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Research Article

A Prospective Interventional Study on Surgical and Visual Outcomes After 23 Gauge Vitrectomy in a Tertiary Eye Care Centre in South India

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Abstract

Since the introduction of pars plana vitrectomy (PPV) in 1971, the most revolutionary development in vitreoretinal surgery in the past few years has been transconjunctival sutureless vitrectomy (TSV). The large number of potential advantages of TSV include reduced surgical trauma, shorter operating time, lesser conjunctival scarring, decreased postoperative inflammation, faster postoperative healing, early visual recovery, improved patient comfort, and reduced postoperative astigmatism when compared to traditional vitrectomy. Fujii., *et al*. introduced 25-gauge vitrectomy in 2002. It had some inherent problems with the instrument flexibility, lower flow rate, and high incidence of complications. Later, modifications in 25-gauge TSV led to improvement in wound integrity and sterility, potentially decreasing the likelihood of these complications. Eckardt introduced 23-gauge TSV in 2005. It offered improved flow rates and stiffer instrumentation with fewer complications and resolved most of the problems with the 25-gauge system. During the past years, 23-Gauge vitrectomy has evolved as a very popular operating technique in a relatively short period of time. The main reasons for its success are the easier transconjunctival pars plana access with less conjunctival scarring, shorter surgical time, decreased postoperative inflammation, and increased patient's comfort. The technique resulted as an effective approach for selected diseases of the posterior segment without significant complications. The aim of our study is to report a prospective consecutive interventional study on the safety and efficacy of 23-Gauge transconjunctival sutureless pars plana vitrectomy for a variety of vitreoretinal conditions. The main endpoint of our study was the anatomical success with retinal reattachment. We also analyzed the functional outcome and complications with particular attention to visual acuity, to changes of the intraocular pressure (IOP) and to the depth and inflammatory reaction of the anterior chamber.

Keywords: Transconjunvtival; Pars Plana; Vitrectomy; Vitreoretinal; Intraocular Pressure; Inflammation

Abbreviations

VA: Visual Acuity; IOP: Intra Ocular Pressure; VH: Vitreous Hemorrhage; TRD: Tractional Retinal Detachment; RRD: Rhegmatogenous Retinal Detachment; FTMH: Full Thickness Macular Hole; ERM: Epiretinal Membrane; CNVM: Choroidal Neovascular Membrane; NS: Nuclear Sclerosis; SOR: Silicone Oil Removal; IPCV: Idiopathic Polypoidal Choroidal Vasculopathy; CRA Patches: Chorio Retinal Atrophic Patches

Introduction

Since the introduction of pars plana vitrectomy in 1971 [1], one of the most important challenges has been to determine the best type of incision: which is the least invasive and with the best instrumentation function during the procedure.

In 2002, the development of a transconjunctival sutureless pars plana vitrectomy with a 25-gauge system was another important step [7,8]. The incision was small enough to be self-sealing without any sutures, and above all with an oblique scleral tunnel [9,10], allowing less invasive surgery with a decrease in the operating time and a faster postoperative recovery. The healing of sclerotomies was significantly faster with fewer inflammatory cells for a 25-gauge transconjunctival sutureless incision than for a 20-gauge incision [11,12].

The 23-gauge transconjunctival sutureless vitrectomy developed by Eckardt [13] uses the same technique of an oblique scleral tunnel made by a stiletto blade but with insertion of the microcannula in a second step. The oblique scleral incision and the decrease of its diameter from 20-gauge to 23-gauge allow a self-sealing and sutureless surgery.

Sutureless posterior segment surgery provides numerous potential advantages over traditional 20-gauge vitrectomy, including faster wound healing, diminished conjunctival scarring, improved patient comfort, decreased postoperative inflammation, and reduced postoperative astigmatic change [14-22]. Eliminating suturing may also shorten surgical opening and closing times [24]. However, compared with traditional 20-gauge systems, postoperative rates of wound leakage, hypotony, and choroidal detachment may be higher [23-25].

Additionally, several reports have documented intraoperative and postoperative retinal tears and detachments, potentially as a result of lack of adequate peripheral vitrectomy with the more flexible instruments and excessive vitreoretinal traction at sclerotomy sites [26,27].

A new approach using a 23-gauge system may obviate some of these shortcomings. The instruments are less flexible and behave more like traditional 20-gauge instruments, allowing more thorough peripheral vitrectomy and higher- complexity maneuvers. This instrument system utilizes tunneled sclerotomy through the use of a slanted microvitreoretinal blade followed by a blunt trocar, which may provide an improved self-sealing incision. This study examines the safety and efficacy of 23-gauge vitrectomy in a consecutive series of cases.

