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Factors associated with surgical success in adult patients with exotropia

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Abstract

Factors associated with surgical success in adult patients with exotropia

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Purpose : The purpose of this study is to report the results of surgical treatment for intermittent or constant comitant exotropia in adults and to examine the factors associated with the surgical outcome.

Methods : The medical records of consecutive patients older than 18 years of age at the time of surgery for intermittent or constant comitant exotropia and with at least 1 year's follow-up were retrospectively reviewed. Surgical success was defined as postoperative esodeviation of <5 prism diopters ($^{\Delta}$), orthotropia, or exodeviation of <10$^{\Delta}$. Overcorrection (defined as esodeviation >5$^{\Delta}$) and recurrence (exodeviation of >10$^{\Delta}$) were considered surgical failure. Preoperative patient characteristics, surgical procedures performed, and early postoperative ocular alignment were evaluated as potential factors associated with the surgical outcome.

Results : A total of 39 patients were included, of whom 28 (72%)

achieved surgical success, 7 (18%) showed overcorrection, and 4 (10%) had recurrence. Alignment at postoperative week 1 was the only significant factor correlated with surgical results. Surgical outcome was best with early postoperative alignment of $<10^{\Delta}$ of esotropia.

Conclusions : In this study, 72% of patients with intermittent or constant comitant exotropia had a successful outcome, with an average 1.9 years of follow-up. Early postoperative overcorrection of $<10^{\Delta}$ resulted in more favorable surgical outcomes in adults undergoing surgery to treat exotropia.

Keyword : exotropia, adult, strabismus surgery, exodrift

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Chapter 1. Introduction

Exotropia is a disorder of ocular alignment characterized by an outward deviation of the eyes. Intermittent exotropia is one of the most common types of strabismus in Asian populations. Studies on strabismus surgery in adults are fewer than those on surgery in children. The main reasons for this might be that strabismus surgery is less common in adults, and the characteristics of strabismus are more variable in adults than in children. Several studies have been performed in adults with exotropia, but the inclusion criteria differed, with various causes of exotropia reported (eg, intermittent, sensory, consecutive, paralytic, or restrictive strabismus), and they used different parameters for assessing the surgical outcome (eg, objective motor results, functional complaints such as diplopia and binocularity, psychosocial complaints, and quality of life).[1,2] In reports of motor alignment in adult strabismus, 68%–85% of patients met the authors' definition of successful outcome, which varied somewhat in each study.[3–6] However, a success rate based on a heterogeneous group may not be applicable to any specific patient with a unique problem.[1]

The factors reported to affect the surgical outcome after exotropia surgery vary widely, including age at the time of surgery,[7,8] preoperative angle of deviation,[9,10] refractive errors,[8,9] type of surgery,[11] and early postoperative ocular alignment.[12–14] Most studies of exotropia deal primarily with children,[15] although the characteristics in adults differ considerably from those in

children.[16] This study investigates the surgical outcomes for intermittent or constant comitant exotropia in adults and examines the factors associated with success.

Chapter 2. Subjects and Methods

The Seoul National University Hospital Institutional Review Board (IRB) approved this study (IRB number 1511-020-716). The medical records of patients who underwent surgery for intermittent or constant comitant exotropia when >18 years of age at Seoul National University Children's Hospital between March 1, 2004 and September 31, 2014, were reviewed retrospectively.

Constant exotropia was defined as intermittent exodeviation that becomes constant with time; all cases of constant exotropia had a previous history of intermittent exotropia. Only patients with at least 12 months' follow-up were included. Patients with sensory, paralytic, or restrictive strabismus, a history of strabismus surgery, or combined surgery for vertical strabismus were excluded. Patients with amblyopia were not excluded if the corrected visual acuity in the amblyopic eyes was better than 20/63. Additionally, patients with an A or V pattern, dissociated vertical deviation, or oblique muscle overaction not requiring surgical correction were included.

All patients underwent complete ophthalmological examinations before surgery, and the following data were recorded: sex, duration from onset of deviation to the time of surgery, age at the time of

surgery, preoperative best-corrected visual acuity with all refractions performed under cycloplegia, distance and near deviation angle, constancy of deviation, and associated strabismus (dissociated vertical deviation, oblique muscle dysfunction, vertical deviation). Deviation was measured using the alternate prism and cover test at a distance (6 m) and close up (33 cm) for the primary gaze, with appropriate spectacle correction when required.

