• Clinical Research •

Refractive and surgical outcomes of scleral buckling with or without vitrectomy in primary pseudophakic retinal detachment

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Abstract

● **AIM:** To report the refractive and surgical outcomes of scleral buckling (SB) with or without pars plana vitrectomy (PPV) in patients with pseudophakic rhegmatogenous retinal detachment (PRRD).

● **METHODS:** A consecutive case series of patients with pseudophakia who underwent retinal detachment (RD) surgery was enrolled. The SB procedures were selected to initially treat primary pseudophakic PRRDs and SB-PPV for more complex cases, according to preoperative findings. Eyes with anterior chamber intraocular lens, proliferative vitreoretinopathy anterior to equator, previous invasive glaucoma surgery, severe degenerative myopia or macular hole, and <6mo follow-up were excluded from outcomes analysis. The primary clinical outcome measures were the single surgery anatomic success (SSAS) and final surgery anatomic success (FSAS) rates. Secondary outcome measures were postoperative visual acuity and refractive error.

● **RESULTS:** A total of 81 consecutive patients (81 eyes) were enrolled for analysis, comprising 66 (81%) men and 15 (19%) women with a mean age of 58y (range, 33-86y) and the mean final follow-up period was 21.0±19.6mo. A total of 62 PRRDs (*n*=62; 76.5%) were repaired with an initial SB, and 19 PRRDs (*n*=19; 23.5%) were repaired with a combined SB-PPV. The SSAS and FSAS rates were 92.6% (75/81) and 100% (81/81), respectively. All initial failures had retinal reattachment after the secondary PPV. The mean final postoperative best-corrected visual acuity (BCVA) was 0.42±0.33 logMAR (visual acuity 20/55) and final mean refractive error was -1.48±1.40 diopters. The patients who underwent initially SB-PPV had a significantly longer duration of RD and a higher giant retinal tear rate ($P<0.05$) preoperatively. SSAS was 56/62 (90.3%) and 19/19 (100%), and the mean postoperative refractive error was -1.30±1.32 D and -1.53±1.38 D for the patients in the SB and SB-PPV groups, respectively. There was no statistically significant difference for those who had SSAS and postoperative refractive errors between the 2 groups. The postoperative BCVAs of the patients with SSAS were not significantly better in the SB group (median, 20/40) than in the SB-PPV group (median 20/50). In the SB group, patients with macula-on had better visual acuity postoperatively than patients with macula-off ($P=0.000$).

● **CONCLUSION:** The initial surgical procedures of SB with or without PPV according to the preoperative findings achieve a high reattachment rate and an acceptable refractive error for primary pseudophakic RRD management.

● **KEYWORDS:** pseudophakic retinal detachment; refractive outcomes; retinal detachment; scleral buckling; vitrectomy

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INTRODUCTION

In rhegmatogenous retinal detachment (RRD), 30%-40% of the eyes are pseudophakic, and RRD occurs within 1y after cataract surgery in approximately 0.5%-1.5% of the cases[1-2]. This rate is expected to rise due to the increase in cataract surgery prevalence and the mean life span[1-6]. Scleral buckling (SB) and pars plana vitrectomy (PPV) are the most common surgical techniques used for treating RRD.

The PPV surgical technique is the first choice of many surgeons, particularly for patients with pseudophakic rhegmatogenous retinal detachment (PRRD), because of its many reported advantages, including less extraocular invasiveness, less pain, ease of performance, less refractive error change, advancements in vitrectomy techniques, shorter surgical time, and a high rate of single surgery success[7-11]. The reported advantages of SB for RRD include less intraocular invasiveness, fewer intraoperatively induced retinal breaks, scleral indentation for more vitreous base visualization after peritomy, and more rapid visual improvement[12].

Surgical outcomes are influenced by the surgical techniques selected by the individual surgeon according to preoperative findings, patient characteristics, available tools, and the experience and ability of the operating surgeon. The study aimed to determine the refractive and surgical outcomes of SB with or without vitrectomy in patients with PRRD.

PARTICIPANTS AND METHODS

Ethical Approval The study adhered to the tenets of the Declaration of Helsinki and was approved by the Chang Gung Medical Foundation Institutional Review Board (No.202400756B0). All the patients were provided with informed consent.