Materials and Methods

Study design

A Prospective interventional study.

Study area

MN eye hospital, Tondiarpet, Chennai, a tertiary eye care centre in South India.

Study population

All patients undergoing 23-gauge pars plana vitrectomy meeting the inclusion and exclusion criteria are included in the study.

Study duration

12months- November 2020- November 2021.

Inclusion criteria

The inclusion criteria for this study includes eyes that undergoes primary, 23-gauge PPV for various indications including**,** Rhegmatogenous retinal detachment (RRD), Tractional retinal detachment (TRD) (Macular and Extra Macular involvement), Vitreous haemorrhage (VH), Epiretinal membrane (ERM), Full thickness macular hole (FTMH).

Exclusion criteria

Exclusion criteria included trauma, infection and patient not willing to participate.

Sample size

Consecutive 100 eyes of patients who underwent 23-gauge transconjunctival vitrectomy surgery at MN eye hospital, Tondiarpet, Chennai, a tertiary eye care centre in South India.

Methodology

The study included consecutive 100 eyes with a wide range of vitreoretinal pathologies.

An informed consent for the participation of study was obtained from all the patients.

All were explained about the study in Tamil and/or English according to the participants convenience and only those who were willing to sign the informed consent were included in the study. The risks and benefits involved in the study and voluntary nature of participation were explained to the participants before obtaining consent. Confidentiality of the study participants will be maintained.

All the relevant parameters were documented in a structured study proforma.

A single surgeon performed surgery for all study patients to minimize bias. All eyes were treated using the 23-gauge vitrectomy system. All patients received three drops of moxifloxacin preoperatively and then underwent standard three-port vitrectomy.

Patient demographic data and history

Age, gender, address, occupation, history of previous ocular treatment or surgery, Systemic history of diabetes, hypertension or any other systemic condition is obtained.

Pre-operative evaluation

Pre-operative evaluation includes,

- BCVA using Snellen's chart
- Refraction
- Slit-lamp bio microscopy
- IOP (NIDEK-Non-contact tonometry)
- UCVA
- Indirect ophthalmoscopy
- Fundus photography
- B-scan
- Optical Coherence Tomography (optovue)
- Duration of disease
- Co-morbidity
- Previous vitreous intervention (PRP, Pre-OP injection)
- Lens status

Post-operative follow-up

Patients had been followed up for a period of 12 months (1,3,6,12 months). Outcome measures includes Postoperative visual acuity, IOP and complication.

- Hypotony
- Vitritis
- Macular scar
- Epiretinal Membrane
- Recurrent Retinal Detachment
- Choroidal neovascular membrane
- Pale disc
- Silicone Oil emulsification
- Secondary glaucoma
- High IOP.

Outcomes

Snellen VAs were converted into logarithm of the minimum angle of resolution (logMAR), Complication and postoperative intraocular pressure (IOP).

Statistical analysis

We applied SPSS version 26.0 from IBM.

Since the data was collected from a single group at 6 different occasions and the data was not distributed normally, we performed Friedman test.

The patient's visual acuity was measured at different occasions on single group. The data is not normally distributed. Hence Friedman test was performed to find statistical significance. The visual acuity was converted to LogMAR values. The statistical analysis was performed with LogMAR value.

Results

Totally 100 eyes underwent vitrectomy.

We had 60 males and 40females with the age group ranging from 21 to above 70.

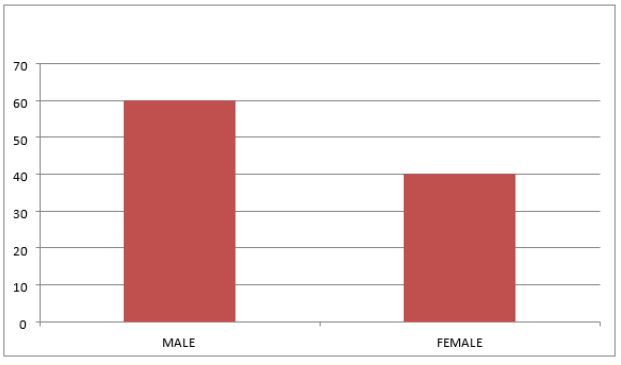

Figure 1: Sex distribution.

