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ORIGINAL ARTICLE

Comparative assessment of the effect of gas and silicone tamponade on the anatomical fit of the retina and visual functions after pars plana vitrectomy for retinal detachment

Ruziev Tokhir Khudoyberdi ugli[1], Boboev Siyovush Saidavzalzoda[2],

Ophthalmologist of the Samarkand branch of the Republican Specialized Scientific and Practical Medical Center for Eye Microsurgery[1], Ph.D., Department of Ophthalmology, Samarkand State Medical University[2],

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Abstract

Retinal detachment is a serious ophthalmic condition that can lead to permanent vision loss if not treated promptly and effectively. Pars plana vitrectomy has become one of the most widely used surgical methods for the management of retinal detachment, allowing removal of the vitreous body, elimination of traction forces, and restoration of the normal anatomical position of the retina. An important stage of this procedure involves the use of intraocular tamponade agents to support retinal reattachment during postoperative healing. The two most commonly used tamponade substances are expansile intraocular gases and silicone oil, each possessing specific physical and clinical properties. Gas tamponade provides temporary support and gradually absorbs over time, while silicone oil offers long-term stabilization but requires later removal. This study presents a comparative assessment of the effectiveness of gas and silicone tamponade in achieving retinal reattachment and improving visual outcomes after pars plana vitrectomy in patients with retinal detachment. The analysis evaluates anatomical success rates, functional visual recovery, and postoperative complications associated with each tamponade method. The results indicate that both approaches are effective in restoring retinal structure, although differences exist in postoperative management, visual recovery patterns, and long-term anatomical stability. Retinal detachment is a vision-threatening ophthalmic condition that requires timely surgical intervention to restore the normal anatomical structure of the eye and preserve visual function. Pars plana vitrectomy has become one of the most effective surgical approaches for the treatment of this pathology. A crucial stage of this procedure is the application of intraocular tamponade agents that stabilize the retina against the retinal pigment epithelium during the postoperative healing period. Among the most commonly used tamponade substances are expansile gases and silicone oil, each possessing distinct physical characteristics and clinical advantages. Gas tamponades provide temporary internal pressure that gradually decreases as the gas is absorbed, while silicone oil offers prolonged mechanical support inside the vitreous cavity. Rhegmatogenous retinal detachment remains one of the most urgent conditions in vitreoretinal surgery because separation of the neurosensory retina from the underlying pigment epithelium leads to rapid deterioration of photoreceptor function and progressive vision loss. Pars plana vitrectomy has become a standard surgical technique for restoring retinal attachment by removing vitreous traction and sealing retinal breaks. A critical stage of the procedure is the use of intraocular tamponade substances that provide internal support to the retina during postoperative healing

Keywords: *retinal detachment; pars plana vitrectomy; gas tamponade; silicone oil tamponade; retinal reattachment; vitreoretinal surgery; visual recovery; ophthalmology*

