Glaucoma valve complications

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Glaucoma in numbers

- the 2nd leading cause of blindness in the world.
- the total number of people (aged 40–80 years) with glaucoma worldwide was estimated to be 64.3 million.
- Africa had the second highest number of cases with 8.3 million (13%)

Glaucoma overview

- Although many risk factors have been described for glaucoma development and progression IOP,age, genetic predisposition and vascular parameters.
- lowering IOP is the only scientifically demonstrated method to slow the progression of the disease.
- IOP reduction in glaucoma patients can be achieved with medical, laser, or surgical therapy.
- Variable success rates for trabeculectomy have been reported in literature. Although success rates are high in the first few years after surgery (70%–92%), they tend to decrease with time (42%–90%), especially in secondary glaucomas.

- Takihara Y, Inatani M, Fukushima M, Iwao K, Iwao M, Tanihara H. Trabeculectomy with mitomycin C for neovascular glaucoma: prognostic factors for surgical failure. Am J Ophthalmol. 2009;147(5):912–918.
- . Iwao K, Inatani M, Seto T, et al. Long-term outcomes and prognostic factors for trabeculectomy with mitomycin C in eyes with uveitic glaucoma: a retrospective cohort study. J Glaucoma. 2014;23(2):88–94.
- . Bettis DI, Morshedi RG, Chaya C, Goldsmith J, Crandall A, Zabriskie N. Trabeculectomy with mitomycin C or Ahmed valve implantation in eyes with uveitic glaucoma. J Glaucoma. 2015;24(8):591–599. [PubMed]
- . Singh D, Chandra A, Sihota R, Kumar S, Gupta V. Long-term success of mitomycin-augmented trabeculectomy for glaucoma after vitreoretinal surgery with silicone oil insertion: a prospective case series. Retina. 2014;34(1):123–128.

History :

- First attempts at developing a glaucoma drainage implant were published in 1906
- the first device currently in use was developed by Molteno et al only in 1976.offers no resistance to AH outflow and associated with high rate of complications, such as hypotony, shallow anterior chamber (AC), choroidal effusion, and choroidal detachment.
- in 1976, Krupin designed a pressure-sensitive unidirectional valve to provide filtration restriction. Its passive mechanism contemplates a silastic tube, whose distal end is sealed and contains several horizontal and vertical slits. Krupin implant is designed to open when IOP is >11 mmHg.
- many other implants have been designed.
- The two basic types are "valved" (Ahmed or Krupin) and "non-valved" (Molteno, Baerveldt) designs

- Rollet M. Le drainage au irin de la chambre anterieure contre l'hypertonie et al douleur. Rev Gen Ophthalmol. 1906;25:481
- Patel S, Pasquale LR. Glaucoma drainage devices: a review of the past, present, and future. Semin Ophthalmol. 2010;25(5–6):265–270
- Krupin T, Podos SM, Becker B, Newkirk JB. Valve implants in filtering surgery. Am J Ophthalmol. 1976;81(2):232–235.

Philosophy behind glaucoma drainage implant

- Aqueous shunts are a reliable alternative to trabeculectomy. Conceptually, shunting aqueous humor (AH) to the posterior subconjunctival space may avoid healing issues, especially in patients who have already undergone previous glaucoma surgeries or conjunctival manipulation.

- Gedde SJ, Schiffman JC, Feuer WJ, Herndon LW, Brandt JD, Budenz DL, Tube versus Trabeculectomy Study Group Treatment outcomes in the tube versus trabeculectomy (TVT) study after five years of follow-up. Am J Ophthalmol. 2012;153(5):789–803

Efficacy of aqueous shunts

Aqueous Shunt
Academy of Op

Objective

Conclusions

Based on level I evidence, aqueous shunts seem to have benefits (IOP control, duration of benefit) comparable with those of trabeculectomy in the management of complex glaucomas (phakic or pseudophakic eyes after prior failed trabeculectomies). Level I evidence indicates that there are no advantages to the adjunctive use of antifibrotic agents or systemic corticosteroids with currently available shunts. Too few high-quality direct comparisons of various available shunts have been published to assess the relative efficacy or complication rates of specific devices beyond the implication that larger–surface-area explants provide more enduring and better IOP control. Long-term follow-up and comparative studies are encouraged.

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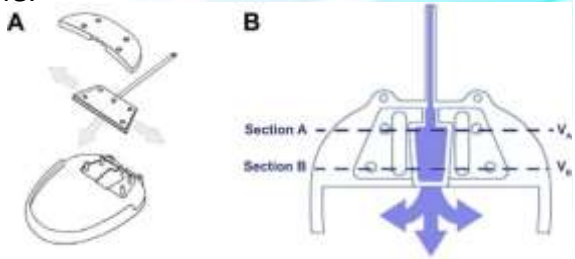
the equatorial plate through the conjunctival surface occurs less frequently. Clinical failure of the various devices over time occurs at a rate of approximately 10% per year, which is approximately the same as the failure rate for trabeculectomy.

Ahmed Glaucoma Valve (AGV)

- AGV provides a more complex mechanism to control AH outflow.
- It was developed by Mateen Ahmed and was approved by the Food and Drug Administration in 1993.
- It consists of 3 parts:
- 1) a plate, in medical grade silicone, polypropylene, or porous polyethylene, depending on the model.
- 2) a drainage tube in medical grade silicone.
- 3) a valve mechanism in medical grade silicone.
- Polypropylene is a rigid plastic, not flexible and highly resistant to torsional forces, whereas silicone is a flexible rubber.



