Bilateral Symmetric and Asymmetric Superior Rectus Recession for Patients with Dissociated Vertical Deviation

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Purpose: To evaluate the outcome of bilateral symmetric and asymmetric superior rectus (SR) recessions in patients with bilateral dissociated vertical deviation (DVD) without oblique dysfunction and determine factors that might influence the surgical outcome.

Design: Retrospective study.

Methods: All patients who underwent bilateral SR recession for bilateral DVD from January 2012 to December 2016 at an eye hospital in New Delhi, India were included. Indication for surgery was decompensated DVD in 1 or both eyes. Symmetric SR recession was performed for symmetric DVD and asymmetric SR recession was performed for asymmetric DVD of 10 prism diopters (PD) or more. Patients with a minimum follow-up of 6 months were included. Success was defined as absence of manifest DVD in both eyes at the final postoperative visit.

Results: Medical records of 27 patients were analyzed. Their median age at surgery was 8 years [interquartile range (IQR), 6–10 years] and mean follow-up was 16.3 months (range, 6–48 months). Symmetric and asymmetric surgeries were performed in 19 and 8 patients, respectively. The amount of SR recession performed ranged from 5 to 10 mm. The median DVD reduced from 9 PD (IQR, 6–14 PD) to 5 PD (IQR, 3–8 PD) in the right eye ($P = 0.015$) and 9 PD (IQR, 7–12 PD) to 6 PD (IQR, 3–10 PD) in the left eye ($P = 0.016$) after surgery. Successful outcome was seen in 63% of patients. There was no difference in successful outcome with respect to age, sex, preoperative horizontal deviation, preoperative vertical deviation, postoperative residual horizontal deviation, surgical technique, asymmetry of SR recession, and magnitude of preoperative DVD. Patients with a preference for fixation were more likely to have a successful outcome.

Conclusions: Bilateral SR recession resulted in a success rate of 63% after single operation for bilateral DVD without oblique dysfunction. We found that the probability of a successful outcome did not depend on age at surgery, sex, preoperative horizontal or vertical deviation, magnitude of preoperative DVD, symmetry of SR recession, or surgical technique.

Key Words: dissociated vertical deviation, eye muscle, strabismus, superior rectus recession

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Dissociated vertical deviation (DVD) is a poorly understood ocular motor phenomenon characterized by a slow disconjugate vertical drifting of the non-fixing eye.[1] It is usually bilateral, variable, asymmetric, and associated with latent or manifest latent nystagmus.[2] Along with the upward drift there is also an exodeviation and excyclotorsional movement of the eye, together referred as "dissociated strabismus complex".[3] Although it is more commonly noted in association with early-onset strabismus,[4–6] it is not infrequently seen with late-onset acquired and sensory deviations.[7–9]

Due to complex motor disturbances present in DVD, the success rate of surgical treatment is lower than that in other strabismus forms. Over the years, a variety of different surgical procedures have been described for the treatment of DVD such as weakening of the inferior oblique (IO),[10,11] anteriorization of the IO muscle alone[12–15] or combined with resection,[16] recession of the superior rectus (SR) muscle alone[17–20] or combined with a posterior fixation suture,[21,22] SR posterior fixation suture alone,[22] resection or plication of the inferior rectus,[23,24] and all 4 oblique muscle-weakening procedures.[25,26]

The magnitude of DVD in different gazes and asymmetry between the 2 eyes are important factors when planning the type and amount of surgery.[27] In cases of DVD without significant oblique muscle dysfunction, unilateral or bilateral SR recession is the preferred option for treatment. Several authors have studied the results of unilateral SR recession for asymmetric DVD or DVD manifesting predominantly in 1 eye.[17,18,21] However, there is an increased risk of decompensation of DVD in the non-operated eye with such an approach.[23,28] There are few studies that mentioned results of bilateral SR recession, albeit with small sample sizes.[19,20,22] Thus, in the present study we evaluated the results of bilateral symmetric and asymmetric SR recessions in patients with bilateral DVD without oblique dysfunction and the factors that might influence the outcome of the surgical treatment of this disease.

