Surgical Management in Advanced Stages of Retinopathy of Prematurity; Our Experience

Ramak Roohipoor, MD; Reza Karkhaneh, MD; Mohammad Riazi-Esfahani, MD
Fariba Ghasemi, MD; Mehdi Nili-Ahmadabadi, MD

Farabi Eye Hospital, Tehran Medical University, Tehran, Iran

Retinopathy of prematurity is a potentially blinding condition. In this article we describe the surgical management for advanced stages of the disease (stages 4 and 5). Indications, options and alternative techniques are described through a review of articles and our personal experience.

Key words: Retinopathy of Prematurity (ROP), Surgical Technique, Scleral Buckling, Vitrectomy

INTRODUCTION

Retinopathy of prematurity (ROP) is a preventable but potentially blinding condition.[1] Premature infants have been screened at our center since 1997 and unfortunately, the overall incidence of ROP and that of advanced stages (4 and 5) of the disease are increasing.[2-4] Despite improvements in screening protocols, peripheral laser ablation, microsurgical techniques and instrumentation, ROP still progresses to retinal detachment (RD) and blindness in 15% to 30% of all involved eyes.[5,6] Advanced stages of ROP (4 and 5) usually require surgical intervention.[7] Premature infants with ROP need timely treatment because of the critical period of visual development.[8]

Several procedures have been described to treat ROP-associated RDs, including open-sky vitrectomy, scleral buckling, closed vitrectomy and lensectomy with or without scleral buckling, and more recently, lens sparing vitrectomy without scleral buckling.[9] Herein we present a review on the options and techniques for surgical management of advanced stages of ROP and describe our experience in this regard.

SCLERAL BUCKLING

Scleral buckling is a well established technique for repair of RD and is also used for ROP related RDs. It mechanically reattaches the retina by counteracting the forces exerting traction on the retina.[10] Although controversy exists on the choice of scleral buckling versus vitrectomy[11-18] for stage 4 ROP, scleral buckling is still used particularly when traction exists anterior to the equator.[19]

The technique of scleral buckling in our patients involves placement of an encircling exoplant (2.5 mm # 240 solid silicone band) as close to the ridge as possible. The band is secured with intrascleral 5-0 polyester suture and tightened to achieve moderate-height buckle effect. Since subretinal fluid drainage is not routinely performed, anterior chamber paracentesis is usually needed to soften the eye.

Encircling buckles induce myopic refractive changes due to axial elongation and forward shift of the crystalline lens.[20] The average induced myopia is -2.75 D in adults,[21] but much greater in infants ranging from -9 to -11.0 D[20,22] which is potentially amblyogenic. Divi-sion or

removal of the exoplant is recommend-ed when stable retinal reattachment is achie-ved[22] to reduce the risk of intrusion and pro-mote eye growth.[11,16] We usually remove the exoplant after 6 months if retinal reattachment is stable or in cases of anisometropia, however it seems logical to delay exoplant removal in unstable situations. Concerns regarding ambly-opia with scleral buckling have led to a pre-ference for vitrectomy in stage 4 ROP.[13,23]
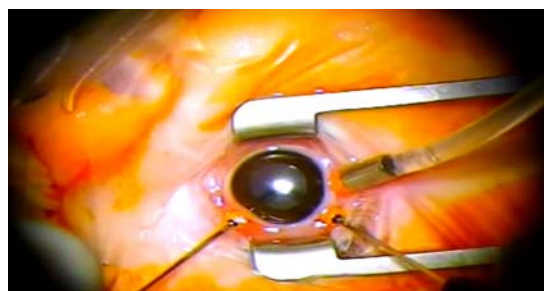
VITRECTOMY

Vitrectomy in advanced stages (4 or 5) of ROP may confer advantages; however it poses specific challenges to the surgeon.[24,25] Vitrec-tomy may be performed in a closed or open system setting, the former is used more com-monly. Open-sky vitrectomy allows direct access to posterior segment structures after re-moval of the cornea and lens. In this technique, the cornea is trephined and the lens is removed intracapsularly, allowing sharp dissection of retrolental membranes. During surgery, an ophthalmic viscosurgical device such as Healon is used to improve visualization, separate the retina and allow posterior dissection. Open-sky vitrectomy offers advantages of bimanual dis-section through a large anterior incision and the possibility of surgery in eyes with cloudy corneas.[26-28] Nowadays, closed system surgery is preferred; a three-port system permits the surgeon to switch hands in order to perform anterior dissection without the risk of transient hypotony.[29] Vitrectomy can be performed with the aid of a contact lens, binocular indirect oph-thalmomicroscope system, or by direct visu-alization using the operating microscope.

Vitrectomy in neonates differs from adults in several aspects:[30] (1) the entry site should be through the pars plicata rather than pars plana;[31,32] (2) the lens is relatively larger; (3) posterior vitreous detachment (PVD) cannot be achieved easily; (4) breaks are extremely poorly tolerated and are rarely repaired successfully; (5) cyclitic and pupillary membranes are com-mon; (6) additional causes for structural failure include iridoretinal and retinal-retinal adhe-sions; (7) subretinal hemorrhage or exudation and retinal pigment epithelium degeneration

may preclude favorable functional outcomes; and (8) maximal functional development may take years to achieve.

