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Glaucoma Drainage Device (GDD) Implantation in Post Trabeculectomy Patients

Ida Ayu Prama Yanthi[1*], I Gusti Ayu Ratna Suryaningrum[2], Ni Kompyang Rahayu[3], and I Made Agus Kusumadjaja[2]

[1]Resident, Ophtalmology Department, Faculty of Medicine, Udayana University/ Prof Dr. I.G.N.G Ngoerah Public Hospital, Bali, Indonesia, 80113

[2]Ophthalmologist of Glaucoma Division, Faculty of Medicine, Udayana University / Prof Dr. I.G.N.G Ngoerah Public Hospital, Bali, Indonesia, 80113

[3]Ophthalmologist of Glaucoma Division, Faculty of Medicine, Udayana University / Bali Mandara Eye Hospital, Bali, Indonesia, 80234

E-mail : ia.prama@gmail.com; ratna_suryaningrum@yahoo.com; nikompyangrahayu@gmail.com; agus280860@gmail.com

*Corresponding author details: Ida Ayu Prama Yanthi; ia.prama@gmail.com

ABSTRACT

Objective: This study aims to report a case of Glaucoma Drainage Device (GDD) implant surgery in a patient who experienced an increase in Intraocular Pressure (IOP) after long term trabeculectomy. ***Case Presentation:*** A 58-year-old male patient came with complaint of blurred vision since two years ago. Patient did not complain of sore and red eyes. He was given 2 x 250 mg of Acetazolamide, 2 x 1 tablet of Aspar K, 2 x 1 right and left eye (RLE) of Latanoprost, and 2 x 1 RLE of Betaxolol HCl. The patient had glaucoma since 20 years ago and had undergone surgery in 2002 on the right eye and left eye surgery in 2004. His right eye intraocular pressure was 38 mmHg with conjungtival bleb (+) flat (+) minimal vascularity (+) horizontal extent 1-2 clock hours. Patient then underwent a GDD implant surgery on the right eye, IOP 8 mmHg post GDD. Three months after surgery, the visual acuity decrease into 6/120 ph 6/21, elevated IOP into 32 with prominent lens opacity, so the phacoemulsification was done to the right eye After the surgery, patient's intraocular pressure was stable with better visual acuity. ***Conclusion:*** In trabeculectomy failure, implantation of the GDD is the safest and most effective option in eyes that have undergone previous intraocular surgery.

Keywords: glaucoma; GDD; trabeculectomy; intraocular pressure

INTRODUCTION

Glaucoma is a progressive optic neuropathy and a leading cause of blindness in the world especially in Asia.[1] Prevalence of glaucoma in worldwide 4 to 5 out 1000 people, and in Indonesia is 0,46%.[2] Predominat subtype of glaucoma is primary open angle glaucoma (POAG), who aged (40–80 years old) was estimated 52.68 million in 2020 and 79.76 million in 2040.[3] Primary open angle glaucoma with cases population In patients with advanced primary open-angle glaucoma (POAG) who experience increased intraiocular pressure (IOP) that cannot be controlled by medical and laser therapy, surgical procedures are a way out with the recommendation of initial choice being trabeculectomy with mitomycin C.[4,5] However, when trabeculectomy fails, or the factors that caused the initial failure cannot be modified, or if it is technically not possible to perform a repeat trabeculectomy, implantation of a shunt tube or so-called glaucoma drainage device (GDD) is the procedure of choice. Long term trabeculectomy failure defined as an increase of IOP (IOP>21 mmHg) that occurred more than a year after trabeculectomy.[6]

Glaucoma drainage devices (GDD) are designed to divert aqueous humor from the anterior chamber to an external reservoir, where fibrous capsule forms about 4-6 weeks after surgery and regulates flow.[1] In patients who have undergone surgery for glaucoma, cataracts can happen due to age factors or as a risk of complications after GDD surgery, hence many patients need cataract surgery afterward.[7] We reported a case of GDD implant surgery and phacoemulsification in a patient who experienced an increase in IOP after long term trabeculectomy.

CASE ILLUSTRATION

A 58-years-old male came to hospital referred by ophthalmologist with diagnosis of right left advance primary open-angle glaucoma (POAG) post trabeculectomy + senile cataract. He complained of blurred vision since two years ago. Patient did not complain of sore and red eyes. He was given 250 mg twice of day Acetazolamide, Aspar K 10 mg once a day, Latanoprost add Betaxolol hydrochloric acid (HCl) one drops twice a day ocular dextra et sinetra.