2.1. Surgical Technique and Postoperative Assessment

All surgeries were performed under general anesthesia by a single surgeon (S-JK) on the basis of the largest angle of preoperative deviation measured at distance or near. Table 1 provides the formula that was used for surgical procedures according to the surgeon's experience. Patients with a fixation preference underwent a unilateral recession of the lateral rectus muscle and resection of the medial rectus muscle of the nondominant eye. Patients with exotropia of $<25^{\Delta}$ both at distance and near underwent unilateral lateral rectus recession. Otherwise, bilateral lateral rectus recession was performed. In cases of large-angle exotropia ($>50^{\Delta}$), the patients underwent three-muscle surgery to recess both lateral rectus muscles maximally and to resect one of the medial rectus muscles. In cases without a fixation preference, the medial rectus muscle was resected randomly on the right or left eye. Before 2009 adjustable sutures were used with the "bow tie" technique, with suture adjustments performed within

the first 24 hours after surgery, as needed.[17] From 2009 to 2014 adjustable sutures were used with the "short tag noose technique," with adjustments performed 2–5 days after surgery as required. The general goal of the adjustment was an initial overcorrection <10$^{\Delta}$.

Table 1. Surgical dosage used for intermittent exotropia in this study.

Prism diopters	Bilateral lateral rectus recession (mm)	Lateral rectus recession/medial rectus resection (mm)	Unilateral lateral rectus recession (mm)
15	4		8
20	5	5/4	9
25	5.5	6/4	9.5
30	6	6/5	
35	7	7/5	
40	8	8/5	
45	9	8/6	
50	9.5	9/6	

Postoperative assessments were made at 1 day, 1 week, and 3, 6, and 12 months after surgery, with annual follow-up thereafter. Postoperative measurements of deviations were performed in the same manner as preoperative measurements. Postoperative esodeviation was managed with an alternating full-time patching for 1 month after surgery. If esodeviation did not abate with patching for 1 month, prism glasses were prescribed.

Patients were divided into one of the following surgical outcome

groups based on the last measurement of deviations available during the last postoperative visit: success, overcorrection, or recurrence. Surgical success was defined as esodeviation of $<5^{\Delta}$, orthotropia, or exodeviation of $<10^{\Delta}$. Overcorrection was defined as esodeviation of $>5^{\Delta}$; recurrence, as exodeviation of $>10^{\Delta}$. Both overcorrection and recurrence were considered surgical failure.

On the basis of early postoperative deviation at distance at 1 day and 1 week, patients were assigned to 3 groups: (1) $>10^{\Delta}$ of esodeviation; (2) $0^{\Delta}-10^{\Delta}$ of esodeviation/orthotropia; (3) $1^{\Delta}-10^{\Delta}$ of exodeviation.

2.2. Statistical Analysis

All statistical analyses were performed with the Statistical Package for Social Sciences version 22.0 for Windows (SPSS Inc, Chicago, IL). A p value of <0.05 was considered significant. The Pearson χ^2 test, Fisher exact test, independent t test, and Mann–Whitney test were used to compare patients characteristics and the surgical outcomes. Linear–by–linear association and analysis of variance were used to compare the surgical outcomes between the early postoperative alignment groups.

Chapter 3. Results

From 1 March 2004 to 31 September 2014, we performed strabismus surgeries in 515 adult patients with exotropia. Of these, 476 patients were excluded from this study because of consecutive (n = 56), sensory (n = 153), paralytic, or restrictive strabismus

due to orbital, neurologic, or systemic disorders (n = 80), history of prior exotropia surgery (n = 72), combined surgery of vertical strabismus (n = 30), and insufficient follow-up (n = 85), leaving a final sample of 39 subjects.

