%	1.22	0.22

Table 6: *Comparison of adverse events between canaloplasty and trabeculectomy.*

Abbreviations: CP: Canaloplasty; Trab: Trabeculectomy; OR: Odds Ratio; CI: Confidence Interval.

Surgical interventions	Studies (n)	Crude event rate, n/N		OR (95% CI)	Heterogeneity		Over Effect	
		CP	Trab		P	I^2 (%)	Z	P
Conjunctival suturing	5	2/133	6/154	0.55 [0.16, 1.88]	0.79	0%	0.95	0.34
Scleral flap revision	3	6/85	9/93	0.75 [0.28, 2.01]	0.03	73%	0.56	0.57
Sensitivity analysis	2	1/49	9/52	0.14 [0.02, 0.83]	0.82	0%	2.17	0.03
Laser cyclophotocoagulation	2	5/49	1/52	4.23 [0.66, 26.9]	0.51	0%	1.53	0.13
Trabeculotomy	2	2/63	0/78	3.76 [0.38, 37.1]	0.91	0%	1.14	0.26
Express shunt	2	2/69	2/87	1.3 [0.22, 7.85]	0.43	0%	0.29	0.78
Ahmed glaucoma valve	2	4/69	1/87	3.93 [0.62, 24.85]	0.28	15%	1.46	0.15

Table 7: *Comparison of postoperative surgical interventions between canaloplasty and trabeculectomy.*

Abbreviations: *CP: Canaloplasty; Trab: Trabeculectomy; OR: Odds Ratio; CI: Confidence Interval.*

Discussion

This meta-analysis of 1 RCTs and 4 retrospective studies including 287 eyes comparing the efficacy and safety of CP and trabeculectomy showed that trabeculectomy had higher success rate and significantly reduced IOP and the number of glaucoma medications. However, it also was associated with higher incidence of adverse events except hyphema.

Canaloplasty, a non-filtering, bleb-free method, lowers IOP through restoring natural pathway of aqueous humour. However, trabeculectomy, a filtering, bleb method, lowers IOP though reestablishing a new pathway. In our meta-analysis, filtering bleb had the greater IOP reduction and success rate compared to the CP. Moreover, the more reduction of IOP were achieved with less glaucoma medications. These results suggest that filtering bleb, a new outflow pathway of aqueous humour, may be more effective than natural pathway. However, trabeculectomy combination with phaco achieved a similar efficacy in IOP reduction compared to CP combination with phaco.

Hyphema was the most common complication in CP, which was in accordance with the previous studies [23,24]. It was reported that hyphema might be a positive prognostic factor, because it might be associated with restored aqueous outflow system [25,26]. Interestingly, corneal erosion was the most prevalence complication in trabeculectomy. Possible reasons included the usage of MMC, bleb formation which interferes with the stability of tear film and surgical technique. As mentioned above, filtering bleb significantly reduced IOP, so the incidences of hypotony and choroidal detachment were also higher in the patients treated with trabeculectomy.

It's critical to acknowledge heterogeneity in a meta-analysis [27]. In our study, heterogeneity was notable for the outcomes of IOPR% (1 month), success rate (no combination with Phaco) and the incidence of scleral flap revision. By carefully reviewing these studies, we found that different sample size, study design, results consistency, operative techniques, and various severity in glaucoma might contribute to the heterogeneity. In the leave-one-out sensitivity procedure, excluding asymmetrical or small sample size studied by Ramesh S for the IOP reduction (1 month) or by Anne., *et al*. for the success rate (no combination with Phaco), and contrary results studied by Evan D., *et al*. for the incidence of scleral flap revision, the differences of heterogeneity were dramatically decreased, suggesting that the sample size and results consistency might be the main source of significant heterogeneity. However, the results altered after excluding the latter two studies. Thus, they should be interpreted with caution.

The following limitations must be taken into account in this meta-analysis while interpreting the results obtained in our meta-analysis. The main limitation is that not only RCTs, but also retrospective studies were included. Thus, rational selection and allocation could not be guaranteed which tended to increase the risk of selection bias. Second, the subtypes of glaucoma and the definitions of success rate and complications were varying in these studies. All of them might be the sources of inter-study heterogeneity. Third, the number of studies included in this meta-analysis was only 5. Subgroup analysis in term of the characteristic of participants, types or severity of glaucoma could not be performed due to limited number of included studies. Moreover, meta-regression also could not be used if heterogeneity was significant. Hence, the results should be explained with caution.

Conclusion

In conclusion, our meta-analysis showed that trabeculectomy had better efficacy in reducing IOP and the number of glaucoma medications in take than CP. Moreover, it had higher success rate. However. it also was associated with higher incidence of adverse events except hyphema. Due to some limitations which should be taken with care in the analysis, the results should be interpreted with caution. In future, the standardized assessment criteria should be established and more well-designed RCTs are needed to confirm or update the findings of this analysis.