The patient had been suffering from glaucoma for 20 years. He had undergone trabeculectomy on his right eye in 2002 and trabeculectomy on his left eye in 2004. The intraocular pressure (IOP) on his right eye has increased since 5 years ago and controlled by eye drops. The IOP then gradually increased again since 1 year ago and could not be controlled by oral medication nor eye drops. Patient had undergone coronary artery bypass graft (CABG) surgery 2 years ago. Currently,the patient was taking Simvastatin 20 mg once a day, Aspirin 80 mg once a day, Bisoprolol 2,5 mg once a day and Ramipril 5 mg once a day. Diabetes mellitus, other systemic illness and allergy history were denied.

Physical examination showed good general condition. Vital signs were within normal limits. Ophthalmological examination revealed an orthophoric eyeball position **(Figure 1)**. The results of right eye: Visual acuity: 6/120 pinhole non improvements (PH NI); anterior segment: bleb conjunctiva (+) flat (+), vascularization (+) minimal, horizontal width at 1-2 o'clock position, clear cornea, anterior chamber angle van herick grading scale -3 (VH3), iris peripheral iridectomy (PI) direction at 12 o'clock position, pupillary reflex (+), relative afferent pupillary defect (RAPD) (-), minimal cloudy lens; Gonioscopy: anterior trabecular meshwork (ATM) in all quadrants peripheral anterior synechiae (PAS) direction at 11 and 1 o'clock position); Funduscopy: Optic nerve head (ONH) has round-shaped with well-defined borders, cup-to-disc ratio (CDR) 0.9 pale (+) with cupping and nasalization, Lamina cribosa sign (+), ratio of arteries and veins is 2/3, normal retina, macular reflex (+); Intraocular pressure (IOP): 38 mmHg. In left eye having visual acuity: 6/60 pinhole (PH) 6/18; anterior segment: bleb conjunctiva (+) flat (+), vascularization (+) minimal, horizontal width at 1-2 o'clock position, clear cornea, anterior chamber angel VH3, Iris PI (+) direction at 12 o'clock position, pupillary reflex (+) RAPD (-), minimal cloudy lens. Gonioscopy: ATM in all quadrants (PAS direction at 10 o'clock position); Funduscopy: Optic nerve head has round-shaped with well-defined borders, CDR 0.9 pale (+) with cupping and nasalization, Lamina cribosa sign (+), Ratio of arteries and veins is 2/3, Normal retina, Macular reflex (+); IOP : 10 mmHg.

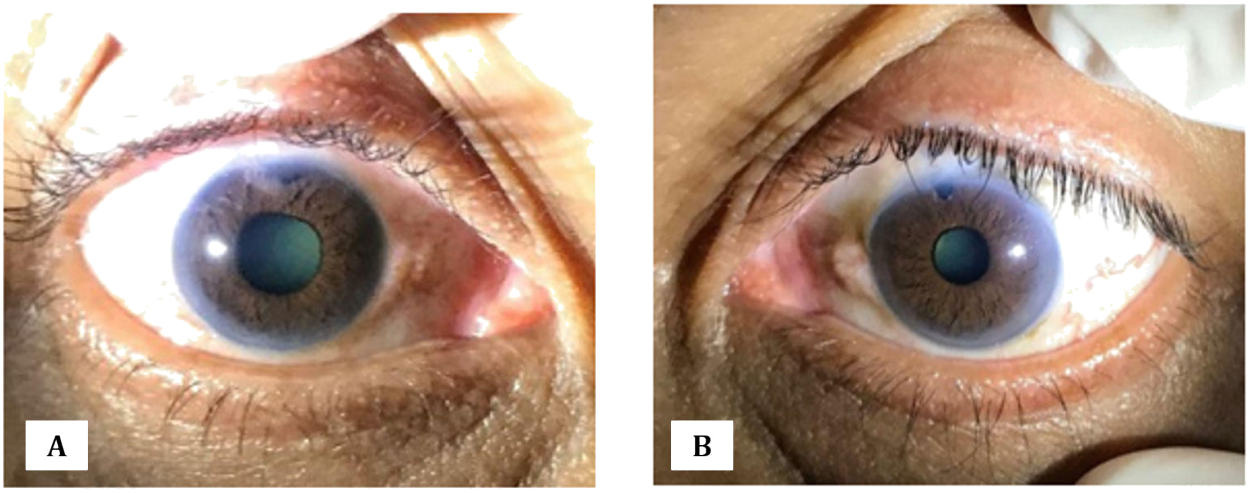

FIGURE 1: A: The right eye (right) anterior segment shown bleb conjunctiva (+) flat (+), vascularization (+) minimal, horizontal width at 1-2 o'clock position, clear cornea, anterior chamber angle van herick grading scale -3 (VH3), iris peripheral iridectomy (PI) direction at 12 o'clock position, pupillary reflex (+), relative afferent pupillary defect (RAPD) (-), minimal cloudy lens and B: left eye (left) anterior segment: bleb conjunctiva (+) flat (+), vascularization (+) minimal, horizontal width at 1-2 o'clock position, clear cornea, anterior chamber angel VH3, Iris peripheral iridectomy (PI) direction at 12 o'clock position, pupillary reflex (+) RAPD (-), minimal cloudy lens. (Courtesy of Prama, 2020)

