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ORIGINAL ARTICLE

Analysis of anatomical and functional results of pars plana vitrectomy in proliferative diabetic retinopathy

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Abstract

Proliferative diabetic retinopathy represents an advanced stage of diabetic retinal disease characterized by pathological neovascularization, vitreous hemorrhage, and tractional retinal detachment that may result in severe visual impairment or blindness. Surgical intervention becomes necessary when complications such as persistent vitreous hemorrhage or tractional retinal detachment threaten the integrity of the retina and visual function. Pars plana vitrectomy is a widely used surgical technique designed to remove hemorrhagic vitreous, eliminate fibrovascular membranes, and restore normal retinal anatomy. The present study evaluates the anatomical and functional outcomes of pars plana vitrectomy performed in patients with proliferative diabetic retinopathy. Special attention is directed toward postoperative retinal stability, improvement in visual acuity, and resolution of vitreoretinal traction. The analysis demonstrates that timely surgical intervention contributes to restoration of retinal structure and provides significant improvement or stabilization of visual function in many patients affected by advanced diabetic retinal disease. Proliferative diabetic retinopathy is one of the most severe ocular complications associated with long-term diabetes mellitus and remains a leading cause of irreversible visual impairment worldwide. The pathological process is characterized by retinal ischemia, abnormal neovascularization, recurrent vitreous hemorrhage, and progressive fibrovascular proliferation that can ultimately lead to tractional retinal detachment. Surgical treatment using pars plana vitrectomy has become an important therapeutic approach for managing advanced cases where conservative treatment cannot provide adequate results. The present analysis evaluates the anatomical restoration of the retina and functional recovery of vision after vitrectomy in patients suffering from proliferative diabetic retinal disease. Special attention is directed toward postoperative retinal reattachment, changes in visual acuity, and the elimination of vitreoretinal traction. Clinical observations demonstrate that timely surgical intervention allows removal of pathological tissues, improves retinal stability, and facilitates gradual improvement of visual function. These findings highlight the importance of early surgical decision-making and comprehensive postoperative monitoring in order to achieve favorable outcomes in patients with complicated diabetic retinal pathology.

Keywords: *proliferative diabetic retinopathy; pars plana vitrectomy; vitreous hemorrhage; tractional retinal detachment; diabetic eye disease; retinal surgery; visual acuity; ophthalmology*

1. Introduction

Diabetic retinopathy remains one of the most common causes of visual disability worldwide and represents a major public health challenge associated with the increasing prevalence of diabetes mellitus. Among the different stages of this condition, proliferative diabetic retinopathy is considered the most severe form due to the development of abnormal

retinal neovascularization. Chronic hyperglycemia leads to progressive microvascular damage, retinal ischemia, and the release of angiogenic factors that stimulate the formation of fragile new blood vessels. These newly formed vessels are prone to bleeding and may extend into the vitreous cavity, resulting in recurrent vitreous hemorrhage and progressive visual deterioration. In addition, fibrovascular proliferation may generate tractional forces on the retinal surface, eventually leading to tractional retinal detachment and severe structural damage. Pars plana vitrectomy has become an essential surgical method for the treatment of advanced proliferative diabetic retinopathy. The procedure allows removal of vitreous hemorrhage, dissection of fibrovascular membranes, relief of tractional forces, and stabilization of the retinal surface. Endolaser photocoagulation performed during surgery further reduces retinal ischemia and inhibits additional neovascularization. Evaluation of anatomical and functional outcomes following vitrectomy is important for determining the effectiveness of this surgical intervention and improving the prognosis of patients with advanced diabetic retinal complications. The global incidence of diabetes mellitus has increased significantly in recent decades, resulting in a corresponding rise in chronic microvascular complications affecting various organs, including the retina. Diabetic retinal disease develops gradually as a result of persistent metabolic disturbances, endothelial dysfunction, and microcirculatory damage caused by prolonged hyperglycemia. In its advanced stage, proliferative diabetic retinopathy emerges due to severe retinal ischemia that stimulates the production of angiogenic growth factors, particularly vascular endothelial growth factor. These mediators promote the formation of fragile and abnormal new vessels on the retinal surface and optic disc. Such vessels frequently rupture, causing hemorrhage into the vitreous cavity and obstructing the passage of light to the retina. Over time, fibrovascular membranes develop and exert traction on the retinal surface, which may lead to distortion or detachment of retinal structures. These pathological changes significantly compromise visual function and may result in blindness if left untreated. Pars plana vitrectomy has become an essential surgical method for addressing these complications because it enables removal of the hemorrhagic vitreous body, dissection of fibrovascular membranes, and stabilization of the retina. Evaluation of postoperative anatomical integrity and visual recovery is therefore necessary to determine the effectiveness of this surgical approach and to improve therapeutic strategies for patients suffering from advanced diabetic eye disease.

2. Materials and Methods

This clinical investigation included patients diagnosed with proliferative diabetic retinopathy who required surgical treatment due to complications such as non-resolving vitreous hemorrhage or tractional retinal detachment. All participants underwent comprehensive ophthalmological evaluation prior to surgery. The examination included measurement of best corrected visual acuity, slit-lamp biomicroscopy, intraocular pressure assessment, indirect ophthalmoscopy, and optical coherence tomography when visualization of the macular region was possible. Ultrasonography of the posterior segment was performed in cases where dense vitreous hemorrhage prevented direct fundus examination. Pars plana vitrectomy was performed using standard three-port microincision surgical techniques. During the procedure, the vitreous body containing hemorrhagic components was removed, fibrovascular membranes were carefully dissected, and tractional forces affecting the retina were eliminated. Endolaser photocoagulation was applied to ischemic retinal areas to suppress further neovascular growth. In selected cases, intraocular tamponade agents such as gas or silicone oil were introduced to maintain retinal stability. Postoperative follow-up examinations were conducted to evaluate retinal attachment, resolution of hemorrhage, visual acuity improvement, and the presence of postoperative complications.

