Outcomes of Bent Ab Interno Needle Goniectomy Versus Incisional Goniotomy In Primary Open Angle Glaucoma Patients Undergoing Cataract Surgery

Mohamed A Awwad[*] , Ashraf Elhabbak[*], Ahmed M. Saeed[*], Ayman M. Elmaghrabi[*], Tamer Salem[*]

[*]Ophthalmology Department, Faculty of Medicine, Benha Univ, Egypt

Email: ayman.almaghrabi2020@gmail.com

Abstract

Background: When contrasted with conventional trabeculectomy, MIGS demonstrates a favorable safety profile. Unfortunately, many patients cannot afford MIGS operations due to the high cost of most equipment.

Purpose: The purpose of this research is to assess the effectiveness and safety of phacogoniotomy as well as the new phacoBANG MIGS procedures.

This research has a prospective design. It ran from June 2022 to June 2024 at Benha University Hospitals' ophthalmology department. Patients whose cataracts were medically relevant and whose POAG was under medical management were included in the study. Each patient was randomly assigned to one of two groups: one that had phacoemulsification in conjunction with standard goniotomy using an MVR blade (group GON) and another that underwent phacoemulsification in conjunction with the innovative "Bent Ab interno Needle Goniectomy" method, which used a syringe that had been manually modified. There were two subgroups within each group: those with severe symptoms (GONs and BANGs) and those with mild symptoms (GONm and BANGm).

Findings: Twenty-six eyes were part of the GON group and twenty-five eyes were part of the BANG group. For twelve months, patients were monitored. On average, the GON group used three different topical glaucoma drugs, resulting in an intraocular pressure (IOP) of 15±3 mmHg. Around one-third of patients had a decrease of at least 20% in intraocular pressure (IOP), and nearly eighty-nine percent needed one less medication. For 53.8% of patients, there was no need for medication to regulate intraocular pressure. The average intraocular pressure (IOP) in the BANG group who were given three to four topical glaucoma medicines was 18 ±2 mmHg. Half of the patients had a 20% decrease in intraocular pressure, and almost two-thirds of those individuals needed one less medication. In 48% of cases, blood pressure medication was unnecessary.

Results: Phaco-BANG and Phacogoniotomy are two MIGS treatments that are both safe and inexpensive. Both reduced intraocular pressure and the need for anti-glaucoma medication. In situations of severe glaucoma, the phaco-BANG surgery yields superior results, even though phacogoniotomy generally produces better clinical effects.

Keywords: Microinvasive Glaucoma Surgery (IGS), Bang, Bang, and Glaucoma (Glaucoma)

1. Introduction

Glaucoma optic neuropathy and visual field abnormalities are shared features of a group of diseases for which increased intraocular pressure (IOP) is a major risk factor1. The global prevalence of POAG is 2.4%.2.

When a patient's glaucoma is uncontrolled, trabeculectomy is the surgical treatment of choice. However, there are a number of potential issues that might arise

from this procedure, including a shallow or lost anterior chamber, hypotony, bleb leakage or failure, raised intraocular pressure (IOP), choroidal separation, and potentially dangerous diseases such as blebitis or endophthalmitis3.

Another aggressive approach to managing intraocular pressure (IOP) in individuals with severe advanced glaucoma is trabeculectomy. For mild to severe glaucoma or if you have a drug sensitivity, it may not be the ideal choice.

When contrasted with conventional trabeculectomy, MIGS demonstrates a favorable safety profile. Among the many benefits of MIGS treatments are their minimally invasive nature, their ability to drop intraocular pressure (IOP) significantly, their ease of usage, and the speed with which patients recover5.

Numerous methods exist for MIGS, including as enhancing uveoscleral outflow via the suprachoroidal space, increasing aqueous shunting via the subconjunctival space, and increasing aqueous outflow from the trabecular meshwork, with or without bypass stents.6.

The trabectome and Kahook dual blade (KDB) For the purpose of goniectomy, they are used to remove TM. Those tools are specialized and costly. It eliminates the need for an implant by creating a direct route to Schlemm's canal.

Both traditional goniotomy and the innovative bent ab interno needle goniectomy (BANG) methods of excisional goniectomy are straightforward, low-cost operations that do not need specific equipment. Additionally, these techniques may help overcome TM resistance without the need for implants. Either method may be administered alone or in conjunction with phacoemulsification8,9.

2. Aim of study

In patients with primary open angle glaucoma who are having cataract surgery, this study will compare the safety and effectiveness of bent ab interno needle goniectomy (BANG-excisional goniectomy) with conventional (incisional) goniotomy procedures combined with phacoemulsification, in terms of reducing intraocular pressure (IOP) and the number of topical medications needed for treatment.

3. Patients and methods

This this research was prospective and comparative. It ran from June 2022 to June 2024 at Benha University Hospitals' ophthalmology department. The research was greenlit by the local ethics committee here at Benha Faculty of Medicine (MD 3-6-2022).

Patients with primary open-angle glaucoma with visually significant cataracts (over the age of 18) were included in the research. The glaucoma outpatient clinic at Benha University Hospitals was the source of all patient recruitment. Our focus was on individuals whose intraoperative blood pressure (IOP) was under 21 mm Hg before surgery, which is considered a statistically normal range.

Patients under the age of 18 were not included in our study. Patients with secondary open or closed angle glaucoma, as well as those who had undergone prior eye surgery or

had injuries that might affect intraocular pressure (IOP), were also not included in the study.

A slit-lamp examination, test of best-corrected visual acuity, and measurement of intraocular pressure (IOP) using a Goldman applanation tonometer were all part of the routine procedure for all test participants. A 4-mirror Volk contact goniolens was used for the gonioscopic examination. An indirect ophthalmoscope and a 90 D lens were used to do the fundus examination.

As part of our glaucoma diagnostic process, we administered a 24-2 Automated Humphrey visual field exam to every patient. This test was developed in Germany by Carl Zeiss AG and is known as the Automated Humphrey Perimeter 745i. In order to confirm a diagnosis of glaucoma, at least two separate, credible assessments of the visual fields were required.

Furthermore, the optic nerve head, peri-papillary retinal nerve fiber layer (RNFL), and ganglion cell complex (GCC) were imaged using Optovue SD-OCT (optovue avanti, USA).

Each patient's preoperative medicated intraocular pressure (IOP) and the total number of drugs used to reduce it were documented. Prior to surgery, every patient was required to sign a written permission form outlining the procedure's goals and any risks involved.

The first group, called GON, had phacoemulsification in conjunction with a standard goniotomy using an MVR blade; the second group, called BANG, underwent phacoemulsification in conjunction with the innovative "Bent Ab interno Needle Goniectomy" method, which used a manually modified goniotome. Both the severe (GONs & BANGs) and non-severe (GONm & BANGm) groups were further subdivided based on the severity of the glaucoma.

Use of the Hodapp Parrish Anderson (HPA) criteria for glaucoma severity assessment was documented. Patients with mild glaucoma had a mean deviation (MD) below -12 and no zero dB sensitive points in the central 5 degrees of the visual field analysis, whereas patients with severe glaucoma had an MD equal to or greater than -12 and/or any point with zero dB sensitive within the central 5 degrees of the visual field.10

Surgical procedures

Local peribulbar anesthetic with 0.5% bupivacaine, 2% lidocaine, and hyaluronidase was used for all procedures. A 2.4 mm transparent corneal incision and two smaller incisions on each side—the nasal and temporal—were done. After completing phacoemulsification and filling the anterior chamber with cohesive vesicoelastic, we placed a foldable intraocular lens (IOL). The anterior chamber was filled with cohesive vesicoelastic, which was not withdrawn until the angle treatment was finished.

After placing the operating microscope and patient head correctly, we used the surgical goniolens to evaluate the anterior chamber angle via the temporal side corneal incision in both groups (Figure 1 & 2).

Figure 3 shows that in order to get a good view of the nasal angle, the patient's head was rotated 30 degrees and 45 degrees away from the surgeon, while the surgical microscope was turned 30 degrees and 45 degrees toward the surgeon.

The space between the cornea and the goniolens was filled with adhesive vesicoelastic. When necessary, intracamerl carbachol was administered to induce miosis and improve angle viewing. To get a good angle view, you had to be at the right place, focus, and zoom in (Figure 4).

The MVR was moved toward the nasal angle in the GON group via the anterior chamber (Figure 5). Then, at the point where the trabecular meshwork's pigmented and non-pigmented sections meet, we made a circular incision of about 60° to 100°. We repositioned the patient's head and the surgical microscope after removing the MVR. At last, the vesicoelastic was rinsed out of the eye.