METHODS

A retrospective review of medical records of patients who had undergone bilateral SR recession for bilateral DVD from January 2012 to December 2016 at Dr Shroff's charity eye hospital in New Delhi, India was performed. The study adhered to the tenets of the Declaration of Helsinki and was approved by the institutional review board of the hospital. Informed consent was also obtained from the patients. Only those patients who had cooperated for a prism under cover test to measure the DVD were included in the study. Patients with significant oblique muscle dysfunction (grade 2 or more) were excluded. Inferior oblique

muscle overaction was graded based on the upward displacement of the eye in adduction during lateral versions: grade 1 – no hypertropia in adduction but slight upward displacement in the field of action of IO; grade 2 – small hypertropia in adduction; grade 3 – obvious hypertropia in adduction; and grade 4 – large hypertropia in adduction along with an abduction movement when the eye is moved into the field of action of the IO.[29] Similarly superior oblique overaction was graded based on the downward displacement of the eye in adduction. Patients with inadequate measurement of DVD, incomplete preoperative and postoperative orthoptic examination, prior SR muscle surgery, and with less than 6 months of follow-up were also excluded. Simultaneous or prior horizontal muscle surgery was not considered to be exclusion criteria.

Horizontal deviation was measured by prism alternate cover test. True hypertropia (non-DVD) was differentiated from DVD by observing the fixing eye for corresponding hypotropia during alternate cover test. Once this hypotropia was neutralized, DVD was measured using the prism under cover test. All measurements were made for both distance (patient fixating at 6 m vision chart) and near (patient fixating at 30 cm at near vision chart) with the patient's refractive error corrected. For the prism under cover test, a base down prism and cover was placed in front of the affected eye. The eye was occluded approximately for 10 seconds, then the cover was switched to the fixing eye and the downward movement of only the uncovered eye was observed. This movement was gradually neutralized by increasing the dioptric power of prisms to obtain the maximum amount of DVD. For the purpose of analysis only the distance measurements were considered. Care was taken to distinguish non-DVD especially IO overaction from DVD by measuring in lateral gazes. Incomitance was described as a difference of 7 prism diopters (PD) or more between the lateral gaze and primary position DVD.[27] Patients with significant incomitant DVD were excluded from the study. The asymmetry of DVD was determined by the magnitude of difference in the deviation in primary position between the 2 eyes. A difference of 10 PD or more between the 2 eyes was considered an asymmetric DVD.

The additional data collected included the following: age at surgery, sex, best-corrected visual acuity (BCVA) for distance as recorded by logMAR chart, presence or absence of fixation preference, amount and type of horizontal deviation, presence and amount of vertical deviation, amount of SR recession performed, and details of any other previous surgery. Amblyopia was defined as a difference of 2 or more lines in BCVA between the 2 eyes.

Indication for surgery was a decompensated DVD in 1 or both eyes. Decompensated DVD was considered when a spontaneous upward drift of the eye was noted while examining the patient in the clinic. All patients underwent bilateral SR recession regardless of fixation preference. The techniques used were hangback, hemi-hangback, or fixed scleral suture. The same technique was used in both eyes of each patient. Irrespective of the technique, meticulous dissection of the SR muscle was performed to avoid postoperative lid or superior oblique muscle dysfunction. In general, large recessions of more than 8 mm were performed using the hemi-hangback or hangback techniques. The amount of SR recession performed was guided by the established nomogram provided in Table 1. Asymmetric surgery was performed if the patient had a difference of 10 PD or more in primary position DVD of both eyes or in the presence of an additional non-DVD of more than 5 PD. The amount of SR recession in asymmetric cases was also guided by the amount of DVD in individual eye (Table 1). In cases where asymmetric surgery was done due to the presence of non-DVD, 1 mm of SR recession was added per 3 PD of hypertropia. Asymmetric surgery was considered if the difference in the amount of SR recession performed was 2 mm or more between the 2 eyes.

TABLE 1. Dose of SR Recession Performed

DVD, PD	SR Recession, mm
<10	6.0
10	7.0
11–15	8.0
16–20	9.0
>20	10.0

DVD indicates dissociated vertical deviation; PD, prism diopters; SR, superior rectus.