Ahmed Glaucoma Valve (AGV)

Ahmed glaucoma valve implant available models

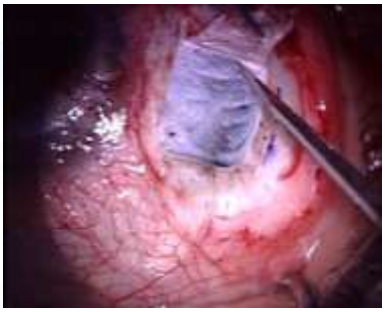
Type	Model	Size (mm^2)	Material (plate)
Single plate	S2	184	Polypropylene
Pediatric size	S3	96	Polypropylene
Double plate	B1	364	Polypropylene
Single plate	FP7	184	Silicone
Pediatric size	FP8	96	Silicone
Double plate	FX1	364	Silicone
Single plate	M4	160	Polyethylene
Pars plana	PS2	184	Polypropylene
Pars plana (pediatric)	PS3	96	Polypropylene
Pars plana	PC7	184	Silicone
Pars plana (pediatric)	PC8	96	Silicone

Surgical technique :

- The implant should be examined for integrity and primed before implantation. Priming is performed by using a 26G cannula, injecting ~1 cc of balanced salt solution (BSS) or sterile water through the drainage tube. Functionality of the implant is demonstrated by BSS flow through the plate
- Surgical technique for AGV implantation consists of a fornix-based or limbal-based conjunctival incision to create a conjunctival flap between 2 recti muscles, generally in the superotemporal quadrant.


Surgical technique :

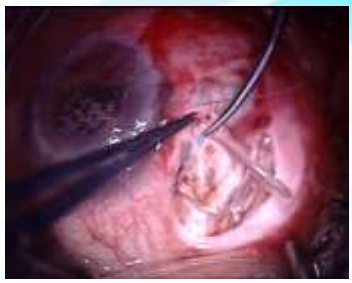
- Body implant is positioned 8–10 mm from the limbus.
- The plate is then sutured to the sclera with a 9.0 or 10.0 nylon suture.


Surgical technique :

- The drainage tube is trimmed to permit a **2–3 mm** insertion in the AC and is bevel cut to an angle of 30°, to facilitate AC entering.
- An AC paracentesis is performed, and viscoelastic substance is injected to increase spaces. The AC is then entered **1–3 mm posteriorly to the corneoscleral limbus** with a 22–23G needle.



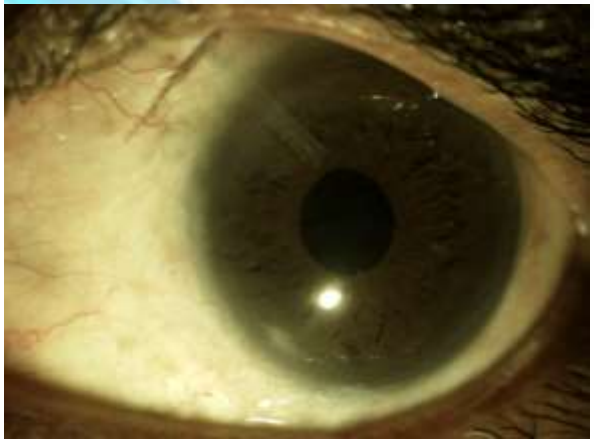


Surgical technique :

- The drainage tube is covered with a piece of preserved, donor sclera, pericardium, cornea, or other suitable patch graft material, which is sutured to the sclera. Alternatively, a two-third thickness limbus scleral flap is created.
- In the final step, conjunctiva is anchored to the limbus with adsorbable/nonadsorbable sutures



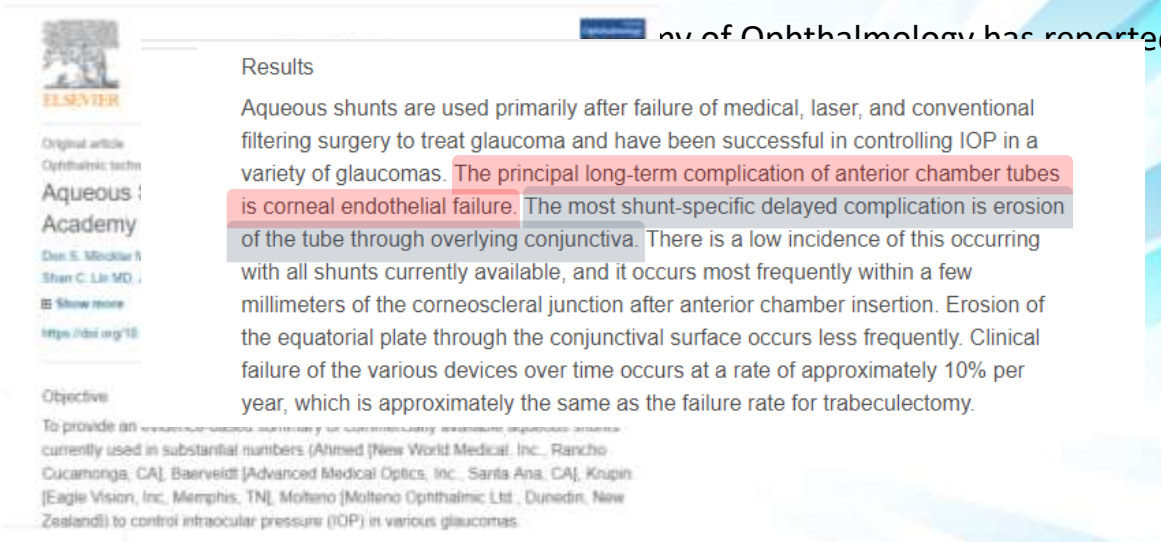
Surgical technique :




