Clinics in Surgery

Research Article
Published: 31 Oct, 2019

Ocular Biometric Changes after Trabectome Surgery

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Abstract

Purpose: To evaluate ocular biometric changes after trabectome surgery.

Design: Prospective non-randomized cohort study.

Methods: We evaluated ocular biometric change in 97 eyes of 81 patients who underwent trabectome surgery at Kitasato University Hospital, involving 37 eyes of 32 patients who underwent trabectome surgery alone (Trab-alone) and 60 eyes of 49 patients who underwent trabectome surgery combined with cataract surgery (Trab-combined). Intraocular Pressure (IOP), Axial Length (AL), Anterior Chamber Depth (ACD), and mean keratometry (mean K) were compared with before and after the surgery. Moreover, comparison of the changes in AL (ΔAL) and IOP (ΔIOP) was done using correlation analysis for each group. IOL MasterTM (Carl Zeiss Meditec Inc.) was used for the biometric measurements.

Result: Three months after surgery, IOP was reduced from 24.4 ± 7.1 to 15.7 ± 3.3 mmHg in the Trab-alone group, from 24.7 ± 6.4 to 15.0 ± 5.8 mmHg in the Trab-combined group (Wilcoxon signed-rank test; P<0.001, P<0.001, respectively). AL was reduced from 25.17 ± 2.16 to 25.12 ± 2.14 mm in the Trab-alone group, from 24.09 ± 1.31 to 23.95 ± 1.30 mm in the Trab-combined group (Wilcoxon signed-rank test; P<0.001, P<0.001, respectively). ACD in the Trab-alone group was decreased slightly from 4.16 ± 0.78 to 4.12 ± 0.80 mm, and in the Trab-combined group was increased 3.14 ± 0.39 to 4.63 ± 0.45 mm. Change of ACD was not significant in the trab-alone group, whereas, it was significant in the Trab-combined group (Wilcoxon signed-rank test; P=0.539 and P<0.001). Mean K in the Trab-alone group was increased slightly from 44.13 ± 1.68 D and 44.19 ± 1.80 D, and in the Trab-combined group 44.46 ± 1.63 to 44.55 ± 1.61 D. Change of mean K was not significant in both groups (Wilcoxon signed-rank test P=0.484 and P=0.202). A significant correlation was recognized between ΔIOP and ΔAL in Trab-alone and Trab-combined groups (Spearman's rank correlation coefficient: R=0.577, P<0.001; R=0.402, P=0.002, respectively).

Conclusion: Ocular biometric changes was shown after trabectome surgery, indicating that we should take notice of the change of postoperative refraction or the refractive error after trabectome surgery combined with cataract surgery in the case whose preoperative IOP was higher.

Keywords: Glaucoma; Trabectome; Trabeculectomy; IOP; Axial length; Ocular biometry

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Received Date: *23 Sep 2019*
Accepted Date: *23 Oct 2019*
Published Date: *31 Oct 2019*

Citation:
Kono Y, Kasahara M, Iida Y, Tsujisawa T, Shoji N. Ocular Biometric Changes after Trabectome Surgery. Clin Surg. 2019; 4: 2634.

Introduction

Aging due to medical development, glaucoma and cataract patients are increasing. As a result, opportunities for glaucoma and cataract surgery have increased. Trabeculectomy is a surgical procedure which can obtain a long-term reduction of Intraocular Pressure (IOP), however, significant reduction of IOP can result in ocular biometric changes [1] which might cause a visual disturbance. On the other hand, Minimally Invasive Glaucoma Surgery (MIGS), including trabectome surgery, would need a small incision and be thought a less likely to influence ocular biometry. MIGS is thought to be an effective performed simultaneously with cataract surgery [2]. To decrease the amount of refraction error after surgery, accurate calculation of the Intraocular Lens (IOL) power is necessary. Therefore, it is very important to know ocular biometric changes after the surgery; however, there are no reports on ocular biometric changes after trabectome surgery. The purpose of this retrospective study was to compare ocular biometry before and after trabectome surgery and to know how much change of ocular biometry after trabectome surgery.

Materials and Methods

Study design and data collection

This was a retrospective clinical study that was performed in compliance with the tenets of the Declaration of Helsinki after obtaining approval from the Ethics Committee at Kitasato University

Hospital. Patients who underwent trabectome surgery for the first time at Kitasato University Hospital between April 2015 and April 2017 and have been followed for at least 3 months. Demographics and baseline characteristics of the study subject were shown in Table 1. Patients who underwent additional glaucoma surgery were not involved in this study. Totally 97 eyes of 81 glaucoma patients who performed trabectome surgery were divided into 2 groups; One was a Trab-alone group consisted of 37 eyes of 32 patients who underwent trabectome surgery alone, the other was Trab-combined group consisted of 60 eyes of 49 patients underwent trabectome surgery combined with cataract surgery. IOP and Ocular biometry were compared before and after surgery in each group. IOP was measured using the Goldmann-applanation tonometer. Ocular biometry was measured using the IOL Master™ (Carl Zeiss Meditec, Dublin, CA, USA). As the main outcome, IOP, Axial Length (AL), Anterior Chamber Depth (ACD), and mean keratometry (mean K) at the baseline and at 3 months after surgery were compared. Moreover, the change in AL (ΔAL; Post AL- Pre AL) and the change in IOP (ΔIOP; Post IOP- Pre IOP) was compared using correlation analysis.

