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COMPARISON OF OUTCOMES BETWEEN 23-GAUGE AND 25-GAUGE PARS PLANA VITRECTOMY IN RETINAL DETACHMENT REPAIR

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ABSTRACT

Background: Pars plana vitrectomy is widely used for rhegmatogenous retinal detachment repair, with both 23-gauge and 25-gauge systems offering minimally invasive approaches.

Objective: To compare the anatomical, visual, operative, and postoperative outcomes of 23-gauge and 25-gauge pars plana vitrectomy in patients undergoing retinal detachment repair.

Methods: This retrospective comparative cohort study was conducted at department of Ophthalmology, Akhtar Saeed Medical & Dental College, Lahore from January 2025 to July 2025, and included 150 patients with rhegmatogenous retinal detachment. Demographic and baseline ophthalmic characteristics including age, gender, affected eye, lens status, duration of symptoms, macular status, extent of retinal detachment, number and location of retinal breaks, baseline best-corrected visual acuity (BCVA), and intraocular pressure (IOP) were recorded.

Results: Baseline characteristics were comparable between groups. Mean operative time was significantly shorter with 25-gauge PPV than with 23-gauge PPV (58.16±13.75 vs. 63.48±14.62 minutes, p=0.023), and sclerotomy suturing was required less frequently (8.0% vs. 20.0%, p=0.035). Final BCVA was similar between the 23-gauge and 25-gauge groups (0.43±0.34 vs. 0.40±0.32 logMAR, p=0.578), with identical mean visual improvement of 0.75 logMAR. Primary anatomical success was 89.3% versus 92.0%, while final anatomical success was 97.3% versus 98.7%, respectively. Recurrent retinal detachment occurred in 10.7% and 8.0% of patients.

Conclusion: Both 23-gauge and 25-gauge pars plana vitrectomy provided comparable visual and anatomical outcomes with similar safety profiles in retinal detachment repair. The 25-gauge technique demonstrated shorter operative time and reduced need for sclerotomy suturing, suggesting modest intraoperative advantages without compromising surgical success.

KEYWORDS: Retinal detachment, Patients, Operative time, Outcomes, Safety

INTRODUCTION

Retinal detachment can be caused by fluid passing through one or more breaks in the retina, leading to a separation of the neurosensory retina from the underlying retinal pigment epithelium (RPE) – this condition is called rhegmatogenous retinal detachment (RRD) and is a potentially blinding eye disease [1]. If not corrected early, the macula may become involved, and the separation may lead to significant and irreversible loss of vision [2]. The main goals of retinal detachment surgery are to locate and repair retinal breaks, to detach vitreoretinal traction, and to reattach the retina, maintain its adhesion, and restore or preserve vision [3]. There are several surgical techniques available such as scleral buckling, pneumatic retinopexy, pars plana vitrectomy (PPV), or a combination of these techniques, depending on the retinal configuration, the condition of the lens, the presence of PVR, the surgeon's preference and the patient's characteristics [4]. The pars plana vitrectomy has proved to be an important surgical technique in both primary and complex RD repair, due to its ability to remove vitreous traction, locate retinal breaks, facilitate endolaser treatment, and introduce internal tamponade [5]. With the development of transconjunctival

microincision vitrectomy surgery (TMV) and the advent of smaller microincision gauge instruments, such as 23-, 25-, and 27-gauge instruments, the surgery has shifted from the larger gauge instruments to the smaller ones [6]. In small-gauge systems, trauma to the conjunctiva and sclera, postoperative inflammation, patient discomfort and recovery time may be decreased, and in appropriately selected cases, wounds can be constructed without suturing [7]. Differences in instrument diameter can, however, have an effect on rigidity, fluidics, vitreous removal, sealing, operative time and ease of movement during surgery [8].

The advantage of the 23 gauge PPV system is that it offers greater rigidity to the instruments and allows for higher flow rates, potentially making it easier to dissect and manipulate the peripheral vitreous during retinal detachment surgery [9]. In clinical experience, 23-gauge vitrectomy has been shown to yield good anatomic and functional results in the repair of rhegmatogenous retinal detachment. The narrow sclerotomies allowed by the smaller 25-gauge system, however, may have benefits with regard to postoperative comfort, wound healing, and reduced surgical trauma [10][11]. Twenty five gauge PPV has also proven to be favourable for the primary reattachment and visual outcome after retina detachment repair [12]. Although these theoretical differences are present, the ideal degree of retinal separation for retinal detachment repair has clinical significance since the success of the surgery depends not only on the final anatomical reattachment, but also on visual outcome, surgical efficiency, postoperative intraocular pressure control, complications, and the need for further procedures [13]. There have been reports of anatomic equality for retinal detachment surgery with various small-gauge vitrectomy systems (SVS) [14]. In a previous study that compared 20, 23, and 25-gauge systems, these methods were proven to be viable options for primary repair of pseudophakic RRD [15]. However, direct comparison of 23-gauge and 25-gauge PPV might help determine if either technique has clinically significant benefits in the standard repair of retinal detachment.