A goniotome was created for the BANG group by using a needle holder to bend the distal 1 mm of a sterile 28-gauge half-inch hypodermic needle toward the bevel (Figure 6). The selected needle diameter of 320 microns allowed for SC penetration without collateral damage. The outside wall of the SC was likewise protected from harm by the heel's smooth exterior.

Vesicoelastomic syringes were used to mount the needle. It was guided through the temporal incision while being examined under a microscope (Figure 7). To remove the nasal 60o:100o of TM, the bent needle was used. Injecting vesicoelastic at the same time pushed away any hyphema that blocked the vision. We took every precaution to remove the excised trabecular leaflets. Every incision was checked for watertightness once the vesicoelastic was removed.

For four weeks after surgery, all patients were given ocular drops containing Moxifloxacin (5 mg/ml) and Prednisolone acetate 1%. Postoperative problems were carefully documented and promptly addressed. At one day after surgery, we measured intraoperative pressure (IOP) using sterile 0.25 percent flouroscine and 4 percent lidocaine syrup.

We took the necessary measures to control intraocular pressure spikes (a rise of more than 10 mm Hg over the preoperative value). For twelve months, we monitored every patient. The first, second, third, sixth, and twelve months after surgery were all scheduled for postoperative checkups. At each appointment, we measured intraocular pressure (IOP), the number of drugs used to reduce it, visual acuity, and the presence or absence of postoperative problems.

Here are the proven success criteria:

A. Partial clinical success: all drugs have been discontinued and, at the 12-month follow-up, the intraocular pressure (IOP) was 21 mm Hg or lower.

The following criteria must be met in order for a procedure to be considered a clinical success: (B) intraocular pressure (IOP) must be equal to or lower than 21 mm Hg utilizing one or more drops (but not more than preoperative drops) at the 12-month follow-up. C. Surgical success requires a 20% reduction from the preoperative medicated IOP or a decree of at least one drop at the 12-month follow-up.

After 12 months of follow-up, if the high intraocular pressure (IOP) remained greater than 21 mm Hg despite medical therapy, clinical failure was determined. Additionally, surgical failure was deemed to have occurred when, at the 12-month follow-up, the intraocular pressure (IOP) did not drop by 20% or more compared to its preoperative value, even after reducing the amount of drugs used to reduce the IOP. When the number of intraocular pressure (IOP) drops needed during surgery exceeds the number of drops administered before the procedure, it is regarded as a clinical and surgical failure.

4. Results

Study There was no statistical significance found for the following variables: age ($P = 0.648$), sex ($P = 0.09$), best corrected visual acuity (BCVA) ($P = 0.175$), cup-to-disc ratio (CDR) ($P = 0.964$), quantity of drops ($P = 0.791$), and visual field mean deviation (VF MD) ($P = 0.74$). People in the BANG group had a greater baseline intraocular pressure ($P < 0.001$).Among the complications, 42.3% of the GON group and 52% of the BANG group had hyphema ($P = 0.488$), as shown in Table 1. When comparing baseline and one-year intraocular pressure (IOP), the BANG group showed a statistically significant change, but the GON group did not. After one year, the quantity of drops decreased dramatically in both the GON and BANG groups. There were no statistically significant changes in the amount of eye drops that patients needed at any time point, as shown in Table 2. At one year of follow-up, there was no statistically significant change in intraocular pressure (IOP) between the two groups ($P= 0.05$). The change in intraocular pressure (IOP) across the study period is seen in Figure 8. Statistical analysis revealed no significant results for the percentage of intraocular pressure (IOP) decline ($P = 0.855$), surgical success as measured by intraocular pressure ($P = 0.611$), number of stopped drops ($P = 0.334$), or surgical success as measured by drops ($P = 0.180$). There was also no statistically significant difference ($P = 0.779$) between the groups when it came to the ultimate result measures, which may be defined as failure, qualified success, or full success. The CDR was greater in the BANG-S group (0.9 ± 0.1) in comparison to the BANG-M group (0.5 ± 0.1) ($P < 0.001$), as shown in Table 3 and Figure 9. In comparison to the BANG-M group, the VF MD was much higher in the BANG-S group (Median [range]: 27 [22 - 32]) ($P < 0.001$). Factors such as age ($P = 0.118$), sex ($P = 1$), BCVA ($P = 0.718$), medicated IOP ($P = 0.812$), and the quantity of drops ($P = 0.452$) did not show any statistical significance. Chapter 4

Both groups had comparable hyphema rates (P = 0.688). On one occasion, the BANG-S group saw an increase in intraocular pressure (IOP). At the 12-month follow-up, the BANG-M group's intraocular pressure (IOP) showed significant changes compared to baseline, but the BANG-S group's IOP showed no significant alterations. After one year, the number of decreases in both the BANG-M and BANG-S groups decreased dramatically. Throughout the follow-up period, there was no difference in the IOP readings between the two groups (Figure 10), as shown in Table 5. Patients in the two groups also did not vary substantially with respect to the total amount of drops they needed at any given moment.

In tables 6 and 11, we can see the comparison of the BANG-M and BANG-S groups' clinical results. In table 7, you can see the demographic and baseline data for both the severe and non-severe illness patients in the GON group. At 12 months, the intraocular pressure (IOP) of the GON-M group showed significant variations when compared to baseline, however no such difference was seen in the GON-S group. Both the GON-M and GON-S groups showed a significant decrease in the number of drops after one year. Table 8 -

After a year, there was no statistically significant change in intraocular pressure (P = 0.094). The progression of variations in intraocular pressure is seen in Figure 38. At every time point after the operation, the GON-S group needed more drops. On the other hand, the GON-S group had a substantially worse best-corrected visual acuity (BCVA) at one year (0.5 ± 0.1) compared to the GON-M group (0.7 ± 0.1) (P < 0.001). The results for patients with severe and non-severe illness in the GON group are shown in table 9 and figure 13, respectively, as reported in tables 8 and 12. The GON-S group had a much greater percentage of qualifying success (63.6%) than the GON-M group (6.7%), and the GON-M group had a far higher rate of full success (86.7%) than the GON-S group (9.1%).

In table 10 we can see the demographics and baseline data of the non-severe illness patients in the research groups. At one year, the BANG-M group had a greater intraocular pressure (IOP) than the GON-M group (Mean ± SD: 16 ± 3 vs. 13 ± 3, P = 0.005). Statistically, there was no difference between the two groups with respect to the number of drops needed at 12 months; however, the BANG-M group had a higher median (range) of 1 (0–3) drops whereas the GON–M group had 0 (0–3) drops. There was no statistically significant change in BCVA between the groups after one year (P = 0.8). Tables 11, 14, and 15. The failure rate was 6.7% in the GON-M group and 6.3% in the BANG-M group (P = 0.048). The percentage of intraocular pressure (IOP) reduction (P = 0.711), surgical success as measured by IOP (P = 0.379), number of stopped drops (P = 0.470), and surgical success as measured by drops (P = 0.220) were among the other variables that failed to exhibit statistically significant differences.

Furthermore, there was a statistically significant difference (P = 0.048) in the two groups' end results; the GON-M group had a greater rate of full success (86.7% vs. 50% in

the BANG-M group) and a higher rate of qualified success (43.8%) vs. 6.7% in the GON-M group. Figure 15, Table 12, and Table 13 shows the demographic and baseline characteristics of the groups of individuals with severe illness that were evaluated. At any given moment, there were no discernible differences between the two groups in terms of mean intraocular pressure (IOP). At different time periods after the operation, there was also no significant difference in the quantity of drops that were necessary. The percentage of intraocular pressure (IOP) reduction (P = 0.503), surgical success as measured by IOP (P = 1), number of stopped drops (P = 0.656), and surgical success as measured by drops (P = 1) did not show any statistically significant differences (Table 14, Figure 16). There was no statistically significant difference (P = 0.253) in terms of the end results. Eleventh Table, Figure 17

5. Discussion

Another aggressive approach to managing intraocular pressure (IOP) in individuals with severe advanced glaucoma is trabeculectomy. For mild to severe glaucoma or if you have a drug sensitivity, it may not be the ideal choice.

When contrasted with conventional trabeculectomy, MIGS demonstrates a favorable safety profile. With MIGS operations, you may expect little disturbance to normal anatomy, an ab interno approach, a considerable decreasing impact on intraocular pressure (IOP), and a quick recovery thanks to the ease of usage. They don't rely on blebs, therefore there's no risk of trabeculectomy's negative side effects. Cataract surgery is a good candidate for combining several of these techniques. Unfortunately, many patients and surgeons throughout the globe cannot afford MIGS operations due to its high cost. 5,11.