Surgical technique

Surgery was performed by three surgeons (NS, KM, and MK) using a trabectome system (Neomedix Inc., Tustin, CA, USA). Patients with cataract were offered combined surgery. In the combined surgery, trabectome was performed prior to phacoemulsification. Details of the surgical technique have been previously published [3.4]. In brief, after topical anesthesia was applied using 0.75% lidocaine hydrochloride eye drops, a 1.7 mm temporal corneal incision was made near the corneal limbus and an ophthalmic viscosurgical device was injected for maintaining the anterior depth. Surgery was performed under gonioscopic control using the Hill Surgical Gonioprism (Ocular Instruments, Bellevue WA, USA) or the Swan Jacob Gonioprism (Ocular Instruments). The trabectome handpiece was advanced nasally and inserted through the trabecular meshwork, and the trabecular meshwork was removed over 90 to 120 degrees with a fixed power of 0.8 W. The intraocular reflex bleeding was then removed using a Simcoe cannula for trabectome alone or using an irrigation and aspiration system after IOL insertion for combined surgery. After combined surgery, the corneal wound was sutured using an 11-0 nylon suture. For the trabectome alone group, suturing was not performed. A monofocal IOL (AQ-11NV; STAAR Surgical, CA, USA) was implanted into the capsular bag.

Data analysis

Wilcoxon's signed-rank test was used to compare the baseline and post-operative IOP, AL, ACD, and mean K. Mann-Whitney's U test was used to compare the various parameters of the patients' background before the surgery, and Fisher's exact test was used for gender comparisons. Statistical significance was set at $p<0.05$ in all tests. Spearman's rank correlation coefficient was used to examine the correlations between the differences ΔIOP and ΔAL.

Results

Changes in IOP, AL, ACD, and mean K in all patients after trabectome surgery are showed in Table 2. IOP was reduced significantly from 24.6 ± 6.6 to 15.2 ± 5.0 mmHg (Wilcoxon signed-rank test P<0.001), AL was shortened significantly from 24.50 ± 1.76 to 24.40 ± 1.76 mm (P<0.001), and ACD was increased significantly from 3.52 ± 0.75 to 4.39 ± 0.69 mm (P<0.001). Mean K did not change significantly (P=0.196). Next, the results according to the surgery type are showed in Table 3 and 4. IOP in the Trab-alone group was reduced from 24.4 ± 7.1 to 15.7 ± 3.3 mmHg, and in the Trab-combined group was reduced 24.7 ± 6.4 to 15.0 ± 5.8 mmHg. Change of IOP was a significant in both groups (Wilcoxon signed-rank test P<0.001 and P<0.001). AL in the Trab-alone group was shortened 25.17 ± 2.16 to 25.12 ± 2.14 mm, and in the Trab-combined group 24.09 ± 1.31 to 23.95 ± 1.30 mm.

Table 1: Demographic and baseline characteristics of the study subject.

	Total	Trab-alone	Trab-combined	P-value
No. of eyes	97	37	60	
Age (year)				
Mean ± SD	66.1 ± 16.3	58.5 ± 16.9	70.8+14.2	<0.001
Range	18-89	22-83	18-89	
Female/male (eyes)	53/44	16/21	37/23	0.0593
Preop IOP (mmHg)				
Mean ± SD	24.6 ± 6.6	24.4 ± 7.1	24.7 ± 6.4	0.8031
Range	12-49	15-49	12-49	
Preop AL (mm)				
Mean ± SD	24.50 ± 1.76	25.17 ± 2.16	24.09 ± 1.31	0.0057
Range	21.41-30.95	21.41-30.95	22.04-27.29	
Preop ACD (mm)				
Mean ± SD	3.52 ± 0.75	4.16 ± 0.78	3.14 ± 0.39	<0.001
Range	1.99-5.96	2.70-5.96	1.99-4.08	
Preop mean K(D)				
Mean ± SD	44.34 ± 1.65	44.13 ± 1.68	44.46 ± 1.63	0.3437
Range	40.85-47.64	41.05-47.64	40.85-47.12	

The P values were calculated using Mann-Whitney's U test to compare between the Trab-alone and the Trab-combined group, and sex was compared using Fisher's exact test.
Abbreviations: Trab-alone: Only Trabectome Surgery; Trab-combined: Cataract and Trabectome Surgery; IOP: Intraocular Pressure; AL: Axial Length; ACD: Anterior Chamber Depth; CP: Corneal Power; SD: Standard Deviation

Table 2: Changes in IOP, AL, ACD, and mean K in all patients.

