• Clinical Research •

Comparison of complications after Ahmed versus Baerveldt implant in glaucoma patients: one year follow-up

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Abstract

● **AIM:** To compare surgical results of the Ahmed and Baerveldt implant procedures in glaucoma patients at 1y follow-up at Jakarta Eye Center (JEC) Eye Hospitals.

● **METHODS:** This cohort retrospective study was conducted on glaucoma patients aged ≥18y who had undergone Ahmed and Baerveldt implant surgery. Intraocular pressure (IOP), visual acuity, glaucoma medication, success rate, early and late postoperative complications, and the number of resurgeries were analyzed.

● **RESULTS:** A total of 351 eyes in the Ahmed group and 94 eyes in the Baerveldt group were included in this study. At 1y follow-up, the mean IOP was found to be significantly lower in the Baerveldt group (13±4.47 mm Hg) compared to the Ahmed group (15.02±5.73 mm Hg; *P*=0.025). Glaucoma medication was required in both the Ahmed and Baerveldt groups (58.92% *vs* 71.67%). Comparable success rate was found in both groups. The Ahmed group revealed a complete and qualified success of 86.82%, and failure of 13.17%. Similarly, the Baerveldt group showed complete and qualified success in 87.75% and failure in 12.25% cases. In the Ahmed group, 11.97% early complications, 26.06% late complications and 9.97% resurgeries were observed. In comparison, in the Baerveldt group, 23.40% early complications, 30.95% late complications and 11.70% resurgeries were observed.

● **CONCLUSION:** Both groups of glaucoma implants show significant IOP reduction, however, the Baerveldt implant group demonstrates greater IOP reduction with more failure rates and complications than the Ahmed implant group.

● **KEYWORDS:** Ahmed implant; Baerveldt implant; intraocular pressure; success rate; complications

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INTRODUCTION

Glaucoma is one fourth of the leading causes of visual impairment and blindness in Indonesia, resulting in more severe consequences compared to cataract, refraction and retinal abnormality[1]. Intraocular pressure (IOP) reduction with glaucoma medication, laser, or surgery is usually required to prevent glaucoma progression[2]. In recent times, glaucoma implant surgery is being increasingly performed on uncontrolled glaucoma patients who showed poor response to trabeculectomy.

A tube versus trabeculectomy study concluded that tube shunt surgery had a higher success rate compared to trabeculectomy with mitomycin C during 5y of follow-up for uncontrolled glaucoma with previous trabeculectomy or cataract extraction[3]. As a result, glaucoma implant procedure as a primary procedure proved to be more beneficial for glaucoma patients.

Both the Ahmed-FP7 valve implant and Baerveldt-350 implant are frequently used for glaucoma implant surgery. Both implants include a silicone tube that drains humor aqueous from the anterior chamber to the subconjunctival reservoir formed by the fibrous capsule around the synthetic plate, whereby the mechanism shifts the aqueous humor through the bleb wall with simple passive diffusion[3-4]. The Ahmed implant introduces venture-based technology with a design that will open a valve when IOP is more than 8 mm Hg and close when IOP is less than 8 mm Hg. This mechanism also minimizes the possibility of postsurgical hypotonia. The Baerveldt implant requires an initial flow restriction to provide adequate time for bleb formation[5]. Temporary ligature of the stent or an

intraluminal temporary stent can be performed to induce initial flow restriction[6].

In this study, which took place between 2015-2018, comparison of surgical results and complications between the Ahmed and Baerveldt implants in glaucoma patients were analyzed after 1y follow-up at Jakarta Eye Center (JEC) Eye Hospitals.

SUBJECTS AND METHODS

Ethical Approval This study was conducted according to the criteria set by the declaration of Helsinki. All patients had been given explanation and signed informed consent.