Traditional goniotomy and excisional goniectomy were compared with the innovative bent ab interno needle goniectomy (BANG) method, which does not need any specialist equipment and is both straightforward and inexpensive. Additionally, these techniques may help overcome TM resistance without the need for implants.

The GON group had a mean intraoperative pressure (IOP) decrease of 11% and a mean drop in IOP of 2% compared to their preoperative level. For the IOP reducing impact, the surgical success rate was 34.6%, but for the IOP lowering drops decrease, it was 80.8%. With a qualified clinical success rate of 30.8% and a complete clinical success rate of 53.8%, the results were rather encouraging. Therapeutic failure is seen in just 15.4% of patients.

There was no statistically significant difference in the surgical success rates of 46.7% for non-severe (GON-M) and 18.2% for severe (GON-S) glaucoma patients in the GON group when comparing the IOP lowering impact. At the 12-month follow-up, the GON-M group had used zero drops and the GON-S group had used one. There was no statistically significant difference between the two groups in terms of success rate according to drop reduction (86.7% for GON-M and 72.7% for GON-S, respectively).

The occurrence of clinical failure was higher in the GON-S group (27.3% vs. 6.7%, with a p-value less than 0.001).

The results of research examining the effects of Phacoemulsification on reducing intraocular pressure (IOP) vary. From the level it was at before surgery, it might be decreased by 8–35%. In conjunction with traditional goniotomy, this impact may be amplified to a decrease of up to 55%. The combination of aqueous stents with phacoemulsification12 results in a decrease of around 44%.

Because we compared the GON group's findings to the medicated preoperative IOP, which was within a statistically normal range, the percentage decrease of IOP in the GON group may have been less. The trial by Mohamed et al., on the other hand, employed preoperative non-medicated IOP as a reference, which led to larger percentages of IOP reduction (13). Our study's 76% surgical success rate is comparable to that of Kim et al., who also used preoperative medicated IOP values and demonstrated a 17% decrease in IOP at the 12-month follow-up.

The amount of anti-glaucoma drugs used by the GON group was much lower than that of previous research. Our research found a value of 2 drops, but Kim et al. found a mean decrease of 1.2 in the combined sample.8. The combined group demonstrates a modest decrease in intraocular pressure (mean 3 drops reduction), according to Mohamed et al.13.

While mohamed et al. found a smaller effect for severe glaucoma cases (mean 1 drop reduction), our study found a larger reduction (mean 2 drops) in the severe (GON-S) group. Additionally, our study ended with fewer drops used for severe cases (mean 1 drop), in contrast to the longer follow-up duration (24 months) of mohamed et al.13 .

With a mean decrease of two IOP lowering drops from preoperative level, the BANG group achieved a 15% reduction in intraocular pressure (IOP) compared to the control group. Reducing intraocular pressure (IOP) by surgery had a success rate of 28% and reducing anti-glaucoma drops by surgery had a success rate of 64%. While 40% of patients had a certified clinical success rate, 48% had a complete success rate. Clinical failure is seen in about 12% of individuals.

The surgical success rate according to IOP reducing impact was 31.2% for non-severe (BANG-M) and 22.2% for severe (BANG-S) glaucoma patients in the BANG group, although there was no statistical significance between the two groups. At the 12-month follow-up, both the BANG-M and BANG-S groups used the same amount of drops (1 drop each), and there was no statistically significant difference in the success rates of the two groups when it came to the decrease of drops (62.5 and 66.7 percent, respectively). With a p-value of just 0.708, the BANG-S group had a higher rate of clinical failure than the BANG-M group (6.3% vs. 22.2%).

Consistent with previous research on the BANG technique's effects on various forms of glaucoma, our findings were positive. The surgical success rate was 37.5 percent, and

the average intraocular pressure drop for POAG patients was 17.69 percent. While surgical success rates for severe and non-severe glaucoma patients are different (50 and 66.6%, respectively), the percentage of intraocular pressure (IOP) drop is comparable (23.5% and 25.8%, respectively). Having said that, their research was retrospective and only followed participants for three months.14.

Shute et al. found that BANG produced superior results. Concerning the lowering of intraocular pressure (IOP) and anti-glaucoma drops, the surgical success rate was 73% after 6 months of follow-up. Results from the trial exceeded our expectations, showing that 41% of patients were able to attain an intraocular pressure (IOP) of 12 mmHg or below without medication and that 73% achieved full clinical success.9.

Comparable treatments with a customized blade (KDB) have shown a 12-month reduction in intraocular pressure (IOP) of up to 26.2%. While KDB alone had a success rate of 68.8%, Phaco-KDB achieved 71.8%.the number of Results from TM ablation using a trabectome were comparable, with an average decrease of 20% in intraocular pressure (IOP).17

For mild to moderate glaucoma, the KDB had a greater impact on lowering intraocular pressure (36% vs. 26%) than for severe glaucoma. Also, the impact on reducing the amount of drops in intraocular pressure (IOP) after surgery was greater in less serious patients. 18.

Low cost, accessibility, and the ability to penetrate tissue more easily with a sharper hypodermic needle than the Kahook are some of the benefits of the BANG approach over KDB. In terms of decreasing intraocular pressure (IOP) and pharmaceutical load, BANG is on par with high-tech goniotomy9,19.

There is no risk associated with phacogoniotomy or phaco-BANG methods. With hyphema occurring in 52.0% of the BANG group and 42.3% of the GON group (P = 0.488), there were no statistically significant differences in complications. All patients had modest hematuria that went away after a week of surgery. Medical management effectively reduces intraocular pressure spikes in only two instances in the GON group and one case in the BANG group on the first day after surgery. All three of these instances fell under the category of severe glaucoma.

With no statistically significant difference between the two groups at the one-year follow-up, both treatments successfully reduced intraocular pressure. The GON group had an IOP reduction rate of 11% and the BANG group of 15%. The surgical success rates for the GON group were 34.6 percent, while the BANG group recorded 28 percent. It is possible that the normal range of preoperatively regulated intraocular pressure (IOP) contributed to the poor surgical success rates in both groups. No parameter showed a statistically significant difference.

With no statistically significant difference between the two groups at the one-year follow-up, it is clear that both treatments successfully reduced the number of

postoperative intraocular pressure (IOP) lowering drops. Two drops were stopped in both groups on average. The surgical success rates in the GON group were 80.8% and in the BANG group 64%, respectively, due to drops. No parameter showed a statistically significant difference.

Whether the result was failure, qualified success, or full success, there was no statistically significant difference (P = 0.779). After a year of follow-up, the GON group had a 53.8% success rate with no decreases compared to the BANG group's 48.

Within the non-severe categories, the GON-M group outperformed the BANG-M group in terms of success rates linked to intraocular pressure (46.7% vs. 31.3%), as well as drops (86.7% vs. 62.5%), but the difference was not statistically significant. Both GON (6.7% failure rate) and BANG (6.3% failure rate) were comparable. The GON-M group had a significantly greater percentage of complete success with zero drops needed (86.7%) compared to the BANG-M group (50%) at the 1-year follow-up (P = 0.048).

When it comes to the success rate associated with intraocular pressure (IOP), the GON-S group shows somewhat lower values than the BANG-S group in severe subgroups (18.2% vs. 22.2%). The success rate associated to drops was greater in the GON-S group (72.7 vs. 66.7%), however this difference was not statistically significant. The findings regarding ultimate outcomes are better with BANG-S, even if the results are statistically insignificant (P = 0.253). At the one-year follow-up, the BANG-S group had a greater success rate (44.4% vs. 9.1% in the GON-S group) when no drops were utilized.

Increased aqueous outflow channels in the treatment region, as seen by aqueous angiography20, are evidence that BANG is successful in avoiding the TM. Some publications have suggested using microscissors or rheuxis forceps to remove the TM leaflet or cut it with a knife in order to prevent BANG failure caused by reattachment of the leaflet. Damage to the schlemm canal outer wall, which causes fibrosis21, is another possible cause of BANG failure.

Limitations of the study

Despite the fact that our research lacked a control group that underwent phacoemulsification, the mixed results from the procedure more than made up for this. We did not compute a target IOP. When considering the clinical utility of such techniques, target intraocular pressure assessment would be preferable. Additional constraints include a tiny sample size and a brief follow-up time.

Although there is no effect on clinical outcomes, the statistical significance is somewhat affected by the higher IOP mean starting point. This occurred because we included individuals whose intraocular pressure (IOP) was under medical control and fell within the normal range, which is defined as the low to high teens. Research in the future may circumvent this problem by examining the impact of patient stratification into low-, medium-, and high-teen groups.

