IJPSR (2012), Vol. 3, Issue 12 (Review Article)

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH

Received on 28 August, 2012; received in revised form 21 October, 2012; accepted 20 November, 2012

STATUS OF AHMED GLAUCOMA VALVE IN MANAGEMENT OF GLAUCOMA: SUCCESS OR FAILURE

Shefali Katiyar* and Yasmin Sultana

Department of Pharmaceutical Sciences, Jamia Hamdard, New Delhi -62, India

Keywords:
Ahmed glaucoma valve,
Baerveldt implant,
Glaucoma,
Intraocular Pressure,
Refractory glaucoma

Correspondence to Author:

Shefali Katiyar

Department of Pharmaceutical Sciences
Jamia Hamdard, New Delhi -62, India
E-mail: shefali.8088@gmail.com

QUICK RESPONSE CODE

IJPSR:
ICV (2011)- 5.07

Website:
www.ijpsr.com

ABSTRACT

Introduction: Glaucoma valves have been used in the treatment of glaucoma in the cases where medications no longer show the appropriate results. Due to the various complications in molteno, other glaucoma valves such as Ahmed glaucoma valve (AGV) were introduced. Ahmed glaucoma valve has proved to be very useful in the management of glaucoma. This review thus summarizes how far AGV has been successful in the management of glaucoma.

Methods: Various case studies were taken into consideration in this review. The studies were retrospective amongst which some were randomized and others non-randomized. Patients with different kind of glaucoma such as Aphakic and Neovascular were selected and implanted with AGV. The results of the success rate were then compiled and summarized.

Results: AGV was found to be not a very successful implant in the management of Traumatic, Congenital and Uveitic glaucoma as compared to the Baerveldt implant. But the success was well observed in other types. It was also observed that the AGV required use of, more medications than others but it is the preferred implant with good results in the early stages.

Conclusion: Glaucoma drainage devices (GDD) are useful in the cases where the other surgical procedures fail. Sometimes it is also used as an adjunct to the medicines for the better reduction of IOP. But the device has shown complications in its long term use such as movement of the tube of the device in the eye, erosion of the tube and drainage plate through the graft tissue. However, there are ways to manage the complications of the device and hence, its use has increased.

INTRODUCTION: Glaucoma is a symptomatic condition, not a disease. The characteristic physical sign is increased intraocular pressure. The normal eye pressure ranges from 10-21mmHg. An increase in clinical circumstances may be due to:

1. Increase in the hydrostatic pressure in the ocular capillaries.
2. Increase in the protein content of the aqueous humor.
3. Obstruction to the circulation of the aqueous at the pupil or its drainage at the angle of the anterior chamber [1].

Treatments for glaucoma may vary from person to person.

In 80% of the cases medicines or laser surgery are used to control glaucoma. But these are not always effective, in such cases glaucoma valves serves as an effective alternative.

Glaucoma Drainage Devices (GDDs) have the potential to regulate the flow consistently, eliminating hypotony [2]. Implantation of a GDD is indicated for cases where glaucoma cannot be controlled by conventional means or where the anatomy of the eye makes conventional surgery ineffective [3]. These devices have shown success in controlling IOP in eyes with previously failed trabulectomy. They also demonstrated success in complicated glaucoma such as uveitic, neovascular glaucoma, paediatric glaucoma and others.

Currently the glaucoma drainage devices are available in different sizes, materials and designs with the presence or absence of an IOP regulating devices. The NON – VALVED glaucoma drainage implants consists of the single plate (135 mm^2) and double plate (270 mm^2) Molteno (polypropylene), as well as Baerveldt (silicone, either 250mm^2 or 350mm^2). A common practice is to restrict the flow of these devices in the postoperative period with an external vicryl suture or an internal a rip-cord suture. However, the rationale of VALVED DEVICES is to provide a minimal amount of flow resistance, preventing hypotony by creating a “cut off switch” to stop flow when a certain IOP is reached. Valved devices includes Kuprin (silicone plate material, 194 mm^2 surface area), the single plate (184 mm^2), and the double plate (364 mm^2) Ahmed (polypropylene or silicone).