Postoperative measurements were recorded at 1 month and at the last follow-up. Success was defined as absence of manifest DVD in both eyes at final postoperative visit. Dissociated vertical deviation was considered latent when the eye drifted upwards only under the cover and returned to primary position as soon as the cover was removed. Additionally, categories of success were defined according to the magnitude of residual DVD for distance as excellent (0–4 PD), good (5–9 PD), fair (10–14 PD), and poor (≥15 PD).[17,18]

Statistical Analyses

Statistical analysis was performed using the Statistical Package for the Social Sciences version 21.0. Normality of data was tested by Kolmogorov-Smirnov test. Quantitative variables were compared using unpaired *t*-test or Mann-Whitney test between the 2 groups. Wilcoxon signed rank test was used for comparison of preoperative and postoperative DVD. Qualitative variables were correlated using Chi-square test/Fisher exact test. Kaplan-Meier survival curve was plotted to assess the actuarial success rate. For all statistical tests, a *P* value less than 0.05 was considered statistically significant.

RESULTS

A total of 27 patients (12 male and 15 female) who underwent bilateral SR recessions for bilateral DVD during the study period met the inclusion criteria. The median age at surgery was 8 years [interquartile range (IQR), 6–10 years] and mean follow-up was 16.3 ± 10.6 months (range, 6–48 months). The median BCVA was 0.1 logMAR (range, 0–0.5) in the right eye and 0.1 logMAR (range, 0–0.8) in the left eye. Amblyopia was seen in 8 patients (29.6%) at the time of surgery. Strabismus was the cause of amblyopia in 4 patients and the other 4 patients had both strabismus and anisometropia. The mean lines of vision loss in the amblyopic eye was 3.12 logMAR. All the patients with amblyopia were undergoing 2 to 3 hours of occlusion of the better eye at the time of surgery. Fixation preference for 1 eye was seen in 24 patients before surgery. Horizontal deviation in the form of either exotropia (n = 16) or esotropia (n = 10) was observed in 26 patients along with the DVD. Among these patients, 48%

had large horizontal deviation at presentation, ie, more than 30 PD whereas 19.2% had less than 15 PD deviation and 32.8% had deviation between 15 and 30 PD. Overall, 23 patients underwent simultaneous horizontal rectus muscle surgery (either medial rectus recession for esotropia or lateral rectus recession for exotropia). None of the patients underwent more than 2 rectus muscle surgeries per eye. A pattern and V pattern was seen in 5 patients and 1 patient, respectively before surgery. None of the patients had significant IO or superior oblique muscle dysfunction. V pattern was corrected by half muscle-width vertical upshifting of both lateral rectus muscles. A pattern of less than 15 PD was corrected by the SR recession alone. A pattern of more than 15 PD in 3 patients was corrected by additional half muscle-width vertical downshifting of the lateral rectus muscles. Abnormal head posture was recorded in 12 patients at the time of presentation. Latent nystagmus was seen in 3 patients.

Preoperatively the median DVD was 9 PD (IQR, 6–14 PD) in the right eye and 9 PD (IQR, 7–12 PD) in the left eye. Asymmetric DVD (>10 PD) was seen in 6 patients (22.2%). Additionally, non-dissociated hypertropia (range, 2–10 PD) was seen in 6 patients preoperatively. This hypertropia was seen in the eye with the larger DVD. The amount of SR recession performed ranged from 5 to 10 mm with a median of 7 mm (IQR, 6–9 mm) in the right eye and 7 mm (IQR, 6–9 mm) in the left eye. The frequencies of hangback, hemi-hangback, and fixed scleral-suture surgery were 13 (48.1%), 7 (25.9%), and 7 (25.9%), respectively. Postoperatively the median DVD reduced to 5 PD (IQR, 3–8 PD) in the right eye (P = 0.015) and 6 PD (IQR, 3–10 PD) in the left eye (P = 0.016) (Fig. 1). Figure 2 shows the graphical representation of outcome of DVD after surgery in each patient. At the last follow-up, DVD remained latent in both eyes in 63.0% of patients. The amount of residual DVD was found to be <5 PD (excellent outcome, n = 23) in 42.6% of the eyes, 5–9 PD (good outcome, n = 17) in 31.5%, 10–14 PD (fair outcome, n = 6) in 11.1%, and ≥15 PD (poor outcome, n = 8) in 14.8% eyes after surgery. Residual DVD of 10 PD or more resulted in manifestation of DVD in 57% of these eyes as compared with 7.5% eyes with residual DVD of less than 10 PD (P = 0.0003). The Kaplan-Meier survival curve is shown in Figure 3. The cumulative success rate was 81.5% after 6 months as well as 1 year following surgery. The success rate reduced to 60.4% and 41.4% at 2 years and 4 years of follow-up, respectively.