Participants We retrospectively enrolled consecutive case series of patients with pseudophakia who underwent RRD surgery between January 2016 and October 2022. All patients underwent comprehensive preoperative and postoperative ophthalmological examinations, and data including age, sex, surgical indications, best-corrected visual acuity (BCVA), and refractive error were collected. The occurrence of intraoperative and postoperative surgical complications and sequential surgeries for recurrent retinal detachment (RD) were documented. To perform a statistical comparison between the groups, the BCVA was converted into the logarithm of the minimum angle of resolution (logMAR).

The inclusion criteria were pseudophakic eyes with RRD managed with SB technique or combined SB and PPV (SB-PPV) technique for at least 3mo after cataract surgery, with >6mo of follow-up. The following RRD subgroups were excluded from the study: 1) RRD associated with anterior chamber intraocular lens; 2) RRD associated with open-globe injury; 3) RRD associated with proliferative diabetic retinopathy or other active vascular diseases; 4) RRD associated with infectious/inflammatory diseases (acute postoperative endophthalmitis or uveitis); 5) recurrent RRD; 6) proliferative vitreoretinopathy anterior to equator; 7) previous invasive glaucoma surgery; 8) RRD associated with severe degenerative myopia or macular hole.

All surgical procedures were performed by the same surgeon (Chen YJ). The surgeon preferred SB procedures to initially treat primary PRRDs and SB-PPV for more complex cases, according to preoperative findings. The SB surgical procedures included a 360° peritomy, 4 rectus muscles isolation, search and cryotherapy for retinal breaks and pathologies under indirect ophthalmoscopy and scleral indentation, a 360° encircling explant (5-mm style 506 sponge) sutured to the sclera. The distance between the anterior site and posterior site of the mattress suture is about 6 mm. After external drainage of subretinal fluid with a 27-gauge needle, the 506 sponge is kept surrounding the equator of the eye smoothly and fixed using 5-0 polyester in proper tension. Then, joint the sponge with 5-0 polyester after trimming it into a proper length. Intravitreal injection of perfluoropropane gas 0.4 to 0.6 mL is performed to flatten the retina according to indirect ophthalmoscopic findings and intraocular pressure. In eyes managed with SB-PPV, the PPV procedure included conventional 23 G vitrectomy, a complete vitrectomy performed using scleral indentation, internal drainage of subretinal fluid through an intended retinotomy, endolaser photocoagulation, fluid-air exchange, and 16%-20% perfluoropropane gas tamponade. In special cases, silicone oil was selected for intravitreous tamponade, including single-eye and giant retinal tears. For all cases, maintenance of the postoperative prone position was advised for 2wk. Patients were followed up at 1, 2, and 6wk, 3, and 6mo for anatomic retinal reattachment.

The primary clinical outcome measures in this study were the single surgery anatomic success (SSAS) and final surgery anatomic success (FSAS) rates. SSAS was defined as no indication of any procedure for retina reattachment 6mo after the initial surgery, and failure was defined as performing additional procedures, including revised SB, PPV, or tamponade, such as gas or air reinjection, or any silicone oil filling. The eyes filled with silicone oil at the end of the study were considered to have anatomic failures.

Secondary outcome measures were postoperative visual acuity and refractive error. The BCVA and refractive error were obtained 3mo and 1mo postoperatively, respectively, in gas tamponade and silicone oil removal cases. The changes in refractive error were calculated only for macula-on cases with preoperative and postoperative refractive error data. Macula-off status was defined as full separation of the fovea.

Statistical Analysis Statistical analysis was performed using SPSS 25.0. Categorical variables were compared between groups using the Mann-Whitney test or Fisher's exact test. Significance level was set at $P<0.05$.