Molteno in 1967, introduced the prototype of the presently used long tube glaucoma implants. The main complications seen with this implant consisted of uveitis occurring in most patients, corneal irritation from the tube and mainly discomfort owing to the presence of large bleb in juxtalimbal position [4]. Beginning in 1990, other long tube implants were introduced by Baerveldt, Ahmed and Krupin, the designs of all these were based on long tube implants.

Ahmed Glaucoma Valve: Ahmed glaucoma valve (AGV), invented by Ahmad Mateen in 1993 as the first aqueous shunting device that has a unidirectional valve mechanism designed to prevent the postoperative hypotony. This device has several attributes which are responsible for its success. It consists of a silicone tube connected to a silicone sheet valve held in polypropylene body.

Recently the end plate was modified from its original polypropylene version to a silicone constitution in an effort to reduce the postoperative inflammation and thereby obtain better IOP control with a diminished complication rate. The AGV implant in the eye is shown in the following **figure 1**:

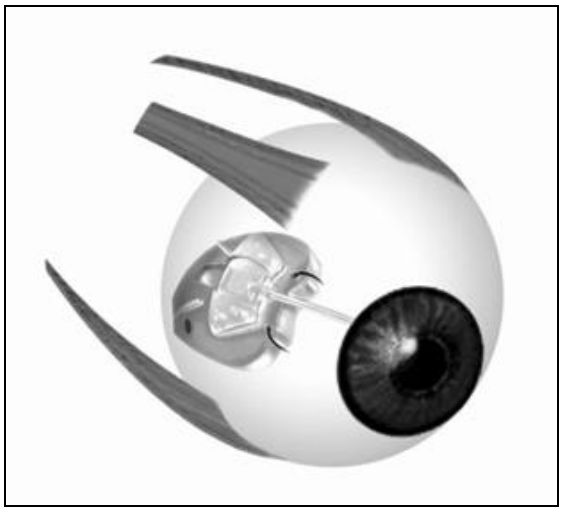

FIG. 1 : AGV IMPLANT PLACEMENT IN THE EYE

When the intraocular pressure is too high, the valve opens thus letting fluid flow out of the eye through the drainage tube. The valve automatically closes when the pressure is normal again. Aqueous humor from the anterior chamber of the eye flows (thick red arrow on the picture) through the tube into the trapezoidal chamber within the plate element. This chamber is formed by a folded over silicone elastomer membrane with its free edges forming a one way valve and producing a venturi effect.

The plate is pre-tensioned to allow the valve to open at a specific intraocular pressure. There are different models of AGV [5]. The valves are made either of silicone or polypropylene and are either double plate or single plate.

The **silicone grade** includes the following models: (see **table 1**)

TABLE 1: SILICONE MODELS OF AGV

Model	Surface area	Features
FP7 (Flexible plate)	184.00 mm^2	Non obstructive valved system, prevents excessive drainage and chamber collapse
FP8 (Flexible Plate) – Paediatrics	96.00 mm^2	Used for paediatrics and small globes
FX1 (Flexible – Bi plate)	184.00 mm^2	Bi-plate design allows greater aqueous drainage
FX4 (Non-Valved Flexible Plate)	180.00 mm^2	Inserted in existing bleb, Used with existing implant and increases its surface area , easily sutured onto the sclera

The **polypropylene grade** includes the following models: (see **table 2**)

TABLE 2: POLYPROPYLENE MODELS OF AGV

Model	Surface Area	Features
S2(Ahmed Glaucoma Valve)	184.00 mm^2	Non Obstructive Valve system, Eliminates drainage tube ligatures
S3 (Paediatric)	96.00 mm^2	Used for paediatrics and small globes, implanted in single stage procedure
B1 (Bi-plate)	364.00 mm^2	Bi-plate design allows for greater aqueous drainage, Prevents excessive drainage and chamber collapse.
B4 (Non Valved plate)	180.00 mm^2	Inserted in existing bleb, used with existing implant and increases its surface area.