Indications of tube shunt procedure

- Neovascular glaucoma.
- Uveitic glaucoma .
- Traumatic glaucoma.
- Silicone induced glaucoma.
- Infantile/Juvenile glaucoma ??

AGV complications



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Shan C. Lin MD

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Objective

To provide an evidence-based summary of commercially available aqueous shunts currently used in substantial numbers (Ahmed [New World Medical, Inc., Rancho Cucamonga, CA], Baerveldt [Advanced Medical Optics, Inc., Santa Ana, CA], Krupin [Eagle Vision, Inc, Memphis, TN], Molteno [Molteno Ophthalmic Ltd., Dunedin, New Zealand]) to control intraocular pressure (IOP) in various glaucomas.

Results

Aqueous shunts are used primarily after failure of medical, laser, and conventional filtering surgery to treat glaucoma and have been successful in controlling IOP in a variety of glaucomas. The principal long-term complication of anterior chamber tubes is corneal endothelial failure. The most shunt-specific delayed complication is erosion of the tube through overlying conjunctiva. There is a low incidence of this occurring with all shunts currently available, and it occurs most frequently within a few millimeters of the corneoscleral junction after anterior chamber insertion. Erosion of the equatorial plate through the conjunctival surface occurs less frequently. Clinical failure of the various devices over time occurs at a rate of approximately 10% per year, which is approximately the same as the failure rate for trabeculectomy.

AGV complications

- Actually, there is no evidence in literature about different rates of complications with 1 AGV model than another. Although an higher IOP reduction with the silicone-plate model than the polyethylene one has been described in the short term, long-term results are not conclusive.

Ishida K, Netland PA, Costa VP, Shiroma L, Khan B, Ahmed II. Comparison of polypropylene and silicone Ahmed glaucoma valves. Ophthalmology. 2006;113(8):1320–1326.

Law SK, Nguyen A, Coleman AL, Caprioli J. Comparison of safety and efficacy between silicone and polypropylene Ahmed glaucoma valves in refractory glaucoma. Ophthalmology. 2005;112(9):1514–1520.

Brasil MV, Rockwood EJ, Smith SD. Comparison of silicone and polypropylene Ahmed glaucoma valve implants. J Glaucoma. 2007;16(1):36–41.

Mackenzie PJ, Schertzer RM, Isbister CM. Comparison of silicone and polypropylene Ahmed glaucoma valves: two-year follow-up. Can J Ophthalmol. 2007;42(2):227–232.

Hinkle DM, Zurakowski D, Ayyala RS. A comparison of the polypropylene plate Ahmed glaucoma valve to the silicone plate Ahmed glaucoma flexible valve. Eur J Ophthalmol. 2007;17(5):696–701.

AGV complications

- ***Hyphema*** :
- Hyphema may occur following procedures performed on eyes with neovascular glaucoma. It is seen less commonly now with the preoperative use of anti-VEGF agents.

AGV complications

- ***Scleral Perforation :***
- Scleral perforation is a rare complication during anchorage of the plate to the sclera. Care must be taken in buphthalmic eyes and eyes with collagen vascular diseases

AGV complications

- ***Migration or Expulsion of the Plate:***
- Rare complications. Migration and expulsion usually result from placing the plate too anteriorly.

