Int Ophthalmol (2019) 39:137–143
https://doi.org/10.1007/s10792-017-0797-7

ORIGINAL PAPER

Role of trabeculectomy in advanced glaucoma: Whether we stand to consider it a bane or a boon today?

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Received: 26 June 2017 / Accepted: 11 December 2017 / Published online: 26 December 2017

Abstract

Purpose To elucidate the role of trabeculectomy in advanced glaucoma.

Materials and methods Only patients with primary open-angle glaucoma were selected. All patients who had cup–disc ratio of 0.9 or a near-total cupping were given a trial of aggressive maximum medical therapy for IOP control for at least 4 weeks. Target IOP was defined as $\leq$ 12 mm Hg. Patients who showed progression were included in the study. A total of 10 patients were selected. Trabeculectomy was performed using limbal-based conjunctival flap. Patients were followed up for a period of 2 years for visual acuity, intraocular pressure, visual fields, slit-lamp biomicroscopy and bleb morphology.

Results Mean preoperative intraocular pressure on five drugs was 21.7 $\pm$ 3.8 mm Hg (range 18–27 mm Hg) on maximum medical therapy. Mean post-operative intraocular pressure was 11 $\pm$ 1.78 mm Hg (range 9–13 mm Hg) and 11 $\pm$ 1.92 mm Hg (range 9–14 mm Hg) at 1 month and 6 months post-operatively, respectively. Post-operatively, the visual acuity remained stable in 17 patients. It dropped by 1 Snellen line in 2 patients and 2 Snellen lines in 1 patient, respectively, over a period of 6 months and later improved to 6/6P following cataract surgery. There was no defined visual field progression in any of the 20 patients.

Conclusion Besides being a cost-effective alternative to medical management, trabeculectomy not only provides a better IOP control but also has a high safety profile when performed by an experienced surgeon.

Keywords Advanced glaucoma · Trabeculectomy · Severely depressed fields · IOP

Introduction

Glaucoma is one of the leading causes of irreversible blindness throughout the world. There are approximately 11.2 million people, 40 years of age and older with glaucoma in India, of which 6.48 million have primary open-angle glaucoma. More than 90% of the patients are unaware of the disease, and thus, nearly one-fifth of the patients are blind in either or in both eyes [1]. Intraocular pressure is the single most important modifiable risk factor for efficient glaucoma control. Traditionally, the initial standard therapy for primary open-angle glaucoma is medical while surgery being reserved for patients who fail medical therapy.

Advanced glaucoma, defined as near-total cupping of optic nerve with or without severe visual field (VF)

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loss within 10 degree of fixation, i.e. scotoma encroaching on or splitting fixation [2], tends to have a worse visual and overall prognosis. Lowering the intraocular pressure (IOP) to the lower teens or even the upper single digits and reducing IOP fluctuations have the strongest evidence of protecting the optic nerve and remaining VF [3, 4]. The traditional management paradigm of trying various medical modalities before the surgical intervention does not apply to the advanced glaucoma stages. Recent guidelines from National Institute of Health and Clinical Excellence of UK recommend primary glaucoma surgery in such cases [5].

Trabeculectomy with or without antimetabolites has considered the gold standard [6] in glaucoma surgery. In the following study, we have evaluated the role of trabeculectomy in advanced glaucoma cases.

Materials and methods

Recruitment was performed from patients attending the specialty glaucoma clinic at Safdarjung Hospital, New Delhi. Only patients with primary open-angle glaucoma were selected. All patients who had cup–disc ratio of 0.9 or a near-total cupping were given a trial of aggressive maximum medical therapy for IOP control including a prostaglandin analogue, α-agonist, β-blocker, carbonic anhydrase inhibitor and cholinergic agonists for at least 4 weeks. Target IOP was defined as $\leq$ 12 mm Hg. Patients who showed progression in terms of uncontrolled IOP or progressive visual field deterioration despite controlled IOP or progressive structural changes despite controlled IOP were included in the study. A total of 20 patients were selected.

Pilocarpine and prostaglandin analogues were stopped 7 days prior to surgery and shifted to oral acetazolamide with or without oral glycerol 5% (1–2 g/kg or 5 ml/kg) as may be required to maintain target pressure. Preoperatively, patients were administered inj. mannitol 20% (1–2 g/kg) to maintain the IOP control. Peribulbar block was given with gentle massage, and super-pinky ball was not used to prevent overzealous hypotony. Trabeculectomy was performed using limbal-based conjunctival flap. After partial-thickness scleral flap was created (triangular shape, base 4 mm), paracentesis was performed to decompress the anterior chamber so as to prevent sudden IOP fluctuations. Surgical sponges soaked in 0.2 mg/ml of mitomycin C were placed subconjunctivally and below the partial-thickness scleral flap for 2 min prior to sclerotomy. Finally, the flap was sutured using releasable sutures.

