New System for Fiberoptic-Free Bimanual Vitreous Surgery

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Objectives: To describe a new system for fiberoptic-free bimanual vitrectomy and to present the outcome of 37 eyes with preretinal membranes due to diabetic retinopathy or proliferative vitreoretinopathy that underwent surgery using this system.

Methods: The system consists of a 40-diopter aspheric field lens suspended from the operating microscope and a prismatic inverting device. The aspheric lens is placed above the cornea, and the illumination from the operating microscope creates an inverted image of the fundus, which is made erect by an inverter system. No fiberoptics are required, and both hands are free to use 2 microinstruments.

Main Outcome Measures: The practical utility of this system and its surgical results and complications.

Results: The system was used successfully in all cases. Membrane dissection and hemostasis were performed without incident. An improvement in visual acuity of 2 or more lines was found in 30 of 37 eyes. Five eyes did not reveal change of 2 or more lines, and 2 eyes had a decrease in visual acuity of more than 2 lines. There was no evidence of phototoxicity.

Conclusion: This system is very useful for bimanual vitrectomy.

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The technique of bimanual vitrectomy is very useful for removing difficult preretinal membranes in cases of diabetic retinopathy and other vitreoretinal diseases. Furthermore, the bimanual technique is also used in intraocular lens replacement and foveal relocation surgical procedures. Several instruments have been developed to facilitate the bimanual technique and self-illuminated devices are common. However, the instruments for self-illumination are expensive and have limitations; for example, the choice of possible instruments is limited, and the area of illumination is restricted.

We have developed a new system for bimanual vitreous surgery without the necessity of a self-illuminating device. We have combined the optical system of a wide-angle microscope with a binocular indirect ophthalmoscope and have used the operating microscope for intraocular illumination instead of a fiberoptic bundle. The illumination from the microscope and a newly designed aspheric 40-diopter lens placed above the cornea create an inverted image of the fundus in the same way as an indirect ophthalmoscope. A prismatic inverting system returns the image to the upright position. This system allows an excellent view of the fundus, and because the hand normally used to hold the fiberoptic illumination probe is not needed, 2 vitrectomy instruments can be used simultaneously. We describe the new system and its results.

Materials and Methods

Illumination-Observation System

This system consists of a 40-D aspheric lens and a prismatic inverting optical system. The 40-D aspheric lens is used as a field lens. It is attached to the microscope (OM610, Topcon, Tokyo, Japan), and when both hands are required, the lens can be swung into place between the objective lens of the microscope and the cornea. The illumination from the microscope gives an inverted image of the fundus, and the inverting device allows us to see an erect image.

Figure 1 shows a photograph of the new system. The refractive power of the lens is critical. When the refractive power is less than 40 D, the distance from the cornea to

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the eyepiece of the microscope is too great to easily perform a vitrectomy; when it is higher, the lens is too close to the cornea, and the light reflections from the lens and cornea interfere with the view of the fundus. The diameter of the lens is also important. The diameter of the commercially available 40-D lens is about 35 mm, and if used for observing the fundus during vitrectomy, the edges of the lens interfere with the movement of the surgical instruments. The diameter of the new lens is 25 mm, small enough to avoid contact with the surgical instruments.

We used a commercially available prismatic inverting system (Ocular Instruments Inc, Bellevue, Wash). The binocular convergence angle of the optical axes of the operating microscope is about 4.1° (pseudophakia and phakia) when a planoconcave contact lens is used on the cornea, but with this system the angle is about 6.9°, which enhances the stereoscopic view of the fundus. However, the pupil size should be larger than 5.0 mm to obtain a wide stereoscopic operating field. An iris retractor can be used in eyes with a small pupil.

The light source of the microscope was a 50-W halogen lamp, and the light intensity on the surface of the retina was 30 mW/cm². The lens and suspending components are sterilized prior to attachment to the microscope before surgery.

PATIENTS AND SURGICAL PROCEDURES

This system was used during vitrectomy in 31 eyes with proliferative diabetic retinopathy and 6 eyes with rhegmatogenous retinal detachment associated with proliferative vitreoretinopathy between October 2000 and March 2001. Twelve patients had a tractional macular detachment, 19 had only a preretinal membrane, and 18 had preretinal or vitreous hemorrhage in addition to a preretinal membrane or detachment.

We first performed a 3-port pars plana vitrectomy with the wide-angle view system to remove the vitreous cortex because the visibility of the extreme periphery was better with a wide-angle view than with our new system. We then removed the membrane using a bimanual technique. In cases without vitreous detachment, we tried to create a posterior vitreous detachment first; when it was difficult, we removed the vitreous-together with the proliferative membrane. Gas or silicone tamponade was used when necessary.

RESULTS

SURGICAL PROCEDURES

We successfully performed bimanual vitrectomy with this system in 37 patients. Preoperatively, 23 of 37 eyes were phakic, 10 were pseudophakic, and 4 were aphakic. In 18 of 23 phakic eyes, a phacoemulsification or lensectomy was performed prior to the vitrectomy (combined surgery) because of a significant cataract.

