



## Original Research Article

## Clinical risk factors and management of consecutive strabismus

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## ABSTRACT

**Material and Methods:** The study was conducted at Pediatric Ophthalmology and Strabismus clinic at our tertiary care institute PGIMS, Rohtak. Patients who developed consecutive tropia after squint surgery for horizontal strabismus from April 2015 to August 2016 were enrolled. Continued esodeviation after surgery for exotropia was termed as consecutive esotropia and post-operative exodeviation present even 2 weeks after surgery for esotropia was termed as consecutive exotropia. The patients were followed up for at least 3 months. Ocular movements, preoperative deviation (PBCT), presence of vertical deviation, DVD, A-V patterns was noted, AC/A ratio, sensory status by Worth Four Dot Test and Titmus test. Immediate post-operative deviation was measured. Follow-up was done at 2 weeks, 6 weeks, 3 months and 6 months.

**Results:** There were a total of 92 patients who underwent squint surgeries for horizontal strabismus. 12 patients developed consecutive squint. Out of 12 patients, 10 patients developed consecutive exotropia and 2 patients developed consecutive esotropia. The mean pre-operative deviation of resolved cases in both the groups was  $45 \pm 8.16$ PD for near and  $42.5 \pm 8.66$ PD for distance and the mean pre-operative deviation of unresolved cases in both the groups was  $39.16 \pm 10.68$ PD for near and  $38.33 \pm 6.83$ PD for distance.

**Discussion:** In our study, the incidence of consecutive squint was 13%. Out of which 10.86% had consecutive exotropia and 2.17% had consecutive esotropia. The patients who developed consecutive squint had infantile esotropia, infantile exotropia, partially accommodative esotropia and non-accommodative acquired esotropia. Amongst consecutive exotropias group, 40% cases resolved while in consecutive esotropia group, 50% resolved.

**Conclusion:** Consecutive squint is a complication of squint surgery which can develop immediately after surgery or years later. Taking care of the errors during measurement of pre-operative deviation improves the success of surgical outcomes.

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## 1. Introduction

Consecutive esotropia (ET) and exotropia (XT) are the types of manifest squint that develop after optical or surgical treatment for exotropia and esotropia respectively. The incidence of consecutive ET has been reported to be between 6 to 15% of patients operated for intermittent XT.<sup>1-3</sup> Consecutive XT is reported to be more common than consecutive ET, seen in 20-27% of patients operated for esotropia.<sup>4,5</sup> This study was planned to find out who are those patients who were at risk for development

of consecutive esotropia and consecutive exotropia and to assess whether the risk factors reported in literature were applicable to Indian population coming from rural background or not. This study also tried to find any additional unreported risk or associated factor.

## 2. Material and Methods

The study was conducted at Pediatric Ophthalmology and Strabismus clinic at Regional Institute of Ophthalmology, PGIMS, Rohtak. Patients who developed consecutive tropia after squint surgery for horizontal strabismus from April 2015 to August 2016 were enrolled. Continued

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esodeviation  $>5$ BO for 2 weeks after surgery for exotropia was termed as consecutive esotropia and post-operative exodeviation  $>10$  BI for near and distance, present even 2 weeks after surgery for esotropia was termed as consecutive exotropia. Inclusion criteria were patients who developed consecutive tropia after squint surgery for horizontal strabismus, age 2-18 years, presence of vertical deviation, dissociated vertical deviation and A- V patterns requiring treatment, those who underwent bilateral recession or unilateral recession – resection (depending on primary deviation) and follow up of at least 3 months. Patients with history of prior strabismus surgery, patients with sensory strabismus, paralytic or restrictive strabismus and patients with neurological disorders such as cerebral palsy were excluded from the study. The following parameters were recorded: Age at the time of surgery, Refractive error (Myopia  $> -1.00$  D, Emmetropia: within  $\pm 1.00$  D, Hyperopia  $> +2.00$  D), presence of amblyopia, lateral incomitance was noted (difference  $>10$  PD in primary and lateral gazes), ocular movements, preoperative deviation (PBCT) for distance and near was measured, presence of vertical deviation, dissociated vertical deviation, A-V patterns was noted, deviation for near was measured using after patch test and  $+3.00$  DS test, AC/A ratio measured by lens gradient method, sensory status i.e. binocular single vision was assessed using Worth Four Dot Test and stereoacuity using Titmus test. Immediate post-operative deviation was measured. Follow-up was done at 2 weeks, 6 weeks, 3 months and 6 months.