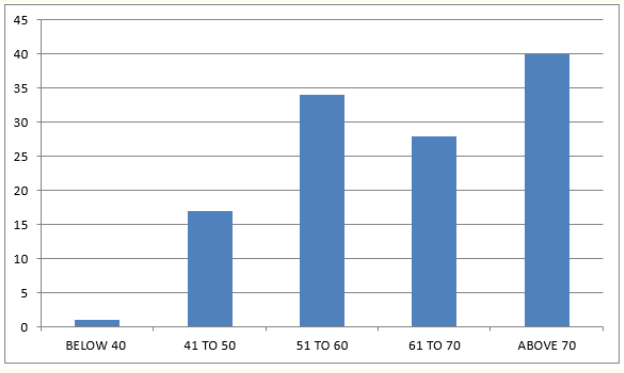

Figure 2: Age distribution.

There was a statistically significant difference in visual acuity measured at 5 different occasions (before surgery, 1 month post operative, 3 months post-operative, 6 months post-operative and 1-year post-operative period) while running Friedman test with $\chi2(4) = 140.7$ with a p-value <0.001.

We performed a similar analysis with subgroups among the total population. The subgroups were the subjects who had ERM, FTMH, RRD, TRD, VH and VHTRD. The Friedman test showed significant difference in visual acuity measured at 5 similar occasions with $\chi2(4) = 15.326$ with a p-value 0.004; $\chi2(4) = 23.899$ with a p-value 0.000 $\chi2(4) = 39.382$ with a p-value 0.000; $\chi2(4) = 46.431$with a p-value 0.000; $\chi2(4) = 17.46$ with a p-value 0.002 for FMTH, TRD, VH, VHTRD and RRD subgroups respectively.

The visual acuity was not statistically different when tested among subgroup ERM with $\chi2(4) = 7.568$ with a p-value 0.109.

The mean value of visual acuity was 2.02 before surgery when measured with Snellen's visual acuity chart and converted to LogMAR notion and it improved gradually post-operatively. This is evident from the following graph.

Figure 3: Mean visual acuity in the study population.

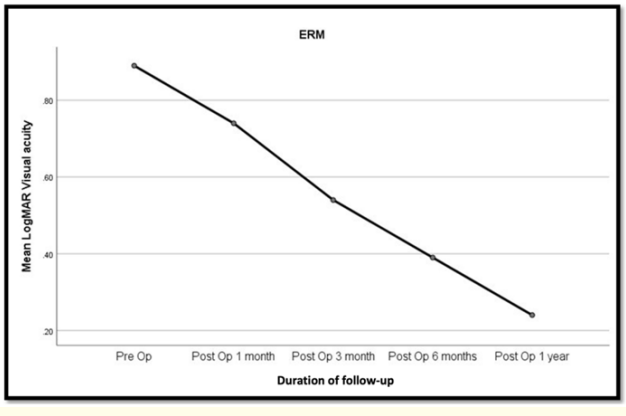

Figure 4: Visual outcome in ERM.

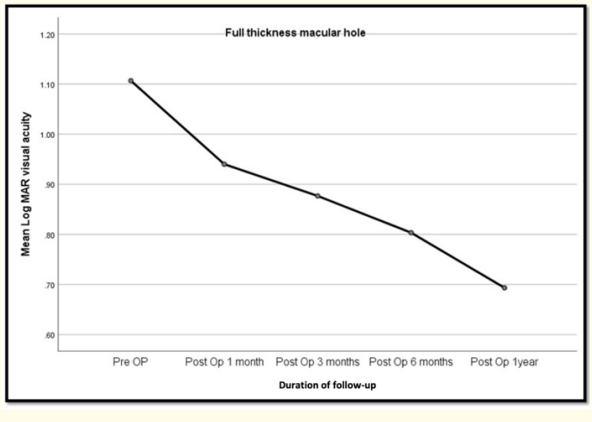

Figure 5: Visual outcome in FTMH.

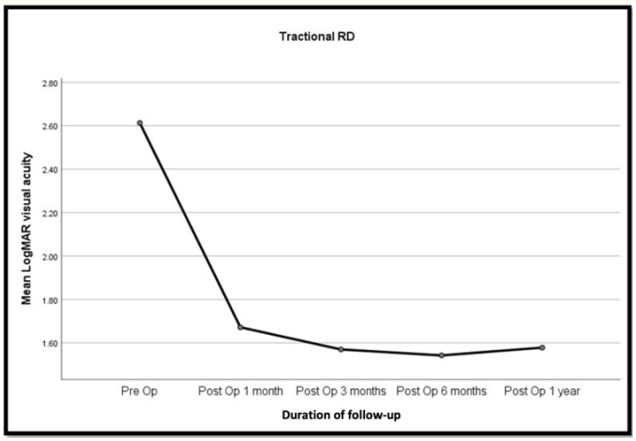

Figure 6: Visual outcome in TRD.

