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Influence of Anatomical Characteristics of Tube on Corneal Endothelial Cell Loss After Ahmed Glaucoma Valve Implantation

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ABSTRACT

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Purpose: The aim of this study was to evaluate the effect of the anatomical features of the tube on corneal endothelial cell loss after the implantation of the Ahmed valve using the anterior segment optical coherence tomography (AS-OCT).
Methods: Anatomical features of the tube in the anterior chamber using AS-OCT was evaluated in 47 eyes from 47 patients who underwent the Ahmed valve implantation by a single surgeon. The central corneal endothelial cell density (ECD) was measured before and after surgery using a specular microscopy and the reduction rate of ECD was calculated. The effect of anatomical features of the tube on ECD reduction was analyzed using multiple regression analysis adjusting other clinical factors that could affect loss of ECD.
Results: The mean follow-up periods was 19.4 ± 12.2 months after the Ahmed valve implantation. ECD was significantly reduced from 2499.4 ± 689.7 to 1776.1 ± 763.7 after the operation ($P = 0.001$). The reduction rate of ECD showed negative correlation with the distance between tube and cornea and positive correlation with the angle and distance between tube and iris with statistical significance in the univariate regression analysis. However, only angle between tube and iris was correlated with reduction

rate of ECD with statistical significance in the multivariate regression analysis (P = 0.017).

Conclusions: This study suggests that the central ECD reduction rate was significantly faster when the angle between the AGV tube and the iris was greater. In particular, if the length of the AGV tube is short as in the present study, how much the tube enters the anterior chamber in parallel with the iris may have an important influence on the ECD change.

Key words: anterior segment optical coherence tomography, corneal endothelium, ahmed glaucoma valve

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I. INTRODUCTION

Recently, glaucoma drainage devices (GDDs) has been considered as one of the important primary surgeries in glaucoma in addition to trabeculectomy. The results from the Tube Versus Trabeculectomy Study revealed that the tube shunt surgery had a higher success rate compared to trabeculectomy with MMC during 5 years of follow-up, with similar reductions in intraocular pressure and the need for supplemental glaucoma medications.[1]

However, the corneal endothelial damage was the most widely known long-term complications of the GDD implantation. Corneal decompensation complications occurred twice as many in the GDD implantation group compared to the trabeculectomy group.[2]

Though, the causes of corneal endothelial cell loss have not yet been clarified and various hypotheses have been raised.[3-5] One of them is that the damage of the corneal endothelium is accelerated depends on the location of the silicone tube located in the anterior chamber. The recent development of the anterior segment optical coherence tomography (AS-OCT) provided an opportunity to view the section of the internal structure in the anterior chamber. Koo et al.[6] reported that the distance between the corneal endothelium and the valve tube measured by AS-OCT was significantly associated with the loss of the corneal endothelial cell. However, this study has its limitations. It only took into account the distance between the valve and the cornea, the length of the valve, and the angle between the valve and the cornea. Other meaningful factors such as the characteristics of the anterior chamber angle, the type of glaucoma, the distance between the iris and the valve, and the intraocular pressure were not taken into consideration.

Thus, I investigated the anatomical characteristics of the tube using anterior segment optical coherence tomography after Ahmed valve implantation. Additionally, I analyzed the effect of the anatomical characteristics of the insertion tube on the corneal endothelial cell loss.

II. MATERIALS AND METHODS

Subjects

This study followed the tenets of the Declaration of Helsinki and was approved by the Severance Hospital Institutional Review Board, Seoul, South Korea. The clinical records of the patients seen at the glaucoma clinic of Severance Hospital at Yonsei University College of Medicine who had undergone Ahmed glaucoma valve (AGV-FP7, New World Medical, Inc., Rancho Cucamonga, CA) implantation surgery between January 2012 and September 2016 were reviewed retrospectively. Surgery was performed if the IOP was > 21 mmHg and there was progression of optic nerve head damage, a retinal nerve fiber layer defect, or a visual field defect despite undergoing a maximum tolerated oral or topical anti-glaucoma medical therapy. All surgeries were conducted by a single surgeon (CY Kim). I included patients aged ≥20 years who had undergone preoperative and postoperative specular microscopy (Topcon SP-3000P; Topcon Corp., Tokyo) and postoperative RTVue-100 Fourier-domain optical coherence tomography (RTVue-100 FD OCT, Optovue, Inc., Fremont, CA, USA).