Patient was diagnosed with right left eye (RLE) advanced POAG post trabeculectomy and immature senile cataract. Implantation of GDD under general anesthesia was planned for patient on October 13th, 2020. In the pre-operative management, after given Manitol drip one hour before surgery and IOP was re-evaluated. Asetazolamid 250 mg three times a day and Aspar K 10 mg twice a day tablets were stopped while the patient was fasting. The surgery was done in one hour and thirty five minutes. **Figure 2** explains the surgery steps. During the surgery, there were no significant difficulties and complications. After surgery, patient received Methylpredinosolone 8 mg once three times, Ciprofloxacin 500 mg twice a day, Xitrol eye drops six times one drop in right eye, Lyteers eye drops six times one drop in right eye, Gentamicin eye ointment three times a day, and analgesic mefenamic acid 500 mg once three times if needed.

Postoperative ophthalmological first day examination are shown at **Figure 4**. This show in right eye visual acuity 1/300; anterior segment: conjungtival vascular injection (CVI) (+), pericorneal conjungtival vascular injection (PCVI) (+), Subconjunctival hemorrhage (SCB) (+), suture (+), plate (+), leakage (-), clear cornea, Shallow anterior chamber, Tube located at 2 o'clock position (superonasal), Hyphema (+) 1/3 anterior chamber, Coagulum (+) in superior tube, Iris PI (+) direction at 12 o'clock position, Pupillary reflex (+), Minimal cloudy lens; fundus reflex (+); IOP (aplanation) 4 mmHg.

Evaluation after 6 days in **Figure 5** in right eye, This show in right eye visual acuity visual 6/35 PH NI; anterior segment: CVI (+), PCVI (+), SCB (+), suture (+), plate (+), leakage (-), clear cornea, shallow anterior chamber, tube located at 2 o'clock position (superonasal), decreased hyphema (+) less than 1/3 anterior chamber, coagulum (+) in central and superior tube, Iris PI (+) direction at 12 o'clock position, mid dilation on tropine, pupillary reflex (+), minimal cloudy lens; Funduscopy: ONH round-shaped, well-defined borders CDR 0.9 pale (+) with cupping and nasalization, Lamina cribosa sign (+), ratio of arteries and veins is 2/3, normal retina, Macular reflex (+); IOP (aplanation): 10 mmHg.

The patient was advised for undergoing cataract extraction 3 months later. At present, patient has undergone phacoemulsification + Intraocular Lens (IOL) surgery under local anesthesia on February 2021, with the last postoperative condition being Visus 6/18 PH 6/15 and IOP 8 mmHg.

