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ORIGINAL ARTICLE

Long-term Evaluation of Efficacy and Safety of Deep Sclerectomy in Uveitic Glaucoma

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ABSTRACT

Purpose: To assess long-term efficacy and safety of deep sclerectomy (DS) in uveitic glaucoma.

Patients and methods: Thirty-three consecutive eyes (21 patients) with uveitic glaucoma underwent DS with mitomycin C and implant. Goniopuncture (GP) was done for uncontrolled postoperative intraocular pressure (IOP).

Results: Mean (±SD) follow-up was 33.2 (±19.8) months. IOP was reduced from a mean preoperative value of 37.2 to postoperative value of 14.7 mmHg ($p < 0.0001$). Complete success was achieved in 24/33 eyes (72.7%); qualified success was obtained in 7/33 eyes (21.2%). Neodymium:YAG GP was performed in 12 eyes. Postoperative complications included cataract progression in 9 eyes, transient hypotony in 6 eyes, shallow choroidal effusions in 4 eyes, hypotony with persistent maculopathy in 1 eye, hyphema in 1 eye, and decompression retinopathy in 1 eye.

Conclusion: DS is safe and effective in patients with uveitic open-angle glaucoma. However, laser goniopuncture is frequently needed to improve the outcome.

Keywords: Deep sclerectomy, glaucoma, goniopuncture, implant, uveitis

Uveitic glaucoma is a not uncommon complication facing our practice. The majority of such patients can be managed medically; surgical intervention is needed for uncontrolled cases. Uveitic glaucoma is reported in the literature to be 10–20% of diagnosed cases.[1–6] Raised intraocular pressure (IOP) is significantly more common in patients with chronic intraocular inflammation than those with acute uveitis. Medical management was effective in about 70% of the cases, while the remaining 30% will need combination of medical and surgical interventions.[1]

Glaucoma in uveitic patients may occur either in open- or closed-angle mechanisms. Synechial angle closure type can present with or without papillary block. Open-angle type is due to biochemical and cellular changes in aqueous composition, direct inflammation of trabecular meshwork, and/or effect of corticosteroid on the trabecular meshwork.[7]

The standard trabeculectomy surgery still plays a role in management of uveitic glaucoma with the potential risk of hyphema, shallow or flat anterior chamber with increased inflammation, hypotony, cataract formation, and choroidal detachment.[8] In an attempt to lower the incidence of complications of trabeculectomy, nonpenetrating glaucoma surgery (NPGS) was developed.[9–20]

There is increasing evidence that deep sclerectomy is probably more appropriate for uveitic glaucoma. Auer et al. have reported that nonpenetrating deep sclerectomy has controlled the intraocular pressure in 90% of eyes with uveitic glaucoma that were resistant to medical therapy, with low rate of surgical complications compared to classical trabeculectomy.[21] Additionally, Souissi et al. have found that deep sclerectomy is highly successful in uveitic glaucoma, with a very low rate of postoperative complications.[22]

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In addition, our previous preliminary study showed the efficacy and safety of deep sclerectomy in patients with uveitic glaucoma.[23]

In the current prospective study, we aimed at recruiting more patients with longer follow-up period to enable more in-depth evaluation of the efficacy and safety of nonpenetrating deep sclerectomy with mitomycin C and implant in patients with uveitic glaucoma.

PATIENTS AND METHODS

A prospective cohort of patients diagnosed as having uveitic glaucoma were operated on using a nonpenetrating deep sclerectomy procedure and followed up to monitor success and complication rates. All patients were managed and followed up for their uveitis by one of the authors (AMA). All cases were diagnosed, managed, operated on, and followed up at King Abdul-Aziz University Hospital, Riyadh, Saudi Arabia. Those patients with a history of elevated intraocular pressure before the clinical onset of uveitis were excluded from our sample. None of the patients had had previous ocular surgery (except for 1 patient who underwent two failed trabeculectomy surgeries). All patients were confirmed to have open-angle glaucoma by gonioscopy examination. Ethical approval was sought and obtained from the King Saud University ethical review board. Consequently, all patients were consecutively enrolled in the study cohort where informed consent was obtained either from the participating patient or his/her legal guardian after a brief explanation about the surgery and the study.

The indications for surgery were having uncontrolled intraocular pressure, defined as high intraocular pressure (>21 mmHg) on maximum tolerated medical treatment, progressive glaucomatous visual field loss, or progressive optic disc cupping. Gonioscopy examination was done for all patients at initial evaluation and the day before surgery. (All patients were evaluated and operated on by one of the authors [SAA]).

