

## Research Article

# The Effect of Surgical Intervention for Dissociated Vertical Deviation Alone on Concurrent Horizontal Strabismus

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**\*Corresponding authors:** Park S, Department of Pediatric Ophthalmology & Strabismus, Cole Eye Institute, Cleveland Clinic, Cleveland, USA**Received:** December 12, 2017; **Accepted:** January 22, 2018; **Published:** January 29, 2018**Abstract****Purpose:** To evaluate the effect of surgery for dissociated vertical deviation (DVD) alone on concurrent horizontal strabismus.**Design:** Retrospective chart review.**Methods:** Patients who underwent surgical intervention by a single surgeon for DVD and had concurrent horizontal strabismus from 1998 through 2015 were identified.**Results:** 55 patients were included and divided into two groups: (1) Those that underwent surgery for DVD only, and (2) those that underwent concurrent surgery for DVD and horizontal strabismus. 34 patients were included in Group 1 and 21 patients in Group 2. Successful outcome for DVD was defined as resolution or improvement in DVD precluding additional surgery. Successful outcome for the horizontal deviation was defined as resolution of horizontal deviation, well-controlled intermittent exotropia, or constant horizontal deviation <10 prism diopters. Failure was defined as any constant horizontal deviation >10 prism diopters and/or subsequent surgery for horizontal strabismus. 29 of the 34 patients (85.3%) in Group 1 had a successful outcome for DVD compared to 18 of the 21 patients (85.7%) in Group 2 ( $p=1.00$ ). 22 of the 34 patients (64.7%) in Group 1 had a successful outcome for the horizontal deviation compared to 15 of the 21 patients (71.4%) in Group 2 ( $p=0.77$ ).**Conclusion:** There was no difference in successful control of horizontal strabismus between patients who underwent concurrent surgery for DVD and horizontal strabismus and those who underwent surgery for DVD alone. Surgery for DVD only can result in the acceptable correction of concurrent horizontal strabismus in the absence of surgery for the latter.**Keywords:** Surgical Intervention; Surgery; Dissociated vertical deviation; Horizontal strabismus**Introduction**

Dissociated vertical deviation (DVD) is a challenging condition to manage, largely due to a poor understanding of its underlying etiology and the dearth of clinical studies that deal with its treatment. Guyton analyzed the vertical, horizontal, and torsional eye movements of six patients carrying the diagnosis of DVD in an attempt to better understand its underlying etiology [1]. He proposed that the vertical vergence component of the DVD serves as a cyclovertical analog of the horizontal convergence used by some patients to help dampen the horizontal component of latent nystagmus, thereby preventing a decrease in vision that the latent nystagmus would otherwise cause. We are not aware of any other postulates on the cause of DVD.

The association between DVD and horizontal strabismus, particularly infantile esotropia has been well described, and DVD also occurs in the context of acquired esotropia, congenital and acquired exotropia, and sometimes intermittent exotropia. Oftentimes surgical correction of the horizontal strabismus is performed at the time of DVD surgery [2-5]. We were unable to find any studies or discussion

of the effect of DVD surgery on concurrent horizontal strabismus; possible reasons are that the two are often repaired simultaneously, or the horizontal strabismus alone is repaired if the DVD is not severe enough.

The purpose of the present study is to determine whether surgery for DVD alone in patients with concomitant horizontal strabismus can improve control of the latter, thereby avoiding additional horizontal muscle surgery.

**Patients and Methods****Patients**

Cleveland Clinic Institutional Review Board approval was obtained approval was obtained for the retrospective chart review of consecutive patients who underwent surgical intervention by a single surgeon (EIT) for DVD and who also carried a diagnosis of horizontal strabismus from 1998 through 2015. All data were secured in compliance with the Health Insurance Portability and Accountability Act. All patients included in the study had a minimum of 3 months of

**Table 1:** Patient Demographics.

	DVD Surgery Alone in Setting of Concurrent Horizontal Strabismus	Concurrent DVD and Horizontal Strabismus Surgery	p-value
# of Patients	34	21	
Average Age (years)	12.1	14.3	0.54
Male	11 (32.4%)	8 (38.1%)	0.77
Female	23 (67.6%)	13 (61.9%)	0.58
Prior Horizontal Strabismus Surgery	28 (82.4%)	14 (66.7%)	0.21

**Table 2:** Types of Horizontal Strabismus.

	DVD Surgery Alone in Setting of Concurrent Horizontal Strabismus	Concurrent DVD and Horizontal Strabismus Surgery	p-value
Constant Esotropia	10 (29.4%)	8 (38.1%)	0.56
Intermittent Esotropia	2 (5.9%)	0 (0%)	0.52
Constant Exotropia	15 (44.1%)	12 (57.1%)	0.41
Intermittent Exotropia	7 (20.6%)	1 (4.8%)	0.12

postoperative follow-up.

