Original Article

The Influence of Surgical and Medical Interventions upon Optic Disc Structure in Patients with Primary Open Angle Glaucoma

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Abstract

Purpose: To evaluate the changes of optic disc parameters in primary open angle glaucoma (POAG) patients after surgical and medical treatment, and analyze the determinants of these changes.

Methods: A total of 67 patients were enrolled in this study. Thirty nine patients (40 eyes) underwent trabeculectomy and 28 patients (32 eyes) received intra-ocular pressure (IOP) lowering medical therapy. All subjects underwent bilateral routine ocular examination and Heidelberg retina tomography (HRT) before treatment and 2 weeks, 1 month, 3 months, 6 months and 1 year after treatment. Changes in optic disc parameters in both the surgical and medical groups were analyzed, as was the influence of disease severity and IOP reduction on these changes.

Results: In the surgical group, the average preoperative IOP was 32.8±8.64 mmHg, which showed a significant decline at each post-operative visit. Most optic disc parameters measured by HRT were significantly improved after trabeculectomy (P = 0.001 ~0.01), though the amount of improvement declined gradually during the post-operative period. Rim volume (RV), cup shape measure (CSM), mean RNFL (mRNFL), RNFL cross sectional area (RNFLA) and vertical cup-to-disc ratio (C/D) still remained significantly below the pre-operative mean one year after surgery. In the medical group, the mean IOP before treatment was 24.8±4.32 mmHg and remained < 21 mmHg on all subsequent post-treatment visits. However, no significant changes in optic disc parameters were found after initiation of medical treatment(F=0.52~2.21, P=0.75~0.07). In the surgical group, the extent of reduction of IOP was positively correlated with the improvement in RV, CSM and vertical C/D (r=0.41~0.58, P=0.001~0.04) at one year after trabeculectomy. The absolute value of the mean deviation on visual field testing was negatively correlated with the improvement of RV and CSM (r=−0.43~−0.62, P=0.03~0.001).

Conclusion: Improvement in optic disc parameters occurred more commonly after surgical than medical treatment in POAG patients. The amount of reduction of IOP was correlated with the extent of this improvement, which may be more limited in more severe glaucoma. (***Eye Science 2011; 26: 185–192***)

Keywords: surgery; medicine; glaucoma; optic disc

Whether the mechanism of glaucomatous optic disc damage lies in mechanical pressure theory, blood supply disorders theory, or both has been heatedly debated. Currently, intraocular pressure reduction remains the most prevalent and effective treatment of glaucoma[1]. In clinical settings, the major tools used for reducing the intraocular pressure for primary open angle glaucoma (POAG) patients include surgical and medical therapies[1]. The structural changes in the optic disc of glaucoma patients serve as a vital physical sign for evaluating the progress of glaucoma-related studies. Observing the changes in the optic disc during follow-ups after surgical and medical interventions has also been regarded as an indispensible procedure for evaluating the treatment efficacy in clinics. Heidelberg retina tomography (HRT-II) can be used to quantitatively analyze the stereo images of the optic disc. Hence, 52 POAG patients were subjected to trabeculectomy by using HRT-II, and 32 subjects received topical intraocular pressure reduction before and after treatments. Then, all participants were followed for one

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year to observe the influence of medical and surgical interventions on the optic disc structure and its changes as time proceeds.

Materials and methods

Study subjects

Operation group: Fifty-two patients (54 eyes) diagnosed with POAG, receiving trabeculectomy between January 2006 and January 2008 in Zhongshan Ophthalmic Center, were enrolled in this study. Subjects excluded from this group were 4 (4 eyes) with whom contact was lost, 2 (2 eyes) receiving repeated operations due to elevated intraocular ocular pressure (IOP), 7 (8 eyes) presenting an aggravated cataract, refraction change, or other fundus lesions. In total, 39 cases (40 eyes) were included in this paper. The average patient age was 45.1±21.7 (17~73)years old, of whom 26 were male (27 eyes) and 13 were female(13 eyes). The preoperative vision acuity was 0.6±0.2; the preoperative IOP was 34.2±7.93 (24~43) mmHg. The preoperative visual field mean defect (MD) was −21.6±10.4 (−3.3~−31.0) dB.