At the onset of operation, the patient un-dergoes full eye examination. If there is enough space to enter the globe through the pars pli-cata together with a free retrolental space, pars plicata vitrectomy is performed; otherwise lim-bal vitrectomy with lensectomy is preferred. Mechanical induction of PVD is not possible and only membranes causing traction should be released and segmented as far as possible using a vitrector (20-, 23- or 25-gauge) or scissors (horizontal or vertical). Extensive mem-branectomy is not possible and not recom-mended; we cut or remove membranes as much as possible and try to avoid iatrogenic breaks. We prefer a 23-gauge vitrectomy sys-tem because of its appropriate size and possi-bility of releasing peripheral tractions (Fig. 1). It may be difficult to remove all peripheral trac-tions by 25-gauge vitrectomy because of instru-ment flexibility which limits appropriate ma-neuvers. Once the tractions are relieved, retinal reattachment is achieved and intraocular tam-ponade is not routinely used. The patients are examined one day after surgery, weekly for 3 weeks, monthly up to 6 months, and every 6 months thereafter. In the case of partial re-attachment, reoperations may be considered when persistent tractions exist.

Figure 1 Twenty-three gauge vitrectomy in a patient with stage 5 retinopathy of prematurity.

In our recent experience, the operation is facilitated by the use of autologous plasmin (unpublished data). In future, enzyme assisted vitrectomy may become a basic component of ROP surgery. For preparation of autologous plasmin, blood is centrifuged at 4,000 rounds

per minute for 15 minutes to obtain complete sedimentation; 1.5 ml of plasma is aspirated under aseptic conditions and transferred into a vial of streptokinase (750,000 IU) already incubated at 37°C for 15 minutes. The vial is shaken gently for 3 to 5 minutes and the solution is incubated at 37°C for 10 more minutes; 0.2 ml of this preparation is used for intravitreal injection 15 minutes prior to surgery during induction of anesthesia.[33]

DISCUSSION

Advantages of vitrectomy in stage 4 ROP include removing endogenous vasodilators and angiogenic factors such as vascular endothelial growth factor (VEGF) from the vitreous cavity in addition to releasing anteroposterior tractions.[19] Both scleral buckling[11,16] and vitrectomy[15,34] have been used to manage advanced ROP; in the past scleral buckling was the treatment of choice and vitrectomy was considered only if buckling had failed. Nowadays, primary vitrectomy is preferred for stage 4 ROP.[5,35] Anatomic success rates vary depending on surgical technique (vitrectomy versus buckling) and stage of detachment (4A or 4B).[16-18] Important drawbacks to scleral buckling which adversely affect the functional outcomes include lower anatomical success rates (60%-75%),[11,12,15–17] need for a secondary procedure to divide or remove the encircling element,[22] and induction of severe myopia and anisometropia with the resulting risk of amblyopia. Outcomes of vitrectomy in stage 4 ROP are more favorable[13,18,19,29,36,37] (90% success with mean follow-up of 1 year) as compared to scleral buckling procedures.[12-14,29,36,37] Although scleral buckling procedures may provide a greater anatomic success rate as compared to untreated eyes, studies have revealed that lens-sparing vitrectomy (LSV) may be superior to scleral buckling in terms of anatomical and functional success rates.[12-15]

Advantages of vitrectomy for advanced ROP with RD consist of addressing the traction directly without need for a second procedure, avoiding compression of anterior segment structures and anatomic distortion, and less induced myopia.[38] In stage 4 ROP, initial LSV

achieves retinal reattachment more often than scleral buckling with anatomic success rates of 82–97%.[9,18,36,39] Vitreoretinal surgery is usually employed for treatment of stage 5 ROP.[25] Despite relatively acceptable rates of retinal reattachment, functional outcomes have been poor.[15,34,40-43] However, taking into account that untreated stage 5 ROP ends in blindness,[43] vitreoretinal surgery is recommended.

Our understanding of the indications, timing and techniques for surgical management of ROP continues to evolve.[7] In our practice, vitrectomy is performed for stage 4 ROP and also for stage 5 in special situations. The choice of scleral buckling versus vitrectomy depends on the stage of ROP, retrolental involvement, vascular activity of the disease (existing plus disease or neovascularization) and presence of an exudative component. In stage 4 ROP, in case of anteroposterior traction and adequate retrolental space for releasing peripheral tractions without removing the lens, we prefer lens sparing vitrectomy; on the other hand with peripheral tractions we prefer scleral buckling. In stage 5 ROP, we routinely perform vitrectomy (Fig. 2) except in exudative forms, for which scleral buckling and intravitreal medications (anti-VEGF with or without corticosteroids) are preferred. Scleral buckling together with vitrectomy may be used for advanced cases of stage 5 ROP. Our algorithm for treatment of advanced stages of ROP is presented in Figure 3.
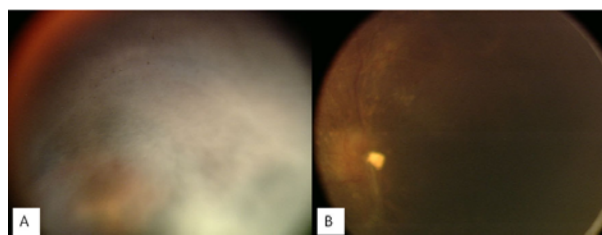
Figure 2 Pre- (A) and post-vitrectomy (B) fundus photographs in a patient with stage 5 retinopathy of prematurity.

