Drain Fluid Cryo-Explant Technique for Treatment of Superior Bullous Rhegmatogenous Retinal Detachment

Kamal Solaiman (✉ kams_8866@yahoo.com)

Zagazig University Faculty of Human Medicine <https://orcid.org/0000-0001-9087-0437>

Mahmoud A Alaswad

Zagazig University

Ashraf Mahrous

Zagazig University

Khaled Salah

Zagazig University

Hesham A Enany

Zagazig University

Ahmad S Khalil

Zagazig University

Basem M Ibrahim

Zagazig University Faculty of Human Medicine

Research article

Keywords: Superior bullous retinal detachment, Scleral buckle, DFCE

Posted Date: April 30th, 2019

DOI: <https://doi.org/10.21203/rs.2.9420/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Background: Evaluation of the safety and efficacy of the Drain Fluid Cryo-Explant (DFCE) technique for management of uncomplicated superior bullous rhegmatogenous retinal detachment (RRD). **Methods:** A retrospective interventional case series study that included eyes with uncomplicated superior bullous RRD and a duration less than one month. The DFCE technique which involved sequential drainage of subretinal fluid (SRF), intravitreal fluid injection, cryotherapy and placement of a scleral explant(s). The primary outcome measure was the anatomical reposition of the retina after a single surgery. Secondary outcome measures included improvement in visual acuity and any reported complication related to the procedure. **Results:** The study included 52 eyes (52 patients) with a mean duration of retinal detachment 19.7 ± 6.4 days. A single retinal break was found in 31 eyes (59.6%) and more than one break were found in 21 eyes (40.4%). The mean detached area per eye was 6.3 ± 2.8 clock hours, and the macula was detached in 23 eyes (44.2%). The mean number of breaks per eye was 1.72 ± 1.04 . Flattening of the retina and closure of all retinal breaks were achieved in all eyes. Late recurrence of RD occurred in 2 eyes (3.9%) due to PVR. No retinal incarceration or retinal folding were reported. **Conclusions:** DFCE is an economic technique that could be effectively used for treatment of uncomplicated superior bullous RRD. It provides good visualization during surgery that allows accurate localization of all retinal breaks, proper placement of a relatively low buckle and precise application of cryotherapy to all margins of the retinal break(s).

Background:

Superior bullous rhegmatogenous retinal detachment is considered a surgical challenge due to high SRF with wide separation of retinal layers that interferes with accurate localization of retinal breaks and makes cryotherapy difficult to judge (1, 2). This condition was treated in the past by the drain air cryo-explant (DACE) technique which included sequential external drainage of SRF, intravitreal injection of air, cryotherapy application and placement of scleral explant (3). However, the main limitation of this technique was difficult visualization after intravitreal injection of air which might lead to difficult localization of retinal breaks, inaccurate placement of the buckle, missed retinal holes and recurrence of retinal detachment. Pneumatic Cryo Explant (PaCE) is another technique that was introduced to overcome the problem of difficult visualization during surgery encountered with DACE (4). It is a two-stage technique in which C3F8 was injected intravitreally with postoperative proper head positioning to allow absorption of SRF. After that cryo retinopexy and scleral buckling were performed in a second surgery. However, it had the disadvantages of two stages surgery, prolonged postoperative head positioning and incomplete absorption of SRF. These were the reasons of shifting treatment of such cases to pars plana vitrectomy which has achieved a great success in treatment of such cases (5, 6, 7). However, the cost of pars plana vitrectomy could not be afforded by many patients in the developing countries. Prolonged postoperative head positioning as well as cataract and removal of the lens are common if intraocular gas or silicone are used with vitrectomy (6, 8, 9). Also, if silicone oil is used, a second operation for its removal is usually needed with the risk of recurrence of detachment in a significant percentage of patients (6, 9).

In this study, eyes having uncomplicated superior bullous RRD were treated with the drain fluid cryo-explant (DFCE) technique. In this technique, fluid was injected intravitreally, instead of the air used in DACE; while draining the SRF. This was followed by cryotherapy and placement of a scleral explant(s). This helped to reposition the detached retina and maintain the eye volume and pressure without interference with visualization during surgery. We could not find any published data reporting the results of DFCE technique in eyes with superior bullous RRD before this study. So the aim of this study is to describe the DFCE technique and to evaluate its safety and efficacy in the management of uncomplicated superior bullous RRD.

