

Outcomes of Ahmed Glaucoma Valv Implantation in Patients with Pars Plana Vitrectomy History

Sevgi Subasi (✉ sevgiozel_5@hotmail.com)

Kocaeli Üniversitesi Tıp Fakültesi

Nursen Yuksel

Kocaeli Üniversitesi Tıp Fakültesi: Kocaeli Üniversitesi Tıp Fakültesi

Levent Veysel Karabas

Kocaeli Üniversitesi: Kocaeli Üniversitesi

Busra Yilmaz Tugan

Kocaeli University: Kocaeli Üniversitesi

Ece Basaran

Kocaeli Üniversitesi: Kocaeli Üniversitesi

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Abstract

Background and Objective: Ahmed glaucoma valv (AGV) implantation is one of the successful surgical methods in secondary glaucoma that develops after pars plana vitrectomy (PPV). In our study, we aimed to evaluate the 1-year results of AGV implantation in patients with a history of PPV.

Study Design: A total of 26 patients who underwent AGV implantation after PPV were included in our retrospective study. Fourteen of 26 patients had AGV implantation due to neovascular glaucoma (NVG) and 12 of them had secondary refractory galucoma. Data of these two groups of patients were evaluated in terms of IOP reduction, number of medication use, surgical complete and qualified success, surgical failure, and complications.

Results: The mean IOP was 29.54 ± 4.87 mmHg at the preoperative of AGV implantation and 12.88 ± 4.17 at the twelfth month visit in overall group. There was no statistically significant difference between two groups in terms of IOP in preoperative and all postoperative visits ($p > 0.05$). The mean intervals between PPV and AGV implantation were 67 ± 34 days in NVG and 391 ± 500 days in non-NVG group ($p = 0.017$). In overall group, 91.7% of patients had improvement in BCVA at the twelfth month visit. Complete and qualified surgical success rates were 75%, 83.3% in NVG group and 50%, 91.7% in non-NVG group respectively. There was no devastating complication in both group.

Conclusion: AGV implantation is a safe and effective surgical method in uncontrolled IOP elevations after PPV. While surgical success and failure rates was similar between etiologies, the time required for AGV implantation after PPV was shorter in NVG etiology.

Introduction

Retinal surgery has been improved a lot with the introduction of closed system vitrectomy in the 70's [1]. As time goes by, the indications for vitrectomy increased considerably [2]. Complications that developed with increasing number of postoperative patients started to be investigated and one of the most important of these is glaucoma [3]. Intraocular pressure (IOP) values higher than 30mmHg were detected in 35% of patients who received pars plana vitrectomy (PPV) [4]. It has been reported that the increase in IOP develops depending on the surgery and the tampon used, responds well to antiglaucoma treatment and is generally temporary [5]. Increased IOP after PPV which cannot be reduced with medical treatment, may require surgery. In these refractory glaucoma cases, especially glaucoma drainage implants are recommended. Krupin-Denver, Joseph, Molteno, Baerveldt and Ahmed glaucoma valve (AGV) have been used as glaucoma devices. The AGV is easy to place and works only when IOP is above 8 mmHg, prevents low IOP [6–8].

Neovascular glaucoma (NVG) is one of the common complications of PPV applied for proliferative diabetic retinopathy [9]. Medical therapy alone is insufficient to control increased IOP in patients with NVG, usually surgical intervention is required. However, traditional filtration surgery shows a poor

prognosis due to increased fibrovascular proliferation or bleeding [10]. AGV implantation is one of the best options for uncontrolled IOP increases after PPV in patients with NVG.

We know that AGV implantation is successful surgical method in reducing IOP in a controlled manner [11]. But there is insufficient data on its results in patients who had undergone PPV. The aim of our study is to clarify the effectiveness, reliability, and surgical success factors of AGV implantation in patients who had undergone PPV for different etiologies and also to compare the effect of etiology on outcomes.

Material And Method

Patients

We retrospectively analyzed the medical records of 26 patients who were treated with AGV implantation due to secondary glaucoma following PPV between 2012 and 2018 by the same surgeon at the ***** University Department of Ophthalmology. Local Ethics Committee of the ***** University approved the study and also the study adhered to the tenets of the Declaration of Helsinki.