In an unpublished study, we used combined procedures (scleral buckling and 25-gauge vitrectomy) in 21 eyes with stage 5 ROP. Retinal reattachment was achieved completely in 52.3% (success rate) and partially in 23.8% of

eyes. Redetachment occurred in three eyes during one year. Success was correlated with disease activity and preoperative treatment (laser therapy or intravitreal bevacizumab). Final reattachment rate was 38%, which is consistent with some previous reports.[25] Because of substantial heterogeneity in patient population and severity of the disease, it is difficult to compare the findings of different studies. Most studies include different stages of ROP and utilize different surgical techniques, which may explain differences in success rates.
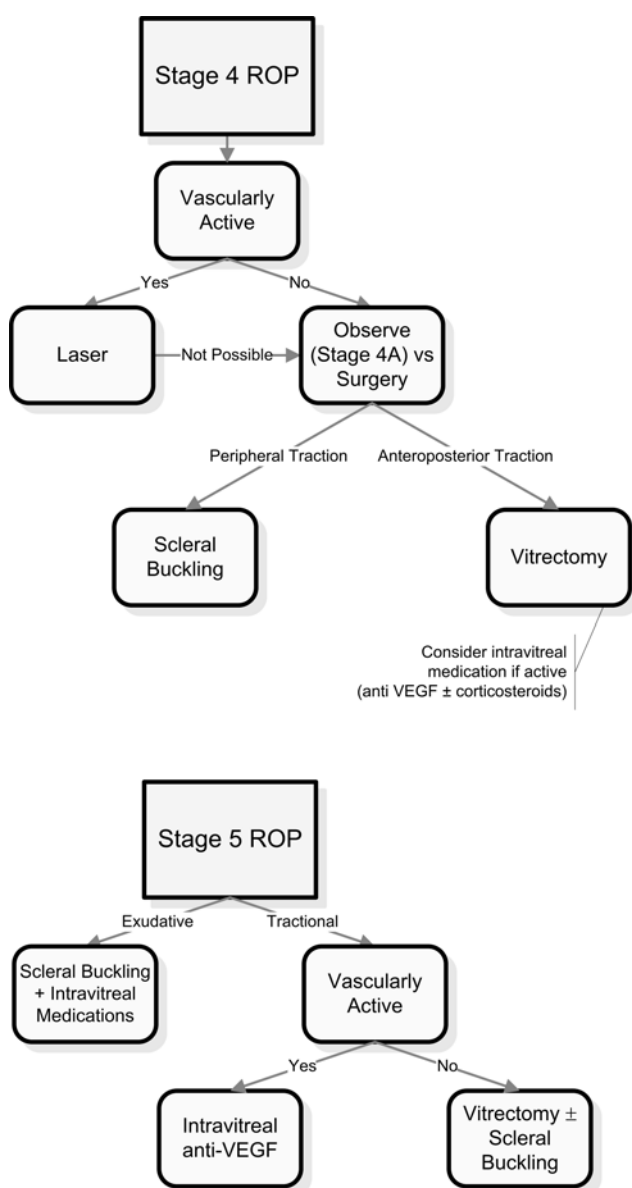
Dilated vessels in the iris and retina indicate disease activity. We usually use intravitreal bevacizumab in vascularly active disease (unpublished data). Anti-VEGF pharmacotherapy may help as preoperative adjuvant treatment. Vascularly active disease is a significant risk factor for failure of retinal reattachment especially in stage 5 ROP and portends a poor prognosis.[44] The poor visual outcome after lensectomy-vitrectomy procedures for RD due to ROP indicates that emphasis should be placed on prevention of RD in premature infants.[40-42] Despite relatively acceptable rates of retinal reattachment in stage 5 ROP, functional outcome has been poor.[15,23,34,40-42] Enzyme-assisted vitrectomy facilitates separation of the internal limiting membrane and posterior hyaloid membranes.[45] Tsukahara et al[46] reported complete reattachment of the posterior pole in all six consecutively treated eyes with stage 5 ROP.

Similar to Lakhanpal et al,[29] we manage ROP-related RDs through (1) observation, (2) scleral buckling alone, (3) vitrectomy alone, (4) vitrectomy plus scleral buckling, and (5) vitrectomy with lensectomy. The choice of technique depends on the location of the traction and the presence or absence of retina-lens apposition.

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VEGF, vascular endothelial growth factor

Figure 3 Our algorithm for management of advanced stages of retinopathy of prematurity.

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