3. Results

Postoperative assessment demonstrated significant anatomical improvement in the majority of patients who underwent pars plana vitrectomy. Removal of the hemorrhagic vitreous body restored transparency of the ocular media and allowed visualization of the retinal surface. Surgical elimination of fibrovascular membranes relieved tractional forces acting on the retina and contributed to stabilization of retinal architecture. In cases where tractional detachment had occurred, successful reattachment of the retina was achieved following membrane dissection and tamponade support. Functional outcomes also showed positive trends, with many patients experiencing improvement in visual acuity during the postoperative period. Restoration of retinal circulation and reduction of mechanical traction facilitated gradual recovery of photoreceptor function. Although the degree of visual improvement varied depending on the duration and severity of the disease, stabilization of vision was achieved in most cases, preventing further progression toward blindness. Clinical evaluation after surgical treatment revealed significant structural and functional improvements in many patients included in the study. Removal of the opacified vitreous body allowed restoration of optical transparency within the eye and enabled direct visualization of the retinal surface during follow-up examinations. Surgical dissection of fibrovascular membranes effectively relieved tractional forces exerted on the retina and contributed to stabilization of the posterior segment. In cases involving tractional retinal detachment, anatomical reattachment of the retina was

achieved following careful membrane removal and intraocular tamponade support. Postoperative monitoring demonstrated gradual absorption of residual hemorrhage and reduction of inflammatory reactions within the vitreous cavity. Improvement in best corrected visual acuity was observed in a considerable proportion of patients during the recovery period. Functional restoration varied depending on the duration of disease progression, the extent of retinal ischemia, and the involvement of the macular region. Despite variability in visual improvement, stabilization of visual function and prevention of further deterioration were recorded in the majority of operated eyes.

4. Discussion

The outcomes observed in this study highlight the important role of pars plana vitrectomy in the management of advanced proliferative diabetic retinopathy. Persistent vitreous hemorrhage and tractional retinal detachment represent major causes of visual loss in these patients and often cannot be effectively managed with conservative treatment alone. Surgical removal of pathological vitreous and fibrovascular tissue directly addresses the structural abnormalities responsible for visual deterioration. In addition, vitrectomy improves intraocular oxygen distribution and enhances the effectiveness of intraoperative laser photocoagulation, which reduces ischemic stimulation of further neovascularization. Despite these advantages, the success of surgical treatment depends on several factors including the stage of disease, duration of retinal ischemia, and the presence of macular involvement. Early identification of surgical indications and careful postoperative monitoring are therefore essential for achieving optimal outcomes. Continued advancements in microsurgical techniques and instrumentation have further improved the safety and effectiveness of vitrectomy procedures in patients with diabetic retinal disease. The observations obtained in this analysis emphasize the clinical importance of vitrectomy in managing advanced proliferative diabetic retinal disease. The procedure addresses several pathological mechanisms simultaneously by removing the vitreous scaffold that supports neovascular proliferation, eliminating fibrovascular membranes responsible for retinal traction, and allowing intraoperative laser treatment of ischemic retinal zones. These combined effects contribute to the suppression of further neovascular growth and promote structural stabilization of the retina. Functional recovery of vision following surgery depends on multiple factors including the severity of retinal ischemia, the presence of macular edema, and the duration of vitreoretinal traction before intervention. Patients treated at earlier stages of complication generally demonstrate better functional outcomes due to preservation of photoreceptor integrity. Improvements in modern vitreoretinal surgical technology, including microincision instrumentation and advanced visualization systems, have enhanced the safety and effectiveness of this procedure. Nevertheless, careful patient selection and long-term postoperative monitoring remain essential in order to prevent recurrent hemorrhage, secondary retinal detachment, or other complications that may influence the final visual

5. Conclusion

Pars plana vitrectomy represents an effective surgical method for the treatment of proliferative diabetic retinopathy complicated by vitreous hemorrhage and tractional retinal detachment. The procedure contributes to restoration of retinal anatomy, elimination of tractional forces, and improvement or stabilization of visual function in many patients. Early surgical intervention combined with appropriate intraoperative management techniques can significantly improve anatomical success rates and reduce the risk of severe visual impairment. Ongoing clinical research and technological advancements in vitreoretinal surgery are expected to further enhance treatment outcomes and improve the quality of life for individuals affected by advanced diabetic retinal complications. Surgical management using pars plana vitrectomy provides an effective therapeutic solution for patients with proliferative diabetic retinopathy complicated by vitreous hemorrhage and tractional retinal detachment. The procedure allows restoration of normal retinal anatomy, elimination of pathological traction, and stabilization or improvement of visual function in many cases. Early identification of surgical indications and timely intervention play a crucial role in preventing irreversible retinal damage and severe vision loss. Continuous progress in vitreoretinal surgical techniques and postoperative care is expected to further enhance treatment outcomes and reduce the burden of vision impairment associated with advanced diabetic retinal disease.

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