Surgical outcomes and occurrence of associated vertical strabismus during a 10-year follow-up in patients with infantile esotropia

Donghun Lee, Won Jae Kim¹, Myung Mi Kim²

Purpose: Authors analyzed long-term surgical outcomes of infantile esotropia and the occurrence of associated strabismus, inferior oblique overaction (IOOA), and dissociated vertical deviation (DVD). Clinical factors related to the occurrence of IOOA and DVD in patients with infantile esotropia were also evaluated.

Methods: Medical records of patients with infantile esotropia, who underwent surgery between 1995 and 2008, were reviewed retrospectively. Included patients were followed for at least 10 years. The incidence and age at development of IOOA and DVD were analyzed. To evaluate predisposing factors for developing IOOA or DVD, patients were divided into two groups: those with infantile esotropia only (group A) and those who developed IOOA or DVD (group B). Results: A total of 122 patients were enrolled and mean follow-up period was 16.0 years (range: 10–32 years). The mean number of surgeries was 1.7 (range: 1–5), and 64 (52.5%) patients achieved optimal horizontal alignment (esotropia <10 prism diopters [PD] and orthotropia). Fifty (41.0%) patients developed IOOA at a median age of 3 years (range: 1–21 years); 54 (44.3%) developed DVD at a median age of 5 years (range: 1–25 years). Patients in group B underwent more horizontal surgeries than those in group A (P = 0.028), and favorable surgical outcomes between the two groups were not different at final visit. There were no other significant differences in clinical factors between the two groups.

Conclusion: Approximately, 52.5% of patients achieved favorable surgical outcomes through 1.7 surgeries during the 10-year follow-up period. DVD tended to develop at a later age than IOOA, and in some cases, up to 20 years after diagnosis of infantile esotropia. To achieve favorable horizontal alignment at final visit, patients with associated vertical strabismus underwent more horizontal muscle surgeries than patients with infantile esotropia only. The presence of IOOA/DVD may affect horizontal alignment outcomes.

Key words: Dissociated vertical deviation, infantile esotropia, inferior oblique overaction

Infantile esotropia is characterized by nonaccommodative, constant large-angle esodeviation, with an onset between birth and 6 months of age.¹ Because the age at onset is relatively young compared with other types of strabismus, many clinicians have observed associated abnormal ocular alignment, such as inferior oblique overaction (IOOA), dissociated vertical deviation (DVD), and latent nystagmus during follow-up of their lifelong condition.²⁻⁴ After the incidence of DVD with infantile esotropia was first reported by Lang in 1967,³ there have been some reports describing the relationships between infantile esotropia and associated vertical strabismus.³⁻⁴ IOOA has been demonstrated to be a clinical factor associated with unsatisfactory outcomes,⁵ while DVD has been noted to play a role in the unsuccessful alignment of the eyes after infantile esotropia surgery.³⁻⁴

Most previous studies investigating associated vertical strabismus were simply incidence surveys,⁶⁻⁸ or vertical strabismus was mentioned only as a risk factor for consecutive exotropia.⁸

Therefore, in the present study, we analyzed the surgical outcomes in individuals treated for infantile esotropia and occurrence of associated vertical strabismus during a 10-year follow-up period. The clinical factors associated with the occurrence of IOOA and DVD were also investigated.

Department of Ophthalmology, Catholic University of Daegu School of Medicine, Daegu, Korea, ¹Department of Ophthalmology, Yeungnam University Medical Center, Daegu, South Korea, ²Nune Eye Hospital, Daegu, South Korea

Correspondence to: Prof. Myung Mi Kim, Nune Eye Hospital, #2179 Dalgubeol-daero, Jung-gu, Daegu, South Korea. E-mail: mmk@med.yu.ac.kr

Received: 04-Dec-2019  Revision: 04-Apr-2020
Accepted: 19-May-2020  Published: 15-Dec-2020