Overall 8 patients underwent bilateral asymmetric SR recession. The median amount of recession asymmetry performed was 3.5 mm (range, 2–5 mm). Indication for asymmetric recession in 6 patients was asymmetric DVD of 10 PD or more and in 2 patients was the presence of non-DVD of more than 5 PD preoperatively. Patients with asymmetric surgery showed a slightly higher success rate (75%) as compared with those with symmetric surgery (57.9%) at the last follow-up. However, this difference was not statistically significant (P = 0.67).

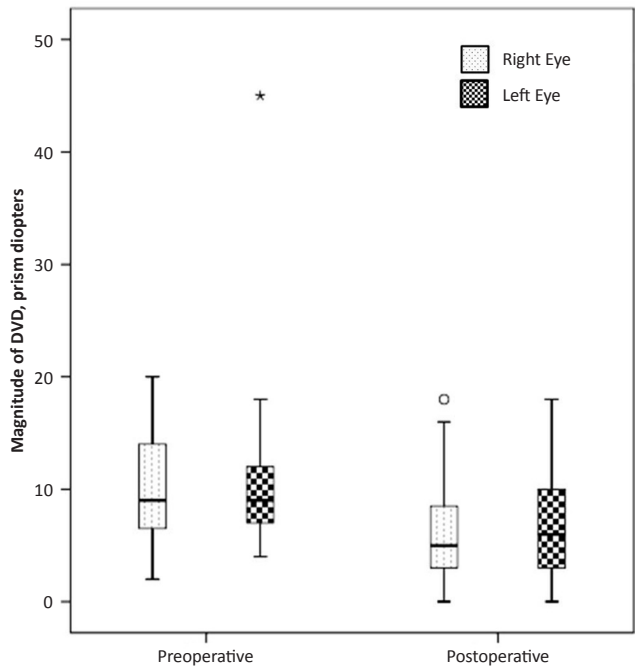

FIGURE 1. Box and whisker plot showing the change in amount of dissociated vertical deviation (DVD) following superior rectus recession in the right and left eye. The horizontal line in the middle of each box indicates the median, whereas the top and bottom borders of the box mark the 75th and 25th percentiles, respectively. The whiskers above and below the box mark the 90th and 10th percentiles. The asterisk and circle beyond the whiskers are outliers beyond the 90th or 10th percentiles.

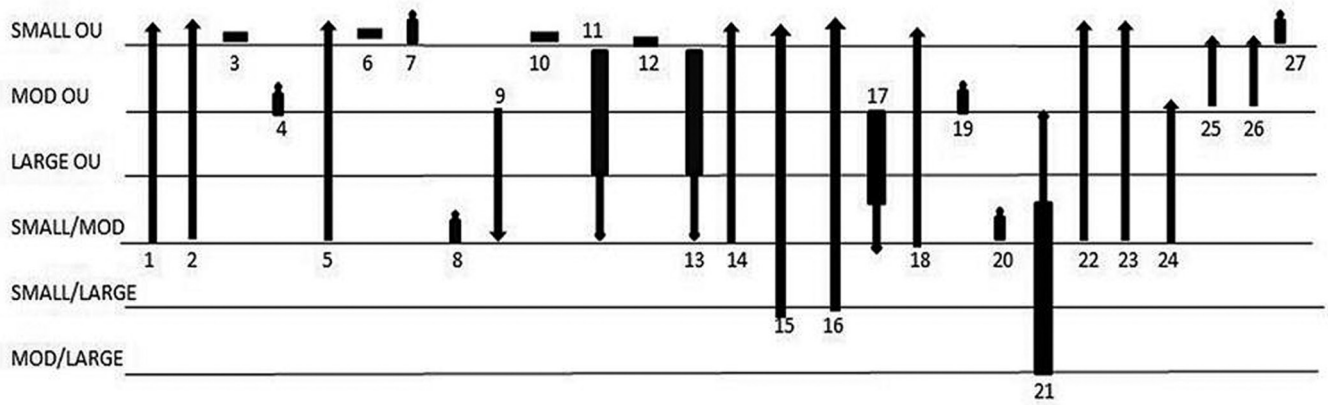

FIGURE 2. Arrow plot showing outcome of bilateral superior rectus recession for bilateral dissociated vertical deviation (DVD) in each of the 27 patients. A grading scale was used in this study: small DVD is 0–9 PD, moderate DVD is 10–19 PD, and large DVD is ≥20 PD of deviation. Thin arrows denote patients with successful outcome and thicker arrows represent patients with manifest postoperative DVD in either eye (failed cases). OU indicates oculus unitas (both eyes); PD, prism diopters.

