

Clinical risk factors for the development of consecutive exotropia: a comparative clinical study

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Abstract

• **AIM:** To compare a group of patients with consecutive exotropia with patients who had ≤ 10 prism diopters (PD) esotropia or no deviation postoperatively in terms of probable clinical risk factors for the development of consecutive exotropia.

• **METHODS:** The study recruited fourteen patients who developed consecutive exodeviation during follow-up period after the correction of esotropia who were categorized as group 1 and thirty-one patients who had still ≤ 10 PD esotropia or no deviation at the final visit that were considered as group 2. Clinical risk factors leading the development of consecutive deviation were analyzed as the main outcome measures.

• **RESULTS:** The mean age of patients was 4.57 ± 3.11 y in group 1 and 5.10 ± 3.52 y in group 2 ($P=0.634$). There was no significant difference of preoperative near and distant deviations among two groups ($P=0.835$, 0.928 respectively). The mean amount of medial rectus recession and lateral rectus resection was similar in both groups ($P=0.412$, 0.648 respectively). Convergence insufficiency and neurological diseases were more frequent in group 1 ($P=0.007$, 0.045). Accompanying neurological disease was found to be as a significant factor increasing the risk of the development of consecutive exotropia significantly [odds ratios (OR): 5.75 (1.04–31.93)].

• **CONCLUSION:** Accompanying neurological disease appears to be a significant clinical risk factor for the development of consecutive exodeviation during postoperative follow-up after the correction of esotropia. However, larger studies are needed in order to interpret the results to the clinical practice and to ascertain other concurrent risk factors.

• **KEYWORDS:** consecutive exotropia; esotropia; medial

rectus recession; neurological disorder; lateral rectus resection

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INTRODUCTION

Consecutive exotropia is an exodeviation that mainly occurs after surgical treatment of esodeviations. The prevalence has been reported to be between 4% and 27%^[1-5]. Consecutive deviations are generally considered as complications of strabismus surgery after which orthophoria is targeted even though initial slight overcorrections may be desirable and even recommended in some selected conditions such as intermittent exotropia^[6-7]. Surgery is preferred in case of long lasting and treatment resistant consecutive exotropia whereas botulinum toxin injection, prismatic glasses, alternating occlusion, full myopic correction or orthoptic exercises are among the nonsurgical methods used to overcome the disabling outcome induced by consecutive deviations when temporary^[8-10]. When the condition seems to be resistant or permanent, the surgical management comprise the reversal of initial surgery and/or intervention for the fellow eye regarding the amount of deviation.

Consecutive exotropia is an undesirable and sometimes frustrating outcome of esotropia surgery. Thus, this study was undertaken with the purpose of identifying the risk factors for the development of consecutive exotropia by comparing a group of patients who ended up with consecutive exotropia during follow-up with another group of patients who had no deviation or still had ≤ 10 prism diopters (PD) esotropia at the last visit eventhough both of them had the similar amount of preoperative esotropia and surgery.

SUBJECTS AND METHODS

A total of 45 patients who underwent surgery for the correction of esotropia were enrolled in this retrospective study. The study was conducted in full accordance with the Tenets of Helsinki and informed consent was obtained from all patients. The study was carried out upon approval of the Institutional Review Board.

The patients who had exotropia at near or at distance postoperatively were categorized as group 1 whereas those

Table 1 The preoperative and postoperative clinical features of group 1 and group 2

Clinical features	Group 1 (n=14)	Group 2 (n=31)	P
Preoperative deviation [$\bar{x} \pm S$ (min-max) PD]			
Near	42.51±13.69 (20-60)	41.61±12.87 (20-70)	0.835
Distance	41.01±16.37 (8-60)	40.58±13.26 (18-70)	0.928
Postoperative deviation [$\bar{x} \pm S$ (min-max) PD]			
Near	16.79±10.24 (6-40)	6.39±3.88 (0-10)	0.002
Distance	16.71±10.51 (6-40)	5.94±3.81 (0-10)	0.002
Postoperative convergence insufficiency	4 (28.6%)	-	0.007
Neurological diseases	6 (42.9%)	4 (12.9%)	0.045

who had ≤ 10 PD esotropia or no manifest deviation at the final visit were classified as group 2. Two groups were mainly matched in terms of age at surgery, preoperative near and distance deviation and amount and type of surgery.

Patients having previous ocular surgery except from the mentioned esotropia surgery, having incomitant or dissociated vertical deviation were all excluded.

The data from the medical files of patients were collected in respect with demographic characteristics, associated systemic diseases, preoperative and postoperative deviations, type and amount of strabismus surgery, refractive status, anisometropia, amblyopia and postoperative convergence ability.

All patients underwent a complete ophthalmological examination and an orthoptic evaluation. The prism and alternate cover tests were performed in order to assess and quantify the deviation at near and distance when possible. All surgeries were performed under general anesthesia and in theatre. Postoperative orthoptic evaluation was based on the visit when the afore mentioned consecutive deviation was observed for the first time in group 1, and the latest visit when the patient had still ≤ 10 PD esotropia or no deviation in group 2. The further management of consecutive deviations was beyond the purpose of the study.