Charts were reviewed for the following data: sex, age at surgery for DVD, previous strabismus surgery, severity of DVD, type and magnitude of horizontal strabismus, type of surgical intervention for DVD and/or horizontal strabismus, follow-up after surgical intervention (1 day, 2 months, 6 months, and 1 year), final ocular alignment outcome (defined as ocular alignment at last follow-up visit), subsequent surgical intervention for strabismus, and date of last follow-up examination.

The intervention was defined as DVD surgery without concomitant surgery for horizontal strabismus.

### Grading of DVD

The following arbitrary grading of DVD was applied:

Grade 0: No DVD;

Grade 1: Trace DVD (<5PD, can be detected under prolonged cover);

Grade 2: Mild DVD (<10PD, only happens under cover, recovers quickly);

Grade 3: Moderate DVD (10-20PD, happens spontaneously and occurs frequently and spontaneously);

Grade 4: Severe DVD (>20PD, manifest).

Patients underwent surgery only if at least one eye demonstrated Grade 3-4 severity

### Grading of horizontal deviation

A horizontal deviation was considered significant if it was constant and measured at least 10 prism diopters, or if it was a poorly controlled intermittent deviation.

### Outcome analysis

A successful outcome for DVD was defined as improvement in its severity, precluding the need for additional surgery. A good outcome for the horizontal deviation was defined as resolution of esotropia or exotropia; continued or improved control of intermittent exotropia; or decreased constant horizontal deviation to less than or equal to

10 prism diopters. Failure of the intervention to control or improve horizontal deviation was defined as a residual constant horizontal deviation of greater than 10 prism diopters and/or the need for subsequent horizontal muscle surgery.

Statistical analysis of preoperative characteristics and outcomes was performed with Fisher's exact test. A P value of <0.05 was considered statistically significant.

## Results

73 patients were identified who received surgery to correct DVD by one surgeon (EIT) from 1998 through 2015. All patients were examined by the surgeon prior to surgery and at every post-operative office visit. 55 patients were included; 18 patients were excluded because they had less than 3 months of postoperative follow-up. Patients were divided into two groups: (1) Those who only underwent surgical correction for DVD, and (2) those who underwent concurrent surgical correction for DVD and horizontal strabismus. Surgical intervention for correction of DVD consisted of recession of the superior rectus muscles in all patients with the exception of 4 patients (1 in Group 1; 3 in Group 2) who underwent anterior transposition of the inferior oblique muscles.

34 patients were included in Group 1, 23 of whom were female (67.6%). Patient age at time of surgery ranged from 2 years to 44 years (mean 12.1 years). Length of follow-up ranged from 4.9 months to 13.8 years, with a mean follow-up of 48.0 months. 28 patients (82.4%) had undergone prior horizontal strabismus surgery. 21 patients were included in Group 2, 13 of whom were female (61.9%). Patient age at time of surgery ranged from 2 years to 45 years (mean 14.3 years). Length of follow-up ranged from 6.0 months to 13.0 years, with a mean follow-up of 48.1 months. 14 patients (66.7%) had undergone prior horizontal strabismus surgery. Groups 1 and 2 were comparable with regards to patient demographics (Table 1).

The types of horizontal strabismus identified in both groups included constant esotropia, intermittent esotropia, constant exotropia, and intermittent exotropia. In Group 1, 10 (29.4%) patients had constant esotropia; 2 (5.9%) had intermittent esotropia; 15 (44.1%) had constant exotropia; and 7 (20.6%) had intermittent exotropia. In Group 2, 8 (38.1%) patients had constant esotropia; 0

Table 3: Outcomes.

