Changing Concepts in the Surgical Repair of Primary Retinal Detachment (Part 2): Comparison of Four Current Surgical Techniques for Repair of Primary Retinal Detachments

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The second part of this literature review deals with the comparison of two intraocular (pneumatic retinopexy and primary vitrectomy) and two extraocular (segmental sponge buckle without drainage, i.e. minimal extraocular surgery and the temporary balloon operation) procedures used to seal off the leaking break in primary retinal detachments. The outcomes, rate of complications and reoperations will be compared among these procedures.

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INTRODUCTION

Part 1 of this literature review presented changing concepts in surgical repair of primary retinal detachments over the past 75 years leading to the introduction of 2 extraocular and 2 intraocular surgical procedures at the beginning of the 21st century. The prerequisite for the success with any of these methods is that the break has to be found and sealed off sufficiently. This is achieved differently in each method and the emphasis on the retinal break varies significantly. But one question remains: Which method is more efficient?

On one hand, an extraocular approach exists in which exclusive treatment of the leaking break is performed without drainage followed by segmental buckling either with a temporary balloon or with a sponge sutured to the sclera, the so-called extraocular minimal surgery. But it should be mentioned that many of the present extraocular detachment surgeons still use cerclage with extensive coagulations to seal off the leaking break(s) and other suspicious areas in the retinal periphery together with drainage of subretinal fluid. Actually, they have not adhered to the Custodis principle[1]: "Surgery limited to the area of the leaking break(s) without subretinal fluid drainage".

On the other hand, intraocular approaches to the leaking break in primary detachment exist which include pneumatic retinopexy with coagulations limited to the area of the break, as suggested by Hilton[2] in 1986; creating a circular barrier of coagulations (a kind of a cerclage of coagulations)[3] spread over the entire retinal periphery modified by Tornamb[4] in 2000 (without gas injection); and vitrectomy with gas injection, combined with coagulations, which might be placed over the entire retinal periphery, or with the addition of cerclage.

These surgical procedures follow different

concepts. Some limit surgery to the area of the leaking break, while others extend surgery prophylactically over the entire retinal periphery to seal off detected and undetected breaks in the "porous" retina by a virtual cerclage of coagulations or by buckle cerclage. Both types of surgery may be performed with an extraocular or intraocular approach.

According to different reports,[2,5-15] retinal reattachment may be achieved in 94 to 99% of cases with primary retinal detchment. But where lies the difference? When comparing the efficacy of procedures with such close success rates one should consider the morbidity of each procedure such as rate of postoperative proliferative vitreoretinopathy (PVR), new break formation, reoperations, and secondary complications which might jeopardize long-term visual function and require additional surgery in the anterior or posterior segment to maintain vision. Therefore, in this literature review, a comparison of different surgical procedures with vaying approaches for closing off leaking retinal breaks will follow in relation to morbidity. In this comparison, extraocular surgery will be represented by the segmental sponge buckle and the temporary balloon procedure without drainage; whereas intraocular surgery will be represented by pneumatic retinopexy and primary vitrectomy.

SURGICAL TECHNIQUES

1. Pneumatic Retinopexy versus Temporary Balloon Buckle

To compare these two techniques, 500 primary retinal detachments with uncomplicated breaks that were treated with an intraocular gas injection,[2,7-15] called pneumatic retinopexy are compared with 500 eyes which underwent the extraocular temporary balloon buckle procedure.[16] After absorption of the gas bubble, retinal reattachment decreased from 91% to 80% (redetachment rate of 11%) (table 1). On the other hand, after removal of the temporary balloon buckle underlying the coagulated breaks, retinal reattachment decreased from 93% to 91%, (redetachment rate of 2%) (table 2). The rate of redetachment following pneumatic retinopexy was 5 times greater than the extraocular balloon operation. Furthermore, postoperative PVR and new break formation were 20 and 10 times more frequent in pneumatic retinopexy as compared to temporary balloon buckling (tables 1 & 2).

2. Pneumatic Retinopexy versus Primary Vitrectomy

Two questions should be addressed. (1) Is there any difference in the rate of complications if a gas bubble is injected into the vitreous and coagulations are limited to the area of the leaking breaks or if the gas bubble is injected into the eye after complete vitrectomy and coagulations are extended over the entire retinal periphery? (2) Does additional vitrectomy reduce the rate of post-operative PVR and reoperations? The results of primary pneumatic retinopexy[15,17-27] and primary vitrectomy[28-37] are listed in tables 3 and 4, respectively. The degree of uncomplicated primary detachments differs slightly in the 2 groups; however, the detachments had one common feature: all of them could have been treated with an external buckle. Selection of primary pneumatic retinopexy or primary vitrectomy depended on the preference of the individual surgeon.