Post-operatively, eye bandage was opened in the evening. Topical steroid–antibiotic combination and topical cycloplegics were prescribed for 6 weeks and then tapered. In cases of impending failure, bleb needling with subconjunctival injections of 5-fluorouracil (5 mg in 0.1 ml) was given using a long needle tract as close to the bleb as possible, without entering the bleb itself. No intraoperative complications were noted.

Patients were followed up for a period of 2 years. The parameters evaluated were visual acuity (Snellen's chart), intraocular pressure (non-contact tonometer NCT), progression in visual fields (Humphrey Visual Fields, Carl Zeiss Meditec), disc changes (slit-lamp biomicroscopy using 90-D lens) and bleb morphology (the Indiana Bleb Appearance Grading Scale).

Results

Out of 20 patients, 17 patients were above 50 years of age. Fourteen of the patients were males, and 6 were females. There was no racial disparity. None of the patients underwent any previous surgery.

IOP

All patients had an uneventful post-operative period. Mean preoperative intraocular pressure on five drugs was 21.7 $\pm$ 3.8 mm Hg (range 18–27 mm Hg) on maximum medical therapy. Mean post-operative intraocular pressure was 11 $\pm$ 1.78 mm Hg (range 9–13 mm Hg) and 11 $\pm$ 1.92 mm Hg (range 9–14 mm Hg) at 1 month and 6 months post-operatively, respectively. IOP was well controlled to levels $<$ 12 mm Hg in 5 cases after trabeculectomy. Three patients required bleb massage post-operatively and then had well-controlled IOP. Two patients, however, had persistent congestion in the peri-bleb area showing signs of bleb failure and necessitated subconjunctival 5-FU injection at 2 weeks to achieve successful IOP control. One patient had an encysted encapsulated bleb at 4 weeks and necessitated bleb