Exclusion criteria for study participants were as follows: congenital glaucoma; corneal endothelium-related disease; receiving corneal transplantation; undergoing cataract surgery at the same time as Ahmed valve implantation; corneal endothelial dysfunction before surgery; receiving intra-ocular surgery within 6 month before Ahmed valve implantation. Patients with these conditions were excluded because these corneal disease or procedure could affect the measurement of the corneal endothelial cell. Moreover, patients whose anterior segment OCT images were of poor quality and cannot be analyzed were exclude. Also, patients who were not followed up for more than 6 months after surgery were excluded.

A subgroup analysis was performed to determine the characteristics of the patients according to the endothelial cell density (ECD) reduction rate. The decrease in corneal endothelial cells has been reported to be between 10.5% and 15.3% at 12 months after GDD surgery with tube insertion into the anterior chamber (AC).[7-10] Therefore, subgroup analysis was performed on the two groups which I divided between those with ECD reduction rate of over 15% per year and those with less than 15%. The former group I call it the fast group and the latter, the slow group.

All subjects underwent preoperative examination including intraocular pressure (IOP), anterior chamber depth, specular microscopy, and RTVue-100 FD OCT. These examinations were repeated at 6–12-month interval after AGV implantation, as necessary. IOP was assessed using a Goldmann applanation tonometer. Anterior chamber depth was measured using IOL master ocular biometric device (Carl Zeiss Meditec, Jena, Germany). Systemic diseases, previous filtering surgery, anti-glaucoma eye drop use and other clinical histories were collected from patient charts.

Surgical technique

AGV implantation was performed following a conventional method. Under sub-tenon anesthesia, a fornix-based conjunctival incision was made and the tenon capsule was dissected with spring scissors. A 4 × 4 mm right-angled rectangular shaped partial-thickness scleral flap and a continuous 2 mm wide × 6 mm long bridge shaped partial-thickness scleral flap were constructed in the supratemporal position of the limbus. Tube priming was performed with balanced salt solution irrigation. The Ahmed valve was positioned in the middle of the quadrant, with the anterior edge of the plate located 8–10 mm posterior to the corneoscleral limbus, and it was fixed at the sclera with two 8-0 polypropylene sutures. The tube was placed under the bridge flap and its tip was cut to the proper length so that the tube could be inserted into and maintained adequately in the anterior chamber. An entrance site into the anterior chamber was made under the scleral flap at the beginning of the blue scleral-limbal interface with a 23-G needle. The tube of the valve was then passed through this 23-G opening into the anterior chamber. 2 sutures were placed at the end of the rectangular scleral flap with a 10-0 nylon. The conjunctiva and Tenon capsule were reapproximated to the limbal area with interrupted 8-0 polyglactin sutures. Topical steroid and antibiotic eye drops were prescribed for 8 weeks, and the patients were observed closely.

Corneal endothelium

Specular microscopy using a non-contact type specular microscopy (Topcon SP-3000P; Topcon Corp., Tokyo, Japan) was performed by one experienced examiner and endothelial cell data were based on the average of two measurements. At least 50 contiguous endothelial cells were hand-marked; a computer algorithm calculated the values. All ECD measurements were made only at the center of the cornea. The ECD measurements were performed preoperatively and postoperatively. Among all postoperative ECD tests which were performed later than 6 months after surgery, the latest test was selected to be analyzed. The rate of ECD reduction per year was measured using the following equation:

Rate of ECD reduction per year = (preoperative ECD – postoperative ECD) / preoperative ECD / follow-up period (year) * 100

