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Original Article

Effects of modified trabeculectomy combined with phacoemulsification and intraocular lens implantation on intraocular pressure and complications in patients with primary open angle glaucoma

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Abstract: Objective: To investigate the effect of modified trabeculectomy combined with phacoemulsification and intraocular lens implantation on intraocular pressure and complications in patients with primary open angle glaucoma. Methods: Clinical data of 114 patients with primary open angle glaucoma were retrospectively analyzed. Forty-nine cases in the research group were treated by modified trabeculectomy combined with phacoemulsification and intraocular lens implantation; the other 65 patients in the control group were treated by trabeculectomy. The preoperative and postoperative intraocular pressure, visual acuity, anterior chamber depth, effective rate of operation and complications of the two groups were compared. Results: There was no significant difference in preoperative intraocular pressure, visual acuity and anterior chamber depth between the two groups (all P>0.05). After operation, intraocular pressure of the research group was significantly lower than that of the control group, and the visual acuity was significantly better than that of the control group (both P<0.001). There was no significant preoperative and postoperative difference in intraocular pressure and visual acuity between the two groups (P>0.05). Anterior chamber depth of the research group was significantly higher than that of the control group (P<0.001), and its preoperative and postoperative difference was also significantly higher in the research group than in the control group (P<0.001). The effective rate of the research group was 100.00%, which was significantly higher than that of the control group (89.23%, P=0.017). The occurrence rate of complications of the research group was 12.24%, which was significantly lower than that of the control group (29.23%, P=0.030). Conclusions: Modified trabeculectomy combined with phacoemulsification and intraocular lens implantation for the treatment of primary open angle glaucoma is superior to traditional single operation, and it provides more significant improvement in terms of complications. It is expected to be an effective means for the treatment of glaucoma in the future.

Keywords: Modified trabeculectomy, phacoemulsification and intraocular lens implantation, primary open angle glaucoma, complication

Introduction

With aging of the population in modern society, eye diseases have become a major clinical problem, among which glaucoma is very common [1]. Study of Wang et al. showed that the incidence of glaucoma increased about 10 times compared with 10 years ago, and it is predicted that the incidence will gradually increase and become the biggest ophthalmological problem in the future [2]. Patients with glaucoma often suffer from optic atrophy and hypopsia, and among patients without properly and timely treatment, 70% might go blind [3, 4]. Due to the high incidence and high risk of glaucoma, more effective treatment plan is explored continuously. The main treatment of glaucoma is to reduce intraocular pressure [5, 6]. Open-angle glaucoma is difficult to treat. The anterior chamber angle of the patients is open, so the outflow resistance of aqueous humor is increased, which highly damages the retinal nerve fiber and more likely to cause optic atrophy [7, 8]. In the early stage, the treatment goal of lowering intraocular pressure was achieved through oral administration, but there were still

Table 1. Comparison of general data

	Research group (n=49)	Control group (n=65)	χ^2/t	P
Age (year)	37.40±10.90	39.30±11.90	0.875	0.384
Course of disease (d)	18.64±4.82	17.84±5.36	0.823	0.412
Weight (kg)	64.25±12.87	66.53±10.92	1.022	0.309
Gender			0.101	0.751
Male	13 (26.53)	19 (29.23)		
Female	36 (73.47)	46 (70.77)		
Diseased eye			0.059	0.809
One eye	20 (40.82)	28 (43.08)		
Both eyes	29 (59.18)	37 (56.92)		
Place of residence			0.116	0.733
Towns	39 (79.59)	50 (76.92)		
Countryside	10 (20.41)	15 (23.08)		

Table 2. Comparison of intraocular pressure (mmHg)

	Research group (n=49)	Control group (n=65)	t	P
Pre-operation	41.58±11.28	42.23±12.37	0.288	0.774
Post-operation	10.24±3.42***	16.27±5.22***	7.025	<0.001
Difference value	29.36±9.17	28.94±12.97	0.193	0.847

Note: ***P<0.001, compared with pre-operation in the same group.

