Downloaded from https://journals.lww.com/retinajournal by [illegible] on 10/18/2021

EXTERNAL DRAINAGE OF SUBRETINAL FLUID DURING RHEGMATOGENOUS RETINAL DETACHMENT REPAIR

PETER J. BELIN, MD,* RUSDEEP MUNDAE, MD,† JONATHAN H. TZU, MD,‡ EMMANUEL CHANG, MD, PHD,‡ DAVID W. PARKE III, MD*

Purpose: To describe the safety and efficacy of rhegmatogenous retinal detachment (RRD) repair with external drainage of subretinal fluid using a 28-gauge External Drainage and Depression device (Vortex Surgical, Chesterfield, MO).

Methods: Retrospective review of patients who underwent primary rhegmatogenous retinal detachment repair with scleral buckle, pars plana vitrectomy, or scleral buckle/pars plana vitrectomy using the drainage device from August 2018 through March 2020, performed by four surgeons at two vitreoretinal practices.

Results: Eighty-three eyes of 83 patients were included. At presentation, 28% had proliferative vitreoretinopathy. Surgery included 65% scleral buckle/pars plana vitrectomy, 33% pars plana vitrectomy, and 2% scleral buckle. There were no cases of retinal incarceration and two subretinal hemorrhages at the drainage site (both < 2 DD), 2 cases of recurrent RD with proliferative vitreoretinopathy (1 had proliferative vitreoretinopathy at presentation), and 6 (10%) new epiretinal membranes (3 were mild). There were no other complications. Mean follow-up was 274 days. Single operation success rate for those with ≥ 6-month follow-up was 97% (57/59).

Conclusion: External drainage of subretinal fluid during rhegmatogenous retinal detachment repair demonstrated a favorable safety profile with a high single operation success rate. Further study of the role of external drainage in rhegmatogenous retinal detachment repair is warranted.

RETINA 41:1828–1832, 2021

During rhegmatogenous retinal detachment (RD), repair subretinal fluid (SRF) is typically drained from an internal approach during pars plana vitrectomy (PPV), via the retinal break, a posterior drainage retinotomy, or with perfluorocarbon liquid. External drainage classically is used in a primary scleral buckle (SB) via a scleral cut down or with direct visualization of external needle drainage, which was first described by Charles in 1985.[1] Draining SRF externally through a needle may reduce the risks of a scleral cut down including subretinal or choroidal hemorrhage and retinal incarceration, as well as allow for a more controlled and complete drainage.

A modified external needle drainage procedure during scleral buckling was described by Kitchens et al in 2011, in which they applied a 270 silicone buckle sleeve to a 26-gauge needle to prevent overpenetration of the needle during external drainage of SRF in what they termed a "guarded needle" technique.[2] More recently, Su et al[3] reported 6 cases of external drainage of SRF with a guarded needle during PPV. In their small series, this method was safe with no cases of subretinal or choroidal hemorrhage and no retinal incarceration at the drainage site.

This method of SRF drainage may be particularly beneficial during vitrectomy for very bullous

From the *VitreoRetinal Surgery, PA, Minneapolis, Minnesota; †Department of Ophthalmology, University of Minnesota, Minneapolis, Minnesota; and ‡Retina and Vitreous of Texas, Houston, Texas.

This manuscript was originally presented as paper at the Retina Society Virtual Annual Meeting 2020.

D. W. Parke and E. Chang receive royalties from Vortex Surgical for their patent on the external drainage and depression device. The remaining authors have no other conflicts of interest to disclose.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.retinajournal.com).

Reprint requests: Peter J. Belin, MD, VitreoRetinal Surgery, PA 3601 West 76th Street, Suite 300, Edina, MN 55435; e-mail: petebelin@gmail.com

Copyright © by Ophthalmic Communications Society, Inc. Unauthorized reproduction of this article is prohibited.