AS-OCT scan analysis

All patients underwent anterior segment imaging using RTVue-100 FD OCT (Optovue, Inc., Fremont, CA, USA) postoperatively. The patients were asked to look at the internal fixation light (through an undilated pupil). The examiner performed the test without pressing the patient's eyeball. Anterior segment scan was measured parallel to the AGV tube angle (Figure 1). The length of tube, the distance between the tube and the cornea, the distance between the tube and the iris, the angle between the tube and the cornea, and the angle between the tube and the iris were measured. In addition, to characterize the anterior chamber angle of the patient, an anterior segment scan within 15 degrees of the AGV tube was performed and trabecular-iris space area at 500μm (TISA 500), trabecular-iris angle (TIA), angle opening distance at 500μm (AOD 500) were analyzed (Figure 2). AS-OCT test was performed on the same day as the specular microscopy, and analysis was performed with the latest test among all postoperative tests later than 6 months after surgery.

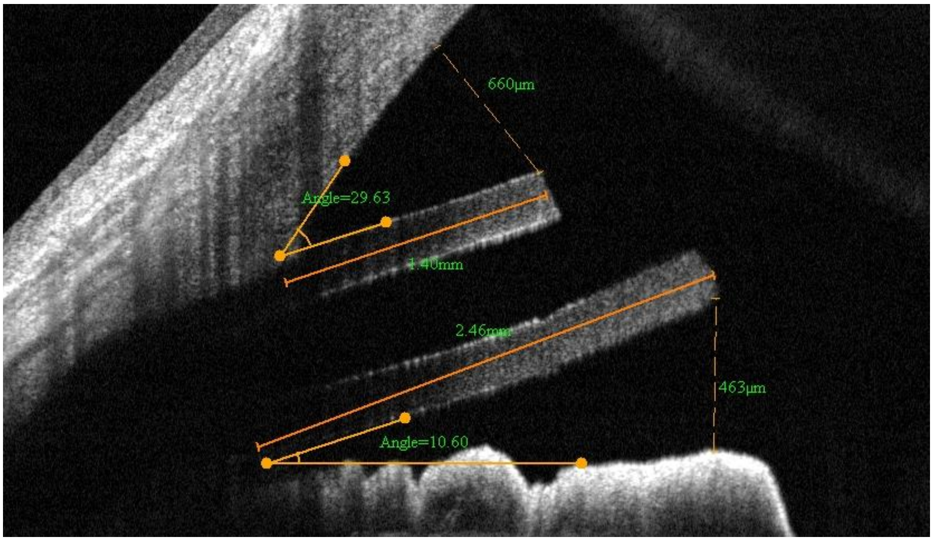

Figure 1. Anterior segment OCT measurements of anatomical tube parameters in anterior chamber

Tube - cornea angle and tube iris angle at the starting point of insertion of the tube into the anterior chamber were measured (solid line with a circle). The short side length (tube length-1) and the long side length (tube length-2) of the tube were measured (solid line). The dash line shows the distance from the tube tip to the cornea or iris.