The rate of re-operation and PVR was 26% and 6.1% after pneumatic retinopexy versus 24.5% and 11.5% after primary vitrectomy, respectively. The rate of reoperation was remarkably similar with both surgical procedures but the rate of PVR was higher after vitrectomy. The expected decrease in PVR and re-operations was not achieved by the addition of vitrectomy prior to gas injection.

3. Primary Vitrectomy versus Extraocular Minimal Surgery

The questions are whether a leaking break in primary rhegmatogenous retinal detachment is better treated by external buckling or by vitrectomy; whether buckling should be limited

to the area of the break or extended over the retinal periphery; and whether an intraocular procedure should be applied to seal off the leaking break. The results after cerclage[15,38] are comparable to those after segmental buckling. However, the available data on scleral buckling with cerclage are not homogenous. The reported series are not limited to primary retinal detachments, treatment consisted of cerclage with or without additional buckling, the extent of coagulations differed (limited to the leaking break or all over the cerclage buckle) and subretinal fluid drainage was not performed consistently.

Table 1 Results and complications of pneumatic retinopexy and reoperation of uncomplicated primary retinal detachments

Surgeon	Detachment	Reattachment			Postoperative	
		with gas	After gas absorption	After 1-3 reoperations	new breaks	PVR
Hilton[2]	20	20	18	20	1	1
Dominguez[7]	43	43	40	42	2	1
Effentèrre[8]	60	54	51	59	7	1
Gnad[9]	27	25	24	27	1	0
Hilton[10]	100	91	84	98	7	3
Poliner[11]	13	12	9	13	2	1
Bovey[12]	27	19	18	27	8	2
Chen[13]	51	40	32	NA	11	5
McAllister[14]	56	48	40	56	11	1
Tornambe[15]	103	102	82	102	24	3
Total	500	454 (91%)	398 (80%)	444 (99%)	74 (15%)	18 (4%)

PVR: proliferative vitreoretinopathy, NA: not available

Table 2 Results and complications of the balloon operation and reoperation of uncomplicated primary retinal detachments

Surgeon	Detachment	Reattachment				Postoperative	
		With balloon	After balloon withdrawal	after 1 reoperation	after 2 reoperations	new breaks	PVR
Kreissig[16]	500*	466 (93%)	454 (91%)	490 (98%)	493 (99%)	7 (1.4%)	1 (0.2%)

PVR: proliferative vitreoretinopathy

* Consisting of 470 primary detachments and 39 reoperations of which 5 detachments had PVR C1-C2

Table 3 Complications of pneumatic retinopexy and reoperation of primary retinal detachments

Surgeon	Detachment	Reoperation	PVR
Tornambe[15]	103	28	3
Algvere[17]	58	21	8
Lowe[18]	55	10	3
Termote[19]	20	4	1
Skoog[20]	50	9	-
Lemmen[21]	54	27	3
Berrod[22]	56	19	9
Algvere[23]	51	7	2
Bochow[24]	17	5	2
Sebag[25]	45	6	2
Gunduz[26]	30	3	1
Boeker[27]	133	36	7
Total	672	175 (26%)	41 (6.1%)

PVR: proliferative vitreoretinopathy

Table 4 Complications of primary vitrectomy with gas and reoperation of primary retinal detachments

Surgeon	Detachment	Reoperation	PVR
Escoffery[28]	29	6	2
Wong[29]	47	19	-
Rosen[30]	78	14	9
Hakin[31]	124	44	25
Gartry[32]	114	30	10
Hoeing[33]	32	7	6
Bartz-Schmidt[34]	33	2	1
Heimann[35]	53	19	9
El-Asrar[36]	22	0	1
Oshima[37]	63	5	0
Total	595	146 (24.5%)	63 (11.5%)

PVR: proliferative vitreoretinopathy

Therefore, for the comparison of scleral buckling versus primary vitrectomy, a Medline search was made of all reports that were identified by the search terms "retinal detachment", "segmental buckling", "minimal extraocular surgery", and "nondrainage." The search revealed 5 homogenous reports with a total of 1,462 retinal detachments.[5,16,39-43] The treated detachments presented various types of leaking breaks, the detachments were aphakic or pseudophakic in 8.3%, and preoperative PVR stage C1-C2 was present in 2.9% (table 5).

All operations were performed under local anesthesia and the primary procedure was minimal segmental buckling with coagulations limited to the breaks in all eyes. Subretinal fluid was not drained in any eye. The coagulation consisted of intraoperative cryopexy under ophthalmoscopic control or laser coagulation on the day after the retina was re-attached. An elastic silicone sponge or a temporary balloon was used for segmental buckling; no cerclage was applied.