Data on necessary demographic and clinical indices were collected, including age; sex; intraocular pressure; visual acuity; number of medications; type and etiology of uveitis (preoperative, postoperative, and at final visit); time of failure (if any); intraoperative, medium-term, and long-term postoperative complications; as well as goniopuncture interventions.

All enrolled patients were admitted 3 days prior to surgery. Immunosuppressive and/or immunomodulatory therapy and maximum tolerated anti-glaucoma medications were continued during inpatient admission. Prednisolone acetate (1%) eyedrops were administered every hour while awake starting 7 days before surgery. Intravenous methylprednisolone (15 mg/kg per day) was given to all patients for 3 days preoperatively, except for those with Fuchs or Posner Schlossman uveitis. All patients were confirmed to have controlled inflammation (0 cells to occasional cells) before surgery.

Surgical Technique

After local or general anesthesia and complete disinfection, the conjunctiva was prepared with a fornix-based flap. A 5×5-mm superficial scleral flap was created and projected for 1.5 mm into clear cornea. The superficial flap was almost one-third of the scleral thickness. A cellulose sponge soaked in a 0.2-mg/mL mitomycin C (MMC) solution was applied for 2 min under the Tenon capsule, followed by irrigation with balanced saline solution. A second deeper rectangular scleral flap (4×4 mm) was created, leaving a very thin layer of scleral tissue over the uvea. This second flap was projected anteriorly to deroof Schlemm's canal and to remove the corneal stroma until the Descemet membrane. The floor of Schlemm's canal was stripped using capsulorhexis forceps. The deep scleral flap was excised and an implant drainage device, either T-flux (Ioltech, La Rochelle, France) or SK gel (Corneal Laboratories, Paris, France), was placed radially in the center of deep sclerectomy dissection. The superficial scleral flap was then repositioned over the implant and secured with two 10/0 nylon sutures. The conjunctiva and Tenon's capsule were closed with a 9/0 Vicryl suture. A subconjunctival injection of dexamethasone 4 mg and gentamicine 20 mg in a 1-mL syringe was given to the lower fornix, combined dexamethasone 0.1% and tobramycin ointment was applied, and the eye was patched.

Postoperatively, topical prednisolone acetate 1% was used every hour, then tapered over 12 weeks. Topical ofloxacin 4 times a day was used for 4 weeks. All patients continued their maintenance dose of immunosuppressive and/or immunomodulatory drugs to control their uveitis. All patients were seen on postoperative day 1, 1 week, 1 month, 2 months, and 3 months, then periodically every 3 months. Anterior chamber inflammation was graded according to the SUN classification.[24] At each visit, patients underwent best corrected visual acuity assessment, slit-lamp examination, and intraocular pressure measurement using a Goldman applanation tonometer along with fundus examination. An additional visit was planned if necessary.

Surgical success was categorized and defined as complete success when IOP was in the range of $\geq$6 to $\leq$22 mmHg without any anti-glaucoma medication, and as qualified success when IOP was $\leq$22 mmHg with one or more postoperative anti-glaucoma medication. Failure was considered when the IOP was

>22 with anti-glaucoma medication or when the eye required further glaucoma surgery to control the elevated IOP.

Statistical Analysis

Data were collected and stored using a specifically designed Microsoft Excel 2007 sheet. The Snellen visual acuity was converted into their equivalent logarithm of the minimum angle of resolution (logMAR) for the ease of statistical analysis. Mann-Whitney *U* test was used to judge the significance of the decrease in IOP between pre- and postoperative measurements and the change in visual acuity as measured by logMAR. Wilcoxon signed-rank test was used to test the significance of reduction in the number of anti-glaucoma medications and the change in visual acuity. Additionally, Kaplan Meier Survival analysis was used to estimate the mean survival time after surgery. A p value less than 0.05 was set as the threshold to indicate statistical significance in addition to the corresponding 95% confidence intervals. SPSS version 19.0 (IBM, Chicago, Illinois) and MedCalc 11.6 (MedCalc Software bvba, Mariakerke, Belgium) were used for data analysis.

