THE TREATMENT OF ADVANCED DIABETIC EYE DISEASE

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Summary

PARS plana vitrectomy can be successfully used to treat complications resulting from proliferative diabetic retinopathy including nonabsorbing vitreous haemorrhage, recent traction or rhegmatogenous retinal detachment, and progressive fibrovascular proliferation. Vitreous surgery can be expected to result in improved vision in approximately 60-70% of these cases and approximately 50% of patients achieve navigational vision or better. If all the posterior cortical vitreous is removed no preretinal fibrovascular growth occurs after surgery. On the other hand, if nonatrophic, epiretinal fibrovascular membranes are not removed, they often undergo contraction after surgery and may detach or distort the adjacent retina. Pars plana vitrectomy is a complex surgical procedure with a significant complication rate, but it does offer a chance of vision in eyes that were hitherto considered untreatable and thus irrevocably blind.

Introduction

The surgical removal of vitreous from the eye has become one of the most dramatic developments in ophthalmic surgery in recent years. Posterior vitrectomy through the pars plana is used in traumatic vitreous haemorrhages, intraocular perforations and foreign bodies, complicated retinal detachments, and especially in diabetic vitreous haemorrhage. Most of these conditions were previously untreatable and resulted in hopelessly blind eyes.

Rationale for Vitrectomy in Diabetic Retinopathy

In proliferative diabetic retinopathy new vessels arising from the retina usually grow along its internal surface for many months without causing visual symptoms. Initially, the new vessels appear "bare", but after a variable period whitish "fibrous" tissue tends to appear adjacent to them. The vessels themselves frequently regress to some extent and, at the same time, fibrous tissue increases. At any stage in this process the new vessels and fibrous tissue may be pulled forward into the vitreous cavity by contraction either of the vitreous to which the new vessels are firmly adherent or of the fibrous tissue itself. At this stage a vitreous haemorrhage frequently occurs, often leading to marked impairment of vision. As traction is transmitted to the retina through the new vessels and associated fibrous tissue, retinal detachment may occur or the retina may be dragged horizontally or vertically. Detachment of the central retina at the macula leads to a marked loss of vision; dragging of the macula usually results in a less profound visual impairment.

During vitrectomy vitreous haemorrhage may be completely removed. In addition, removal of the preretinal fibrovascular proliferations, cutting of large fibrous tissue membranes into smaller segment, and the removal of the adherent posterior vitreous, if accomplished before extensive contraction has occurred, may reduce the risk of vitreous haemorrhage and retinal distortion or detachment. Removal of the detached

posterior vitreous surface, thus depriving new vessels of the scaffold along which they grow, may discourage their further proliferation.

Indications for Vitrectomy in the Treatment of Proliferative Diabetic Retinopathy

1. Non-resolving vitreous haemorrhage.
2. Traction retinal detachment involving the macula.
3. Complicated rhegmatogenous retinal detachment associated with proliferative diabetic retinopathy.

Vitreous Instrumentation

Machemer *et al* (1972) developed the vitreous infusion suction cutter (VISC), which was the first clinically proven instrument of its type. This instrument consisted of a micromotor; a rotating cutting mechanism in the tip of the vitreous instrument; and suction and infusion systems. It excised formed vitreous, while simultaneously replacing the vitreous volume with an infusion of saline solution. The fiberoptic sleeve could be placed over the instrument tip to provide intraocular illumination.

Other investigators have independently developed surgical instrumentation for pars plana vitrectomy (O'Malley and Heintz, 1972; Douvas, 1973; Kloeti, 1973; Peyman, 1973). The design and mechanical principles of these instruments differ, but they share the same common objective of providing an efficient cutting mechanism that can be introduced into the eye through a small incision and manipulated under direct visualisation (Fig. 1). The tissue within the eye is excised under direct visual control utilising a motorised operating microscope (Zeiss OPMI 6). This microscope provides zoom optics and is capable of

