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Bilateral Glaucoma Drainage Device (GDD) Implantation in Steroid Induced Glaucoma



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ABSTRACT

Objective: This study aims to report a case of Bilateral Glaucoma Drainage Device (GDD) implantation surgery in a patient with Steroid Induced Glaucoma.

Case Presentation: A 18-year-old male patient with steroid-induced glaucoma and allergic conjunctivitis. The patient also complained about red eyes and itchy in both eyes and had been using steroid eye drops for 5 years. The patient also complained about headaches and blurry vision. The patient had undergone trabeculectomy surgery 5 months ago on the left eye. The visual acuity was 6/6 on the right eye and 6/7.5 on the left eye. His intraocular pressure (IOP) on the right eye was 24 mmHg, and his left eye was 23 mmHg with conjunctival left eye bleb, flat, and fibrosis. The patient then underwent a non-valve Vigna's GDD implant surgery on the right eye. On day two post-GDD, the IOP was 4 mmHg, and the COA was shallow, so reform the

COA. At the first month follow-up, the patient's right eye pressure was still in normal condition with no complications, and then the plan was for left eye Vigna's GDD implantation surgery. At the first month follow-up after left eye GDD implantation, the visual acuity was 6/9 on the right eye and 6/24 on the left eye, with IOP RE 11mmHg and LE 16mmHg, from anterior segment deep anterior chamber, no plate exposed, no leakage, and tube not attached to the corneal endothelium. The patient's intraocular pressure was still in normal condition in both eyes, and no complications was found, although the patient was still using low-dose topical steroid eye drops.

Conclusion: In steroid-induced glaucoma, after trabeculectomy failure, the implantation of GDD is the most effective option in controlling high IOP and slowing down glaucoma progressivity.

Keywords: Steroid Induced Glaucoma, Intraocular Pressure, Glaucoma Drainage Device.

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INTRODUCTION

Glaucoma is an irreversible but preventable optic neuropathy that leads to progressive visual field loss. Glaucoma is usually asymptomatic until the advanced stages, where permanent visual impairment begins. Therefore, early detection and appropriate treatment are required. Steroid-induced glaucoma is one of the most common secondary open-angle glaucoma diseases and can occur at any time after receiving steroids. The mechanism of open-angle glaucoma is decreasing the aqueous humor outflow, especially when there is resistance on the trabecular meshwork. The prevalence of steroid-induced open-angle glaucoma remains unknown.¹ Approximately 61-63% of studies had an increase in intraocular pressure (IOP) of

<5mmHg, and approximately 33% were highly responsive to steroids, with an IOP increase of >15mmHg.²

Allergic keratoconjunctivitis is an inflammatory disorder of the eye caused by a type I hypersensitivity reaction. It requires treatment with cold compresses, artificial tear drops, antihistamines, topical corticosteroids, and avoidance of triggering factors. The more severe the disease process, the stronger the treatment used to reduce symptoms. In addition, given the potential for high effectiveness and rapid symptom relief, corticosteroids are often misused without knowing the vision-threatening complications, especially cataracts and steroid-induced glaucoma. IOP in steroid-induced glaucoma can be controlled by discontinuing steroid use or giving antiglaucoma medication, trabeculectomy,

or implantation of a glaucoma drainage device.^{3,4} We reported a case of bilateral non-valve GDD implantation surgery in a patient with bilateral steroid-induced glaucoma after long term trabeculectomy.

