



# TO ASSESS THE CHANGES IN BINOCULAR SUMMATION (Bis) IN CONCOMITANT ESOTROPIA AFTER STRABISMUS SURGERY

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## ABSTRACT

**Aim:** To determine binocular summation of surgically treated intermittent Esotropia (ET) patients by measuring the Visual acuity threshold.

**Introduction:** Intermittent Esotropia (IET) is a disorder of ocular misalignment. It manifests frequently when one views a distant visual target or has illness or fatigue, but maintains a good alignment and binocular fusion when focusing on the visual target for near. So, their otherwise normal vision function can be disrupted intermittently by a sudden inward deviation of one eye <sup>(1)</sup>. During the intermittent deviation of one eye, binocular fusion gets interrupted. To prevent diplopia, the brain begins to suppress visual information from the peripheral temporal retina in each eye <sup>(3-5)</sup>. The suppression can eventually become permanent and worsen fusion.

**Method:** We enrolled 38 ET patients who had undergone strabismus surgery at least a year prior to this study, including 21 with good alignment and 17 with recurrence after their surgery, ranging from 12 to 48 months. The patients with good alignment were defined as eso-deviation  $\leq 10$  prism diopter (pd) and no vertical misalignment both at near and distance viewing; while with recurrence were those whose eso-deviation more than 10 pd at near (33 cm) or distance (6 m) viewing <sup>(13)</sup>. All of these patients had been successfully corrected at 3-month post-surgery, which is the routine follow-up time for assessment, and a detailed examination would be performed at that time. Moreover, we recruited 20 normal subjects, who had matched age and refractive diopter, as controls.

**Result:** The BCVA of all the enrolled participants were  $\geq 20/20$ . Based on their post-operative esodeviation, we divided the participants into two groups: those with recurrence and those with good alignment. The participants with recurrence (17 patients) ET post operative BiS have diplopia or decreased BiS after the range of time (12-48 months). The eso-deviation of ET good alignment was mean deviation of 0 to 10 pd at 33 cm and 0 to 10 pd at 6 m. While for the patients with recurrence, it was 11 to 25 pd for near and 11 to 20 pd for distance, respectively. There was a significant difference in the extent of near and far eso-deviation in patients with recurrent eso-drift compared to those with good alignment.

## KEYWORDS

Binocular summation, intermittent Esotropia, good alignment, recurrence, Visual acuity threshold level.

## INTRODUCTION

Intermittent Esotropia (IET) is a disorder of ocular misalignment. It manifests frequently when one views a distant visual target or when one has illness or fatigue, but maintains a good alignment and binocular fusion when focusing on the visual target for near. So, their otherwise normal vision function can be disrupted intermittently by a sudden inward deviation of one eye <sup>(1)</sup>. During the intermittent deviation of one eye, binocular fusion gets interrupted. To prevent diplopia, the brain begins to suppress visual information from the peripheral temporal retina in each eye <sup>(3-5)</sup>. The suppression can eventually become permanent and worsen fusion.

Surgery is the standard treatment for ET. It not only aligns the eye position but also improves the binocular visual function, such as stereopsis and simultaneous perception <sup>(6)</sup>. However, studies have found that the success rate of surgery varies from 35.6 to 92.5% <sup>(6-9)</sup>, depending on the different follow-up periods (from 6 months to 10 years) and the criteria for assessing the recovery. The high occurrence rate of eso-drift or recurrence <sup>(6, 10, 11)</sup> in surgically treated patients has also been a source of concern for ophthalmologists and researchers. Studies have indicated that multiple factors could affect the long-term outcome of surgery, such as patient's age of onset, preoperative angle of deviation, oblique dysfunction, early overcorrection, and their sensory fusion abilities, such as fusional convergence amplitude, and stereopsis <sup>(8, 12-16)</sup>.

However, these studies have not reached a consensus on which factor is most pertinent. Therefore, there is a specific need to investigate whether ET with short-term postoperative alignment still have functional impairment of visual information processing in different visual pathways. Exploring such impairment might help us to further reveal the potential mechanism of postoperative eso-drift.