Indications for PPV are as follows: vitreous hemorrhage due to central retinal vein occlusion, diabetic retinopathy or tractional retinal detachment, rhegmatogenous retinal detachment, drop intraocular lens and endophthalmitis. Despite the maximum tolerable medical treatment after PPV, IOP remained high in all patients and therefore the need for surgery occurred. All AGV implantation surgeries were performed by the same surgeon (NY) and AGV-FP7 model was used in all of them. Twenty-four of the 26 patients completed the 12 months follow-up, while 2 patients died after the 6 months follow-up. Patients with primary open-angle glaucoma before PPV and no light perception before AGV implantation were excluded from the study. Neovascular glaucoma was diagnosed as an IOP increase despite maximum medication use accompanied by neovascularization of the iris and/or anterior chamber angle. Patients with a history of PPV who had AGV implantation due to NVG and other than neovascular glaucoma (non-NVG) were evaluated and compared as two separate groups simultaneously.

The ophthalmologic examination results were obtained from the patients' records, the data included in the evaluation were: best corrected visual acuity (BCVA), biomicroscopy, gonioscopy, fundus examination, IOP measurement value with Goldmann applanation tonometry and the number of glaucoma medication used. The time interval between PPV and AGV implantation were recorded. Patients' findings at 3, 6 and 12 months after AGV implantation including; change of BCVA (improvement or maintenance within 1 Snellen line or decrease more than one line), IOP, number of glaucoma medications, and complications were evaluated. All patients with increased IOP after AGV implantation were treated medically, and none of them required additional surgery.

Complete success of AGV implantation was defined as follows: an IOP of 5 to 18 mmHg and a decrease in IOP of $\geq 20\%$ from baseline IOP without medications and further glaucoma surgery. Qualified success was defined as follows: an IOP of 5 to 18 mmHg and a decrease in IOP of $\geq 20\%$ from baseline IOP with or without glaucoma medications. Failure was defined as IOP higher than 18 mm Hg on maximally

tolerated medical therapy, loss of light perception due to glaucomatous optic neuropathy, requirement of additional glaucoma surgery, development of the devastating complications [12]. To estimate failure rates, survival analysis was performed using recorded data.

Surgical procedures

All patients underwent standard PPV with three 23-gauge sclerotomies, additional procedures (posterior chamber lens implantation, endophotocoagulation, phacoemulsification) were applied if necessary. In patients with regmatogenous retinal detachment, SO or C3F8 gas were used as a tamponade to ensure retinal reattachment. SO was removed after the resolution of the retinal detachment or when the IOP increased because of the pupillary block. Silicone oil was taken before AGV implantation in all patients. An additional vitrectomy was performed when retinal detachment or vitreous hemorrhage developed.

AGV implantation was performed using the fornix-based conjunctival blebs into the upper temporal quadrant between the superior rectus and the lateral rectus muscles. A half scleral thickness 4x4mm wide scleral flap was created. The device was sutured to the sclera with 10 – 0 nylon sutures approximately 8 to 9mm behind the limbus. The anterior chamber was accessed with a 23-gauge needle under the scleral flap, then the tube placed into the anterior chamber through the needle track. The scleral flap was sutured with 10 – 0 nylon sutures and conjunctiva were closed with 8 – 0 vicryl sutures.

Statistical analysis

All statistical analyses were performed using IBM SPSS for Windows version 20.0 (SPSS, Chicago, IL, USA). Shapiro-Wilk's test was used to assess the assumption of normality. Continuous variables were presented depending on normal distribution with either mean \pm standard deviation or (in case of no normal distribution) median (25th-75th percentile). Categorical variables were summarized as counts (percentages). Comparisons of continuous variables between groups were carried out using independent samples t test/Mann-Whitney U test, whichever was appropriate. The changes in variables between time periods were analyzed by paired samples t test/related samples Wilcoxon signed rank test and Friedman's two-way analysis of variance. Association between two categorical variables was examined by Chi-square test. Kaplan-Meier method with Log Rank test was used for survival analysis. All statistical analyses were carried out with 5% significance and a two-sided p-value < 0.05 was considered as statistically significant.