### 3. Results

There were a total of 92 patients who underwent squint surgeries for horizontal strabismus during the study period. 12 (13%) patients developed consecutive squint. Out of 12 patients, 10 patients developed consecutive exotropia and 2 patients developed consecutive esotropia. The mean age was  $8.33 \pm 4.30$  years. 9 (75%) patients were males and 3 (25%) were females. Mean age at the onset of squint was  $18.5 \pm 16.67$  months and mean age at the time of surgery was  $7.5 \pm 4.39$  years. Pre-operative diagnosis was infantile esotropia in 4 (33.33%) patients, infantile exotropia in 2 (16.66%), partial accommodative esotropia in 4 patients (33.33%) and non- accommodative acquired esotropia in 2 (16.66%) patients. 7 out of 12 patients (58.33%) had amblyopia. 3 (25%) patients had hyperopia of  $<3$ D, while 4 (33.33%) patients had hyperopia of  $>3$ D, 1 (8.33%) had myopia and 4(33.33%) patients had astigmatism associated with strabismus. As far as dissociated vertical deviation (DVD) is concerned, 4 (33.33%) patients had bilateral DVD, 7 (58.33%) patients had unilateral DVD. 2 (16.66%) patients had vertical strabismus. 2 (16.66%) patients showed some pattern associated with horizontal strabismus while 2 (16.66%) patients had oblique dysfunction on examination. None of the patient had lateral incomitance.

The mean pre-operative deviation was  $41.5 \pm 9.73$ PD for near and  $40 \pm 7.45$ PD for distance in consecutive exotropia group and  $42.5 \pm 3.53$  PD for near and  $32.5 \pm 3.53$ PD for distance in consecutive esotropia group. For pre-operative deviation, bilateral medial rectus recession was done in 3 (25%) cases, bilateral lateral rectus recession was done in 2 (16.66%) cases and recession with resection was done in 7 (58.33%) cases. 2 (16.66%) patients underwent bilateral superior rectus recession. Regarding treatment of consecutive tropias, alternating patching was advised in 6(50%) patients, dominant eye patching was advised in 5(41.6%) patients. 6(50%) patients were advised to wear minus lenses. 4(33.33%) patients were advised convergence exercises. Amongst consecutive exotropias group, 4 cases resolved while in consecutive esotropia group, 1 case resolved. The mean pre-operative deviation of resolved cases in both the groups was  $45 \pm 8.16$ PD for near and  $42.5 \pm 8.66$ PD for distance and the mean pre-operative deviation of unresolved cases in both the groups was  $39.16 \pm 10.68$ PD for near and  $38.33 \pm 6.83$ PD for distance.

### 4. Discussion

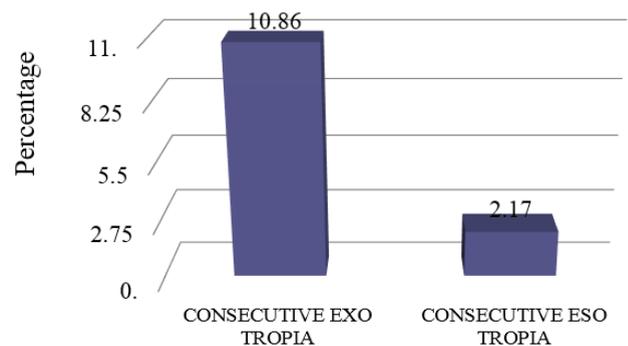
This study was planned to study the incidence of consecutive esotropia and exotropia and to report the risk factors associated with occurrence of consecutive squint at our hospital. The mean age of the patients at the time of the study was 8.33 years. Mean age at the onset of primary squint was 18.5 months and mean age at the time of surgery was 7.5 years. Our observation was similar to a study done by Ganesh et al<sup>5</sup> on 85 patients with consecutive exotropia, where the mean age at the onset of esotropia was 1.85 years while at the time of surgery it was 6 years. In a study by Kim et al,<sup>6</sup> mean age at the onset of exotropia was 2.91 years and mean age at the time of surgery was 4.8 years. The timing of surgery for primary squint has been a matter of debate. Pratt- Johnson et al reported that patients who got operated before 4 years of age, consecutive esotropia developed more frequently in them, although success rate was higher.<sup>7</sup> Keech and Stewart divided patients operated for intermittent exotropia into two groups (overcorrection with esodeviation  $\geq 3$  PD vs no overcorrection) at the last follow-up (at a 2 minimum of 6 months), and found that the overcorrection group had a two-fold higher mean age at surgery.<sup>8</sup> Dunlop observed that age at the time of surgery did not influence the extent of overcorrection.<sup>9</sup> Jampolsky recommended that operation at an early age should be avoided as performing surgery after the age of 7 years had many advantages including an ability to observe the progress of exotropia, precise diagnostic determination, accurate management of the angle of deviation, ability to train patients to conduct pre- and post-operative visual function exercises, a low risk for amblyopia, and suppression even if overcorrection had in fact occurred.<sup>10</sup>