RESULTS

A total of 81 consecutive patients (81 eyes) were enrolled for analysis (Table 1), comprising 66 (81%) men and 15 (19%) women with a mean age of 58y (range, 33-86y). All patients underwent at least a 6-month follow-up, and the mean final follow-up period was 21.0±19.6mo. The mean duration of RD was 14.6±25.1 (range, 2-180)d. Forty-five patients (55.6%) had preoperative macula-off. The choice for the initial surgical techniques (SB or SB-PPV) was decided by the surgeon according to preoperative clinical findings (Table 2). A total

Table 1 Clinical characteristics of pseudophakic patients with primary rhegmatogenous retinal detachment *n*=81

Items	Data
Age, mean±SD (range)	59±10y (33-86y)
Gender	
Male	66 (81%)
Female	15 (19%)
Type of IOL	
Posterior chamber IOL	81 (100%)
Duration of RD, mean±SD (range)	14.6±25.1d (2-180d)
PVR-C	2 (2.5%)
GRT	3 (3.7%)
Preoperative macula-off	45/81 (55.6%)
Initial surgical method	
SB	62 (76.5%)
SB-PPV	19 (23.5%)
Initial silicone oil tamponade	3 (3.7%)
Single surgery anatomic success	75/81 (92.6%)
Final surgery anatomic success	81/81 (100%)
Final BCVA, mean±SD (logMAR; convert to VA)	0.42±0.33 (20/55)
Final refraction error, mean±SD	-1.48±1.40 D
Follow-up, mean±SD	21.0±19.6mo

SD: Standard deviation; IOL: Intraocular lens; RD: Retinal detachment; PVR: Proliferative vitreoretinopathy; GRT: Giant retinal tear; SB: Scleral buckling; SB-PPV: Combined scleral buckling and pars plana vitrectomy; BCVA: Best-corrected visual acuity; logMAR: Logarithm of the minimum angle of resolution; VA: Visual acuity; D: Diopters.

Table 2 Considerations for combined scleral buckling and pars plana vitrectomy in 19 patients

Consideration	*n*
Inferior retinal detachment	5
Vitreous opacity	3
GRT	3
PVR-C	2
Multiple breaks (more than 4)	2
Posterior large size break	1
Sulcus intraocular lens	1
Scleral fixation of intraocular lens	1
Pseudophacodonesis	1

GRT: Giant retinal tear; PVR: Proliferative vitreoretinopathy.

of 62 PRRDs (*n*=62; 76.5%) were repaired with an initial SB, and 19 PRRDs (*n*=19; 23.5%) were repaired with a combined SB-PPV. The initial SB-PPV group includes 2 eyes with proliferative vitreoretinopathy grade C (PVR-C) and 3 eyes with a giant retinal tear. The surgical procedure for subretinal fibrosis removal was performed in 1 of the 2 eyes with PVR-C. Initial silicone oil tamponade was performed for total 3 eyes (1 with PVR-C, 1 with giant retinal tear, and 1 with scleral fixation of the intraocular lens) that were included in the SB-PPV group. Initial reattachment was achieved in 75 eyes and final reattachment in 81 eyes. Therefore, the SSAS and FSAS rates were 92.6% (75/81) and 100% (81/81), respectively. All initial failures had retinal reattachment after the secondary surgery (PPV). The mean final postoperative BCVA was 0.42±0.33 logMAR (VA 20/55) and final mean refractive error was -1.48±1.40 diopters (D).

Table 3 presented the characteristics and outcomes of the patients in the SB and SB-PPV groups. The patients who underwent SB-PPV had a significantly longer duration of RD and a higher giant retinal tear rate ($P<0.05$) preoperatively. In addition, the patients who underwent SB-PPV tended to have higher preoperative PVR-C rates ($P=0.053$). SSAS was achieved in 56/62 (90.3%) and 19/19 (100%) of the mean postoperative refractive error was -1.30±1.32 D and -1.53±1.38 D for the patients in the SB and SB-PPV groups, respectively. However, there was no statistically significant difference for those who had SSAS and postoperative refractive errors between the 2 groups. In addition, the postoperative BCVAs of the patients with SSAS were not significantly better in the SB group (median, 20/40) than in the SB-PPV group (median 20/50). Besides the major complication of recurrent RD, the other late postoperative complication was an obvious epiretinal membrane, which occurred in 2 cases after the initial surgery. Surgical removal of the epiretinal membrane was performed in 1 eye of the SB group and 1 eye in the SB-PPV group.