Looking forward

One alteration that has not been well researched is visco-BANG. Step one involves inserting the needle into the TM via the vesicoelastic cannula, and step two involves injecting methyle into the SC at the same time. As a consequence, the SC is dilated, and the procedure's effectiveness and failure rate are both increased while the outside wall is avoided.

Intraoperative TM strip removal may affect outcomes and be valuable for histological examination.

6. Conclusion

Both Safe and low-cost MIGS treatments like phacogoniotomy and phaco-BANG provide results that are on par with those of much more costly options. Both reduced intraocular pressure and the need for anti-glaucoma medication. In situations of severe glaucoma, the phaco-BANG surgery yields superior results, even though phacogoniotomy generally produces better clinical effects.

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7. References

1. **George ACF, Jane D, Girkin CA, Gross RL, Peter A, John RS.** Open-Angle Glaucoma: In: Basic and clinical science course, section 10, chapter 4; American Academy of Ophthalmology, Singapore. 2011; 96-99
2. **Zhang N, Wang J, Li Y, Jiang B.** Prevalence of primary open angle glaucoma in the last 20 years: a meta-analysis and systematic review. Sci Rep. 2021 Jul 2;11(1):13762. doi: 10.1038/s41598-021-92971-w. PMID: 34215769; PMCID: PMC8253788.
3. **Watson PG, Jakeman C, Ozturk M, Barnett MF, Barnett F, Khaw KT**. The complications of trabeculectomy (a 20-year follow-up). Eye (Lond). 1990;4 (Pt 3):425-38. doi: 10.1038/eye.1990.54. PMID: 2209905.X
4. **Okeke CO, Quigley HA, Jampel HD, Ying GS, Plyler RJ, Jiang Y, Friedman DS.** Adherence with topical glaucoma medication monitored electronically the Travatan Dosing Aid study. Ophthalmology. 2009 Feb;116(2):191-9. doi: 10.1016/j.ophtha.2008.09.004. Epub 2008 Dec 12. PMID: 19084273.
5. **Saheb H, Ahmed II.** Micro-invasive glaucoma surgery: current perspectives and future directions. Curr Opin Ophthalmol. 2012 Mar;23(2):96-104. doi: 10.1097/ICU.0b013e32834ff1e7. PMID: 22249233.
6. **Gurnani B, Tripathy K.** Minimally Invasive Glaucoma Surgery. Aug 25. In: StatPearls [Internet]. 2023. Treasure Island (FL): StatPearls Publishing; 2024 Jan–. PMID: 35881761.
7. **Maeda M, Watanabe M, Ichikawa K.** Evaluation of trabectome in open-angle glaucoma. J Glaucoma. 2013 Mar;22(3):205-8. doi: 10.1097/IJG.0b013e3182311b92. PMID: 23429629.
8. **Kim WJ, Kim JM, Lee WH, Kim KN, Kim CS.** Effect of combined goniotomy and phacoemulsification on intraocular pressure in open-angle glaucoma patients. Clin Exp Ophthalmol. 2019 Aug;47(6):757-765. doi: 10.1111/ceo.13506. Epub 2019 Apr 11. PMID: 30924282.
9. **Shute T, Green W, Liu J, Sheybani A.** An Alternate Technique for Goniotomy: Description of Procedure and Preliminary Results. J Ophthalmic Vis Res. 2022 Apr 29;17(2):170-175. doi: 10.18502/jovr.v17i2.10787. PMID: 35765640; PMCID: PMC9185202.
10. **Susanna R Jr, Vessani RM.** Staging glaucoma patient: why and how?. Open Ophthalmol J. 2009;3:59-64. Published 2009 Sep 17. doi:10.2174/1874364100903020059
11. **Samuelson TW, Katz LJ, Wells JM, Duh YJ, Giamporcaro JE; US.** iStent Study Group. Randomized evaluation of the trabecular micro-bypass stent with phacoemulsification in patients with glaucoma and cataract. Ophthalmology. 2011 Mar;118(3):459-67. doi: 10.1016/j.ophtha.2010.07.007. Epub 2010 Sep 15. PMID: 20828829.

12. **Spiegel D, Wetzel W, Haffner DS, Hill RA.** Initial clinical experience with the trabecular micro-bypass stent in patients with glaucoma. Adv Ther. 2007 Jan-Feb;24(1):161-70. doi: 10.1007/BF02850004. PMID: 17526473.
13. **Mohamed A Awwad , Hend Gouda Helal , Taisir Hamouda , Soha Moussa Mohamed.** Impact of Phacoemulsification versus Combined Phacoemulsification-goniotomy on Intraocular Pressure in Primary Open-angle Glaucoma Patients. BMFJ 2023;40(surgical issue):142-156.
14. **Jackson T., Ayesha B., Stephan D., Priyanka P.,** Elizabeth M; Outcomes of bent ab interno needle goniectomy in primary open angle glaucoma. Invest. Ophthalmol. Vis. Sci. 2021;62(8):3431.
15. **Sieck EG, Epstein RS, Kennedy JB, SooHoo JR, Pantcheva MB, Patnaik JL, Wagner BD, Lynch AM, Kahook MY, Seibold LK.** Outcomes of Kahook Dual Blade Goniotomy with and without Phacoemulsification Cataract Extraction. Ophthalmol Glaucoma. 2018 Jul-Aug;1(1):75-81. Doi: 10.1016/j.ogla.2018.06.006. Epub 2018 Jul 6. PMID: 32672636.
16. **Dorairaj, S. K., Seibold, L. K., Radcliffe, N. M., Aref, A. A., Jimenez-Román, J., Lazcano-Gomez, G. S., Darlington, J. K., Mansouri, K., & Berdahl, J.** P. 12-Month Outcomes of Goniotomy Performed Using the Kahook Dual Blade Combined with Cataract Surgery in Eyes with Medically Treated Glaucoma. Adv Ther. 2018;35(9):1460-1469. doi:10.1007/s12325-018-0755-4
17. **Bendel RE, Patterson MT.** Long-term Effectiveness of Trabectome (Ab-interno Trabeculectomy) Surgery. J Curr Glaucoma Pract. 2018;12(3):119-124. doi:10.5005/jp-journals-10028-1256
18. **Dorairaj S, Radcliffe NM, Grover DS, Brubaker JW, Williamson BK.** A Review of Excisional Goniotomy Performed with the Kahook Dual Blade for Glaucoma Management. J Curr Glaucoma Pract. 2022;16(1):59-64. doi:10.5005/jp-journals-10078-1352
19. **Laroche D, Okaka Y, Ng C.** A Novel Low Cost Effective Technique in Using a 23 Gauge Straight Cystotome to Perform Goniotomy: Making Micro-invasive Glaucoma Surgery (MIGS) Accessible to the Africans and the Diaspora. J Natl Med Assoc. 2019 Apr;111(2):193-197. doi: 10.1016/j.jnma.2018.09.006. Epub 2018 Oct 17. PMID: 30342703.
20. **Dada T, Bukke AN, Huang AS, Sharma N, Verma S.** Recruitment of Temporal Aqueous Outflow Channels After Bent Needle Ab-Interno Goniectomy Demonstrated by Aqueous Angiography. J Glaucoma. 2023;32(2):e15-e18. doi:10.1097/IJG.0000000000002131
21. **Dada T, Bukke AN, Verma S, Joshi S.** Readhesion of trabecular meshwork strip post ab-interno needle goniectomy in primary open angle glaucoma. BMJ Case Rep. 2022;15(10):e253021. Published 2022 Oct 7. doi:10.1136/bcr-2022-253021
22. **Dada T, Beri N, Sethi A, Sharma N.** Viscodilation of Schlemm's Canal Combined with Goniectomy Using a 30 G Needle (Visco-Bent Ab Interno Needle Goniectomy). J Curr Glaucoma Pract. 2023;17(4):210-213. doi:10.5005/jp-journals-10078-1424

Tables

Table 1: Demographic and baseline characteristics of the studied groups

		GON (n = 25 p, 26 eyes)	BANG (n = 21 p, 25 eyes)	P-value
Age (years)	Mean ±SD	62 ±4	61 ±10	0.648
Sex				
Males	n (%)	13 (52)	16 (76.2)	0.09
Females	n (%)	12 (48)	5 (23.8)	
BCVA	Median (range)	0.15 (0.05 - 0.4)	0.2 (0.05 - 0.6)	0.175
IOP	Mean ±SD	15 ±3	18 ±2	**<0.001***
CDR	Mean ±SD	0.7 ±0.2	0.7 ±0.2	0.964
Number of drops	Median (range)	3 (1 - 3)	3 (1 - 4)	0.791
VF (MD)	Median (range)	12 (5 - 32)	11 (9 - 32)	0.74

