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Drain fluid cryo-explant technique for treatment of superior bullous rhegmatogenous retinal detachment in young adults

Kamal A.M. Solaiman, Ashraf Mahrous, Hesham A. Enany and Ashraf Bor'i

Abstract

Purpose: To evaluate the efficacy of the drain fluid cryo-explant (DFCE) technique for the management of uncomplicated superior bullous rhegmatogenous retinal detachment (RRD) in young adults.

Patients and methods: A retrospective study that included eyes with uncomplicated superior bullous RRD in patients ⩽40 years old. DFCE technique consists of sequential drainage of subretinal fluid, intravitreal fluid injection, cryotherapy, and placement of a scleral explant(s). The primary outcome measure was anatomical reposition of the retina after a single surgery. Secondary outcome measures included improvement in best corrected visual acuity (BCVA) and any reported complication related to the procedure.

Results: The study included 51 eyes which met the study eligibility criteria. The mean duration of detachment was 19.7 ± 6.4 days. A single retinal break was found in 31 eyes (60.8%), and more than one break were found in 20 eyes (39.2%). The mean number of breaks per eye was 1.72 ± 1.04. The mean detached area per eye was 7.21 ± 3.19 clock hours, and the macula was detached in 22 eyes (43.1%). Flattening of the retina and closure of all retinal breaks was achieved in all eyes after a single surgery. Late recurrence of retinal detachment occurred in two eyes (3.9%) due to proliferative vitreoretinopathy (PVR). No complicated cataract or iatrogenic retinal breaks were detected in all eyes.

Conclusion: DFCE technique could be effectively used for treatment of uncomplicated superior bullous RRD in adults ⩽40 years. It is safe and provides good visualization during surgery with no iatrogenic retinal breaks or complicated cataract.

Keywords: drain fluid cryo-explant, scleral buckle, superior bullous retinal detachment

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Introduction

Superior bullous rhegmatogenous retinal detachment (RRD) is considered a surgical challenge due to high subretinal fluid (SRF) with wide separation of retinal layers that interferes with accurate localization of retinal breaks and makes site of cryo-probe on the sclera 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 results in difficulty in retinal break visualization, inaccurate placement of the buckle, missed retinal holes, and recurrence of retinal detachment. Pneumatic cryo-explant 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 C3 F8 was injected intravitreally with postoperative proper head positioning to allow absorption of SRF. After that, cryo

Correspondence to:
Kamal A.M. Solaiman
Professor, Department of Ophthalmology, Faculty of Medicine, Zagazig University, Zagazig 44519, Egypt.
kams_8866@yahoo.com

Ashraf Mahrous
Hesham A. Enany
Ashraf Bor'i
Department of Ophthalmology, Faculty of Medicine, Zagazig University, Zagazig, Egypt

retinopexy and scleral buckling were performed in a second surgery. However, it had the disadvantages of two-stage surgery, prolonged postoperative head positioning, and incomplete absorption of SRF. These were the reasons of shifting the treatment of such cases to pars plana vitrectomy and reports of good outcome with this technique. However, pars plana vitrectomy in young myopic patients could be complicated with iatrogenic retinal tears.[5–7]

In this study, young adults with uncomplicated superior bullous RRD were treated with the drain fluid cryo-explant (DFCE) technique. In this technique, fluid was injected intravitrealy, 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 did not find any published study reporting the results of DFCE technique in eyes with superior bullous RRD in our search using popular search engines. So the aim of this study is to describe the DFCE technique and to evaluate its efficacy in the management of uncomplicated superior bullous RRD in young adults.

Patients and methods

A retrospective interventional study that included a consecutive series of patients who were admitted for surgical repair of superior bullous RRD and had a regular follow-up visits for at least 1 year. Medical records of consecutive patients who were diagnosed to have superior bullous RRD and had surgical repair from July 2013 to January 2019 and met the study inclusion criteria were used for the study analysis. The study was performed in accordance to the following inclusion criteria: superior bullous RRD with identifiable retinal break(s), a duration less than 1 month, and a clear viewing of the fundus in young patients $\leqslant$40 years old. 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 through 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 using general anesthesia. After performing a 360° periotomy and isolation of the four 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 four recti muscles was done to elevate intraocular pressure while SRF was drained. This was followed by simultaneous injection of balanced salt solution into the middle of vitreous cavity through pars plana and gradual release of traction on the recti muscles until the normal intraocular pressure was regained. The amount of the injected balanced salt solution was enough to build up the intraocular pressure. After drainage of SRF, the site of drainage was sutured if away from the site of 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 or segmental scleral explant was put in the superior quadrant(s). Encircling 504-silicone sponge was performed when there were multiple breaks at the same level. Topical and systemic antibiotic and anti-inflammatory drugs were used postoperatively. After examination on the first postoperative day, follow-up examinations were scheduled every week for 1 month then monthly till the sixth month and every 3 months thereafter till the end of a year. At each visit, complete eye examination was done especially fundus and BCVA (logMAR). The primary outcome measure was anatomical success which is defined as complete retinal reattachment and closure of all retinal breaks with no SRF 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 SRF occurring any time during the follow-up period.