Medicine group: Clinical information was compiled from 35 patients (45 eyes) who were diagnosed and received topical medical therapy in Zhongshan Ophthalmic Center between January 2006 and January 2008. Of these, contact was lost with 4 patients (8 eyes) during follow-up, 1 case (2 eyes) underwent surgical treatment due to uncontrolled IOP, resulting in a final number of 28 patients (32 eyes) enrolled in this investigation. The mean age of all patients was 36.1±16.9 (23~68) years old, of whom 18 were male (21 eyes) and 10 were female (11 eyes). Vision acuity was 1.0±0.1, and the IOP was 24.8±4.32 (22~34) mmHg prior to treatment. The preoperative MD value was -5.22±4.96 (0.31~-13.98) dB.

Inclusion criteria of POAG: ① IOP>21mmHg before surgical and medical treatments or IOP >21 mmHg repeatedly during the daytime measured by Goldmann tonometry; ② those with a retinal nerve fiber layer (RNFL) or optic disc damages or visual field abnormality with glaucoma characteristics; ③ open angle; ④those receiving either trabeculectomy or drug therapy lowering IOP alone.

Exclusion criteria: ① those complicated with other fundus lesions or refraction media opacity prior to surgical or medical treatment, affecting fundus imaging; ② those with IOP>21 mmHg during subsequent follow-up after surgical or medical treatment and requiring supplementary medical or alternative surgical treatments; ③ those with whom contact was lost, but had refraction media changes or other fundus changes affecting fundus imaging and imaging signaling after surgical or medical treatment.

Study procedure

The patients in the operation group received routine ocular examinations, IOP measurements, and HRT optic disc morphology examinations under high IOP level before surgery and 2 weeks, 1 month, 3 months, 6 months and 1 year post-operation. In addition, they also underwent bilateral Humphrey visual field exams preoperatively and 3 months, 6 months, and 1 year postoperatively.

Medicine group: The patients in the medicine group received routine ocular examinations, IOP measurements, and HRT optic disc morphology examinations under high IOP level before surgery and 2 weeks, 1 month, 3 months, 6 months, and 1 year post-operation. In addition, they also underwent bilateral Humphrey visual field exams preoperatively and 3 months, 6 months, and 1 year postoperatively.

Routine ocular examinations included the followings: a correction of visual acuity by a Snellen visual chart, an anterior segment examination by using a slit lamp, a fundus examination using a direct ophthalmoscope, and an IOP measurement by Goldmann tonometry.

HRT examination and analysis method: Retinal tomograhy scanning was performed under mydriatic status by HRT-II (Heidelberg, Germany), and the high-quality images were stored and analyzed. After delineating the optic disc profile, automatic analysis was performed by analyzing software, and the following indexes of optic disc topography were obtained: the optic disc area (DA), the optic cupping area(CA), the rim area (RA), the ratio of disc cupping/disc area (C/DAR), the ratio of the rim area/disc area (R/DAR), the height variation of the optic disc contour (HVC), the optic cupping volume (CV), the rim volume (RV), the maximum optic cupping depth (MxCD), the mean optic cupping depth (MCD), the optic cupping shape measurement (CSM), the mean RNFL thickness (mRNFLT), the cross-section area of RNFL (RNFLA), the horizontal C/D ratio, and the vertical C/D ratio. Each re-examination was conducted under the initial refraction status. The high-quality images were restored and analyzed. Eyes affected by>1D refraction changes were excluded from this study. Visual acuity examination: the visual field was examined with threshold detection program 30-2 of the Humphrey full-automatic perimeter (Carl Zeiss). A field reliability index: default fixation loss rate< 20%, false positive rate<15%, and false negative rate<15% were considered as reliable results.