CASE ILLUSTRATION

An 18-year-old male patient with right and left eye (RLE) glaucoma induced by long-term use of steroid drops and allergic conjunctivitis. The patient has been using steroid eye drops since 5 years ago when the patient experiences red and itchy eyes. The complaints usually appear when the patient does a lot of activities outside the home. The patient is the second child in the family. None in the family has complaints such as high intraocular pressure or a history of recurrent red eyes. The patient said that he often experienced

Table 1. Ophthalmology Examination of Right and Left Eye Pre-Surgery

<p>Right Eye 6/6</p> <p>Conjunctiva CVI (+) minimal Clear cornea Anterior chamber angle VH3 Iris regular Pupillary reflex (+) RAPD (-) clear lens</p> <p>PTM shows open-angle in all quadrants ONH round-shaped, well-defined borders, CDR 0.5 with cupping and nasalization, IR>SR, Ratio of arteries and veins is 2/3 Normal retina, Macular reflex (+) 25 mmHg</p>	<p>Visual acuity</p> <p>Anterior Segment</p> <p>Gonioscopy</p> <p>Funduscopy</p> <p>IOP</p>	<p>Left Eye 6/7.5 PH 6/6</p> <p>Bleb conjunctiva (+) flat (+) Vascularization (+) minimal CVI (+) minimal Clear cornea Anterior chamber angle VH3 Iris regular Pupillary reflex (+) RAPD (-) clear lens</p> <p>PTM shows open-angle in all quadrants ONH round-shaped, well-defined borders, CDR 0.9 with cupping and nasalization, Ratio of arteries and veins is 2/3 Normal retina, Macular reflex (+) 23 mmHg</p>
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PH= pinhole; NI = no improvement; VH = van herick's; PI = Peripheral Iridectomy; RAPD = relative afferent pupillary defect; ATM = anterior trabecular meshwork; PTM= posterior trabecular meshwork, PAS = peripheral anterior synechiae; ONH = optic nerve head; CDR = cup disc ratio

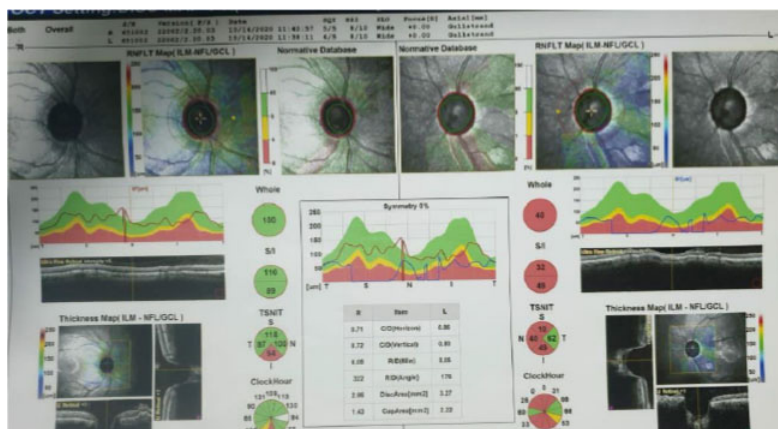


Figure 1. ONH and RNFL OCT: Right eye vertical C/D ratio 0.72 and left eye C/D ratio 0.80 with neuroretinal rim thinning in both eyes' inferior, superior, nasal and temporal areas.

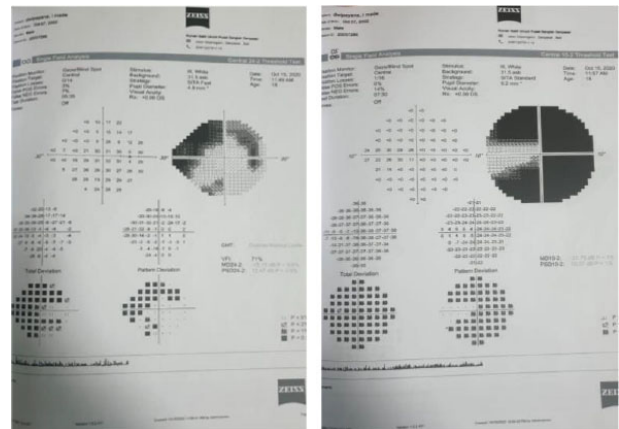


Figure 2. Perimetry: the right eye looks superior arcuate. The left eye looks superior and inferior arcuate.

complaints of headaches that disappeared and sometimes felt nauseous, but not accompanied by vomiting. The patient denied any blurred vision. The patient had undergone trabeculectomy surgery on the left eye five months ago at a private hospital in Denpasar. However, the patient's intraocular pressure was still high after the trabeculectomy.