Of the 62 PRRDs (76.5%) repaired with initial SB, 28 eyes (45.2%) were macula-on and 34 eyes (54.8%) were macula-off preoperatively. Table 4 presented the characteristics and outcomes of the patients in the SB group. RD duration, SSAS rate, and postoperative refractive error in SSAS cases were not significantly different between the macula-on and macula-off subgroups. However, patients with macula-on had better visual acuity postoperatively than patients with macula-off ($P=0.000$). The final BCVA was also better in the macula-on subgroup than in the macula-off subgroup. Thirteen eyes with SSAS in the macula-on SB subgroup had preoperative refractive error data. The mean change of refractive error (myopic shift) for these cases was -0.79±0.44 D (median -0.63 D) after initial surgery (Table 5). No major explant-related complications occurred postoperatively, such as infection, migration, ocular ischemia, or diplopia.

DISCUSSION

The increased popularity of PPV (with or without supplemental SB) for PRRD treatment is due to various reasons, including the absence of any risk of post-vitrectomy cataract formation[7-9,13-14]. The only major prospective randomized multicenter clinical study (scleral buckling versus primary vitrectomy in rhegmatogenous retinal detachment study, or the SPR Study) was performed in 2000 to compare SB and PPV outcomes for RRD treatment[13]. The study showed that SB provided better visual outcomes in phakic eyes and PPV provided better anatomic outcomes in pseudophakic eyes. However, the use of SB in the group of patients undergoing PPV was determined

Table 3 Characteristics and outcomes of patients in scleral buckling and combined scleral buckling and pars plana vitrectomy groups *n* (%)

Variables	SB (*n*=62; 76.5%)	SB-PPV (*n*=19; 23.5%)	*P*
Duration of RD, mean±SD, d (median)	8.8±6.5 (7)	33.5±46.5 (14d)	0.001[a]
PVR-C		2 (10.5%)	0.053[b]
GRT		3 (15.8%)	0.011[b]
Preop. macula-off	34 (54.8%)	11 (57.9%)	
Initial SO tamponade		3 (15.8%)	
Single surgery anatomic success	56 (90.3%)	19 (100%)	0.327[b]
Final surgery anatomic success	62 (100%)	19 (100%)	
BCVA (logMAR) of SSAS cases, mean±SD	0.39±0.33	0.61±0.54	0.122[a]
Median	0.30	0.40	
Median convert to VA	20/40	20/50	
Postop. refraction error of SSAS cases, mean±SD (median)	-1.30±1.32 (-1.00)	-1.53±1.38 (-1.32)	0.359[a]
Postop. ERM	1 (1.6%)	1 (5.3%)	
Follow-up	21.5±20.5mo	19.4±16.6mo	

SB: Scleral buckling; SB- PPV: Combined scleral buckling and pars plana vitrectomy; PVR: Proliferative vitreoretinopathy; GRT: Giant retinal tear; SO: Silicone oil; BCVA: Best-corrected visual acuity; logMAR: Logarithm of the minimum angle of resolution; SSAS: Single surgery anatomic success; VA: Visual acuity; ERM: Epiretinal membrane. [a]Mann-Whitney test; [b]Fisher's exact test.

Table 4 Characteristics and outcomes of patients in scleral buckling group

Variables	Preop. macula-on (*n*=28; 45.2%)	Preop. macula-off (*n*=34; 54.8%)	*P*
Duration of RD (median), d	9.3±7.1d (7)	8.1±5.9d (7)	0.401[a]
Single surgery anatomic success	27/28 (96.4%)	29/34 (85.3%)	0.209[b]
Final surgery anatomic success	28/28 (100%)	34/34 (100%)	
BCVA (logMAR) of SSAS cases (median)	0.21±0.17 (0.15)	0.55±0.36 (0.4)	0.000[a]
Convert to VA	20/28	20/50	
Postop. refraction error of SSAS cases (median)	-1.50±1.43 (-1.32)	-1.12±1.21 (-0.88)	0.248[a]
Follow-up (mo)	19.5±20.9	23.2±20.7	

RD: Retinal detachment; BCVA: Best-corrected visual acuity; logMAR: Logarithm of the minimum angle of resolution; SSAS: Single surgery anatomic success; VA: Visual acuity. [a]Mann-Whitney test; [b]Fisher's exact test.