Objective

To compare the anatomical, visual, operative, and postoperative outcomes of 23-gauge and 25-gauge pars plana vitrectomy in patients undergoing retinal detachment repair.

METHODOLOGY

This retrospective comparative cohort study was conducted at department of Ophthalmology, Akhtar Saeed Medical & Dental College, Lahore from January 2025 to July 2025, and included 150 patients who underwent pars plana vitrectomy for rhegmatogenous retinal detachment. Patients were divided into two groups according to the vitrectomy gauge used: Group A included patients who underwent 23-gauge pars plana vitrectomy (n=75), while Group B comprised patients treated with 25-gauge pars plana vitrectomy (n=75). Patients aged 18 years or older with primary rhegmatogenous retinal detachment requiring pars plana vitrectomy, identifiable retinal breaks, and complete preoperative and postoperative ophthalmic records were included. Both phakic and pseudophakic patients and those with macula-on or macula-off retinal detachment were eligible. Patients with tractional or exudative retinal detachment, proliferative vitreoretinopathy grade C or higher, previous vitreoretinal surgery in the affected eye, penetrating ocular trauma, active intraocular inflammation or infection, advanced glaucoma, severe corneal opacity preventing retinal visualization, or incomplete follow-up records were excluded.

Data Collection

After obtaining approval from the Institutional Ethical Review Committee, eligible patients were identified from hospital and surgical records using a non-probability consecutive sampling technique. Demographic and baseline ophthalmic characteristics including age, gender, affected eye, lens status, duration of symptoms, macular status, extent of retinal detachment, number and location of retinal breaks, baseline best-corrected visual acuity (BCVA), and intraocular pressure (IOP) were recorded. Surgical variables included vitrectomy gauge, operative time, type of internal tamponade, use of endolaser photocoagulation, drainage retinotomy, combined cataract surgery, and requirement for suturing of sclerotomy sites. BCVA was converted to logarithm of the minimum angle of resolution (logMAR) units for statistical analysis. Postoperative assessments included BCVA, IOP, anatomical retinal attachment, postoperative inflammation, hypotony, ocular hypertension, vitreous hemorrhage, endophthalmitis, cataract progression, recurrent retinal detachment, and requirement for additional retinal surgery. Primary anatomical success was defined as complete retinal attachment after a single operation without additional retinal detachment surgery. Final anatomical success, change in BCVA, operative time, postoperative complications, and reoperation rates were compared between the two groups.

Statistical Analysis

Data were analyzed using SPSS version 26.0. Continuous variables were expressed as mean±standard deviation, while categorical variables were presented as frequencies and percentages. Baseline characteristics, operative parameters, anatomical success, visual outcomes, and postoperative complications were compared between the 23-gauge and 25-

gauge groups using the independent t-test or Mann-Whitney U test for continuous variables and the Chi-square test or Fisher's exact test for categorical variables. A p-value ≤0.05 was considered statistically significant.

RESULTS

The two groups were comparable at baseline. Mean age was 56.84±11.72 years in the 23-gauge group and 55.91±12.08 years in the 25-gauge group (p=0.632), with males comprising 60.0% and 57.3%, respectively. Right-eye involvement was 52.0% versus 54.7%, while phakic status was 57.3% versus 60.0%. Mean symptom duration was 7.42±4.36 versus 7.08±4.11 days, and macula-off detachment occurred in 64.0% versus 61.3%.