Statistical analysis

SPSS statistical software was used for data analysis in this study. Optic disc index variations before and after treatment were compared as time proceeded using ANOVA. Optic disc general indexes before and after treatment were compared at various time points using Bonferron's multiple comparison test. The effect of IOP reduction and the course of the disease upon the optic disc structure parameters was analyzed with Spearman correlation analysis. $P>0.05$ was considered as significant difference.

Results

IOP changes between operation and medicine groups before and after treatment

In the operation group, the mean IOP of 39 patients (40 eyes) was 32.8±8.64 mmHg; in the medicine group, the average IOP of 28 cases (32 eyes) achieved 24.8±4.32 mmHg. The IOP in both groups significantly declined after surgical and medical interventions, while a more evident decrease in IOP was found in the operation group (P=0.00), as shown in Table 1.

Table 1 IOP and IOP variations observed at 6 time points between surgical and medical groups (mean ± s)

	Medical group(mmHg)	Operation group(mmHg)	Medical group(%)	Operation group(%)	*t*	*P*
Before treatment	24.8±4.32	32.8±8.64	–	–	–	–
Two weeks after treatment	18.2±3.14	12.5±3.65	30.2±13.8	58.0±9.76	6.68	0.00
One month after treatment	18.2±3.24	13.1±3.90	30.3±13.2	56.1±10.9	5.34	0.00
Three months after treatment	18.8±3.52	13.4±3.33	28.6±14.9	55.2±13.3	5.56	0.00
Six months after treatment	16.9±4.29	14.2±2.60	30.9±16.3	53.3±10.6	4.73	0.00
One year after treatment	18.5±3.72	14.7±2.46	26.5±13.7	51.0±10.7	5.01	0.00

The influence of trabeculectomy upon the structure parameters of the optic disc

For the 39 POAG patients (40 eyes), optic disc parameters were measured at 6 time points preoperatively and postoperatively and then analyzed using the Bartlett Test of Spherity (all $P>0.001$). To illustrate the significant statistical correlation among repeatedly measured values at different time points, ANOVA was adopted to analyze repeated measurements. Statistical results revealed that multiple preoperative parameters including CA, C/DA, CV, CSM, horizontal C/D, and vertical C/D were smaller compared to postoperative parameters, while RA, R/DAR, RV, mRNFL, RNFLA, and HCV significantly improved preoperatively compared to postoperatively ($F=4.355\sim7.50, P<0.05$). No significant difference was noted in MCD and MxCd before and after operation (F=1.84, 1.564, P=0.06, 0.20), as indicated in Table 2.

Bonferron's multiple comparison test found significant differences regarding 11 parameters, except for DA, HCV, MCD, and MxCD before and 6 months post-operation. Significant differences were noted when comparing RV, CSM, RNFL thickness, RNFL cross-sectional area, and vertical C/D before and 1 year after operation, as indicated in Table 3. The optic disc topography 1-year post-operation was ameliorated compared to preoperatively (Figure 1).

The influence of medical treatment upon optic disc structure parameters

The optic disc parameters from 28 POAG patients (34 eyes) at 6 time points were compared using the Bartlett Test of Spherity (all $P>0.001$), suggesting that significant differences exist among various parameters repeatedly measured at different time points. Relevant results indicated that no significant

Table 2 Optic disc parameter changes over time before and after trabeculectomy (mean± s)

