Repair of Primary Retinal Detachment: A Review of its Development and a Comparison of the Present Techniques in Use: Review

Primer Retina Dekolmanı Onarımı: Gelişimin Derlemesi ve Günümüzde Kullanılmakta Olan Tekniklerin Karşılaştırılması

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ABSTRACT The evolution of the present surgical approaches for reattaching a primary retinal detachment and the issues which determined the various techniques will be analyzed starting from 1929. Literature of retinal detachment surgery during the past 80 years is reviewed. There had been a change from surgery of the entire retinal detachment to a surgery limited to the retinal break and a change from extraocular (e.o.) to intraocular (i.o.) surgery for retinal reattachment. The four major surgeries for repair of primary retinal detachment, applied in the beginning of the 21st century, have one common issue: to find and close the break which caused the retinal detachment or would cause redetachment. This is independent whether surgery is limited to the area of break or extending over the entire detachment and whether it is performed as an e.o. or i.o. procedure. This is followed by comparison of the presently applied four techniques in relation to: morbidity, proliferative vitreoretinopathy (PVR), rate of reattachment and reoperations. To find and close the leaking retinal break in a primary detachment once and for all has accompanied the efforts of detachment surgeons as a "red thread" over the past 80 years and is still the premise for sustained reattachment. However, at present four requirements have to be fulfilled: (1) Retinal reattachment should be achieved with one operation, (2) operation should have minimum of morbidity, (3) surgery should be performed on a small budget and under local anesthesia, (4) surgery should not harbour secondary complications jeopardizing regained visual acuity during subsequent years.

Key Words: Vitrectomy; retinal detachment; scleral buckling

ÖZET Retinayı tekrar yatıştırmak için mevcut cerrahi yaklaşımları araştırılmıştır ve çeşitli teknikleri belirleyen ana hususlar 1929 dan başlayarak analiz edilmektedir. Geçmiş 80 yılın retinal dekolman cerrahi literatürü gözden geçirilmiştir. Zaman içinde tüm retina dekolman cerrahisinden retinal yırtığa sınırlı cerrahi geliştirilmiştir ve retinal dekolman için ekstraoküler cerrahiden (e.o.) intraoküler (i.o.) cerrahiye değişim oluşmuştur. Yirmi birinci yüzyılın başında geçerli olan, primer retina dekolmanı onarımı için uygulanan dört büyük cerrahi yöntemin bir ortak konusu var: retina dekolmanına neden olan veya olabilecek yırtığı bulmak ve kapatmak. Bu durum cerrahinin yırtık bölgesine sınırlı veya tüm dekolman bölgesini kapsamasından veya e.o veya i.o. cerrahi yöntem uygulanımından bağımsızdır. Uygulanan dört cerrahi teknik morbidite, proliferatif vitreoretinopati (PVR), retinanın tekrar yatışma oranı ve tekrar eden cerrahi oranı açısından değerlendirilmektedir.. Primer retina dekolmanında öncelikle sızdıran yırtığı bulmak tüm retina cerrahlarının müşterek çabasıdır ve 80 yıldan fazla ve günümüzde bu yöntem "red thread" (kırmızı şerit) halen kalıcı retina yatışıklığının ön koşulunu oluşturmaktadır. Ancak dört koşul yerine getirilmelidir: (1) retinanın yatıştırılması bir cerrahi girişim ile gerçekleştirilmeli, (2) morbiditesi en düşük yöntem uygulanmalı, (3) cerrahinin maliyeti düşük tutulmalı ve lokal anestezi kullanılmalı, (4) cerrahi girişim ileriki yıllarda görme keskinliğininin artmasını engelleyecek sekonder komplikasyonlar içermemelidir.

Anahtar Kelimeler: Vitrektomi; retina dokelmanı, skleral çökertme

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The treatment of a primary rhegmatogenous retinal detachment is again being discussed. This time the issues are no longer: Treating the retinal break by (1) surgery performed without drainage or with drainage of subretinal fluid and (2) e.o. retinal surgery, limited to the area of the break or extending over the entire circumference of the retina. Instead, today's question is: Treating the retinal break by e.o. retinal surgery or i.o. vitreoretinal surgery for retinal reattachment? This will be analyzed by a review of the past 80 years including the present state-of-the-art.

REVIEW

Prior to 1929, retinal detachments were a blinding disorder.