This cohort retrospective study was conducted at JEC Eye Hospitals incorporating all glaucoma patients with glaucoma implant; either a 184 mm^2 single plate Ahmed implant (News World Medical, Rancho Cucamonga, Ca., USA) or a 350 mm^2 Baerveldt implant (Advanced Medical Optics, Santa Ana, Ca., USA). All patient data and essential information were retrieved from medical records during the periods of 2015-2018. All patients aged ≥18y who had previously undergone glaucoma implant surgery were included in this study. Eyes with cornea abnormality and infection were excluded. Implant surgery was performed by 8 glaucoma surgeons at the JEC Eye Hospitals.

Data was collected on gender, age, lateralization, diagnosis, history of previous eye surgeries, IOP, diverse glaucoma medication, and visual acuity before and after surgery (1wk, 1, 3, 6mo, 1y), early and late postoperative complications, and the number of resurgeries. Assessment of success and failure criteria and visual acuity reduction was also evaluated.

Complete success was defined as successfully controlled IOP (≤21 mm Hg and >5 mm Hg, reduced by 20% from baseline on 2 consecutive measurements after 3mo) without glaucoma medication. Qualified success was defined as successfully controlled IOP (≤21 mm Hg and >5 mm Hg, reduced by 20% from baseline on 2 consecutive measurements after 3mo) with glaucoma medication. Failure was defined as IOP>21 mm Hg or less than 20% reduction below baseline on 2 consecutive study visits after 3mo, or IOP≤5 mm Hg on 2 consecutive measurements after 3mo, resurgery, loss of light perception vision or necessary removal of implant[7].

Visual acuity (VA) reduction was defined as decreased Snellen VA by two or more lines from baseline at 1y. Snellen VA measurements were converted to a logarithm of minimum angle of resolution (logMAR) equivalents for the purpose of data analysis. Early complication was defined as a complication appeared right after surgery, while late complication was more than 1mo.

Statistical Analysis To evaluate data, statistics analysis was performed using Microsoft Office Excel 2013 and SPSS 20.0. All results were presented as mean±SD and quantitative data using independent-samples *t*-test or Mann-Whitney test according to the distribution of data and statistical significance was defined as $P<0.05$.

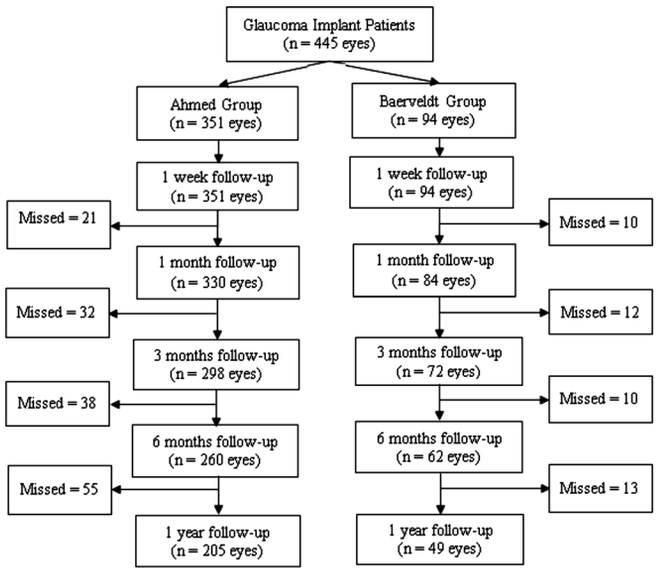

Figure 1 Glaucoma implant patients' diagram of follow-up.

RESULTS

A total of 464 eyes from 434 patients underwent glaucoma implant surgery between 2015-2018 in JEC Eye Hospitals. Thirty patients had glaucoma implant surgery performed on both eyes. Nineteen patients were excluded due to lack of data. Included in this study were 445 eyes from 415 patients, 351 eyes in the Ahmed group and 94 eyes in the Baerveldt group. A total of 205 eyes in the Ahmed group and 49 eyes in the Baerveldt group completed 1y of follow-up as shown in Figure 1.

Table 1 represents the demographic and basic characteristics data in both groups. Most of the patients were male and 50 years older. Primary open angle glaucoma (POAG) was the most common diagnosis in the Ahmed group. In the Baerveldt group, secondary glaucoma, such as neovascular glaucoma, was found to be the most common diagnosis. Baseline IOP before surgery was not statistically different between the groups.