Parameters	Before operation	2-week postoperatively	1-month postoperatively	3-month postoperatively	6-month postoperatively	12-month postoperatively	*P*
DA(mm^2)	2.21±0.93	2.21±0.93	2.21±0.93	2.21±0.93	2.21±0.93	2.21±0.93	1.0
CA(mm^2)	1.27±0.60	1.00±0.52	1.00±0.60	1.01±0.55	1.11±0.57	1.19±0.59	0.002*
RA(mm^2)	0.94±0.47	1.21±0.49	1.20±0.45	1.16±0.55	1.11±0.45	1.03±0.53	0.004*
C/DAR	0.57±0.23	0.45±0.25	0.45±0.28	0.46±0.23	0.50±0.25	0.53±0.25	0.004*
R/DAR	0.42±0.23	0.55±0.28	0.55±0.26	0.54±0.23	0.50±0.22	0.47±0.23	0.004*
CV(mm^3)	0.61±0.41	0.38±0.29	0.39±0.18	0.47±0.37	0.45±0.28	0.54±0.41	0.004*
RV(mm^3)	0.16±0.14	0.29±0.18	0.30±0.24	0.26±0.16	0.24±0.18	0.22±0.21	0.002*
MCD(mm)	0.44±0.18	0.40±0.15	0.41±0.17	0.43±0.16	0.42±0.16	0.43±0.18	0.60
MxCD(mm)	0.91±0.31	0.92±0.27	0.92±0.32	0.96±0.29	0.92±0.28	0.89±0.30	0.53
HVC	0.47±0.19	0.53±0.22	0.63±0.31	0.50±0.18	0.49±0.18	0.47±0.16	0.004*
CSM	−0.04±0.1	−0.11±0.1	−0.10±0.1	−0.09±0.1	−0.10±0.1	−0.09±0.1	0.000*
RNFLT(mm)	0.13±0.14	0.23±0.12	0.28±0.20	0.22±0.12	0.23±0.10	0.18±0.12	0.010*
RNFLA(mm^2)	0.67±0.72	1.21±0.63	1.46±1.03	1.18±0.59	1.20±0.50	0.96±0.61	0.007*
Horizontal C/D	0.80±0.22	0.70±0.23	0.65±0.28	0.72±0.21	0.71±0.25	0.76±0.25	0.009*
Vertical C/D	0.77±0.25	0.67±0.25	0.63±0.27	0.67±0.25	0.67±0.26	0.69±0.27	0.009*

Table 3 Comparison of optic disc parameters before and at various time points after operation (mean± s)

Parameters	2-week postoperatively VS preoperatively	1-month postoperatively VS preoperatively	3-month postoperatively VS preoperatively	6-month postoperatively VS preoperatively	1-year postoperatively VS preoperatively
DA(mm^2)	1.000	1.000	1.000	1.000	1.000
CA(mm^2)	0.002	0.012	0.000	0.019	0.18
RA(mm^2)	0.003	0.015	0.00	0.012	0.12
C/DAR	0.00	0.02	0.007	0.01	0.07
R/DAR	0.00	0.02	0.007	0.01	0.07
CV(mm^3)	0.005	0.018	0.007	0.042	0.10
RV(mm^3)	0.000	0.015	0.001	0.004	0.02*
MCD(mm)	0.377	0.151	1.000	1.000	0.726
MxCD(mm)	0.90	0.80	0.22	0.88	0.43
HVC	0.54	0.00	0.62	0.48	0.13
CSM	0.004	0.003	0.007	0.03	0.03*
mRNFLT(mm)	0.000	0.026	0.001	0.003	0.02*
RNFLA(mm^2)	0.00	0.019	0.001	0.002	0.03*
Horizontal C/D	0.005	0.012	0.003	0.02	0.34
Vertical C/D	0.01	0.007	0.005	0.006	0.02*

Table 4 Comparison of optic disc parameters before and at various time points after drug intervention (mean± s)