Table 2 provides a summary of patient demographics. The mean age of patients was 37.7 ± 13.6 years (range, 18-63) and the mean preoperative exodeviation at distance was 51.4^{Δ} ± 17.9^{Δ} (range, 15^{Δ}-104^{Δ}). Of 39 patients, 28 (72%) achieved surgical success, 7 patients (18%) showed overcorrection, and 4 patients (10%) had recurrence. The outcome of surgical success was present at both the one year postoperatively as well as the last follow-up period. The average postoperative follow-up was 22.4 ± 11.9 months (range, 12-76). No patients underwent revision surgery during the follow-up period.

Of the preoperative variables investigated (sex, time from deviation onset to surgery, age at surgery, best-corrected visual acuity, refraction, distant and near deviation angle, constancy of deviation, associated strabismus), none were found to be significantly associated with the surgical outcome. There was no significant difference in the age and refraction of each eye among the three surgical outcome groups based on the last measurement (p = 0.247, 0.605, 0.727, respectively).

Of the 39 patients, 15 patients (39%) were treated with bilateral lateral rectus recessions; 10 patients (26%), with recession-resection procedures; and 14 (36%), with bilateral lateral rectus recession with unilateral medial rectus resection.

When the surgical results of bilateral lateral rectus recession and recession-resection were compared, no statistically significant difference was found. Twenty-eight patients (72%) received adjustable sutures, and postoperative adjustment was required in 11 patients. There was no significant difference in the use of adjustable sutures between the success and failure groups.

Table 2. Demographics and ocular characteristics of patients and factors affecting surgical results.

	Total (range)	Success	Failure	*p* value
No. of patients	39	28	11	
Age at surgery, years	37.7 ± 13.6 (18-63)	35.7 ± 13.6	42.9 ± 12.6	0.140**
Duration from onset of deviation to surgery, years	25.1 ± 14.0 (6-51)	23.8 ± 14.8	28.4 ± 11.8	0.360*
Refractive errors, D				
OD	-2.2 ± 3.0 (-9.0 to 1.3)	-2.6 ± 3.0	-1.5 ± 3.0	0.331**
OS	-2.0 ± 2.8 (-8.0 to 2.0)	-2.2 ± 2.7	-1.5 ± 3.1	0.481*
Sex (M:F)	19 : 20	15 : 13	4 : 7	0.333†
Preoperative deviation at distance, PD	51.4 ± 17.9 (15-104)	51.8 ± 17.5	50.3 ± 19.7	0.508**
Preoperative deviation at near, PD	54.0 ± 18.9 (15-113)	53.1 ± 17.7	56.3 ± 22.6	0.914**
Intermittent : Constant deviation	12 : 27	11 : 17	1 : 10	0.122**
Associated vertical	20	16	4	0.243†

strabismus				
Amblyopia	3	2	1	1.000††
BLR : RR procedure	15 : 10	11 : 7	4 : 3	1.000††
Adjustable suture	28	20	8	1.000††
Post-operative adjustment	11	6	5	0.234††
Postoperative follow-up, months	22.4 ± 11.9 (12-76)	21.2 ± 8.0	25.4 ± 18.7	0.914**

D = diopters, OD = right eye, OS = left eye, PD = prism diopters, BLR = bilateral lateral rectus recession,

RR = lateral rectus recession - medial rectus resection

Data are presented as mean ± standard deviation.

*: Independent t test

**: Mann-Whitney test

†: Pearson $\chi 2$ test

††: Fisher's exact test

3.1. Early Postoperative Alignment

Table 3 provides the deviations at postoperative week 1. The chance of a successful outcome was highest in patients with an early postoperative alignment of 0^{Δ}-10^{Δ} at week 1 ($p < 0.001$). At day 1, a successful outcome was also highest in patients with a postoperative alignment of 0^{Δ}-10^{Δ} of esodeviation/orthotropia; however, there was no significant difference ($p = 0.247$). The mean angles of deviation at each postoperative time point in the 3 groups, divided on the basis of the postoperative deviation at 1 week, are shown in Table 4 and Figure 1. In the esodeviation group with postoperative alignment of $>10^{\Delta}$, 64% of patients remained