Table 1. Patient Demographics and Baseline Ocular Characteristics

	N = 83
Female	27 (33%)
Right eye	37 (45%)
Mean age (years)	63.5
Duration of symptoms, days, mean (median)	18 (14)
Macula involving	48 (58%)
Macula sparing	26 (31%)
Macula splitting	9 (11%)
Posterior vitreous detachment	77 (93%)
Vitreous hemorrhage	4 (5%)
ERM	15 (17%)
PVR Grade B or C	23 (28%)

Table 2. Surgical Techniques and Details

	N = 83
SB	3 (4%)
PPV	27 (33%)
SB/PPV	53 (64%)
Sulfur hexafluoride (SF6)	23 (28%)
Perfluoropropane (C3F8)	59 (71%)
Silicone oil	1 (1%)
Drainage retinotomy	29 (35%)
Perfluorocarbon liquid	0
Retinectomy	0

visualization during vitrectomy and scleral buckling. For very bullous detachments, it allows for flattening of the retina before vitrectomy, which can decrease the risk of iatrogenic breaks from highly mobile retina and facilitate peripheral shaving. In addition, external drainage under direct visualization may allow for more complete SRF removal and obviate the need for other subsequent drainage maneuvers. If any subretinal or choroidal hemorrhage is noted, the surgeon can apply tamponade immediately before the hemorrhage spreads by indenting with the depressor and raising infusion pressure. The procedure can be done transconjunctivally without need for a peritomy and scleral cutdown.

In the current study, we assessed the safety and efficacy of external needle drainage during PPV with or without scleral buckling using a commercially available EDD device designed specifically for this purpose. The added benefits of the EDD include direct visualization of the drainage sight with depression before deploying the needle, rather than indenting with the actual needle. This ensures penetration into the subretinal space at the must bullous area of fluid while avoiding large choroidal vessels. The ability to drain SRF passively or actively via the extrusion line of the vitrectomy system or a syringe allows for a more controlled rate of aspiration depending on the chronicity of the detachment and viscosity of the SRF. In addition, there is minimal risk of incarceration into a 28-g needle tract with beveled tip, which can be slowly retracted as the retina flattens. In our series, we had no cases of retinal incarceration and only two cases of small, localized, and clinically insignificant subretinal hemorrhage.

A potential advantage of draining SRF externally is limiting access of the SRF to the vitreous cavity and inner retinal surface. Many risk factors for the development of PVR have been identified, all of which are fundamentally related to breakdown of the blood retinal barrier or dispersion of RPE cells into the vitreous cavity.[4] In addition to RPE and glial cells, the SRF also contains apoptotic photoreceptors liberated from the ischemic outer retina, which activate other cytokines implicated in the inflammatory cascade of PVR formation.[5] External drainage may help to eliminate these RPE cells and cytokines before they have access to the vitreous cavity and inner retinal surface and promote PVR. In our series, there was a high SOSR of 97% with only two patients developing redetachment due to PVR. Of note, preoperative PVR Grade B or C was present in 28% of eyes.

Draining SRF externally during vitrectomy can also reduce the need for creating a posterior drainage retinotomy, which is more inflammatory and can liberate RPE cells, thus promoting PVR formation.[6] In our series, a drainage retinotomy was only necessary in 1/3 of patients and no patients required perfluorocarbon liquid. As it is impossible to drain 100% of the SRF with the EDD and more fluid may accumulate during the vitrectomy, the decision to use a drainage retinotomy for residual fluid was at the discretion of the surgeon to avoid any macular folds. Postoperative positioning was also at the discretion of the surgeon, with some using immediate face-down positioning and others positioned to support the breaks.

Table 3. Surgical Outcomes and Postoperative Follow-Up

	N = 83
Average follow-up (days)	274 (range 12–834)
>6 month follow-up	59 (71%)
Single operation success rate	57/59 (97%)
Subretinal hemorrhage at drainage site	2/83 (2%)*
Retinal incarceration at drainage site	0
ERM formation	6/59 (10%)

*Less than two disk diameters and clinically insignificant.

Copyright © by Ophthalmic Communications Society, Inc. Unauthorized reproduction of this article is prohibited.

The pathophysiology of ERM formation after RD repair is similar to PVR, resulting from proliferation RPE and glial cells on the retinal surface and is considered by many to be a forme fruste PVR.[7] After retinal detachment repair with scleral buckling, the incidence of ERM formation has been estimated to be 3%–8.5%[8,9] A higher incidence has been previously reported after vitrectomy alone at 12.8% when diagnosed clinically and more recently 31.2% when diagnosed with OCT, presumably due to the greater dispersion of RPE and other progenitor cells in the SRF throughout the vitreous cavity when draining through existing retinal breaks or a posterior drainage retinotomy.[10,11] Combined SB and vitrectomy has the highest estimated rate of ERM formation at 48.4%.[11] In our series, only six patients (10%) developed ERMs, three of which were mild. This incidence is more consistent with that of scleral buckling, possibly due to the external drainage of SRF.