Parameters	Before operation	2-week postoperatively	1-month postoperatively	3-month postoperatively	6-month postoperatively	12-month postoperatively	*P*
DA(mm^2)	2.34±0.85	2.34±0.85	2.34±0.85	2.34±0.85	2.34±0.85	2.34±0.85	1.0
CA(mm^2)	1.09±0.46	1.03±0.40	1.08±0.49	1.08±0.44	1.08±0.47	1.05±0.44	0.26
RA(mm^2)	1.25±0.31	1.31±0.42	1.26±0.36	1.26±0.35	1.26±0.43	1.29±0.42	0.74
C/DAR	0.47±0.16	0.44±0.10	0.46±0.19	0.46±0.14	0.46±0.17	0.45±0.14	0.6
R/DAR	0.53±0.11	0.56±0.12	0.54±0.16	0.54±0.15	0.54±0.13	0.55±0.14	0.56
CV(mm^3)	0.40±0.25	0.38±0.23	0.39±0.22	0.39±0.24	0.41±0.26	0.37±0.21	0.75
RV(mm^3)	0.35±0.11	0.39±0.16	0.36±0.13	0.35±0.12	0.36±0.15	0.37±0.15	0.56
MCD (mm)	0.43±0.15	0.41±0.13	0.41±0.13	0.42±0.14	0.42±0.13	0.41±0.14	0.29
MxCD (mm)	0.94±0.25	0.96±0.22	0.96±0.24	0.96±0.20	0.95±0.22	0.95±0.24	0.27
HVC	0.54±0.17	0.51±0.17	0.54±0.27	0.46±0.15	0.47±0.13	0.45±0.12	0.30
CSM	−0.11±0.04	−0.13±0.04	−0.13±0.04	−0.11±0.06	−0.11±0.06	−0.13±0.05	0.07
mRNFL (mm)	0.28±0.09	0.31±0.07	0.29±0.08	0.29±0.08	0.29±0.09	0.30±0.08	0.48
RNFLA (mm^2)	1.48±0.48	1.54±0.42	1.51±0.40	1.49±0.42	1.50±0.48	1.50±0.47	0.54
Horizontal C/D	0.73±0.13	0.71±0.14	0.72±0.15	0.72±0.13	0.71±0.15	0.70±0.15	0.88
Vertical C/D	0.62±0.12	0.60±0.12	0.62±0.14	0.62±0.09	0.61±0.12	0.61±0.10	0.85