Parameter	Pre (Mean ± SD)	Post (Mean ± SD)	Post-Pre (Δ) (Mean ± SD)	P-value
IOP (mmHg)	24.6 ± 6.6	15.2 ± 5.0	-9.4 ± 6.7	<0.001
AL (mm)	24.50 ± 1.76	24.40 ± 1.76	-0.10 ± 0.08	<0.001
ACD (mm)	3.52 ± 0.75	4.39 ± 0.69	0.87 ± 0.85	<0.001
Mean K (D)	44.34 ± 1.65	44.42 ± 1.69	0.08 ± 0.39	0.196

The P values were calculated using Wilcoxon's signed-rank test to compare the postoperative data with the baseline data.
Abbreviations: Trab-alone: Only Trabectome Surgery; Trab-combined: Cataract and Trabectome Surgery; IOP: Intraocular Pressure; AL: Axial Length; ACD: Anterior Chamber Depth; mean K: Mean Keratometry

Table 3: Changes in IOP, AL, ACD, and mean K values in the Trab-alone group.

Parameter	Pre (Mean ± SD)	Post (Mean ± SD)	Post-Pre (Δ) (Mean ± SD)	P-value
IOP(mmHg)	24.4 ± 7.1	15.7 ± 3.3	-8.8 ± 8.0	<0.001
AL(mm)	25.17 ± 2.16	25.12 ± 2.14	-0.06 ± 0.08	<0.001
ACD(mm)	4.16 ± 0.78	4.12 ± 0.80	-0.04 ± 0.18	0.5390
Mean K (D)	44.13 ± 1.68	44.19 ± 1.80	0.06 ± 0.49	0.4840

The P values were calculated using Wilcoxon's signed-rank test to compare the postoperative data with the baseline data.
Abbreviations: Trab-alone: Only Trabectome Surgery; Trab-combined: Cataract and Trabectome Surgery; IOP: Intraocular Pressure; AL: Axial Length; ACD: Anterior Chamber Depth; mean K: Mean Keratometry

Table 4: Changes in IOP, AL, ACD, and mean K values in the Trab-combined group.

Parameter	Pre (Mean ± SD)	Post (Mean ± SD)	Post-Pre (Δ) (Mean ± SD)	P-value
IOP (mmHg)	24.7 ± 6.4	15.0 ± 5.8	-9.8 ± 5.8	<0.001
AL (mm)	24.09 ± 1.31	23.95 ± 1.30	-0.13 ± 0.07	<0.001
ACD (mm)	3.14 ± 0.39	4.63 ± 0.45	1.50 ± 0.47	<0.001
mean K (D)	44.46 ± 1.63	44.55 ± 1.61	0.09 ± 0.32	0.2020

The P values were calculated using Wilcoxon's signed-rank test to compare the postoperative data with the baseline data.

Abbreviations: Trab-alone: Only Trabectome Surgery; Trab-combined: Cataract and Trabectome Surgery; IOP: Intraocular Pressure; AL: Axial Length; ACD: Anterior Chamber Depth; mean K: Mean Keratometry

Change of AL was a significant in both groups (Wilcoxon signed-rank test P<0.001 and P<0.001). ACD in the Trab-alone group was decreased slightly from 4.16 ± 0.78 to 4.12 ± 0.80 mm, and in the Trab-combined group was increased 3.14 ± 0.39 to 4.63 ± 0.45 mm. Change of ACD was not significant in the trab-alone group, whereas, it was significant in the Trab-combined group (Wilcoxon signed-rank test P=0.539 and P<0.001). Mean K in the Trab-alone group was increased slightly from 44.13 ± 1.68 D and 44.19 ± 1.80 D, and in the Trab-combined group 44.46 ± 1.63 to 44.55 ± 1.61D. Change of mean K was not significant in both groups (Wilcoxon signed-rank test P=0.484 and P=0.202). We found a significant correlation between ΔIOP and ΔAL in trab-alone and trab-combined groups (Spearman's rank correlation coefficient: R=0.577, P<0.001; R=0.402, P=0.002, respectively; Figure 1 and 2).