Brasil [6] compared the silicone and polypropylene AGV implants. This study compared the implantation of an AGV model FP 7 (silicone) or S2 (polypropylene) in uveitic or neovascular glaucoma. All other patients underwent AGV implantation after previously failed trabulectomy. Before FP 7 model became available all patients received S2 polypropylene implant. The postoperative medication regimen included a topical antibiotic for 1 week and topical steroids. The surgical success was defined as final IOP reduction of at least 20% below the preoperative value and IOP >5 and <22mm Hg, with or without glaucoma medication. There was no statistical difference in the occurrence of hypotony (defined as IOP ≤ 5mm Hg) at any of the post operative time points.

The overall rate of hypotony was 33.6% in the silicone group and 30% in the polypropylene group. The overall rate of postoperative complications was similar between the 2 groups. It was finally found that no significant differences were found between the 2 AGV models studied. Experimental studies have shown that silicone endplates are less inflammatory than those made of polypropylene. Although a greater proportion of patients with polypropylene AGV models experienced a lack of visual acuity, the lack of statistical significance of this finding and the similarity between the 2 groups with respect to IOP reduction and complications lead to believe that the 2 devices are similar with respect to safety and efficacy in managing patients with refractory glaucoma.

Ahmed Glaucoma Valve vs Baerveldt Implant: The difference between the success rates in lowering the intraocular pressure by using the AGV and Baerveldt implant has been different. In a comparative case series, a retrospective study was conducted by Goulet [3], in which he compared the efficacy of the Ahmed S2 glaucoma valve and the Baerveldt 250mm^2 glaucoma implant. The analysis was done on the 59 eyes of 59 patients with Ahmed S2 valve and 133 eyes of 133 patients with Baerveldt 250 mm^2. The mean duration of the follow up was 20 months for Ahmed eyes and 22.9 months for Baerveldt eyes.

The cumulative success rates at 12 months were 0.73 confidence interval(CI) for Ahmed group and 0.92 for Baerveldt group. At 24 months the success rates were 0.62 for Ahmed group and 0.85 for Baerveldt group and at 36 months the cumulative success rates were 0.62 in Ahmed group and 0.73 in Baerveldt group. At the last follow up visit , Ahmed group had significantly lower IOP (19.8±9.5 vs 15.8±7.9mmHg) and more antiglaucoma medications (1.4±1.2 vs 0.9±1.1 medications).

Thus, the study concludes that the Ahmed S2 glaucoma valces amy be less effective at lowering IOP than the Baerveldt 250mm^2 glaucoma implant. Another multicenter, randomised clinical trial was conducted by Christakis [7] on total of 238 patients among which 124 received the Ahmed FP7 implant and 114 received the Baerveldt 350mm^2 implant.

The primary outcome measure was failure defined by the range of the IOP i.e. 5-18mmHg. The mean age of the study group was 66±16years among which 55% were women with a greater proportion in the Baerveldt group. Preoperatively the study group had mean IOP of 31.4±10.8 on a mean of 3.1±0.1 glaucoma medications. The mean IOP at 1 year was 16.5±5.3mmHg in Ahmed group and 13.6±4.8mmHg in Baerveldt group. The mean number of glaucoma medication required were 1.6±1.3 in Ahmed group and 1.2±1.3 in the Baerveldt group.