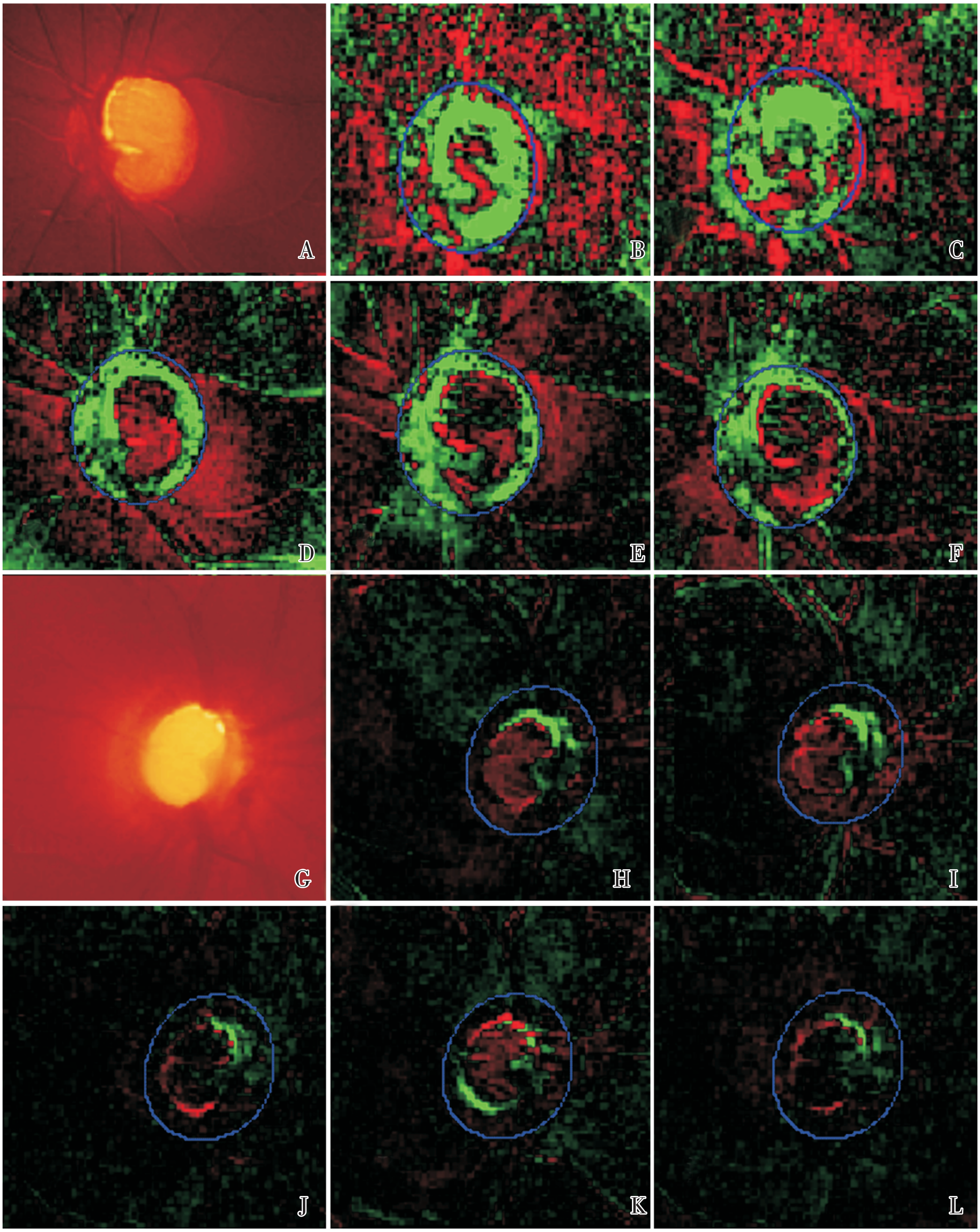

Figure 1 Optic disc topography changes before and after surgical and medicine treatment (The green color indicates improvement was observed compared with the first detection)

A to F indicate optic disc changes before and after surgical intervention (left eye). Patient's info: male, 45 years. A: optic disc topography prior to operation, IOP=32 mmHg; B: 2 weeks postoperatively, IOP=10 mmHg; C: 1 month postoperatively, IOP=12 mmHg; D: 3 months postoperatively, IOP=14 mmHg; E: 6 months postoperatively, IOP=15 mmHg; F: 1 year postoperatively, IOP=15 mmHg. Following the operation, the affected eye showed optic disc resilience and an increased disc rim. The disc rim gained significant improvement 1 year after the operation compared to before the operation.

G to L show optic disc changes before and after medicine intervention (right eye). Patient's info: male, 40 years. G: optic disc topography prior to operation, IOP=25 mmHg; H: 2 weeks postoperatively, IOP= 18 mmHg; I: 1 month postoperatively, IOP=15 mmHg; J: 3 months postoperatively, IOP=17 mmHg; K: 6 months postoperatively, IOP=18 mmHg; L: 1 year postoperatively, IOP=16 mmHg. Optic disc structures underwent insignificant changes before and after medical intervention.

difference was noted among all parameters before and after treatment (F=0.52~2.21, P=0.75~0.07), as shown in Table 4 and Figure 1.

Factors influencing optic disc parameter variations after trabeculectomy correlation analysis between IOP reduction and optic disc structure parameter variation

The Spearman correlation analysis found a positive correlation between IOP reduction and RV, CSM, and vertical C/D improvement 1 year post-operation (r=0.45, 0.41, 0.58; P=0.02, 0.04, 0.00). The greater the decrease in IOP, the more changes occurred in RV, CSM, and vertical C/D compared to pre-operation.

Correlation analysis between preoperative MD and 1 year postoperative optic disc structure parameters

The Spearman correlation analysis indicated a negative correlation between preoperative MD and RV and 1 year postoperative CSM improvement. Prior to operation, the greater the MD value, the fewer changes occurred in RV and CSM (r=−0.43, −0.62; P=0.03, P<0.001).