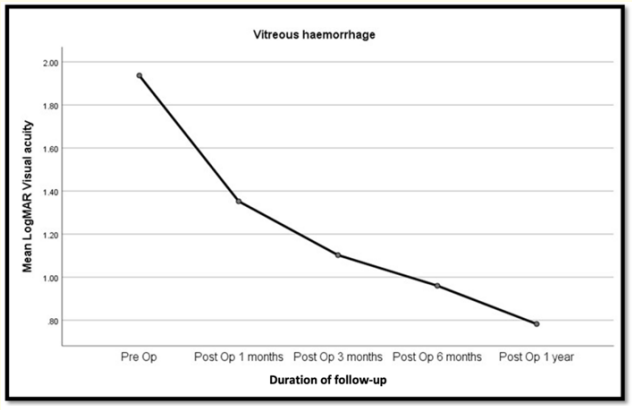

Figure 7: Visual outcome in VH.

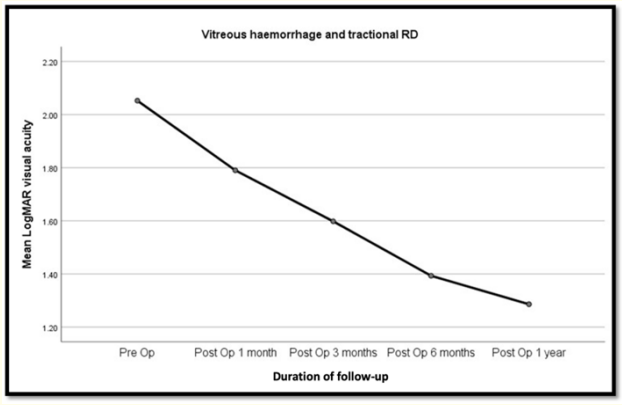

Figure 8: Visual outcome in VH and TRD.

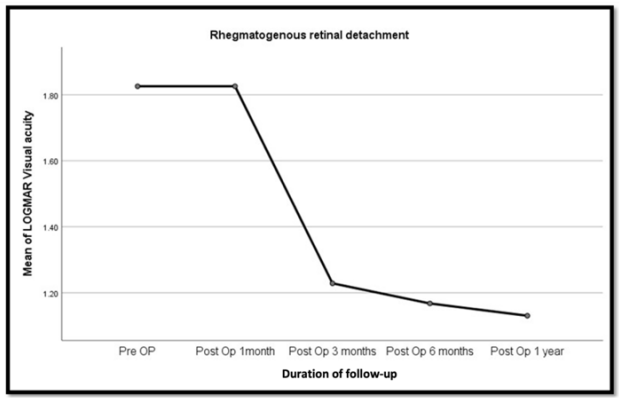

Figure 9: Visual outcome in RRD.

There was a statistically significant difference in IOP measured at 6 different occasions (before surgery, 3 days post-operative, 1 month post operative, 3 months post-operative, 6 months post-operative and 1-year post-operative period) while running Friedman test with $\chi2(5) = 25.746$ with a p-value <0.001.

We performed a similar analysis with subgroups among the total population. The subgroups were the subjects who had RRD, TRD, VH, FTMH, ERM and VHTRD. The Friedman test showed significant difference in IOP measured at 6 similar occasions with $\chi2(5) = 17.87$ with a p-value 0.003; $\chi2(5) = 14.641$ with a p-value 0.012 in RRD and VHTRD respectively.

The IOP was not statistically different when tested among subgroups TRD, ERM, hemorrhage and FTMH with $\chi2(5) = 6.863$ with a p-value of .231; $\chi2(5) = 8.0$ with a p-value of .156; $\chi2(5) = 8.066$ with a p-value of .153; $\chi2(5) = 4.195$ with a p-value of .52 respectively.

The mean value of IOP was 14.35 mmHg when measured with non-contact tonometer before surgery and it had peak at 3 days post operative period 18 mmHg and it reduced gradually over a period of one year to 17 mmHg. This is evident from the following graphs.

We further divided the population into two groups with respective to the type of tamponade that they had during the surgery. They were silicone oil and gas.

Figure 10: Mean IOP in the study population.

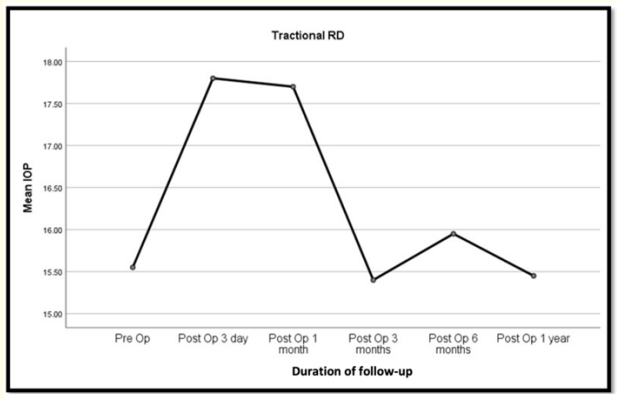

Figure 13: IOP in TRD.