Follow up after 1y, comparison between IOP, VA and the total requirement of glaucoma medication needed for both groups are shown in Table 2. The Baerveldt group had a higher success rate in IOP reduction compared to the Ahmed group (60.26% *vs* 57.80%) with a mean IOP 13.00±4.47 mm Hg and 15.02±5.73 mm Hg, respectively. The mean IOP reduction between the groups was significantly different after 6mo and 1y ($P=0.002$ and $P=0.025$). In total, there was no change of VA from baseline after 1y follow up in both groups, however some eyes showed VA improvement after 1y in the Ahmed group. Comparison of VA between the two groups could not be determined due to the different initial characteristics. Reduction of required glaucoma medication was observed to be higher in the Baerveldt group than in the Ahmed group

Table 1 Baseline demographic and clinical characteristics data

Characteristics	Ahmed group (*n*=351)	Baerveldt group (*n*=94)
Gender		
Male	198	55
Female	128	34
Age (mean±SD)	55.47±14.20	53.65±29.62
≤40y	55	17
>40y	296	77
Lateralization (OD:OS)	177:174	46:48
Baseline IOP (mean±SD), mm Hg	35.59±13.96	37.81±12.95
Diagnosis		
Primary glaucoma		
POAG	152	27
PACG	39	4
Juvenile glaucoma	10	4
Secondary glaucoma		
Neovascular glaucoma	46	30
Uveitic glaucoma	9	4
Steroid-induced glaucoma	12	1
Posner-Schlossman syndrome	3	0
Secondary glaucoma after vitrectomy	23	11
Secondary glaucoma after keratoplasty	9	6
Other secondary glaucoma (post trauma, lens subluxation, pseudophakia, aphakia, *etc*)	48	7
Prior surgery glaucoma medication	2.97±2.03	3.0±1.34
Systemic disease		
Hypertension	79	11
Diabetes mellitus	98	33

(71.67% *vs* 58.92%), however, there was no significant difference (*P*=0.122).

Success rate after 1y follow up in both groups was comparable (*P*=0.061), as shown in Table 3. The Ahmed group revealed complete success in 27.31%, qualified success in 59.51%, and failure in 13.17% of cases. Whereas, in the Baerveldt group, complete success was achieved in 44.90%, qualified success in 42.85% and failure in 12.25% of cases.

Early and late complication variables were seen in Tables 4 and 5. The Ahmed group experienced fewer early complications (11.97%) compared to the Baerveldt group (23.40%). Hyphema and uncontrolled IOP were the most frequent complications in the Ahmed group, while flat anterior chamber (AC) and wipe out were frequent in the Baerveldt procedure.

Similar results were also observed in late complications. A lower percentage (26.06%) of late complications was seen in the Ahmed group, with uncontrolled IOP and reduced VA as the most frequent complications. The rate of late complications in the Baerveldt group was higher (30.95%) with decreased VA as the most frequent complication with 2 eyes had experiences of wipe out.

Table 2 Comparison of IOP, visual acuity, and total glaucoma medication required in both groups

Time	Ahmed group	Baerveldt group	*P*
Pre-operation			
IOP (mm Hg)	35.59±13.96	37.81±12.95	0.068
VA (logMAR)	0.85±0.80	1.03±0.80	
Total medication required	2.97±2.03	3.00±1.34	0.275
n	351	94	
1wk			
IOP (mm Hg)	11.97±5.29	12.12±8.29	0.608
VA (logMAR)	0.92±0.79	1.28±0.84	
Total medication required	0.26±0.71	0.25±0.70	0.698
n	351	94	
1mo			
IOP (mm Hg)	15.30±5.74	16.01±9.15	0.216
VA (logMAR)	0.82±0.76	1.12±0.80	
Total medication required	0.75±1.09	0.69±1.10	0.424
n	330	84	
3mo			
IOP (mm Hg)	15.22±5.64	14.83±5.73	0.653
VA (logMAR)	0.76±0.77	0.97±0.76	
Total medication required	0.97±1.17	1.15±1.38	0.503
n	298	72	
6mo			
IOP (mm Hg)	14.56±4.16	12.74±4.33	0.002[a]
VA (logMAR)	0.78±0.81	0.96±0.83	
Total medication required	1.05±1.15	1.00±1.27	0.444
n	260	62	
1y			
IOP (mm Hg)	15.02±5.73	13.00±4.47	0.025[a]
VA (logMAR)	0.74±0.81	0.99±0.86	
Total medication required	1.22±1.23	0.85±1.24	0.122
n	205	49	