The first conceptional progress for treatment was made by Gonin,[1] who postulated that a break is the cause of the retinal detachment. He applied Ignipuncture coagulations around the break after drainage of subretinal fluid. The reattachment rate increased from practically 0% to 57%. However, the precise localization of the break was difficult and therefore, already in 1931 Guist and Lindner[2,3] placed instead many scleral trephines posterior to the estimated position of the break and cauterized the choroid at each trephine opening to create adhesions as a "barricade" posterior to the break. With this operation, reattachment increased to 70%, but redetachment occurred, because the retinal break was not closed off, started to leak again and crossed the barricade of coagulations.

A second conceptional progress in the treatment of retinal detachment evolved with Rosengren[4] in 1938 who limited again the coagulations to the break, but, after drainage of subretinal fluid, added an i.o. air bubble to tamponade the break. Retinal reattachment increased to 77%. However redetachments developed again, because the duration of the air bubble was too short for a sufficient adhesion to develop, and the break started to leak again. Another problem was that the precise localization of the coagulations around the break was difficult. Therefore, the Rosengren technique did not take hold and, instead, the pendulum again swang back from this surgery, limited to the break, to a surgery with extensive coagulations.

Now the coagulations were placed posterior to the break and this was reinforced by an additional scleral resection. Subsequently an additional plombe was embedded into the resection creating a high scleral wall, but since the break was not supported anteriorly, it started to leak again (Figure 1a, b). Several lines of coagulations were added between the buckle and the ora serrata as additional barricade to stop a redetachment from progressing. However this did not work either, since the break, positioned at the anterior edge of the buckle, was not sufficiently tamponaded. It started to leak again, caused an anterior redetachment, which crossed the barricades of coagulations, descended behind the buckle and redetached the posterior retina. Then a longer plombe was applied, but the same sequence of redetachment developed (Figure 1 c, d).

The logical consequence might have been to search for a more sufficient tamponade of the break, i.e., to tamponade it posteriorly and as well anteriorly, but, instead, a more effective, i.e., longer barricade against redetachment was created. Thus, in 1953 the segmental plombe was enlarged to a circular plombe by Schepens[5] and the cerclage with drainage of subretinal fluid had evolved. It represented a maximum of barricade for the leaking break towards posteriorly. More retinas were reattached, more than 80%. But redetachment occurred again, due to the break still leaking anteriorly (Figure 1e). As reoperation, the cerclage was either made higher by more constriction of the globe or positioned more posteriorly. Despite all, if the break was not tamponaded sufficiently, it started again to leak and redetachment followed.

In subsequent years the cerclage technique with drainage of subretinal fluid was further refined by positioning the break on the circular buckle and, if needed, tamponaded by an additional plombe or wedge.

A third conceptional progress in detachment surgery was made by Custodis in 1953.[6] He limited again the treatment to the break, but in addition he omitted drainage of subretinal fluid. Nondrainage was made feasible by the use of an elastic explant, the polyviol plombe, which was compressed by an

intrascleral mattress suture over the detached retinal break. However, the sclera was treated by full-thickness diathermy, which subsequently proved detrimental to this technique. Due to the subsequent expansion of the compressed elastic plombe, the retinal break would be closed and subretinal fluid absorbed. Thus, drainage was eliminated and the intraoperative complications were reduced to a minimum. Despite all, this exceptional technique was nearly abandoned, not because it did not work, but because of unexpected serious *postoperative* complications caused by the polyviol plombe compressed over full-thickness diathermized sclera. The diathermized sclera became necrotic, and if bacteria were present under the explant, a scleral abscess with perforation could result. In 1960 the Boston group[7] reported serious postoperative complications after the Custodis procedure, i.e., scleral abscess, endophthalmitis and even enucleation. As a result, this technique was abandoned in the United States and in Europe.

Actually, this was not true for everybody in the United States – not for Lincoff in New York. He had observed complications as well, but he did not give up the Custodis method, because he was convinced of the logical approach and simplicity of this new procedure. Therefore, in the subsequent years he with his group replaced diathermy with cryopexy[8,9] and the polyviol plombe with a tissue-inert silicone plombe, the Lincoff sponge.[10]

This operation was subsequently named as cryosurgical detachment operation. It represents an e.o. approach, since drainage was eliminated, and the cryosurgery and the buckle were limited to the area of the break. However, the acceptance of this procedure was delayed because there were major doubts: (1) Is the cryosurgical adhesion strong enough? This was eventually confirmed by extensive animal experiments by Kreissig and Lincoff.[11] (2) Would this spontaneous or "magical" disappearance of subretinal fluid occur by tamponading the break ab externo with an elastic buckle, even if the break is still detached over the buckle at the end of surgery? Yes, that would result, but the "conditio sine qua non" for spontaneous reattachment after nondrainage is that all of the leaking breaks have been found and tamponaded sufficiently intraoperatively.