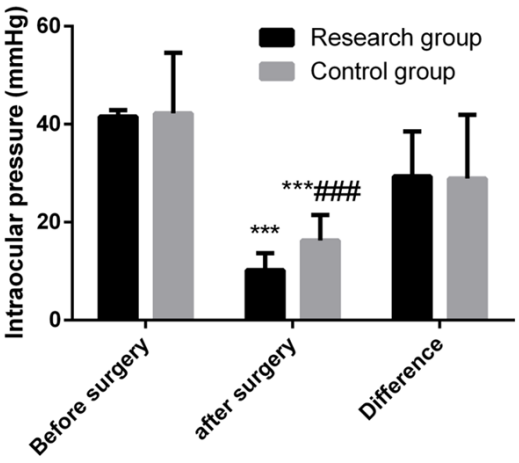

Figure 1. Intraocular pressure before and after surgery. Compared with pre-operation in the same group, ***P<0.001; compared with the research group after surgery, ###P<0.001.

some patients who had no significant improvement after medication. For those patients, surgery was carried out for secondary treatment [9, 10].

Trabeculectomy is currently the most effective surgery to reduce intraocular pressure. Nevertheless, due to the removal of trabecular and adjacent tissues in patients' eyeball, tissue collapse in the eyeball may easily occur, resulting in cataract. How to effectively improve the cure rate, reduce possible complications and improve prognosis of patients with glaucoma is the focus of research [11, 12]. With the continuous progress and development of medical technology and equipments, there are more treatment plans for glaucoma, but prognosis after various treatment methods is different [13-15]. Intraocular lens implantation can effectively avoid other eye diseases caused by the collapse of intraocular tissues after trabeculectomy. It may have higher application value compared with traditional trabeculectomy. During surgical treatment of glaucoma, lens capsule damage may lead to metabolic disorder of lens, resulting in nubecula [16]. The turbid substances in the eyeball can be removed through phacoemulsification with a very small incision, thus greatly reducing the risk of secondary cataract, and a smaller surgical incision is beneficial to the recovery of patients [17]. At present, phacoemulsification combined with intraocular lens implantation is the most commonly used surgical method in clinical treatment of cataract. However, there are few studies reported it for the treatment of glaucoma. Trabeculectomy combined with phacoemulsification and intraocular lens implantation may effectively make up for the shortcomings of traditional single trabeculectomy in treating glaucoma. However, there is a very high demand for the professional knowledge and experience of the main doctor, so due to the difficulty of the operation, its application in clinic is far from comprehensive. In recent years, we performed modified trabeculectomy with phacoemulsification and intraocular lens implantation for the treatment of glaucoma, and achieved effective treatment results. Therefore, we retrospectively analyzed the data of patients with primary open-angle glaucoma treated in Affiliated Nanhua Hospital, University of South China over the past 6 years, so as to analyze the difference between the combined method and traditional method and to provide reference and guidance for clinical treatment of glaucoma.

Table 3. Comparison of visual acuity

	Research group (n=49)	Control group (n=65)	t	P
Pre-operation	0.21±0.07	0.20±0.08	0.488	0.488
Post-operation	0.74±0.18***	0.52±0.27***	4.934	<0.001
Difference value	0.35±0.75	0.37±0.24	0.202	0.840

Note: ***P<0.001, compared with pre-operation in the same group.