Results

Twenty-six eyes of 26 patients were included in our retrospective study. There were 6 (23.1%) female and 20 (76.9%) male patients. The mean age of the patients was 60.85 ± 14.35 years. Fourteen eyes had NVG (53.8%) and 12 eyes had non-NVG (46.2%).

Baseline parameters including; age, indication of PPV, tamponade of post-PPV, preoperative IOP values, interval between PPV and AGV implantation and follow-up time were shown in Table 1. There was no complication in 20 patients (76.9%). The complications that occurred were hyphema in three eyes, early

hypotonia in four eyes, device exposure in one eye, shallow anterior chamber in one eye and choroid detachment in one eye. The most of the complications were improved with medical intervention but for device exposure, surgical intervention required. There was no statistically significant difference between NVG and non-NVG groups in terms of patients implanted with tamponade after PPV ($p=0.084$). The interval between vitrectomy and AGV implantation was 216 ± 574 days in overall group. There was statistically significant difference between NVG group (67 ± 34 days) and non-NVG group (391 ± 500 days) in terms of interval ($p=0.017$).

The mean pre-AGV IOP and the mean preoperative number of medications were similar between NVG and non-NVG groups ($p=0.193$, $p=0.494$, respectively). There were no statistically significant difference between NVG and non-NVG groups in terms of mean IOP and mean number of medications use at 6 and 12 months (Table 2, Figure 1). There was statistically significant decrease of repeated measures of IOP (between pre-AGV and post-AGV visits) both NVG and non-NVG groups ($p<0.001$, $p<0.001$, respectively). The number of medication use was shown statistically significant decrease after AGV implantation in all groups. Nevertheless, Also BCVA values and change of BCVA were shown in Table 3.

The surgical complete and qualified success rates of overall patients were 18/26 (69.2%), 25/26 (96.2%) in 6 months and 15/24 (62.5%), 21/24 (87.5%) in 12 months, respectively. The surgical failure rate of overall patients were 1/26 (3.8%) and 3/24 (12.5%) in 6 and 12 months respectively. The distribution of surgical success and failure rates according to groups were shown in Table 4. Kaplan Meier survival analysis showed that there was no statistically significant difference in surgical failure between NVG and non-NVG groups (Figure 2, $p=0.581$, Kaplan-Meier survival analysis with Mantel-Cox Log Rank test).

Discussion

Secondary glaucoma is one of the common complications which is caused by many reasons seen after vitreoretinal surgery. Some of the reasons reported in the literature are: increased oxidative load in vitreous cavity causing trabecular damage after vitrectomy, trabecular scars due to small lesions created during vitrectomy, progress of neovascularization, use of silicone oil in vitreoretinal surgery [13–16]. In several studies, increased IOP in the late period after vitreoretinal surgery has been reported as 26–41% [17, 18]. Glaucoma devices come to the fore because the success rates of traditional methods are low in such conditions when medical treatment's lowering IOP effect is insufficient both of these conditions. AGV is one of the most used glaucoma devices and its success has been reported in such cases [19, 20]. Neovascular glaucoma is another entity where AGV implantation is one of the most important surgical options in resistant IOP increases after vitrectomy. Vitrectomy is the main treatment for complications such as vitreous hemorrhage, tractional retinal detachment which secondary to proliferative diabetic retinopathy, and retinal vein occlusion. However, after vitrectomy eyes usually results in progression of anterior segment neovascularization and NVG. The incidence of postoperative NVG in such patients has been reported between 2% and 18% [16, 21]. In these conditions AGV implantation is one of the most recommended surgical methods.