Aware of the essential preconditions for spontaneous postoperative reattachment, the diagnostics for detecting the breaks were further improved by binocular indirect ophthalmoscopy, biomicroscopy, various direct and indirect contact lenses, by defining four Rules to find the primary break,[12,13] and subsequently by four additional rules to detect the missed break in an eye requiring reoperation.[14,15]

By performing this minimal e.o. surgery, limited to the retinal break, the time required for a retinal detachment operation became dramatically reduced, however, the time needed for preoperative study increased. If, however, retinal reattachment did not result the days following surgery, the logical questions had to be: (1) Has a break been overlooked or (2) is it still leaking due to an inadequate tamponade? Both causes of failure are iatrogenic. Thus, one can understand why an operation with drainage that would provide: (1) Retinal reattachment on the table and (2) by the cerclage an additional prophylaxis for overlooked breaks, might be preferred. Soon it was found that a leaking break is more sufficiently tamponaded by a radial than a circumferential buckle. This refined detachment surgery evolved as "Minimal segmental buckling without drainage" or "Extraocular minimal surgery".[16]

MORE RECENT OPERATIONS FOR REPAIR OF RHEGMATOGENOUS RETINAL DETACHMENT

1. CERCLAGE WITH DRAINAGE

It consists of a circular buckle with extensive coagulations, often combined with an i.o. gas injection after drainage of subretinal fluid and provides reattachment on the table, but drainage of subretinal fluid represents a vision-threatening complication, such as: i.o. hemorrhages in 6.9% to 16%, choroidals in 8.6%, and i.o. infection or incarceration of vitreous and retina. The reattachment rate ranges after several reoperations between 80% and 96%.[17]

In this context attention should be drawn to a recent publication by Lincoff et al. reporting about

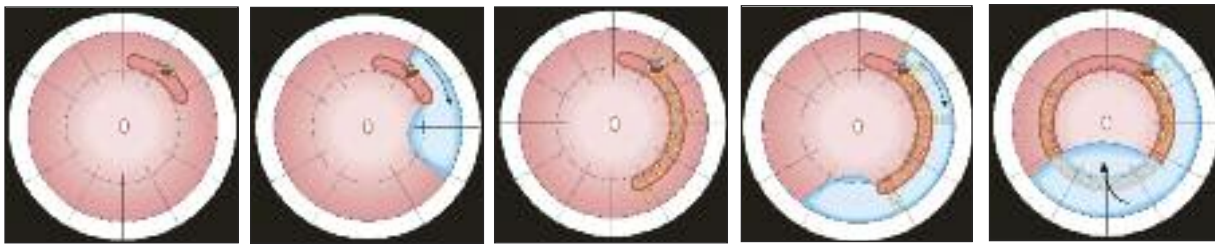

FIGURE 1: a. Segmental plombe, embedded into the scleral resection, with retinal break positioned on anterior edge of buckle and diathermy coagulations around the break. **b.** Retinal break starts to leak anteriorly since not supported sufficiently by buckle, redetachment anterior to the buckle, descending inferiorly and redetaching posterior retina. **c.** Enlarged segmental plombe with retinal break again positioned on anterior edge of buckle, surrounded with diathermy coagulations, additional coagulations on entire buckle and several, so-called, coagulation barricades towards ora serrata. **d.** Retinal break again starts to leak anteriorly, redetachment anterior to buckle, subsequently crossing the various barricades of coagulations, finally progressing towards posterior retina. **e.** Circular plombe (cerclage) with coagulations on the buckle and anterior to it. An anterior redetachment, originating from the leaking break, crosses again the barricades of coagulations, crosses the cerclage buckle inferiorly and progresses towards posterior retina. (Fig. 1 from Harvey. Lincoff, MD, New York)

the effect of an encircling band on ocular blood flow.[18] It was found that an encircling band does reduce the pulsatile ocular blood flow to a mean of 43% in comparison to the fellow eye. However cutting the band, independent whether it had a constriction of 25% or only 10%, resulted in a mean recovery of 85.6% of the pulsatile ocular blood flow. After cutting the band no retina redetached. It was concluded that a cerclage, if applied, should be cut when the retinal findings are stabilized, but the latest after six months to restore significant ocular blood flow and to avoid possible deleterious effect on long-term visual function.