Methods

This retrospective study was conducted after approval of the Institutional Review, and all procedures adhered to the tenets of the Declaration of Helsinki. The medical records of patients with infantile esotropia, who underwent strabismus surgeries between June 1995 and July 2008, were retrospectively reviewed. Among these patients, those followed-up for at least 10 years were included in the study. About the frequency of follow-up, patients visited our clinics 3–4 times a year when treatments of their strabismus and amblyopia were actively performed. After then, the frequency of follow-up visits was 1–2 times a year when angle of strabismus and their visual acuity were stabilized. Infantile esotropia was diagnosed in those patients with a history of inward deviation within 6 months after birth and having a constant large angle of strabismus. Patients with neurological deficit and developmental delay were excluded from the study. Patients with ocular anatomical abnormalities, such as optic nerve hypoplasia or previous history of ocular surgery, were also excluded.

Sex, age at diagnosis, age at first surgery, total number of surgeries during the follow-up period, the presence of amblyopia at first and final visit, preoperative angle of esodeviation,

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKLRRPMedknow_reprints@wolterskluwer.com

Cite this article as: Lee D, Kim WJ, Kim MM. Surgical outcomes and occurrence of associated vertical strabismus during a 10-year follow-up in patients with infantile esotropia. Indian J Ophthalmol 2021;69:130-4.
refractive error, and angle of horizontal deviation at final visit were evaluated in all patients. Favorable horizontal alignment at the final visit was defined as esotropia under 10 prism diopters (PD) and orthotropia. Surgical success was analyzed based on the horizontal deviation at the final visit.

To evaluate predisposing factors for developing IOOA and DVD, the enrolled patients were divided into two groups: patients with infantile esotropia only (group A) and patients who developed associated vertical strabismus, IOOA or DVD (group B). Children with IOOA and DVD at presentation were also included in the group B. Clinical factors associated with the development of vertical strabismus were compared between the two groups.

The incidence and the age at the development of IOOA and DVD were evaluated. The severity of IOOA was graded according to the degree of over-elevation of the eye in adduction using the +1 to +4 rating system.[9] The criteria for the occurrence of associated vertical strabismus in this study were defined as IOOA >2 and DVD >10 PD, using categories described by Scott.[10] IOOA (DVD itself can produce overelevation in adduction)[7] DVD was distinguished from IOOA with an alternate cover test in side gaze: DVD was dissociated, while IOOA produced a true hypertropia of the adducted eye.

In this study, the type of surgeries for infantile esotropia and vertical strabismus was also evaluated. The number of surgeries for residual esotropia, recurrent esotropia, consecutive esotropia, IOOA, and DVD was analyzed. Their additional surgeries for horizontal deviation and vertical strabismus might have been performed simultaneously or sometimes separately.

Each surgery was performed under general anesthesia by a single surgeon. Bilateral medial rectus recession was performed as a surgical treatment of infantile esotropia. To correct associated vertical strabismus, graded inferior oblique (IO) recession for IOOA and superior rectus (SR) recession for DVD were performed. For patients with both IOOA and DVD, graded IO recession was preferentially performed. If DVD did not decrease under 10 PD after IO surgery, SR recession was done.

Amblyopia was defined as best-corrected visual acuity of less than 20/30 in one eye or a difference 2 or more lines of best-corrected visual acuity between both eyes. If infants were unable to estimate their visual acuity, a clear preference for the use of one eye also classified as having amblyopia. Amblyopia was treated with glasses and occlusion therapy.

Pre and postoperative angle of esodeviation was evaluated using the alternate prism cover test at distance (6 m) and near (33 cm). Hirschberg or modified Krimsky test were used in patients in whom the alternate prism cover test could not be performed due to a lack of cooperation.

Preoperative cycloplegic refractive errors were measured 30 min after instillation of 1% cyclopentolate 3 times, 5 min apart. Patients in whom hyperopia was greater than 1.5 diopters were prescribed glasses. To exclude the possibility of partially accommodative esotropia, patients were excluded from the study if there was a decrease in esodeviation over 10 PD after wearing hyperopic spectacles full-time for at least 3 weeks.[11] After cycloplegic refraction, results were converted to spherical equivalent (SE), and the mean value of SE in both eyes was used for statistical analyses. Stereoaucity was measured using the Lang 1 stereotest (Lang-Stereotest AG, Küsnacht, Switzerland) and the Stereo Fly Stereotest (Stereo Optical Co., Chicago, IL, USA).