Methods:

A retrospective interventional study in which a consecutive series of eyes that were admitted for surgical repair of superior bullous RRD in a private eye hospital were studied. During the period from July 2013 to March 2017, the patients' medical records were revised for this retrospective analysis. An informed written consent was obtained from all the participants before surgery. Ethics approval was obtained from the Institutional Review Board/Ethics Committee, in accordance with the Declaration of Helsinki. The study inclusion criteria were superior bullous RRD with identifiable retinal break(s), a duration less than 1 month and a clear viewing of the fundus. The detachment was considered bullous if the retinal break could not be approximated to the underlying retinal pigment epithelium by scleral indentation (3). Exclusion criteria included eyes with previous retinal detachment surgery, large retinal break, giant retinal tear, multiple breaks at different levels, proliferative vitreoretinopathy (PVR) grade B or more and pseudophakia or aphakia. Before surgery, all patients were subjected to full ophthalmic examination including logMAR of best corrected visual acuity (BCVA) and detailed fundus examination with a fully dilated pupil using the indirect ophthalmoscope, scleral indentation and slit lamp biomicroscopy. The extent of the retinal detachment, the site and number of retinal breaks, the depth of SRF between the retinal break and the retinal pigment epithelium, and the state of macula were also reported.

All patients were operated upon under general anesthesia. After performing a 360 degrees periotomy and isolation of the 4 recti muscles, a scleral incision was performed for drainage of SRF. The site of draining of SRF was always away from the vortex veins and was preferred to be below or above the corresponding horizontal rectus muscle according to the site and extent of retinal detachment. Traction on 4 recti muscles was done to elevate intraocular pressure while subretinal fluid was drained. Simultaneous intravitreal injection of balanced salt solution was done until the intraocular pressure was formed. This was accompanied with gradual release of traction on the recti muscles. After drainage of SRF, the site of drainage is sutured if not covered by the scleral explant. After that the retina started to be flattened and this allowed accurate localization of the retinal break(s) and precise cryotherapy of the margins of retinal breaks with proper positioning of the scleral explant under good visualization.

Soft silicon sponge and 5/0 Dacron sutures were used and according to the size, site and number of retinal break(s), radial and /or segmental scleral explant was put in the superior quadrant(s). Encircling 504-silicone sponge was performed when there were multiple breaks at different levels. Topical and

systemic antibiotic and anti-inflammatory drugs were used postoperatively. After examination in the first postoperative day, follow up examinations were scheduled every week for one month then monthly till the sixth month and every 3 months thereafter till the end of a year. In each visit, complete eye examination was done especially fundus and BCVA (logMAR). The primary outcome measure was initial anatomical success which is defined as complete retinal reattachment and closure of all retinal breaks with no subretinal fluid after a single surgery. Secondary outcome measures were changes in the BCVA and any complication related to the surgical procedure. Reoperation was indicated when there was persistent or recurrent retinal detachment with increasing amount of subretinal fluid occurring any time during the follow up period.

Results:

The study included 52 eyes (52 patients) which had uncomplicated superior bullous RRD and were eligible with the inclusion criteria of the study. The age range was 29 - 67 years with a mean of 49.46 ± 9.61 years. Male patients were 33 (63.5%) while female patients were 19 (36.5%). The duration of retinal detachment at the time of surgery ranged between 8 days and 30 days with a mean of 19.72 ± 6.37 days. Thirty-nine eyes (75%) were myopic. A single retinal break was found in 31 eyes (59.6%) and more than one break in 21 eyes (40.4%). A flap tear was found in 26 eyes (50%). In all eyes, the retinal breaks were found above the horizontal meridian. The mean detached area per eye was 6.21 ± 2.74 clock hours and the macula was detached in 23 eyes (44.2%). The preoperative mean logMAR BCVA was 0.65 ± 0.19 (20/100). All eyes were phakic with clear lens. Table (1) shows the demographic and preoperative data of all patients.