2. MINIMAL SEGMENTAL BUCKLING WITHOUT DRAINAGE (E.O. MINIMAL SURGERY)

This surgery consists of cryopexy and a sponge plombe, limited to the area of the break without drainage of subretinal fluid. The size of the buckle is not determined by the extent of the detachment, but by the size of the break (Figure 2).

In a prospective study, 107 consecutive retinal detachments were treated with minimal segmental buckling (sponge(s)) without drainage between 1979 and 1980 with a follow-up for every patient over 15 years.[19] Retinal reattachment after one operation resulted in 93% and after one reoperation in 97% during a 2-year follow-up. Proliferative vitreoretinopathy (PVR) ranged at 3.7%. Visual acuity had increased from 0.3 preoperatively to 0.5 after six months and 0.6 after one year. In the slight decrease of visual acuity over 15 years, there is no statistically significant difference in comparison to the course of vision in the fellow eye (Figure 3). The slight decrease is due to ageing.

3. BALLOON-OPERATION WITHOUT DRAINAGE

To reduce the surgical trauma of minimal segmental buckling without drainage even further, in 1979 the sewed onto sclera segmental buckle as tamponade for the retinal break was replaced by a temporary balloon buckle (Lincoff-Kreissig balloon).[20] The balloon buckle, limited to detachments with 1 break or a group of breaks within 1 clock hour, is not fixated by sutures and withdrawn after one week. The rationales for removing the balloon after one week were the results of our earlier animal experiments on the strength of the cryosurgical ad-

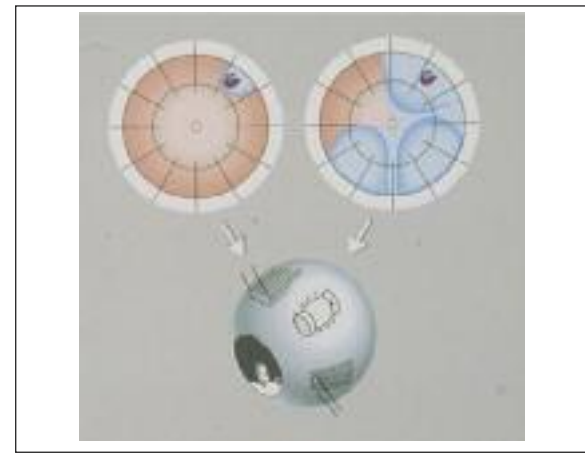

FIGURE 2: Minimal segmental buckling without drainage, so-called e.o. minimal surgery. Treatment limited to area of break and not determined by extent of detachment. The small (top left) and the more extensive detachment (top right) are caused by the same horseshoe tear at 1:00 and treatment of both is the same: Buckling the tear by a segmental radial sponge (as depicted) or a temporary balloon without drainage.