The time until the requirement for AGV implantation after vitrectomy has been mentioned in some of the past studies. In a NVG study, the time between PPV and NVG development was reported as 151 days and it was emphasized that surgery was required in 56% of these patients [16]. In another one the interval between PPV and AGV implantation was reported as 7.5 ± 2.2 months [22]. Furthermore, in our study, the mean interval between PPV and AGV implantation was 1.8 ± 2.3 months (67 ± 34 days). We attribute the short time between AGV implantation and PPV to the fact that the NVG development process started before vitrectomy and the IOP control during vitrectomy was due to medical treatment. The progression of neovascularization after vitrectomy resulted in deterioration of drug control in a short time. Besides that the mean intervals between PPV and AGV implantation were 12.41 ± 16.2 months and the mean interval between PPV and secondary refractory glaucoma formation was 391 ± 500 days in our non-NVG group. According to our results, the development time of the secondary glaucoma that will require AGV implantation in vitrectomized eyes varies depending on the etiology (NVG or non-NVG). Patients who are followed up for reasons such as proliferative diabetic retinopathy and vein occlusion, who are likely to develop NVG, should be followed up more closely in terms of IOP after PPV. The requirement for surgery in terms of IOP develops earlier in such patients.

When the literature is examined, the place of AGV implantation in the NVG and secondary glaucoma that develops in vitrectomized eyes is becoming more and more solid. Although there are various success rates in the literature, there are not enough data comparing the success rates between NVG and non-NVG etiology. Park et al reported the cumulative probabilities of success rates as 92.9%, 89.9%, 74.7% and 62.5% after AGV implantation in NVG patients who had vitreoretinal surgery history at 6 months, 1, 2 and 3 years, respectively [20]. Jo et al reported overall success rate as 80.1% during a mean follow-up period of 43.6 months in patients who had secondary glaucoma after vitrectomy [23]. 73.1% and 63.2% success rates were reported in NVG patients after AGV implantation, at 12 months by Netland and Yalvac et al, respectively [24, 25]. However, some of these patients were not vitrectomized in these studies. In our study, success rates were evaluated in overall patients and separately NVG and non-NVG patients. Surgical qualified success rates were 96.2% and 87.5% in overall patients at 6 and 12 months, respectively. In terms of surgical success and surgical failure rates, the etiology of patients (NVG and non-NVG) did not cause statistical significant change. Nevertheless, while surgical qualified success rates in the 6th month were similar between the NVG (92.9%) and non-NVG (100%) groups, the surgical qualified success rate in the NVG group (83.3%) at the 12th month decreased similar as the non-NVG group (91.7%). According to complete success rates NVG group had greater rate (75%) than non-NVG group (50%) at 12 months but this difference was not statistically significant. Cumulative probability of success rates were similar between groups in terms of qualified success.

In our study, in accordance with the literature, even if the etiology is NVG, refractory secondary glaucoma after vitrectomy, it was seen that AGV implantation significantly reduces IOP and the amount of medication used. Besides that, in terms of BCVA, 92.6%, 91.7% of overall patients had improvement or maintenance at 6 and 12 months, respectively. There was no devastating complication at any case. The AGV implantation at all groups had safety and efficacy in terms of IOP, BCVA and complications.

Limitations of our study are small sample size, retrospective design and the lack of control cases. For providing stronger evidence in terms of these conditions, there is need of prospective randomized large sample sized studies with case- control design.

In conclusion, AGV implantation in both patients (NVG and non-NVG etiology) with uncontrolled IOP after vitreoretinal surgery was safe and effective choice. The surgical success and failure rates were similar and the necessity of time of AGV implantation was lesser in NVG etiology.

Declarations

Authors declare no potential conflict of interest.