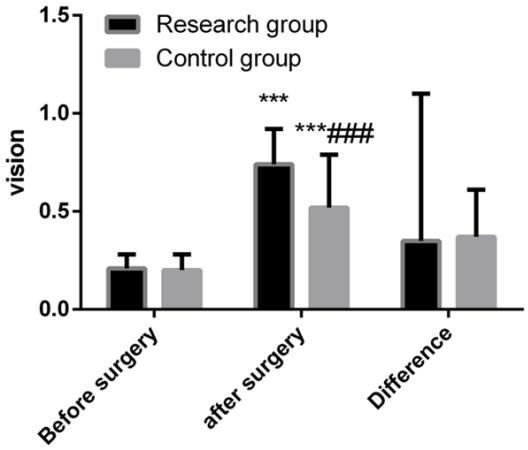

Figure 2. Visual acuity before and after surgery. Compared with pre-operation in the same group, ***P<0.001; compared with the research group after operation, ###P<0,001.

Materials and methods

General data

A total of 114 patients with primary open-angle glaucoma who were admitted to Affiliated Nanhua Hospital, University of South China from February 2012 to January 2018 were selected as subjects. Forty-nine cases treated by modified trabeculectomy combined with phacoemulsification and intraocular lens implantation were regarded as the research group. The other 65 patients treated by trabeculectomy were enrolled in the control group. This experiment was approved by the Ethics Committee of Affiliated Nanhua Hospital, University of South China.

Inclusion criteria: The diagnostic results met the Diagnostic Guidelines of Glaucoma in 2012 [18]; the clinical manifestations conformed to the symptoms of glaucoma, patients diagnosed as primary open-angle glaucoma; patients who received operation after no effective improvement by treating with intraocular pressure-lowering agents in Affiliated Nanhua Hospital, University of South China; patients aged 20-60 years old; patients who followed the arrangement of medical staff; patients with complete data.

Exclusion criteria: Patients with other eye diseases, serious cardiovascular or cerebrovascular diseases, diabetes or cancer; patients with mental defects; patients with physical disabilities; patients with surgical tolerance; patients who transferred to other hospitals during treatment.

Methods

Two incisions were performed during surgery in the research group. The first incision was made for modified trabeculectomy with the corneal limbus as the base. The second incision was made for phacoemulsification with the temporal transparent cornea as the base. Anesthesia was performed at the posterior of eyeball, and the upper rectus muscle was fixed by suture. Mitomycin cotton piece (0.22-0.33 g/L) was placed under the prepared scleral flap and conjunctival flap for 5 min with the corneal limbus as the base, and then the eyes were washed by balanced salt solution repeatedly. After modified trabeculectomy, phacoemulsification was conducted. Viscoelastic solution was injected in through the incision; then hydrodissection and water stratification were performed after posterior continuous curvilinear capsulorhexis. The residual crystal cortex was absorbed during the phacoemulsification process, and the foldable intraocular lens was implanted. A strip shape of trabecular tissues (2 mm * 1 mm) and surrounding iris tissues were excised. The wound was sutured after resection. After the operation, 2.5 mg dexamethasone injection (Shiyao Yinhu Pharmaceutical Co., Ltd., China) was injected under the conjunctiva for analgesia, and tobramycin dexamethasone eye drops (Chengdu Qingshan Likang Pharmaceutical Co., Ltd. China) were instilled daily, 4 times a day for 30 days. In the control group, only trabeculectomy was performed, and the operation procedures were the same as above.

Outcome measures

Main indices: Preoperative and postoperative intraocular pressure (by Goldmann applanation tonometer), visual acuity (by international stan-

Table 4. Comparison of anterior chamber depth (mm)

	Research group (n=49)	Control group (n=65)	t	P
Pre-operation	1.84±0.28	1.79±0.30	0.906	0.368
Post-operation	3.42±0.47***	2.52±0.39***	11.163	<0.001
Difference value	1.57±0.54	0.84±0.52	7.300	<0.001

Note: ***P<0.001, compared with pre-operation in the same group.