[a]Significant if *P*<0.05; Mann-Whitney *U* test.

Table 3 Comparison of Ahmed and Baerveldt implant 1y outcome

Outcomes	Ahmed (%)	Baerveldt (%)	*P*
Complete success	56 (27.31)	22 (44.90)	0.061
Qualified success	122 (59.51)	21 (42.85)	
Failure	27 (13.17)	6 (12.25)	

Chi-square test.

A higher percentage of re-surgery (Table 6) was performed in the Baerveldt group (21.27%) compared to the Ahmed group (10.82%). Tube revision followed by tube exposure and AC reformation were the most commonly performed surgical interventions on both groups.

DISCUSSION

This study reported successful IOP reduction following implantation of glaucoma drainage device (GDD). Glaucoma implant is an artificial filtering device to lower the IOP by draining aqueous humor to the external subconjunctival space.

Table 4 Early complications (≤1mo) after glaucoma implant surgery in both groups *n* (%)

Early complications	Ahmed group, 351 eyes	Baerveldt group, 94 eyes	Total, 445 eyes
Hyphema	12 (3.42)	1 (1.06)	13 (2.92)
Flat AC	9 (2.56)	6 (6.38)	15 (3.37)
Hypotony	3 (0.85)	2 (2.13)	5 (1.12)
IOP>21 mm Hg	12 (3.42)	5 (5.32)	17 (3.82)
Diplopia	1 (0.29)	0	1 (0.23)
Tube exposed	4 (1.14)	0	4 (0.90)
Iris covered tube	1 (0.29)	0	1 (0.23)
Wipe out	0	3 (3.19)	3 (0.67)
Corneal erosion	0	1 (1.06)	1 (0.23)
Snellen VA declined ≥2 line	0	1 (1.06)	1 (0.23)
Endophthalmitis suspect	0	1 (1.06)	1 (0.23)
Hyphema+flat AC	0	1 (1.06)	1 (0.23)
IOP>21 mm Hg+tube exposed	0	1 (1.06)	1 (0.23)
Total	42 (11.97)	22 (23.40)	64 (14.38)

Table 5 Late complications (>1mo) after glaucoma implant surgery in both groups *n* (%)

Late complication	Ahmed group, 330 eyes	Baerveldt group, 84 eyes	Total, 414 eyes
IOP>21 mm Hg	36 (10.91)	2 (2.38)	39 (9.42)
Hypotony	1 (0.30)	2 (2.38)	4 (0.97)
Snellen VA declined ≥2 line	27 (8.18)	10 (11.91)	37 (8.94)
Diplopia	1 (0.30)	0	1 (0.24)
Tube exposed	11 (3.33)	4 (4.76)	15 (3.62)
Tube retraction	1 (0.30)	0	1 (0.24)
Wipe out	4 (1.21)	2 (2.38)	4 (0.97)
Tube exposed+coagulum	1 (0.30)	0	1 (0.24)
Iris covered tube	1 (0.30)	0	1 (0.24)
Flat AC	0	1 (1.19)	1 (0.24)
Flat AC+tube exposed	0	1 (1.19)	1 (0.24)
Hypotony+flat AC	1 (0.30)	0	1 (0.24)
IOP>21 mm Hg+declined VA	1 (0.30)	1 (1.19)	2 (0.48)
Hypotony+declined VA	1 (0.30)	1 (1.19)	2 (0.48)
Endophthalmitis	0	2 (2.38)	2 (0.48)
Total	86 (26.06)	26 (30.95)	112 (27.05)

The general design of the most commonly used glaucoma implant is based on the principles of the Molteno implant and includes the presence of a permanent sclerostomy (tube), a predetermined bleb area (plate) and diversion of aqueous humor to the equatorial region away from the limbal subconjunctival space. These three factors ensure that the aqueous shunts are more resistant to scarring as compared to trabeculectomy[7-8].