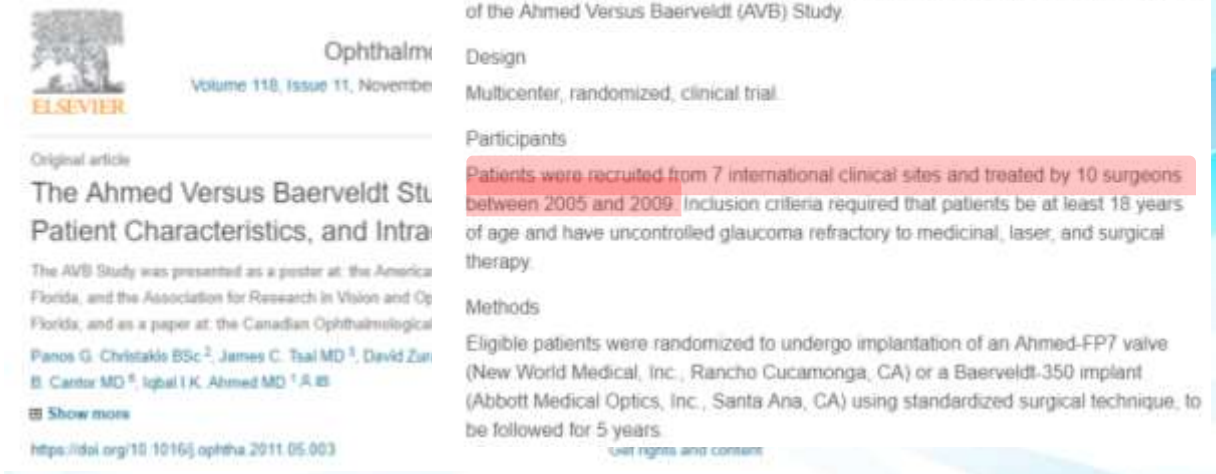


AGV complications

- ***Hypoyony :***
- AGV valve mechanism was designed with the aim of preventing postoperative hypotony, allowing for AH drainage when IOP is in the range of 8–12 mmHg.
- Studies have demonstrated that the mechanism is effective in reducing, but not abolishing.

AGV complications

- ***Hypoyony :***



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Ophthalm

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Original article

The Ahmed Versus Baerveldt Stu
Patient Characteristics, and Intra

The AVB Study was presented as a poster at: the America
Florida, and the Association for Research in Vision and Op
Florida, and as a paper at: the Canadian Ophthalmological

Panos G. Christakis BSc [2], James C. Tsai MD [3], David Zur
B. Cantor MD [6], Iqbal I.K. Ahmed MD [1,7,8]

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https://doi.org/10.1016/j.ophtha.2011.05.003

Objective

To report the design, baseline patient characteristics, and intraoperative complications of the Ahmed Versus Baerveldt (AVB) Study.

Design

Multicenter, randomized, clinical trial.

Participants

Patients were recruited from 7 international clinical sites and treated by 10 surgeons between 2005 and 2009. Inclusion criteria required that patients be at least 18 years of age and have uncontrolled glaucoma refractory to medicinal, laser, and surgical therapy.

Methods

Eligible patients were randomized to undergo implantation of an Ahmed-FP7 valve (New World Medical, Inc., Rancho Cucamonga, CA) or a Baerveldt-350 implant (Abbott Medical Optics, Inc., Santa Ana, CA) using standardized surgical technique, to be followed for 5 years.

AGV complications

- ***Hypoyony :***

Results

A total of 238 patients were enrolled in the study; 124 received the Ahmed-FP7 valve implant and 114 received the Baerveldt-350 implant. The 2 treatment groups did not differ in any baseline characteristics with the exception of sex. The mean age of the study group was 66±16 years, and 55% were women, with a greater proportion in the Baerveldt group (P=0.01). The mean baseline IOP of the study group was 31.4±10.8 on a mean of 3.1±1.0 glaucoma medications. The median Snellen visual acuity was 20/100, mean number of previous laser therapies was 0.9±1.1, and mean number of previous surgeries was 1.7±1.2. Five (4%) patients in the Ahmed group and 4 (4%) patients in the Baerveldt group experienced significant intraoperative complications.

Conclusions

Aqueous drainage devices are being increasingly used for glaucoma refractory to conventional treatment, and the AVB Study compares the 2 most commonly implanted devices. The 2 groups had similar baseline characteristics, and there were a similar number of intraoperative complications for both devices.

	Ahmed-FP7	Baerveldt-350 implant
No of eyes	**124**	**114**
suprachoroidal hemorrhage	0	3
had retinal/choroidal detachments	**0**	**3**
refractory hypotony	0	5

AGV complications

- ***Hypoyony :***
- **The reason** of persistent hypotony after AGV implantation is **not completely clear.** Attention should be taken during surgical procedure to not over-prime the tube and to not excessively manipulate the valve housing, as these actions could damage the valve mechanism embedded in the implant.
- **ciliary body** function **may fail** or decrease after surgery in complicated eyes in which glaucoma drainage implants are used.

- Sarkisian SR., Jr Tube shunt complications and their prevention. Curr Opin Ophthalmol. 2009;20(2):126–130. [PubMed]
- Krupin T, Ritch R, Camras CB, et al. A long Krupin-Denver valve implant attached to a 180 degrees scleral explant for glaucoma surgery. Ophthalmology. 1988;95(9):1174–1180.

AGV complications

- ***IOP increase and excessive capsule fibrosis:***
- An **"hypertensive" phase** after glaucoma drainage implantation is quite common and has been frequently described in patients with AGV. Typically, this phase peaks at **1 or 2 months** postoperatively and resolves within 6 months.
- The hypertensive phase could be **less frequent** in patients who have been implanted **with the silicone** than with the polypropylene AGV, probably because silicone is less inflammatory than polypropylene.

- Huang MC, Netland PA, Coleman AL, Siegner SW, Moster MR, Hill RA. Intermediate-term clinical experience with the Ahmed glaucoma valve implant. Am J Ophthalmol. 1999;127(1):27–33.
- Nouri-Mahdavi K, Caprioli J. Evaluation of the hypertensive phase after insertion of the Ahmed glaucoma valve. Am J Ophthalmol. 2003;136(6):1001–1008.

AGV complications

- ***IOP increase and excessive capsule fibrosis:***
- The **primary reason** for elevated IOP in the postoperative period is from **capsular fibrosis**. Attempts have been made to modulate the fibrotic reaction around the plate, varying plate size, shape, flexibility, and materials.