RESULTS

A total of 33 eyes of 21 patients (7 [33.3%] males and 14 [66.7%] females) were enrolled in this study. The study population had a mean (±SD) age of 29.7 (±14.3), ranging from 11 to 71 years. The mean (±SD) follow-up time was 33.2 (±19.8) ranging from 12 to 120 months. The uveitic etiologies of these patients included Vogt-Koyanagi-Harada (VKH) disease (17 eyes, 51.5%), juvenile idiopathic arthritis (7 eyes, 21.2%), Fuchs uveitis (5 eyes, 15.2%), sarcoidosis (2 eyes, 6.1%), idiopathic uveitis (1 eye, 3%), and Posner Schlossman syndrome (1 eye, 3%) eye.

All patients underwent deep sclerectomy with an implant and MMC. Two eyes (6.1%) required phacoemulsification with posterior chamber intraocular lens implantation at the time of deep sclerectomy surgery.

Preoperative visual acuity ranged from counting fingers (CF) to 20/20 (mean logMAR: 0.3 (±0. 3). The postoperative visual acuity ranged from CF to 20/20 (mean logMAR: 0.3 (±0. 4). However, the difference between mean pre- and postoperative logMAR (VA) was not statistically significant ($p = 0.661$, 95% CI: [-0.1029–0.0663]). At the most recent visit, 2 (6.1%) eyes showed improvement of vision, whereas 29 (82.9%) eyes had no change in their vision and the remaining 2 (6.1%) eyes had deteriorated vision. The pattern of mean change in logMAR visual acuity during follow-up is demonstrated in Figure 1.

There were no intraoperative complications recorded in this series.

The mean preoperative IOP was 37.2 (±8.8), (range: 16–53) mmHg, while the mean number of preoperative anti-glaucoma medications was 3.2 (±0. 5) (range, 2–4). The postoperative IOP was significantly reduced after deep sclerectomy with an implant and MMC from a preoperative mean of 37.2 (±8.8) to 14.7 (±4.3) mmHg at the last postoperative assessment. This 22.5-mmHg reduction in the IOP mean was highly statistically significant ($p < 0.0001$, 95% CI: [18.56–26.62]. Likewise, the mean number of anti-glaucoma medications was significantly reduced from 3.2 (±0.5) preoperatively to 0.4 (±0.7) at the last visit ($p < 0.0001$). The pattern of change in IOP during follow-up is

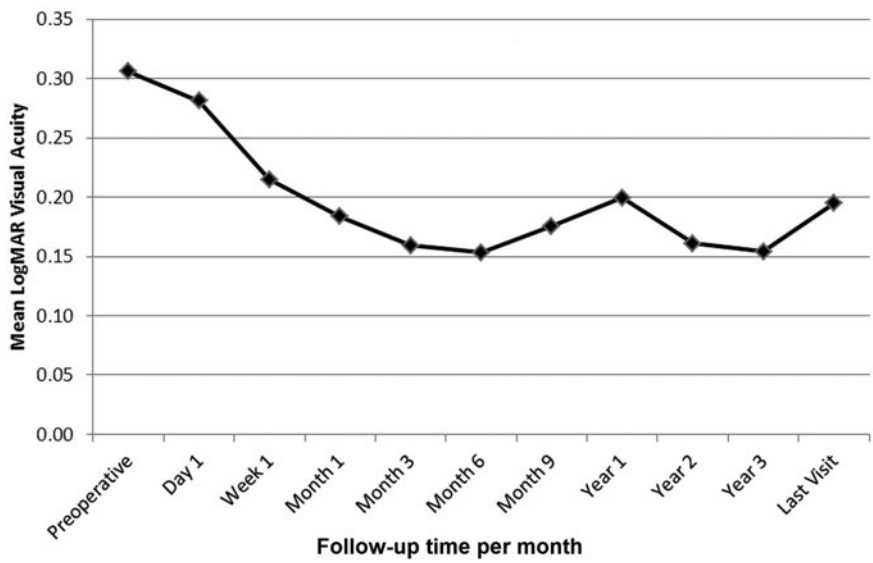

FIGURE 1. Pattern of mean logMAR visual acuity change during follow-up visits.

demonstrated in (Figure 2). Complete success (IOP ≥ 6 and ≤ 22 mmHg without medications) was obtained in 24/33 (72.7%) eyes, whereas qualified success (IOP ≤ 22 mmHg with medication) was obtained in 7/33 (21.2%) eyes, which yielded an overall success rate of 31/33 (93.9%). The remaining 2 (6.1%) eyes have failed. If a threshold of <18 mmHg is considered as criteria, the complete success rate will be 69.7% and the qualified success rate will be 12.1%, which yields an overall success rate of 81.8%.