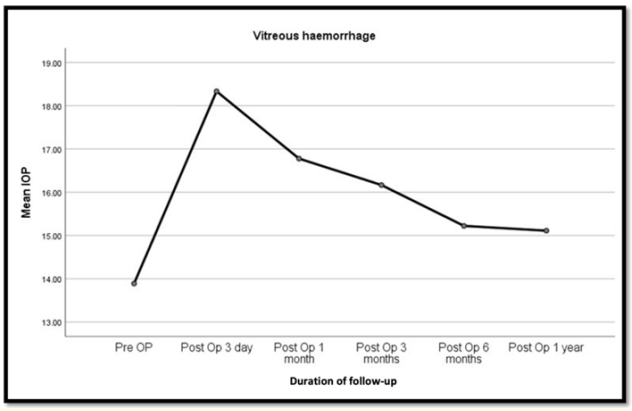

Figure 11: IOP in VH.

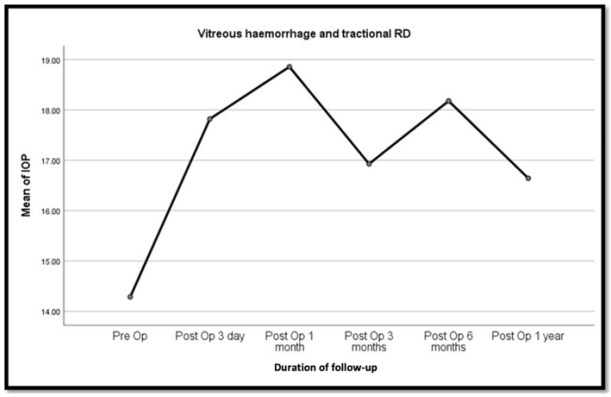

Figure 14: IOP in VH and TRD.

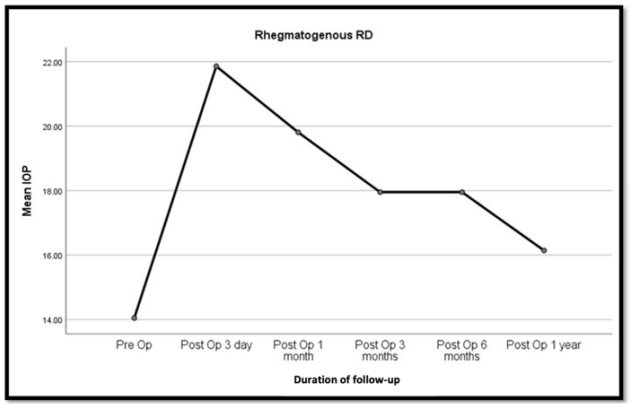

Figure 12: IOP in RRD.

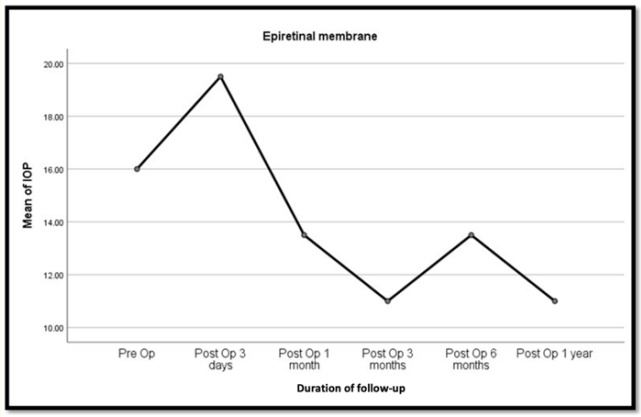

Figure 15: IOP in ERM.

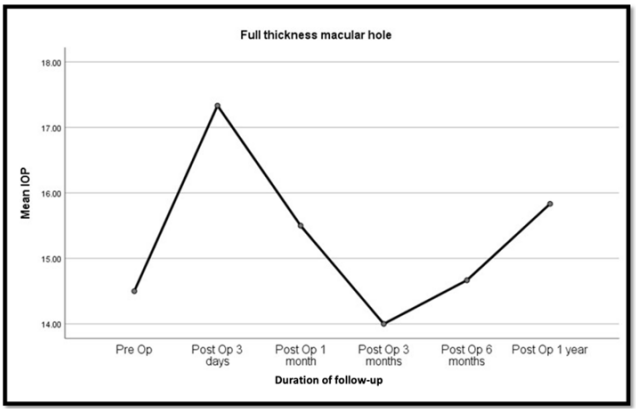

Figure 16: IOP in FTMH.