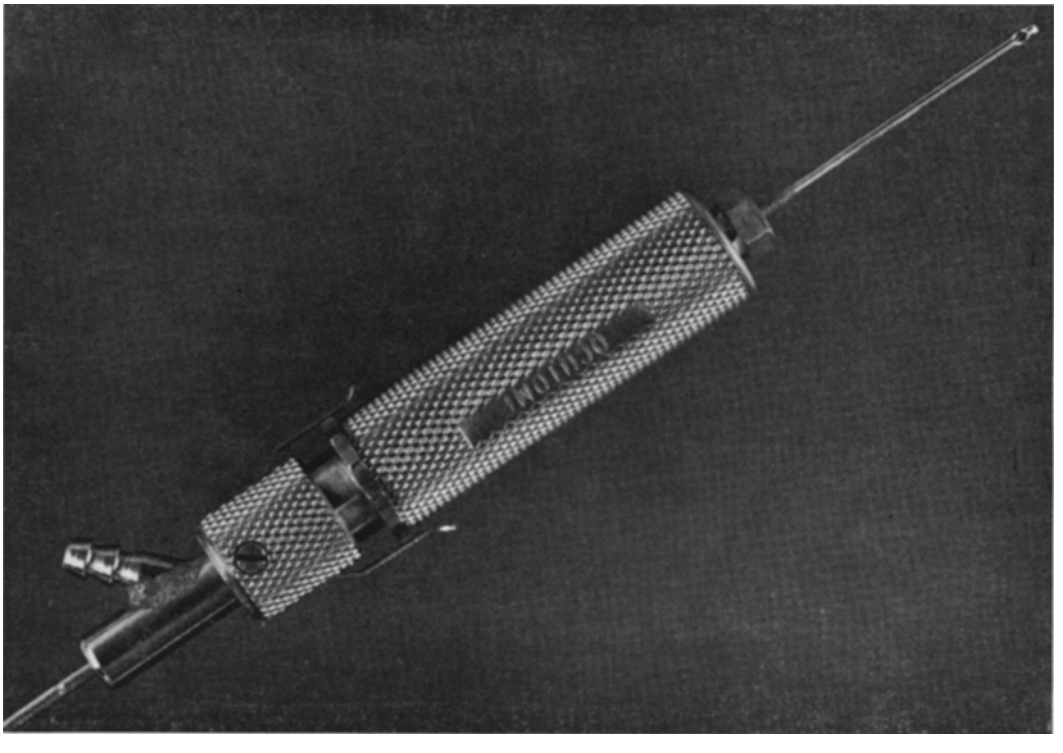

Fig. 1—The vitrectomy probe provides suction to aspirate the vitreous and a guillotine cutting mechanism to cut the vitreous.

two-dimensional, horizontal as well as up and down movement controlled by a foot pedal operated by the surgeon. With the addition of a modified contact lens and fiberoptic intraocular illumination, surgery can be carried out at the surface of the retina with reasonable safety.

In the course of clinically applying the above surgical techniques, a number of additional instruments and special technical manoeuvres have proved useful. These include instruments used for the dissection of fibrous membranes on the surface of the retina, intraocular diathermy and the use of temporary intraocular gas tamponade. Epiretinal fibrous membranes can often be mechanically separated from the retina using a needle with a hooked tip, or when these membranes are adherent to the retina, they may be divided with a microscissor thus relieving the traction on the retina.

Following vitrectomy, in eyes with retinal tears, intraocular gas can be effectively used to provide a temporary intraocular tamponade. Air and sulphur-hexafluoride gas have both been successfully used clinically (Norton, 1973). Sulphur-hexafluoride has the desirable property of remaining in the eye for about 7-10 days before the bubble begins to decrease significantly in size.

Surgical Concepts and Techniques for Vitrectomy

Concepts and surgical techniques employed in pars plana vitreo-retinal surgery were developed by Machemer (1972, 1974a, 1974b). Pars plana vitrectomy usually has four goals :

1. To create an optically clear vitreous cavity and remove the crystalline lens if significant lens opacities are present.
2. To cut all vitreous bands or sheets coursing in an anteroposterior direction in order to relieve or prevent traction between the vitreous base anteriorly and the optic nerve head or retina posteriorly.
3. To cut vitreous bands or sheets passing from one area of the retina to another (retino-vitreo-retinal bridges) that can produce a surface traction on the retina.
4. To separate epiretinal membranes from the surface of the retina if removal of the membrane would result in improved vision.