The external drainage device could also be used to safely collect SRF samples for laboratory analysis in the setting of neoplasm, inflammatory serous detachment, or for research purposes.

Limitations of our study include the lack of a comparison group, small sample size, and relatively short duration of follow-up. There are several reasons for the short and variable follow-up. First, the practices in this study are large referral centers with many patients coming from out of state who would follow-up with the referring doctor. In addition, some surgeons would only routinely follow their patients until postoperative month 2 to 3 as this is the critical time for PVR development. While majority of the patients have > 6 months followup, some were lost to followup at a shorter time interval. This may create some ascertainment bias in the final SOSR analysis for patients who were followed for greater than 6 months duration. The true rate of ERM formation may be higher with longer follow-up past 6 months. Despite these limitations and high incidence of preoperative PVR, this series does support the safety and efficacy of external drainage of SRF under direct visualization using a commercially available EDD, with low rates of PVR and ERM formation. Future studies would ideally include prospective design, with larger sample sizes, including a control group and potential laboratory analysis of the cellular components of the drained SRF to identify potential biomarkers for PVR development.

Key words: Rhegmatogenous retinal detachment, external drainage, subretinal fluid, pars plana vitrectomy, scleral buckle, proliferative vitreoretinopathy.

References

1. Charles ST. Controlled drainage of subretinal and choroidal fluid. Retina 1985;5:233–234.
2. Kitchens JW. Modified external needle drainage of subretinal fluid in the management of rhegmatogenous retinal detachment using a "guarded needle" approach. Arch Ophthalmol 2011; 129:949–951.
3. Su D, Obeid A, Hsu J. External drainage of subretinal fluid during vitrectomy for rhegmatogenous retinal detachment. Retina 2019;39:S115–S118.
4. Nagasaki H, Shinagawa K, Mochizuki M. Risk factors for proliferative vitreoretinopathy. Prog Retin Eye Res 1998;17: 77–98.
5. Lo ACY, Woo TTY, Wong RLM, et al. Apoptosis and other cell death mechanisms after retinal detachment: implications for photoreceptor rescue. Ophthalmologica 2011;226(Suppl 1):10–17.
6. McDonald HR, Lewis H, Aaberg TM, Abrams GW. Complications of endodrainage retinotomies created during vitreous surgery for complicated retinal detachment. Ophthalmology 1989;96:358–363.
7. Avila MP, Trempe CL, Kozlowski JM, et al. Biomicroscopic study of the vitreous in eyes with macular pucker after retinal detachment surgery. Ann Ophthalmol 1985;17:403–410.
8. Wilkinson CP. Visual results following scleral buckling for retinal detachments sparing the macula. Retina 1981;1:113–116.
9. Lobes LA Jr, Burton TC. The incidence of macular pucker after retinal detachment surgery. Am J Ophthalmol 1978;85: 72–77.
10. Katira RC, Zamani M, Berinstein DM, Garfinkel RA. Incidence and characteristics of macular pucker formation after primary retinal detachment repair by pars plana vitrectomy alone. Retina 2008;28:744–748.
11. Banker TP, Reilly GS, Jalaj S, Weichel ED. Epiretinal membrane and cystoid macular edema after retinal detachment repair with small-gauge pars plana vitrectomy. Eur J Ophthalmol 2015;25:565–570.

Copyright © by Ophthalmic Communications Society, Inc. Unauthorized reproduction of this article is prohibited.

detachments by allowing the retina to flatten before initiating vitrectomy and thus reducing the risk of iatrogenic break in a highly mobile retina. In addition, externally draining the SRF, which contains liberated retinal pigment epithelium (RPE) cells and other cytokines, may theoretically decrease the risk of proliferative vitreoretinopathy (PVR), by preventing this inflammatory milieu from accessing the vitreous cavity and inner retinal surface.

Herein, we propose a further modification to the procedure for external drainage of SRF during rhegmatogenous retinal detachment repair using a novel device that combines scleral depression for precise localization under direct visualization and a retractable needle for safe advancement into the subretinal space. The aim of this study was to report the safety and anatomical outcomes of this procedure during rhegmatogenous retinal detachment repair by SB, PPV, or combined SB plus vitrectomy. To the best of our knowledge, this is the first report of an external drainage and depression (EDD) device for this purpose.