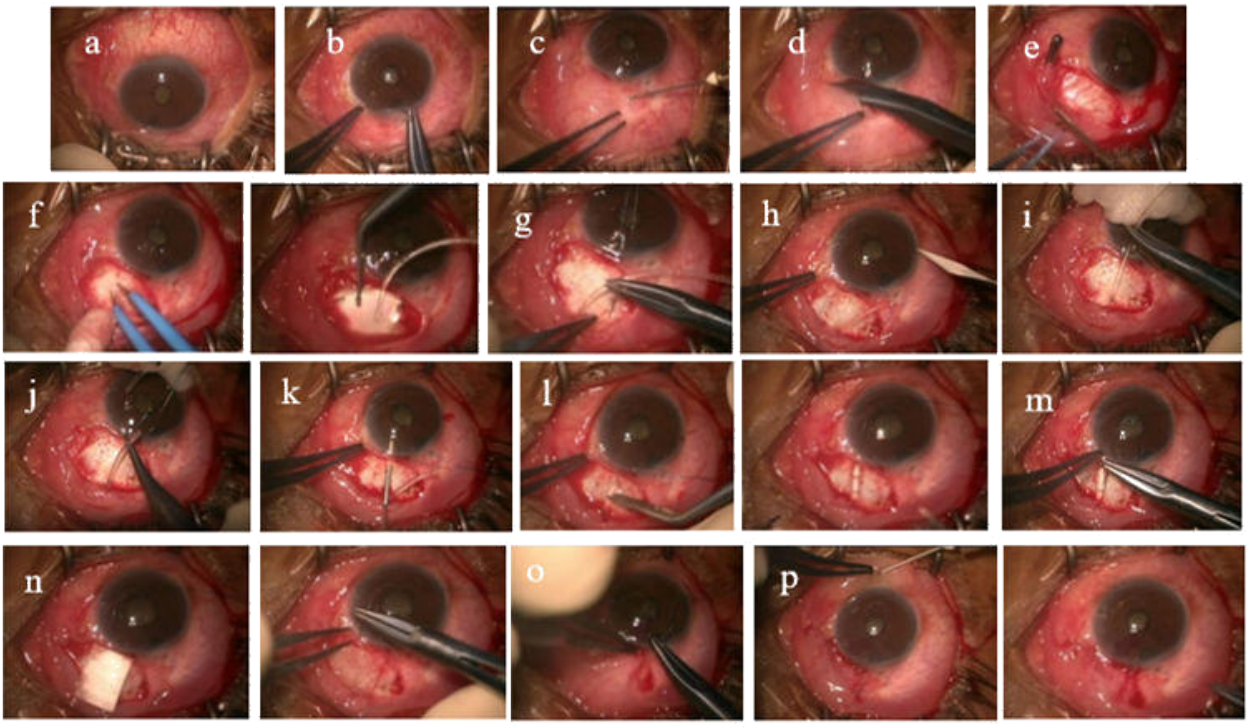

FIGURE 2: GDD Implantation Surgery Steps on the Right Eye; a. setting up of blepharostat, b.corneal fixation using prolene 7.0, c. subconjunctival pehacaine injection, d. conjunctival peritomy, fornix base, conjunctival undermine, e.identification of rectus temporal and superior muscles, f. implantation of GDD Virna 8 mm from the limbus in superonasal region, g. Plate fixation with prolene 7.0 and tube ligation with vycril 8.0, h. parasynthesis with 15o stab at 9 o'clock, i. tube measurement and cutting, j. tube lane made at 1 o'clock, k. the lane was penetrated directly into the anterior chamber (BMD) with a needle 23 G, l. tube fixation with nylon 10.0, m. perforating tube, n. pericardial membrane measurement, o. suturing the conjunctiva with pericardial membrane using vicryl 8.0, p. evaluation of BMD, hydration, intracamera injection of cefazoline, betadine irrigation and xytrol drops. (Courtesy of Prama, 2020)

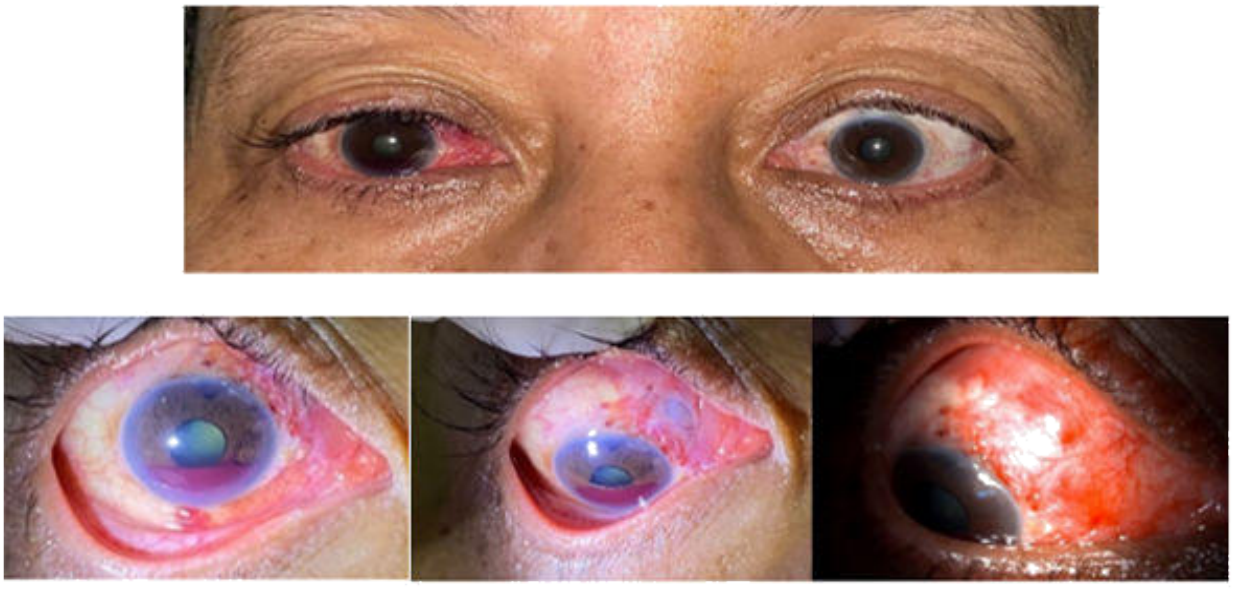

FIGURE 3: RE condition on the first day after GDD implantation surgery shown anterior segment: conjungtival vascular injection (CVI) (+), pericorneal conjungtival vascular injection (PCVI) (+), Subconjunctival hemorrhage (SCB) (+), suture (+), plate (+), leakage (-), clear cornea, Shallow anterior chamber, Tube located at 2 o'clock position (superonasal), Hyphema (+) 1/3 anterior chamber, Coagulum (+) in superior tube, Iris PI (+) direction at 12 o'clock position, Pupillary reflex (+), Minimal cloudy lens. (Courtesy of Prama, 2020)