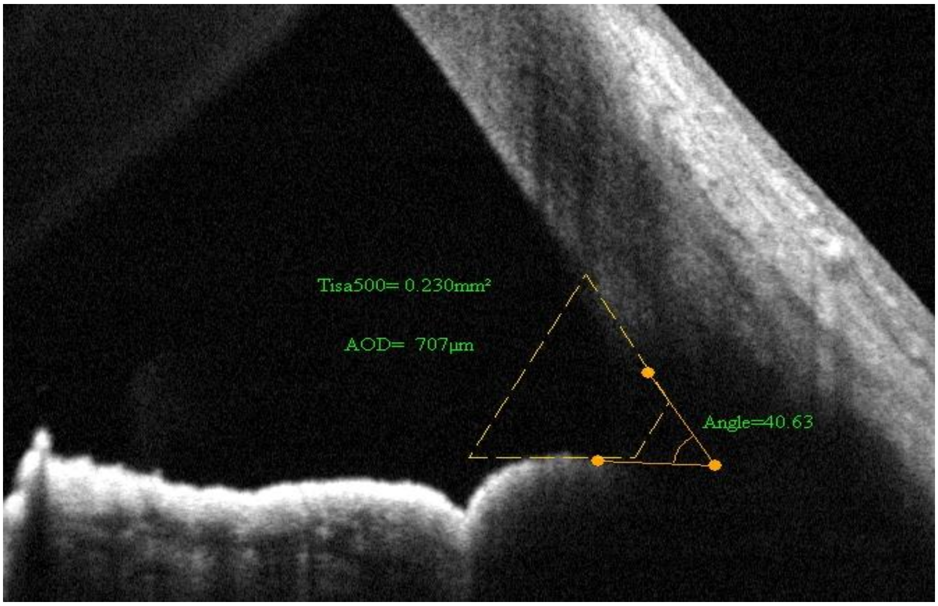

Figure 2. Anterior segment OCT measurements of angle parameters
The characteristics of the patient's unique angle were analyzed at a distance of less than 15 degrees from the tube. Trabecular-iris space area at 500µm (TISA 500), trabecular-iris angle (TIA), angle opening distance at 500µm (AOD 500) were analyzed as angle parameters.

Statistical analysis

The ECD difference and reduction rate before and after surgery were calculated. To investigate the effect of the anatomical location of the anterior chamber on the reduction of ECD, I performed a univariate and multivariate linear regression analysis to correct age, sex, anterior depth, IOP, anti-glaucoma medications, preoperative ECD. The subgroup analysis was performed on the two groups, fast and slow according to reduction rate of ECD per year. Two-sample Student's t-test, $\chi 2$ test and Fisher's exact test were used to determine the major factor of differences between the two groups. All statistical analyses were performed using SPSS software (ver. 20.0; SPSS Inc., Chicago, IL, USA). P-values < 0.05 were considered to indicate statistical significance.

III. RESULTS

A total of 47 eyes with Ahmed valve implantation satisfied the eligibility criteria of this study. The detailed demographic and clinical characteristics of the patients who underwent AGV implantation are summarized in Table 1. The mean age was 61.6 ± 14.8 and 29 (61.7%) were male. Primary open angle glaucoma (POAG), chronic angle closure glaucoma (CACG), neovascular glaucoma (NVG) and secondary glaucoma were 21 eyes (44.73%), 3 (6.4%), 10 (21.3%), and 13 (27.7%), respectively. Most of them were pseudophakic eyes and only 7 eyes were phakic eyes. The mean follow-up period was 19.4±12.2 months (Table 1). TIA was as wide as 45.6 ± 7.31 degrees because most of them were pseudophakic eyes. Mean AGV tube length was short; 1067.3 ± 579.0 μm in the short side (tube length-1) and 2051.3 ± 747.8 μm in the long side (tube length-2). Other AGV tube parameters are summarized in Table 1. Postoperative complications were 5 cases: hyphema in 4 eyes (8.5%) and hypotony in 1 eye (2.1%).

Table 1. Characteristics of Study Eyes

Characteristics	AGV Eyes (N=47)
Age,[mean (SD)]years	61.6 (14.8)
Sex, male (%)	29 (61.7)
Diagnosis (%)	
POAG	21 (44.7)
CACG	3 (6.4)
NVG	10 (21.3)
2^{nd} glaucoma	13 (27.7)
Systemic disease (%)	
DM	20 (42.6)
HTN	21 (44.7)
Cardiovascular disease	10 (21.3)
Thyroid disease	3 (6.4)
Previous filtering surgery (%)	10 (21.3)
Pseudophakic eyes (%)	40 (85.1)
ACD,[mean (SD)] mm	3.95 (0.71)
Follow up period,[mean (SD)] months	19.4 (12.2)
Angle parameters	
TIA,[mean (SD)] degrees	45.6 (7.31)
AOD 500,[mean (SD)] μm	504.6 (188.1)
TISA 500,[mean (SD)] mm^2	0.207 (0.089)
Tube parameters [mean (SD)]	
Tube-corneal angle, degrees	30.3 (12.2)
Tube-iris angle, degrees	12.0 (12.2)
Tube-corneal distance, μm	574.0 (354.1)
Tube-iris distance, μm	476.7 (569.9)
Tube length-1, μm	1067.3 (579.0)
Tube length-2, μm	2051.3 (747.8)
Post-operative complications (%)	
Hyphema	4 (8.5)
Hypotony	1 (2.1)