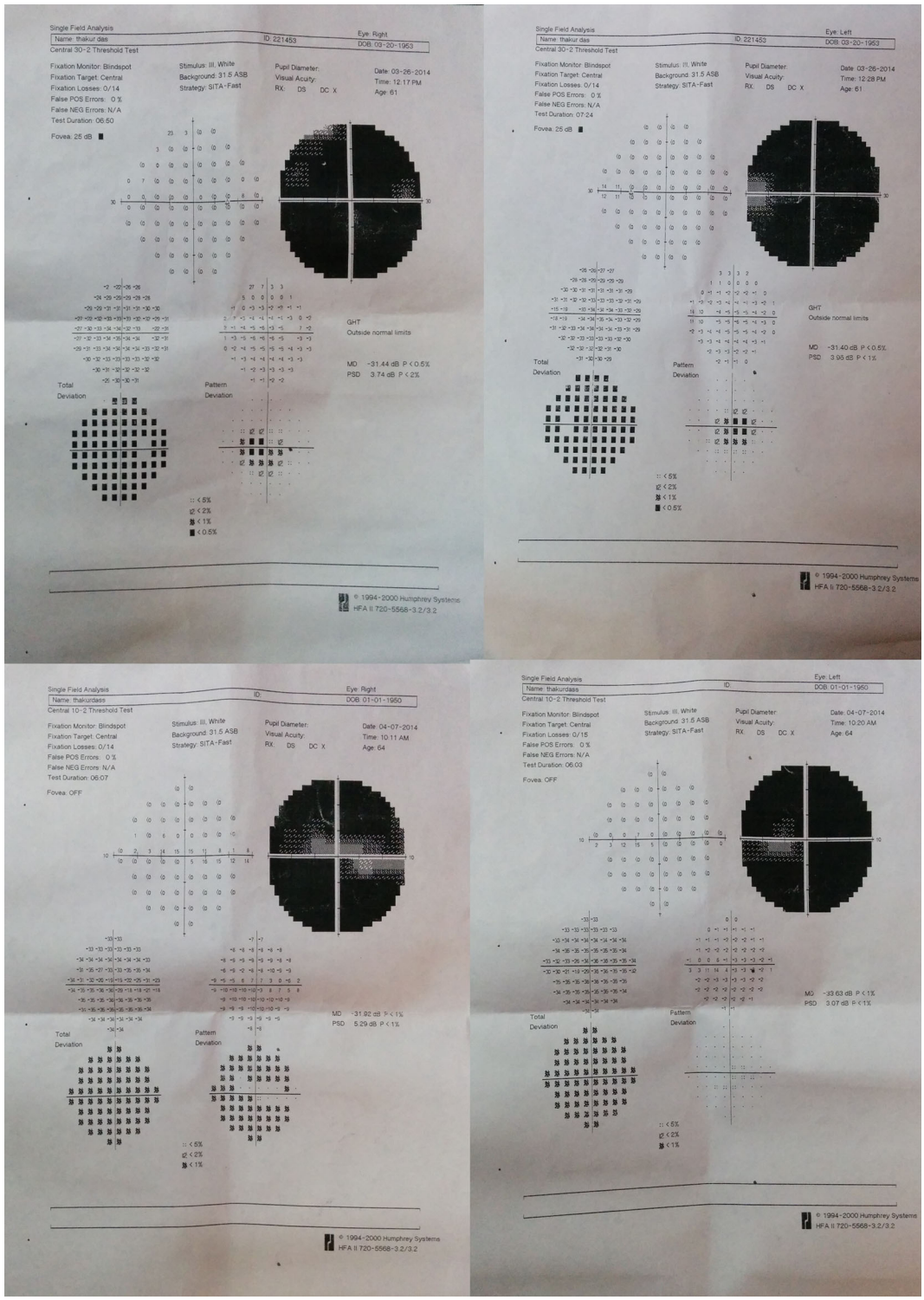

Fig. 1 Humphrey's visual field analyser charts of a patient with cup–disc ratio 0.9 showing generalized depression in 30-2 visual field charting and macular splitting in 10-2 visual field charting in both eyes

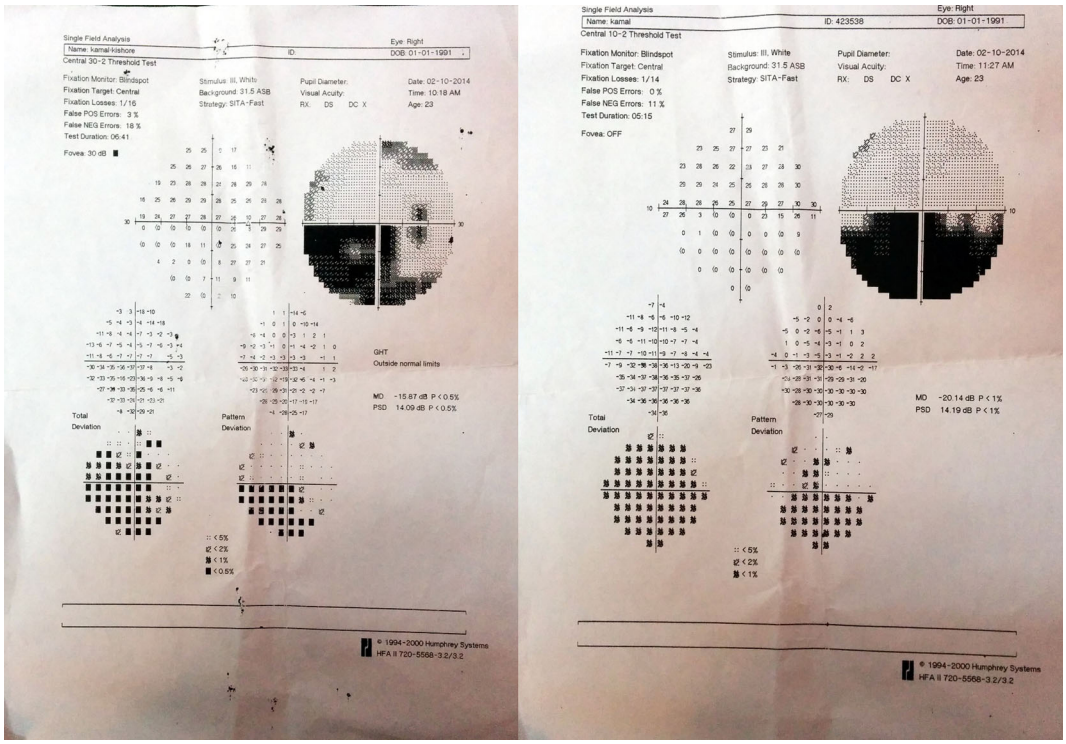

Fig. 2 Humphrey's visual field analyser charts of a patient with cup–disc ratio 0.8 and a superior notching showing inferior arcuate scotoma in 30-2 visual field charting and macular splitting in 10-2 visual field charting in right eye

needling using 26-G needle to achieve a functional bleb and thus successful IOP control.