Methods

Patients and Design

A retrospective review of 83 consecutive patients who underwent RD repair via PPV, SB, or PPV with SB and using an EDD device for drainage of SRF. The EDD (Vortex Surgical, Chesterfield, MO) is a commercially available scleral depressor with a retractable 28-gauge needle that extends 2.4 mm and is connected to two in. of extension tubing, which can be connected to the extrusion line during PPV or a syringe during primary SB for active drainage, or left open to air for passive drainage (Figure 1). The surgery was performed at two surgery centers affiliated with two vitreoretinal practices (VitreoRetinal Surgery, P.A. Minneapolis, MN, and Retina and Vitreous of Texas, Houston TX) by four different surgeons between August 2018 and March 2020.

Data collected included patient demographics, details of the RD, type of surgical procedure, intraoperative and postoperative complications, development of PVR or epiretinal membrane (ERM), and single operation success rate (SOSR). Of note, cases with PVR at presentation were not excluded.

The study adhered to the tenets of the Declaration of Helsinki, and institutional review board approval was obtained.

Surgical Technique

Pars Plana Vitrectomy With or Without Scleral Buckle. If an SB was used, a 360-degree conjunctival peritomy was created and the buckle was placed in the surgeon's standard fashion. All patients underwent 23- or 25- gauge, 3-port PPV. After placement of the trocars and opening the infusion line, the external drainage procedure was performed. The EDD is primed with balanced salt solution and connected to the extrusion line of the vitrectomy system for active drainage. The infusion line is clamped and trocars plugged to ensure the eye remains pressurized. Under the operating microscope and wide-field viewing lens, the sclera is indented with the EDD in the most bullous area of the detachment, taking care to avoid the rectus muscles, large choroidal vessels, and SB if present. For PPV alone, the EDD can be used transconjunctivally. After confirming the location of the depressor in the desired location, the needle is advanced into the subretinal space while maintaining a "toe-in" orientation to keep the needle nearly perpendicular to the sclera (Figure 2). The infusion line is unclamped and active extrusion is engaged with the foot pedal at a vacuum setting of 200 to 400 mmHg depending on the turbidity of the fluid. The final remaining fluid can take proportionally longer to drain and the needle can be slightly retracted to avoid contacting the retina. Once the fluid is drained sufficiently, the needle is retracted completely and the drainage sight is inspected with the depressor. If any hemorrhage is present, pressure should be held with the depressor and the infusion pressure increased to achieve hemostasis.

For passive drainage, the same procedure is performed without connecting the EDD to the extrusion line. After unclamping the infusion line, the infusion pressure is gradually raised above 35 mmHg to attain a desired rate of fluid drainage. Manually depressing the globe can also aid in achieving the desired rate of passive drainage. If using an SB, the buckle should not be pulled up until after passive drainage to allow for a more controlled rate of drainage.

See Video, Supplemental Digital Content 1, http://links.lww.com/IAE/B420, which demonstrates this technique.

Scleral Buckle

For a primary SB, the same procedure as above is performed with the option of using the vitrectomy system or a syringe for active drainage, or the procedure described above for passive drainage using manual depression to raise the intraocular pressure. An indirect ophthalmoscope or an operating microscope

Copyright © by Ophthalmic Communications Society, Inc. Unauthorized reproduction of this article is prohibited.

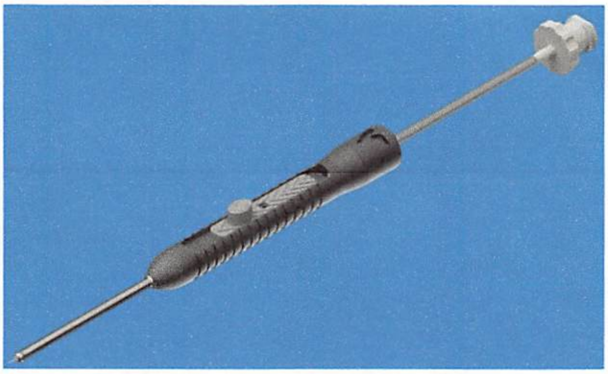

Fig. 1. External drainage and depression device.