The probability of a successful outcome did not depend on age at surgery, sex, preoperative type or magnitude of horizontal deviation, preoperative vertical deviation, amblyopia, and postoperative residual horizontal deviation. Also the outcome did not differ in moderate (<15 PD) and large DVD (≥15 PD). The only factor that favored a successful outcome was the presence of fixation preference ($P = 0.041$). Table 2 shows the distribution of various preoperative and postoperative factors between the successful and failure groups.

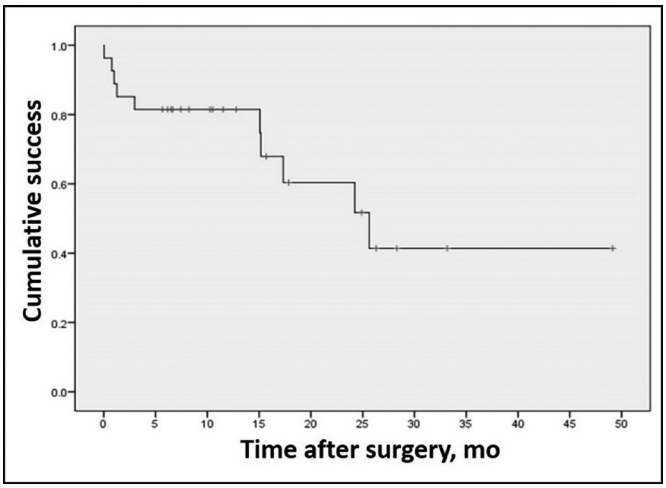

FIGURE 3. The Kaplan-Meier survival curve showing the cumulative success rate of bilateral superior rectus recession for dissociated vertical deviation at different time points.

Three eyes developed elevation limitation (grade −1 or −2) in the immediate postoperative period. However it did not persist till the last follow-up visit. Additionally other surgical complications like upper lid retraction, ptosis, or superior oblique dysfunction were not seen even in those patients of whom 10-mm recession was performed. Two patients developed small hypotropia (<7 PD) after symmetrical recession of SR muscle. One patient who underwent asymmetric surgery developed pseudo-IO overaction in the eye with lesser amount of SR recession with residual DVD in the better eye and a switch in fixation preference. Three additional patients switched fixation preference after surgery; all of whom underwent symmetric surgery.

DISCUSSION

Several publications reported their results of unilateral SR recession for DVD.[17,18,21] The reason for unilateral intervention was that the DVD was mostly manifested in the non-preferred eye and majority of their patients displayed a fixation preference.

TABLE 2. Factors Affecting Surgical Outcome of DVD Following Bilateral Superior Rectus Recession

	Surgical Outcome		
	Failure (n = 10)	**Successful (n = 17)**	***P* Value**
Age at surgery (median; IQR), y	9; 6–11	7; 6–9	0.595
Sex			1
Male	4	8	
Female	6	9	
Amblyopia			0.67
Present	2	6	
Absent	8	11	
Fixation preference			0.041
Present	7	17	
Absent	3	0	
Type of preoperative horizontal deviation			0.692
Esotropia	4	6	
Exotropia	5	11	
Magnitude of preoperative horizontal deviation (median; IQR), PD*	30; 18–46	35; 20–35	0.623
Magnitude of preoperative DVD, PD*			1
<15	10	36	
≥15	1	7	
Preoperative vertical deviation, PD			1
Present	2	4	
Absent	8	13	
Surgical technique			0.439
Hangback	4	9	
Hemi-hangback	2	5	
Fixed scleral suture	4	3	
Postoperative residual horizontal deviation (median; IQR), PD*	5; 3–8	5; 3–9	0.898
Follow-up (median; IQR), d	462; 233–722	346; 217–758	0.651

DVD indicates dissociated vertical deviation; IQR, interquartile range; PD, prism diopters.

* Results shown for distance deviation.