ACD, anterior chamber depth; AGV, Ahmed glaucoma valve; AOD, angle opening distance; CACG, chronic angle closure glaucoma; DM, diabetes mellitus; HTN, hypertension; N, number; NVG, neo-vascular glaucoma; PAOG, primary open angle glaucoma; SD, standard deviation; TIA, trabecular-iris angle; TISA, trabecular-iris space area.

The number of ECD, IOP, and anti-glaucoma medications before and after surgery were summarized in Table 2. The number of endothelial cells was decreased with statistical significance after surgery compared with before surgery. (P < 0.001). The rate of ECD reduction per year was 20.51%. There was a significant decrease in IOP and the number of anti-glaucoma medications after AGV surgery (P < 0.001)

Table 2. Comparison of endothelial cell loss, intraocular pressure, and number of anti-glaucoma medications between pre-operative and post-operative

	Pre-operative	Post-operative	P value[a]
Sepecular microscopy			
ECD, cells/mm2	2499.4 (689.7)	1776.1 (763.7)	<0.001
Decreased ECD per months	1.71 (1.44)		
Decreased ECD per year	20.51 (17.25)		
Intraocular pressure, (mmHg)	30.96 (9.48)	14.63 (6.03)	<0.001
Anti-glaucoma medications	4.43 (0.68)	2.23 (1.48)	<0.001

The values of continuous variables are presented as means (SD).
ECD, endothelial cell density; SD, standard deviation.
[a]Paired t-test

To analyze the relationship between ECD reduction rate and tube parameters, univariate and multivariate regression analysis were performed (Table 3). In univariate analysis, tube-iris angle and tube-iris distance showed a significant positive correlation with ECD reduction rate, and tube-corneal distance showed a significant negative correlation (P < 0.05). In multivariate analysis, only the tube-iris angle showed a significant positive correlation after adjusting for age, sex, anterior chamber depth, IOP, anti-glaucoma medications, preoperative ECD, and angle parameters (P = 0.001).

Table 3. Linear Regression Analysis of Associations between Tube Parameters and Rate of ECD Reduction

Tube parameters	Univariate[a]			Multivariate[b]		
	β	P value	R^2	β	P	R^2
Tube-corneal angle,	-0.005	0.271	0.029	-	0.750	0.66
Tube-iris angle,	**0.865**	**<0.001**	**0.504**	**0.73**	**0.001**	**0.66**
Tube-corneal	**-0.022**	**0.003**	**0.191**	-	0.559	0.66
Tube-iris distance,	**0.012**	**0.005**	**0.173**	0.00	0.957	0.66
Tube length-1, μm	-0.005	0.287	0.027	0.00	0.355	0.66
Tube length-2, μm	-0.008	0.050	0.089	-	0.190	0.66

ECD, endothelial cell density.
[a] Univariate linear regression; [b] Age -, sex -, anterior chamber depth -, IOP -, anti-glaucoma medications -, preoperative ECD -, and angle parameters- adjusted multivariate linear gregression; Bold characters refer to statistical significance ($P<0.05$).

The subgroup analysis was performed by dividing the reduction rate of ECD into the fast and slow groups (Table 4). There was no significant difference in age, sex, mean follow-up period, IOP before and after surgery, and the number of anti-glaucoma medication between the two groups. However, 8 patients (34.8%) were diagnosed as NVG in the fast group which was significantly more than that in the slow group (P = 0.036). There was no significant difference in preoperative ECD between the fast and slow groups.