Table 5 Refractive errors of 13 eyes with single surgery anatomic success in the macula-on scleral buckling subgroup

Patient No.	Preop. RE (SE)	Postop. RE (SE)
1	0-0.50×100 (-0.25)	0-1.00×110 (-0.50)
2	+0.75-0.25×175 (+0.62)	+0.25-0.25×20 (+0.12)
3	+0.50-0.50×10 (+0.25)	-0.25-0.50×50 (-0.50)
4	-1.00-1.25×175 (-1.63)	-1.50-1.25×180 (-2.13)
5	-1.00-1.00×170 (-1.50)	-1.25-0.50×120 (-1.50)
6	+1.50-2.00×95 (+0.50)	+0.25-1.50×65 (-0.50)
7	-1.50-1.50×150 (-2.25)	-2.25-2.00×135 (-3.25)
8	+0.50-1.00×65 (0)	-0.50-0.75×30 (-0.88)
9	-0.25-1.50×90 (-1.00)	-1.75-0.50×135 (-2.00)
10	-0.50-2.75×175 (-1.88)	-1.75-2.00×175 (-2.75)
11	+0.25-1.00×70 (-0.25)	-0.75-2.00×175 (-1.75)
12	-1.75-0.50×165 (-2.00)	-2.50-0.50×140 (-2.75)
13	+0.50-0.50×130 (+0.25)	-0.25-0.50×110(-0.50)

Myopic shift: -0.79±0.44 D (median -0.63 D). Preop: Preoperative; RE: Refractive error; SE: Spherical equivalent; Postop: Postoperative; D: Diopters.

by surgeon discretion, and supplemental SB (combined PPV and SB) was performed in more than 50% of the RRDs randomly selected for PPV. This raises the question of whether it is better to do SB with or without PPV. Moreover, in the SPR study, the SSAS rate after SB (53.4%) seemed to be lower than that might have been expected for the pseudophakic group. The broader variety of individual surgical skills and the prospective nature of the trial might be some of the reasons[13]. Since the SPR was performed, the use of PPV to repair all types of RRD has increased, and the use of SB has decreased so much that the majority of surgeons no longer use SB alone for PRRD treatment[15-23]. In the present study of retrospective nonrandomized clinical cases series, primary PRRDs were repaired much more with primary SB (62/81; 76.5%) than repaired with combined SB-PPV (19/81; 23.5%). Of the total 81 eyes, the SSAS and FSAS rates were 92.6% (75/81) and 100% (81/81), respectively. In general, for reasons including selection bias, surgeon technique preferences, and different study populations, the success rates reported in retrospective trials are commonly better than those in prospective trials of the same topic. Therefore, based on different clinical findings, individual surgeons can choose their preferred technique to achieve better outcomes in the real world. Considerations for the initial surgical techniques using combined SB-PPV (Table 2) were based on the individual surgeon experiences. However, not every consideration has exact evidence-based support due to disease variability. In addition to the anatomical outcomes of SSAS, the functional results (mean final VA, 20/55) were not inferior to most of those published studies using PPV or PPV-SB in pseudophakic RRD[13,15-16,24-27]. However, the results did not show a benefit for 1 procedure over another because of the retrospective nature of this non-randomized clinical study.

Methods used to repair RRD have shifted from SB to PPV over a 15-year period. Whether this shift is better for recovery and preservation of vision remains a subject of debate. The general consensus regarding the fundamental principle for treating RRDs is to identify and seal all breaks. However, the difficulty in visualizing the peripheral retina in pseudophakic eyes is mainly due to the presence of a small pupil, posterior or anterior capsule opacifications, cortical remnants, vitreous opacities, and optical aberrations at the rim of the intraocular lens[28]. Some of those inducing difficulty in visualizing the peripheral retina may cause disturbances in performing PPV alone for PRRD without a supplemental SB or peritomy for sufficient scleral indentation. The SB can support the peripheral retina and reduce vitreous traction and secondary retinal tear formation. It also provides better visual improvement in phakic RRD[13]. In the present study, the SSAS was achieved in 56/62 (90.3%) and 19/19 (100%) of the patients in SB and SB-PPV groups, respectively. There were no significant differences in SSAS, FSAS, or postoperative BCVA of SSAS cases between the 2 groups. However, a longer duration of RD and a higher preoperative giant retinal tear rate were observed in the SB-PPV group ($P<0.05$). The PVR-C rate was also higher in the SB-PPV group. The cases in the SB-PPV group appeared to be more complicated preoperatively, and the SB-PPV group achieved results similar to those of the SB group postoperatively. These results suggest that the combined SB-PPV technique is superior to SB alone. Multiple studies have shown greater primary success rate for SB-PPV in comparison to PPV alone in PRRDs[13,16,24]. However, the purpose of our study was not to investigate the superiority of surgical procedures SB or SB-PPV because of the initial selection bias from the surgeon and the small numbers of cases in the SB-PPV group. This observation does not imply that SB-PPV should be performed in all PRRD cases. Instead, performing SB-PPV in more complicated cases may yield better results. In our study, there was no significant difference in the postoperative refractive error (myopia) between the SB and SB-PPV groups. This indicated fewer refractive errors of myopia were induced by PPV in these cases.