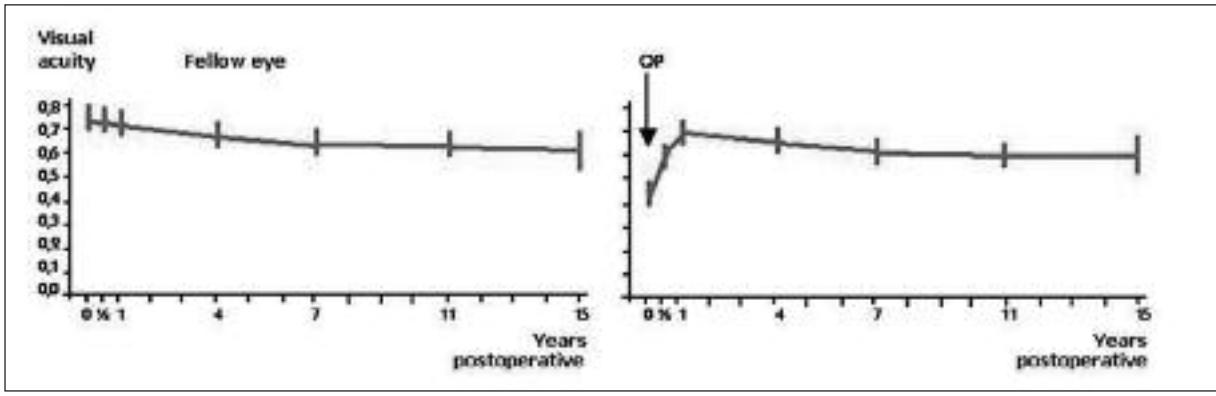

FIGURE 3: Course of mean visual acuity during 15 years: Visual acuity in the 107 unoperated fellow eyes during the 15-year follow-up (left) and in the 107 eyes with retinal detachment operated with extraocular minimal surgery, consisting of segmental sponge buckle(s) without drainage during 15 years after surgery. Preoperative visual acuity of 0.3 had increased to 0.5 at 6 months and to 0.6 at 1 year, and decreased to 0.5 after 15 years due to age (right).

hesion.[8,9] Thus, 10 years later, the adhesive strength of the cryosurgical adhesion was confirmed by the balloon operation with a temporary buckle. The break was surrounded intraoperatively by cryosurgery or after reattachment by laser. With the balloon the last complications of segmental buckling: Infection/extrusion of the buckle (< 0.5%) and diplopia (< 1%) were eliminated.

Here are the results of 500 retinal detachments treated with a temporary balloon buckle and a 2-year follow-up: After one operation the retina was reattached in 93%, after balloon removal in 91% and after reoperation (2nd reoperation only needed in 0.8%) in 99%. Postoperative PVR was reduced to 0.2%, which reflects the minimized surgical trauma inflicted to the eye by the balloon operation.[21]

4. INTRAOCULAR SF6 GAS WITH DRAINAGE

Soon it was found that giant tears were not suitable for buckling, because the required long circumferential plombes caused constriction of the globe and radial retinal folds resulting in leakage of the giant tear. Therefore, the gas operation of Rosengren was re-introduced by Norton[22] and Lincoff[23] for detachments with problematic tears. After drainage of subretinal fluid, SF6 was injected into the vitreous to unfold and to tamponade the giant tear. After reattachment the edges of the tear were coagulated with cryopexy or laser coagulation. Reattachment increased with the gas operation, but again this procedure was combined with drainage of subretinal fluid.

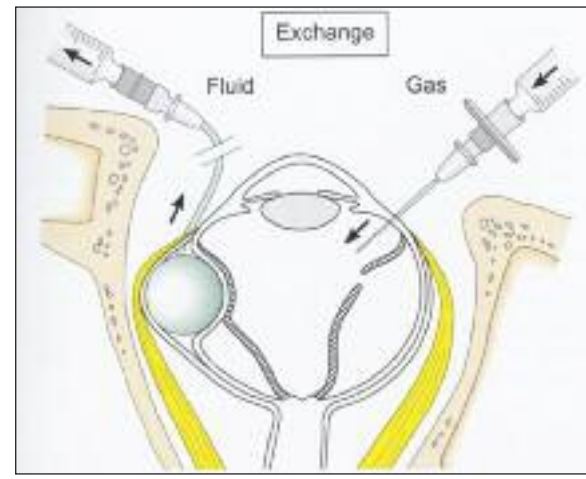

FIGURE 4: Balloon-gas procedure: Balloon is used for providing a kind of fluid-gas exchange. The i.o. space for subsequent gas injection without drainage of subretinal fluid is created by prior insertion of a parabulbar balloon inducing internal drainage of aqueous from the vitreous due to its continuous oculocompression. About 2 hours later, the obtained i.o. space is replaced by an i.o. injection of gas combined with simultaneous withdrawal of balloon contents providing space for i.o. injection of a larger gas bubble without prior drainage or vitrectomy. Procedure is done under topical anesthesia.