On examination, it was found that the sharp vision in the right eye was 6/6, and the left eye was 6/7.5 pinhole (PH) 6/6. Anterior segment examination obtained in the left eye showed conjunctival vascular injection (CVI), bleb (+) flat (+), minimal vascularization (low), and minimal clouding of the lens in the left eye. Funduscopy examination on the right eye showed that the optic nerve head is round-shaped with well-defined

borders, a Cup-to-disc ratio (CDR) of 0.5 with cupping IR (inferior region) > SR (superior region), and nasalization, retina normal macular reflex good. On the left eye, a funduscopy was a round optic nerve head with well-defined borders, CDR 0.9 with cupping and nasalization, retina normal, and macular reflexes still good. Examination of intraocular pressure using Goldmann applanation obtained right eye 25 and left eye 23.

On gonioscopic examination of the four quadrants of the right and left eye, posterior trabecular meshwork was obtained. The patient underwent ONH and RNFL OCT examination and Perimetry (Figures 1 and 2). Based on the history, clinical findings, and supporting examination like gonioscopy, OCT, and perimetry, the patient was diagnosed

with RLE secondary glaucoma induced by steroids + allergic conjunctivitis. The patient got acetazolamide 3x250mg, Aspar K 1x1, Timolol 0.5% eye drops 2x1 drops on the right and left eyes, Posop eye drop 2x1 drops on the right and left eyes, and lyteers 4x1 drops on the right and left eyes.

Considering the rise of IOP and trabeculectomy failure in the left eye, the patient was planned for surgery on the right eye for implantation of a non-valve Virna's Glaucoma Drainage Device (GDD) under general anesthesia on November 3, 2020. The patient's condition before surgery was visual acuity 6/6 in the right eye, deep anterior chamber, and intraocular pressure with care 33 mmHg. Then, the patient received a mannitol drip of 5ml / kgBB (300 mL) that ran out within 1 hour preoperatively. After one hour of re-