Two recent studies <sup>(17, 18)</sup> directly address this issue and show that the eyes are much more imbalanced in surgically corrected ET patients than those of normal controls using a binocular phase combination task. These findings indicate that an abnormal binocular vision can remain in ET patients even after surgery. However, the aforementioned studies were conducted at a suprathreshold level whose stimuli are always set at high Visual activity. Different visual pathways seem to be involved when suprathreshold and threshold visual stimuli are processed <sup>(19-21)</sup>. Previous studies have also shown that different Visual acuity levels demonstrate different extents of binocular deficits <sup>(22-25)</sup>.

Binocular summation, which is defined as the superiority of binocular over monocular performance on visual threshold tasks such as Visual acuity detection, is another means to evaluate binocular function <sup>(26)</sup>. In binocular summation studies, a binocular summation ratio (BSR) is computed as an index for the superiority of both eyes working together to one eye working alone. Pineles et al. <sup>(27)</sup> demonstrated subnormal binocular summation in strabismic patients. However, it is still unknown whether the ability of patients to process visual information at threshold level is different from that of normal population, and how the ability to process visual information is in the long-term after operation.

To address this issue, we evaluated binocular summation by measuring Visual acuity sensitivity of each and both eyes using psychophysics. We compared the BSR between normal controls and ET patients who had undergone strabismus surgery at least a year prior to our study. Our goal was to find whether surgically corrected ET had the normal ability to process visual information at the Visual acuity threshold level, and whether such ability to process visual information could be associated with good alignment or stereopsis.

## MATERIAL AND METHODS

- **STUDY DESIGN:** Cross-sectional Observational study
- **SAMPLE SIZE:** The study included 38 people
- **INCLUSION CRITERIA-**  
1: Anisometropia  $\leq 1D$ .

- 2: Successfully corrected at 3-month post-surgery.
- 3: No other ocular surgical treatment or trauma.

#### **EXCLUSION CRITERIA-**

- 1- Anisometropia  $\geq 1D$ .
- 2: Successfully corrected less than 3-month post-surgery.
- 3: Other ocular surgical treatment or trauma.