- Huang MC, Netland PA, Coleman AL, Siegner SW, Moster MR, Hill RA. Intermediate-term clinical experience with the Ahmed glaucoma valve implant. Am J Ophthalmol. 1999;127(1):27–33.
- Nouri-Mahdavi K, Caprioli J. Evaluation of the hypertensive phase after insertion of the Ahmed glaucoma valve. Am J Ophthalmol. 2003;136(6):1001–1008.

AGV complications

- ***IOP increase and excessive capsular fibrosis:***
- An option in the **management** of the hypertensive phase is, similar to trabeculectomy, **digital massage**. The purpose of digital massage is to force AH through the tube, opening the valve mechanism, and reducing scar formation. Caution should be placed in this maneuver in order to avoid repeated tube-corneal endothelial touch.

- McIlraith I, Buys Y, Campbell RJ, Trope GE. Ocular massage for intraocular pressure control after Ahmed valve insertion. Can J Ophthalmol. 2008;43(1):48–52.
- Smith M, Geffen N, Alasbali T, Buys YM, Trope GE. Digital ocular massage for hypertensive phase after Ahmed valve surgery. J Glaucoma. 2010;19(1):11–14.

AGV complications

- ***IOP increase and excessive capsular fibrosis:***
- **Late IOP increase** (>6 months) is the main cause of **long-term failure** of AGV surgery.
- **encapsulation** of the plate is evident, a **needling** revision of the bleb may be attempted +/- 5FLU injection .
- If medical therapy and needling revision are not successful, surgical **revision of the implant** should be performed.