Table 4. Subgroup analysis for Comparison of Clinical Characteristics and Anatomical Tube Parameters between Fast – and Slow – Groups

Characteristics	Fast group (n=23)	Slow group (n=24)	P value
Age,[mean (SD)]years	62.0 (14.3)	61.1 (15.6)	0.827 [a]
Sex, male (%)	14 (60.9)	15 (62.5)	0.908 [b]
Diagnosis (%)			
POAG (%)	8 (34.8)	13 (54.2)	0181 [b]
CACG (%)	2 (8.7)	1 (4.2)	0.609 [c]
NVG (%)	8 (34.8)	2 (8.3)	**0.036** [c]
2nd glaucoma (%)	5 (21.7)	8 (33.3)	0.374 [b]
Mean Follow up periods, months	16.7 (12.1)	22.0 (13.5)	0.154 [a]
Preop specular microscopy ECD, cells/mm^2	2660.5 (579.9)	2330.4 (748.2)	0.094 [a]
Postop specular microscopy ECD, cells/mm^2	1473.9 (778.6)	2033.4 (668.1)	**0.010** [a]
Decreased ECD, % of loss	45.6 (24.0)	12.7 (11.0)	**<0.001** [a]
Decreased ECD per year	38.4 (21.8)	6.8 (4.1)	**<0.001** [a]
Intraocular pressure, mmHg			
Pre-operative	31.7 (9.1)	30.3 (9.9)	0.608 [a]
Post-operative	14.9 (7.8)	14.4 (3.8)	0.755 [a]
Anti-glaucoma medications			
Pre-operative	4.5 (0.6)	4.3 (0.8)	0.350 [a]
Post-operative	2.1 (1.5)	2.4 (1.4)	0.510 [a]
TIA, degrees	45.8 (7.6)	45.4 (6.8)	0.134 [a]
AOD 500, µm	539.4 (333.6)	469.0 (235.0)	0.450 [a]
TISA 500, mm^2	0.213 (0.130)	0.201 (0.087)	0.691 [a]

Subgroup analysis was performed divided by fast group (Rate of ECD loss per year over 15%) and slow group (under 15%).

AOD, angle opening distance; CACG, chronic angle closure glaucoma; n, number; NVG, neo-vascular glaucoma; PAOG, primary open angle glaucoma; SD, standard deviation; TIA, trabecular-iris angle; TISA, trabecular-iris space area.
[a]two-sample Student's t-test; [b]χ2 test; [c]Fisher's exact test; Bold characters refer to statistical significance (P<0.05).

The parameters of AGV tube were compared between the fast and the slow groups (Table 5). Tube-corneal angle and tube-cornea distance were significantly smaller in the fast group than in the slow group (P = 0.001 for both tube-corneal angle and tube-cornea distance). Tube-iris angle was larger in the fast group than in the slow group (P = 0.001). Tube-iris distance, tube length-1 and tube length-2 did not show statistically significant differences between the two groups.

Table 5. Comparison of Anatomical Tube Parameters between Fast - and Slow - groups

	Fast group (n=23)	Slow group (n=24)	-fold	P value [a]
Tube – cornea angle, degrees	24.2 (12.1)	35.8 (9.5)	1.48	**0.001**
Tube – iris angle, degrees	19.5 (17.9)	5.8 (5.7)	0.30	**0.001**
Tube – cornea distance, µm	439.2 (276.4)	697.3 (373.1)	1.59	**0.010**
Tube – iris distance, µm	640.0 (447.6)	356.0 (672.2)	0.56	0.092
Tube length 1, µm	1020.3 (672.2)	1141.6 (478.9)	1.12	0.128
Tube length 2, µm	1916.0 (887.3)	2230.8 (571.9)	1.16	0.151

n, number. The fold increase represents the ratio between slow group and fast group means.
[a]Two-sample Student's t-test; Mean (SD); Bold characters refer to statistical significance (P<0.05).