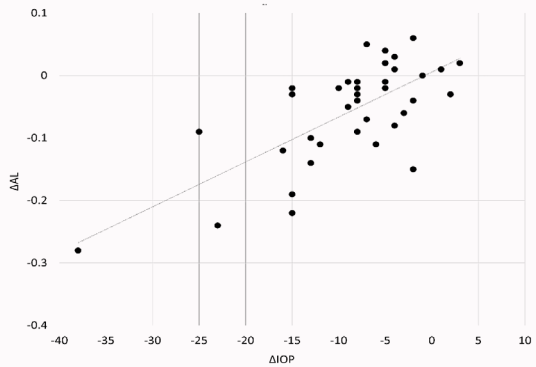

Figure 1: Relationship between ΔIOP and ΔAL in the Trab-alone group.
Notes: ΔIOP=Post IOP-Pre IOP, ΔAL=Post AL-Pre AL; R=0.577, P<0.001.

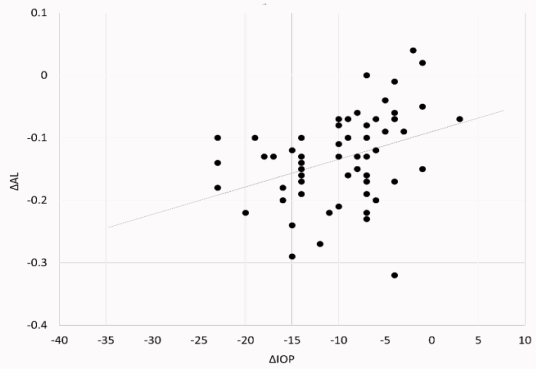

Figure 2: Relationship between ΔIOP and ΔAL in the Trab-combined group.
Notes: ΔIOP=Post IOP-Pre IOP, ΔAL=Post AL-Pre AL; R=0.402, P=0.002.

Discussion/Conclusion

Recently, surgical procedures such as trabectome surgery, termed as MIGS, are selected as an appropriate modality for early- to mid-stage glaucoma [2]. Because trabectome surgery could be performed through a small clear corneal incision, trabectome surgery combined with cataract surgery increased and was thought more effective from the aspect of IOP reduction. However, it is not clear whether the combined procedure would increase the postoperative refractive error. For the patient who need cataract surgery, the accurate IOL power calculation needs to decrease the refractive error. Therefore, it is very important to evaluate ocular biometric changes after trabectome surgery. On the other hand, it is well known that the change of ocular biometry was significant because IOP would be reduced drastically after trabeculectomy. There are many reports on the ocular biometric changes after trabeculectomy [1,5-11]. AL was shortened significantly between 0.10 and 0.30 mm at 3 months after trabeculectomy alone by not- contact biometry [5-9]. Karasheva reported ACD was almost unchanged at all postoperative visit after trabeculectomy alone by not-contact biometry [9]. Pakravan and Alvani reported mean K was a significantly steep change between 0.27 and 0.41 D after trabeculectomy [10,11]. In contrast, the AL after cataract surgery shortened between 0.08 and 0.10 mm. This result is considered an effect on measurement due to the change from a crystalline lens to IOL [12-14]. Trabectome surgery dose not need a large incision and a tight suture such as trabeculectomy, so it was thought that trabectome surgery would not influence on ocular biometry after surgery. However, there has been no study on ocular biometric changes after trabectome surgery. In this study, change of IOP was significant in both the Trab-alone and Trab-combined groups. IOP after trabectome has been reported to decrease to approximately 15 to 16 mmHg, which was the same as that previously reported [16-22]. AL was shortened after surgery in both groups. The correlation between ΔIOP and ΔAL means that shortening the AL of trab-alone group is the effect IOP reduction. Moreover, AL shortened to a greater extent in the Trab-combined group than in the Trab-alone group. This was a result of the IOP reduction and the change from a crystalline lens to IOL. Francis reported that the larger IOP reduction, the shorter is AL after trabeculectomy. Compared with trabeculectomy, IOP reduction from 24.6 ± 6.6 mmHg to 15.2 ± 5.0 mmHg was small, so AL shortening was also small in this study. When combined with cataract surgery, it is necessary to pay attention to post-operative refractive errors. Mean K slightly changed but was not significantly different, suggesting that IOP reduction has little effect on mean K. As for ACD, there was no change in the Trab-alone group. In the Trab-combined group, ACD increase by replaceing crystaline lens with IOL, which was reported previously [13]. Based on the above findings of AL, ACD, and mean K, IOP reduction has less effect on the ocular biometric changes after trabectome surgery compared to trabeculectomy. The larger IOP reduction, the shorter is AL after surgery, so patients with pre-operative high IOP should be careful before surgery. The limitations of this study are that it was a retrospective study, and the selection of patients was biased. Moreover, although measured after more than 3 months after surgery, the measurement point varied from patient to patient, which likely affected the results. This is the first study about ocular biometric changes after trabectome surgery. Ocular biometric changes was showed after trabectome surgery, indicating that we should take notice of the change of postoperative refraction or the refractive error after trabectome surgery combined with cataract surgery in the case whose preoperative IOP was higher.

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