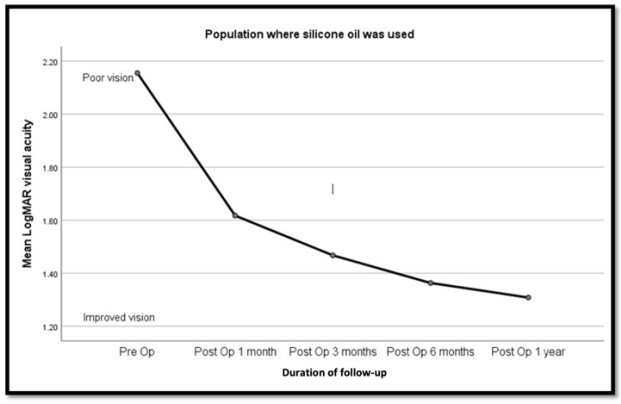

Figure 18: Visual outcome in silicone oil tamponade.

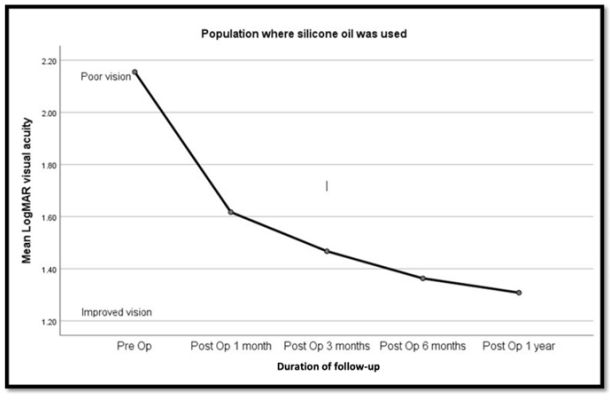

Figure 17: Visual outcome in silicone oil tamponade.

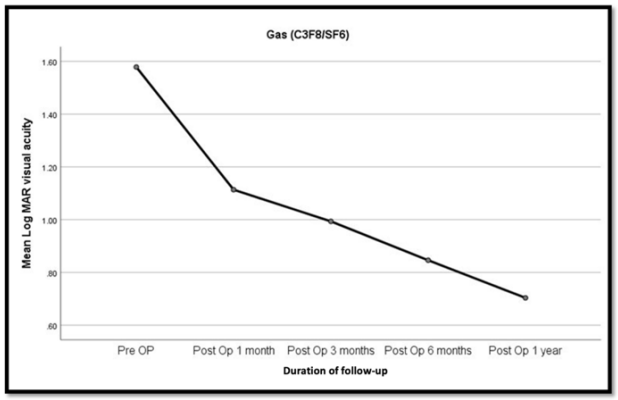

Figure 19: Visual outcome in gas tamponade.

There was a statistically significant difference in visual acuity measured at 5 different occasions (before surgery, 1 month post operative, 3 months post-operative, 6 months post-operative and 1-year post-operative period) while running Friedman test with $\chi2(4) = 48.740$ with a p-value <0.001 for gas tamponade group.

Similarly, the Friedman test was seen in silicone oil tamponade group also. We found $\chi2\ (4) = 92.007$ with a p-value <0.001 for gas tamponade group.

Hence, we noted that there was a good improvement in visual acuity in both the groups. This is graphically shown below.

There were 6 cases where we found interoperative complications such as iatrogenic break and retinal bleeding.

Figure 20: Early post operative complication.

There were 13 cases where we found early post operative complications (1st week) such as corneal edema, increase in IOP, hyphaema, Severe inflammation- fibrin, SRH, recurrent vitreous hemorrhage.

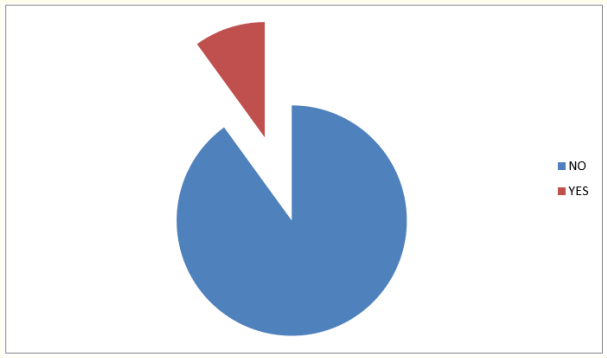

Figure 21: Late post operative complication.