In a Meta-analysis covering the years from 1966 to 2004, a comparison of conventional SB and PPV revealed that PPV resulted in better anatomical and visual outcomes in patients with pseudophakic RD[14]. However, in another Meta-analysis focusing on randomized controlled trials covering the years from 1966 to 2010, primary reattachment was achieved in 279 of 373 patients (approximately 75%) in the PPV group compared to 274 of 407 (approximately 67%) patients in the SB group among patients with pseudophakic/aphakic eyes. There were no significant differences in proportions of primary reattachment and postoperative BCVA at 6mo or more in pseudophakic/aphakic eyes[29]. A multicenter clinical trial published in 2016 that compared surgical techniques for the management of pseudophakic and aphakic RD revealed SB, PPV, and SB-PPV had comparable outcomes[12]. In the SB group of our retrospective study, SSAS and FSAS were achieved in 56/62 (90.3%) and 62/62 (100%), respectively, and the postoperative BCVA (logMAR) of SSAS was 0.39±0.33 (VA, 20/40). Selection bias and surgeon technique preference resulted in better outcomes. Better postoperative BCVA was observed for patients in the macula-on SB subgroup, which is similar result to the results of other published studies[27-28,30]. However, the RD duration, SSAS, and postoperative refraction error in SSAS cases were not significantly different between the macula-on and macula-off subgroups. Therefore, performing surgery before macula-off offers benefits for visual outcomes.

Epiretinal membrane was reported in 2%-17% of eyes after SB and extensive RD with macular involvement increases the risk of epiretinal membrane development[12]. In our study, one case (1.6%) had an obvious epiretinal membrane in the SB group that required further surgery for removal. One reason for this is that no regular optical coherence tomography examination is performed after surgery to identify less severe epiretinal membrane. One study showed that encircling SB causes an average increase in axial length (0.99 mm) and induced myopia (-2.75 D) in phakic RDs[31]. However, in a study of pseudophakic RDs, the mean change in refractive error was -1.38 (range -0.5 to -2.25) D in the SB group and -0.85 (range -0.25 to -1.0) D in the PPV group, which was statistically significant in both groups (P=0.016)[9]. In addition, the PPV surgical procedure causes fewer refractive changes (myopic shift) than the encircling SB procedure[9,32]. In another study on PRRD, patients suffered from a shift in spherical refraction of -1.0 D in the combined PPV and encircling band group[26]. Of all cases in our study, the mean final refractive error was -1.48±1.40 D and postoperative refractive error of SSAS cases was -1.30±1.32 D in the SB group and -1.53±1.38 D in the SB-PPV group. The postoperative refractive error was acceptable and less than that in a previous study on phakic RDs. Since the postoperative refractive target after cataract surgery is usually set at a little minus diopters (myopia), the myopic shift after surgery in our cases was supposed to be less than the final refractive error. The acceptable postoperative myopic results in our study may have been due to the pseudophakic population of RD and the explant style (style 506 sponge) used in most (99%) of our cases. A possible interpretation is that the thickness of the intraocular lens in pseudophakic eyes was less than that in phakic eyes, and the rigidity of the sponge explants used in our study was less than that of the solid explants used in other studies. Actual preoperative refractive error is difficult to measure in macula-off RRD. In our study, 13 eyes with SSAS in the macula-on SB subgroup had preoperative refractive error data. The change of refractive error (myopic shift) of these cases was -0.79±0.44 (median -0.63) D after initial surgery. In conclusion, SB with or without PPV according to the preoperative findings achieved a high reattachment rate and an acceptable refractive error for primary pseudophakic RRD management.

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