In our study, the incidence of consecutive squint was 13%. Out of which 10.86% had consecutive exotropia and 2.17% had consecutive esotropia. In literature, the incidence of consecutive exotropia has been reported to be 4-27%.<sup>11,12</sup> The incidence of consecutive esotropia after surgery for intermittent exotropia ranges from 6-15% depending upon the length of follow-up and measures to diagnose the esotropia.<sup>1-3</sup>

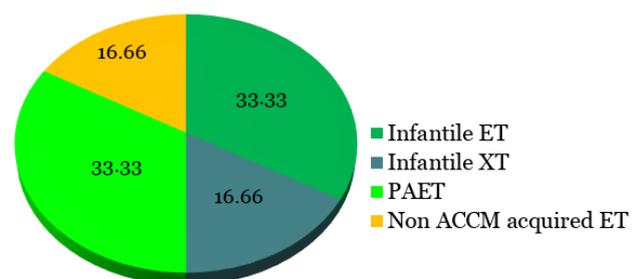
In the present study, the patients who developed consecutive squint had infantile esotropia, infantile exotropia, partially accommodative esotropia and non-accommodative acquired esotropia mainly as primary diagnosis. More than half of the patients had pre-existing amblyopia. In a study by Paduca et al, 67.6% patients who developed consecutive exotropia had amblyopia as an associated factor.<sup>13</sup> Many studies have considered amblyopia as an important contributing factor in the development of consecutive exotropia.<sup>14-16</sup> Kim et al reported that amblyopia was a statistically significant risk factor for consecutive esotropia in their study.<sup>6</sup> So, it is very important that we should treat amblyopia fully in children before taking them for surgery and the treatment should continue even after the surgery for residual amblyopia as good final visual acuity and fully developed binocular function help in post-operative stability of correction.

In the present study, most of the patients had one or the other refractive error like hyperopia  $\leq 3D$ , hyperopia  $> 3D$ , myopia and astigmatism. In a study by Ganesh et al, 25% of patients with high hypermetropia developed consecutive exotropia.<sup>5</sup> Patients with hyperopia have been reported to develop consecutive exotropia even without surgery.<sup>17,18</sup> In our study, other associated factors were dissociative vertical deviation, vertical strabismus, pattern and oblique dysfunction. Jang et al studied factors predisposing to consecutive esotropia after surgery to correct intermittent exotropia. Significant correlations were found with high myopia, amblyopia, preoperative angle of deviation of 25–40 PD at distance, deviation at distance – deviation at near  $> 10$  PD, lateral incomitance, tenacious proximal convergence fusion type, unilateral lateral rectus muscle recession and medial rectus muscle resection.<sup>19</sup> Some studies report medial rectus limitation<sup>20</sup> and the presence of an exodeviation in the upgaze and downgaze positions<sup>21</sup> as risk factors for consecutive exotropia after surgery for undercorrected esotropia. One should be careful while performing surgeries on such patients and should aim for undercorrection of their squint. Edelman et al<sup>22</sup> and Raab and Parks<sup>23</sup> found that high AC/A ratio increased the incidence of consecutive esotropia in their studies. Beneish and Flanders reported that good pre-operative stereopsis resulted in good surgical results.<sup>24</sup> In our study, the mean pre-operative deviation in consecutive exotropia group was 41.5D for near and 40PD for distance, while in consecutive esotropia group, it was 42.5PD for near and 32.5PD for

distance. Abbasoglu et al found that pre-operative deviation was the only factor influencing response to surgery. The response was higher for larger preoperative deviations.<sup>25</sup> Gordon and Bachar found that response was determined by the magnitude of the larger pre-operative deviation and besides this average corrected visual acuity, the degree of anisometropia and the average spherical equivalent also influenced the surgical response.<sup>26</sup> Graf et al reported that pre-operative deviation did not influence the response to surgery in exotropic patients.<sup>27</sup> This lack of consensus may be due to variability in pre-operative deviation in exotropic patients. Error in measuring pre-operative deviation is also an important factor which plays a role in final outcome of surgery. It is advisable to treat overcorrection by non-surgical means upto a year. Deviation less than 20PD usually resolves with conservative methods. The success rates of surgical outcomes are 10-100%.<sup>24,28</sup> In our study, the only non-surgical measures were taken, which were alternating patching, dominant eye patching and convergence exercises. Amongst consecutive exotropias group, 40% cases resolved while in consecutive esotropia group, 50% cases resolved.