Statistical analyses were performed using SPSS version 22.0 (IBM Corporation, Armonk, NY, USA). Comparisons between groups A and B were evaluated using the independent t-test and Chi-square test. A level of \( P < 0.05 \) was assumed statistically significant.

### Results

#### Basic characteristics of the included patients and long-term surgical outcomes

A total of 122 patients met the inclusion criteria for this study. Fifty-seven patients were male and 65 were female. The mean follow-up period was 16.0 ± 4.9 years (range: 10–32 years) and the mean age at diagnosis was 17.6 ± 12.4 months (range: 1–60 months). The mean age at first surgery was 28.3 ± 14.9 months (range: 4–67 months). The mean number of surgeries for treating infantile esotropia, IOOA, and DVD was 1.7 ± 0.8 (range: 1–5). The mean angle of horizontal deviation before first surgery was 41.6 ± 13.0 PD (range: 20–80 PD esotropia) and after several surgeries, esotropia decreased to 3.0 ± 7.2 PD esotropia at final visit (range: 16–20 PD esotropia). Of the 122 patients, 64 (52.5%) achieved favorable horizontal alignment (esotropia under 10 PD to orthotropia) at the final visit. Fig. 1 illustrates the incidence of vertical strabismus of 122 patients with infantile esotropia. During a 16-year follow-up period, 53 patients developed infantile esotropia only and those were enrolled in group A. Sixty-nine patients developed IOOA or DVD. Those were grouped B.

The type of surgery for treating infantile esotropia and associated vertical strabismus are summarized in Table 1. Sixty-three of the 122 patients (51.6%) underwent only one correction surgery for infantile esotropia. Thirty-two (26.2%) patients underwent additional surgery for residual or recurrent esotropia, and 12 (9.8%) for consecutive esotropia. In addition, 42 (34.4%) patients underwent additional surgery for IOOA and 23 (18.9%) for DVD [Fig. 2].

#### Incidence of IOOA in patients with infantile esotropia

Fig. 3 illustrates the occurrence of IOOA in patients with infantile esotropia. Fifty (41.0%) patients were detected to have IOOA, 26 of whom presented with simultaneous infantile esotropia at the first visit. The median age at development of IOOA was 3 years (range: 1–21 years). The oldest patient was a 21-year-old man with a history of three surgeries before IOOA detection: the first surgery for esotropia, and the remaining two for DVD with consecutive esotropia. Because he did not want to undergo any further surgeries, his IOOA was observed.

#### Incidence of DVD in patients with infantile esotropia

Fig. 4 illustrates the occurrence of DVD with patients with infantile esotropia. Fifty-four (44.3%) patients were diagnosed with DVD at a median age of 5 years (range: 1–25 years). This was older than the median age at development of IOOA. Ten of the 54 patients were diagnosed with simultaneous infantile esotropia at the first visit. The oldest patient diagnosed was a 25-year-old woman. The patient had recorded normal versions annually after her first and last surgery for infantile esotropia when she was 40 months of age. In 2010, at her last follow-up, DVD of 10 PD was measured in the right eye; however, she was lost to follow-up thereafter.

#### Factors associated with the development of IOOA and DVD in patients with infantile esotropia

The baseline characteristics and surgical outcomes of patients in groups A and B are summarized in Table 2. There were no statistically significant differences in sex, mean follow-up period, age at diagnosis, age at first surgery, the presence of amblyopia at first and final visit, the preoperative angle of esodeviation,
refractive error, or the angle of horizontal deviation at the final visit. The mean number of total surgeries was 1.3 times (range: 1–3) in group A and 2.0 times (range: 1–5) in group B. This was significantly more in group B than that in group A (P < 0.001). In addition, the mean number of additional surgeries only for horizontal deviation was also more in group B than that in group A (P = 0.028). Although the percentage of better stereopsis was numerically higher in group A than in group B, the difference was not statistically significant (P = 0.576 [Lang I stereotest]; and P = 0.353 [Stereo Fly stereotest]).