Visual acuity

Preoperative Snellen's visual acuity was better than 6/12 in 14 patients and 6/60–6/12 in 6 patients. Postoperatively, the visual acuity remained stable in 17 patients. It dropped by 1 Snellen line in 2 patients and 2 Snellen lines in 1 patient, respectively, over a period of 6 months and later improved to 6/6P following cataract surgery.

Disc changes

Structural changes were identified by slit-lamp biomicroscopy and staged using disc damage likelihood scale. No structural deterioration was noted in a follow-up period of 2 years.

Field changes

Preoperatively, all patients had visual fields with grossly depressed total deviation plots. Visual fields showed bi-arcuate scotoma in 9 of the patients with sparing of a central and temporal island of vision without a macular splitting on 10-2 field charting, 3 had bi-arcuate scotoma with annular vision as well as a macular splitting on 10-2 field charting, 3 patients had inferior arcuate scotomas (Fig. 1), 3 patients had a superior arcuate scotoma while 2 patients had a severely depressed field with macular split on 10-2 visual field (Fig. 2). Mean of mean standard deviation plot was 29.33 ± 2.46 dB. Deepened or enlarged defect was defined as worsening of two or more points within or adjacent or contiguous to the existing scotoma by more than 10 dB. There was no defined progression in any of the 10 patients; however, mean deviation was found to be increased in 2 patients which improved substantially following cataract surgery.

Bleb status

Bleb was graded on four parameters, namely height, extent, vascularity and Seidel's test. Fourteen patients had single, well-formed, diffuse, uniformly translucent and had similar vascularity as surrounding conjunctiva. Three patients had a shallow bleb requiring bleb massage post-operatively and then had well-controlled IOP. Two patients, however, had an angry-looking bleb with signs of bleb failure and necessitated subconjunctival 5-FU injection at 2 weeks to achieve successful IOP control. One patient had an encysted encapsulated bleb at 4 weeks and necessitated bleb needling using 26-G needle to achieve a functional bleb and thus successful IOP control.

No post-operative choroidal effusion, suprachoroidal haemorrhage, hypotony, blebitis or endophthalmitis were noted.

Discussion

Glaucoma is the third leading cause of visual disability in world [7, 8]. Approximately 20.9% of patients with POAG were blind in either or in both eyes, in the Aravind Comprehensive Eye Study [9].

There is a lack of consensus on the definition of advanced glaucoma. According to the classic Hodapp–Parrish–Anderson [10] textbook, patients with a mean deviation of − 12 dB on the standard Humphrey visual field 24-2 program (Carl Zeiss Meditec) have advanced glaucoma. The International classification of Diseases 9 (365.73) and 10 (7th digit "3") diagnostic code defines severe stage (or advanced-stage or end-stage glaucoma) as optic nerve abnormalities consistent with glaucoma and glaucomatous visual field abnormalities in both the hemifields and/or loss within 5° of fixation in at least one hemifield. Here, we have included the patients with 0.9 or near-total cupping with visual field defects encroaching or sparing the central 10° of fixation, as these are the patients with worst prognosis and in need of aggressive glaucoma control with intensive treatment.

Persistently elevated IOP and IOP fluctuations are the most important risk factors for glaucoma progression. A 40% decrease in IOP has been proposed to halt progression in advanced glaucoma cases [3]. In the Advanced Glaucoma Intervention Study (AGIS), patients that did not progress had a mean IOP of 12 mm Hg [3]. This reduction in the IOP may not be achievable despite maximal medical therapy, or may induce undesirable short- and long-term fluctuations in IOP. Control of peak diurnal or long-term IOP fluctuations is as important as the absolute reduction in the IOP and should be considered when a patient with low office measurement of IOP shows structural or functional progression. In Indian scenario, economic constraints and limited access to resources may pose as a challenge for maintaining compliance. Hence, glaucoma filtration procedures become indispensable. Greater and tighter IOP control, with minimal IOP fluctuations, can be achieved with surgery [11].