In the first year after surgery, the number of patients experiencing the postoperative complications were 45% in Ahmed group and 54% in Baerveldt group but a greater number of patients in Baerveldt group required interventions. Thus, the study concluded that the Baerveldt 350 group had higher success rates than the Ahmed group after 1 year follow up but required greater number of interventions. The success rates of Ahmed vs Baerveldt implant in different glaucoma are listed below in **table 3**:

TABLE 3: EFFICACY OF AHMED S2 VERSUS BAERVELDT 250MM^2 IMPLANT[8]

Glaucoma	Ahmed S2	BAERVELDT 250mm^2
Primary open angle glaucoma	32%	28%
Neovascular	37%	27%
Chronic angle closure	19%	20%
Secondary open angle	8%	8%
Uveitic	2%	6%
Congenital	2%	2%
Traumatic	0%	2%

The difference between the success rates in lowering the intraocular pressure may also depend upon the models used during the study. A 1 year follow up study was conducted by Budnez [9] in a similar manner as was carried out by Christakis [7].

The study was carried out in 276 patients including 143 patients implanted with Ahmed FP7 implant and 133 with Baerveldt Glaucoma Implant (BGI) model 101-350. The preoperative IOP was 31.2±11.2mmHg in AGV group and 31.8±12.5mmHg in BGI group. After 1 year, mean IOP was 15.4±5.5mmHg in AGV group and 13.2±6.8mmHg in BGI group. The postoperative complications were found to be more in BGI group(58%) compared with AGV group (43%).

Although the average IOP after 1 year was slightly higher in patients who received AGV, there were fewer early and serious postoperative complications associated with use of AGV than the BGI.

Functional Aspects: Considering the poor prognosis for success of trabulectomy, glaucoma drainage implants have been a useful alternative in the treatment of intractable elevation of IOP in neovascular glaucoma. Neovascular glaucoma diagnosed by a glaucoma subspecialist was defined as neovascularisation of the iris and anterior chamber angle with elevated intraocular pressure. According to the study conducted by Netland [10] in 76 eyes of 76 patients, the mean IOP was decreased significantly ($P < 0.001$) after drainage implant surgery in both control and eyes with neovascular glaucoma.

The majority of eyes (97%) received single plate implants with 1 eye in controls and 1 eye in the neovascular glaucoma group treated with the double plate AGV. The majority of eyes in both the groups (70 of 76 eyes, 92%) had been treated with polypropylene plate model S 2, whereas 6 of 76 eyes (8%) had been treated with silicone plate (model FP 7).

The mean IOP at last follow up were 16.2 ± 5.2 mm Hg in controls and 15.5 ± 12.5 mm in neovascular glaucoma eyes. This study had identified significant differences in success rates over time in eyes with neovascular glaucoma and controls indicating that neovascular glaucoma patients have a greater risk of surgical failure after AGV surgery compared with patients with other glaucoma diagnoses.

The significant treatment outcome difference found in this study indicates that neovascular glaucoma is a risk factor for failure of glaucoma drainage implant surgery. Despite improved mean IOP with AGV, visual outcomes were poor probably owing to progression of the underlying disease.

In neovascular glaucoma patients, the loss of vision despite lowering average IOP by drainage implant surgery suggests the need for improved therapy to preserve function of the retina and optic nerve in the underlying conditions that cause neovascular glaucoma.

Although patients in whom elevated IOP develops after pars plana vitrectomy and silicone endotamponade, can be controlled medically, some require surgical intervention. Ishida [11] investigated the clinical outcome of AGV implantation in eyes treated with pars plana vitrectomy and silicone oil endotamponade and compared the results to eyes that had not been treated with silicone oil. All implantations were performed for increased IOP that was not responsive to maximum tolerated medical therapy and for eyes considered by retina consultant to be poor candidates for silicone oil removal owing to the risk of detachment.

The study included the use of AGV model S2 or FP7 (New World Medical Inc., Rancho Cucamonga, CA). In eyes containing silicone oil, viscoelastic material was used intraoperatively in the anterior chamber during tube placement to prevent flow of silicone oil into the tube while the patient is in supine position. The AGV implant was placed in one of the inferior quadrants. In control eyes, the AGV was placed in the superior quadrants in all cases. Although the presence of silicone oil is a risk factor for failure of the AGV compared with eyes not treated with silicone oil. In patients with silicone oil endotamponade, the IOP and number of glaucoma medications was decreased in majority of patients after treatment with AGV.