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Tables

Table 1: Baseline characteristics of patients before AGV implantation surgery

	Total (n=26)	NVG (n=14)	Non-NVG (n=12)	p value
Age (years)	60.85 ± 14.35	64.29 ± 11.30	56.83 ± 16.86	p=0.274
Indication of vitrectomy				
Proliferative diabetic retinopathy and central retinal vein occlusion	14(53.8%)	14(53.8%)		
Regmatogenous retinal detachment	8(30.8%)		8(66.7%)	
Drop intraocular lens	2(7.7%)		2(16.7%)	
Endophthalmitis	2(7.7%)		2(16.7%)	
Tamponade of post-PPV				
Silicone oil	9(34.6%)	2(14.3%)	7(58.3%)	
C3F8 gas	4(15.4%)	3(21.4%)	1(8.3%)	
Fluid	13(50.0%)	9(64.3%)	4(33.3%)	
IOP (mmHg)				
Before vitrectomy	19.15±6.54	20.21±6.80	17.92±6.28	0.297
After vitrectomy	20.50±7.88	20.50±8.13	20.50±7.93	0.940
Before AGV	29.54±4.87	28.36±4.76	30.92±4.83	0.193
Pre-AGV number of medication	3.62 ± 0.85	3.71 ± 0.82	3.50 ± 0.90	p=0.494
Interval between PPV and AGV				
Month	6.73±12.16	1.85±2.31	12.41±16.26	p=0.020
Day	216±574	67 ± 34	391 ± 500	p=0.017
Follow-up time after AGV				
Month	30.7 ± 26.2	31.0± 30.0	30.4 ± 22.3	p=0.667
Day	946 ± 800	960 ± 486	936 ± 677	p=0.667

Table 2: Intraocular pressure (IOP) and medication use assessment of patients before and after AGV implantation.

	Total	NVG	Non-NVG	p value
IOP (mmHg)				
Pre-AGV	29.54±4.87	28.36±4.76	30.92±4.83	0.193
Post-AGV 1 st month	15.42±4.62	16.00±6.00	14.75±2.17	0.742
Post-AGV 3 rd month	16.19±4.65	16.29±5.99	16.08±2.61	0.781
Post-AGV 6 th month	13.92±3.03	14.36±3.58	13.42±2.27	0.212
Post-AGV 12 th month	12.88±4.17	14.33±4.11	11.42±3.84	0.045
p value		<0.001	<0.001	
Number of medication use				
Pre-AGV	3.62±0.85	3.71±0.82	3.50±0.90	0.494
Post-AGV 12 th month	1.00±1.23	1.21±1.47	0.75±0.86	0.595

Table 3: Best corrected visual acuity (BCVA) assessment of patients before and after AGV implantation.

	Total	NVG	Non-NVG
Preoperative BCVA (before AGV)			
Light perception	0	0	0
Hand motion	11(42.3%)	8(57.1%)	3(25.0%)
≤20/200- counting finger	8(30.8%)	6(42.9%)	2(16.7%)
≥20/200	7(26.9%)	0	7(58.3%)
BCVA (Post.AGV 3rd month)			
Loss of ligh perception	1 (3.8%)	1 (7.1%)	0
Light perception	0	0	0
Hand motion	9(34.6%)	6 (42.9%)	3 (25%)
≤20/200- counting finger	6(23.1%)	5 (35.7%)	1 (8.3%)
≥20/200	10(38.5%)	2 (14.3%)	8 (66.7%)
Change of BCVA (Post.AGV 3rd month)			
Improvement or maintenance	21(80.8%)	11 (78.6%)	10 (83.3%)
Decrease more than 1 line	5(19.2%)	3 (21.4%)	2 (16.7%)
BCVA (Post.AGV 6th month)			
Loss of ligh perception	1(3.8%)	1 (7.1%)	0
Light perception	0	0	0
Hand motion	8(30.8%)	6(42.9%)	2(16.7%)
≤20/200- counting finger	6(23.1%)	5(35.7%)	1(8.3%)
≥20/200	11(42.3%)	2(14.3%)	9(75%)
Change of BCVA (Post.AGV 6th month)			
Improvement or maintenance	25(92.6%)	13 (92.9%)	12(100%)
Decrease more than 1 line	1(3.8 %)	1(7.1%)	0
BCVA (Post.AGV 12th month)			
Loss of ligh perception	2(8.3%)	1 (8.3%)	1(8.3%)

Light perception	0	0	0
Hand motion	6(25%)	5 (41.7%)	1(8.3%)
≤20/200- counting finger	4(6.7%)	3 (25%)	1 (8.3%)
≥20/200	12(50%)	3(25%)	9 (75%)
Change of BCVA (Post.AGV 12 th month)			
Improvement or maintenance	22(91.7%)	11 (91.7%)	11 (91.7%)
Decrease more than 1 line	2(8.3%)	1 (8.3%)	1 (8.3%)

Table 4: Evaluation of surgical success and failure rates at 6 and 12 months.