There were 7 cases where we found late post operative complications (after 1 week) such as Recurrent RD, increase in IOP, Recurrent VH.

There were 3 patients whose vision did not show any improvement causes for such scenario includes pale disc, intractable glaucoma, CR Atrophic patches**.**

Lens changes

There were 5 cases where we found that the clear lens changed to NS-I. Out of 4 cases which showed early lens changes pre operatively, 2 cases changed to NS-I and 2 cases changed to NS-II post-operatively.

Out of 16 cases which showed NS-I pre-operatively, 4 cases changed to NS-II;11 cases underwent cataract surgery.

Out of 13 cases which showed NS-II pre-operatively, 1 case changed to NS-III;12 cases underwent cataract surgery.

The Chi square test was done to find out the association between macular status and visual improvement in VH+TRD cases.

The post operative visual acuity was compared with the pre operative vision. Even if there is a single line improvement this was considered an improvement. If the post operative visual acuity is same as the pre operative visual acuity it was categorized in the "no improvement" category.

There was a significant difference in visual acuity improvement for macular status "on" when compared to macular status "off" with the $\chi 2(1) = 5.79$ with a p-value of 0.01. The number of cases improved and not improved was plotted as a bar graph in the following figure.

Figure 22: Visual outcome depending on macular status.

Discussion

Indications for 23- gauge vitrectomy have been expanding since its introduction with the advent of newer and better instruments and vitrectomy machines that allow a more efficient vitreous shaving thereby reducing iatrogenic complication.

In our study population of 100 patients 60 were male and 40 were female, mean age group was 57.5. Similarly in a study conducted by Ndubuisi., *et al.* study, 70% were male and 30% were female with average age of 47. Thus, in both the study vitreoretinal disease were common in male however the mean age group in our study was higher.

When comorbidities associated with vitreoretinal disease was studied among the study population, 37% had diabetes, 7% had hypertension, 30% had diabetes and hypertension and one had coronary heart disease. In our study, diabetes was the most common comorbidities, seen in 67% of the study population. This is in concordance with most literature that support vitreo retinal disease are common in people with diabetes.

The indications for 23 G vitrectomy among the 100 eyes included in the study were analyzed, 30 eyes had vitreous haemorrhage and retinal detachment, 21 had tractional retinal detachment, 21 had RRD, 19 had vitreous haemorrhage, 7 had full thickness macular hole and 2 had epiretinal membrane. Overall, retinal detachment (TRD and RRD) was found to be the most common indication surgery. This coincides with the study conducted by Ndubuisi., *et al.* who reported rhegmatogenous retinal detachment, diabetic retinopathy (DR) and trauma to be the top three indications for surgery.

Intraoperative complication like retinal break and retinal bleeding were observed in 4 eyes and 2 eyes respectively. This was also the most common intra operative complication reported by Rehman., *et al.*

The post operative complications identified within 1 week of surgery were categorized early post operative complication and those identified after 1 week of surgery were categorized as late post operative complication. 13 eyes developed early post operative and 7 eyes developed late post operative complication. The most common early post operative complication was increase in IOP and Severe inflammation- fibrin, which were each identified in 4 eyes. Next most observed early post operative complication was hyphaema and corneal edema both of which noted in 3 eyes each. 1 eye developed SRH and 1 eye developed recurrent vitreous haemorrhage. Increase in IOP was the most common late post operative complication which was seen in 4 eyes. Recurrent RD, Recurrent VH were identified in 1 eye each.

BVCA was checked in all 100 eyes, 92% eyes showed statistically significant improvement in visual acuity at 5 intervals namely: first day and one month post operative, 3rd post operative month and 6th month and at end of first year (P, 0.002). Akçay., *et al.* studied 350 eyes and reported a significant decrease in mean BCVA ($P < 0.001$, $P < 0.028$, respectively) on postoperative first day and first week, and significant increase in visual acuity in the first month and final control ($P < 0.001$).

The study population was divided into subgroups of eyes with ERM, FTMH, TRD, VH and VHTRD, analysis of the observed BCVA was done for each group individually. The Friedman test showed significant improvement in visual acuity measured at all 5 intervals; with p-value = 0.004; p-value 0.000 $\chi2(4) = 39.382$ with a p-value 0.000; $\chi2(4) = 46.431$ with a p-value 0.000; $\chi2(4) = 17.46$ with a p-value 0.002 for FMTH, TRD, VH, VHTRD and RRD subgroups respectively. In eyes with ERM, no statistically significant improvement in visual acuity was observed There was no improvement between pre operative and post operative BCVA in 3 eyes due to pale disc, intractable glaucoma and chorio retinal atrophic patch. 5 eyes were lost to follow up till the end of the study.