In this series, two eyes underwent a combined procedure of deep sclerectomy plus phacoemulsification. The outcome of these 2 eyes at the final visit assessment in terms of IOP was reduction from 33 and 34 to 16 and 10 mmHg, respectively. Visual acuity improved from preoperative of 20/60 and 20/40 to 20/28 and 20/20, respectively. Both cases achieved complete success. Interestingly, removing these 2 cases from the success rate analysis yielded a mean IOP reduction from preoperative mean of 37.4 (±9.1) to 14.8 (±4.3) mmHg postoperatively, while the complete success rate was 22/31 (71%) and the overall success rate was 29/31 (93.5%).

With regard to the postoperative complications, none of the eyes have developed a shallow or flat anterior chamber. Furthermore, none of the eyes had postoperative endophthalmitis or flare-up of uveitis. Anterior chamber reaction was also followed up postoperatively and the pattern of change is illustrated in Figure 3. One eye had postoperative hyphema, which spontaneously resolved. Four (12.1%) eyes developed shallow choroidal effusions, which have also spontaneously resolved without any treatment. Six (18.2%) eyes had transient hypotony in

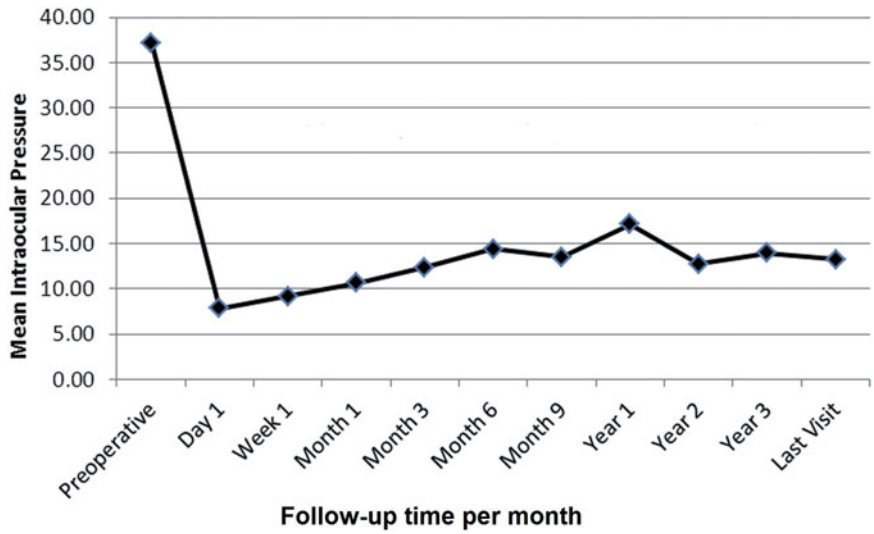

FIGURE 2. Pattern of intraocular pressure change during follow-up visits.

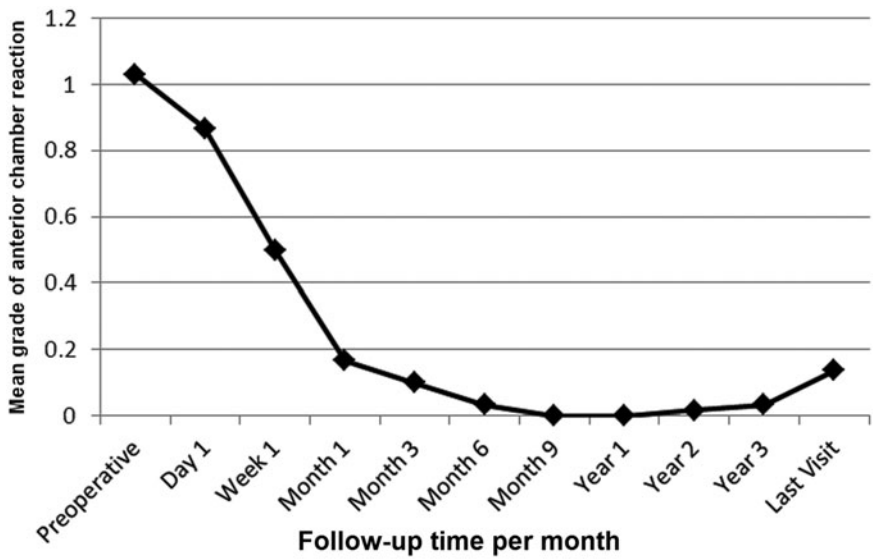

FIGURE 3. Pattern of anterior chamber reaction change during follow-up visits.