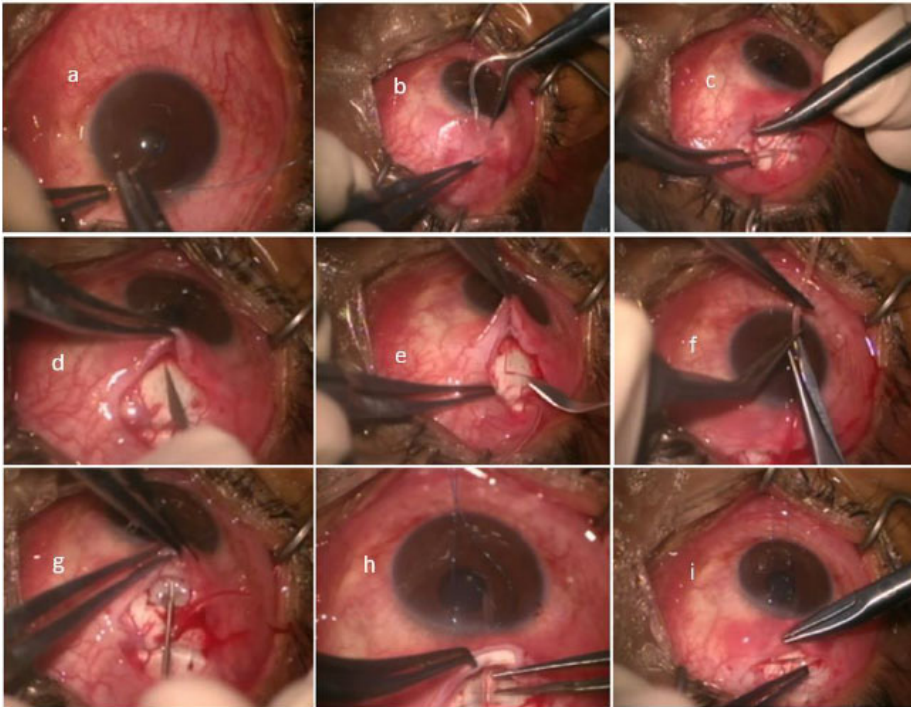


Figure 3. GDD Implantation Surgery Steps on the Right Eye; (a) corneal fixation using prolene 7.0, (b) conjunctival peritomy, (c) identification of rectus temporal and superior muscles, (d) sclerostomy, (e) flap scleral window, (f) implantation of GDD Virna 8 mm from the limbus in superonasal region, (g) Plate fixation with prolene 7.0 and tube ligation with vicryl 8.0, (h) tube measurement and cutting, (i) suturing the conjunctiva with pericardial membrane using vicryl 8.0, p. evaluation of BMD, hydration, intracameral injection of cefazolin, betadine irrigation and xitol drops

vascular injection (PCVI), subconjunctival bleeding (SCB), suture, no plate exposed, no leakage, Descemet fold on the cornea, Shallow anterior chamber, Tube located at 11 o'clock position (superotemporal), Pupillary reflex positive, clear lens; IOP (applanation) 4 mmHg. Then, the patient plans for COA reform surgery using local anesthesia.

Evaluation after 10 days in Figure 5 in right eye, This show in right eye visual acuity visual 6/7,5 PH 6/6; anterior segment: CVI, PCVI, SCB, no plate exposed, no leakage, Descemet fold on cornea, shallow anterior chamber, tube located at 11 o'clock position (superotemporal), pupillary reflex positive, clear lens; Fundoscopy: ONH round-shaped, well-defined borders CDR 0.5 with cupping and nasalization, ratio of arteries and veins is 2/3, normal retina, Macular reflex (+); IOP (applanation): 13 mmHg.

After 1 month of follow-up, the patient's right eye pressure is still in normal condition, and no complications happen after right eye GDD implantation. With the successful GDD implantation on the right eye, the patient plans for left eye non-valve Virna's GDD implantation surgery under general anesthesia on January 26, 2021. The patient's condition before surgery was visual acuity 6/24 in the left eye, deep anterior chamber and intraocular pressure with an icare 47 mmHg. Then, a mannitol drip of 5ml / kgBB (300 mL) was inserted, which ran out within 1 hour preoperatively. After re-evaluation, the pressure of the left eyeball was found to be 40 mmHg.

Postoperative ophthalmological first-day examinations are shown in Figure 6. This is shown in left eye visual acuity 1/60; anterior segment: CVI, PCVI, SCB, suture, no plate exposed, no leakage, Descemet fold on cornea, Shallow anterior chamber, Tube located at 2 o'clock position (superotemporal), Pupillary reflex positive, clear lens; IOP (applanation) 5 mmHg.

At the first month follow-up after LE GDD implantation, the patient's intraocular pressure was still in normal condition in both eyes, and no complications were found. The visual acuity is 6/9 on the right eye and 6/24 on the left eye, with IOP RE 11mmHg and LE



Figure 4. RE condition on the first day after GDD implantation surgery shown anterior segment: CVI, PCVI, SCB, suture, no plate exposed, no leakage, Descemet fold on cornea, Shallow anterior chamber, Tube located at 11 o'clock position (superotemporal), Pupillary reflex positive, Clear lens.

evaluation, the right intraocular pressure was decreased to 24 mmHg.

Figure 3 explains the surgery steps. During the surgery, there were no significant difficulties or complications. After surgery, the patient received Methylprednisolone 8 mg once three times, Cefixim 500 mg twice a day, Posop eye drops six times (one drop in the right

eye), Lyteers eye drops six times (one drop in the 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. The right eye examination visual acuity 6/15; anterior segment: conjunctival vascular injection (CVI), peri corneal conjunctival

16mmHg, from the anterior segment deep anterior chamber, no plate exposed, no leakage, tube not attached to the corneal endothelium. Funduscopic examination: for right eye ONH round-shaped, well-defined borders CDR 0.5 with cupping and nasalization, the ratio of arteries and veins is 2/3, normal retina, and macular reflex (+).

and veins is 2/3, normal retina, Macular reflex (+). For the left eye, ONH is round-shaped, with well-defined borders, CDR 0.9 with cupping and nasalization, the ratio of arteries and veins is 2/3, normal retina, and macular reflex (+).