Table I. Baseline Demographic and Ophthalmic Characteristics

Characteristic	23-Gauge PPV (n=75)	25-Gauge PPV (n=75)	p-value
Age, years, Mean±SD	56.84±11.72	55.91±12.08	0.632
Male, n (%)	45 (60.0)	43 (57.3)	0.739
Female, n (%)	30 (40.0)	32 (42.7)	0.739
Right eye, n (%)	39 (52.0)	41 (54.7)	0.744
Phakic, n (%)	43 (57.3)	45 (60.0)	0.739
Pseudophakic, n (%)	32 (42.7)	30 (40.0)	0.739
Symptom duration, days, Mean±SD	7.42±4.36	7.08±4.11	0.624
Macula-off detachment, n (%)	48 (64.0)	46 (61.3)	0.735
Macula-on detachment, n (%)	27 (36.0)	29 (38.7)	0.735
Retinal breaks, number, Mean±SD	1.84±0.91	1.76±0.87	0.583
Detachment extent, clock hours, Mean±SD	6.21±2.14	6.05±2.08	0.644
Baseline BCVA, logMAR, Mean±SD	1.18±0.54	1.15±0.51	0.727
Baseline IOP, mmHg, Mean±SD	13.82±3.21	13.64±3.08	0.727

The 25-gauge group had a significantly shorter operative time than the 23-gauge group (58.16±13.75 vs. 63.48±14.62 minutes, p=0.023) and required fewer sclerotomy sutures (8.0% vs. 20.0%, p=0.035). Endolaser was used in all patients. Gas tamponade was used in 73.3% versus 70.7%, silicone oil in 26.7% versus 29.3%, drainage retinotomy in 13.3% versus 16.0%, and combined cataract surgery in 25.3% versus 22.7%.

Table II. Intraoperative Characteristics According to Vitrectomy Gauge

Operative characteristic	23-Gauge PPV (n=75)	25-Gauge PPV (n=75)	p-value
Operative time, minutes, Mean±SD	63.48±14.62	58.16±13.75	0.023
Endolaser photocoagulation, n (%)	75 (100.0)	75 (100.0)	1.000
Gas tamponade, n (%)	53 (70.7)	55 (73.3)	0.716
Silicone oil tamponade, n (%)	22 (29.3)	20 (26.7)	0.716
Drainage retinotomy, n (%)	12 (16.0)	10 (13.3)	0.646
Combined cataract surgery, n (%)	17 (22.7)	19 (25.3)	0.703
Sclerotomy suturing required, n (%)	15 (20.0)	6 (8.0)	0.035
Intraoperative complication, n (%)	5 (6.7)	4 (5.3)	0.732

Both techniques achieved comparable visual and anatomical outcomes. BCVA at 1 month was 0.72±0.43 versus 0.68±0.41 logMAR, at 3 months 0.51±0.37 versus 0.47±0.35, and final BCVA 0.43±0.34 versus 0.40±0.32 for 23- and 25-gauge PPV, respectively. Mean BCVA improvement was identical at 0.75±0.46 versus 0.75±0.44 logMAR (p=1.000). Primary anatomical success was 89.3% versus 92.0%, final success 97.3% versus 98.7%, and recurrent detachment and additional surgery occurred in 10.7% versus 8.0%.

Table III. Visual and Anatomical Outcomes Following Surgery

Outcome	23-Gauge PPV (n=75)	25-Gauge PPV (n=75)	p-value
BCVA at 1 month, logMAR, Mean±SD	0.72±0.43	0.68±0.41	0.561
BCVA at 3 months, logMAR, Mean±SD	0.51±0.37	0.47±0.35	0.498

Final BCVA, logMAR, Mean±SD	0.43±0.34	0.40±0.32	0.578
Mean BCVA improvement, logMAR	0.75±0.46	0.75±0.44	1.000
Primary anatomical success, n (%)	67 (89.3)	69 (92.0)	0.576
Final anatomical success, n (%)	73 (97.3)	74 (98.7)	0.560
Recurrent retinal detachment, n (%)	8 (10.7)	6 (8.0)	0.576
Additional retinal surgery, n (%)	8 (10.7)	6 (8.0)	0.576
Final IOP, mmHg, Mean±SD	14.76±3.62	14.31±3.44	0.437

Early hypotony occurred in 9.3% versus 13.3%, ocular hypertension in 14.7% versus 12.0%, significant inflammation in 16.0% versus 6.7%, vitreous hemorrhage in 8.0% versus 5.3%, and cataract progression in 32.6% versus 28.9% of phakic eyes in the 23- and 25-gauge groups, respectively. No endophthalmitis occurred in either group. Recurrent detachment occurred in 10.7% versus 8.0%, wound leakage in 8.0% versus 2.7%, and postoperative discomfort in 24.0% versus 12.0%.