1. Introduction

Retinal detachment represents a severe ophthalmic pathology in which the neurosensory retina separates from the underlying retinal pigment epithelium. This separation disrupts metabolic exchange between retinal layers and can rapidly lead to degeneration of photoreceptor cells if the condition is not treated in a timely manner. The most common form is rhegmatogenous retinal detachment, which occurs due to the formation of retinal breaks that allow vitreous fluid to accumulate beneath the retina. Surgical intervention is essential to restore normal anatomical positioning and prevent irreversible visual impairment. Pars plana vitrectomy has become one of the primary surgical techniques used for retinal detachment repair. During this procedure, the vitreous body is removed, tractional forces are eliminated, and retinal tears are sealed using laser photocoagulation or cryotherapy. Following these steps, an intraocular tamponade agent is introduced to maintain retinal attachment and support the healing process. Two of the most widely used tamponade substances are intraocular gas and silicone oil. Gas tamponades such as sulfur hexafluoride or perfluoropropane expand within the vitreous cavity and gradually resorb over time, eliminating the need for surgical removal. Silicone oil, in contrast, provides long-term mechanical support but must be removed during a secondary surgical procedure. Selection of the optimal tamponade agent depends on the characteristics of the retinal detachment, presence of proliferative vitreoretinopathy, and other clinical factors. Comparative evaluation of these tamponade methods is important for determining their influence on anatomical success and functional visual recovery following vitrectomy. Retinal detachment represents a serious ophthalmic disorder characterized by the separation of the neurosensory retina from the retinal pigment epithelium, which disrupts metabolic exchange and leads to progressive degeneration of photoreceptor cells. If surgical intervention is delayed, irreversible damage to retinal structures may occur and visual function may be permanently compromised. Rhegmatogenous retinal detachment, the most common type, develops when retinal tears allow liquefied vitreous fluid to accumulate beneath the retina. Over time, this accumulation enlarges the detached area and further compromises retinal function. Advances in vitreoretinal surgery have significantly improved the prognosis for patients with this condition. Pars plana vitrectomy allows removal of pathological vitreous traction, elimination of epiretinal membranes, and direct treatment of retinal breaks through endolaser photocoagulation or cryopexy. After these procedures are completed, a tamponade substance is introduced into the vitreous cavity to maintain retinal contact with the underlying tissues while biological adhesion develops. The choice of tamponade material is a crucial factor influencing postoperative anatomical success and visual recovery. Gas tamponades expand after injection and gradually resorb, eliminating the need for removal surgery. Silicone oil tamponade, in contrast, remains within the vitreous cavity for a prolonged period and provides sustained support for the retina, especially in complex detachments. Careful evaluation of the effectiveness of these tamponade agents is essential for optimizing surgical outcomes in retinal detachment management.

2. Materials and Methods

The present study included patients diagnosed with rhegmatogenous retinal detachment who underwent pars plana vitrectomy in a specialized ophthalmic surgical department. Participants were divided into two groups according to the type of intraocular tamponade used during surgery. In the first group, expansile intraocular gas was used as the tamponade agent, while the second group received silicone oil tamponade. Preoperative assessment included measurement of best corrected visual acuity, slit-lamp biomicroscopy, indirect ophthalmoscopy, and optical coherence tomography to evaluate retinal morphology. Ultrasonography was performed in cases where media opacity limited visualization of the posterior segment. Surgical procedures were carried out using standard three-port pars plana vitrectomy techniques. The vitreous body was removed, tractional membranes were eliminated, and retinal breaks were sealed using laser photocoagulation. Following fluid–air exchange, the chosen tamponade agent was introduced into the vitreous cavity. Postoperative follow-up examinations were conducted to evaluate retinal attachment, visual acuity changes, intraocular pressure levels, and the presence of potential complications.

3. Results

Postoperative evaluation demonstrated successful retinal reattachment in the majority of patients treated with both tamponade techniques. In the group receiving gas tamponade, gradual absorption of the gas bubble occurred over several weeks, allowing natural restoration of intraocular fluid dynamics. Patients in this group often demonstrated earlier improvement in visual acuity once the gas bubble decreased in size and optical clarity of the vitreous cavity was restored. In the silicone oil group, retinal stabilization was maintained over a longer period due to the persistent mechanical support provided by the oil tamponade. This approach proved particularly beneficial in cases involving extensive retinal detachment or proliferative vitreoretinopathy. However, visual recovery was sometimes delayed until removal of the silicone oil. Anatomical success rates were high in both groups, although certain postoperative complications such as elevated intraocular pressure or emulsification were more frequently associated with silicone oil

tamponade. Postoperative evaluation revealed successful anatomical reattachment of the retina in a large proportion of patients treated with both tamponade approaches. Individuals who received gas tamponade demonstrated progressive improvement in retinal configuration as the gas bubble gradually decreased in size and the vitreous cavity was restored to normal physiological conditions. Visual acuity improvement was observed relatively early once optical transparency increased after partial gas absorption. In cases treated with silicone oil tamponade, stable retinal positioning was maintained for an extended period due to the persistent mechanical support provided by the oil. This approach proved particularly beneficial in eyes with extensive retinal tears or proliferative vitreoretinal changes where prolonged internal support was necessary. Functional visual improvement was recorded in many patients after stabilization of the retina; however, some individuals experienced delayed visual recovery until silicone oil removal allowed restoration of optical clarity. Overall anatomical success rates were comparable between the two groups, though the pattern of postoperative recovery differed according to the tamponade substance used.