The result of the study indicated that the eyes containing silicone oil have an increased risk of failure of AGV implantation compared with eyes not containing silicone oil. One possible reason for the high failure rate of AGV associated with silicone oil endotamponade may be chronic inflammation. Another reason for the failure may be silicone itself. Migration of silicone oil into the subconjunctival space through tube has been reported for after the MOLTENO implant, the AGV, and the BAERVELDT implant, which may interfere with flow of aqueous through the pseudocyst around the plate.

In conclusion, AGV can control the IOP in majority of the eyes after pars plana viterctomy and silicone oil injection. This technique has been proved to be useful in eyes that cannot have the oil removed owing to the risk of recurrent retinal detachment.

The use of the AGV was also seen in the APHAKIC glaucoma. Because studies on childhood aphakic glaucoma are scarce and there is no consensus on the procedure of choice, Pakravan [12] conducted study to compare the outcomes of 2 procedures: trabulectomy with Mitomycin C (MMC) and AGV with MMC as the primary procedure for treatment of aphakic glaucoma. Patients who had previously undergone anterior lensectomy and vitrectomy for treatment of congenital cataract with unresponsive aphakic glaucoma were selected and randomly allocated in 2 groups.

In this present study , significant reduction in the IOP in both groups was observed with no statistically significant difference between them. Beck et al also found similar IOP reduction in childhood glaucoma (9mm Hg for trabulectomy with MMC and 12mm Hg for glaucoma drainage devices). In both groups, choroidal effusion was the most prevalent complication which required surgical intervention. This may be due to the postoperative hypotony. Even though the type of complication in the 2 groups somehow different in nature, the overall rate of complication was not statistically different in 2 study groups.

The study concluded that the success and complications in paediatric aphakic glaucoma with no history of previous glaucoma procedures. But the mere reduction in the IOP in the upper normal range does not prevent glaucomatous progression in majority of the patients.

The results of the landmark studies such as Advanced Glaucoma Intervention Study have shown that lowering IOP into the lower teens and below reduces progression rates. Smith [14] decided to examine the results of Ahmed GDD implantation in patients with preoperative IOP of 20mm Hg or less. The AGV was used for all surgeries, initially the S2 model and in recent years the model FP7.

The surgical success was defined as IOP > 5mm Hg and 20% lower than preoperatively with or without hypotensive therapy. About 57.6% and 53% of patients were considered a success at 12 months and final follow up respectively.

Fourteen patients (21.2%) underwent additional glaucoma surgery, 8 of which had a second Ahmed GDD insertion. It was also seen that the lowest success rate was associated with a preoperative IOP of 14mm Hg or less. The results showed that Ahmed GDD surgery is effective in lowering patients with preoperative IOP of 20mm Hg or less. The mean IOP reduced from 16.3mm Hg preoperatively to 12.5 to 12.4 mm Hg at 12 months and final follow up, respectively representing a drop of 25% approximately.

When contemplating GDD surgery for patients, the valve mechanisms of the Ahmed GDD is also considered. In the clinical settings a valve which opens at 16mm Hg and closes at 13mm Hg may well limit the success of surgery in patients who require IOPs in the lower teens. In conclusion, modern glaucoma management often requires the achievement of IOPs in low teens and below, leading to the need of surgery in patients with IOPs 20mm Hg or less. Ahmed GDD serves as an effective option for such patients but the success rates of surgery must be balanced against the risk of complications.

Complications:

1. **Tube Related Problems:** Ahmed Glaucoma Valve (AGV) implant uses a tube to deliver aqueous from within the eye to an episcleral plate covered by tenon tissue and conjunctiva. The episcleral plate that is secured to the sclera at the equator of the globe with non dissolvable sutures that stimulates fibrovascular encapsulation around the plate. IOP reduction is dependent on the resistance of aqueous flow across the fibrovascular capsule. The tube may be too anterior, resulting in corneal touch, local or diffuse corneal decompensation. If too posterior, the damage to the iris or lens may occur.