All surgeries were performed under general anaesthesia and using the same technique of DFCE. External drainage of SRF was performed in all eyes. Segmental buckle (504-silicone sponge) was used in 33 eyes (63.5%), radial buckle (505-silicone sponge) was used in 8 eyes (15.4%), combined radial and segmental buckle was used in 2 eyes (3.9%) and encircling buckle was used in 9 eyes (17.3%). The postoperative mean logMAR BCVA has improved significantly to 0.31 ± 0.11 (20/40) ($P < 0.05$) at the end of the follow up period.

Intraoperative complications were mild and were not significant. Mild vitreous haemorrhage occurred in 2 eyes (1.9%). Minimal residual SRF due to incomplete drainage was found in 7 eyes (13.5%) but in all these eyes the retinal tear was approximated to the retinal pigment epithelium with the cryo-probe and the surgery completed as planned with spontaneous absorption of the residual SRF postoperatively. Subretinal hemorrhage occurred at the drainage site in 5 eyes (9.6%), and was treated by temporarily raising the intraocular pressure during surgery. Postoperative diplopia without restriction of motility occurred in two eyes (3.9%), and in both the explant was beneath a vertical muscle. In one of them diplopia could not be tolerated and the explant was removed after 2 months, and fortunately the retina remained attached till the end of follow up. Recurrence of RD occurred in 2 eyes (3.9%); one eye in the third and the other in the fifth postoperative month, and both were due to PVR. No missed retinal hole had been detected in any of the eyes of the study. Nuclear cataract was detected 9 months after surgery in one eye (1.9%).

Postoperative elevation of IOP occurred in five eyes (9.6%) early after surgery, but IOP was normalized within few weeks of treatment with anti-glaucoma agents. No retinal incarceration at the site of drainage of SRF and no retinal folding were reported in this study. Operative and postoperative results are summarized in Table (2).

Discussion:

Since the introduction of the scleral buckling procedure in 1949 by Ernst Custodis (10), it remained the gold standard treatment modality for rhegmatogenous retinal detachment for a long time. The introduction of vitrectomy by Machemer (7) in the early 1970s has expanded the scope of management of many complex vitreoretinal disorders with a visual outcome that approaches or even exceeds that achieved with scleral buckling. The studies (3, 6) investigated the use of scleral buckling in eyes with superior bullous RRD are few especially after the era of vitrectomy. Elimination of vitreous floaters, diminished postoperative pain and absence of postoperative diplopia are definite advantages of vitrectomy over scleral buckling (7, 13). However, scleral buckling may be preferred to vitrectomy for cases that could be equally treated with either scleral buckling or vitrectomy, due to many reasons: first, strict continuous head positioning in the first few days after vitrectomy is difficult to adhere to by many patients. Second, vitrectomy could be associated with iatrogenic retinal tears. Posterior hyaloid is sometimes taught and difficult to be separated from retina with the possibility of iatrogenic retinal break in young patients undergoing vitrectomy (12). Third the possible postoperative complications of using intraocular gas or silicone oil such as cataract and IOP elevation (9, 11). Also, if silicone oil is used in vitrectomized eyes, it will necessitate a second surgery for its removal with the risk of recurrence of retinal detachment in a significant percentage of patients (9). Finally, the financial cost of scleral buckling is less than that of vitrectomy. A study compared the surgical outcome of vitrectomy and scleral buckling for uncomplicated superior retinal detachment reported an equal initial success rate for both techniques (6).

The use of scleral buckling for treatment of superior bullous RRD is challenging as the detached retina is high with deep SRF. This makes accurate localization of retinal breaks difficult and consequently inaccurate placement of the scleral buckle. Also, application of cryotherapy is difficult to judge, and excessive cryotherapy is frequently used. Treatment of such cases by scleral buckling alone without drainage of SRF was reported to have a high failure rate of 27.7% (13/47) (3). The introduction of external drainage of SRF (14) has improved the results, as the depth of SRF could be reduced significantly, but with a high possibility of formation of radial folding of the retina and a high reoperation rate in eyes with bullous detachment (1, 3). Also, a high failure rate (33.3%) has been reported by using scleral buckling with drainage of SRF and cryotherapy (3).

