Surgery as the Primary Management of Proliferative Vitreoretinopathy

A History Reflecting My Experiences and Biases

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Although attempts were made to reattach retinas using proliferative vitreoretinopathy by various techniques before the 1970s, it was the development and subsequent refinement of closed-eye, mechanized pars plana vitrectomy that initiated the rapid rise in the surgical success rate. This article presents a personal history of the milestone accomplishments that facilitated the strong possibility of success that patients with proliferative vitreoretinopathy can now anticipate. Currently, various gasses, chemical compounds, and pharmaceutical agents serve adjunctively to advance surgical techniques with the expectation that they may be the primary curative procedure in the future. As in the past, what is unconventional today may be common tomorrow.

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It is with great humility that I extend my sincere appreciation to The Retinal Research Foundation, The Schepens International Society, and Alice McPherson, MD, for inviting me to be the second lecturer to honor the legacy of Charles Schepens, MD. I first met Dr Schepens while I was in the Howe Laboratory, Massachusetts Eye and Ear Infirmary, during a year of research on aqueous dynamics that preceded my clinical residency. It was apparent that I needed indirect ophthalmoscopy skills to see the peripheral retina in our experimental model in which we canuluated the pars plana. Dr Schepens mentored my improvement in ophthalmoscopic techniques and promoted my joy in seeing the peripheral retinal structures, including elusive retinal tears. These techniques and Dr Schepens' instruction served me well during my subsequent clinical residency, culminating in my career interest in vitreoretinal diseases.

BEGINNING OF THE MODERN ERA OF PVR MANAGEMENT

Closed-Eye Mechanized Pars Plana Vitrectomy

The 1970s were a decade of both advancement and proliferation of vitrectomy instrumentation, resulting in a doubling of the success rate of PVR surgery to 30%. On April 20, 1970, Robert Machemer, MD, performed his first human closed-eye pars plana vitrectomy with the vitreous infusion suction cutter (written and oral communication, November 1994), profoundly changing ophthalmic surgery and thus helping many patients who were previously considered untreatable. Like other major therapeutic changes in the practice of ophthalmology, vitrectomy, at that time, had detractors as well as advocates, the latter ranging from adamantly arguing for removing all portions of the vitreous gel to a more cautious surgical approach. I defended my position in the letter section of Controversies in Oph-
state depth of focus; (3) greater range
ablezoom depth with greater steady-
foot-controlled movement; (2) vari-
2-dimensional horizontal (x-y)
modification advances included (1)
reotaxic unit. 24 The cannula size
the functions into separate illumi-
ment, eventually was reduced by splitting
functions into separate illumination, infusion, and cutting. 23
Concurrent equipment submile-
stones during the aforementioned
vitrectomy development were ad-
vances in illumination and micro-
scopic visualization of the posterior
pole. Early illumination was coaxial
and/or aligned slit beam light; both
had insufficient light intensity and
interfering light reflexes at every
intervening tissue optical interface.
Most problems were minimized by
endoscopic light. 26 Microscope
modification advances included (1)
2-dimensional horizontal (x-y)
foot-controlled movement; (2) vari-
able zoom depth with greater steady-
state depth of focus; (3) greater range
of magnification; 27; and (4) wide-
angle viewing. 28
Each advance facilitated other ad-
vances. With improved illumination
and visualization, same-gauge auxi-
liary instruments were developed to
be interchangeable through scler-
otomy ports with the vitrector such
as diathermy, scissors, forceps, pics,
extrusion devices, magnets, and more.

Intraocular Solutions and Gases

During the first decade of closed-eye
vitrectomy, little was known about the
tolerance of the eye for infused li-
quids, particularly for the volume and
duration of early vitrectomy infu-
sions that compounded the patients'
debilitating ocular conditions such as
diabetes, sickle cell, trauma, and mul-
tiple previous surgeries. Vitrectomy
surgeons thus noted while using the
basic saline or lactated Ringer solu-
tions that were available (or variants
thereof) that the corneas and lenses
lost clarity during surgery and, post-
operatively, the corneas were thick-
ened for a considerable period of time.
Eyes of diabetic patients that de-
veloped intraoperative cataract neces-
sitating concurrent lensectomy then
had a greater risk of postoperative rub-
boseis irides.