**Discussion**

This study reported the surgical outcomes of 122 patients with infantile esotropia and the occurrence of associated vertical strabismus during a median 16-year follow-up period. Approximately, 52.5% of the patients achieved under favorable horizontal alignment through 1.7 surgeries. Of 122 patients, 48.3% underwent additional surgeries for treating consecutive exotropia, residual esotropia, and recurrent esotropia, IOOA, or DVD. More than 40% of patients were diagnosed with IOOA or DVD and they required further surgical interventions than patients with infantile esotropia only.

Although there have been several hypotheses for the development of IOOA or DVD in infantile esotropia in previous studies,[7,12-15] the precise mechanism remains unclear. Spielmann[15] assumed that DVD with infantile esotropia was caused by an imbalance in binocular stimulation. In addition, Louwagie et al.[14] demonstrated that, compared with those with acquired esotropia, worse stereopsis in patients with infantile esotropia was noted as a risk factor for poorer motor alignment, resulting in the development of IOOA and DVD. Moreover, Guyton et al.[12,13] believed that excyclotorsion of IOOA, which dampens latent cyclovertical nystagmus and accompanying DVD, is regarded as an unavoidable byproduct of the nystagmus damping mechanism. Furthermore, Wilson and Parks[7] reported that in adduction, the nose may act as an occcluder, allowing DVD to simulate IOOA.

To evaluate the age at occurrence of IOOA or DVD, and the clinical factors of patients with or without associated vertical strabismus, we aimed to investigate the long-term course of infantile esotropia, focusing on the occurrence of associated vertical strabismus. It is meaningful that the present study was based on a relatively long period of observations; a minimum of 10 years to a maximum of 32 years after the diagnosis of infantile esotropia.

In our study, the mean number of surgeries was 1.7 times, which was not different from the results of previous studies (1.0–2.6).[4,16-18] In addition, 64 (52.5%) patients achieved favorable horizontal alignment at the final visit. Although it is difficult to simply compare the success rate among several studies because the follow-up period and the criteria for surgical success vary, this result was also relatively not different compared to previous studies, which reported 45%–80% of children with microtropia.[14,16,19-21]

**Figure 1:** The incidence of vertical strabismus of 122 patients with infantile esotropia. During 16-year follow-up, 53 patients developed infantile esotropia only and those were enrolled in group A. Sixty-nine patients developed inferior oblique overaction (IOOA) or dissociated vertical deviation (DVD). Those were grouped B

**Figure 2:** Pre- and postoperative photographs of the patient with infantile esotropia who followed up for 16 years. She was diagnosed with infantile esotropia and underwent bilateral medial rectus recession when she was 12 months old. At the age 5, DVD and IOOA of the right eye was developed. Right IO recession surgery was performed. (a) At the age 10, contralateral IOOA (arrow) was detected and her 3rd surgery, left IO recession was done. (b) At her last visit, significant abnormal eye alignment was no longer observed

**Figure 3:** The occurrence of inferior oblique overaction (IOOA). Fifty (41.0%) patients were diagnosed with inferior oblique overaction (IOOA) at a median age of 3 years (range: 1–21 years)

**Figure 4:** The occurrence of dissociated vertical deviation (DVD). Fifty-four (44.3%) patients were diagnosed with dissociated vertical deviation (DVD) at a median age of 5 years (range: 1–25 years)
Table 3 represents the incidence of associated vertical strabismus in previous reports. Although incidences vary, 11.3%–68% in IOOA and 15.5%–62% in DVD, generally studies with longer postoperative durations reported higher rates of IOOA and DVD development. However, despite 10-year follow-up, incidences in our study were lower than those reported by Wilson and Parks with 5-year observation. This is presumably due to the difference in the criteria for the development of IOOA and DVD among several studies. In the present study, the occurrence of associated strabismus was restricted to grade +2 – +4 IOOA, and DVD >10 PD. In other words, IOOA grade 1 and <10 PD DVD were not included in the criteria, resulting in the possibility of lower incidence compared with the results reported by Wilson and Parks.