After minimal segmental buckling without drainage, primary retinal reattachment was achieved in 91% and increased to 97%, which persisted during a 2-year follow up (table 6). The causes of final failure included PVR stage C1-C2 in 28 eyes (1.9%), despite the fact that PVR was present preoperatively in 43 eyes; missed breaks in 12 eyes (0.8%), and suprachoroidal hemorrhage in 4 highly myopic eyes (0.3%). In a more recent meta-analysis of 1,854 segmental buckle procedures (sponge and balloon) with cryopexy and without drainage, published by Lincoff et al[44] in 2005, the postoperative rate of PVR was even further decreased to 0.9%.

Table 5 Preoperative characteristics of primary retinal detachments treated with minimal segmental buckling (sponge or balloon) without drainage

Series No.	Detachment	Aphakia/ Pseudophakia	Perforating injury	Reoperation	PVR stage*		Myopia >7-25 D
					C1	C2	
1[39,42]	752	30	–	7	5	-	NA
2[5,43]	107	22	–	–	12	4	9
3[40]	35	3	–	–	5	1	5
4[41]	68	5	1	–	11	-	5
5[16] **	500	62	3	30	3	2	71
Total	1,462	122 (8.3%)	4 (0.27%)	37 (2.5%)	43 (2.9%)		

PVR: proliferative vitreoretinopathy, D: diopter, NA: not available
* present preoperatively ** treated with balloon

Table 6 Reattachment after minimal segmental buckling (sponge or balloon) without drainage and reoperation of primary retinal detachments during a 2-year follow-up

Series No.	Detachment	Preoperative PVR C1-C2	Primary Reattachment	Reoperation	Final Reattachment	PVR C1-C2	Missed break	Suprachoroidal hemorrhage
1[39,42]	752	5	672	60	732	14	4	3
2[5,43]	107	16	99	5	104	4	3	–
3[40]	35	6	35	–	35	–	–	–
4[41]	68	11	65	3	60	8	–	–
5[16*]	500	5	454	39	493	2	5	1
Total	1,462	43 (2.9%)	1,325 (91%)	107 (7.3%)	1,424 (97%)	28 (1.9%)	12 (0.8%)	4 (0.3%)

PVR: proliferative vitreoretinopathy * treated with balloon

Visual function was described in 4 of the 5 series; mean visual acuity was 0.67 after 2 years (table 7). Currently, the longest follow-up in terms of postoperative visual acuity is available only after extraocular segmental buckling. With this procedure visual acuity remains favourable

even after 15 years, without being jeopardized by secondary complications.[43] No statistically significant difference was found in visual acuity between operated eyes and the fellow eye during a 15-year follow-up. The observed slight decrease in visual function over time was due to ageing and coincided with visual deterioration after the age of 60, as determined by Slataper[45].

Table 7 Visual acuity 2 years after minimal segmental buckling (sponge or balloon) without drainage and reoperation of primary retinal detachments

Series No.	Detachment	Preoperative PVR C1-C2	Reoperation	Final re-attachment	Mean VA
1[39,42]	752	5	60	732	NA
2[5,43]	107	16	5	99	0.6
3[40]	35	6	–	35	0.6
4[41]	68	11	3	60	0.3
5[16]*	500	5	39	493	0.7
Total	1,462	43 (2.9%)	107 (7.3%)	1,424 (97%)	0.67

PVR: proliferative vitreoretinopathy, VA: visual acuity, NA: not available
* treated with balloon

DISCUSSION

This review demonstrated that for closing off a leaking break in primary retinal detachments, the same rate of reattachment can be obtained with extraocular segmental buckling and intraocular surgery. However, the morbidity, implying the rate of reoperations and redetachments, is significantly higher after intraocular surgery.

Keeping in mind that intraocular surgery currently requires several operations for long-term reattachment, the question that arises is whether short- and long-term visual function can be as favourable after intraocular surgery as after extraocular surgery.

With the present trend toward intraocular surgery, various investigators have compared primary vitrectomy with scleral buckling. However, the authors chose to compare primary vitrectomy with extensive surgery consisting of cerclage combined with additional buckles, extensive coagulations, subretinal fluid drainage and often, intraocular tamponade. Such comparison concluded that scleral buckling, i.e., cerclage, has higher morbidity than primary vitrectomy. But if the authors had compared primary vitrectomy with minimal segmental buckling without drainage, they would have found that segmental buckling has less morbidity than primary vitrectomy, i.e., 6 times less postoperative PVR and 3 times less re-operations.