5. EXPANDING-GAS OPERATION WITHOUT DRAINAGE

In 1979 Kreissig published a technique treating these problem detachments with an i.o. gas bubble *without* drainage.[24] After ocular compression, the gas SF6 was injected without prior drainage. A larger gas bubble could be injected which subsequently increased due to its expansion coefficient. Now - for the first time-the nondrainage principle was transferred to the gas operation and used for detachments with giant tears and posterior breaks. But in contrast to the low rate of PVR after e.o.

minimal surgery, postoperative PVR had increased significantly after i.o. gas. Therefore, the gas operation without drainage, called "expanding-gas operation" was reserved for problem detachments and not used for detachments with uncomplicated breaks, because in the meantime the balloon operation with less morbiditiy was available for these eyes.[20,21]

6. THE PERFLUOROCARBON GASES

The expanding-gas operation with SF6 was further improved with the introduction of four perfluorocarbon gases (CF_4; C_2F_6; C_3F_8; C_4F_{10}) by Lincoff and his group.[25,26] The expansion of CF4 is 1.9x and of the three other perfluorocarbons 3.3x, 4x, and 5x of their original volume. As a result, more complicated tears could be treated with the "expanding-gas operation" without drainage.[27] However, the larger expansion of the gas was combined with a longer duration in the eye, and this resulted in a higher rate of PVR.

8. BALLOON-GAS-PROCEDURE

To reduce this higher rate of PVR after i.o. gas, Kreissig started in 1984 to use a combination of an e.o. balloon buckle and i.o. gas, the so-called "balloon-gas-procedure" (Figure 4) for problem detachments.[28] Under topical anesthesia the balloon was inserted into the parabulbar space, due to the compression of the eye internal drainage induced and two hours later a larger volume of gas injected into the eye without closing off the central retinal artery. The patient was instructed to report the moment light in the eye is disappearing, then fluid from the pre-placed balloon was withdrawn to restore retinal circulation and light perception. This was repeated until the balloon volume was completely withdrawn and replaced by the i.o. gas bubble. Thus, a larger gas bubble could be injected and a less expandable gas be selected with a shorter i.o. duration. As a result, even for larger volumes of i.o. gas, nondrainage with less complications could be sustained. This procedure could be applied for giant tears up to 90° and posterior holes as a first try without drainage and without prior vitrectomy, but with a substantial rate of PVR.

9. PNEUMATIC RETINOPEXY

Despite the reported complications after the i.o. expanding-gas operation without drainage, published in the German literature in 1979[24], Hilton and Grizzard[29]- not knowing this German publication - re-introduced this gas technique without drainage in 1986 as treatment for *uncomplicated* detachments and re-named it as "pneumatic retinopexy". This procedure is still in use today due to its simplicity and despite the fact that it harbours a greater morbidity. In a study of 500 uncomplicated detachments[30] the retina was reattached after one gas injection in 91% and after disappearance of the gas in 80%. Yet after several reoperations-up to three operations in originally uncomplicated detachments and reoperation was needed in every fifth detachment-reattachment was obtained in 99%. New breaks had developed in 15% and PVR in 4%.

10. PRIMARY VITRECTOMY

Perhaps due to the increased rate of postoperative PVR and reoperations after pneumatic retinopexy, it was thought, that with a vitrectomy prior to the gas injection the rate of PVR could be eliminated. This modified gas operation, consisting of vitrectomy and a gas injection, was now used for primary retinal detachments with uncomplicated breaks and called "primary vitrectomy".

Vitrectomy was available since 1972, developed by Machemer et al[31] for retinal detachments with vitreous traction and PVR. The original vitrectomy instrument, the "VISC", was refined by O'Malley to the "Ocutome". Kreissig in Bonn, Germany - after her 3-year training with Lincoff in New York - received the fist Ocutome shipped to Europe. However at that time vast amounts of retinal detachments were sent to her for repair with this minimal segmental buckling without drainage which she had learnt in New York. Due to this minimal buckling operation without drainage few failures due to PVR resulted which actually would have required a vitrectomy as reoperation. However there was Neubauer in Cologne, 12 miles North of Bonn, who had developed a special technique to remove nonmagnetic i.o. foreign bodies[32] and many perforating injuries were concentrated there. Therefore,

Kreissig offered Neubauer and his senior Heimann to use her new Ocutome for their trauma eyes.

Despite applying an additional vitrectomy prior to the gas injection for a primary retinal detachment, postoperative PVR and new breaks, as experienced after pneumatic retinopexy, were not eliminated.