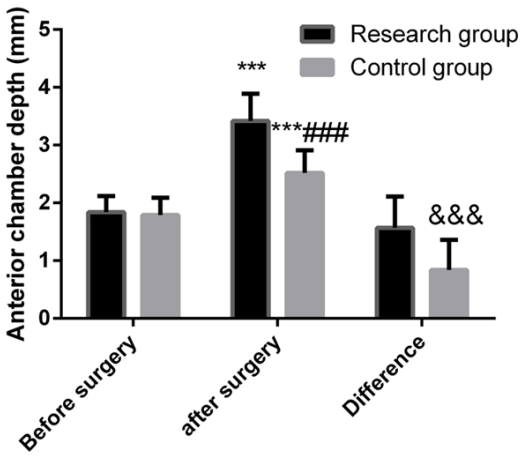

Figure 3. Anterior chamber depth before and after surgery. Compared with pre-operation in the same group, ***P<0.001; compared with the research group after operation, ###P<0.001; comparison of preoperative and postoperative differences between two groups, &&&P<0.001.

dard optotype for acuity measurement) as well as anterior chamber depth (by gonioscope).

Secondary indices: Surgical effects, excellent: intraocular pressure ≤21 mmHg, good: intraocular pressure >21 mmHg, but decreased to ≤21 mmHg after taking lowering intraocular pressure drugs; poor: intraocular pressure >21 mmHg, Effective rate of operation = Patients with (excellent + good) effect/total number * 100%. Complications, Occurrence rate of complications = Cases with complications (one or more)/total number * 100%.

Statistical methods

SPSS 22.0 statistical software was used to process the data. Measurement data such as age, weight and intraocular pressure are expressed as mean ± standard deviation. Paired t test was used for comparison before and after operation within groups; independent sample t test was used for comparison between the two groups (after treatment as well as preoperative and postoperative difference). Count data, such as gender, effect of operation and incidence of complications, are expressed as rate and tested by chi-square. Difference of P<0.05 is considered statistically significant.

Results

Comparison of general data

There were no significant differences in age, course of disease, weight, gender, diseased eye and place of residence between the two groups (all P>0.05), which indicated that the two groups were comparable. See **Table 1**.

Comparison of intraocular pressure

There was no significant difference between preoperative intraocular pressure between the research group (41.58±11.28 mmHg) and the control group (42.23±12.37 mmHg, P=0.774). The postoperative intraocular pressure of the research group was 10.24±3.42 mmHg, which was significantly lower than that of the control group (16.27±5.22 mmHg, P<0.001). There was no significant preoperative and postoperative difference in intraocular pressure between the two groups (P=0.847), which proved that the intraocular pressure of the two groups were effectively improved. See **Table 2** and **Figure 1**.

Comparison of visual acuity

There was no significant difference in preoperative visual acuity between the research group (0.21±0.07) and the control group (0.20±0.08; P=0.488). The postoperative visual acuity in the research group was 0.74±0.18, which was significantly higher than that of the control group (0.52±0.27; P<0.001). However, there was no significant preoperative and postoperative difference in visual acuity between the two groups (P=0.840), indicating that the visual acuity of the two groups of patients was effectively improved after surgery. See **Table 3** and **Figure 2**.

Comparison of anterior chamber depth

There was no significant difference in preoperative anterior chamber depth between the

Table 5. Comparison of effective rate

	Research group (n=49)	Control group (n=65)	χ^2	P
Excellent	44 (89.80)	33 (50.77)		
Good	5 (10.20)	25 (38.46)		
Poor	0 (0.00)	7 (10.77)		
Effective rate (%)	100.00	89.23	5.622	0.017

Table 6. Comparison of complications

	Research group (n=49)	Control group (n=65)	χ^2	P
Fibrinous exudate	4 (8.16)	10 (15.38)		
Anterior chamber hemorrhage	2 (4.08)	8 (12.31)		
Shallow anterior chamber	1 (2.04)	4 (6.15)		
Corneal edema	1 (2.04)	2 (3.08)		
Incidence of complications (%)	12.24	29.23	4.708	0.030

research group (1.84±0.28 mm) and the control group (1.79±0.30 mm; P=0.368). The postoperative anterior chamber depth in the research group (3.42±0.47 mm) was significantly higher than that in the control group (2.52± 0.39 mm, P<0.001). The preoperative and postoperative difference in anterior chamber depth was significantly higher in the research group than in the control group (P<0.001), indicating that the improvement of anterior chamber depth was significantly better in the research group than in the control group. See **Table 4** and **Figure 3**.