IV. DISCUSSION

In this study, I analyzed the association between the corneal endothelial cell loss after the AGV implantation and the anatomical characteristics of the anterior chamber of the AGV tube. The reduction rate of ECD showed positive correlation between the Tube-iris angle and the Tube-iris distance and negative correlation between the Tube-corneal distance in the univariate analysis. Furthermore, it showed positive correlation with the Tube-iris angle in multivariate analysis. These findings suggest that the ECD could be further reduced when the tube is inserted steeply into the corneal and not parallel to the iris. In the subgroup analysis, the fast group involved more patients with underlying NGV than the slow group. Also, the fast group showed significantly smaller Tube-corneal angle and Tube-corneal distance and larger Tube-iris angle. The Tube-iris angle was the only factor that showed a significant correlation in both multivariate analysis and the subgroup analysis.

The corneal endothelium decreases with age with a natural decreasing rate of ~0.6±0.5% per year.[11] According to previous reports, when an AGV is inserted in the AC, the rate of ECD loss is faster than the natural course.[7-10] In a prospective study, Kim et al.[7] reported 10.5±14.9% endothelial cell loss after the Ahmed valve implantation at 12 months. A retrospective study of AGVs in 72 eyes and a control group of 31 eyes revealed a 10.7% decrease in ECD at 12 months after AGV implantation.[8] Lee et al.[9] reported that the corneal endothelial cell loss after AGV implantation was 15.3% and 18.6% at 12 and 24 months after surgery, respectively. Although these studies cannot be compared directly due to differences in study designs and subjects, the rates of ECD loss are similar to the rate in this study (20.51% per year).

The mechanism by which ECD loss progresses after AGV implantation is unknown. A few studies have indicated that inflammation or sequelae from inflammation such as peripheral anterior synechiae could be a risk factor for increased endothelial cell loss.[12, 13] Another hypothesized mechanism is that alteration to the aqueous humor proteome could cause endothelial damage.[14] Also, turbulence,[7] the distance from the tip of the tube to the cornea,[6] ocular massage,[15] and tube migration[16] have been reported to mechanically affect the ECD loss. Our finding supports the hypothesis that the angel of the insertion of the tube could mechanically reduce the ECD in that the AGV tube further reduced the ECD when it is inserted steeply without being parallel to the iris.

Some studies have reported the association between the ECD reduction and position in the anterior chamber of the tube using AS-OCT. Koo et al.[6] reported that the Tube-cornea distance was significantly associated with the ECD loss in the multivariate regression analysis. However, this study only measured the tube-cornea distance, the tube length, and the tube-cornea angle. They did not measure the distance or angle between the tube and iris, and did not compensate for the glaucoma diagnosis, the intraocular pressure, or the anterior chamber angle structure, which may affect the ECD loss. Moreover, this study has a limitation that they assessed ECD loss by comparing the ECD of superotemporal cornea with inferiortemporal cornea and not by comparing the ECD in the postoperative period with that in the preoperative period. Oh et al.[17] reported that the distance between the AGV tube tip and cornea was significantly correlated with ECD loss. However, they enrolled only 24 eyes and estimated simply the distance between the AGC tube tip and cornea.

Unlike the two previous studies, only the ECD reduction rate and the tube-iris angle showed a significant correlation in multivariate regression analysis. Tube-cornea distance was significant only in the univariate analysis. This difference may be due to the fact that the anatomical location of the tube was more precisely measured and analyzed in our study and the angle structure of the patient was adjusted which was not corrected in previous studies. It is also possible that the tube-iris angle is a good indicator of the dynamic movement of the tube. One of the hypothesis that causes endothelial loss is known as the tube movement. [16] If the tube does not enter the iris in parallel, it is likely to change its position according to the movement of the eye and cause a corneal injury. In fact, two patients with large tube-iris angles showed significant movement. However, further study is needed because it is not a study of all subjects.