Surgeries to control IOP in glaucoma that work on enhancing aqueous outflow pathways [12] include:

1. increase outflow by creating a new outflow channel (e.g. traditional trabeculectomy, EX-PRESS glaucoma implant, aqueous drainage devices and Fugo blade transciliary filtration);
2. augment the conventional (trabecular) outflow pathway (Fugo blade goniotomy, Trabectome, canaloplasty, excimer laser trabeculotomy and trabecular micro-bypass stent);
3. increase uveoscleral outflow (e.g. SOLX Gold Shunt).

Glaucoma drainage devices (GDDs) have attained success rates ranging between 25 and 94%, most commonly above 60%, depending on the type of shunt used, the definition of success criteria, the length of follow-up and the characteristics of the population studied [13]. These provide long-lasting IOP control with low rate of late infections and lesser bleb-related complications. Drainage devices are indicated in cases of failed trabeculectomy, pseudoexfoliative, uveitic glaucoma, paediatric glaucomas and Sturge–Weber syndrome. However, the use of GDDs is limited by the cost of the device and tube-related complications including corneal decompensation, tube migration and scleral necrosis. In our study, all patients had maximal IOP < 12 mm Hg with peakless diurnal variation without any IOP fluctuations. This could be attributed to a combination of a multitude of factors including aggressive preoperative IOP control on maximal medical therapy, preoperative mannitol to prevent IOP fluctuations, aggressive episcleral clearance to

prevent post-operative bleb fibrosis, intraoperative paracentesis to prevent sudden anterior chamber decompression, use of mitomycin C and releasable suturing for better post-operative management.

Non-penetrating procedures such as visco-canalostomy and deep sclerectomy involve deroofing of Schlemm's canal and aqueous flow through a thin trabeculo-Descemet's window, reducing the dependency on conjunctival healing. These have a long learning curve and risk of late scarring, i.e. higher failure rates. Other procedures like trabectome, gold micro-shunt and Ex-Press Minishunt appear promising but have certain limitations of moderate IOP lowering and higher cost. These procedures have a superior safety profile; however, in terms of efficacy, they cannot compete with the excellent IOP reduction achieved with a trabeculectomy [14].

Trabeculectomy consists of creating a partial-thickness scleral flap and thus a fistula between anterior chamber and the subconjunctival space for filteration of the aqueous and bleb formation. It achieves reasonable IOP control in 65–85% of adults depending upon the type of glaucoma, disease severity, use of antimetabolites, post-operative healing response and bleb modulation techniques, duration of follow-up and the skill with which the surgery is performed. According to a recent study [3], trabeculectomy survival (IOP less than 21 mm Hg) at 20 years was approximately 60% with no topical medication and approximately 90% with additional topical medication; 7 and 15% of eyes had become blind by 10 and 20 years, respectively.

The introduction of antimetabolites such as mitomycin C and 5-fluorouracil, collagen implants (Ologen) that reduce the risk of post-operative subconjunctival scarring, post-operative bleb titration using releasable sutures or laser suturolysis, and the use of antivascular endothelial growth factors (VEGF) have lead to even better outcomes of the procedure. As a result of the above, the success rate of modern trabeculectomy in experienced hands is estimated between 60 and 100%, depending on patient selection, definition of success and length of follow-up [11].

Mitomycin C 0.2 mg/ml or 5-fluorouracil 5 mg/ml can be used subconjunctivally intraoperatively to reduce excessive subconjunctival fibrosis and bleb failure. MMC in concentration of 0.02 mg/ml and 5-FU 5 mg/ml can also be used for post-operative bleb re-needling to break subconjunctival fibrotic bands in cases of high IOP and flat bleb. Ologen collagen implants are biodegradable, porous, porcine implants that can be placed subconjunctivally to minimize fibrosis and improve bleb survival. It is a 3-D scaffold porous structure that can guide fibroblast to grow randomly, instead of linear alignment. The releasable sutures, or laser suturolysis by argon green laser provides IOP titration post-operatively with the ease of bleb modulation on a slit lamp. Anti-VEGFs help in decreasing the concentration of growth factors subconjunctivally, thus reducing bleb scarring.

Trabeculectomy, however, is associated with various complications such as intraoperative suprachoroidal haemorrhage, and post-operative risks such as hypotony and bleb-related infection can result in rapid and profound visual loss. Other causes of visual compromise in patients undergoing trabeculectomy are cataract, cystoid macular oedema, retinal detachment or optic nerve damage due to uncontrolled IOP. It also has a poor prognosis in conjunctival scarring due to previous surgical procedures.