Discussion

The influence of surgical treatment upon optic disc topography parameters

A substantial amount of studies[2–4] indicated the reversal of the optic cup in glaucoma patients. Topouzis et al[3]. found that partial optic disc parameters presented significant improvement 2 weeks post-trabeculectomy. However, no statistical significance was noted regarding these parameters before and 8 months post-operation. Krzyzanowska et al[4]. noted that CA, CV, RA, RV, MCD, and CSM were evidently ameliorated 2 weeks post-trabeculectomy compared to before the operation. However, a significant difference was merely noted in MCD and CSM before and 12 months after the trabeculectomy. In this study, most optic disc parameters were significantly improved postoperatively within 6 months. However, the improvement in optic disc parameters relatively was withdrawn as postoperative time proceeded. One year post-operation, albeit optic disc parameters showed certain improvement, only RV, CSM, mRNFLT, RNFLA, and vertical C/D presented significant differences before and after the trabeculectomy (P=0.00~0.03), which was in accordance with the outcomes reported by Topouzis and Krzyzanowska. According to Kawasaki et al[5]. the sharply elevated IOP after trabeculectomy probably leads to the imbalance of intracranial pressure and IOP, which induces transient mild edema in the cribriform plate, causes slight edema to the optic disc, and leads to evident improvement in early optic disc structural parameters. In this paper, we equally observed the most significant improvement in the optic disc within the early postoperative period. However, the number of improved parameters shrank as time prolonged. Edema may play a role in substantial improvement of parameters during the early stage of postoperative period. In addition, Kotecha et al[6]. did not observe significant changes in optic disc parameters until 2 years after the operation, which possibly indicates the reason that the average IOP was adjusted to the lowest level 2 years after surgery. In the current investigation, the mean IOP was controlled at a relatively low level of (14.7±2.46) mmHg and declined by 51.0% on average at 1 year after the operation. Hence, partial optic disc parameters still displayed pronounced improvement before and after the operations.

The results in this study indicated that most optic disc parameters showed certain improvement 1 year after the operation. Parameters closely related to glaucoma nerve damages, including RV, CSM, mRNFLT, RNFLA, and vertical C/D, showed significant differences compared with before the operation, which were characterized by an increase in RV, mean RNFL thickness, and the cross-sectional area of RNFL, but a reduction in vertical C/D. All of these changes suggested that the optic disc structure parameters postoperatively gained relative improvement. CSM, as a parameter reflecting the topography of the optic disc, showed significant improvement before and after surgery. Additionally, GSM presented the greatest improvement rate of 175% and 125% 1 year after the operation. CSM serves as an index measuring the topography of the optic disc. Greater GSM value indicates a steeper optic cup. Neither MCD nor MxCD gained significant post-operation improvement. However, CSM measurement was more comprehensive and sensitive compared with linear measurement. Based upon the results above, we noted that the optic disc structure was relatively ameliorated 1 year after the trabeculectomy, suggesting that the optic cup of glaucoma adults is postoperatively reversal. The reversal of the optic cup after surgery appears when the IOP is properly controlled. Raitta et al[7]. found that the patients with a decline in IOP by 30% showed a significant improvement regarding CV 12 months after the operation. The mean IOP (14.7±2.46 mmHg) of those patients enrolled in this study decreased by 50.98% 1 year after surgery; thus this shows the reversal of the optic cup.