Results

The study included 51 eyes (51 patients) which had uncomplicated superior bullous RRD and were eligible based on the present inclusion criteria for the study. The age range was 23–40 years with a mean of 32.3 ± 3.9 years. Male patients were 36 (70.6%) while female patients were 15 (29.4%). The duration of retinal detachment at the time of surgery ranged between 8 days and 30 days with a mean of 19.7 ± 6.4 days. Thirty-nine eyes (76.5%) were myopic. A single retinal break was found in 31 eyes (60.8%) and more than one break in 20 eyes (39.2%). A flap tear was found in 26 eyes (51%); all of them were myopes and had incomplete posterior vitreous detachment (PVD). The mean number of breaks per eye was 1.72 ± 1.04. In all eyes, the retinal breaks were found above the horizontal meridian. The mean detached area per eye was 7.21 ± 3.19 clock hours and the macula was detached in 22 eyes (43.1%). The preoperative mean logMAR BCVA was 0.66 ± 0.13 (20/100). All eyes were phakic with clear lens. Table 1 shows the demographic and preoperative data of all patients.

Table 1. Demographic and preoperative data of patients.

Number of eyes (patients)	51 (51)
Sex (male/female)	36/15
Mean age (range)	32.3 ± 3.9 years (23–40)
Myopia	39 (76.5%)
Number of retinal breaks	
Single	31 (60.8%)
Multiple	20 (39.2%)
Mean extent of RD (clock hours)	7.21 ± 3.19
Macula (on/off)	29/22
Mean duration of RD (days)	19.7 ± 6.4
Mean logMAR BCVA	0.66 ± 0.13 (20/100)

BCVA, best corrected visual acuity.

All surgeries were performed under general anesthesia and using the same technique of DFCE. External drainage of SRF was performed in all eyes. Segmental buckle (504-silicone sponge) was used in 34 eyes (66.7%), radial buckle (505-silicone sponge) was used in 7 eyes (13.7%), combined radial and segmental buckle was used in 2 eyes (3.9%) and encircling buckle was used in 8 eyes (15.7%). The anatomical state of the retina was determined in all eyes within the first postoperative month. Flattening of the retina and closure of all retinal breaks was achieved in all eyes after a single surgery. The postoperative mean logMAR BCVA has improved significantly to 0.30 ± 0.64 (20/40) ($p < 0.05$) at the end of the follow-up period.

Intraoperative complications were mild and were not significant. Mild vitreous haemorrahge occurred in 2 eyes (3.9%). Minimal residual SRF due to incomplete drainage was found in 6 eyes (11.8%), but in all of these eyes, the retinal tear was approximated to the retinal pigment epithelium with the cryo-probe, and the surgery completed as planed with spontaneous absorption of the residual SRF postoperatively. Subretinal hemorrhage occurred at the drainage site in 4 eyes (7.8%) and was treated by temporarily raising the intraocular pressure during surgery. Postoperative diplopia without restriction of motility occurred in 2 eyes (3.9%), and in both, the explant was beneath the superior rectus muscle. In one of them, diplopia could not be tolerated, and the explant was removed after 4 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 retinal break was missed in any of the eyes of the study. Postoperative elevation of intraocular pressure (IOP) occurred in six eyes (11.8%) early after surgery, but IOP was normalized within few weeks of treatment with use of anti-glaucoma agents. None of the eyes developed a postoperative cataract. No eye suffered intraoperative retinal incarceration at the time of SRF drainage and no case of postoperative retinal fold 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,[8] it remained

Table 2. Operative and postoperative results.