Table IV. Postoperative Complications and Recovery

Postoperative outcome	23-Gauge PPV (n=75)	25-Gauge PPV (n=75)	p-value
Early postoperative hypotony, n (%)	7 (9.3)	10 (13.3)	0.438
Ocular hypertension, n (%)	11 (14.7)	9 (12.0)	0.629
Significant postoperative inflammation, n (%)	12 (16.0)	5 (6.7)	0.075
Vitreous hemorrhage, n (%)	6 (8.0)	4 (5.3)	0.514
Cataract progression among phakic eyes, n (%)	14/43 (32.6)	13/45 (28.9)	0.706
Endophthalmitis, n (%)	0 (0.0)	0 (0.0)	1.000
Recurrent retinal detachment, n (%)	8 (10.7)	6 (8.0)	0.576
Sclerotomy-related wound leakage, n (%)	6 (8.0)	2 (2.7)	0.145
Postoperative discomfort at first visit, n (%)	18 (24.0)	9 (12.0)	0.056
Mean follow-up, months, Mean±SD	7.84±2.61	7.69±2.48	0.719

DISCUSSION

In the present study, the results of 23-gauge and 25-gauge pars plana vitrectomy (PPV) procedures were compared in 150 patients undergoing surgery for rhegmatogenous retinal detachment (RRD). The two techniques were equally successful in terms of anatomical and functional results without significant differences in the postoperative visual acuity, primary or final retinal attachment, recurrent retinal detachment or most postoperative complications. From these results both systems have been proven to be useful for retinal detachment repair. Anatomical success rates of 88.9% and 93.3% have also been reported after a single operation with 23-gauge and 25-gauge PPV, respectively, in the past, and there was no difference between the two in final visual outcomes and final retinal attachment in all cases [16] [17]. There was a good balance across the groups with regard to baseline characteristics, such as age, sex, lens status, degree of macular involvement, symptom onset, lens involvement, number of retinal breaks, and baseline VA and IOPs. The comparability enhances the inference that the differences following surgery were more likely a function of surgical factors than of a significant imbalance in the preoperative status. Of the patients who underwent 23-gauge PPV, 64.0% had macula-off RD; of those who underwent 25-gauge PPV, 61.3% had macula-off RD. Macular status and duration of macular detachment have also been used previously as important factors to assess visual recovery after vitrectomy for retinal detachment [18]. There were no other significant differences during the operation. The operative time was shorter with 25-gauge PPV (58.16±13.75 minutes) than with 23-gauge PPV (63.48±14.62 minutes, p=0.023). Previous studies that have directly compared 25- and 23-gauge microincision vitrectomy have shown similar operative times of 33.68 and 34.47 minutes, respectively, but have demonstrated that both systems are equally efficient for surgery [19]. The shorter duration noted in the 25-gauge surgery in the present study may be attributed to a difference in wound construction or instrumentation, surgeon technique or lack of need for wound closure, and not to the size of the gauge. A significant difference was found between the 25-gauge PPV group and the 23-gauge PPV group about the requirement for sclerotomy suturing (8.0% vs. 20.0%, p=0.035). This discovery backs up the potential benefit of smaller incisions in reducing wounds. Another study found that 7 patients who underwent the 23-gauge procedure needed suturing to close the sclerotomy while only 3 patients who underwent the 25-gauge procedure required suturing [19]. Smaller transconjunctival incisions may thus aid in self-sealing the wound and minimize the need for further suturing, but proper evaluation of wound closure is still necessary.

In both groups, visual improvement was significant, and similar between the groups. The final BCVA in the 23-gauge group 0.43±0.34 logMAR, which is a mean improvement of 0.75±0.46 logMAR, and the final BCVA in the 25-gauge group 0.40±0.32 logMAR, which is a mean improvement of 0.75±0.44 logMAR. Similar studies comparing 23- and 25-gauge systems showed both groups had significant improvements in BCVA postoperatively but there was no significant difference in the amount or timing of visual recovery [20]. These results indicate that the functional recovery following retinal reattachment may not be different between the 23- and 25-gauge instruments in the long term, provided the reattachment is successful. The success rates of the primary anatomical results were 89.3% and 92.0% for PPV with 23- and 25-gauge needles, respectively, and the final anatomical results were 97.3% and 98.7%, respectively. The comparable final IOP values of 14.76±3.62 and 14.31±3.44 mmHg also indicate good long-term integrity and intraocular pressure stability of both. There are some limitations with this study. It may have suffered from selection and documentation bias due to its retrospective design, and the small number size and single center may have restricted generalizability. Other factors, such as surgical technique, tamponade selection, and postoperative care, may also have differed based on physician preference or patient factors. Furthermore, the length of the follow-up period was comparatively short, and so very long-term visual outcomes, cataract development and late onset of RD could not be evaluated. The study offers a helpful head-to-head comparison of anatomical, visual, operative and safety results of 23-gauge and 25-gauge PPV surgery even with these limitations.