P: patients SD: Standard deviation; BCVA: Best-corrected visual acuity; IOP: Intraocular pressure; CDR: Cup disc ratio; VF (MD): Visual field (Mean deviation)

Table 2: Complications and postoperative follow-up in the studied groups

		GON (n = 25 p, 26 eyes)	BANG (n = 21 p, 25 eyes)	P-value
Complications				
Hyphema	n (%)	11 (42.3)	13 (52)	0.488
Baseline				
IOP	Mean ±SD	15 ±3	18 ±2	**<0.001***
Number of drops	Median (range)	3 (1 - 3)	3 (1 - 4)	0.791
1st day				
IOP	Mean ±SD	17 ±4	17 ±6	0.955
Spike	n (%)	2 (7.7)	1 (4)	1
Number of drops	Median (range)	0 (0 - 2)	0 (0 - 2)	0.904
1st week				
IOP	Mean ±SD	15 ±4	15 ±6	0.669
Drops	Median (range)	0 (0 - 2)	0 (0 - 3)	0.885
One month				
IOP	Mean ±SD	15 ±5	16 ±4	0.731
Number of drops	Median (range)	0 (0 - 3)	0 (0 - 3)	0.702
Three months				
IOP	Mean ±SD	13 ±3	16 ±3	**<0.001***
Number of drops	Median (range)	0 (0 - 3)	0 (0 - 3)	0.39
Six months				
IOP	Mean ±SD	14 ±3	17 ±3	**0.002***
Number of drops	Median (range)	0 (0 - 3)	1 (0 - 3)	0.221

One year				
BCVA	Mean ±SD	0.6 ±0.2	0.6 ±0.2	0.390
IOP	Mean ±SD	14 ±4 [NS]	16 ±3 [S]	0.051
Number of drops	Median (range)	0 (0 - 3) [S]	1 (0 - 3) [S]	0.338

p: Patients; SD: Standard deviation; IOP: Intraocular pressure; BCVA: Best-corrected visual acuity; S: Significantly different from baseline within that group; NS: Not significantly different from baseline within that group

Table 3: Outcomes in the studied groups

		GON (n = 25 p, 26 eyes)	**BANG (n = 21 p, 25 eyes)**	**P-value**
Percent IOP decrease	Median (range)	11 (0 - 45)	15 (0 - 30)	0.855
Number of discontinued drops	Median (range)	2 (0 - 3)	2 (0 - 3)	0.334
Surgical success (IOP)	n (%)	9 (34.6)	7 (28)	0.611
Surgical success (drops)	n (%)	21 (80.8)	16 (64)	0.180
Final outcome				
Failure	n (%)	4 (15.4)	3 (12)	0.779
Qualified success	n (%)	8 (30.8)	10 (40)	
Complete success	n (%)	14 (53.8)	12 (48)	

p: Patients; SD: Standard deviation; IOP: Intraocular pressure

Table 4: Demographic and baseline characteristics in patients with severe and non-severe disease in the BANG group

		BANG-M (13 p, 16 eyes)	**BANG-S (n = 8 p, 9 eyes)**	**P-value**
Age (years)	Mean ±SD	59 ±10	66 ±8	0.118
Sex				
Males	n (%)	10 (76.9)	6 (75)	1
Females	n (%)	3 (23.1)	2 (25)	
BCVA	Median (range)	0.2 (0.1 - 0.5)	0.2 (0.05 - 0.6)	0.718
IOP	Mean ±SD	18 ±2	18 ±2	0.812
CDR	Mean ±SD	0.5 ±0.1	0.9 ±0.1	**<0.001***
Number of drops	Median (range)	3 (2 – 4)	2 (1 – 3)	0.452
VF (MD)	Median (range)	10 (9 – 11)	27 (22 – 32)	**<0.001***

SD: Standard deviation; BCVA: Best-corrected visual acuity; IOP: Intraocular pressure; CDR: Cup disc ratio; VF (MD): Visual field (Mean deviation)

Table 5: Complications and postoperative follow-up in patients with severe and non-severe disease in the BANG group

		BANG-M (13 p, 16 eyes)	BANG-S (n = 8 p, 9 eyes)	P-value
Complications				
Hyphema	n (%)	9 (56.3)	4 (44.4)	0.688
Baseline				
IOP	Mean ±SD	18 ±2	18 ±2	0.812
Number of drops	Median (range)	3 (2 – 4)	2 (1 – 3)	0.452
1st day				
IOP	Mean ±SD	15 ±5	20 ±6	0.057
Spike	n (%)	0 (0)	1 (11.1)	0.360
Number of drops	Median (range)	0 (0 - 2)	0 (0 - 2)	0.522
1st week				
IOP	Mean ±SD	14 ±5	18 ±7	0.125
Drops	Median (range)	0 (0 - 2)	0 (0 - 3)	0.452
One month				
IOP	Mean ±SD	15 ±3	17 ±4	0.170
Number of drops	Median (range)	0 (0 - 2)	0 (0 - 3)	0.559
Three months				
IOP	Mean ±SD	17 ±3	16 ±3	0.477
Number of drops	Median (range)	0 (0 - 2)	1 (0 - 3)	0.487
Six months				
IOP	Mean ±SD	17 ±3	16 ±3	0.602
Number of drops	Median (range)	1 (0 - 3)	1 (0 - 3)	0.76
One year				
BCVA	Mean ±SD	0.7 ±0.1	0.5 ±0.2	0.055
IOP	Mean ±SD	16 ±3 ^{S}	17 ±3 ^{NS}	0.533
Number of drops	Median (range)	1 (0 – 3) ^{S}	1 (0 – 3) ^{S}	0.934

p: Patients; SD: Standard deviation; IOP: Intraocular pressure; BCVA: Best-corrected visual acuity; S: Significantly different from baseline within that group; NS: Not significantly different from baseline within that group.

Table 6: Outcome in patients with severe and non-severe disease in the BANG group

		BANG-M (13 p, 16 eyes)	BANG-S (n = 8 p, 9 eyes)	P-value
Percent IOP decrease	Median (range)	15 (0 - 30)	16 (0 - 30)	0.934
Surgical success IOP	n (%)	5 (31.3)	2 (22.2)	1.0
Number of discontinued drops	Median (range)	2 (0 - 3)	1 (0 - 3)	0.677
Surgical success drops	n (%)	10 (62.5)	6 (66.7)	0.835
Final outcome				
Failure	n (%)	1 (6.3)	2 (22.2)	0.708
Qualified success	n (%)	7 (43.8)	3 (33.3)	

Complete success	n (%)	8 (50)	4 (44.4)	

p: Patients; SD: Standard deviation; IOP: Intraocular pressure

Table 7: Demographic and baseline characteristics in patients with severe and non-severe disease in the GON group

		GON-M (n = 14 p, 15 eyes)	GON-S (n = 11 p, 11 eyes)	P-value
Age (years)	Mean ±SD	63 ±4	62 ±5	0.801
Sex				
Males	n (%)	5 (35.7)	8 (72.7)	0.066
Females	n (%)	9 (64.3)	3 (27.3)	
BCVA	Median (range)	0.2 (0.05 - 0.4)	0.1 (0.05 - 0.3)	0.357
IOP	Mean ±SD	15 ±2	16 ±3	0.365
CDR	Mean ±SD	0.6 ±0.1	0.8 ±0.1	**<0.001***
Number of drops	Median (range)	2 (1 – 3)	3 (2 – 3)	**0.001***
VF (MD)	Median (range)	9 (5 – 12)	24 (16 – 32)	**<0.001***

SD: Standard deviation; BCVA: Best-corrected visual acuity; IOP: Intraocular pressure; CDR: Cup disc ratio; VF (MD): Visual field (Mean deviation)

Table 8: Complications and postoperative follow-up in patients with severe and non-severe disease in the GON group