Table 1: Type of surgeries for infantile esotropia and associated vertical strabismus

| Groups                                      | No. of patients with surgery (%) | Mean no. of surgeries (range) |
|---------------------------------------------|----------------------------------|------------------------------|
| No additional surgery                       | 63/122 (51.6)                   |                              |
| Additional surgery for horizontal deviation |                                  |                              |
| Residual or recurrent esotropia             | 32/122 (26.2)                   | 1.2±0.4 (1-2)                |
| Consecutive exotropia                       | 12/122 (9.8)                    | 1.3±0.5 (1-2)                |
| Additional surgery for associated vertical strabismus | | |
| IOOA                                        | 42/122 (34.4)                   | 1.2±0.4 (1-2)                |
| DVD                                         | 23/122 (18.9)                   | 1.1±0.3 (1-2)                |

IOOA: Inferior oblique overaction; DVD: Dissociated vertical deviation

Table 2: Baseline characteristics of 122 patients

|                              | Total  | Group A | Group B | P   |
|------------------------------|--------|---------|---------|-----|
| No. of patients (%)          | 122    | 53 (43.4) | 69 (56.6) |     |
| Gender (male: female)        | 57 : 65 | 30 : 23 | 27 : 42 | 0.055<sup>a</sup> |
| Mean follow-up period (years)| 16.0±4.9 | 15.9±5.4 | 16.0±4.6 | 0.908<sup>b</sup> |
| Mean age at diagnosis (months)| 17.6±12.4 | 17.4±9.6 | 17.8±14.2 | 0.878<sup>b</sup> |
| Mean age at 1st surgery (months) | 28.3±14.9 | 28.6±14.0 | 28.0±15.7 | 0.822<sup>b</sup> |
| Mean no. of total surgeries (n)| 1.7±0.8 | 1.3±0.6 | 2.0±0.9 | <0.001<sup>a</sup> |
| Mean no. of additional surgery for horizontal deviation (n) | 1.4±0.7 | 1.3±0.6 | 1.5±0.7 | 0.028<sup>b</sup> |
| No. with amblyopia at 1st visit (%) | 95 (77.9) | 37 (69.8) | 58 (84.1) | 0.060<sup>a</sup> |
| Angle of esodeviation before surgery (PD) | 41.6±13.0 | 41.2±12.7 | 41.9±13.4 | 0.783<sup>b</sup> |
| Refractive errors at 1st visit (SE, diopters) | +1.3±1.6 | +1.5±1.8 | +1.1±1.4 | 0.148<sup>b</sup> |
| Stereoaucity after surgery | Lang - test, passed (n) | 4/42 | 2/13 | 2/29 | 0.576<sup>a</sup> |
| Stereo Fly Stereotest, ≤400 arcsec (n) | 6/42 | 3/13 | 3/29 | 0.353<sup>a</sup> |
| No. with amblyopia at final visit (%) | 29 (23.8) | 13 (24.5) | 16 (23.2) | 1.000<sup>a</sup> |
| Angle of horizontal esodeviation at final visit (PD) | 3.0±7.2 | 4.0±7.3 | 2.3±7.1 | 0.190<sup>a</sup> |
| No. of patients with favorable surgical outcome (%) | 64 (52.5) | 27 (50.9) | 37 (53.6) | 0.769<sup>b</sup> |

<sup>a</sup> Chi-square test, <sup>b</sup> Independent t-test. Values are presented as mean±SD. Favorable surgical outcome was defined within 10 PD esotropia or orthotropia. Group A, patients who had only infantile esotropia; Group B, patients who had occurred associated strabismus with infantile esotropia, inferior oblique overaction or dissociated vertical deviation; Arcsec: Seconds of arc; SE: Spherical equivalent; PD: Prism diopters