In addition, the tube-cornea distance will unavoidably increase as the length of the tube increases, regardless of which direction the tube enters into the anterior chamber. In other words, there is a possibility of the cornea-tube distance becoming greater when a longer tube is inserted toward the cornea than when a shorter tube is inserted parallel to the iris. In our study, the mean tube length was short as 1.07 ± 0.6 mm (tube length-1) and 2.1 ± 0.7 mm (tube length-2), while the mean tube length was 3.4 ± 0.8 in previous study.[6] Therefore, I can conclude that the tube-cornea distance is not significant in the multivariate analysis in this study because the tube-cornea distance increases proportionally as the tube length increases. How much the tube goes parallel to the iris is more important to the ECD change rather than the tube-cornea distance. Because the factors affecting the ECD change may vary depending on the tube length, further study is needed to assess the ECD change post-surgery by the tube length.

Our study had some limitations. First, this study was limited by its small sample size and its retrospective nature. Further study with larger samples are required to be performed. Second, the postoperative measurement of the ECD and AS-OCT was not measured at a certain time after the AGV implantation but was measured at various times. To compensate this limitation, ECD loss was calculated by the annual reduction rate. Third, I only estimated the ECD of the central cornea. Since the AGV is implanted at superotemporal quadrant, the superotemporal endothelium is expected to be affected first. It may require considerable time for the central cornea to be influenced by the affected peripheral endothelium. However, our study will be meaningful because I have followed up on the patient for longer periods than the other studies have and have identified significant ECD changes of the central cornea which has a clinically significant effect on visual acuity than the peripheral area.

V. CONCLUSION

Our study suggests that the central ECD reduction rate was significantly faster when the angle between the AGV tube and the iris was greater. In particular, if the length of the AGV tube is short as in the present study, how much the tube enters the anterior chamber in parallel with the iris may have an important influence on the ECD change. Therefore, I suggest that it is necessary to follow up the tube in the anterior chamber during postoperative period and carefully observe the ECD changes when it was not inserted in parallel with the iris.

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ABSTRACT (IN KOREAN)

아메드밸브 삽입술 후 튜브의 해부학적 특징이 각막내피세포 감소에 미치는 영향

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목적: 전안부 빛간섭단층촬영술을 이용하여 아메드밸브 삽입술(Ahmed Glaucoma Valve implantation) 후 튜브의 해부학적 특징이 각막내피세포 감소에 미치는 영향에 대하여 알아보고자 한다

방법: 단일 술자에 의해 아메드밸브 삽입술을 받은 47명 47안에서 전안부 빛간섭단층촬영(OCT)을 이용하여 튜브의 전방 내 해부학적 위치를 측정하고 경면현미경을 이용해 중심부 각막내피세포 밀도(ECD)를 측정하여 수술 전후 감소 정도를 계산하였다. ECD 감소에 영향을 미칠 수 있는 다른 임상적 인자들에 대해서도 후향적으로 조사하여 튜브의 해부학적 특징이 ECD 감소에 미치는 영향을 다중 회귀분석을 이용하여 분석하였다.

결과: 아메드밸브 삽입술 후 평균 19.4 ± 12.2개월에 경면현미경 및 전안부 OCT 검사를 시행하였고 수술 전 후 ECD는 2499.4 ± 689.7에서 1776.1 ± 763.7로 통계적으로 유의하게 감소하였다 (P=0.01). 단순회귀분석 상 각막과 튜브 사이 거리가 작을수록, 홍채와 튜브 사이 이루는 각도와 거리가

멀수록 ECD 감소 속도와 유의미한 양의 상관관계를 보였다. 하지만 다중 회귀분석을 하였을 때에는 홍채와 튜브 사이 각도만 통계적으로 유의미하게 ECD 감소 속도와 연관성을 보였다 (P=0.001).

결론: 아메드벨브 삽입술 후 튜브의 전방 내 위치가 홍채와 큰 각도를 이루고 있는 경우 각막내피세포 감소와 유의미한 상관관계를 보이므로 수술 시 아메드벨브 튜브를 홍채와 최대한 평행하게 삽입하는 것이 중요할 것으로 보인다.

핵심되는 말: 전안부 빛간섭단층촬영, 각막내피세포, 아메드벨브