So what drives the increasing use of primary vitrectomy for uncomplicated detachments? One important factor is that the new generation of detachment surgeons is inadequately trained (1) in the art of detecting the retinal break, (2) in the skill of tamponading it effectively with minimal buckling, and (3) in achieving this without subretinal fluid drainage. In addition, the newly trained retinal detachment surgeons, now already called vitreoretinal surgeons, are enthusiastic about developing vitrectomy technology. This type of surgery offers further applications in macular holes, submacular surgery, diabetic macular edema, de-sheathing in retinal branch vein occlusion, macular rotation in age-related macular degeneration, neurotomy of the optic disc, etc. The present vitreoretinal surgeon is so involved with these new options that the time-consuming preoperative diagnostic evaluations for the leaking break which are essential for success with extraocular minimal buckling, which is also not adequately reimbursed by insurance, no longer seem to be attractive. Instead, the detachment patient is brought into the operating room, to search for the leaking

break with the great optics of the binocular indirect ophthalmomicroscope. But this is now done in an expensively equipped operating theatre with the additional expense of the personnel in attendance. If the break is not found or the media seems to be problematic, the full spectrum of intraocular surgery can be applied: (1) phacoemulsification with intra-ocular lens implantation in phakic eyes and anterior vitrectomy to reconstruct the anterior segment in pseudophakic eyes, (2) application of a barrier of coagulations in the retinal periphery, (3) use of expensive heavy perfluorocarbon liquids to reattach the retina, (4) filling the eye with gas or silicone oil, and (5) a cerclage. This will reattach the retina already on the table for today; however, the operation is more than expensive concerning time, personnel, equipment, and injected tamponade. In addition, the rate of reoperations will be significantly higher than minimal buckling without drainage.

Despite application of this full armamentarium of intraocular surgery, the premise for sustained retinal reattachment remains as true as ever: "The leaking break, the cause of detachment or redetachment, has to be found and closed once and for all". This becomes more obvious when comparing the causes of failure after intraocular and extraocular surgery. In a recent series of 171 primary detachments treated with primary vitrectomy,[46] the cause of failure was a missed and still leaking break in 64.3%. In another series of 962 rhegmatogenous retinal detachments, treated with segmental sponge without drainage, the cause of primary failure was a missed break in 43% and an insufficiently tamponaded break in 35% (table 8). Therefore, the addition of vitrectomy, intended to remove the presumed culprit of surgical failure, has not been eliminated. The leaking retinal break remains the main cause for primary failure. This validates the postulate of Gonin,[47] defined about 75 years ago: "The retinal break is the cause of a retinal detachment".

Consequently, we still have to concentrate on the retinal break. The leaking break will continue to be the "red thread" which has already accompanied preceding generations of detachment surgeons and which will have to guide future efforts to reattach the retina once and for all.

Table 8 Causes of primary failure after a single session of minimal segmental buckling without drainage in primary retinal detachment

Series No.	Reasons for Primary Failure				Total
	Missed break(s)	Inadequate buckle	PVR	Suprachoroidal hemorrhage	
1[39,42] (n= 752)	31+2*	27	17	3	80
2[5,43] (n= 107)	4	4	-	-	8
3[40] (n= 35)	-	-	-	-	-
4[41] (n= 68)	2	1	-	-	3
Total (n= 962)	39 (43%)	32 (35%)	17 (19%)	3 (3%)	91

* Macular hole

The future requirements of an optimal technique for repair of a primary retinal detachment will be:

1) A single operation should reattach the retina once and for all.
2) The surgery should have a minimum rate of morbidity.
3) The procedure should be performed on a small budget and under local anesthesia.
4) The operation should provide the best long-term visual function, not jeopardized by secondary complications during the life expectancy of the patient.

Outlook

At this point in time we have to wait and see: (1) whether extraocular surgery, limited to the breaks, will remain an optimal approach for reattaching a retina. (2) Whether the current trend toward primary vitrectomy, an intraocular surgical approach will prove it to be the method of choice. Or (3) whether intraocular surgery will be further refined to an operation with less morbidity, higher rate of primary reattachment and lower rate of secondary operations. The newly developed 25- and 23-gauge vitrectomy systems might represent such refinement; however, we have to wait for the long-term results.[48,49] It may also be possible, as often witnessed during the past 75 years, that the pendulum will swing back to surgery limited to the area of the leaking break. Therefore, perhaps in this situation, the Custodis principle will be re-emphasized, once again and extraocular minimal surgery will be reapplied as a procedure with a low rate of morbidity, reoperations and secondary operations performed under local anesthesia with low cost and with a lower rate of secondary complications.

This might be more of an issue, when we become aware that available resources for ophthalmic care will diminish as life expectancy increases. New treatments for an increasing number of ageing people with macular and retinal diseases will be needed. This expanding spectrum of diagnostic and treatment modalities includes invasive and noninvasive procedures, which are often quite expensive. We might have to reconsider how to spend the limited financial resources for an increasing number of patients who require them.

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