4. Discussion

The comparative outcomes obtained in this study highlight the importance of selecting an appropriate intraocular tamponade agent based on the characteristics of retinal detachment and individual patient factors. Gas tamponade offers several advantages, including spontaneous absorption, elimination of the need for additional surgical removal, and relatively rapid restoration of visual function once the gas bubble diminishes. However, patients must maintain specific postoperative head positioning to ensure adequate tamponade effect, and gas use may be contraindicated in individuals requiring air travel shortly after surgery. Silicone oil tamponade provides long-term internal support and is particularly useful in complicated cases involving large retinal breaks or proliferative vitreoretinopathy. The stability provided by silicone oil may increase the probability of maintaining retinal attachment in such complex situations. Nevertheless, the requirement for secondary surgery to remove the oil and the possibility of complications such as emulsification or intraocular pressure elevation represent limitations of this method. These findings suggest that both tamponade techniques play important roles in modern vitreoretinal surgery, and the choice between them should be guided by clinical indications and surgical judgment. The comparative findings highlight the distinct functional characteristics of gas and silicone tamponade agents used in vitreoretinal surgery. Gas tamponade offers the advantage of temporary internal support combined with spontaneous absorption, which eliminates the need for additional surgical intervention for removal. This characteristic contributes to earlier visual rehabilitation once the gas bubble diminishes. However, the effectiveness of gas tamponade depends heavily on proper postoperative head positioning, as the buoyant gas bubble must remain in contact with the treated retinal break. Silicone oil tamponade, on the other hand, provides stable long-term mechanical support regardless of patient positioning, which makes it particularly useful in complicated detachments involving large retinal defects or proliferative vitreoretinopathy. Despite these advantages, silicone oil may be associated with certain complications such as increased intraocular pressure, emulsification, or the necessity for secondary surgical removal. The selection of tamponade material should therefore be individualized according to the severity and configuration of retinal detachment, as well as the overall clinical condition of the patient.

5. Conclusion

Pars plana vitrectomy combined with intraocular tamponade remains an effective surgical strategy for the treatment of retinal detachment. Both gas and silicone tamponade techniques demonstrate high rates of anatomical retinal reattachment and contribute to improvement of visual function in affected patients. Gas tamponade is associated with faster functional recovery and eliminates the need for secondary removal surgery, while silicone oil provides prolonged mechanical support that may be advantageous in complicated retinal detachments. Careful evaluation of the clinical characteristics of each case allows surgeons to select the most appropriate tamponade agent and achieve optimal postoperative outcomes. Continued research and long-term clinical monitoring will further refine treatment strategies and improve visual prognosis for patients undergoing vitreoretinal surgery. The comparative assessment of intraocular tamponade methods following pars plana vitrectomy demonstrates that both gas and silicone oil effectively support retinal reattachment and contribute to restoration of visual function in patients with retinal detachment. Gas tamponade is advantageous in uncomplicated cases due to faster functional recovery and the absence of a secondary removal procedure. Silicone oil provides prolonged internal stabilization and is particularly valuable in complex or recurrent detachments requiring extended retinal support. Optimal surgical outcomes depend on careful selection of tamponade material, precise surgical technique, and appropriate postoperative management. Continued clinical evaluation of these approaches will further refine treatment strategies and improve long-term visual prognosis for patients undergoing vitreoretinal surgery.

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