the early postoperative visit and all of them have resolved spontaneously except for only 1 (3%) eye, which developed persistent hypotony with maculopathy. The patient with previous surgery (failed trabeculectomy in both eyes) survived for 2 years after deep sclerectomy, then an additional goniopuncture was performed (both eyes), which controlled the IOP for another 3 months with medication. However, 6 months after goniopuncture, the patient underwent additional tube surgery in both eyes to control the increased IOP. At the last follow-up visit (12 months later) both eyes had achieved complete success. Progression of cataract was detected in 9 (27.3%) eyes after surgery.

Among our series, 4 patients (7 eyes; 2 bilateral females and 1 unilateral and 1 bilateral male) were in the age group ≤18 years (mean [SD] age was 13.7 [±2.3], range 11–17). All the patients aged 18 years and younger (7 eyes) were diagnosed to have juvenile idiopathic arthritis. Interestingly, among this specific group, the surgical complete success rate was 100% as none of them required postoperative anti-glaucoma medications. Moreover, the IOP was significantly reduced from a mean preoperative value of 39.7 (±9.9) to 12.7 (±3.3) postoperatively ($p = 0.018$).

YAG (Nd:YAG) laser goniopuncture (LGP) was performed in 12 (36.4%) eyes. Mean time to goniopuncture was 10.5 (±9.4) months ranging from 15 days to 34 months. Performance of goniopuncture significantly reduced the IOP from a mean of 23 (±5.9), range 23–36 prior to goniopuncture to a mean of 14.8 (±3.8), range 6–28, $p = 0.007$. Among these 12 eyes, complete success was achieved in 7/12 (57.1%) eyes, qualified success was achieved in 2/12 (19%) eyes, giving an overall success of (9/12; 76.1%), while only 3 cases (23.8%) have failed at 2, 6, and 12 months of follow-up with a mean failure time of 6.7 (±5), range 2–12 months. Specific complications due to goniopuncture were recognized in 2 cases. One developed adherence of the iris to trabeculo-Descemet's window (TDW), and the second developed severe hypotony maculopathy. Moreover, none of the patients in the age group of ≤18 years had needed goniopuncture.

Conduct of Kaplan Meier Survival function and the associated plot yielded that the estimated mean (±SE) for survival time after surgery was (35.2 [±3. 5], 95% CI: 28.274–42.071) months, which demonstrates a conveniently high probability to survive (44.4%) after the first 2 years of follow-up, where the last failure case was at 22 months of follow-up (Figure 4).

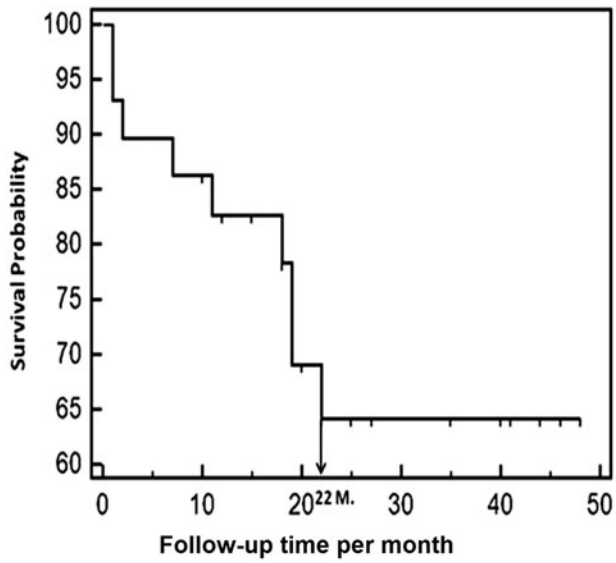

FIGURE 4. Kaplan-Meier survival curve showing mean survival time.