**Fig. 1:** Pie chart showing percentage of cases diagnosed as consecutive tropia (N=12) (Total Surgeries = 92)



**Fig. 2:** Pie chart showing diagnosis of patients

**Table 1:** Demographic profile

Parameters	No. of cases	Percentage
Mean age(years)	8.33±4.30	-
Male	9	75
Female	3	25
Mean age at onset(months)	18.5±16.67	-
Mean age at surgery(years)	7.5±4.39	-
Diagnosis		
Infantile ET		
Diagnosis		
Infantile ET	4	33.33
Infantile XT	2	16.66
PAET	4	33.33
Non ACCM acquired ET	2	16.66

**Table 2:** Distribution of cases

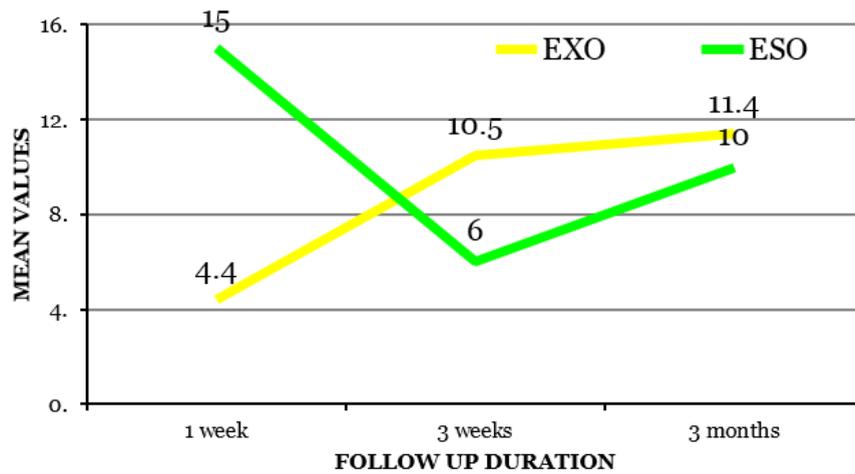
Parameters	No. of cases	Percentage
Amblyopia	7	58.33
Hyperopia <3 >3	3 4	25 33.33
Myopia	1	8.33
Astigmatism	4	33.33
DVD		
L/E	4	33.33
R/E	3	25
B/L	4	33.33
Vertical deviation	2	16.66
Pattern	2	8.33
Oblique dysfunction	2	16.66
Lateral incomitance	0	-

**Table 3:**

Parameters	Mean±SD No. of cases	Percentage
Preoperative deviation		
Consecutive Exo group (N)	41.5±9.73	
Consecutive Exo group (D)	40±7.45	
Consecutive Eso group (N)	42.5±3.53	
Consecutive Eso group (D)	32.5±3.53	
B/L recession		
MR	3	25
LR	2	16.66
Recession / resection	7	58.33
B/L SR recession	2	16.66

**Table 4:**

Parameters	No. of cases	Percentage
Consecutive		
Exo > 2 weeks	5	41.66
Exo < 2 weeks	5	41.66
Eso > 2 weeks	0	0
Eso < 2 weeks	2	16.66
Treatment (n=12)		
ALT patch	6	
Minus lens	6	
Patch dominant eye	5	
Reduce plus	1	
Convergence exercises	4	25



**Fig. 3:** Line diagram showing follow up of exo and eso cases at different time intervals

**Table 5:**

Resolved cases exo group		
Yes	4	33.33
No	6	50
Resolved		
< 2 weeks	1	8.33
> 2 weeks	3	25
Unresolved		
< 2 weeks	4	33.33
> 2 weeks	2	16.66
Resolved cases eso group		
Yes	1	8.33
No	1	8.33
Resolved		
<2 weeks	1	8.33
Unresolved		
> 2 weeks	1	8.33
Follow up (Exo) (n=4) resolved		
1 week	-1±8.24	
3 weeks	5.25±7.08	
3 months	4.25±6.99	
Follow up (Exo) (n=6) unresolved		
1 week	6.33±12.81	
3 weeks	15±5.79	
3 months	14.33±4.45	

**Table 6:**

Preop. Deviation resolved cases	
N	45±8.16
D	42.5±8.66
Preop. Deviation unresolved cases	
N	39.16±10.68
D	38.33±6.83

Table 7:

Parameters studied	Kim HJ et al. (2015)	Sekeroglu HT et al. (2015)	Han Y et al. (2015)	Leon BG et al. (2014)	Lee EK et al. (2013)	Our study (2015-16)
Incidence of conse. tropia	Clinical course of conse ET using conservative. 4.94% ET >10PD (at 1 mth)	28.6% >10 BI NO specific period	6.2% XT of > 10BI At 1 mth	3-29% >10BI	25.2% (consecutiv ET) ET of 5BO or >at 4 wks FUP	Risk factors and conservative measures 10.86% (XT) 2.17% (ET)
Study population	26 pts of 526 (4.94%) consecutive ET	45pts-14 pts dev consecutive XT	54 pts	20pts	105pts 54.45%(RR) 11.2%(BLR)	12 pts of 92 surgeries
Age at onset	2.91 ± 2.44(yrs)	4.57±3.11 yrs	1.35±1.8		4.8±2.9 (0.83-14.0)	18.5±16.67
Age at Sx	4.80±2.10	NA	3.09±2.11	3.1±2.0yrs	7.5±3.2(higher age)	7.5±4.39
Mean pre-op deviation	D-29.04±5.83 N-27.95±8.81 No risk factor	D-41.01±16.37(8-60) N-42.51±13.69(20-60)	D-35.89±13.43 N-36.50±13.38	ET-6.5±8.9	D-24.1±6.0(16-43) N-23.8±6.1(12-40)	41.5±9.73 40±7.45 42.5±3.53
Consecutive deviation	22.19±12.27BO	D-16.71±10.51(-40) N-16.79±10.24(6-40)	20.89±5.62(D) 19.87±5.37(N)	28BI(Avg)	10.9±4.1 BO	32.5±3.53 14.33±4.45
Duration of appearance of XT/ET after Sx	15.96±18.62 (months) Long FUP	5.36±4.39 (2-15)mo Shorter time course	4.49±3.81 Longer FUP 3Yrs	14.6±19.3 Yrs	2.7±2.2 (0.2-9.5)	>2 weeks <2 weeks

**Table 8:**

	<b>Kim DW et al. (2015)</b>	<b>Sekeroglu HT et al. (2015)</b>	<b>Han Y et al. (2015)</b>	<b>Leon BG et al. (2014)</b>	<b>Lee EK et al. (2013)</b>	<b>Our study (2015-16)</b>
Pre-op diagnosis	Basic XT=20%(divergence excess)	NA	Infantile ET -13(24.1%) Acquired ET 41 (75.9%)	Congenital ET25% Accommodative ET 10% Acquired non accommodative ET 7(35%)	Not specified	Infantile esotropia- 33.3% Infantile XT-16.% PAET-33.3% Non accommodative ET- 16.6%
Amblyopia	22.72% Sig risk factor	7pts No risk factor	27(50.0%)	NA	4(11.8%) HIGH	58.33
Vertical deviation	65.35%	NA	NA	NA	2 (5.9%)	16.66
A-V pattern	3.84%	NA	NA	NA	1(2.95)	8.33
Oblique dysfunction	15.38%	NA	8 (14.8%)	NA	10(29.4%)	16.66
DVD	11.53%	NA	16(29.1%)	NA	0 (0%)	33.33
Lateral Incomitance	3.84%	6.01±0.6488(5-77)	NA	NA	13(38.2%)	NO
Conservative management	Alternate occlusion+prism 15 resolved 11 persisted	Not evaluated	surgical	Surgical Post MR adv After 4-8 wks Exotropic drift(17PD) 50%-recurrent XT	Prismatic correction 20.9 mths 71.4% resolved 5.7%persisted 2yrs FUP	Alternate patch minus lens orthoptic exercises 50% resolved
Type of surgery	BLR	BMR(71.4%)	BMR	BMR	> RR	RR 58.33
Conclude	Younger age Amblyopia BLR Day 1 overcorrection	Neurological disease is a risk factor OR=5.75	Amblyopia &DVD-risk factor	MA corrects 4PD /mm	Poor fusion & stereopsis- > exotropic drift	Similar Risk Factors

## 5. Conclusion

Consecutive squint is a complication of squint surgery which can develop immediately after surgery or years later. A little amount of post-operative overcorrection may resolve spontaneously, but if it doesn't resolve it can cause amblyopia in children and bothersome diplopia in adults. Younger age at surgery, amblyopia, divergence excess exotropia are reported as risk factors for consecutive esotropia, and DVD and amblyopia are proven risk factors for consecutive exotropia in many studies. Taking care of these risk factors and avoiding errors during measurement of pre-operative deviation improve the success and predictability of surgical outcomes.

## 6. Source of funding

None.

## 7. Conflict of interest

None.

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