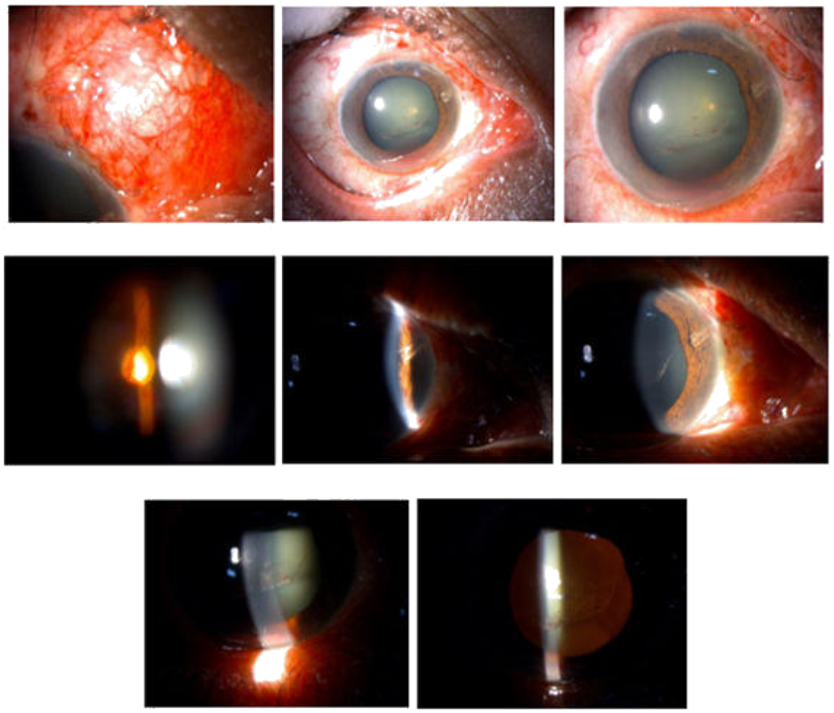

FIGURE 4: RE condition on the sixth day after GDD implantation surgery shown anterior segment: CVI (+), PCVI (+), SCB (+), suture (+), plate (+), leakage (-), clear cornea, shallow anterior chamber, tube located at 2 o'clock position (superonasal), decreased hyphema (+) less than 1/3 anterior chamber, coagulum (+) in central and superior tube, Iris PI (+) direction at 12 o'clock position, mid dilation on tropine, pupillary reflex (+), minimal cloudy lens. (Courtesy of Prama, 2020)

DISCUSSION

A 58 year old male patient, came with a diagnosis of RLE POAG advance post trabeculectomy add immature senile cataract. The patient has been suffering from glaucoma for 18 years and underwent trabeculectomy surgery in 2002 on the right eye and in 2004 on the left eye.

The management of glaucoma patients with baseline IOP <25 mmHg commence with one eye drop and if there is no reduction of 15% within 2 weeks, eye drops can be replaced with other eye drops or added and observed for 3-4 months. If the baseline IOP is 25-30 mmHg, a combination of 2 eye drops can be started and if there is no reduction of 15% within 10 days, 1-2 drugs can be added and observed again in 3-4 months. At baseline IOP > 30 mmHg, a combination of eye drops and oral anti-glaucoma drugs is needed, observed for 10 days. If the target has not been achived, add bromonidine / Carbonic Anhydrase Inhibitor (CAI) then observed for 3-4 months. If the IOP target is still not achieved after 3-4 months, then surgery is recommended. The first line of glaucoma treatment that is widely chosen is prostaglandin analogues (latanoprost eye drops) because they can reduce IOP effectively with minimal side effects compared to other anti-glaucoma drugs.[8] Indication for GDD are refractory glaucoma to other surgical procedures.[9] In our study, patient has been receiving oral medical therapy with Acetazolamide and Aspar K, as well as topical Latanoprost and Betaxolol, but his IOP was still high (38 mmHg). It indicated that the trabeculectomy surgery that has been performed and the drugs used so far are not sufficient to control IOP, so a GDD was planned.

Trabeculectomy failure can occur in the long term after trabeculectomy, can be stated if IOP > 21 after more than a year after trabeculectomy.[10] The risk of trabeculectomy failure increases over time. Trabeculectomy success rate according to Ehrnroot et al. is 82% in the first year, 70% in the second year, 64% in the third year, and 52% in the fourth year. Factors that interfere the success of long-term trabeculectomy are the type of exfoliating glaucoma and glaucoma uveitis, preoperative IOP >30, younger age, use of more than 2 types of preoperative topical treatment, and severe visual field loss before surgery.[10–12] In this patient, after trabeculectomy, he had no complaints for many years.