Amblyopia was defined as an interocular visual acuity difference more than 2 lines. Anisometropia was defined as a the difference in refractive error of 0.75 diopter or greater.

As the main outcome measure, risk factors contributing to the development of consecutive exotropia were analyzed.

Statistical Analysis The data was evaluated in collaboration with the Department of Biostatistics. Data analysis was performed by SPSS 15.0 (Statistical Package for Social Sciences, SPSS Inc. Chicago, IL, USA) software package. Numerical variables were evaluated for normality of data distribution by using the Kolmogorov-Smirnov test. Descriptive statistics were expressed as mean \pm standard deviation (SD) or median (min-max) according to the assumption of normal distribution.

In case of normal distribution of data, independent samples t -test was performed to compare the means of two groups. Mann-Whitney U test was used for non-parametric data. Before and after measurements was compared using paired sample t -test. Yates' Chi-square test or Fisher-exact tests

were used to compare difference between groups for categorical variables. Binary logistic regression was used to evaluate which independent variables (postoperative convergence, systemic diseases, myopia) were statistically significant predictors of the binary dependent variable (groups). Using the logistic models, odds ratios (OR) and their respective 95% confidence intervals (CIs) were calculated. A $P < 0.05$ was accepted as statistically significant.

RESULTS

A total of 45 patients (21 females, 24 males) were enrolled in the study. Group 1 consisted of 14 (5 females, 9 males) patients whereas group 2 included 31 (16 females, 15 males) patients.

The mean age of patients in group 1 was 4.57 ± 3.11 y and 5.10 ± 3.52 y in group 2 ($P = 0.634$). The operation was performed as bilateral medial rectus (MR) recession in 10 patients (71.4%) in group 1 and in 24 patients (77.4%) in group 2. The recession-resection procedure was performed in 4 (28.6%) patients in group 1 and in 7 (22.6%) patients in group 2. There was no significant difference among both groups in terms of the type of strabismus operation ($P = 0.717$).

The mean MR recession in bilateral MR recession procedure was 5.35 ± 0.97 (3.5-6.5) mm in group 1 whereas it was 5.01 ± 0.61 (4-6) mm in group 2 ($P = 0.212$). The mean MR recession in recession-resection procedure was 5.25 ± 0.29 (5-6) mm in group 1 and 4.86 ± 0.75 (4-6) mm in group 2 ($P = 0.412$). The mean amount of lateral rectus (LR) resection was 6.01 ± 0.82 (5-7) mm in group 1 and 5.82 ± 1.16 (4.5-8) mm in group 2 ($P = 0.648$). The maximum amount of MR recession was 6.5 mm in bilateral MR recession and it was performed in two patients in group 1. Group 1 and group 2 were matched in terms of age of patient, preoperative near and distance deviation and type and amount of strabismus surgery.

Table 1 incorporates data on preoperative and postoperative clinical characteristics in both of the groups. The mean time for the development of consecutive deviation in group 1 was 5.36 ± 4.39 (2-15)mo whereas the mean postoperative follow-up time in group 2 was 26.32 ± 12.28 (15-56)mo.

The visual acuity could be evaluated in 10/14 patients of group 1 and in 16/31 patients of group 2. The mean best corrected visual acuity for these patients was similar (0.5 ± 0.31 vs 0.76 ± 0.22 , $P = 0.072$). The mean refractive error as

spherical equivalent was 1.66 ± 0.98 (-3.75 to +3.25) D in group 1 and 2.16 ± 1.28 (-3.25 to +6.50) D in group 2 ($P=0.201$). There was no case of myopia of higher or equal than 6.00 D. The frequency of myopia was higher in group 1 (42.9%, $n=6$ vs 6.5%, $n=2$, $P=0.007$).

The amblyopia was observed in 7 patients in group 1 and in 7 patients in group 2 ($P=0.110$). There was no patients with anisometropia in group 1 whereas 2 (6.5%, 2/31) patients had anisometropia in group 2 ($P=1.000$). No complication related to strabismus surgery was seen in any of the groups. The amount of preoperative near and distance deviation was significantly reduced postoperatively in both groups ($P < 0.001$ for all).

The systemic diseases included cerebral palsy, mental retardation and epilepsy. Six patients (42.9%) in group 1 and 4 patients (12.9%) in group 2 had neurological disorders ($P=0.045$). When age at surgery, preoperative near and distance deviation, amblyopia and anisometropia, the amount of MR recession and LR resection, postoperative convergence, presence of systemic diseases and visual acuity were all analyzed, presence of systemic disease was found to increase the risk of consecutive deviation with an odds ratio equal to 5.75 (1.04-31.93).

DISCUSSION

In the present study, we were able to demonstrate that associated neurological disorders may compromise targeted postoperative outcome and may be among many risk factors for the development of consecutive exotropia. Consecutive exotropia may occur after the surgical correction of convergent strabismus as well as spontaneously or after botulinum toxin injection^[11-12]. The time of presentation is variable. Restriction in eye movements, intractable diplopia, persistent large angle consecutive deviations, risk of amblyopia or loss of binocularity may require prompt orthoptic and/or surgical intervention for consecutive deviations. The targeted final outcome for esotropia and exotropia is different in many aspects. Initial esodeviation may be desirable after the surgical correction of intermittent exotropia in order to prolong the duration of orthophoria^[7,13-14]. Treatment methods for the consecutive deviations comprise alternate occlusion, prismatic glasses, Fresnel prisms, and finally surgery^[8,15]. Botulinum toxin injection has been reported to be effective in the treatment of consecutive esotropia^[9,16-17].