PRACTICAL UTILITY OF THE SYSTEM

The diameter of the area that could be observed with this system was about 40° (Figure 2), which is smaller than the field obtained with the wide-angle view system but larger than that with the planoconcave contact lens. The field of view with this system was sufficient for membrane removal in the posterior pole, and more peripheral lesions could be treated by rotating the eye or indenting the sclera. However, lesions in the extreme periphery, where stereoscopic viewing is difficult, could not be treated using this system.

Although the light reflection from the 40-D lens, crystalline or intraocular lens, or cornea sometimes interfered with the view, it was not difficult to eliminate most of it by moving the microscope and/or the eye, as is done with an indirect ophthalmoscope. The reflected light was less in aphakic eyes than in phakic or pseudophakic eyes. The small...
light at the center of the field cannot be removed. However, this small reflection is always present in the center of the cornea when anterior segment surgery is performed with a microscope.

The 40-D lens was located about 2.0 cm above the cornea, where the fundus was clearly visible. This did not interfere with the surgeon’s manipulation of the instruments for vitreous surgery. To prevent dehydration of the corneal surface, the cornea was occasionally moistened with a small amount of irrigating solution (BSS Plus; Alcon, Fort Worth, Tex). The 2-cm distance between the lens and cornea was sufficient to allow the irrigation of the cornea, and the view was kept clear during the operation.

The distance from the cornea to the objective lens of the microscope is normally about 18 cm during vitrectomy in our hospital, but it was 25 cm with this system. Thus, the microscope must be moved farther from the eye to focus on the image of the fundus. The new height of the microscope was acceptable to all who used it.

**Application of This System to Vitrectomy**

This system was useful for the following procedures:

1. Membrane dissection in proliferative diabetic retinopathy (Figure 3A).
2. Hemostasis in proliferative diabetic retinopathy (Figure 3B).
3. Membrane peeling from the detached retina in proliferative vitreoretinopathy (Figure 3C).

**Results of Surgery**

Although membrane dissection was completed with our new system, 1 patient with diabetes developed neovascular glaucoma after surgery, and 1 patient with proliferative vitreoretinopathy experienced a recurrence of the retinal detachment. Thirty of 37 eyes had an improvement in visual acuity of 2 or more lines, whereas 5 did not show a change in visual acuity of 2 or more lines. Two eyes had a decreased visual acuity of more than 2 lines because of neovascular glaucoma or a recurrent detachment.

**Figure 3.** A, Bimanual technique using microscissors and microforceps in a patient with proliferative diabetic retinopathy (PVR). B, Bimanual technique using a soft-tipped needle and diathermy in a patient with PVR. C, Bimanual technique using 2 pairs of forceps in a patient with PVR. One pair was used to grasp the retina while another peeled the membrane.

**COMMENT**

This study demonstrates that a new system can be used effectively for vitrectomy. In our experience, membrane dissection with this system is much easier than with self-illuminated devices because of the even illumination of the operating field and enhanced stereopsis. Although some
practice is required to use this system, we believe that any surgeon who has used the binocular indirect ophthalmoscope will quickly adjust to this system.

Several methods have been used to illuminate the fundus during vitrectomy. The coaxial light from a microscope has been used for this purpose, but the external illumination-induced bright reflections at every optical interface disturb the view of the fundus. Stilbam lamp illumination has also been used, but the operating field seems to be too small. Another method of illumination for vitreoretinal surgery is the use of an indirect ophthalmoscope, which provides a bright and even illumination but an inverted image. Currently, a fiberoptic bundle is widely used for intraocular illumination during vitrectomy, and a wide-angle view system has recently been developed for observation of the peripheral retina.

With this system, a lens of more than 100 diopters is placed on the cornea, and the fiberoptic bundle provides an inverted image of a wide area of the fundus. An optical system is used to make the inverted image erect.

The use of both hands would be expedient for several procedures. The fiberoptic pipe combined with a membrane pick has been used to hold the epiretinal membrane while several surgeons illuminate the field. Endoillumination has been combined with an infusion cannula. The fiberoptic illuminating system can also be fixed in a scleral port (4-port technique). Diathermy and self-rectors, scissors, and a fluted needle are useful in epiretinal surgery. Because this system does not include disposable parts, we believe that the cost is less than other systems.

The illumination from an operating microscope has been reported to cause phototoxic damage to the retina during cataract surgery, glaucoma surgery, and vitrectomy. This occurs because the intraocular lens focuses the illumination on the fovea. In our system, however, the light is focused near the cornea and illuminates a wide area of the fundus. Therefore, the intensity of the retinal illumination in this system is not as high as with focused illumination. Endoillumination from a fiberoptic system also causes retinal phototoxicity during membrane dissection. The estimated retinal irradiation in our system is 30 mW/cm², which is lower than when a fiberoptic bundle is placed 6 mm from the retina. In owl monkeys, the calculated exposure time of this light to reach the threshold of phototoxic damage (200 J/cm²) was 111 minutes. Membrane removal was completed within 30 minutes in our patients, and we have found no evidence of toxic effects from the light. We believe that this intensity is not toxic.

We conclude that this system is safe and very useful, allowing both hands to be free for vitreoretinal surgery.

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Dr Horiguchi has applied for a patent (2001-15991, 2001-160177, and 2001-178299) with the Japanese patent office, Tokyo.

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