Patient have an increase of intraocular pressure in the right eye since 5 years ago and controlled by eye drops but since 1 year ago, the IOP cannot be controlled by eye drops or oral medication. The patient began to feel pain in the eye since 2 years ago. One of suspected factors that causing trabeculectomy failure our patient is young age. Age under 40 years, or younger age is associated because of the degree of thickness of the tenon capsule and strong wound scarring. In Ishida et al study cohort, the risk of failure decreased by 3% for each year of increasing age. In addition, male sex was associated with a greater frequency of failure (26.5% versus 17.1%), although this difference was not significant.[13] Meanwhile, IOP pre-trabeculectomy and other preoperative conditions such as medication used and degree of decreased visual field in this patient were unknown.[14]

In cases of failed trabeculectomy with antifibrotic administration, a second trabeculectomy may be performed in some clinical situations. However, when the factors that caused the initial failure cannot be modified, or if it is not technically feasible to perform a second trabeculectomy, then shunt tube implantation may be the procedure of choice.[11] Trabeculectomy has relative contraindications including previous trabeculectomy failure, high risk of failure, high risk of surgical complications, blindness, neovascularization with active anterior segment.[15]

In this study, GDD was performed due to failure of trabeculectomy. Things that need to be considered in GDD surgery in post trabeculectomy patients are the condition of the bleb and the characteristics of the conjunctiva.[14] The clinician must assess the mobility of conjunctiva to determine the best quadrant for drainage implant placement.

Iris, anterior chamber depth and gonioscopy should be performed to determine the location of synechiae that could interfere tube insertion. In patients with cataracts, combined cataract surgery with glaucoma surgery can be considered. In this patient, there were cataracts, so there was a possibility that phacoemulsification surgery would be carried out, so the superonasal location was chosen considering that it would make the main port and side port to insert operating instruments. Another consideration for choosing a superonasal location for plate insertion is the presence of a bleb on the superotemporal conjunctiva and the condition of the conjunctiva which is fibrotic and immobile for plate implantation.[9]

Generally, there are 2 types of GDD namely valved and non-valved GDD. Valved GDD implantation serves to provide resistance to the flow of aqueous humor and prevent hypotonia after surgery. Non-valved GDD implants have a tube that functions as aqueous humor drainage after surgery until fibrosis forms around the GDD plate.[6] In this study, we used Virna Glaucoma Implant, that product from Indonesia, because it is affordable in price and availability with the same effectiveness and safety as other polymethylmethacrylate (PMMA) implants. Virna GDD is a type of non-valved GDD made from polymethylmethacrylate (PMMA) developed in Indonesia. This type of tube allows a one-way flow of aqueous humor so that hypotonic conditions can be prevented. Histopathologically, Virna GDD is equivalent in inflammatory response to other types of GDD and better surface flatness than silicone-based glaucoma implants.a The advantage of Virna's GDD is that it is made in Indonesia, and it has lower price, which is only 1/10 of the price of other GDDs, so it is more affordable.[16]

There are various types of grafts used in GDD implantation and to prevent tube exposed complications after surgery. Previous research stated that a patch graft using the pericardium has a higher risk than cornea graft. Dubey et al. stated that heterologous sclera grafts are effective in patients who are undergoing GDD implantation for the first time and can reduce the risk of complications after surgery with a success rate of 89.1%.[6,17] Meanwhile, Smith et al. (2002) compared sclera, pericardium, and dura grafts in 64 eyes after GDD surgery, and reported exposure rates of 4.3% in the sclera, 5.6% in the dura, and 0% in the pericardium.[18] Due to the similar incidence of thinning, affordability and availability, scleral grafts are becoming the preferred option. In this case, the patient used a pericardial membrane graft. The advantage of pericardial grafts is sterility, while the grafts that are often used at PROF. Dr. IGNG Ngoerah Hospital and Bali Mandara Eye Hospital are sclera grafts.

Target of therapy is a reduction of 20-30% from baseline or 10-12 mmHg for severe glaucoma, 12-15 mmHg for moderate glaucoma, and 15-17 mmHg for mild glaucoma.[15] In our patient, there was a significant decrease in IOP from 32 mmHg to 8 mmHg after GDD surgery, which means that the postoperative IOP target has been reached.