Postoperative outcome after strabismus surgery may sometimes differ in two patients even if the amount of preoperative deviation and the surgical plan are completely the same. Thus, we aimed by conducting this study to determine the probable factors contributing to the development of consecutive exotropia. Our purpose was not the management of consecutive deviations but the risk factors for the development of any amount of consecutive exotropia therefore any amount of exodeviation was considered as consecutive deviation regardless of whether the amount was.

There have been studies about the risk factors for consecutive exotropia. The reported mean interval between the initial and the final surgery for the correction of over- or undercorrected deviations ranged between 10y and 29y^[15,18]. The patients in the present study experienced consecutive exodrift in a shorter time course (5.36 ± 4.39 mo). However, it should be kept in mind that this time period only points the time when consecutive exotropia is noticed.

Anisometropia, asymmetric surgery, amblyopia, restriction of adduction postoperatively have been reported to be associated with the development of consecutive exotropia^[19]. In the present study, 28.6% of patients in group 1 experienced convergence deficit of some sort suggesting deficit in MR function whereas none of the patients in group 2 had. However, it was not found to increase significantly the risk of postoperative exodeviation in logistic regression analysis. It has been postulated that stretched scar might be one of the reasons contributing to the development of consecutive exodeviations^[18]. In the present study, the data about the management of consecutive deviation were kept beyond the purpose of the study and we can not be sure about the results of a forced duction test and/or surgical exploration indicating the presence of a slipped MR muscle.

Ganesh *et al*^[5] investigated consecutive exotropia after surgery for infantile esotropia, added multiple surgeries to the aforementioned risk factors and found that age at onset, age at surgery and the amount of surgery were not related significantly to the risk of consecutive exodeviation.

High refractive errors may compromise the measurement of deviations and may cause miscalculation of the surgical amounts^[20]. In the present study, there was no significant difference among two groups in terms of spherical equivalents but the frequency of myopia was higher in group 1. Amblyopia appears to be associated with less favorable outcome and accounts for one of the main factors predisposing overcorrection in the literature although it was not found to be a risk factor in the present study. However, there is a controversy about the contribution of amblyopia into the development process of consecutive exotropia^[10,20-23]. Concerning the development of spontaneous consecutive exodeviation, early onset of esotropia, hyperopia more than 5 D and altered binocular vision have been reported as risk factors^[11]. The occurrence of spontaneous consecutive exotropia has been attributed to low AC/A ratio^[21,24].

The management of strabismus in patients with neurological impairment has been studied in detail in the literature. Charles and Moore^[25] compared the outcomes of strabismus surgery for infantile esotropia with and without neurological problems and /or prematurity. They found similar frequency of orthophoria in both groups and they recommend not to delay the surgery for infants with neurological problems.

Bang and Brodsky^[26] reported that large angle exodeviations might be corrected by adjusted surgical numbers in patients with neurological impairment. Hauviller *et al*^[27] suggested

that botulinum toxin injection might be the primary treatment in esotropic children with neurological impairment.

The present study should be assessed in the setting of the following restrictions: At first, the number of patients in both of the groups may cause the underestimation or the ignorance of other important risk factors such as amblyopia and binocular function in this retrospective study. Secondly, the neurological diseases reported in the study consist of epilepsy and mental retardation with undetermined origin and we can not be sure about their contribution to the deviation type and its amount. In addition, there was no follow-up time for the consecutive group. The time recorded was the only period when the consecutive deviation was noticed. We don't know whether the consecutive deviation was temporary or not. Furthermore, the interventions for the correction of the consecutive deviations were beyond the purpose of the study. Longer period for follow-up is necessary in order to assess the persistence of the consecutive deviation. Longer follow-up time may introduce some confounding factors as well. Data concerning the binocular status of the patients as being one of the main factors providing ocular alignment, were not precise for all patients and limited the interpretation of the findings. The lack of further standardization of the surgery as a result of a retrospective study creates another weakness in addition to the other points mentioned above.

This study indicates and highlights the higher risk of postoperative consecutive exotropia in patients with neurological diseases. It is apparent that careful review of the generally used surgical amounts is required if a patient has associated neurological problems.

The type and the severity of neurological impairment that may lead the development of consecutive exodeviation still remains as a matter of debate and may influence the time of occurrence and the amount of consecutive deviation in respect with the tonosity of extraocular muscles and sensorial control. Furthermore, the results of the study may be extrapolated only for the mentioned age group. The results of the present study can not be extrapolated to all patients with neurological problems because we were not able to grade neither the severity of the disease nor the association between the severity of the disease and the frequency of consecutive deviation. It should be borne in mind that accompanying neurological disorder may increase the risk of consecutive deviation after esotropia surgery.

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