DISCUSSION

A 18-year-old male patient came with a diagnosis of RLE steroid-induced glaucoma and allergic conjunctivitis. The patient has been suffering from allergic conjunctivitis and has consumed steroid eyedrop treatment for 5 years and underwent trabeculectomy surgery in 2020 on the left eye, but no significant decrease in IOP, and there is fibrosis on the conjunctiva. The prevalence of steroid-induced open-angle glaucoma remains unknown.

Increased intraocular pressure due to long-term steroid use can result in secondary steroid-induced glaucoma. If the increased intraocular pressure is not treated properly, it can progress to glaucomatous optic neuropathy. Corticosteroids are anti-inflammatory drugs that are commonly used in certain systemic conditions. Steroids trigger increased intraocular pressure when administered topically, periocular, systemically or inhaled. Long-term topical steroid use is often seen in patients with a systemic history, such as allergic conjunctivitis.¹ Treatment of allergic conjunctivitis is using mild doses of antiallergic eye drops. Long-term topical steroid therapy leads to eye complications such as cataracts and glaucoma.⁵ Exogenous corticosteroids are more often increased in intraocular pressure. Systemic steroid therapy is the least route to increasing IOP. In general, the IOP-raising effect due to steroids is directly proportional to their anti-inflammatory



Figure 5. RE condition on the tenth day after GDD implantation surgery shown anterior segment: minimal CVI, minimal PCVI, no plate exposed, no leakage, Descemet folds on cornea, shallow anterior chamber, tube located at 11 o'clock position (superotemporal), pupillary reflex positive, clear lens.

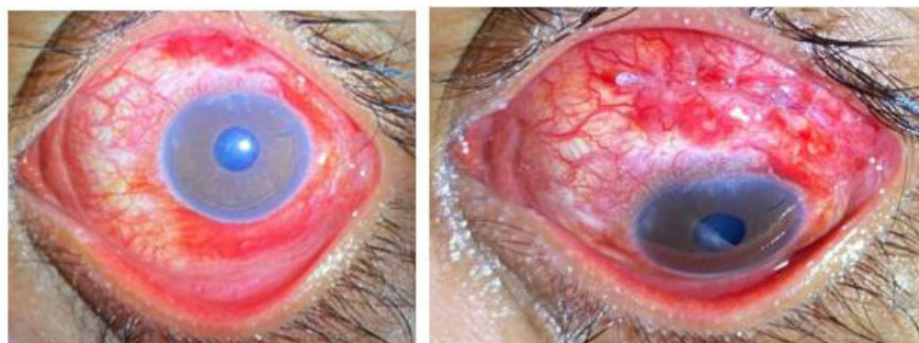


Figure 6. LE condition on the first day after GDD implantation surgery shown anterior segment: CVI, PCVI, SCB, suture, no plate exposed, no leakage, clear cornea, Shallow anterior chamber, Tube located at 2 o'clock position (superotemporal), Pupillary reflex positive, clear lens.

Table 2. Ophthalmology Examination of Right Eye Day 1 and 1-month after surgery

Left eye	Day-1	Day-30
Visual acuity	6/15	6/7.5 PH 6/6
Anterior Segment	CVI (+), PCVI (+), SCB (+), suture (+), GDD superotemporal plate (+) not exposed, tube at 11 o'clock not touched endothelium cornea, leakage (-) Cornea Descemet fold (+) Shallow anterior chamber Iris regular Pupillary reflex (+) clear lens	GDD superotemporal plate (+) not exposed, tube at 11 o'clock not touched endothelium cornea, leakage (-) Cornea clear anterior chamber VH3 Iris regular Pupillary reflex (+) clear lens
Funduscopy	Fundus reflex (+)	ONH round-shaped, well-defined borders, CDR 0.5 with cupping and nasalization, IR>SR, Ratio of arteries and veins is 2/3 Normal retina, Macular reflex (+)
IOP (applanation)	4 mmHg	11 mmHg

PH= pinhole; NI = no improvement; CVI = conjunctival vascular injection; PCVI = pericorneal vascular injection; SCB = subconjunctival bleeding; PI = Peripheral Iridectomy; ONH = optic nerve head; CDR = cup disc ratio; IOP = intraocular pressure.