Bibliography

1. Quigley HA and Broman AT. "The number of people with glaucoma worldwide in 2010 and 2020". *British Journal of Ophthalmology* 90.3 (2006): 262-267.
2. Rolim de Moura C., *et al*. "Laser trabeculoplasty for open angle glaucoma". *Cochrane Database of Systematic Reviews* 4 (2007): CD003919.
3. Razeghinejad MR FS and Spaeth GL. "The changing conceptual basis of trabeculectomy: a review of past and current surgical techniques". *Survey of Ophthalmology* 57.1 (2012): 1-25.
4. Lewis RA., *et al*. "Canaloplasty: Circumferential viscodilation and tensioning of Schlemm's canal using a flexible microcatheter for the treatment of open-angle glaucoma in adults - Interim clinical study analysis". *Journal of Cataract and Refractive Surgery* 33.7 (2007): 1217-1226.
5. Shingleton B., *et al*. "Circumferential viscodilation and tensioning of Schlemm canal (canaloplasty) with temporal clear corneal phacoemulsification cataract surgery for open-angle glaucoma and visually significant cataract: one-year results". *Journal of Cataract and Refractive Surgery* 34.3 (2008): 433-440.
6. Lewis RA., *et al*. "Canaloplasty: Circumferential viscodilation and tensioning of Schlemm canal using a flexible microcatheter for the treatment of open-angle glaucoma in adults Two-year interim clinical study results". *Journal of Cataract and Refractive Surgery* 35.5 (2009): 814-824.
7. Lewis RA., *et al*. "Canaloplasty: Three-year results of circumferential viscodilation and tensioning of Schlemm canal using a microcatheter to treat open-angle glaucoma". *Journal of Cataract and Refractive Surgery* 37.4 (2011): 682-690.
8. Matlach J., *et al*. "Comparison of phacotrabeculectomy versus phacocanaloplasty in the treatment of patients with concomitant cataract and glaucoma". *BMC Ophthalmology* 13 (2013): 1.
9. Ayyala RS., *et al*. "Comparison of surgical outcomes between canaloplasty and trabeculectomy at 12 months' follow-up". *Ophthalmology* 118.12 (2011): 2427-2433.
10. Schoenberg ED., *et al*. "Comparison of Surgical Outcomes Between Phacocanaloplasty and Phacotrabeculectomy at 12 Months' Follow-up: A Longitudinal Cohort Study". *Journal of Glaucoma* 24.7 (2015): 543-549.
11. Matlach J., *et al*. "Trabeculectomy versus canaloplasty (TVC study) in the treatment of patients with open-angle glaucoma: a prospective randomized clinical trial". *Acta Ophthalmologica* 93.8 (2015): 753-761.

12. Bruggemann A., *et al*. "Intraindividual comparison of Canaloplasty versus trabeculectomy with mitomycin C in a single-surgeon series". *Journal of Glaucoma* 22.7 (2013): 577-583.

13. Sara H and Downs NB. "The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions". *Journal of Epidemiology and Community Health* 52.6 (1998): 377-384.

14. Borgert MJ., *et al*. "What are effective strategies for the implementation of care bundles on ICUs: a systematic review". *Implementation Science* 10 (2015): 119.

15. Hooper P JJ and Strong G. "Age-related macular degeneration and low-vision rehabilitation: a systematic review". *Canadian Journal of Ophthalmology* 43.2 (2008): 180-187.

16. Chudyk AM JJ., *et al*. "Systematic review of hip fracture rehabilitation practices in the elderly". *Archives of Physical Medicine and Rehabilitation* 90.2 (2009): 246-262.

17. Higgins JP GS. "Cochrane Handbook for Systematic Reviews of Interventions". Version 510 [updated March, 2011]: The Cochrane Collaboration (2011).

18. Stewart WC KA., *et al*. "Meta-analysis of 24-hour intraocular pressure studies evaluating the efficacy of glaucoma medicines". *Ophthalmology* 115.7 (2008): 1117-1122.

19. van der Valk R WC., *et al*. "Intraocular pressure-lowering effects of all commonly used glaucoma drugs: a meta-analysis of randomized clinical trials". *Ophthalmology* 112.7 (2005): 1177-1185.

20. Tan HaiBo KX., *et al*. "Comparison of Ahmed Glaucoma Valve Implantation and Trabeculectomy for Glaucoma: A Systematic Review and Meta- Analysis". *PloS One* 10.2 (2015): e0118142.

21. Christakis PG TJ., *et al*. "The Ahmed versus Baerveldt study: three-year treatment outcomes". *Ophthalmology* 120.11 (2013): 2232-2240.

22. Higgins JP TS., *et al*. "Measuring inconsistency in meta-analyses". *British Medical Journal* 327.7414 (2003): 557-560.

23. Brusini P CG., *et al*. "Canaloplasty in open-angle glaucoma: mid-term results from a multicenter study". *Journal of Glaucoma* 25.5 (2016): 403-407.

24. Rekas M BA., *et al*. "Canaloplasty versus non-penetrating deep sclerectomy - a prospective, randomised study of the safety and efficacy of combined cataract and glaucoma surgery: 12-month follow-up". *Graefe's Archive for Clinical and Experimental Ophthalmology* 253.4 (2015): 591-599.

25. MC Grieshaber AS, *et al*. "Postoperative microhyphema as a positive prognostic indicator in canaloplasty". *Acta Ophthalmologica* 91.2 (2013): 151-156.

26. Koch JM., *et al*. "[Canaloplasty and transient anterior chamber haemorrhage: a prognostic factor?]". *Klinische Monatsblatter fur Augenheilkunde* 228.5 (2011): 465-467.

27. Minwen Zhou WW., *et al*. "Diabetes Mellitus as a Risk Factor for Open-Angle Glaucoma: A Systematic Review and Meta-Analysis". *PloS One* 9.8 (2014): e0102972.

Volume 9 Issue 6 June 2018