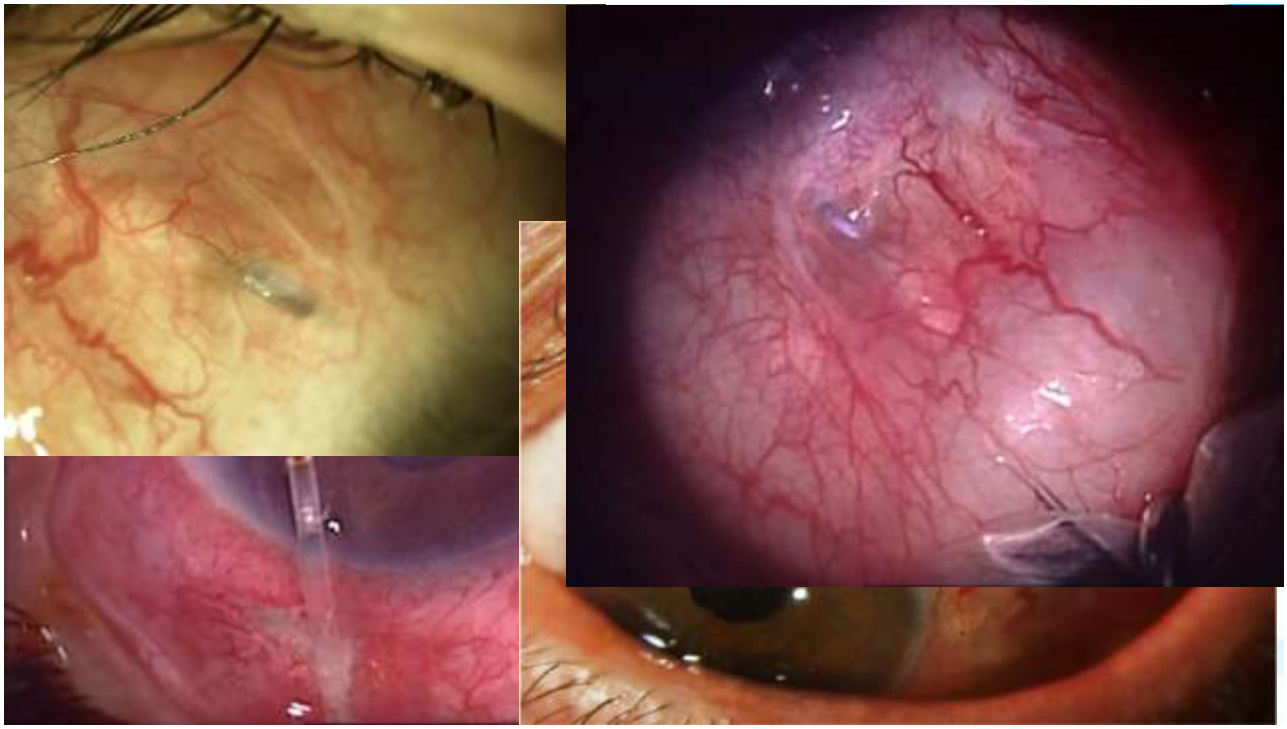
AGV complications

- ***IOP increase without capsular fibrosis:***

AGV complications

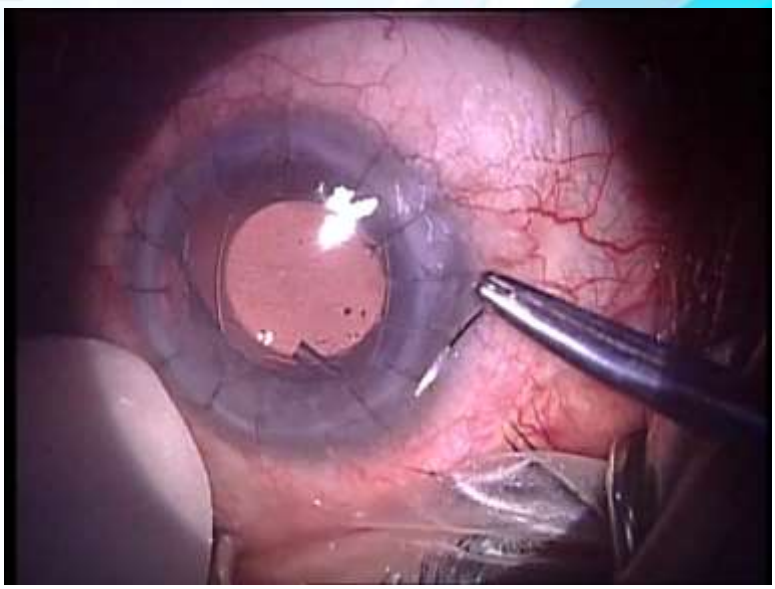
- ***Tube exposure :***
- Tube **exposure** is a well-known complication of glaucoma drainage implants. **Erosion** of the conjunctiva and of the covering patch graft has been described in the late postoperative period in **2%–7%** of eyes after implantation of glaucoma devices.

- Huang MC, Netland PA, Coleman AL, Siegner SW, Moster MR, Hill RA. Intermediate-term clinical experience with the Ahmed glaucoma valve implant. Am J Ophthalmol. 1999;127(1):27–33.
- Smith M, Geffen N, Alasbali T, Buys YM, Trope GE. Digital ocular massage for hypertensive phase after Ahmed valve surgery. J Glaucoma. 2010;19(1):11–14.



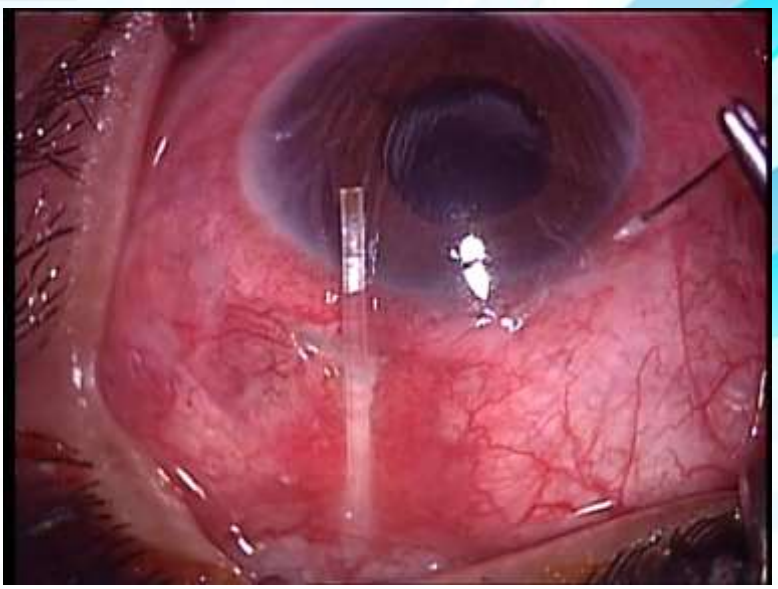
AGV complications

- ***Tube exposure :***



AGV complications

- ***Tube exposure :***
- ***After sever blunt trauma***



AGV complications

- ***Tube exposure :***
- **The mechanism** responsible for tube exposure is **not completely clear :**
- A high grade**, immune-mediated** process could be responsible for rapid melting (<6 months) of the patch.
- A **mechanical** process could be involved in patch erosion as well.
- If tube is **not fixed on the sclera**, continuous and minimum movements may produce tube-graft tension resulting in gradual patch atrophy.
- Finally, **patch melting** could occur as a result of a low grade, possibly immune-mediated, long-term, atrophy process, with consequent gradual patch thinning.

AGV complications

- ***Malignant glaucoma :***
- first described by **von Graefe** in 1869
- characterized by elevated IOP with a shallow or flat anterior chamber.
- usually occurs following ocular surgery.
- **Other names**: including aqueous misdirection, ciliary block glaucoma and lens block angle closure.

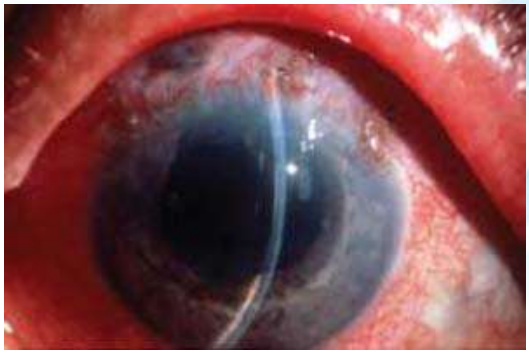
AGV complications

- ***Malignant glaucoma :***
- **Risk factors** :
- 1) 2-4%of eyes undergoing surgery for angle-closure glaucoma.
- 2) hours to days or years after iatrogenic causes such as trabeculectomy, cataract extraction with or without IOL implantation, glaucoma drainage implantation, laser iridotomy, capsulotomy, laser suture lysis or argon laser photocoagulation, miotic therapy, needling of filtering blebs, viscoelastic use or intravitreal injection.
- 3) Women are three times more likely than men to develop malignant glaucoma, possibly because they have a smaller mean axial length than men

- Ruben, S. et al. Br J Ophthalmol 1997;81:163–167.