Table 3: The incidence of associated vertical strabismus in previous reports

| Authors | No. of enrolled patients | Follow-up periods | The incidence of IOOA (%) | The incidence of DVD (%) |
|---------|--------------------------|-------------------|---------------------------|-------------------------|
| von Noorden (1988) | 408 | - | 68 | 51 |
| Wilson and Parks (1989) | 158 | > 5 years | 72 | 62 |
| Kim et al. (1997) | 176 | > 6 months | 47 | 44 |
| Trigler and Siatkowski (2002) | 149 | > 6 months | 38.3 | 15.7 |
| Chung et al. (2005) | 165 | > 2 years | 11.3 | 21.1 |
| Current study | 122 | Mean of 16 years | 41.0 | 44.3 |
simply confirms when elevation in adduction was noticed. DVD is characterized by the drifting of either eye upward when fusion is artificially interrupted by covering one eye for a while. In addition, when the eye is covered, the amount of elevation varies tending to increase after prolonged occlusion. Thus, mild DVD is difficult to detect and may also present in a latent form as well as manifest form. These clinical features of DVD can be considered the potential reasons that DVD is detected at a later age with good cooperation.

When comparing pre or postoperative clinical factors between patients with infantile esotropia only (group A) and patients with IOOA or DVD (group B), there was no significant difference in parameters except for the number of surgeries. Patients with IOOA or DVD underwent more surgical interventions, which the authors attributed to the need for a second surgery to correct the vertical strabismus. However, the interesting finding is that the mean number of additional surgeries only for horizontal deviation was also more in group B than that in group A. It seems to mean that although there was no significant difference in the success rate between two groups in last follow-up, more horizontal strabismus surgery required in patients with IOOA/DVD to achieve the favorable surgical outcome. In other words, the presence of IOOA/DVD may affect horizontal alignment outcomes or need for additional horizontal alignment surgery.

There were some limitations to our study. The authors of several other studies reported that poorer stereopsis in infantile esotropia may require multiple surgeries unsatisfactory outcomes, or development of vertical deviation. However, because the present study was limited by its retrospective design, not all patients’ stereoeacuity was used in the analysis. The percentage of better stereopsis was numerically higher in group A than in group B; however, the difference was not statistically significant. A second limitation was that preoperative angle measurements are less accurate in young children, leading to the masking of vertical deviation and resulting in the possibility of lower incidence in IOOA and DVD than actual. However, the problem of low accuracy of angle measurements due to young age is an inevitable and inherent limitation in treating and studying infantile esotropia. In addition, because the purpose of this study was to analyze long-term surgical outcomes of infantile esotropia and the occurrence of associated vertical strabismus, the authors analyzed data of patients who were able to visit the clinic over 10 years, and many patients were excluded because they had less than 10-year follow-up. It is possible that there was some omission bias in this point, as patients with less than optimal outcomes failed to return for their follow-up. This type of bias could potentially make the reported success rates may seem better than they actually are.

Nevertheless, the strength of this study is the relatively large number of subjects and the long duration of follow-up; 122 patients with a mean follow-up period of 16.0 years. It is worth noting that in this study, the age-18 development of IOOA or DVD was analyzed, and DVD tended to develop at a later age than IOOA. Furthermore, because IOOA and DVD can develop up to 20 years after diagnosis of infantile esotropia, regular, long-term observation is advisable for all patients with infantile esotropia. This delayed onset of IOOA/DVD over 20 years in some individuals contributes to the conundrum of why and how IOOA and DVD develop in infantile esotropia patients. In addition, although our data did not show a significant difference in clinical factors and the surgical success rate between two groups, taking into consideration more times of horizontal muscle surgery in the group B, the development of vertical strabismus may affect a negative effect on horizontal alignment in patients with infantile esotropia.

Conclusion

The results of our study indicate that about half of the patients with infantile esotropia achieve long-term favorable surgical outcome. The subgroup of patients who manifest late-onset DVD or IOOA or both may need relatively more horizontal muscle surgeries to achieve an acceptable alignment.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References
1. Campos EC. Binocular Vision and Ocular Motility. 6th. Mosby; 2002. p. 320.