It is of importance to note that the Ahmed implant was the preferred option by most surgeons because of its ease and quick installation compared to the Baerveldt implant. Even though neovascular glaucoma was the most common secondary glaucoma in this study, the Ahmed implant was selected to avoid any unwanted complications, flat AC and reduction of vision, However, due to high IOP, more surgeons decided to use the Baerveldt implant instead.

Table 6 Resurgery in the Ahmed and Baerveldt groups *n* (%)

Resurgery	Ahmed group, 351 eyes	Baerveldt group, 94 eyes	Total, 445 eyes
Tube revision	18 (5.13)	7 (7.45)	25 (5.62)
AC reformation	7 (1.99)	4 (4.26)	11 (2.47)
AC irrigation and aspiration	3 (0.86)	0	3 (0.67)
Needling tube	2 (0.57)	0	2 (0.45)
Laser tube	2 (0.57)	0	2 (0.45)
Re-implant tube	1 (0.29)	0	1 (0.23)
Cyclocryotherapy	1 (0.29)	0	1 (0.23)
Anterior vitrectomy	1 (0.29)	0	1 (0.23)
AC irrigation aspiration+tube revision	2 (0.57)	1 (1.06)	3 (0.67)
Hyphema irr/ asp+Avastin injection	1 (0.29)	0	1 (0.23)
AC reformation+tube revision	0	2 (2.13)	2 (0.45)
AC reformation+vitrectomy	0	1 (1.06)	1 (0.23)
Tube revision+antibiotic injection	0	1 (1.06)	1 (0.23)
Tube revision+aff tube	0	1 (1.06)	1 (0.23)
Tube ligation	0	1 (1.06)	1 (0.23)
Aff tube ligation	0	2 (2.13)	2 (0.45)
Total	38 (10.82)	20 (21.27)	58 (13.03)

Christakis *et al*[9] in the Ahmed *vs* Baerveldt Study (AVB Study) noted there was greater IOP reduction in the Baerveldt group (57%) compared to the Ahmed group (47%). A similar result was observed in this study demonstrating greater IOP reduction in the Baerveldt group (60.28%) than in the Ahmed group (57.80%). Schwartz *et al*[10] suggested that the surface area of encapsulation around a glaucoma drainage implant is directly proportional to the end plate size, therefore greater pressure reduction may be achieved using implants with larger end plates.

Another possible explanation for greater IOP reduction in the Baerveldt group relates to exposure of the filtering bleb to postoperative inflammatory material. In the Ahmed valve implant, there is an immediate flow of aqueous humor to the bleb, exposing it to inflammatory cells, cytokines and protein resulting from the surgery which, as a result, may produce more vigorous scarring of the fibrous capsule surrounding the end plate. The fibrous capsule forms about 4-6wk after surgery. Meanwhile, by occluding the Baerveldt implant for a period of several weeks, the bleb is exposed to much less inflammatory material[11-13]. Freedman and Iserovich[14] proposed that when the pressure in the eye goes up, proinflammatory cytokines are formed, particularly TGFb-2. These cytokines lead to the formation of fibrosis in the wound healing process. Furthermore, high pressure causes a breakdown of the blood-aqueous barrier and formation of the cytokines.