AGV complications

- ***Malignant glaucoma :***



AGV complications

- ***Malignant glaucoma :***

[Malignant glaucoma following combined Ahmed valve implant and phacoemulsification surgery for chronic angle-closure glaucoma].

[Article in Spanish]

Martínez-de-la-Casa JM[1], García-Feijoó J, Castillo A, Polo V, Larrosa JM, Pablo L, García-Sánchez J.

⊕ **Author information**

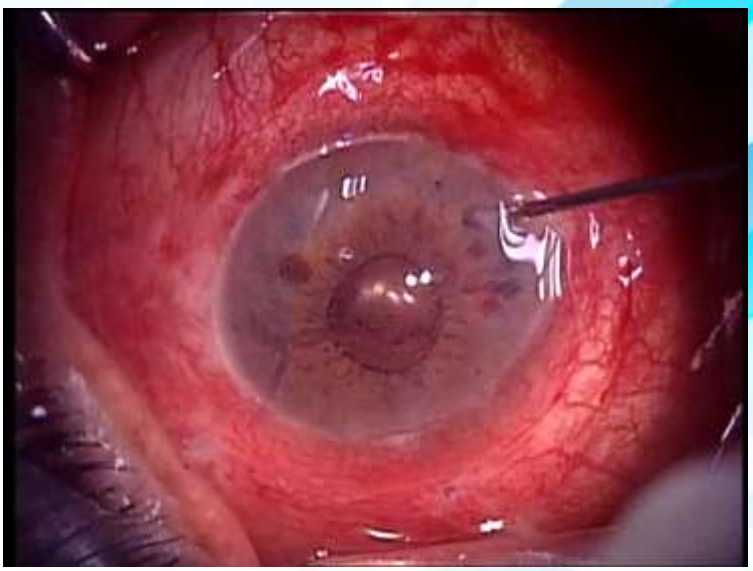
Abstract

CASE REPORT: Simultaneous Ahmed valve implant, combined with phacoemulsification cataract surgery, is a useful therapeutic option for patients with chronic angle-closure glaucoma, when conventional filtering surgery fails. This combined approach permits both control of intraocular pressure and early recovery of visual function. We report the results in five patients successfully treated with this combined procedure, two of whom developed early postoperative malignant glaucoma.

DISCUSSION: Predisposing anatomic features in patients with chronic angle-closure glaucoma, associated with sudden anterior chamber decompression and increased postoperative inflammation, may facilitate the development of malignant glaucoma following combined glaucoma implant and phacoemulsification surgery.

AGV complications

- ***Malignant glaucoma :***

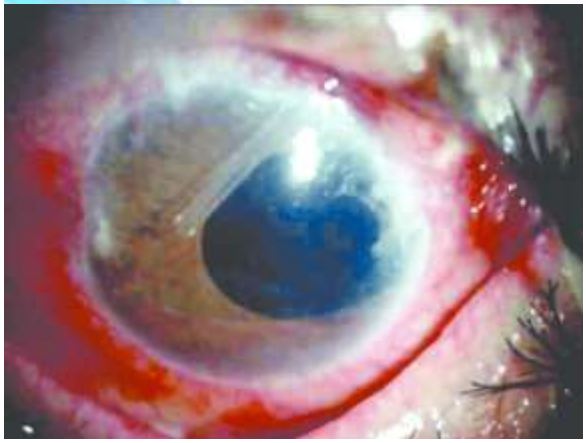


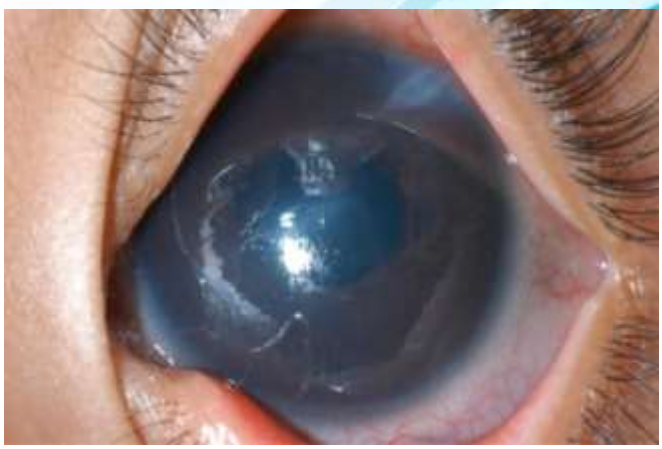
AGV complications

- ***Corneal complications :***
- The presence of the **silicone tube in the AC** is known to disturb corneal endothelium and may induce corneal decompensation and edema.
- The exact **frequency** of corneal issues in patients implanted with AGV is not known, but it has been reported to be **9%–27%** in the long term