Complications of GDD for early that often occur includes hypotonia, flat chambers and suprachoroidal hemorrhage. Other possible complications include valve malfunction, hyphema, scleral perforation, tube-related problems, tube erosion, endophthalmitis, plate migration or expulsion, corneal decompensation, overfiltration, and strabismus.[19] Hypotony, choroidal effusion, or suprachoroidal hemorrhage, is more frequently observed in non-valved drainage devices. Early postoperative hypotonia is usually caused by wound leakage, inflammation, incomplete tube occlusion, or a larger ventilation gap with a nonvalved implant.[8]

Valved implant usually reduce the risk of hypotony, but do not eliminate the possibility of hypotony. Complications of hypotonia are managed conservatively as long as anterior chamber depth is maintained.[20] If there is corneolenticular touch, viscoelastic should be injected to reshape the anterior chamber. Choroidal effusion associated with hypotonia is generally treated with corticosteroids and cycloplegic agents. Bleb revision with surgery is necessary if the early mentioned interventions fail to restore bleb function.[15]

In case of low IOP and shallow BMD with iridocorneal touch, evaluate for choroidal effusion and corneolenticular touch. If there is no choroidal effusion or corneolenticular touch, give regular topical steroids and cycloplegics[13]. If choroidal effusion is present, add oral steroids and if unresponsive to oral steroids, consider choroidal drainage. If there is a corneolenticular touch, reform the BMD. If IOP is high and BMD and posterior segment normal, rule out tube occlusion and administer aqueous suppressant. However, if the IOP is high and the BMD is shallow, exclude suprachoroidal hemorrhage and malignant glaucoma.[21]

In this case, early complications occurred in the form of hypotonia, shallow bone mineral density (BMD) and hyphema. The patient was then treated by administering tropine drops. This is consistent with the theory that after GDD it is necessary to pay attention to tube position, IOP, and wound structure. In there is no corneolenticular touch in patient's tube posiion, no conjunctival retraction on wound structure, low IOP, shallow BMD, and no choroidal effusion, so the treatment is topical steroids and cycloplegics (tropins).[21]

After the surgery was done, the patient received Methylprednisolone 1 x 16 mg, Xitrol eye drops 6 x 1 OD, Tropin eye drops 2 x 1 OD, Levofloxacin eye drops 6 x 1 OD, Lyteers eye drops 6 x 1 OD, Betaxolol ed 2 x 1 OS. In accordance with the theory, postoperative eye drops usually consist of antibiotic eye drops, steroids and cycloplegic agents.[8,17] Cycloplegic (tropin) is given to paralyze the accommodation muscles and dilate the pupils, so as to help relieve pain caused by post-surgery edema and inflammation. Topical treatment of the unoperated eye should be continued unless advised otherwise. Patients should always be followed up on the first postoperative day, then weekly for the first 4 weeks and possibly more frequently if the IOP is high or too low or shows early signs of bleb failure.[15,17]

The patient was also diagnosed with immature senile cataract. Cataract surgery has been reported to affect IOP control in eyes with GDD implants because the lens debris may be flows through the GDD tube into the bleb cavity during cataract surgery. Intraoperative use of viscoelastic materials can also cause GDD obstruction and increased IOP.[7] Combination cataract and glaucoma surgery (phacoemulsification-trabeculectomy) is generally less effective than trabeculectomy alone in controlling IOP. So in uncontrolled glaucoma, combination surgery is usually performed only in certain circumstances.[22,23] In this case, phacoemulsification and IOL were performed on February 15th, 2021. The goal of performing GDD and cataract extraction separately was to avoid perioperative problems with increased IOP and to achieve a long-term reduction in the amount of drug needed.

CONCLUSION

Treatment with GDD implants can be used as the last choice in managing glaucoma patients, if trabeculectomy fails to control IOP in long term.

REFERENCES

[1] APGS. Asia Pacific Glaucoma Guidlines. Kugler Publication, Amsterdam, The Netgerlands on behalf of the Asian Pacific Galucoma Society; 2016.

[2] Angriani N, Akib MNR, Mulyadi FE, Irmandha S, Hadi S, Syamsu RF. Glaucoma Risk Factors. Green Medical Journal 2022;4:1–8. https://doi.org/10.33096/gmj.v4i1.94.

[3] Zhang N, Wang J, Li Y, Jiang B. Prevalence of primary open angle glaucoma in the last 20 years: a meta-analysis and systematic review. Scientific Reports 2021;11:1–12. https://doi.org/10.1038/s41598-021-92971-w.

[4] Dilman B, Hawkins AS. Advice on Glaucoma Drainage Devices. Glaucoma Today 2012:49–56.

[5] Schimiti RB, Abe RY, Tavares CM, Vasconcellos JPC, Costa VP. Intraocular pressure control after implantation of an Ahmed glaucoma valve in eyes with a failed trabeculectomy. Journal of Current Glaucoma Practice 2016;10:97–103. https://doi.org/10.5005/jp-journals-10008-1209.

[6] Arifani AF, Prahasta A, Gustianty E, Rifada RM, Umbara S. Penatalaksanaan Tube Exposed Glaukoma Implant pada Glaukoma Sudut Terbuka. Ophthalmologica Indonesiana 2020;46:87. https://doi.org/10.35749/journal.v46i2.100086.