COMPARISON OF FOUR SURGICAL TECHNIQUES FOR REPAIR OF A PRIMARY RHEGMATOGENOUS RETINAL DETACHMENT IN USE AT PRESENT

1. PNEUMATIC RETINOPEXY VERSUS TEMPORARY BALLOON BUCKLE

For this comparison 500 primary retinal detachments with uncomplicated leaking breaks were treated with pneumatic retinopexy,[30] and 500 with an e.o. temporary balloon buckle.[33] After disappearance of the gas bubble, retinal reattachment decreased from 91% to 80% and after removal of the temporary balloon buckle only from 93% to 91%. After i.o. pneumatic retinopexy new breaks were 10x more frequent, PVR 20x, and redetachments 5x more frequent than after an e.o. balloon operation.

2. PNEUMATIC RETINOPEXY VERSUS PRIMARY VITRECTOMY

With this comparison the question should be addressed: Does the additional vitrectomy reduce the rate of postoperative PVR and reoperations? When the results after these two procedures were compared, it became apparent that after pneumatic retinopexy the rate of reoperations ranged at 26% and PVR at 6.1% and after primary vitrectomy reoperations at 24.5% and PVR at 11.5%.[34] Thus, the rate of postoperative reoperation was remarkably similar with both procedures and the expected decrease of PVR and reoperations was not achieved by additional vitrectomy.

3. EXTRAOCULAR MINIMAL SURGERY VERSUS PRIMARY VITRECTOMY

The results after a cerclage[35] are comparable to those after segmental buckling. But, to use the available data on cerclage for comparison, the various series are not homogenous.

Therefore, for the following comparison of scleral buckling versus primary vitrectomy, a Medline search was made by the search terms "retinal detachment", "segmental buckling", "nondrainage". The analysis consisted of five reported homogenous series with a combined total of 1.462 retinal detachments.[16,33,36-39] The primary rhegmatogenous retinal detachments presented various types of breaks, an aphakia or pseudophakia in 8.3%, and preoperative PVR C1-C2 in 2.9% (Table 1). After minimal segmental buckling without drainage, primary retinal reattachment was obtained in 91% and after reoperation, needed in 7.3%, in 97% which persisted during a 2-year follow-up. The cause of final failure was: PVR stage C1-C2 in 1.9% - despite the fact that PVR was present preoperatively already in 2.9%-,

TABLE 1: Reattachment and visual acuity after minimal segmental buckling (sponge(s) or balloon) without drainage and reoperation of primary retinal detachments (n = 1,462) during 2-year follow-up.

						Cause of Final Failure			
Series	Detachment	Preoperative PVR C1-C2	Primary Reattachment	Reoperation	Final Reattachment	PVR C1-C2	Missed break	Choroidals	Visual Acuity 2 years postoperative
Lincoff[36]	752	5	672	60	732	14	4	3	n.a. ①
Kreissig[16]	107	16	99	5	104	4	3	–	0.6
Sivkova[37]	35	6	35	–	35	–	–	–	0.6
Sirtautiene[38]	68	11	65	3	60	8	–	–	0.3
Kreissig[33]①	500	5	454	39	493	2	5	1	0.7
Total	1.462	43 (2.9%)	1.325 (91%)	107 (7.3%)	1.424 (97%)	28 (1.9%)	12 (0.8%)	4 (0.3%)	0.67 (mean)

① treated with balloon.

missed break(s) in 0.8%, and choroidals in 0.3% in highly myopic eyes. The mean postoperative visual acuity function ranged at 0.67 after two years. In a recent metaanalysis of 1,854 segmental buckle operations (sponge(s), balloon) with cryopexy and without drainage, published by Lincoff et al in 2005, the postoperative PVR was further reduced to 0.9 % and reoperations ranged at 9.1%.[40]

In an earlier metaanalysis of 595 primary retinal detachments, treated with primary vitrectomy, the rate of reoperation ranged at 24.5% and PVR at 11.5%,[34] and in a more recent metaanalysis after the introduction of more refined instruments for vitrectomy and more experience in this procedure, the rate of reoperation was reduced to 13.3% and PVR to 5.3%.[40]

Thus, even when comparing the more recent data, minimal segmental buckling still harbours less reoperations and less postoperative PVR than primary vitrectomy.

4. INTRAOCULAR VERSUS EXTRAOCULAR SURGERY

In 2005 Lincoff et al did an odds ratio of pooled 3,384 i.o. gas operations and vitrectomies versus 1.854 e.o. sponge and balloon buckles, procedures applied for repair of a primary retinal detachment.[40] They found that despite the recent refinements in vitrectomy the risk of reoperation after i.o. procedures is still 2.5x higher than after e.o. surgery and the risk of postoperative PVR 6x higher after i.o. surgery than after e.o. surgery.