A great advance that eventually
saved the vision of many postopera-
tive patients occurred when Henry
Edelhauser, PhD, developed the pro-
totype glutathione bicarbonate rings
solution with osmolarity, buffer-
ing capacity, and pH compatible
with the aqueous humor. 29
Further research by Haimann and
Edelhauser et al 30 showed that the
eyes of persons with diabetes, invari-
ably accustomed to higher preop-
erative intraocular aqueous glucose
levels (hence higher osmolality),
maintained intraoperative lens clar-
ity better when adding additional
dextrose to the irrigating solution.
Retina surgeons had used air for
many years for intravitreal tampon-
ade of retinal holes and to maintain
proper retinal alignment. Air had been
used intraoperatively during vitrec-
tomy in the late 1970s but was not
practical until automated air injec-
tion in the early 1980s. Because air
disperses quickly from the vitreous
cavity, vitreoretinal surgeons were
also excited by studies in the mid 1970s
that demonstrated the ability of sul-
fur hexafluoride gas to expand and
persist for many days in the eye. 31 This
was followed by other gaseous com-
ounds such as perfluoropropane,
which expanded and persisted even
longer. 32,33 Surgery in an air-filled eye
had greater interface surface tension
than a fluid-filled eye so tangential
traction in a fluid-filled eye could be
severed and maintained postopera-
tively with an air-gas exchange at the
conclusion of surgery. Thus, the the-
rapeutic armamentarium of the sur-
geon expanded, albeit with some risk.

Intraocular Laser
Endocoagulation initially used a xe-
on light source but was ineffective
in an air-filled eye, so it was soon re-
placed by intraocular laser. This dra-
amically altered the technical capa-
bilities of the vitreoretinal surgeon,
permitting intraoperative treatment of
retinal holes and demarcation of in-
tractable anterior disease in air-filled
eyes. These capabilities allowed suc-
cess in some eyes that would other-
wise have failed and increased the
overall rate of surgical success in PVR
to 63%. 34-36

Sustained Retinal Tamponade

Silicone oil has been used since the
previtrectomy 1960s when Cibis 37
used it as a substance to separate pre-
retinal tractional membranes and af-
ford long-term retinal tamponade. Ex-
cept for the surgical tenacity of Scott 38
and a few others who continued to use
silicone oil, it was rarely used in the
early 1970s. Its renewed interest came
as an adjunct to pars plana vitrec-
tomy techniques, 39-41 leading to a ran-
domized clinical trial comparing sili-
cone oil to long-acting gas as a retinal
tamponade in PVR. 12,45

During this time, 2 further ad-
vances occurred: (1) recognition of
the significance of proliferation in or
about the posterior insertion of the vi-
treous base, ie, the anterior component
of PVR, 33,36 and (2) developing clini-
ical experience with perfluorocarbon
liquids; a variety were available but
perfluoro-N-octane became the most
clinically used to reposition the mo-
bilized retina after membrane dissec-
tion. 44 By understanding the mecha-
nisms and significance of periretinal
membrane proliferation and devel-
oping the surgical corrections, the suc-
cess rate of PVR surgery rose to 78%
by 1987 15 and currently is even higher.

Anticipated Pharmacologic/
Immunologic Milestones for PVR

Thirty three years ago, Dr Schepens
aptly stated, “The greatest limiting fac-
tor of vitreous surgery cannot be over-
come . . . the continuing growth of
new formed tissue . . . in instances of
massive preretinal retraction . . . the
control of such regrowth will cer-
tainly require considerable research
work.” 47 Such research continues, and
headway is being made.

Because initial surgical reattach-
ment of primary retinal detachments