	Total	NVG	Non-NVG
6 th month			
Complete success	18/26 (69.2%)	11/14 (78.6%)	7/12 (58.3%)
Qualified success	25/26 (96.2%)	13/14 (92.9%)	12/12(100%)
Surgical failure	1/26 (3.8%)	1/13 (7.1%)	0/12 (0%)
12 th month			
Complete success	15/24 (62.5%)	9/12 (75%)	6/12 (50%)
Qualified success	21/24 (87.5%)	10/12 (83.3%)	11/12 (91.7%)
Surgical failure	3/24 (12.5%)	2/12 (16.7%)	1/12 (8.3%)

Figures

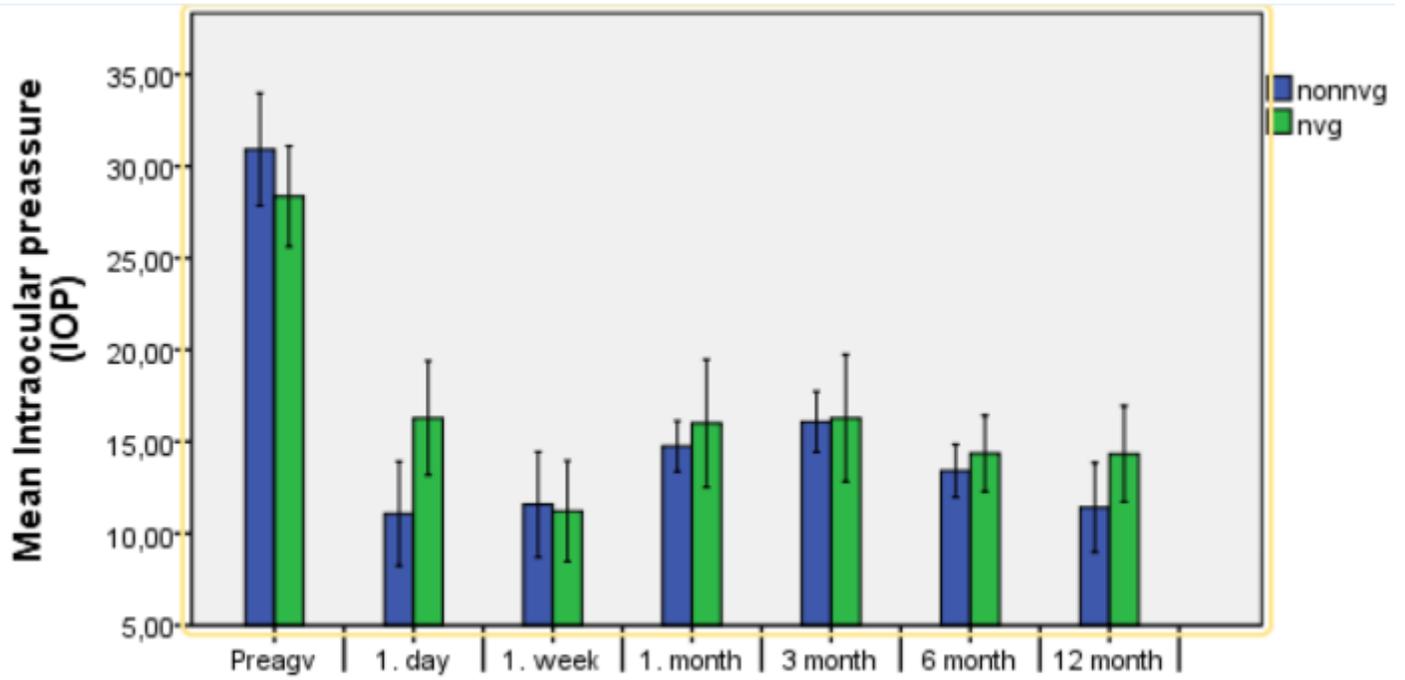


Figure 1

The mean intraocular pressure (IOP) distribution of groups according to follow-up time.