DISCUSSION

Surgical management of uveitic glaucoma is indicated for uncontrolled IOP despite maximum tolerated anti-glaucoma medications. Trabeculectomy is well known as the gold standard primary procedure for primary and secondary adulthood glaucoma. Towler et al. found that intraoperative application of 5 fluorouracil (5-FU) appears to be a safe and effective adjunct to trabeculectomy in uveitis-related glaucoma.[25] Stavrou et al.[26] reported the success rate of 53% in 32 eyes with uveitic glaucoma that underwent trabeculectomy without anti-metabolite after 5 years of follow-up. Furthermore, Wright et al.[27] reported good control of IOP in 24 eyes with uveitic glaucoma that underwent trabeculectomy with MMC but with frequent complications. The success rate of trabeculectomy with postoperative 5-FU injections was reported by Patitsas et al. as 71% after a median follow-up of 35 months.[28] Few reports that compared the trabeculectomy with MMC versus 5-FU in uveitic glaucoma have found that both procedures have long-term success in patients at high risk, although, MMC seems to be lowering the IOP more than the 5-fluorouracil.[29,30] Glaucoma drainage devices are recommended in uveitic glaucoma among patients at high risk of trabeculectomy failure, such as aphakic patients, juvenile idiopathic arthritis, previous trabeculectomy failures, or retinal detachment surgery.[31] Da Mata et al.[32] reported a success rate of 92% at 1 year with the Ahmed glaucoma drainage device.

In an attempt to lower the incidence of trabeculectomy complications, nonpenetrating glaucoma surgery (NPGS) was developed. It was first described by Epstein in the late 1950s[33] and Krasnov in the late 1960s.[34] NPGS was modified in the early 1980s by Fyodorov et al. (deep sclerectomy)[35] and Zimmerman et al. (nonpenetrating trabeculectomy)[36] so that a portion of Schlemm's canal is excised under a superficial sclera flap to improve the efficacy and safety of filtering procedures by avoiding intraoperative and early postoperative complications.

The overall outcome of deep sclerectomy with implant and intraoperative MMC in this study is very encouraging. Complete success was obtained in 24/33 eyes (72.7%), whereas qualified success was obtained in 7/33 (21.2%) eyes, which yielded an overall success rate of 31/33 (93.9%). The value of IOP reduction in our series was 60.1%. The use of intraoperative MMC and implant as well as meticulous follow-up in addition to performance of goniopuncture when needed may explain the high overall success rate in our study. Our findings confirm the results of previous studies that demonstrated the efficacy of deep sclerectomy in uveitic glaucoma.

Auer et al.[21] reported a mean reduction of IOP of 71.7% in 11 eyes that underwent deep sclerectomy and completed 12 months follow-up. Six eyes had implant during surgery in their study. Complete success was obtained in 5 (45.4%) eyes, qualified success in 5 (45.4%) eyes, and failure in 1 patient (9.2%). Souissi et al.[22] reported a mean decrease of IOP of (52.9%) in 8 eyes that underwent deep sclerectomy without antimetabolites after a mean follow-up of 42.2 months. Complete success was obtained in 50% of cases, whereas qualified success was obtained in 37.5%, and failure in 12.5% of cases. Anand[37] reported 26 eyes of uveitic glaucoma with mean follow-up of 46.5 ±22 months. Fifteen eyes (58%) had previous intraocular surgery. Preoperative IOP was 33 ± 12 mmHg. Intraocular pressure at 1, 2, and 3 years after surgery was 13 ± 4 mmHg, 13 ± 4 mmHg, and 14 ± 4 mmHg, respectively. The probability of IOP <21 and 18 mmHg with needle revision and laser goniopuncture but without medications or further glaucoma procedure was 89 and 84%, respectively, at 3 years. Dupas et al.[38] reported a retrospective comparative study of two groups of patients with uveitis who underwent deep sclerectomy or trabeculectomy. The cumulative probability of success at 12 months was 89% for trabeculectomy and 88% for deep sclerectomy ($p = 0.306$). More postoperative adjustments were necessary to lower IOP after deep sclerectomy than after trabeculectomy (85 vs. 9.5%, $p < 0.001$), but 7 days after surgery, intraocular inflammation was higher after trabeculectomy (245.8 vs. 38.5 ph/ms, $p < 0.001$).

Among our series, progression of cataract was diagnosed in 9 (27.3%) eyes during the postoperative period. There is no sufficient evidence to prove that cataract was not surgically induced. However, since all patients were suffering from chronic uveitis and were using topical treatment with or without systemic corticosteroids, most probably cataract developed as a result of intraocular inflammation and the chronic use of corticosteroids. It is unlikely that deep sclerectomy contributed to the progression of cataract in this series because of the extraocular nature of the procedure.