		GON-M (n = 14 p, 15 eyes)	GON-S (n = 11 p, 11 eyes)	P-value
Complications				
Hyphema	n (%)	6 (40)	5 (45.5)	0.781
Baseline				
IOP	Mean ±SD	15 ±2	16 ±3	0.365
Number of drops	Median (range)	2 (1 – 3)	3 (2 – 3)	**0.001***
1st day				
IOP	Mean ±SD	14 ±2	21 ±4	**<0.001***
Spike	n (%)	0 (0)	2 (18.2)	0.169
Number of drops	Median (range)	0 (0 – 0)	1 (0 – 2)	**0.001***
1st week				
IOP	Mean ±SD	13 ±2	18 ±4	**0.004***
Drops	Median (range)	0 (0 – 0)	1 (0 – 2)	**0.001***
One month				
IOP	Mean ±SD	13 ±2	19 ±5	**0.001***
Number of drops	Median (range)	0 (0 – 0)	1 (0 – 3)	**<0.001***
Three months				
IOP	Mean ±SD	12 ±1	15 ±3	**0.006***
Number of drops	Median (range)	0 (0 – 0)	1 (0 – 3)	**<0.001***

Six months				
IOP	Mean ±SD	13 ±2	15 ±3	**0.048***
Number of drops	Median (range)	0 (0 – 1)	1 (0 – 3)	**<0.001***
One year				
BCVA	Mean ±SD	0.7 ±0.1	0.5 ±0.1	**<0.001***
IOP	Mean ±SD	13 ±3 [S]	16 ±5 [NS]	0.094
Number of drops	Median (range)	0 (0 – 3) [S]	1 (0 – 3) [S]	**<0.001***

p: Patients; SD: Standard deviation; IOP: Intraocular pressure; BCVA: Best-corrected visual acuity; S: Significantly different from baseline within that group; NS: Not significantly different from baseline within that group

Table 9: Outcome in patients with severe and non-severe disease in the GON group

		GON-M (n = 14 p, 15 eyes)	GON-S (n = 11 p, 11 eyes)	P-value
Percent IOP decrease	Median (range)	18 (0 - 45)	0 (0 - 40)	0.281
Surgical success IOP	n (%)	7 (46.7)	2 (18.2)	0.131
Number of discontinued drops	Median (range)	2 (0 - 3)	2 (0 - 3)	0.357
Surgical success drops	n (%)	13 (86.7)	8 (72.7)	0.620
Final outcome				
Failure	n (%)	1 (6.7)	3 (27.3)	**<0.001***
Qualified success	n (%)	1 (6.7)	7 (63.6)	
Complete success	n (%)	13 (86.7)	1 (9.1)	

p: Patients; SD: Standard deviation; IOP: Intraocular pressure

Table 10: Demographic and baseline characteristics in patients with non-severe disease in the studied groups

		GON-M (n = 14 p, 15 eyes)	BANG-M (n = 13 p, 16 eyes)	P-value
Age (years)	Mean ±SD	63 ±4	59 ±10	0.211
Sex				
Males	n (%)	5 (35.7)	10 (76.9)	0.031
Females	n (%)	9 (64.3)	3 (23.1)	
BCVA	Median (range)	0.2 (0.05 – 0.4)	0.2 (0.1 – 0.5)	0.654
IOP	Mean ±SD	15 ±2	18 ±2	**<0.001***
CDR	Mean ±SD	0.6 ±0.1	0.5 ±0.1	0.817
Number of drops	Median (range)	2 (1 - 3)	3 (2 - 4)	0.054
VF (MD)	Median (range)	9 (5 - 12)	10 (9 - 11)	0.358

SD: Standard deviation; BCVA: Best-corrected visual acuity; IOP: Intraocular pressure; CDR: Cup disc ratio; VF (MD): Visual field (Mean deviation

Table 11: Complications and follow-up in patients with non-severe disease in the studied groups

		GON-M (n = 14 p, 15 eyes)	BANG-M (n = 13 p, 16 eyes)	P-value
Complications				
Hyphema	n (%)	6 (40)	9 (56.3)	0.366
Baseline				
IOP	Mean ±SD	15 ±2	18 ±2	**<0.001***
Number of drops	Median (range)	2 (1 - 3)	3 (2 - 4)	0.054
1st day				
IOP	Mean ±SD	14 ±2	15 ±5	0.331
Number of drops	Median (range)	0 (0 - 0)	0 (0 - 2)	0.379
1st week				
IOP	Mean ±SD	13 ±2	14 ±5	0.292
Drops	Median (range)	0 (0 - 0)	0 (0 - 2)	0.379
One month				
IOP	Mean ±SD	13 ±2	15 ±3	**0.013***
Number of drops	Median (range)	0 (0 – 0)	0 (0 – 2)	0.247
Three months				
IOP	Mean ±SD	12 ±1	17 ±3	**<0.001***
Number of drops	Median (range)	0 (0 - 0)	0 (0 - 2)	0.078
Six months				
IOP	Mean ±SD	13 ±2	17 ±3	**<0.001***
Number of drops	Median (range)	0 (0 - 1)	1 (0 - 3)	**0.027***
One year				
BCVA	Mean ±SD	0.7 ±0.1	0.7 ±0.1	0.8
IOP	Mean ±SD	13 ±3 ^{S}	16 ±3 ^{S}	**0.005***
Number of drops	Median (range)	0 (0 – 3) ^{S}	1 (0 – 3) ^{S}	0.072

p: Patients; SD: Standard deviation; IOP: Intraocular pressure; BCVA: Best-corrected visual acuity; S: Significantly different from baseline within that group.

Table 12: Outcome in patients with non-severe disease in the studied groups

		GON-M (n = 14 p, 15 eyes)	BANG-M (n = 13 p, 16 eyes)	P-value
Percent IOP decrease	Median (range)	18 (0 – 45)	15 (0 – 30)	0.711
Surgical success IOP	n (%)	7 (46.7)	5 (31.3)	0.379
Number of discontinued drops	Median (range)	2 (0 – 3)	2 (0 – 3)	0.470
Surgical success drops	n (%)	13 (86.7)	10 (62.5)	0.220
Final outcome				
Failure	n (%)	1 (6.7)	1 (6.3)	**0.048***
Qualified success	n (%)	1 (6.7)	7 (43.8)	
Complete success	n (%)	13 (86.7)	8 (50)	

p: Patients; SD: Standard deviation; IOP: Intraocular pressure

Table 13: Demographic and baseline characteristics in patients with severe disease in the studied groups

		GON-S (n = 11 p, 11 eyes)	BANG-S (n = 8 p, 9 eyes)	P-value
Age (years)	Mean ±SD	62 ±5	66 ±8	0.268
Sex				
Males	n (%)	8 (72.7)	6 (75)	1
Females	n (%)	3 (27.3)	2 (25)	
BCVA	Median (range)	0.1 (0.05 – 0.3)	0.2 (0.05 – 0.6)	0.201
IOP	Mean ±SD	16 ±3	18 ±2	**0.032***
CDR	Mean ±SD	0.8 ±0.1	0.9 ±0.1	0.109
Number of drops	Median (range)	3 (2 - 3)	2 (1 - 3)	0.08
VF (MD)	Median (range)	24 (16 - 32)	27 (22 - 32)	0.295

SD: Standard deviation; BCVA: Best-corrected visual acuity; IOP: Intraocular pressure; CDR: Cup disc ratio; VF (MD): Visual field (Mean deviation)

Table 14: complications and postoperative follow-up in patients with severe disease in the studied groups

		GON-S (n = 11 p, 11 eyes)	BANG-S (n = 8 p, 9 eyes)	P-value
Complications				
Hyphema	n (%)	5 (45.5)	4 (44.4)	1
Baseline				
IOP	Mean ±SD	16 ±3	18 ±2	**0.032***
Number of drops	Median (range)	3 (2 - 3)	2 (1 - 3)	0.08
1st day				
IOP	Mean ±SD	21 ±4	20 ±6	0.587
Spike	n (%)	2 (18.2)	1 (11.1)	1
Number of drops	Median (range)	1 (0 - 2)	0 (0 - 2)	0.503
1st week				
IOP	Mean ±SD	18 ±4	18 ±7	0.991
Drops	Median (range)	1 (0 - 2)	0 (0 - 3)	0.552
One month				
IOP	Mean ±SD	19 ±5	17 ±4	0.338
Number of drops	Median (range)	1 (0 - 3)	0 (0 - 3)	0.201
Three months				
IOP	Mean ±SD	15 ±3	16 ±3	0.772
Number of drops	Median (range)	1 (0 - 3)	1 (0 - 3)	0.456
Six months				
IOP	Mean ±SD	15 ±3	16 ±3	0.516
Number of drops	Median (range)	1 (0 - 3)	1 (0 - 3)	0.503
One year				
BCVA	Mean ±SD	0.5 ±0.1	0.5 ±0.2	0.191

IOP	Mean ±SD	16 ±5 [NS]	17 ±3 [NS]	0.7
Number of drops	Median (range)	1 (0 - 3) [S]	1 (0 - 3) [S]	0.503

p: Patients; SD: Standard deviation; IOP: Intraocular pressure; BCVA: Best-corrected visual acuity; S: Significantly different from baseline within that group; NS: Not significantly different from baseline within that group

Table 15: Outcomes in patients with severe disease in the studied groups

		GON-S (n = 11 p, 11 eyes)	**BANG-S (n = 8 p, 9 eyes)**	**P-value**
Percent IOP decrease	Median (range)	0 (0 - 40)	16 (0 - 30)	0.503
Surgical success (IOP)	n (%)	2 (18.2)	2 (22.2)	1
Number of discontinued drops	Median (range)	2 (0 - 3)	1 (0 - 3)	0.656
Surgical success (drops)	n (%)	8 (72.7)	6 (66.7)	1
Final outcome				
Failure	n (%)	3 (27.3)	2 (22.2)	0.253
Qualified success	n (%)	7 (63.6)	3 (33.3)	
Complete success	n (%)	1 (9.1)	4 (44.4)	

p: Patients; SD: Standard deviation; IOP: Intraocular pressure

Figures

Figure (1): surgical goniolens, (Alcon Volk Goniolens, Alcon laboratories, USA).