Ahmed *vs* Baerveldt Comparison Study (ABC Study) by Budenz *et al*[7] claimed that complete success in the Baerveldt

group was 36% compared to 23% in the Ahmed group and failure cases in the Ahmed group (16.4%) was higher than in the Baerveldt group (14.0%). This study demonstrates that, complete success in the Baerveldt group was also higher than in the Ahmed group, but comparable in the failure percentage. Final IOP showing more than 21 mm Hg was the most common complication in the Ahmed implant which indicated clearly that support increased proinflammatory cytokines reaction load, as described. Also the plate had as smaller surface area (180 mm^2) to accommodate aqueous humor outflow[15]. However, there was no statistically difference between complete success and failure between the two groups. Chen and Gedde[16] also reported that the Baerveldt implant has a higher rate of surgical success than the Ahmed implant, but however, the Baerveldt implantation carried a higher risk of hypotony which similar was experienced in this study.

In contrast, Syed *et al*[17] showed that both the Baerveldt-350 implant and the Ahmed valve resulted in similar IOP control and surgical outcome in patients with refractory glaucoma at 1y follow-up[17]. In addition, Tsai *et al*[18] noted that no differences were observed in longer-term survival rates and IOP profiles between the Ahmed and Baerveldt shunt implants up to 48mo following surgery. Patients in the Baerveldt group were more likely to develop early postoperative hypotony-related complications and failure, whereas patients undergoing Ahmed implants were more likely to be on additional glaucoma medication (starting at 18mo post surgery) and prone to develop later onset failure. A similar report from Wang *et al*[19] described no significant difference in success rate between the two groups. However, the Baerveldt implant was more effective for control of IOP and required less medication than the Ahmed implant, however the Ahmed implant demonstrated a lower incidence of total and severe complications.

According to Budenz *et al*[7] early complications in the Baerveldt group (77.58%) were higher than in the Ahmed group (14.0%). No difference was observed in this study in terms of early and late complications. Flat AC was the most common early complication in the Baerveldt group, and more frequently hyphema and IOP>21 mm Hg in the Ahmed group. All glaucoma surgeons were concerned mainly with the vision threatening complications, which appeared to prevail in the Baerveldt group[7]. A high percentage of eyes with the Baerveldt implant showed VA reduction after 1y. In 5y of follow-up reported by Budenz *et al*[20] long-term rates of declining vision and visual loss after re-surgery appeared to be higher in the Baerveldt implant. Kim *et al*[21] in his Baerveldt implantation study, demonstrated that 25.50% eyes had long-term vision loss and 30.08% eyes had transient vision loss after 6mo follow-up. The four most common causes of long-term vision loss were progression of glaucoma, corneal edema, cataracts, and hypotony maculopathy[21]. In this study, 27.66% eyes in the Baerveldt group and 15.09% eyes in the Ahmed group had vision decline after 1y. Three eyes had visual acuity reduction due to glaucoma progession, cataracts, and hypotony. Hypotony was found to present more complications in the GDD procedure than trabeculectomy. Chronic hypotony after 4wk was associated with accelerated cataract formation, choroidal detachments, hypotony maculopathy, and expulsive, and delayed suprachoroidal hemorrhages[22].

Another complication found to arise in both groups is wipe out, a condition that may affect patients suffering from severe glaucomatous damage or advanced glaucoma. Advanced glaucoma is defined as almost total cupping of the optic nerve with or without severe visual field loss within 10° of fixation, for example, scotoma encroaching on or splitting fixation. There are a number of possible mechanisms of wipe out, including direct damage to the optic nerve from anesthetic technique (retrobulbar) and pressure spike (high IOP) following surgery in patients with advanced glaucoma and postoperative hypotony[23-24].

This study presented more eyes with IOP>21 mm Hg as a late complication in the Ahmed group. This is supported a study by Riva *et al*[25] that a hipertensive phase is quite common following the Ahmed glaucoma implant. This phase peaks at 1 or 2mo postoperatively and usually resolves within 6mo. The primary reason for elevated IOP in the postoperative period is due to capsular fibrosis. The timing of first time contact between aqueous humor and the surgical wound forms a risk factor for capsular fibrosis because growth factors in the aqueous outflow exert fibrogenic effects. In the Ahmed implant, the humor aqueous exposed to subtenon's fibroblasts following implantation may enhance the degree of bleb encapsulation. While in the Baerveldt implant, immediate drainage of aqueous outflow is prevented by temporary ligation of the stent. The Ahmed implant also has a rougher surface compared to the Baerveldt implant which enables fibroblasts to adhere more easily[26]. The study by Ayyala *et al*[27] also reported a higher incidence of hypertensive phase in the Ahmed device (40%-80%) than in the Baerveldt device (20%-30%)[28]. Since most patients who receive glaucoma implants have advanced glaucoma, the hypertensive phase could induce further damage to the optic nerve, thus necessitating further treatment.