In 1985, Stanford and Chingell (3) have introduced the Darin Air Cryo-Explant (DACE) technique in which about 2 ml air were injected into the vitreous cavity after external drainage of SRF and prior to cryotherapy and scleral buckling. This helped to completely flatten the detached retina and approximate it to the underlying retinal pigment epithelium without retinal folds. They reported a success rate of 96% (24/25 eyes) without serious complications by using this technique. However, DACE technique could be

associated with many obstacles such as difficult visualization and localization of retinal breaks, inaccurate placement of the buckle, passage of air under the retina if the retinal break is large, and postoperative posterior subcapsular cataract if air comes into contact with the lens (1). Some surgeons recommended removal of air prior to cryotherapy and placement of the buckle, but this will consume more time and could be difficult if the injected air formed multiple intravitreal bubbles. In a study that reported the results of 138 eyes having RRD due superior flap retinal tears and were treated by DACE technique, recurrence of RD occurred in 11 eyes (8%) and in all was due to inaccurate placement of buckle (6). In our study, no recurrence due inaccurate placement of the buckle was reported.

Although the DFCE technique was described many years ago (15), but this might be the first study to report the results of this technique since it had been described. DFCE is a low-cost procedure that is frequently applicable in developing countries where the vitrectomy machine and the use of gas are not always available in every hospital. Even when they are available, few patients only can afford the high cost of vitrectomy. In the DFCE technique, intravitreal BSS is injected; instead of air, via the pars plana simultaneous with external drainage of SRF. This counteracts the hypotony caused by drainage of large amount of SRF and allows proper reposition and flattening of the detached retina against the RPE without formation of retinal folds. Unlike air, BSS does not obscure visualization during surgery and thus allows accurate localization of all retinal breaks and proper placement of scleral buckle in a shorter time. Cryotherapy can be applied more precisely to the edges of the retinal breaks and a relatively low scleral buckle can be applied to support all margins of the break. The intraocular volume can be easily adjusted and controlled during surgery. After surgery, no need for head positioning in the early postoperative days to avoid posterior subcapsular cataract that might occur with DACE if air comes in contact with the lens.

The chance of fluid to run out of the drainage site in such cases is minimal. At least this was not reported in any of our cases for the following reasons: *first*, no large retinal break was found in all eyes of the study as this was one of the exclusion criteria. *Second*, there were no traction on the edges of the retinal break(s) or the flap as the study did not include eyes with PVR grade B or more. *Third*, retinal break(s) was found in the superior quadrant(s), while fluid was injected into the middle of vitreous cavity away from the retinal break. This restores the normal IOP and allows the vitreous gel to temporarily occlude the retinal break without reaccumulation of SRF, till application of cryotherapy and formation of chorioretinal adhesion.

The success rate achieved with DACE technique ranged between 90% and 96% (3, 6, 16), and the recurrence in all failed cases in these studies was due to inaccurate placement of the buckle (3, 6). The success rate achieved in this study using DFCE technique was (96%), and is comparable to the success rate achieved with DACE. In all cases of the study the buckles were accurately placed in relation to the retinal tears, because visualization was not obscured during surgery as happened with DACE. No retinal incarceration at the site of drainage of SRF was reported in this study. This could be because a small sclerotomy opening was always used and the injection of fluid was cautious without elevation of the IOP. Also, no retinal folding reported in all eyes of the study because encircling buckle, which increases the incidence of retinal folding, was used in 9/52 eyes (17.3%) only, and in all it was of a relatively low height

due to flattening of the retina after drainage of SRF. Also, the simultaneous guarded injection of fluid intravitreally during drainage of SRF maintained the intraocular volume and prevented hypotony which is a common cause of retinal folding. Mild subretinal hemorrhage occurred near the drainage site in 5 eyes (9.6%). Minor bleeding from choroid at the sclerotomy site is the most common complication of draining SRF (16). Postoperative elevation of IOP in 5 eyes (9.6%) was temporary and controlled by anti-glaucoma medications. The cataract detected 9 months after surgery in one eye (1.9%) was most probably a senile cataract as it was bilateral and nuclear. No complicated cataract was reported in all the operated eyes during the duration of the study. Preserving lens clarity and accommodation is a great advantage of this technique especially in young patients. Cataract is a common complication following vitrectomy (17, 18) and some surgeons are doing simultaneous lens extraction in patients over a certain age even if they have a relatively clear lens. No iatrogenic retinal tear was reported in all eyes.