While attempting to achieve these mechanical goals, an effort is made to excise all of the cortical vitreous except that portion anterior to the equator in the region of the vitreous base. This is done to prevent post-operative contraction of the remaining vitreous which could cause traction on the retina. Also, during the operation any intraocular bleeding is stopped, and any retinal breaks are treated with cryotherapy and intraocular gas tamponade with or without scleral buckling.

Because of pre-existing cataract, removal of the lens is performed in many eyes undergoing vitrectomy. Also, removal of the lens may improve intraoperative visualisation of the posterior segment, and this can be important when performing delicate manoeuvres near the retina. In addition, removal of the lens facilitates healing of any subsequent vitreous haemorrhage by permitting the blood to reach the anterior chamber outflow channels more easily.

A soft cataract is readily removed through the pars plana using the suction and cutting features of the vitrectomy instruments. A hard lens may be managed by conventional cataract surgery techniques or may be removed through the pars plana incision using an ultrasound fragmenter. Ultrasonic vibrations readily disrupt the solid lens nucleus which is then aspirated from the eye using the suction system of the ultrasonic probe.

Vitrectomy is performed by first excising vitreous in the centre of the vitreous cavity and then progressing in an anter-

posterior hyaloid of the vitreous is usually separated from the retina except in ior to posterior direction (Fig. 2). The areas of attachment of the optic nerve head and regions of preretinal fibrovascular proliferation. The posterior vitreous is often opaque and has a funnel-shaped configuration extending between the vitreous base anteriorly and points of attachment posteriorly. A major goal of vitrectomy is to cut this funnel-shaped sheet so that no anterior to posterior traction persists within the vitreous cavity.

After the major mechanical objectives of the vitrectomy procedure have been accomplished, the scleral incisions are closed, any retinal tears are treated with cryotherapy, and any retinal detachments procedure or the placement of sulphurhexafluoride gas within the eye are performed

Results of Vitrectomy in the Treatment of Proliferative Diabetic Retinopathy

1. *Vitreous haemorrhage*

Eyes with dense vitreous haemorrhage, but without severe fibrovascular proliferation or traction retinal detachment affecting the posterior retina have the highest success rate and improved vision can be expected in 70-80% of cases (Mandelcorn *et al*, 1976; Michels, 1978). However, many eyes with dense vitreous haemorrhage before surgery will be found, during surgery, to have severe fibrovascular proliferation covering or distorting the posterior retina and macula. Again, improved vision may be expected in 70% of these cases (Michels, 1978).

Certainly, the most common indication for vitrectomy is blindness caused by non-absorbing vitreous haemorrhage. However, in these cases in addition to