	DVD Surgery Alone in Setting of Concurrent Horizontal Strabismus	Concurrent DVD and Horizontal Strabismus Surgery	p-value
Successful Control of DVD	29 (85.3%)	18 (85.7%)	1
Failure to Control DVD	5 (14.7%)	3 (14.3%)	0.71
Successful Control of Horizontal Strabismus	22 (64.7%)	15 (71.4%)	0.77
Failure to Control Horizontal Strabismus	12 (35.3%)	6 (28.6%)	0.77

(0%) had intermittent esotropia; 12 (57.1%) had constant exotropia; and 1 (4.8%) had intermittent exotropia. There was no significant difference between the two groups with regards to type of horizontal strabismus (Table 2).

30 of the 34 patients (88.2%) in Group 1 underwent bilateral surgery for DVD, whereas 17 of the 21 patients (81.0%) in Group 2 underwent bilateral surgery for DVD ( $p=0.46$ ). Of the 4 (11.8%) patients in Group 1 who underwent unilateral DVD surgery, 3 required subsequent surgery for the contralateral DVD, and 1 required subsequent surgery for horizontal strabismus. Of the 4 (19.0%) patients in Group 2 who underwent unilateral DVD surgery, 3 required subsequent surgery for horizontal strabismus; none required subsequent surgery for contralateral DVD.

Success of surgical intervention for both the DVD and horizontal deviation were evaluated according to the criteria outlined in the methods section. 29 out of the 34 patients (85.3%) in Group 1 had a successful outcome for DVD. 18 out of the 21 patients (85.7%) in Group 2 had a successful outcome for DVD ( $p=1.00$ ) (Table 3). 5 out of the 34 patients (14.7%) in Group 1 required additional surgery to control the DVD, whereas 3 out of the 21 patients (14.3%) in Group 2 required additional surgery to control the DVD ( $p=0.71$ ). 22 out of the 34 patients (64.7%) in Group 1 had a successful outcome for the horizontal deviation. 15 out of the 21 patients (71.4%) in Group 2 had a successful outcome for the horizontal deviation ( $p=0.77$ ). Following the initial surgery, 12 out of the 34 patients (35.3%) in Group 1 had either a constant horizontal deviation of greater than 10 prism diopters or required subsequent surgery to correct the horizontal deviation. In comparison, 6 out of the 21 patients (28.6%) in Group 2 had either a constant horizontal deviation of greater than 10 prism diopters or required subsequent surgery to correct the horizontal deviation ( $p=0.77$ ) (Table 3).

## Discussion

We found no difference in the outcome of horizontal strabismus between patients who underwent concurrent surgery for DVD and horizontal deviation and those who underwent surgery for DVD alone. There have been numerous studies investigating the surgical approach to DVD as well as a few studies examining the sequential correlation between DVD and congenital esotropia following horizontal strabismus surgery [6-13]. Struck et al. reported a case series in which hypertropia resolved with surgical correction of intermittent exotropia alone, however, their study excluded all patients with a diagnosis of DVD [14]. After extensive literature search, we have been unable to identify any published studies examining the effect of DVD surgery alone on co-existing horizontal strabismus.

It is possible that the high rates of previous horizontal strabismus surgery (82.4%) in the group undergoing surgery for DVD alone

predisposed our subjects to improved control of the horizontal strabismus following DVD surgery, however, the rate of prior horizontal strabismus surgery did not differ between this group and the group undergoing simultaneous surgery for both DVD and horizontal strabismus. The predominant type of horizontal strabismus in our patient population was constant exotropia (57.1% in Group 1; 44.1% in Group 2), which is inconsistent with what has been reported in the literature as the most commonly associated horizontal strabismus pattern was reported to be infantile esotropia [13,15]. This discrepancy may suggest that our patient sample may not be representative of most patients with DVD; however we did not exclude patients with infantile esotropia and included all patients operated on for DVD. So in fact, DVD may be more common in patients with exotropia than previously observed.

The strengths of the present study include the fairly long follow-up time of approximately 4 years in both groups, and a moderately large sample size in each group. Limitations include a lack of prospective randomized approach to treatment, non-uniform surgical approach to the correction of DVD with a majority of patients in both groups having undergone superior rectus recession and a small subset of patients having undergone anterior transposition of the inferior oblique as well as those inherent to a retrospective study design.

The findings of the present study suggest that up to two-thirds of patients with both DVD and concomitant horizontal strabismus (even in the setting of prior horizontal strabismus surgery) can have improvement of their horizontal strabismus following surgery for DVD alone, obviating the need for additional horizontal strabismus surgery in some. Prospective randomized studies are necessary to provide more definitive results related to the effect of DVD surgery on concomitant horizontal deviations.

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