   Although movement of the tube shunt device is uncommon after the implantation, retraction of the tube has been reported as a late complication in the study conducted by Law [5]. In this study, 3 cases of dynamic tube movement of poly-propylene AGV model S2, hard plate model which lacks fenestrations was used. In all the 3 cases, dynamic tube movement in the anterior chamber were noted.

   Possible explanations include loosening of the nonabsorbable suture, extrusion of the suture from the sclera, a relatively stronger adhesion to the sclera, or a combination of 2 or 3 possible mechanisms. All 3 cases of tube movement were reported in patients with prior surgery and 2 of 3 had further surgery after tube placement. However, retraction of the chamber has been reported as a late complication in studies on the safety of drainage device procedures for refractory glaucoma.

   The erosion and exposure of the tube has also been seen in the management of recalcitrant glaucoma also. The erosion occurs through the graft tissue or the overlying conjunctiva. Conjunctival erosion occurs mostly at the limbus and other locations and it does not appear to be related to the conjunctival incision line being placed a few millimetres away from the limbus.

2. **Plate Related Problems:** Although hypotony and diplopia are the most commonly described valve associated complications, other long term problems such as chronic uveitis, lens cornea touch and tube or plate exposure are well reported and may require revision or removal of the Ahmed Drainage Device (ADD). According to the study conducted by Smith [14], patients who underwent insertion of an Ahmed ADD were identified and those cases in which ADD removal was carried out were included.

   A single surgeon performed all the operations. Due to the risk of the eye becoming soft after tube removal of the additional ADD was inserted before removal of the existing tube. A flexible plate AGV, model FP7 was used for the insertion of a new device. This was performed under the same operating session, in a separate quadrant from the initial ADD according to the standard technique.

   In cases where the indication for surgery was plate exposure, the entire ADD was removed. With the exception of cases where there is plate exposure, the plate was left in situ. Topical atropine 1% and a steroid combination were given at the end of the surgery.

The results showed that the patients who require removal of the Ahmed ADD due to complications, removal of the offending ADD and replacement in another quadrant is effective in resolving the complications. The preoperative complications resolved in all cases, with inflammation and CME settling postoperatively in patients with preoperative uveitis and no patient developing tube or plate exposure by last follow up. In addition, the IOP was equal or lower to preoperative levels in all cases.

In conclusion, in patients who require removal of ADDs due to complications, removal of the offending ADD and replacement in another quadrant is effective in both resolving the complications and maintaining IOP control. However, hypotony and its complications still continue to be clinical problems with valved glaucoma implants. Other risk factors associated may be the shallow anterior chambers after AGV implantation. A young age seems to be one of the risk factors to have shallow anterior chamber because of weaker sclera rigidity followed by hypotony.

3. **Hypotony:** The reported incidence of hypotony following AGV ranges from 11% to 25% [16, 4, 1, 17]. However, Chen reported hypotony in 42% of their patients, which is comparable to studies involving non-valved implants [18]. This is higher than that reported in the adult population (<10%) [15]. Park [19] carried out retrospective study in patients who had postoperative intraocular pressure of 5mm Hg or below after AGV surgery. They were divided into 2 groups by depth of anterior chamber and various factors including glaucoma type, age, sex, diabetes hypertension. Partial Ligation of AGV tube was significantly different between the 2 groups. The control group had more partial ligation of the tube than the shallow anterior chamber. Ligating the tube could be an effective protective method to prevent anterior chamber collapse during hypotony. When the shallow anterior chamber by hypotony is highly possible with many risk factors, thorough observations and more adequate management is needed to reduce the risk of complication and to increase the success rate of AGV implant.