Another serious, but rare, complication of trabeculectomy that has been identified in advanced glaucoma patients, particularly those with macular split on visual field examination, is the snuff-out or wipe-out phenomenon. It refers to an idiopathic, irreversible loss of central vision after surgery for advanced glaucoma and has an incidence of 0–7% [15]. These data come from older retrospective reports using older surgical procedures. It is found to be of rare occurrence in the present-day procedure of trabeculectomy with MMC. In our study, there was a favourable outcome with respect to bleb formation, stability of IOP, visual acuity and visual fields and no known complications of choroidal detachment or effusions in a follow-up period of 2 years. No snuff-out phenomenon was noted in two patients with preoperative macular split. Thus in our opinion, it is safe to perform trabeculectomy as a primary management option in advanced glaucoma cases, which have healthy conjunctiva with no prior ocular surgery.

Surgery provides an edge over socioeconomic issues and adherence, with the benefit of strict IOP control and little diurnal variations. This is important in Indian scenario where nearly 35% of the population falls below the international poverty line. In ACES [9], one or more problems in medication use were reported in 42% of the glaucoma patients. With excellent

results of trabeculectomy, we can advise it as a primary management option.

Conclusion

Despite the paradigm shifts that have been proposed in the management of advanced glaucoma, trabeculectomy not only provides a better IOP control but also has a high safety profile when performed by an experienced surgeon. Since it can also serve as a cost-effective alternative to medical management of advanced glaucoma cases, it has literally withstood the test of time to preserve salvageable vision in patients of advanced glaucoma.

Compliance with ethical standards

Conflict of interest The authors report no conflict of interest in the publication of this manuscript.

References

1. George R, Ve RS, Vijaya L (2010) Glaucoma in India: estimated burden of disease. J Glaucoma 19(6):391–397
2. Gessesse GW, Damji KF (2013) Advanced Glaucoma: management pearls. Middle East Afr J Ophthalmol 20(2):131–141
3. VanVeldhuisen Paul C, Ederer F et al (2000) The advanced glaucoma intervention study (AGIS): 7. The relationship between control of intraocular pressure and visual field deterioration. Am J Ophthalmol 130:429–440
4. Caprioli J, Coleman AL (2008) Intraocular pressure fluctuation a risk factor for visual field progression at low intraocular pressures in the advanced glaucoma intervention study. Ophthalmology 115(1123–1129):e3
5. National Institute for Health and Clinical Excellence (NICE) (2009) Glaucoma: diagnosis and management of chronic open angle glaucoma and ocular hypertension. Clinical Guidelines CG85, UK National Institute for Health and Clinical Excellence (NICE) guidelines. Developed by the National Collaborating Centre for Acute Care
6. Landers J, Martin K, Sarkies N et al (2012) A 20-year follow-up study of trabeculectomy: risk factors and outcomes. Ophthalmology 119(4):694–702
7. Quigely HA, Borman AT (2006) The number of the people with glaucoma worldwide in 2010 and 2020. Br J Ophthalmol 90:262–267
8. Grant WM, Burke JF (1982) Why do some people go blind from glaucoma? Ophthalmology 89:991–998
9. Ramakrishnan R, Nirmalan PK, Krishandas R et al (2003) Glaucoma in a rural population of southern India: the Aravind comprehensive eye survey. Ophthalmology 110:1484–1490
10. Hodapp E, Parrish RK II, Anderson DR (1993) Clinical decisions in glaucoma. Mosby, St. Louis
11. Jones E, Clarke J, Khaw PT (2005) Recent advances in trabeculectomy technique. Curr Opin Ophthalmol 16:107–113
12. Francis BA, Singh K, Lin SC et al (2011) Novel glaucoma procedures: a report by the American Academy of Ophthalmology. Ophthalmology 118(7):1466–1480
13. Souza C, Tran DH, Loman J, Law SK, Coleman AL, Caprioli J (2007) Long-term outcomes of Ahmed glaucoma valve implantation in refractory glaucomas. Am J Ophthalmol 144:893–900
14. Ramakrishnan R, Khurana M (2011) Surgical management of glaucoma: an Indian perspective. Indian J Ophthalmol 59:S118–S122
15. Moster MR, Moster ML (2005) Wipe-out: a complication of glaucoma surgery or just a blast from the past? Am J Ophthalmol 140:705–706