Table 3. Ophthalmology Examination of Left Eye Day 1 and 1-month after surgery

Left Eye Visual acuity	Day-1 1/60	Day-6 6/9 PH 6/6
Anterior Segment	CVI (+), PCVI (+), SCB (+), suture (+), GDD superotemporal plate (+) not exposed, tube at 2 o'clock not touched endothelium cornea, leakage (-) Bleb conjunctiva (+) flat (+) Cornea Descemet fold (+) Suture (+) Shallow anterior chamber Iris regular Pupillary reflex (+) clear lens	GDD superotemporal plate (+) not exposed, tube at 2 o'clock not touched endothelium cornea, leakage (-) Bleb conjunctiva (+) flat (+) Clear cornea Anterior chamber angle VH3 Iris regular Pupillary reflex (+) clear lens
Funduscopy	Fundus reflex (+)	ONH round-shaped, well-defined borders, CDR 0.9 with cupping and nasalization, Ratio of arteries and veins is 2/3 Normal retina, Macular reflex (+)
IOP (applanation)	4 mmHg	14 mmHg

PH= pinhole; NI = no improvement; CVI = conjunctival vascular injection; PCVI = pericorneal vascular injection; SCB = subconjunctival bleeding; PI = Peripheral Iridectomy; ONH = optic nerve head; CDR = cup disc ratio; IOP = intraocular pressure.

potency.^{6,7} In steroid-responsive patients, an increase in IOP usually occurs within the first week of steroid administration. Still, it can increase over a faster period of one hour or over a longer period of years after long-term steroid use. When the steroid use is discontinued, the IOP usually normalizes after 1 to 4 weeks of discontinuation.⁶

Patients with steroid use usually present with the same symptoms as those of open-angle glaucoma (POAG). Signs and symptoms may differ based on the age of the patient. Pediatric age with congenital glaucoma symptoms such as watery eyes, blepharospasm or photophobia. In adolescent patients, as in open-angle juvenile glaucoma. Adult patients show elevated IOP, open angle on gonioscopy, cupping of the optic disc, and visual field defects.⁶ The management of steroid glaucoma is to discontinue steroid use. If discontinuation is not possible, then a dose reduction or replacement with a lower class of steroid is recommended.⁸ Management of steroid-induced glaucoma can be done through medication, laser, or surgical therapy. Long-term administration of antiglaucoma drugs has adverse side effects on the body.⁹ Laser trabeculoplasty is the initial treatment, especially in patients with low drug compliance. This laser therapy has a minimally invasive effect when compared to surgical therapy.¹⁰

This patient had a history of recurrent allergic conjunctivitis using topical steroids, and attempts were made to substitute weaker steroids and smaller

doses. The patient also had a history of trabeculectomy surgery on the left eye, but the intraocular pressure remained high, thus still requiring oral and topical antiglaucoma medication. This patient was observed for 2 weeks, but the intraocular pressure was still high, and the trabeculectomy bleb was still flat, found fibrosis conjunctiva, so a glaucoma drainage device implantation.