Although Akçay., *et al.* reported post operative mild hypotony (IOP ≤ 10 mmHg) in 112 (32%) eyes and in 59 (16.8%) on day 1 and in week 1 respectively. Postoperative serious hypotony (≤5 mmHg) was reported in 34 (9.7%) eyes on day 1, it was not detected in any eyes at the end of the first week. However, none of the eyes included in our study developed hypotony when IOP was measured at 6 different occasions (before surgery, 3 days post-operative, 1 month post operative,3 months post-operative,6 months post-operative and 1-year post-operative period). A statistically significant difference in the measured IOP was noted at the 6 different occasions while running Friedman test with $\chi2(5) = 25.746$ with a p-value = 0.001. Although, a raise in IOP was present on post operative day 3 as compared to preoperative IOP, the IOP in all the eyes were within the normal range throughout the study.

In our study group who underwent 23G vitrectomy, 24 patients underwent gas tamponade (SF6 in 5 patients and C3F8 in 19 patients) and 76 patients underwent silicon oil tamponade. Postoperative visual acuity was measured in both the subgroups and a statistically significant difference in visual acuity p-value = 0.001 for gas implant group also p-value = 0.001 for silicon oil group. Similarly, in the study conducted by Moharram., *et al.* significant improvement in visual acuity was seen in eyes of patients who underwent oil and gas tamponade. The postoperative median BCVA improved from 2.00 at baseline to 1.00 ($p < 0.001$) in the silicone oil tamponade group and from 2.1 to 0.7 in the gas tamponade group ($p < 0.001$).

In our study 54 eyes were pseudo phakic and 46 eyes were phakic. Lens change were noted postoperatively and compared with that of the preoperative findings. Clear lens present preoperatively in 5 eyes changed to NS-I post operatively in all the 5 eyes. Out of 5 eyes that presented preoperatively with early lens changes, the nature of the lens in 1 eye remained the same, in 2 eyes the nature of the lens changed to NS-I and in the other 2 eyes to NS-II post-

operatively. None of the eyes presenting with clear lens or lens with early changes underwent cataract surgery. Among 18 eyes in which the lens was recorded to be NS-I pre-operatively, the nature of the lens in 1 eye remained the same, the lens in 4 eyes changed to NS-II and 11 (68.7%) underwent cataract surgery. 2 were lost to follow up. The lens in 13 eyes were observed to be NS-II pre-operatively, in 1 eye the lens changed to NS-III and 12 (92.3%) eyes underwent cataract surgery. Lens in 3 eyes were noted to be NS-III and all 3 underwent cataract surgery. 1 eye had mature cataract and 1 eye had posterior subcapsular cataract, both underwent cataract surgery.

There was progression of lens change noted in 14 (30.4%) eyes of the 46 phakic eyes and 29 (63.04%) of those required cataract surgery. This was higher than the study by Yee., *et al.* in which cataract surgery was performed in 35% eyes after limited vitrectomy. However, in the same study by Yee., *et al.* there was a higher incidence of cataract surgery (87%) after extensive vitrectomy.

In the subgroup of 76 eyes which underwent silicon oil tamponade in our study, 27(35.5%) eyes underwent SOR with cataract surgery and 43(56.5%) eyes underwent SOR alone.

A very small number of eyes in our study group; i.e., 4 eyes underwent revitrectomy. Among these, 2 eyes had recurrent vitreous haemorrhage, 1 eye had recurrent retinal detachment and 1 eye had hyphaema. This is lesser as compared to Akçay., *et al.* who reported 3.7% eyes were reoperated for recurrent vitreous haemorrhage. Unlike our study in which no eyes were reoperated more than once; Akçay., *et al.* reported reoperation on the 2nd (6.5%), 3rd (2.5%) and 4th (0.2%) time.

The eyes with retinal detachment were divided as eye with macular (macular status on) and extra macular (macular status off) involvement. The improvement in vision was found to be better among the eyes which had macular status on as compared to the eyes with macular status off. This was similar to the study by Thelen., *et al.* who reported lower success rate of 80.46% in patients with macula status off retinal detachment as compared to 88.24% success rate in patients with their macula status on

Conclusion

The 23-gauge vitrectomy in the surgical management of vitreoretinal disease was associated with a low rate of complication and good safety profile. It conserves the advantage of the minimally invasive 25-gauge procedure in improving patient recovery, comfort, care and management with respect to the conjunctival tissue and very low inflammatory response with high anatomic success rate. No case of hypotony were reported in the study. 23-gauge vitrectomy offers significant improvement in visual acuity.

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