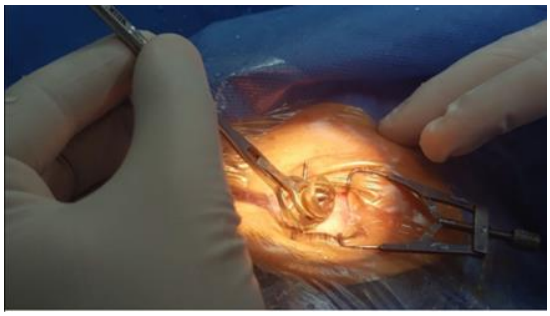

Figure (2): The surgical gonioprism on the globe intraoperative.

Figure (3): Microscope tilting (along red line) and patient head tilting (along the blue line).

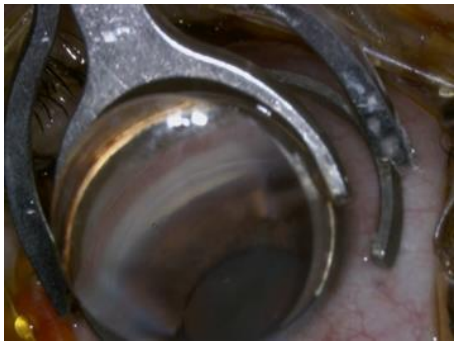

Figure (4): Anterior chamber angle under Gonioscopic viewing

Figure (5): MVR was advanced towards the nasal angle under Gonioscopic viewing.

Figure (6): The modified hypodermic needle showing the sharp near 90 degree bent (right) with smooth outer surface (left)

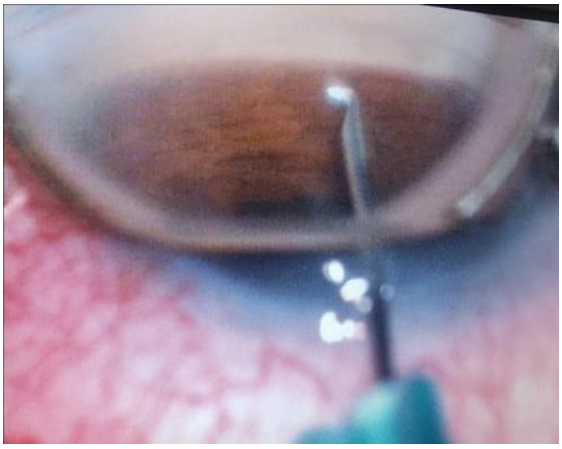

Figure (7): appearance of needle advancement towards the anterior chamber angle.

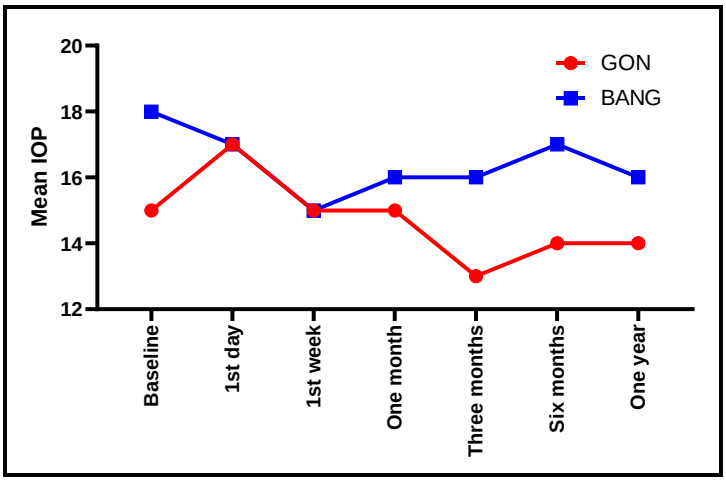

Figure 8: Baseline and follow-up IOP in the studied groups

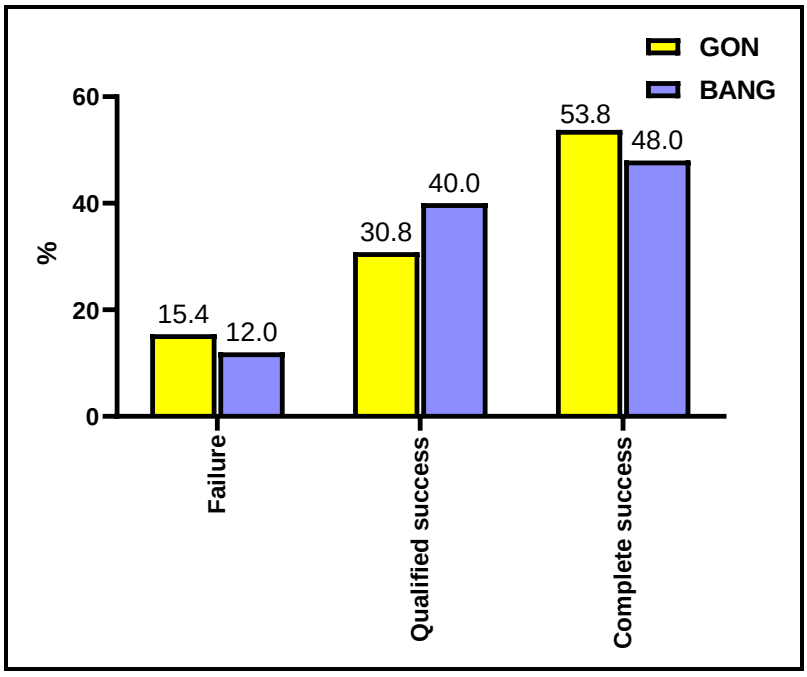

Figure 9: Final outcome in the studied groups

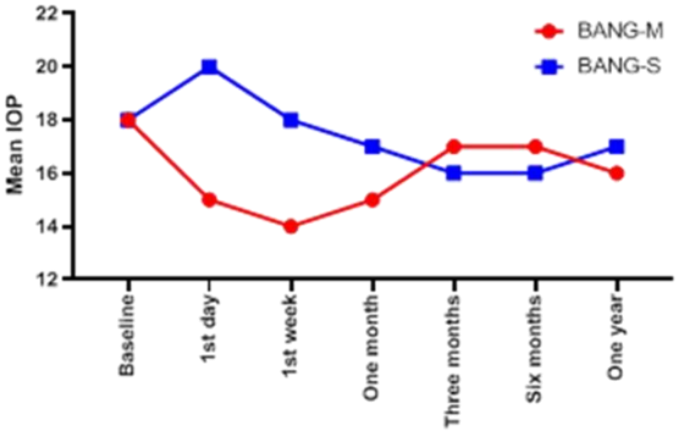

Figure 10: Baseline and follow-up IOP in patients with severe and non-severe disease in the BANG group

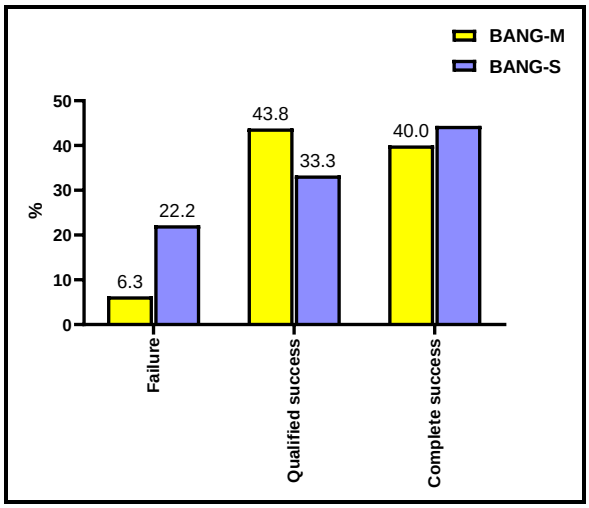

Figure 11: Final outcome in patients with severe and non-severe disease in the BANG group