2. Nordstrom GK. A reassessment of infantile esotropia XLIIV Edward Jackson memorial lecture. Am J Ophthalmol 1988;105:1-10.

3. Zak T, Morin J. Early surgery for infantile esotropia: Results and influence of age upon results. Can J Ophthalmol 1982;17:213-8.

4. Hiles DA, Watson BA, Biglan AW. Characteristics of infantile esotropia following early bimedial rectus recession. Arch Ophthalmol 1980;98:697-703.

5. Lang J. Der kongenitale oder frühkindliche Strabismus. Klin Monatsbl Augenheilkd 1967;154:201-8.

6. Kim JH, Kim KH, Cho YA. Dissociated vertical deviation after correction of infantile esotropia. J Korean Ophthalmol Soc 1997;38:1451-7.

7. Wilson ME, Parks MM. Primary inferior oblique overaction in congenital esotropia, accommodative esotropia, and intermittent esotropia. Ophthalmology 1989;96:750-7.

8. Lee KW, Paik HJ. Risk factors for consecutive esotropia and hyperopic changes after bilateral medial rectus recession. J Korean Ophthalmol Soc 2018;59:276-81.

9. Rosenbaum AL, Santiago AP. Clinical Strabismus Management: Principles and Surgical Techniques: David Hunter; 1999.

10. Scott WE, Sutton VJ, Thalacker JA. Superior rectus recessions for dissociated vertical deviation. Ophthalmology 1982;89:317-22.

11. Mohney BG. Common forms of childhood esotropia. Ophthalmology 2001;108:805-9.

12. Cheeseman EW, Guyton DL. Vertical fusional vergence: The key to dissociated vertical deviation. Arch Ophthalmol 1999;117:1188-91.

13. Guyton DL, Cheeseman EW Jr, Ellis FJ, D Straumann, Zee DS. Dissociated vertical deviation: An exaggerated normal eye movement used to damp cyclovertical latent nystagmus. Trans Am Ophthalmol Soc 1990;88:389-429.

14. Louwagie CR, Diehl NN, Greenberg AE, Mohney BG. Long-term follow-up of congenital esotropia in a population-based cohort. J AAPOS 2009;13:8-12.

15. Spielmann A. A translucent occluder for studying eye position under unilateral or bilateral cover test. Am Orthopt J 1986;36:65-74.

16. Staanya F, Braege A, Eriksen M, Elston R. Late results for surgery for congenital esotropia. Acta Ophthalmol Scand Suppl 1986;139:1-12.

17. Simonsz H, Hellmann D, Kutner D, Kallin K. Final report of the early vs. late infantile strabismus surgery study (ELISSS), A controlled, prospective, multicenter study. Strabismus 2005;13:169-99.

18. Trigler L, Siatkowski RM. Factors associated with horizontal reoperation in infantile esotropia. J AAPOS 2002;6:15-20.

19. Maruo T, Kubota N, Sakaue T, Usui C. Esotropia surgery in children: Long term outcome regarding changes in binocular alignment; A study of 956 cases. Binocul Vis Strabismus Q 2000;15:213-20.

20. Teller J, Savir H, Yelin N, Cohen R, Leviav A, Elstin R. Late results of surgery for congenital esotropia. Metab Pediatr Syst Ophthalmol 1988;11:156-9.

21. Tolun H, Dikici K, Ozkiris A. Long-term results of bimedial rectus recessions in infantile esotropia. J Pediatr Ophthalmol Strabismus 1999;36:201-5.

22. Chung EJ, Chang YH, Chang HJ, Han SH, Lee JB. Clinical manifestations and surgical outcome of infantile esotropia. J Korean Ophthalmol Soc 2005;46:853-8.

23. Guyton DL. Dissociated vertical deviation: Etiology, mechanism, and associated phenomena. J AAPOS 2000;4:131-44.