Scleral explant	
Segmental	34 (66.7%)
Radial	7 (13.7%)
Combined segmental/radial	2 (3.9%)
Encircling	8 (15.7%)
Intraoperative complications	
Vitreous hemorrhage	2 (3.9%)
Subretinal hemorrhage	4 (7.8%)
Iatrogenic retinal break	0 (0%)
Retinal incarceration	0 (0%)
Retinal folds	0 (0%)
Inaccurate placement of buckle	0 (0%)
Postoperative complications	
Residual SRF	6 (11.8%)
IOP elevation	6 (11.8%)
Diplopia	2 (3.9%)
Late recurrence of RD	2 (3.9%)
Complicated cataract	0 (0%)
Mean logMAR BCVA (12 months)	0.30 ± 0.64 (20/40)

BCVA, best corrected visual acuity; IOP, intraocular pressure; SRF, subretinal fluid.

the gold standard for treatment of RRD for several decades. The introduction of vitrectomy by Machemer[7] in the early 1970s expanded the scope of management of many complex vitreoretinal disorders with a visual outcome for RRD that approaches or even exceeds that achieved with scleral buckling. Studies[3,6] investigating 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.[7,9] However, scleral buckling may be preferred to vitrectomy in young adults who could be treated with either scleral buckling or vitrectomy, for several reasons: *first*, vitrectomy could be associated with iatrogenic retinal tears especially in myopic eyes.[10] *Second*, strict continuous head positioning in the first few days after vitrectomy is difficult to adhere to by many patients. *Third*, the possible postoperative complications of using intraocular gas or silicone oil such as cataract.[11–13] Also, if silicone oil was 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 eyes.[11] Finally, the financial cost of scleral buckling is less than that of vitrectomy. In this study, the eyes with flap retinal tear had incomplete PVD but scleral buckling was preferred to vitrectomy because all were myopes and of young age and were liable to iatrogenic retinal breaks during 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 and SRF is deep. 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 Chignell[3] have introduced the DACE technique in which about 2 mL air was 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 with the use of 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, and postoperative posterior subcapsular cataract if air comes into contact with the lens.[15]

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 to superior flap retinal tears and 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 occurred due to inaccurate placement of the buckle, and this was due to good visualization during surgery.

Although the DFCE technique was described many years ago,[15] 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 could be 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 all of the study eyes 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 re-accumulation of SRF till application of cryotherapy and formation of chorioretinal adhesion.

The success rate achieved in this study using DFCE technique was 96%, and in all eyes, the buckles were accurately placed in relation to the retinal tears because visualization was not obscured during surgery. Recurrence of RRD that occurred in 2 eyes (4%) was due to the development of PVR. On the contrary, the success rate achieved with DACE technique ranged between 90% and 96%,[3,6,16] and all the recurrences of RRD in these studies were due to inaccurate placement of the buckles. 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 was reported in all eyes of the study because encircling buckle, which increases the incidence of retinal folding, was used in 8/51 eyes (15.7%) 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 four eyes (7.8%). Minor bleeding from choroid at the sclerotomy site is the most common complication of draining SRF.[16] Postoperative elevation of IOP in six eyes (11.8%) was temporary and controlled by anti-glaucoma medications. 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 old age patients 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 permitted 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 1 month and no excessive cryotherapy was used.

In conclusion, DFCE technique is a safe one-stage surgery that could be effectively used in young adults 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. It is especially beneficial for young myopic patients with clear lens, who are liable to iatrogenic retinal tear and cataract if treated with vitrectomy. 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.

Author contributions

K.A.M.S assisted in performing the surgery in some patients and was the main contributor in writing the manuscript and interpretation of the results. A.M. was the main surgeon in all cases. H.A.E. assisted in performing the surgery in some patients as well as examination of those patients. A.B. assisted in performing the surgery in some patients and was responsible for preoperative examination of patients, postoperative follow-up examination, and reporting of patients' data.

Author's note

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Ethics statement

The study was carried out in accordance with the code of ethics of the World Medical Association (Declaration of Helsinki). The Ethics committee of Al Fat'h Eye Hospital waived the need for ethics approval for the collection, analysis, and publication of data, given this was a retrospective study. An informed written consent was obtained from all patients before surgery, and included their agreement to use the patient data for research and publication purposes.

ORCID iD

Kamal A.M. Solaiman https://orcid.org/0000-0001-9087-0437

Data availability

The data sets used and analyzed during the current study are available from the corresponding author on reasonable request.

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