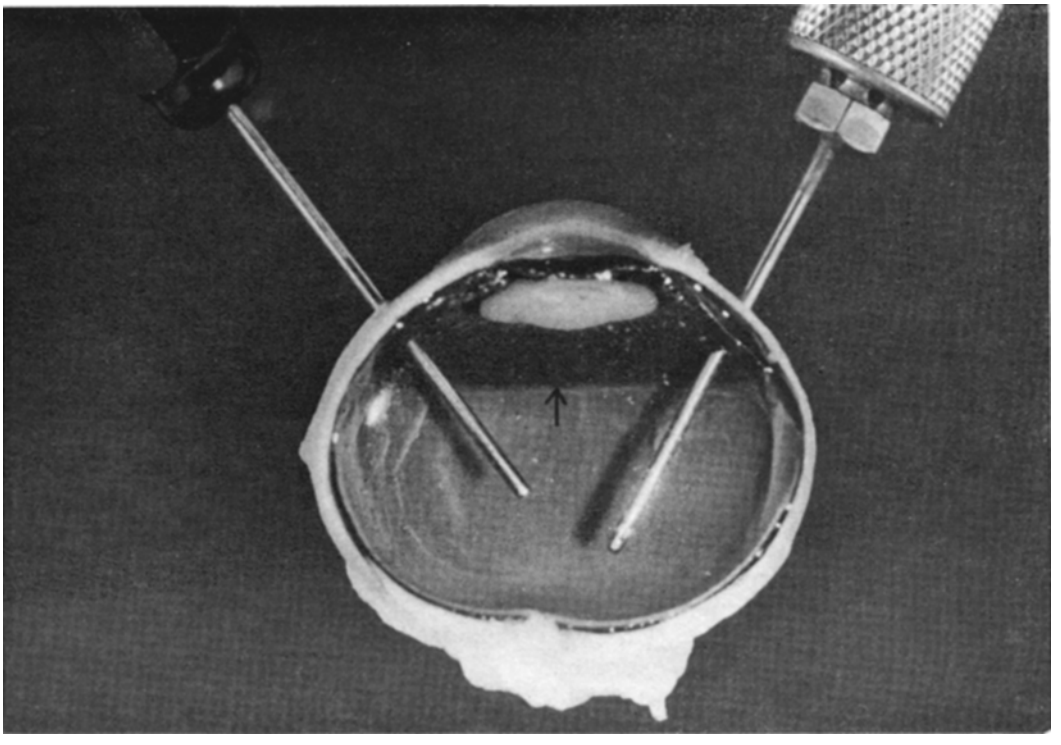

Fig. 2—Photograph of a cadaver illuminator probe inserted through the pars plana into the vitreous cavity. The instruments are inserted anterior to the edge of the retina, which is indicated by the arrow.

the vitreous haemorrhage, the posterior retina and macula are often severely damaged by fibrovascular proliferation or retinal detachment. This finding accounts for reduced final visual acuity in many otherwise successfully operated cases. Because of these retinal changes very few patients achieve normal (6/6) vision, but overall more than 50% of patients achieve navigational vision (3/60 or better). It must be emphasised that in the context of a previously blind eye, this improvement in vision is highly significant and of great benefit to the patient (Fig. 3).

Fig. 3—Postoperative fundus photograph at six months post-vitrectomy for a longstanding vitreous haemorrhage. The visual acuity in this eye improved from hand movements to 6/12. Note that a frond of fibrovascular tissue present over the superior temporal retinal vessels has involuted and become atrophic following vitrectomy.

2. *Traction retinal detachment*

In these eyes with traction retinal detachment involving the macula, anatomical reattachment of the retina may be obtained in 70% of cases (Charles, 1979). Improved vision can be expected in 63% of cases, 43% having a visual acuity of 3/60 or better, i.e. navigational vision (Charles, 1979). Until the advent of vitrectomy and these new intraocular microsurgical techniques, all eyes with traction retinal detachment became irrevocably blind.

Complications of Vitrectomy

Pars plana vitrectomy is a complex and delicate surgical technique with a risk of significant complications present in every case (Machemer, 1975; Michels, 1976).

Important complications after vitrectomy in diabetic eyes include persistent corneal oedema, elevated intraocular pressure, retinal detachment, and rubeosis iridis. The incidence of persistent corneal oedema has been reduced by decreased operating time, and by the use of more physiological intraocular irrigating solutions. With regard to raised intraocular pressure, usually the pressure can be controlled with medications and tends to become normal within 72 hours.

Retinal tears and retinal detachment are a major complication of vitreous surgery but these can usually be successfully treated at the time of operation.

Rubeosis iridis is the most common complication resulting in failure of an otherwise successful operation. Its incidence may be as high as 40% initially, with persistent rubeosis in about 10% of cases. The rubeosis can be treated by panretinal scatter photocoagulation. The risk of rubeosis seems to be especially high in young patients with active proliferative retinopathy and in patients with sizeable areas of traction retinal detachment remaining after vitrectomy.