Comparison of efficiency rate

The effective rate in the research group was 100.00%, which was significantly higher than that of the control group (89.23%; P=0.017). The excellent rate in the research group was 89.80%, while in the control group was only 50.77%. In addition, no patients in the research group had poor surgical results, while 10.77% of the patients in the control group had poor surgical results. See **Table 5**.

Comparison of complications

The incidence of complications was 12.24% in the research group and 29.23% in the control group, which was significantly lower in the research group than in the control group (P= 0.030). Fibrinous exudate was the most common complication (8.16% in the research group and 15.38% in the control group). There were 4.08% of the patients in the research group with anterior chamber bleeding, 2.04% with shallow anterior chamber, 2.04% with corneal edema, and among all the 6 cases of complications in the research group, there were 2 cases with anterior chamber hemorrhage combined with fibrinous exudate. In the control group, there were 15.38% of patients with anterior chamber fibrinous exudate, 12.31% with anterior chamber hemorrhage, 6.15% with shallow anterior chamber and 3.08% with corneal edema, and among all the 19 cases with complications in control group, there were 5 cases with two complications. See **Table 6**.

Discussion

The modified trabeculectomy combined with phacoemulsification and intraocular lens implantation is a complex operation with high professional requirements for the surgeon, but the efficacy is significant in reducing the intraocular pressure and improving prognosis [19, 20]. The new external drainage channel is established for aqueous humor by trabeculectomy, and phacoemulsification and lens implantation can avoid the collapse of the anterior chamber caused by trabeculectomy as well as deepen and widen the central anterior chamber and the chamber angle, so as to effectively reduce intraocular pressure, maintain unobstructed drainage and prevent complications [21, 22]. In this study, the postoperative intraocular pressure and visual acuity were improved after operation in both groups. The research group had significantly better improvement than the control group in terms of anterior chamber depth, operation efficiency and the incidence of complications. Our results were consistent with the findings of Tetz et al., which corroborated the results of this experiment [23].

The high incidence of complications in the control group was due to the small pupil in the glaucoma patients and the hard nucleus of the lens which could not enjoy the best of the single

operation, and the high incidence might be also about the defects of the operation [24]. The operation skill of the medical staff is one of the key factors to determine the effectiveness of the operation. Eyeball is a very fragile part of the human body. Once the operation is unsuitable, it will easily cause rupture of the fundus blood vessels, resulting in secondary injuries to patients [25]. Therefore, during glaucoma surgery, it is necessary to move gently. Before phacoemulsification, a small incision should be performed at the corneal limbus at three o'clock direction, which will release the excess aqueous humor and reduce the incidence of infection. During the process of lens implantation, close attention should be paid to the perfection of the corneal endothelium so as to provide the best efficacy. At the same time, phacoemulsification with small trauma can greatly reduce the risk of infection and complications that may occur after the operation, and accelerate the recovery of the patients.

There are still some shortcomings in this experiment, such as the small number of subjects and the simple population. Statistical analysis was not carried out in cases with other pathological glaucoma for the small number of received patients. This study aims at exploring the value of modified trabeculectomy combined with phacoemulsification and intraocular lens implantation for primary open angle glaucoma. We will carry out a longer follow-up in subjects of this study, and we will expand the sample size as well as constantly improve our experiments to achieve the best results in the future.

In summary, modified trabeculectomy combined with phacoemulsification and intraocular lens implantation for the treatment of primary open angle glaucoma is superior to traditional single operation, and it provides more significant improvement in terms of prognosis. It is expected to be an effective means for the treatment of glaucoma in the future.

Disclosure of conflict of interest

None.

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