4. **Motility Problems:** The motility problems are believed to be secondary to a mass effect from the equatorial filtering bleb, a faden or posterior suture fixation effect, or fat adherence syndrome [20, 10, 14]. Almost all patients with motility disturbance had a large fibrous capsule surrounding the implant plate, adjacent muscles and sclera [21]. Surgical intervention included muscle surgery, removal of the fibrous capsule around the implant, and size reduction of the implant plate [21].

CONCLUSION: The Ahmed glaucoma implant have been the recent choice of the surgeons. This device is useful in the cases where the other surgical procedures fail. It is generally used in cases where the medicines have not been an effective treatment in the reduction of IOP. The amount of reduction in the IOP has been tremendous. Its use in the cases of refractory glaucoma is of great importance. The rate of success of AGV may be listed in the following **table 4**:

TABLE 4: SUCCESS RATE OF AGV IN DIFFERENT GLAUCOMA

Type of Glaucoma	No. of Eyes	Success rate
Neovascular (Netland *et al*., 2009)	38	73.1%
Congenital (Nassiri *et al*., 2011)	38	92%
Aphakic (Nassiri *et al*., 2011)	41	90%
Refractory (Mokbel *et al*., 2012)	40	92.5%
Paediatric Glaucoma (Morad *et al*., 2003)	60	93%

Sometimes it is also used as an adjunct to the medicines for the better reduction of IOP. But the device has shown complications in its long term use. The complications include the movement of the tube of the device in the eye, erosion of the tube and drainage plate through the graft tissue. However, there are ways to manage the complications of the device and hence its use has increased.

REFRENCES:

1. Djodeyre MR, Peralta Calvo J and Abelairas Gomez J: Clinical evaluation and risk factors of time to failure of Ahmed glaucoma valve implant in pediatric patients. Ophthalmology 2001; 108:614–620.
2. Leng T. Glaucoma Valves and Shunts 2008.
3. Goulet RJ, Phan T Anh-Danh, Cantor LB and WuDunn D: Efficacy of the Ahmed S2 glaucoma valve compared with the Baerveldt 250mm^2 glaucoma implant. American academy of Ophthalmology 2007; 115(7):1141-1147.
4. Englert JA, Freedman SF and Cox TA: The Ahmed valve in refractory pediatric glaucoma. Am. J. Ophthalmol 1999; 127(1):34–42.