The surgical therapy that can be performed is filtration surgery. Trabeculectomy is one type of filtration surgery that is effective in lowering intraocular pressure that does not decrease with antiglaucoma medication. However, trabeculectomy has early and late complications. Risk factors for failure of filtration surgery include age, gender, duration of allergic or vernal conjunctivitis, duration of steroid therapy, preoperative IOP, amount of antiglaucoma medication taken preoperatively, enlarged cup disk ratio (CDR), type of steroid used, or type of filtration surgery.¹¹

Glaucoma Drainage Devices (GDD) are designed for draining the aqueous humor from the anterior chamber of the eye to an external reservoir, where a fibrous capsule will form after 4-6 weeks, which will regulate the drainage flow through the blood vessels around the capsule. GDD has successfully controlled IOP in patients with a history of failed trabeculectomy or eyes with conjunctival abnormalities, such as scars from previous surgical procedures or trauma.¹² GDDs are available in various sizes, materials, and designs with valves (Ahmed) or without valves (Morteno,

Baerveldt, Virna). The GDD valve creates a one-way flow of ejection (flow restrictor), while a GDD without a valve is a passive flow only.⁴ GDDs with valves are preferred as they use a simpler surgical technique by localizing to one quadrant without manipulating the adjacent rectus muscle. Intraocular pressure (IOP) control in the early postoperative period is more predictable due to the flow restriction mechanism. The material of the plate determines the outcome of the IOP, as it impacts the tissue reaction and the degree of bleb encapsulation.¹³ The size of the implant's superior surface and the material derived from PMMA determine the outcome of IOP.¹⁴ In patients with poor adherence to postoperative medication and follow-up visits, valve implants may be preferred as they usually require less follow-up and postoperative care.⁷

Early postoperative IOP control is determined by the presence or absence of a valve on the implant, as the tube provides no resistance to aqueous flow. GDDs with valves provide rapid IOP control, resulting in lower rates of hypotony.¹⁵ As non-valve GDDs are often blocked at the stent or ligature suture, post-operative IOP measurement does not change. It requires continued use of antiglaucoma medication until a fibrous capsule is formed.¹⁶ In all types of GDDs, long-term IOP control depends on the implant surface area, which is determined by the size of the bleb, the tissue response to the implant, and the fibrous capsule thickness that controls aqueous humor flow through the bleb wall.¹⁷ This patient had undergone

trabeculectomy surgery on the left eye 5 months before, but the IOP was still high, so the patient planned for GDD implantation. This patient procedure using Virna (non-valve) GDD implantation.

The things that need to be considered during the postoperative follow-up of GDD implants are the depth of the anterior chamber and its inflammatory reaction, the position of the tube, and the healing of the conjunctiva. Antibiotics and topical steroids should be used for 4-6 weeks. For GDD with valves, preoperative antiglaucoma medication is no longer used to prevent hypotony.¹⁸ In GDD without valves, antiglaucoma medication is continued until the fibrous capsule around the plate is formed.¹³

On the first postoperative day of the right eye, the first day of follow-up found a hypotony complication with a shallow anterior chamber. So, the treatment was carried out by reforming the COA by adding viscoelastic. Whereas after GDD implant surgery on the left eye, after 2 weeks of follow-up, IOP 47 was found, and treatment was given in the form of systemic and topical antiglaucoma. At the next control, the IOP of the left eye became 11mmHg, so the antiglaucoma drug was stopped. After 1 month with the use of 1 type of topical antiglaucoma drug in the left eye, the IOP of both eyes remained controlled, although the patient was still using low-dose topical steroid eye drops in the left eye. The prognosis for a good visual recovery from steroid-induced glaucoma depends on an early diagnosis and management that aids IOP control and prevents optic nerve damage.¹⁹

CONCLUSION

Long-term steroid use results in permanent damage to the trabecular meshwork and leads to open-angle glaucoma. This requires the administration of antiglaucoma drugs and surgical procedures such as trabeculectomy. Treatment with GDD implants can be used as the last choice in managing glaucoma

patients if trabeculectomy fails to control IOP in the long term.

CONFLICT OF INTEREST STATEMENT

The authors state no conflict of interest.

CONSENT FOR PUBLICATION

Informed consent has been obtained from all individuals included in this study.

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None.

AUTHOR CONTRIBUTION

The author contributed to literature searching, data collecting, and manuscript preparation.

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