In the present series, 4 patients (7 eyes) were aged 18 years or less. Complete success was obtained in all of these eyes. These findings might suggest that deep sclerectomy is associated with high success rate in juvenile uveitic glaucoma. Recently, Bohnsack et al.[39] published findings from a series of 36 patients with juvenile uveitic glaucoma (<18 years) that were more or less similar to our juvenile cases in terms of mean age and diagnosis. However, Bohnsack's intervention of choice was goniotomy, which yielded a complete success rate of only 48.4% where (15/31) eyes did not require any further intervention. Although the number of our juvenile cases is much fewer than Bohnsak's series, our findings showed the superiority of deep sclecretomy compared to goniotomy in children with juvenile uveitic glaucoma.

Goniopuncture in the current study was done in 12 eyes (36.4%) with significant reduction of the IOP by 35.7% and relatively high complete success rate (7/12 [57.1%]), with an overall success of 76.1%. Meanwhile, complications attributed to goniopuncture were relatively minimal and limited to 2 cases. One eye developed partial adherence of the iris to the trabeculo-descemato window, and the second one developed hypotony maculopathy that was corrected by repeated autologus blood injection to the bleb area. Our findings are consistent with a previous report by Mermoud et al.[40] They performed goniopuncture in 41% of their patients with open-angle glaucoma who underwent deep sclerectomy with collagen implant. The mean time between surgery and laser goniopuncture was 9.9 (±1. 2) months. Anand et al.[41] reported in another study, the rate of laser goniopuncture was 67.0% in patients with open-angle glaucoma with a mean interval between laser goniopuncture and deep sclerectomy of 10.3 ± 8.7 months. A review of the literature shows reported rates of laser goniopuncture vary from 4.6 to 81%.

Exacerbation of uveitis after surgery was not detected among patients included in the current study. The meticulous control of inflammation before and after surgery and the nonpenetrating nature of the procedure can account for this. Dupas et al.[38] reported that postoperative inflammations were more frequent in the trabeculectomy group compared with the deep sclerectomy group. He also concluded that successful deep sclerectomy has required more postoperative adjustments and closer monitoring than the trabeculectomy.

Tube surgery, is one of the common procedures in uveitic glaucoma cases. Da Mata et al.[42] showed an overall success of 100% in 21 eyes with chronic uveitic glaucoma followed up for a mean of 2 years with only 4 complications (2 hypotany, 1 valve replacement, and 1 corneal decompensation). Meanwhile, Rachmiel et al.[31] did not detect any significant difference while comparing tube surgery success rate of uveitic glaucoma to that of open angle glaucoma (15 and 53 eyes, respectively). The cumulative success rates at 3 and 30 months for the uveitic and open-angle groups were 80 and 66.6% versus 84.9 and 57%, respectively.

Documented complications in the uveitic group included 4 cases with transient hypotony, 3 wound dehiscence, 3 hyphema, 2 tube erosion, 1 exposed tube, 1 tube touch, 1 overfiltration, and 1 choroidal detachment. Ceballos et al.[43] reported good short-term results in the eyes with uveitic glaucoma (overall success rate of 91.7% after 2 years of follow-up) with the Baerveldt glaucoma drainage device. Additionally, Molteno et al.[44] reported long-term results of Molteno implant in 40 cases with uveitic glaucoma. The study showed Molteno implant controlled the IOP in 95% of cases up to 1 year after operation. With increasing follow-up, cases failed at an average rate of 1.8% per annum. However, the study reported a high rate of complications. Early postoperative complications included flattening of the anterior chamber (AC) in 4 cases, marked shallowing of the AC in 6 cases, blockage of the drainage tube by the iris in 5 cases, hyphema in 9 cases, and choroidal detachment in 7 cases. Findings from Krishna et al. study[45] shows an overall success rate of 78% after 2 years of follow-up. These reported outcomes of tube surgery in uveitic glaucoma patients show satisfactory success rates. However, our findings and those of others[21–23,37,38] suggest that deep sclerectomy for uveitic glaucoma may be associated with fewer complications compared to tube surgery.

In conclusion, our findings indicate that deep sclerectomy with an implant and MMC in uveitic glaucoma has a high success rate with a low rate of intraoperative and postoperative complications. Our findings suggest that deep sclerectomy might be a good surgical option for uveitic open-angle glaucoma. Success rate after a long-term follow-up was encouraging, but goniopuncture is frequently needed to improve the outcome.

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DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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