[7] Välimäki J. Cataract surgery in patients with glaucoma drainage implants: the hooked tube technique. International Ophthalmology 2019;39:605–10. https://doi.org/10.1007/s10792-018-0852-z.

[8] Sihota R, Angmo D, Ramaswamy D, Dada T. Simplifying "target" intraocular pressure for different stages of primary open-angle glaucoma and primary angle-closure glaucoma. Indian Journal of Ophthalmology 2018;66:495. https://doi.org/10.4103/ijo.IJO_1130_17.

[9] American Academy of Ophthalmology. 2021-2022 Basic and Clinical Science Course, Section 10: Glaucoma. San Fransisco: American Academy of Ophthalmology J 2022;10:271–8.

[10] Ehrnrooth P, Lehto I, Puska P, Laatikainen L. Long-term outcome of trabeculectomy in terms of intraocular pressure. Acta Ophthalmologica Scandinavica 2002;80:267–71. https://doi.org/10.1034/j.1600-0420.2002.800307.x.

[11] Landers J, Martin K, Sarkies N, Bourne R, Watson P. A twenty-year follow-up study of trabeculectomy: Risk factors and outcomes. Ophthalmology 2012;119:694–702. https://doi.org/10.1016/j.ophtha.2011.09.043.

[12] Fernández Argones L, Padilla González CM, Obret Mendive I, Piloto Díaz I, Fumero González FY. Factores pronósticos de fracaso de la trabeculectomía en una población de Cuba. Archivos de La Sociedad Española de Oftalmología 2016;91:27–33. https://doi.org/10.1016/j.oftal.2015.09.004.

[13] Ishida A, Miki T, Naito T, Ichioka S, Takayanagi Y, Tanito M. Surgical Results of Trabeculectomy among Groups Stratified by Prostaglandin-Associated Periorbitopathy Severity. Ophthalmology 2023;130:297–303. https://doi.org/10.1016/j.ophtha.2022.10.024.

[14] Ishida K, Nakano Y, Ojino K, Shimazawa M, Otsuka T, Inagaki S, et al. Evaluation of Bleb Characteristics after Trabeculectomy and Glaucoma Implant Surgery in the Rabbit. Ophthalmic Research 2021;64:68–76. https://doi.org/10.1159/000509135.

[15] American Academy of Ophthalmology. 2019-2020 Basic and Clinical Science Course, Section 10: Glaucoma. American Academy of Opthalmology 2019;10:214–7.

[16] Oktariana Asrory VD, Sitompul R, Artini W, Estuningsih S, Noviana D, Morgan WH. The inflammatory and foreign body reaction of polymethyl methacrylate glaucoma drainage device in the rabbit eye. Translational Vision Science and Technology 2020;9:1–7. https://doi.org/10.1167/tvst.9.3.20.

[17] Gandhi M, Bhartiya S. Practical Illustrated Guide Glaucoma Drainage Devices. Springer. 2019. Springer 2019:2019.

[18] Smith MF, Doyle JW, Ticrney JW. A comparison of glaucoma drainage implant tube coverage. Journal of Glaucoma 2002;11:143–7. https://doi.org/10.1097/00061198-200204000-00010.

[19] Wang MY, Patel K, Blieden LS, Chuang AZ, Baker LA, Bell NP, et al. Comparison of Efficacy and Complications of Cyclophotocoagulation and Second Glaucoma Drainage Device after Initial Glaucoma Drainage Device Failure. Journal of Glaucoma 2017;26:1010–8. https://doi.org/10.1097/IJG.0000000000000766.

[20] Schimiti RB, Abe RY, Tavares CM, Vasconcellos JPC, Costa VP. Intraocular pressure control after implantation of an Ahmed glaucoma valve in eyes with a failed trabeculectomy. Journal of Current Glaucoma Practice 2016;10:97–103. https://doi.org/10.5005/jp-journals-10008-1209.

[21] Kaushik S, Joshi G. Postoperative Care and Follow-Up of the Patient with Glaucoma Drainage Devices. Glaucoma Drainage Devices, Singapore: Springer Singapore; 2019, p. 127–33. https://doi.org/10.1007/978-981-13-5773-2_18.

[22] MacIver S, MacDonald D, Prokopich CL. Screening, Diagnosis, and Management of Open Angle Glaucoma. Canadian Journal of Optometry 2019;79:5–71. https://doi.org/10.15353/cjo.v79i1.1606.

[23] Patel HY, Danesh-Meyer H V. Incidence and management of cataract after glaucoma surgery. Current Opinion in Ophthalmology 2013;24:15–20. https://doi.org/10.1097/ICU.0b013e32835ab55f.