5. Law SK, Coleman AL and Caprioli J: Dynamic tube movement of Ahmed Glaucoma Valve. Journal of Glaucoma 2009; 18(8):628 – 631.
6. Brasil and Moura Oliveira MV: Comparison of silicone and polypropylene ahmed glaucoma valve implants. Journal of Glaucoma 2007; 16(1):36-41.
7. Christakis PG, Kalenak JW, Zurakowski D, Tsai JC, Harasymowycz PJ and Ahmed Aqbal IK: The Ahmed versus Baerveldt Study:One year treatment outcomes. Ophthalmology 2011; 118(11):180-189.
8. Gouws P, Moss EB, Trope GE and Ethier CR: Continuous Intraocular Pressure (IOP) Measurement during Glaucoma Drainage device Implantation. Journal of Glaucoma 2007; 16(3):329-333.
9. Budnez DL, Barton K, Feuer WJ, Schiffman, Costa VP, Godfrey DG and Buys MY: Treatment outcomes in the Ahmed Baerveldt comparison study after 1 year follow up. Ophthalmology 2010; 118(30):443-452.
10. Netland AP: The Ahmed Glaucoma Valve in neovascular glaucoma. Trans Am Ophthalmol Soc 2009; 107:325-342.
11. Ishida K, Ahmed I and Netland PA: Ahmed Glaucoma Valve surgical outcomes in eyes with and without Silicone Oil Endotamponade. Journal of Glaucoma 2009; 18(4):325 – 330.
12. Pakravan M, Homayoon N, Shahin Y and Ali Reza BR: Trabeculectomy with Mitomycin C versus Ahmed Glaucoma Implant with Mitomycin C for treatment of Pediatric Aphakic glaucoma. Journal of Glaucoma 2007; 16(7):631 – 639.
13. Park HY, Lee NY and Park CK: Risk Factors of Shallow Anterior Chamber other than Hypotony after Ahmed Glaucoma Valve Implant. Journal of Glaucoma 2009; 18(1):44 – 48.
14. Smith SL, Starita RJ, Fellman RL and Lynn JR: Early clinical experience with the Baerveldt 350-mm2 glaucoma implant and associated extraocular muscle imbalance. Ophthalmology 1993; 100:914–918.
15. Smith M, M Buys Y and Trope GE: Replacement of Ahmed Aqueous Drainage Device in eyes with Device related Complications. Journal of Glaucoma 2008; 18(6):484 – 487.
16. Coleman AL, Smyth RJ, Wilson MR and Tam M: Initial clinical experience with the Ahmed glaucoma valve implant in pediatric patients. Arch. Ophthalmol 1997; 115 (2):186–191.
17. Morad Y, Donaldson CE, Kim YM, Abdolell M and Levin AV: The Ahmed drainage implant in the treatment of paediatric glaucoma. Am. J. Ophthalmol 2003; 135:821-29.
18. Chen TC, Bhatia LS and Walton DS: Ahmed valve surgery for refractory pediatric glaucoma: a report of 52 eyes. J. Pediatr. Ophthalmol 2005; 42:274–283.
19. Park HY, Lee NY and Park CK: Risk Factors of Shallow Anterior Chamber other than Hypotony after Ahmed Glaucoma Valve Implant. Journal of Glaucoma 2009; 18(1):44 – 48.
20. Christmann LM and Wilson ME: Motility disturbances after Molteno implants [case report]. J. Pediatr. Ophthalmol 1992; 29:44–48.
21. Sarkisian and Steven R: Tube shunt complications and their prevention. Curr. Opin. Ophthalmol 2009; 20:126–130.
22. Rootman DB, Trope GE and Rootman DS: Glaucoma Aqueous Drainage Device Erosion Repair with Buccal Mucous Membrane Grafts. Journal of Glaucoma 2009; 18(8):618 – 622.
23. Duke Elder S: Parson's Diseases of the eye. J & A Churchill Ltd, Edition 13, 1959, 293.
24. Freedman J: What is new after 40 years of glaucoma implants. Journal of Glaucoma 2010; 19(8):504 – 508.
25. Lim KS, Allan BDS, Lloyd AW, Muir A and Khaw PT: Glaucoma Drainage Devices; Past , present and future. Br. J Ophthalmol 1998; 82:1083-1089.
26. Maria Vitoria Oliveira Moura Brasil, Rockwood EJ and Smith DS: Comparison of Silicone and Polypropylene Ahmed Glaucoma Valve Implants. Journal of Glaucoma 2007;16(1):36 – 41.
27. Mokbel TH, Khalaf MA, El-Khouly SE and El-Metwally NO: Flexible Ahmed Valve for selected cases of refractory glaucoma. Eur J Ophthalmol 2012; 22(1): 80-86.
28. Nassiri N, Mahdavi N and Coleman AL: Ahmed glaucoma valve in children: A review. Saudi Journal of ophthalmology 2011; 25:317-327.
29. Netland PA, Ishida K and Boyle JW: The Ahmed Glaucoma Valve in patients with and without Neovascular Glaucoma. Journal of Glaucoma 2010; 9(9):581-586.
30. Rootman DB, Trope GE and Rootman DS: Glaucoma Aqueous Drainage Device Erosion Repair with Buccal Mucous Membrane Grafts. Journal of Glaucoma 2009; 18(8):618 – 622.

How to cite this article:
Katiyar S and Sultana Y: Status of Ahmed Glaucoma Valve in Management of Glaucoma: Success or Failure. *Int J Pharm Sci Res*. 3(12); 4651-4658.