CONCLUSION

When closing off the leaking break in a primary retinal detachment with i.o. surgery, the same rate of retinal reattachment can be obtained as with e.o. segmental buckling. However, the morbidity, i.e., the rate of PVR, redetachments and reoperations, is significantly higher after i.o. surgery. However it would be unrealistic not to recognize the present trend towards i.o. surgery.

What then drives the increasing use of primary vitrectomy for uncomplicated detachments? The new generation of detachment surgeons is inadequately trained: (1) In the art of finding the retinal break and (2) in the art of tamponading it effectively with a minimum of buckling and (3) in achieving this without drainage of subretinal fluid. The present vitreoretinal surgeon is more involved in other options of vitrectomy, i.e., for macular, vascular and vitreous pathology than in the time-consuming preoperative diagnostics for finding the leaking break in a retinal detachment. Instead, the patient with a retinal detachment can be brought to the operating room to search there for the leaking break. However this search for the break is done in an expensively equipped operating theatre with additional expensive personnel in attendance. If the break is not found or the optic media seem problematic, the full spectrum of i.o. surgery can be added: In a phakic eye, (1) a phakoemulsification with an i.o. lens implantation or in a pseudophakic eye an anterior vitrectomy to reconstruct the anterior segment. This can be followed by (2) application of a barricade of coagulations in the retinal periphery, (3) the use of expensive heavy perfluorocarbon liquids to reattach the retina already on the table, (4) a fill of the eye with gas or silicone oil, and (5) often by an additional cerclage. This will reattach the retina *on the table* for today, however, the operation is more than expensive concerning: The time for repair of a retinal detachment including subsequent reoperations, personnel, equipment, and injected tamponades. In addition, the rate of reoperations after primary vitrectomy is still significantly higher than after minimal buckling without drainage. Even when applying the full armamentarium of i.o. surgery, the premise cited over and over for sustained retinal reattachment remains as true as ever:

"The break - the cause of detachment - has to be found and closed once and for all."

In this context the recent results of the European Multicenter Study comparing primary vitrectomy with scleral buckling (MPS-Study) for repair of a primary retinal detachment should be mentioned.[41,42] In this study buckling consisted in most cases in a cerclage with or without an additional buckle and with drainage of subretinal fluid. In phakic eyes the functional results were statistically significant better after scleral buckling than after

primary vitrectomy. In pseudophakic eyes the anatomical results after primary vitrectomy, if combined with a cerclage, were better. But the final results after both procedures were comparable, if several reoperations were added.

However, whatever technique for reattaching the retina will be selected,

AT PRESENT FOUR REQUIREMENTS HAVE TO BE FULFILLED:

- (1) Only one 1 operation should reattach the retina.

- (2) The operation should have a minimum of morbidity.

- (3) The operation should be done under local anesthesia and on a small budget.

- (4) The operation should provide long-term visual function, not jeopardized by secondary complications requiring additional operations during the prolonged life expectancy of the patient.

OUTLOOK

At this point we have to wait whether e.o. minimal segmental buckling will still remain an optimal technique for reattaching a retina and this in particular in phakic eyes. In addition, we will have to define clearly in which conditions of a retinal detachment a primary vitrectomy will be the better option. More recent publications[43,44] indicate a further widening of the spectrum of primary vitrectomy, such as, for detachments with breaks at different latitudes, detachments with choroidals or with inadequate view to the fundus. The newly developed 23-, 25- and 27-gauge instruments for vitrectomy might be able to reduce further the morbidity of i.o. surgery and in particular the rate of PVR.[45-47] But first of all, we have to wait for the long-term results: 1. Whether primary vitrectomy will fulfill the four listed requirements of an optimal technique for reattaching a retina and 2. whether it will achieve retinal reattachment during follow-up without secondary complications which would require reoperation or jeopardize regained visual acuity.

On the other hand, it might be also possible that the pendulum, as often witnessed during the past 80 years, will again swing back from i.o. surgery to minimal e.o. surgery, limited to the break. Our present financial situation might even force us to think about a minimal surgery at low costs. This might be even more requested since the resources for ophthalmology are continously decreasing and this at the same time combined with a tremendous increase of new expensive treatment options for various macular and vascular diseases.

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