Posterior subcapsular lens opacities develop in 10-20% of patients after vitrectomy when the lens is left intact. This complication is particularly prone to occur in diabetic eyes and it is the practice to remove the lens during vitrectomy if any posterior subcapsular lens opacities are present pre-operatively.

Contraindictions to Vitrectomy in Proliferative Diabetic Retinopathy

The main contraindication to pars plana vitrectomy in the treatment of

diabetic eyes with non-absorbing vitreous haemorrhage or traction retinal detachment affecting the macula, is the presence of severe iris neovascularisation (rubeosis iridis). Rubeosis will usually cause or increase secondary glaucoma and repeated haemorrhages. These eyes often become blind and painful and may have to be excised. On the other hand, slight rubeosis is not necessarily a contraindication to vitrectomy although its presence may, to some extent, prejudice the prognosis.

In addition to the eye examination, the decision to operate depends on the general condition of the patient with special attention given to blood pressure and kidney function.

Study (DRVS)
Diabetic Retinopathy Vitrectomy

In a multi-centre study in the United States, the value of vitrectomy in the treatment of certain categories of proliferative diabetic retinopathy is being currently assessed. In a controlled trial the effects of early vitrectomy, performed between one month and 6 months after the onset of vitreous haemorrhage, is being compared with delayed vitrectomy performed at 12 months after the date of onset of haemorrhage. Although the results of this study are not yet available, preliminary information suggests that the complication rate is the same for early and for late vitrectomy. The purpose of this study is, firstly, to determine whether prompt surgical intervention after severe vitreous haemorrhage is equally safe as deferred information of particular importance to the patient with recent severe vitreous haemorrhage in his/her only seeing eye. Secondly, to determine whether early intervention will improve the long-range visual outcome either by reducing possible deleterious effects of long-standing intravitreal blood or by interrupting the progressive course of contraction of the vitreous and fibrous proliferations at an early stage, thereby reducing the risk of subsequent retinal distortion and/or detachment and of recurrent vitreous haemorrhage.

The DRVS group is also performing another separate, multi-centre study to assess the place of vitrectomy in the treatment of severe proliferative diabetic retinopathy (Group *NR*). These eyes have extensive fibrovascular proliferations but they have useful vision and do not have significant haemorrhage or traction retinal detachment affecting the macula. The addition of early vitrectomy to conventional treatment is being compared with conventional treatment only. Conventional treatment usually consists of photocoagulation unless vitreous haemorrhage, retinal detachment and/or scar tissue prevents the use of this treatment. The rationale is that by performing vitrectomy before the development of severe vitreous haemorrhage or clearcut detachment of the macula in eyes with severe proliferative retinopathy, it may be possible to prevent these complications and improve the chance of retaining useful vision. It has already been identified in a preliminary study in which eyes with severe proliferative diabetic retinopathy of this type were followed for a 12 month period, that 40% of these eyes lose all useful vision despite conventional treatment. It is because of this very poor outlook with conventional treatment (photocoagulation) that the trial of early vitrectomy has been proposed. Experience in diabetic eyes after vitrectomy for vitreous haemorrhage seems to support this hypothesis. Vitreous surgeons have been impressed by the observation that proliferative diabetic retinopathy often remains quiescent after vitrectomy. New preretinal proliferations seldom occur post-operatively when it has been possible to excise all of the cortical vitreous and to separate and remove epiretinal membranes. Also, fronds of preretinal neovascularisation often undergo marked regression after all vitreous attachments have been cut,

even though the frond was not treated by diathermy or photocoagulation.

Conclusions

Pars plana vitrectomy techniques can be successfully used to treat several complications of proliferative diabetic retinopathy. The mechanical objectives of the operation are quite specific and, when these objectives are achieved, visual acuity is usually improved and further growth of preretinal fibrovascular tissue does not appear to occur. Since this complicated surgical procedure has a significant complication rate, surgery is usually reserved for eyes with both reduced vision and an unfavourable prognosis without surgery. However, studies are in progress to assess the place of vitrectomy in the treatment of other categories of severe proliferative diabetic retinopathy.

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