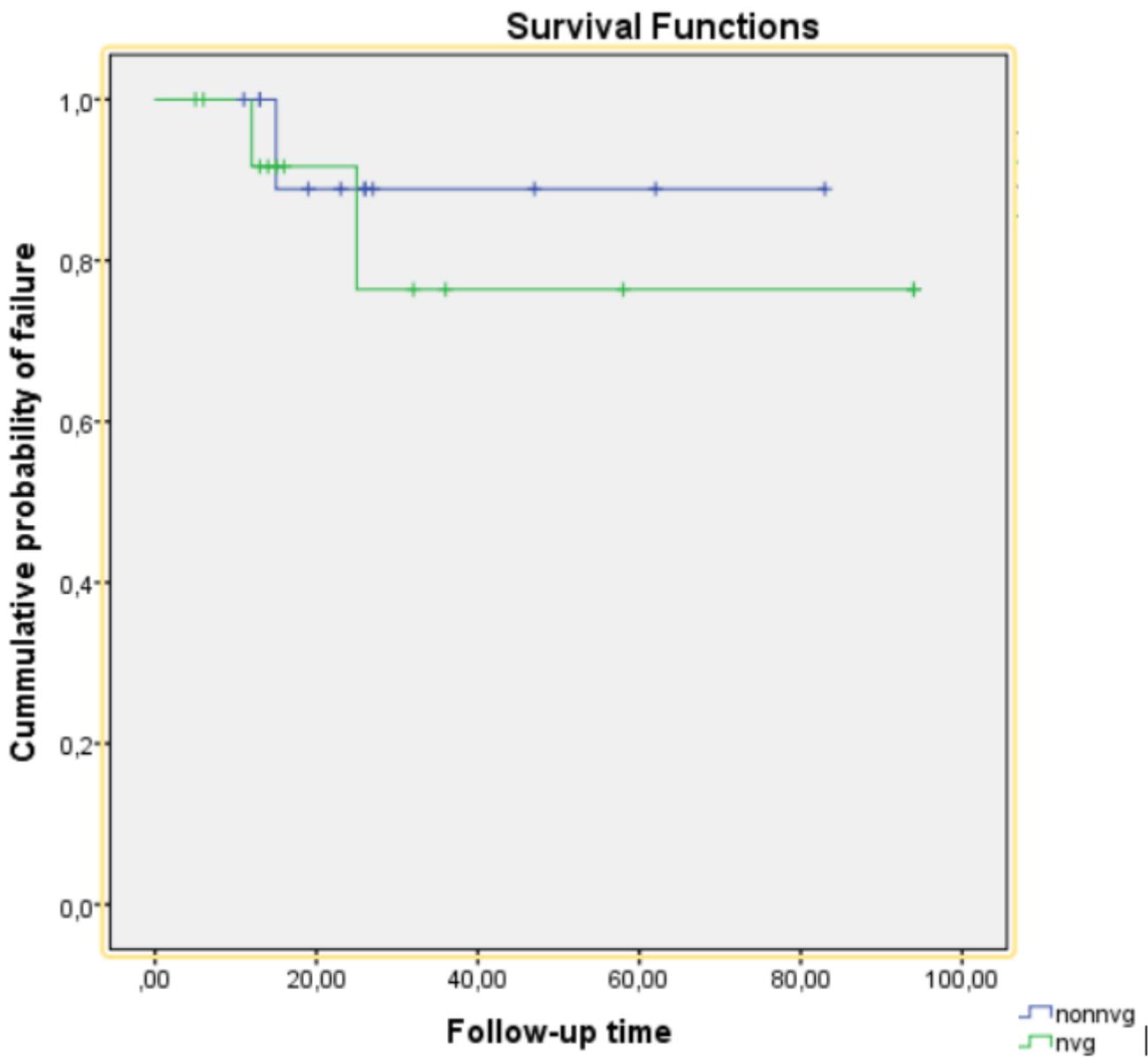


Figure 2

Cumulative probability of surgical failure. There was no significant difference in surgical failure rates of the NVG and non-NVG groups ($P=0.581$; Kaplan-Meier survival analysis with the Mantel-Cox log rank test).