No recurrence of retinal detachment has occurred in the early postoperative period in this study because flattening of the retina and good visualization during surgery permit accurate localization of the retinal breaks, proper placement of the buckle and avoid excessive cryotherapy. Late recurrence of retinal detachment occurred in two eyes (3.9%) during the third and fifth postoperative months and was due to development of PVR and reopening of the retinal tear. Both were treated with vitrectomy and intravitreal gas injection. The presence of scleral buckle in such cases is expected to add to the success of the vitrectomy procedure. A study compared the results of vitrectomy with and without encircling buckle for superior RRD had reported an initial success rate 100% in the former and 86.3% in the latter group (6), indicating that adding encircling buckle increases the success rate of vitrectomy for such cases. The incidence of postoperative PVR has been reported to be 8 -20% in eyes undergoing vitrectomy and 5 -10% in eyes undergoing scleral buckling (5, 18-20), while in this study it was 3.9% over a year. This may be because eyes included in this study had uncomplicated RRD, the duration of detachment was less than one month and no excessive cryotherapy was used.

In conclusion, DFCE technique is a one stage surgery that could be effectively used for treatment of uncomplicated superior bullous RRD in which there is no PVR grade B or more and the retinal break(s) is not large. DFCE provides good visualization during surgery and this allows accurate localization of all retinal breaks, proper placement of a relatively low buckle and precise application of cryotherapy to all margins of the retinal break(s). It is an economic technique with a lower cost than vitrectomy and could be of great benefit especially in developing countries. Also, it could be beneficial for young myopic patients with clear lens, who are liable to iatrogenic retinal tear and cataract if treated by vitrectomy.

Abbreviations:

Drain Fluid Cryo-Explant(DFCE),Rhegmatogenous Retinal Detachment(RRD),Subretinal Fluid(SRF),Drain Air Cryo-Explant(DACE),Pneumatic Cryo-Explant(PaCE), Proliferative Vitreoretinopathy(PVR),Best Corrected Visual Acuity(BCVA), Intraocular Pressure(IOP).

Declarations:

- Ethics approval and consent to participate, in accordance with the Declaration of Helsinki, was obtained from the Institutional Review Board/Ethics Committee, Alpha-Vision Eye Center. IRB No.: 2/21-01-2018
- An informed written consent was obtained from all the participants before surgery.
- Consent for publication: Not applicable
- The datasets used and /or analysed during the current study are available from the corresponding author on reasonable request.
- The authors declare that they have no competing interests.
- The authors did not receive fund from any organization.
- Authors' Contributions:

KS assisted in performing the surgery and was the main contributor in writing the manuscript and interpretation of the results. MA and AM were the main surgeons in all cases. Kh S, HE, AK and BI were responsible for preoperative examination of patients, postoperative examination and follow up and reporting of patients' data.

- Acknowledgements: Not applicable

References:

- 1- Chignel AH, Fison LG, Davies EWG, Hartley RE, Gundry MF. Failure in retinal detachment surgery. Br J Ophthalmol 1973; 57: 525 – 30.
- 2- Laqua H, Machemer R. Repair and adhesion mechanisms of the cryotherapy reaction in experimental retinal detachment. Am J Ophthalmol 1976; 81: 833 – 46.
- 3- Stanford MR, Chignell AH. Surgical treatment of superior bullous rhegmatogenous retinal detachments. Br J Ophthalmol 1985; 69: 729 – 32.
- 4- Saeed M, Ganishalingham R, McHugh D. PaCE: a technique to avoid subretinal fluid drainage in retinal detachment surgery. Acta Ophthalmol Scand 2006; 84 (1): 47 – 53.
- 5-Escoffery RF, Olk RJ, Grand MG, Boniuk I. vitrectomy without scleral buckling for primary rhegmatogenous retinal detachment. Am J Ophthalmol 1985; 99: 275 – 81.
- 6- Miki D, Hida T, Hotta K, Shinoda K, Hirakata A. Comparison of scleral buckling and vitrectomy for retinal detachment resulting from flap tears in superior quadrants. Jap J Ophthalmol 2001; 45 (2): 187 - 91.