CONCLUSION

Both 23-gauge and 25-gauge pars plana vitrectomy were effective and safe for rhegmatogenous retinal detachment repair, with comparable visual improvement, primary and final anatomical success, recurrence rates, and postoperative complications. The 25-gauge approach was associated with a significantly shorter operative time and lower requirement for sclerotomy suturing. These findings suggest that either technique can provide favorable outcomes, while 25-gauge vitrectomy may offer modest intraoperative advantages without compromising anatomical or functional success.

REFERENCES

1. Sedova, A., Steiner, I., Matzenberger, R. P., Georgopoulos, M., Scholda, C., Kriechbaum, K. F., ... & Pollreisz, A. (2021). Comparison of safety and effectiveness between 23-gauge and 25-gauge vitrectomy surgery in common vitreoretinal diseases. *PLoS One*, *16*(3), e0248164.
2. Starr, M. R., Yonekawa, Y., Obeid, A., Ryan, E. H., Ryan, C., Ammar, M., ... & Primary Retinal Detachment Outcomes (PRO) Study Group. (2021). Comparison of visual and anatomic outcomes following rrd surgery using 23-gauge versus 25-gauge vitrectomy: PRO study report no. 12. *Ophthalmic Surgery, Lasers and Imaging Retina*, *52*(2), 70-76.
3. McCullough, P., Mohite, A., Virgili, G., & Lois, N. (2023). Outcomes and complications of pars plana vitrectomy for tractional retinal detachment in people with diabetes: a systematic review and meta-analysis. *JAMA ophthalmology*, *141*(2), 186-195.
4. Echegaray, J. J., Vanner, E. A., Zhang, L., Fortun, J. A., Albini, T. A., Berrocal, A. M., ... & Haddock, L. J. (2021). Outcomes of pars plana vitrectomy alone versus combined scleral buckling plus pars plana vitrectomy for primary retinal detachment. *Ophthalmology retina*, *5*(2), 169-175.
5. Awan, M. A., Shaheen, F., & Janjua, K. (2021). Outcomes of 27gauge pars plana vitrectomy for a variety of posterior segment diseases. *J Pak Med Assoc*, *71*(11), 2570-2575.
6. Umeda, Y., Yoshida, G., & Watanabe, N. (2025). Comparison of 27-and 25-gauge pars plana vitrectomy for the treatment of canine rhegmatogenous retinal detachment. *Journal of the American Veterinary Medical Association*, *263*(8), 1-8.
7. Tan, A., Bertrand-Boiché, M., Angioi-Duprez, K., Berrod, J. P., & Conart, J. B. (2021). Outcomes of combined phacoemulsification and pars plana vitrectomy for rhegmatogenous retinal detachment: a comparative study. *Retina*, *41*(1), 68-74.
8. Mizuguchi, T., Horiguchi, M., Ito, Y., Sakurai, R., Yata, K., & Tanikawa, A. (2026). Risk factors for re-detachment after 25-gauge pars plana primary vitrectomy for rhegmatogenous retinal detachment: a retrospective observational single-center study. *Japanese Journal of Ophthalmology*, *70*(2), 351-357.
9. Ma, J., Wang, Q., & Niu, H. (2020). Comparison of 27-gauge and 25-gauge microincision vitrectomy surgery for the treatment of vitreoretinal disease: a systematic review and meta-analysis. *Journal of ophthalmology*, *2020*(1), 6149692.
10. Duong, R. T., Cai, X., Ambati, N. R., & Shildkrot, Y. E. (2023). Clinical Outcomes of 27-Gauge Pars Plana Vitrectomy for Diabetic Tractional Retinal Detachment Repair. *Journal of vitreoretinal Diseases*, *7*(4), 281-289.
11. Tang, Y., Lin, B., Chen, J., Chen, D., & Wu, R. (2022). Outcomes of 25-gauge pars plana vitrectomy alone with air tamponade for the management of rhegmatogenous retinal detachment with inferior breaks. *BMC ophthalmology*, *22*(1), 213.