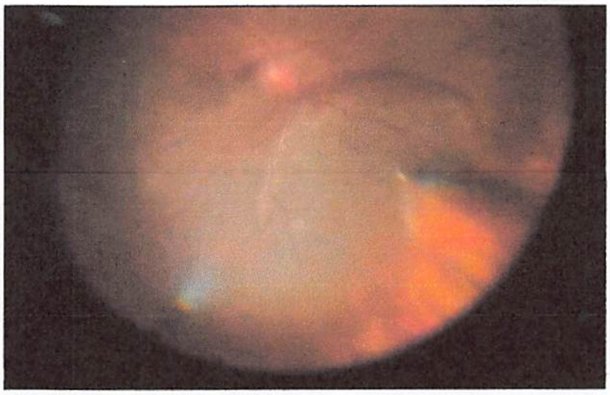

Fig. 2. EDD used during SB/PPV.

with chandelier endoillumination can be used for visualization (Figure 3). The buckle is pulled up to an appropriate height after drainage and the procedure is then completed in the standard fashion.

Primary Outcomes

The primary outcomes were surgical complications (including subretinal hemorrhage and retinal incarceration at the drainage site), development of PVR, and SOSR. Secondary outcomes measured included ERM formation.

Results

The study included 83 eyes from 83 patients (33% female, 45% left eye, Table 1). Participant demographics and baseline ocular characteristics are presented in Table 1. The average age was 63.5 years. The median duration of symptoms was 14 days. Approximately 58% of retinal detachments were macula-involving, 31% macula-sparing, and 11% macula-splitting. Before surgery, posterior vitreous detachment was present in 93% of subjects, vitreous hemorrhage in 5%, ERM in 17%, and PVR (Grade B or C) in 28%.

The surgical procedures performed are shown in Table 2. Procedures included SB/PPV in 65% of patients, PPV in 33%, and SB in 2%. Tamponades used were perfluoropropane (C3F8) in 71% of subjects, sulfur hexafluoride (SF6) in 28%, and silicone oil in 1%. A drainage retinotomy was required in 35% of cases. There were no cases of retinal incarceration at the drainage site. Two patients had subretinal hemorrhage at the drainage site; however, both were less than two disk diameters (DD) in area and were clinically insignificant. Surgical outcomes can be found in Table 3. The average length of follow-up was 274 days (range 12–834 days, Table 3) with 71% of patients having at least 6 months of follow-up. The SOSR for those with at least 6 months of follow-up was 97% (57/59, Table 3). The average length of follow-up for this subset with at least 6 months of follow-up was 350 days (SD = 170.1 days).

Two patients had recurrent detachments with PVR. The first patient failed initial laser barricade and presented for their initial surgery with a macula involving RD with a single break and Grade B PVR. This patient underwent PPV with C3F8 gas tamponade and required posterior drainage retinotomy. The second patient was symptomatic for 21 days and presented with a macula involving RD with vitreous hemorrhage, two breaks, and no PVR. They underwent PPV with C3F8 gas tamponade. Both patients ultimately achieved anatomical success after their second surgery. ERM developed in six patients (10%, Table 3), 3 of which were mild. No other complications were noted to have developed.

Discussion

External needle drainage of SRF during retinal detachment repair until recently has been largely reserved for scleral buckling procedures. There are several benefits of external drainage under direct

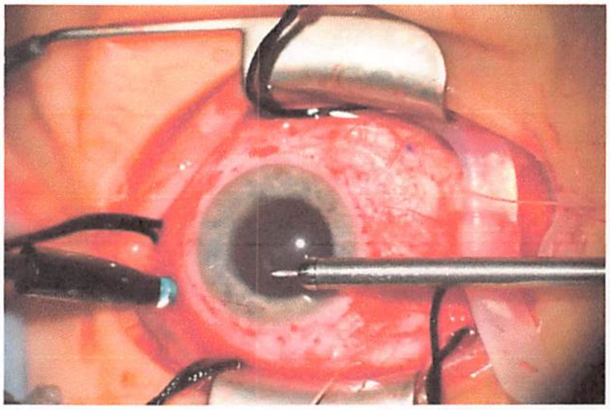

Fig. 3. EDD used during primary SB with chandelier illumination.

Copyright © by Ophthalmic Communications Society, Inc. Unauthorized reproduction of this article is prohibited.