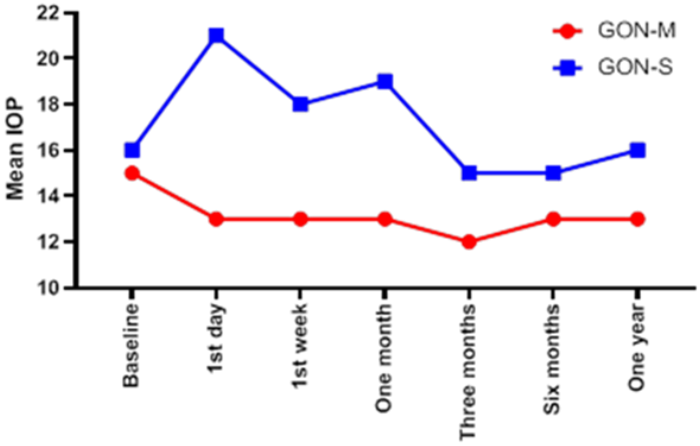

Figure 12: Baseline and follow-up IOP in patients with severe and non-severe disease in the GON group

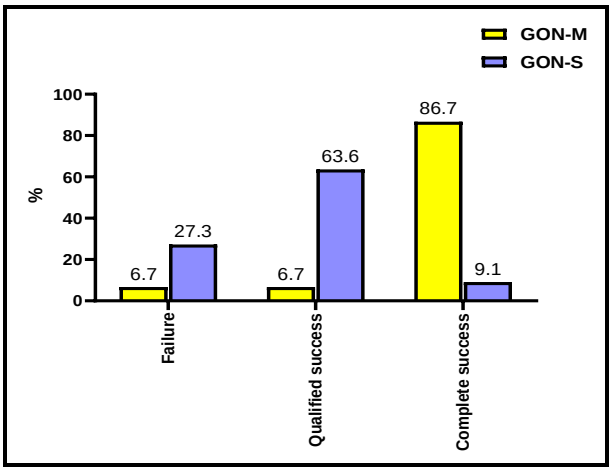

Figure 13: Final outcome in patients with severe and non-severe disease in the GON group

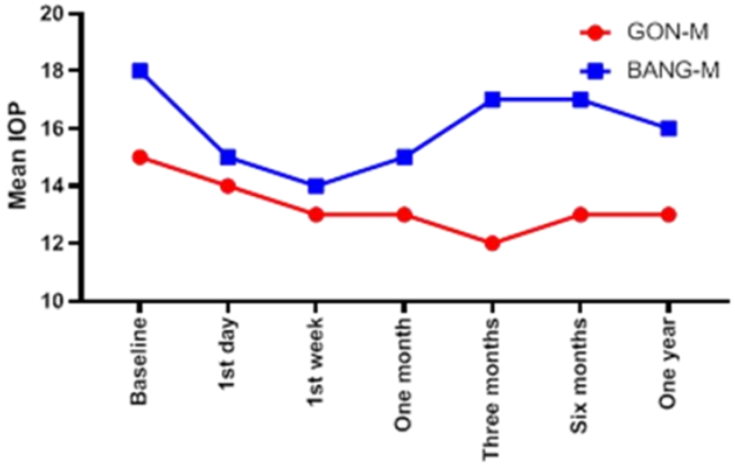

Figure 14: Baseline and follow-up IOP in non-severe disease in the studied groups

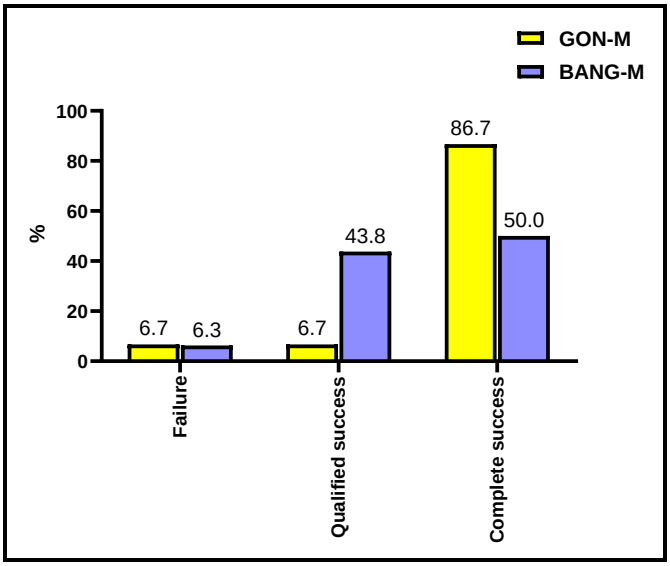

Figure 15: Final outcome in patients with non-severe disease in the studied groups

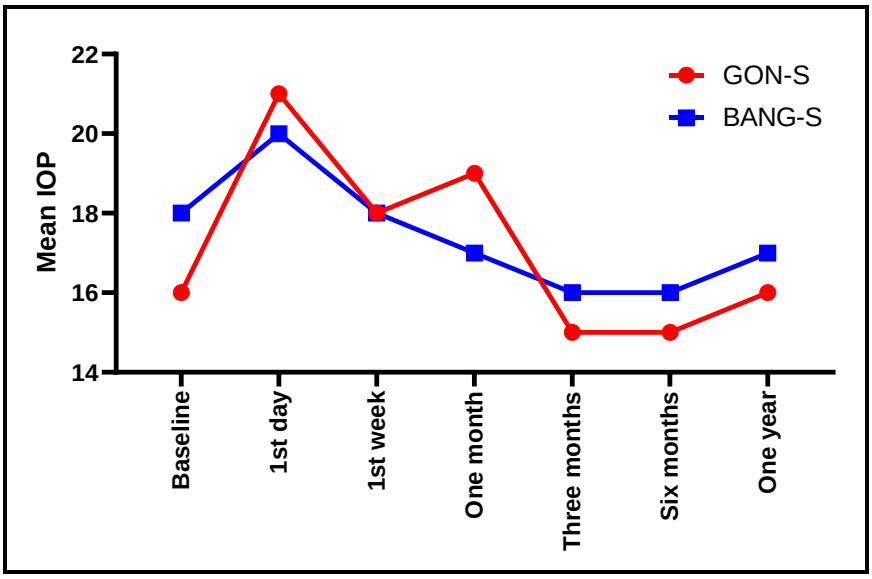

Figure 16: Baseline and follow-up IOP in patients with severe disease in the studied groups

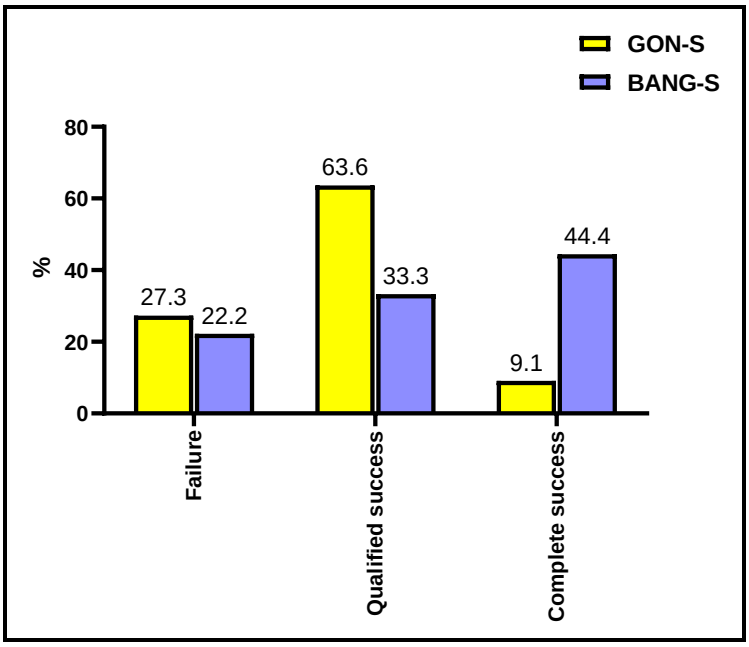

Figure 17: Final outcomes in patients with severe disease in the studied groups