AGV complications

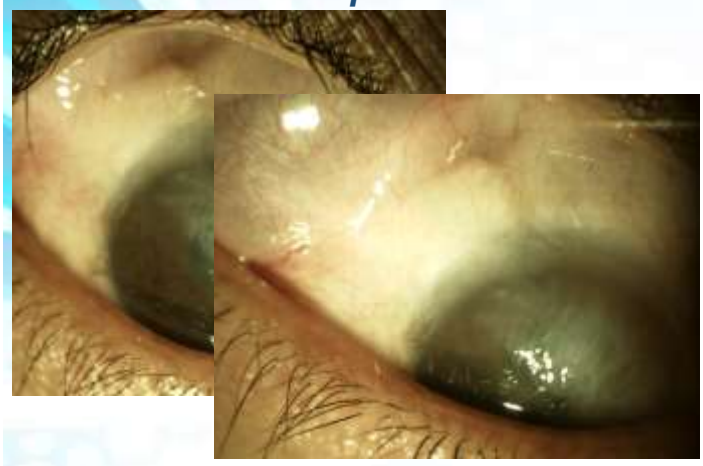
- ***Corneal complications :***





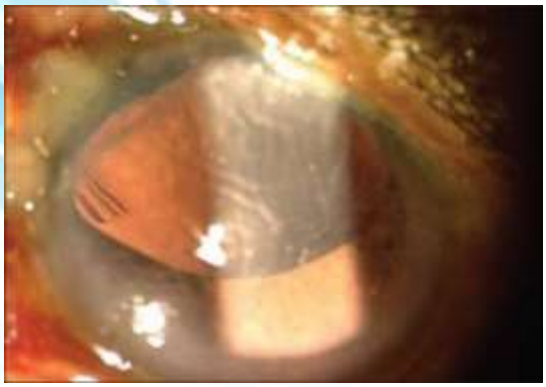
AGV complications

- ***Corneal complications :***



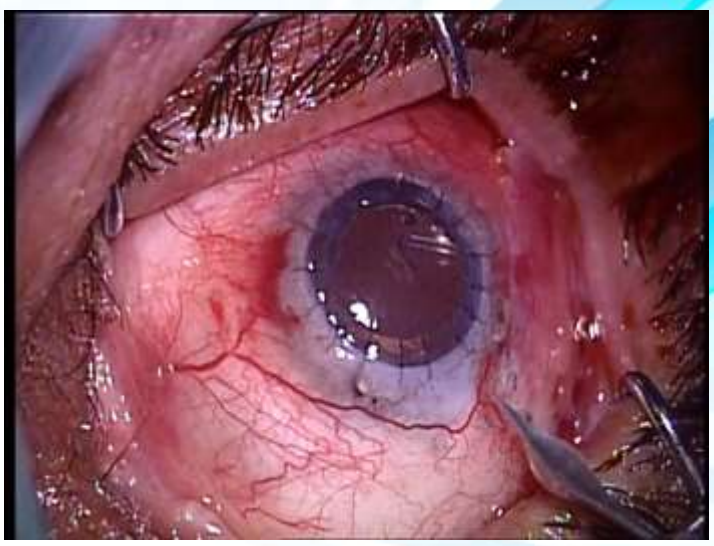
AGV complications

- ***Corneal complications :***
- Prevention → tube insertion in PC in selected cases .
  → tube adjustment .



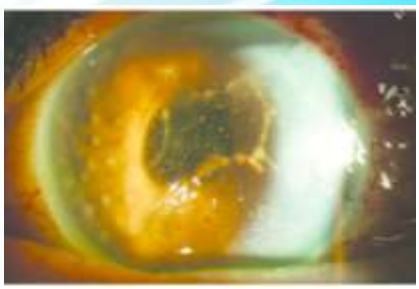
AGV complications

- ***Corneal complications :***



AGV complications

- ***Infection and endophthalmitis:***



AGV complications

- ***Infection and endophthalmitis:***
- Endophthalmitis or infections associated with grafting material covering the tube is a **rare complication** of glaucoma drainage implants. For this reason, recurrent blebitis after trabeculectomy can be a reasonable indication for shunt implantation, according to a report by the American Academy of Ophthalmology.

AGV complications

- ***Infection and endophthalmitis:***
- Several retrospective studies about glaucoma drainage implants included few cases of endophthalmitis, resulting in rates ranging from **0.8% to 6.3%** (mean: 2.0%).
- There appears to be **no significant difference** in reported rates of endophthalmitis among **various glaucoma drainage implants**
- Conjunctival **erosion and tube exposure** appear to be a **major risk factor** for infection development in eyes with glaucoma drainage implants.

- Al-Torbak AA, Al-Shahwan S, Al-Jadaan I, Al-Hommadi A, Edward DP. Endophthalmitis associated with the Ahmed glaucoma valve implant. Br J Ophthalmol. 2005;89(4):454–458.

AGV complications

- ***Diplopia and strabismus:***
- Diplopia and strabismus are **well-known postsurgical complications** of glaucoma drainage devices.
- The cause of diplopia is likely a **restrictive strabismus**, either from the plate itself or from the plate impinging on the muscle insertion. **Manipulation of the rectus muscles** during surgery may induce strabismus as well, which **usually resolves spontaneously** in weeks or months.

- Ayyala RS, Zurakowski D, Smith JA, et al. A clinical study of the Ahmed glaucoma valve implant in advanced glaucoma. Ophthalmology. 1998;105(10):1968–1976.

AGV complications

- ***Diplopia and strabismus:***