- 7- Machemer R. The development of pars plana vitrectomy: a personal account. Graefes Arch Clin Exp Ophthalmol 1995; 233: 453 -68.
- 8- Ogora Y, Kitagawa K, Ogino N. Prospective longitudinal studies on lens changes after vitrectomy-quantitative assessment by fluorophotometry and refractometry. Nippon Ganka Gakkai Zasshi (Jpn J Clin Ophthalmol) 1993; 627 – 31.
- 9- Gallemore RP, McCuen BW, 2nd. Silicone oil in vitreoretinal surgery. In: Ryan SJ, editor. Retina. 4th ed. Vol. 3. Philadelphia, PA: Mosby; 2006. Pp.2211 -34.
- 10- Custodis E. Bedeutet die Plombenaufnahme auf die Sklera einen Fortschritt in der operativen Behandlung der Netzhautablosung? Ber Zusammenkunft Dtsch Ophthalmol Ges 1953; 58: 102 – 5.
- 11- Chang S. Intraocular gases. In: Ryan SJ, editor. Retina. 4th ed. Vol. 3. Philadelphia, PA: Mosby; 2006. Pp.2165 -77.
- 12- Dogramaci M, Lee EJK, Williamson TH. The incidence and risk factors for iatrogenic retinal breaks during pars plana vitrectomy. Eye (Lond.). 2012; 26 (5): 718 -22.
- 13- Mason JO, 3rd, Neimkin MG, Mason JO, 4th, et al. Safety, efficacy , and quality of life following sutureless vitrectomy for symptomatic vitreous floaters. Retina 2014; 34 (6): 1055 - 61.
- 14- Charles ST. Controlled drainage of subretinal and choroidal fluid. Retina 1985; 5 (4): 233 – 4.
- 15- Wilkinson CP, Rice TA. Complicated types of retinal detachment. In: Michels RG, ed. Retinal Detachment. 2nd ed. Vol. 2. St Louis: Mosby, 1997. Pp 641 – 771.
- 16- Gilbert C, McLeod D. D-ACE surgical sequence for selected bullous retinal detachments. Br J Ophthalmol 1985; 69: 733 – 6.
- 17- de Bastors S, Thompson JT, Michels RG, Enger C, Rice TA, Glaser BM. Nuclear sclerosis after vitrectomy for idiopathic epiretinal membranes. Am J Ophthalmol 1988; 105: 160 – 4.
- 18- Gartry DS, Chingell AH, Franks WA, Wong D. Pars plana vitrectomy for the treatment of rhegmatogenous retinal detachment uncomplicated by advanced proliferative vitreoretinopathy. Br J Ophthalmol 1993; 77: 199 – 203.
- 19- Heimann H, Bornfeld N, Friedrichs W, et al. Primary vitrectomy without scleral buckling for rhegmatogenous retinal detachment. Graefes Arch Clin Exp Ophthalmol 1996; 234: 561 – 8.
- 20- Sharma T, Challa JK, Ravishakar KV, Murugesan R. Scleral buckling for retinal detachment. Retina 1994; 14: 338 – 43.

Tables

Table (1): Demographic and preoperative data of patients.

Number of patients (eyes)	52 (52)
Sex (Male/Female)	33 / 19
Mean age (Range)	49.46 $\pm$ 9.61 years (29-67)
Myopia	39 (75%)
Number of retinal breaks:	
Single	31 (59.6%)
Multiple	21 (40.4%)
Mean extent of RD (Clock hours)	6.21 $\pm$ 2.73
Macula (On / Off)	29/23
Mean duration of RD (Days)	19.72 $\pm$ 6.37
Mean logMAR BCVA	0.65 $\pm$ 0.19 (20/100)

Table (2): Operative and postoperative results.

Scleral explant:	
Segmental	33 (63.5%)
Radial	8 (15.4%)
Combined segmental/radial	2 (3.9%)
Encircling	9 (17.3%)
Intraoperative Complications:	
Vitreous hemorrhage	2 (3.9%)
Subretinal hemorrhage	5 (9.6%)
Retinal incarceration	0 (0%)
Retinal folds	0 (0%)
Inaccurate placement of buckle	0 (0%)
Postoperative Complications:	
Residual SRF	7 (13.5%)
IOP elevation	5 (9.6%)
Diplopia	2 (3.9%)
Recurrence of RD	2 (3.9%)
Mean logMAR BCVA (12 months):	0.31 ± 0.11 (20/40)