This approach may, however, lead to hypotropia in the operated eye and/or manifestation of DVD in the nonoperated eye.[17,23,28] Shwartz and Scott[17] showed that after unilateral SR recession, 17% patients developed DVD in the contralateral eye and 21% patients developed hypotropia in the operated eye postoperatively. By statistical analysis, they demonstrated that in patients with any DVD present in the contralateral eye preoperatively, there was 15 times greater risk of developing a significant DVD (≥15 PD) in that eye postoperatively. Therefore, bilateral SR recession is preferred by most strabismologists and was also the technique used in the current study. We performed bilateral SR recessions in spite of 89% of our patients displaying fixation preference before surgery. None of the patients included in the study had profound amblyopia or poor vision in 1 eye. In such cases we performed unilateral surgery as the worse eye is unlikely to resume fixation any time in future.

We observed a successful outcome (no manifest DVD) in 63% of patients after bilateral SR recession. Esswein et al[21] studied outcome of large SR recessions (7–9 mm) in 86 patients and reported a success rate of 72% at 3 years of follow-up. They, however, included both unilateral and bilateral cases in their analysis. Also the successful outcome in their study was classified as either DVD not manifesting at all (corrected) or reduced to cosmetically acceptable levels (improved). In contrast, we classified failure as decompensated DVD in either of the eyes irrespective of the magnitude of the DVD. This could explain the slightly reduced success rate in our study. Magoon et al[19] studied the outcome of large bilateral SR recession in 25 patients with bilateral DVD. They also performed bilateral surgery despite fixation preference and asymmetry of DVD. They found that this approach was highly successful with 19 (76%) of 25 patients having small DVD in both eyes postoperatively. The majority of their patients had large DVD (>20 PD) in both eyes prior to surgery and underwent 10 mm or more SR recession for DVD. They also found decompensated hypertropia of more than 10 PD in 10 (40%) patients that failed to get corrected in 5 patients postoperatively. Therefore, they suggested asymmetric surgery in such patients. Although we observed hypertropia in 22% of patients, the magnitude was small (≤10 PD).

We did not observe upper lid retraction, ptosis, or limitation of elevation in any of the eyes that underwent SR recession similar to other authors.[17,19,21] One patient who underwent asymmetrical SR recession (10 mm in the right eye and 6 mm in the left eye) for asymmetrical DVD developed larger decompensated DVD in the lesser operated eye postoperatively. Additionally this patient showed pseudo-IO overaction in the left eye. This complication is similar to that reported by Freeman and Rosenbaum.[30]

We did not find overcorrection of DVD in any of our patients. The only major complication of the surgery was undercorrection as was found in many other studies.[19,22,30,31] The rate of undercorrection, however, was not found to be affected by any of the parameters analyzed including age, amblyopia, type of surgical technique, residual postoperative horizontal deviation, asymmetry of DVD, asymmetry of surgery, and even the amount of preoperative DVD except fixation preference. None of the 3 patients who lacked fixation preference had a successful outcome. Among the 3 patients, 1 maintained alternate fixation, whereas the other 2 developed fixation preference for 1 eye following surgery. Varn et al[31] suggested combining IO-weakening procedure along with large recession (≥10 mm) of SR muscle for large DVD (>20 PD) in order to prevent residual deviation. Since we did not find any difference in our results for DVD greater than 15 PD, we do not propose combined procedure as the first modality of treatment.

The results of this study should be interpreted within the limitations of its retrospective design. There were 3 surgeons involved in management of the patients. However, since the surgical dosages and techniques followed were similar, we do not consider this a major limitation. There were 3 types of surgical techniques performed: hangback, hemi-hangback, and fixed scleral sutures. Although there are some concerns of anterior creeping of the muscle with hemi-hangback and hangback technique,[32,33] we did not find more undercorrection when using these techniques. Another limitation is the involvement of multiple examiners for measurement of DVD. Dissociated vertical deviation is a highly variable deviation and the measurements may change depending on the length of the time eye is dissociated and the attention span of the patient. We therefore considered the manifestation of DVD (which is perceived both by the patient and the ophthalmologist as residual deviation) to be the criteria for failure and not the absolute magnitude of the DVD.

CONCLUSIONS

In our series, 63% of our patients attained a successful outcome (DVD not manifesting spontaneously in either eye) after bilateral asymmetric or symmetric SR recession. All the failures were undercorrections of DVD and no overcorrections were found. Even in those patients with excellent results, DVD could not be completely abolished. Whether combination of other surgical procedures or a larger amount of SR recession will improve the success rate of this procedure warrants further study.

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