The influence of medicine treatment upon optic disc topography parameters

Bowd et al[8]. compared the optic disc parameters of 29 patients with glaucoma and ocular hypertension before, 2 weeks and 4 weeks after IOP-lowering drug therapy, respectively, and found no statistical significance in terms of optic disc parameter variations. Tan et al[2]. reported that approximately 2/3 of OHT and POAG eyes with a decrease in IOP by 25% showed no improvement in RA after receiving drug treatment, suggesting that the optic disc structure merely displays mild changes. Parrish et al[9]. evaluated the optic disc changes before and after surgical and medicine interventions by using fundus photography. During a 5-year follow up, the incidence of the optic cup reversal achieved 21/163 (13%) in the operation group, while only 2/185 (1%) in the medicine group. Our study yielded results similar to those mentioned above. No significant difference was noted when comparing optic disc parameters before and 1, 3, 6, and 12 months after the medicine intervention, respectively. Lesk et al[10]. adopted HRT to analyze glaucoma patients before and after IOP-lowering therapy and found that the optic cup presented significant changes when IOP declined by over 40%. In the current study, the mean IOP in the operation group decreased by 58% during the early stage after operation and declined by 50.98% during the 1-year follow-up. However, the mean IOP in the medicine group dropped by approximately 30% before and after drug administration. The IOP reduction in the medicine group was less than that in the operation group, probably resulting from unapparent optic disc structure changes of affected eyes in the medicine group.

Factors influencing the postoperative changes in optic disc structure parameters

It has been widely recognized that IOP reduction is a factor affecting the changes in optic disc structures. Rath et al[11]. concluded that the optic disc of patients whose IOP was controlled at a relatively low level or was undergoing great IOP reduction easily recovered, while the optic disc of the patients with a slight IOP reduction or whose IOP adjusted to a relatively high level showed only a few changes. In this paper, we found that patients in the medicine group underwent a mild IOP decline and showed no significant changes regarding their optic disc structure parameters. However, subjects in the operation group experienced great IOP reduction and displayed evident improvement in terms of RV, CSM, mRNFLT, RNFLA, and vertical C/D after a 1-year follow-up, reinforcing the notion that IOP reductions serve as a vital factor affecting optic disc reversal. In the current investigation, we analyzed the correlation between IOP reduction and optic disc parameter changes 12 months after the operation and noted that IOP decline positively correlates with changes in RV, CSM, and vertical C/D, indicating that a greater IOP decrease leads to more changes in RV, CSM, and vertical C/D before and after treatment.

MD is considered an important index reflecting the extent of optic nerve damages. Liang Xu et al[12]. observed the biopsy changes in optic discs of glaucoma patients before and after IOP-lowering treatment by using the stereoscopic image flashing method and concluded that the recovery proportion of optic discs in glaucoma patients varied based upon various degrees of damages. The recovery rate for those patients in early and progression stages achieved 74% and 33%, respectively, while the recovery rate for late-stage patients was much lower. The results in this study revealed that the preoperative MD absolute value in the operation group negatively correlates with changes in RV and CSM 1 year after the operation; that is, the greater the MD absolute value, the less changes in RV and CSM, suggesting that the extent of optic nerve damages influence the optic disc changes following IOP lowering treatment. Our results are consistent with those previously reported by Shirakashi et al[13], who observed that the reversibility of the optic disc in glaucoma monkeys with early-stage optic nerve damages was more significant compared with those monkeys at the progression stage. Hernands et al. found that the elastin contained in cribriform plates is different between glaucoma patients and normal subjects. Newly formed elastin was observed in early-stage glaucoma patients; an abnormal increase in enzymatic activity was noted in patients with late-stage glaucoma, which damaged the formation of new elastin. In addition, he also found a reduction regarding the content of collagen in cribriform plates of glaucoma patients, basement membrane proliferation, and the disappearance of elastic tubular fibrous tissues. During late-stage glaucoma, the visual field damages became more severe and cribriform plates showed more evident structural changes but worse compliance, and optic disc parameters gained less improvement. However, the mean MD for the patients in the medicine group was −5.22±4.96 dB, significantly less serious than that in the operation group (−21.6±10.4 dB on average). The reversal of the optic disc was not identified in the medical group, suggesting that IOP reduction is a key factor in optic disc reversal, while the degree of optic nerve damage acts as a supplementary factor.

To sum up, surgical therapy is more efficacious than medicine treatment in terms of IOP control. Optic disc parameter improvement and optic disc resilience are more likely to occur following operation. The amount of reduction of IOP was correlated with the extent of this improvement, which may be more limited in more severe glaucoma.

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