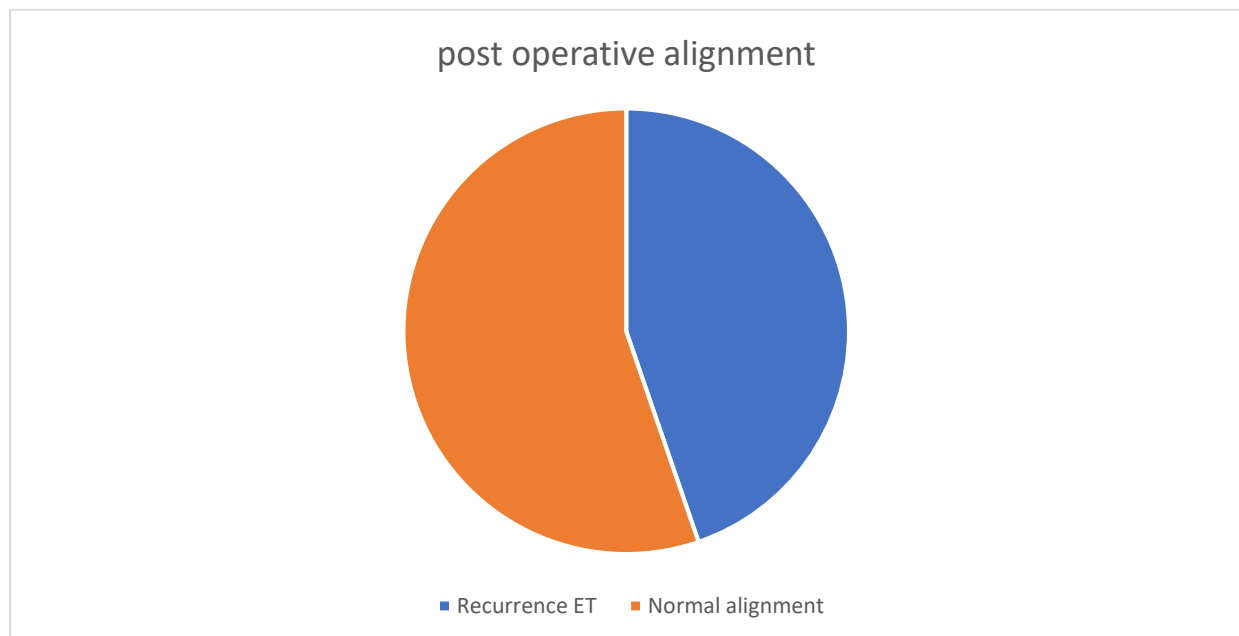
#### **METHOD OF DATA COLLECTION:**

We enrolled 38 ET patients who had undergone strabismus surgery at least a year prior to this study, including 21 with good alignment and 17 with recurrence after their surgery, ranging from 12 to 48 months. The patients with good alignment were defined as eso-deviation  $\leq 10$  prism diopter (pd) and no vertical misalignment both at near and distance viewing; while with recurrence were those whose eso-deviation more than 10 pd at near (33 cm) or distance (6 m) viewing (13). All of these patients had been successfully corrected at 3-month post-surgery, which is the routine follow-up time for assessment, and a detailed examination would be performed at that time. Moreover, we recruited 20 normal subjects, who had matched age and refractive diopter, as controls.

The basic information of each participant, such as age, sex, refractive status, the pre- and post-operative characteristics, surgical method, was obtained from the patients' medical records. Each participant underwent comprehensive ophthalmic examinations, including BCVA, subjective refraction, slit-lamp bio-microscopy, and fundus examination. Prism and alternative cover tests (PACTs) were performed at 5 m and 33 cm to measure the magnitude of the deviation.

#### **OBSERVATIONS AND RESULTS**

The BCVA of all the enrolled participants were  $\geq 20/20$ . Based on their post-operative esodeviation, we divided the participants into two groups: those with recurrence and those with good alignment. The participants with recurrence (17 patients) ET post operative BiS have diplopia or decreased BiS after the range of time (12-48 months). The eso-deviation of ET good alignment was mean deviation of 0 to 10 pd at 33 cm and 0 to 10 pd at 6 m. While for the patients with recurrence, it was 11 to 25 pd for near and 11 to 20 pd for distance, respectively. There was a significant difference in the extent of near and far eso-deviation in patients with recurrent eso-drift compared to those with good alignment.



There were 38 total no. of participants included in which 17 patients have recurrence after the ET surgery (from 12 to 48 months) and 21 patients have good alignment.

## DISCUSSION

In this study, we measured the binocular summation ratio with a Visual acuity sensitivity test from surgically corrected ET patients and normally sighted observers. We found that, regardless of whether the surgically treated ET had good alignment or recurrent alignment, their BSR at different spatial frequencies and AULVASF were similar to those of normal controls.

The binocular summation BiS evaluated in our study was achieved by a Visual acuity sensitivity test. Pinele et al. (36) found that childhood- and infantile-onset esotropia obtained the worst improvement in binocular summation BiS scores postoperatively. In the case of ET patients in our study, intact binocular summation BiS was obtained postoperatively, which might be associated with the high probability of preoperative fusion during early visual development. Although intact binocular summation BiS at a Visual acuity threshold level was found in our study, this does not ensure that there is no impairment of pathways of visual function in postoperative ET.

In short, there seems to be a discrepancy between the impaired sensory eye balance (17, 18) and stereopsis at a suprathreshold level, and intact binocular summation at a Visual acuity threshold level. We assessed binocular summation at a Visual acuity threshold level in our study. Previous studies have examined binocular combination (17, 18) and stereoacuity (6, 8, 11) using suprathreshold stimuli whose Visual acuity are set at a high level.

## SUMMARY AND CONCLUSION

Our findings of normal Visual acuity sensitivity binocular summation ratio in ET after surgical treatment suggest that the ability of the visual cortex in processing binocular information is intact at the Visual acuity threshold level. The binocular summation BiS evaluated in our study was achieved by a Visual acuity sensitivity test. It is a more comprehensive and accurate method to assess the patient's ability to process threshold-level visual information at different spatial frequencies.

However, at a suprathreshold level, the difference in visual acuity between the eyes may lead to such an imbalance (25). Therefore, although our results suggest that their binocular summation at a visual acuity level is normal after surgery, successfully corrected ET patients may still show binocular imbalance at a suprathreshold level.

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