Diplopia after surgery may be demonstrated after both the Ahmed and Baerveldt implant surgical intervention. Superonasal quadrant implant placement carries a higher risk of vertical diplopia from restricting the superior oblique muscle, for example, pseudo-Brown's restrictive strabismus syndrome[29]. Glaucoma implant with a longer anteroposterior length, such as the Ahmed implant, may encroach on the

optic nerve when placed in superonasal quadrant, resulting in a significant injury response[30]. In this study only 1 patient presented diplopia following Ahmed implant surgery and resolved within 6mo.

Nguyen *et al*[31] reported the incidence of endophthalmitis as 1% 1mo following Baerveldt implant. Al-Torbak *et al*[32] in their study reported the incidence of endophthalmitis as 1.7% after Ahmed implant surgery. In this study, endophthalmitis showed early complication in 1 eye (1.06%) and late complication in 2 eyes (2.38%). Both early and late complications were found in the Baerveldt group in those patiens who had undergone vitrectomy surgery combined with intravitreal antibiotics. After re-surgery, all patients had better VA and IOP.

In contrast with this study, Christakis *et al*[9] discovered that the Baerveldt group (42%) had a higher number of patients undergoing re-surgery compared to the Ahmed group (26%). Tube revision due to tube exposure was the most frequent re-surgery in both groups. According to Trubnik *et al*[33] the incidence of tube exposure was 2.0%. Their study suggested that the incidence of tube exposure did not differ according to the type of implants used and could occur at any time within the first 5y after implantation[33]. Early tube exteriorization is usually related to a dehiscence of the suture, while late onset of tube extrusion is produced by erosion of the scleral/graft patch and the overlying conjunctiva in the quiet eye[34]. Tube exposure can lead to ocular inflammation, hypotony, poor vision and phthisis. Tube exposure represents a major risk factor for the development of late endophthalmitis, as the exposed tube provides a way for microorganisms to migrate into the eye from ocular surface and conjunctiva[25].

Menon *et al*[35] noted, in the case of tube exposure that the, conjunctiva does not remain sufficiently closed over immediately underlying synthetic materials, such as plastic, silastic, silicone, or polypropylene. In such cases, patch grafts have to be applied. The graft tissues used in tube exposure repair include autologous and donor eye tissues (full thickness sclera, split thickness hinged scleral flap, cornea, conjunctival pedicle flaps), extraocular tissues (amniotic membrane, donor acellular dermis, pericardium, duramater, fascia lata, buccal mucosa) and synthetic materials, such as biodegradable scaffold collagen matrix Ologen[35].

Koh *et al*[36] in his review showed that the Baerveldt tube is more appropriate for eyes that require amuch lower IOP, such as eyes with advanced glaucoma or in young patients. The Ahmed tube would be more suitable for patients who are at risk of hypotony (such as uveitic and neovascular glaucoma) and those who require immediate IOP lowering after surgery.

The difference between the total number of subjects in both groups and the retrospective study design, whereby not every subject fulfilled 1y of follow-up, appeared to be a weak factor in this study, thus affecting the overall study result. Despite this fact, this study showed evidence of the early and late complications in GDD in Indonesian eyes.

In conclusion, both the Ahmed and Baerveldt implants demonstrated significant IOP reduction. The Baerveldt implant showed greater IOP reduction, complete success requiring less glaucoma medication and a lower failure rate than the Ahmed implant. However, a higher percentage of early and late complications were evident when compared to the Ahmed implant.

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