12. Saleh, O. A., Alshamarti, S. A., & Abu-Yaghi, N. E. (2020). Comparison of characteristics and clinical outcomes in 27-gauge versus 23-gauge vitrectomy surgery. *Clinical Ophthalmology*, 1553-1558.
13. Chen, P. L., Chen, Y. T., & Chen, S. N. (2021). Comparison of 27-gauge and 25-gauge vitrectomy in the management of tractional retinal detachment secondary to proliferative diabetic retinopathy. *PLoS One*, *16*(3), e0249139.
14. Li, Y., Cheung, N., Jia, L., Zhang, H., & Liu, N. (2020). Surgical outcomes of 25-gauge pars plana vitrectomy using air as an internal tamponade for primary rhegmatogenous retinal detachment. *Retina*, *40*(11), 2077-2082.
15. Amara, A., Bernabei, F., Chawki, M. B., Buffet, J., Adam, R., Akesbi, J., ... & Rothschild, P. R. (2022). Comparison between air and gas as tamponade in 25-gauge pars plana vitrectomy for primary superior rhegmatogenous retinal detachment. *Eye*, *36*(10), 2028-2033.
16. Shen, P., Kong, X., Chen, G., Jiang, J., Yan, S., Lu, X., & He, M. (2022). 25-Gauge pars plana vitrectomy combined with air tamponade for primary rhegmatogenous retinal detachment. *Journal of International Medical Research*, *50*(12), 03000605221139702.
17. Han, G., Huang, W., He, L., Wei, H., Wei, L., & Huang, H. (2024). The efficacious combined treatment of rhegmatogenous retinal detachment (PVR≤ C2) with inferior breaks using 25-gauge pars plana vitrectomy and air tamponade. *Medicine*, *103*(39), e39555.
18. Tetsumoto, A., Imai, H., Hayashida, M., Otsuka, K., Matsumiya, W., Miki, A., & Nakamura, M. (2020). The comparison of the surgical outcome of 27-gauge pars plana vitrectomy for primary rhegmatogenous retinal detachment between air and SF6 gas tamponade. *Eye*, *34*(2), 299-306.
19. Huang, R. S., Mihalache, A., Lau, T. H. A., Popovic, M. M., Kertes, P. J., & Muni, R. H. (2024). Pars plana vitrectomy with silicone oil or gas tamponade for uncomplicated retinal detachment: a systematic review and meta-analysis. *American Journal of Ophthalmology*, *266*, 144-155.
20. Elghawy, O., Duong, R., Nigussie, A., Bogaard, J. D., Patrie, J., & Shildkrot, Y. (2022). Effect of surgical timing in 23-g pars plana vitrectomy for primary repair of macula-off rhegmatogenous retinal detachment, a retrospective study. *BMC ophthalmology*, *22*(1), 136.
21. Moharana, B., Dogra, M., Tigari, B., Singh, S. R., Katoch, D., Arora, A., & Singh, R. (2021). Outcomes of 25-gauge pars plana vitrectomy for cytomegalovirus retinitis-related retinal detachment. *Indian journal of ophthalmology*, *69*(9), 2361.
22. Mohamed, M. A. E. B., Abd EL-Hady, A. M., Elkareem, A. M. G., & Ali, K. I. (2022). Comparative study between Chandlier assisted 23, 25 and 27 gauge Bimanual Vitrectomy for Diabetic Tractional Retinal detachment and vitreous hemorrhage. *The Egyptian Journal of Hospital Medicine*, *89*(1), 5865-5870.
23. Elbaklish, K. H. (2021). 23-Gauge vitrectomy for retinal detachment with upper and lower retinal breaks A comparative study.
24. Stalmans, P. (2021). A comparative study of 23-gauge and 27-gauge vitrectomy for puckers or floaters, including evaluation of the effect of combined phaco-vitrectomy surgery on postoperative outcome. *Ophthalmologica*, *244*(3), 245-249.
25. Moussa, G., Mathews, N., Makhzoum, O., & Park, D. Y. (2022). Retinal detachment repair with vitrectomy: air tamponade integration to a vitreoretinal service, comparison with gas tamponade, and literature review. *Ophthalmic Surgery, Lasers and Imaging Retina*, *53*(2), 87-95.