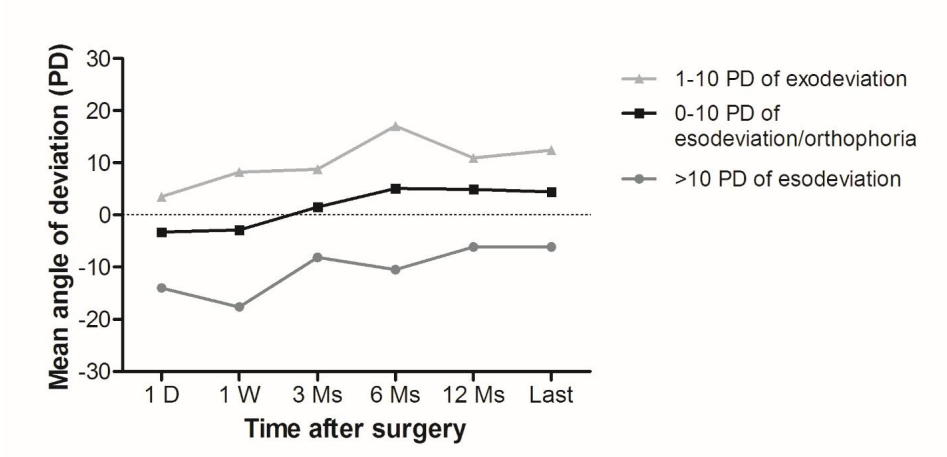
overcorrected at the final follow-up, and the final mean postoperative angle of deviation was $-6.1^{\Delta} \pm 7.8^{\Delta}$.

Table 3. Deviation at postoperative week 1 in the successful and failure groups ($p < 0.001$)

Alignment at postoperative week 1	No. of patients		Total
	Success (%)	Failure (%)	
>10 PD of esodeviation	4 (36.4)	7 (63.6)	11
0–10 PD of esodeviation /orthotropia	17(100.0)	0 (0.0)	17
1–10 PD of exodeviation	7 (63.6)	4 (36.4)	11
Total	28	11	39

Comparison performed using linear-by-linear association.

Figure 1. Mean postoperative angle of deviation at each postoperative time point in each group.



The positive numbers represent exodeviation and the negative numbers represent esodeviation. *PD*, prism diopter; *D*, day; *W*, week; *Ms*, months; *Last*, final follow-up.

Table 4. Postoperative angle of deviation at each postoperative time point in each group.

Time after surgery	Angle of deviation in PD, mean ± SD (range)			
	>10 PD of esodeviation	0–10 PD of esodeviation/ orthophoria	1–10 PD of exodeviation	*p* value (by ANOVA)
1 day	−14.0 ± 7.9 (−25 to 0)	−5.1 ± 6.3 (−16 to 8)	4.0 ± 7.7 (−6 to 20)	< 0.001
1 week	−17.6 ± 5.2 (−25 to −12)	−3.3 ± 4.2 (−10 to 0)	8.6 ± 8.0 (1 to 25)	< 0.001
3 months	−8.1 ± 6.0 (−15 to 3)	1.5 ± 4.5 (−6 to 12)	9.8 ± 9.0 (0 to 28)	< 0.001
6 months	−10.5 ± 8.5 (−20 to −4)	4.0 ± 3.2 (0 to 8)	16.4 ± 12.0 (0 to 35)	0.004
1 year	−6.1 ± 7.9 (−20 to 6)	4.1 ± 2.4 (0 to 10)	13.1 ± 16.3 (0 to 45)	< 0.001
Last follow up	−6.1 ± 7.8 (−20 to 6)	3.7 ± 2.7 (0 to 10)	12.4 ± 13.1 (0 to 40)	< 0.001

PD = prism diopters, SD = standard deviation

The positive numbers represent exodeviation and the negative numbers represent esodeviation.

Chapter 4. Discussion

In this study, 72% of patients with intermittent or constant comitant exotropia had a successful outcome, with an average 1.9 years of follow-up. This result is comparable to those reported in other studies on adult strabismus, although the inclusion criteria and

the length of follow-up vary widely between reports.[3-6]

There is widespread agreement that, because of postoperative exodrift, an initial overcorrection is desirable for long-term surgical success.[10,18] Additionally, some reports have demonstrated that a larger initial overcorrection showed good surgical results for exotropia.[12,13] However, all of these reports deal primarily with children. In adults with exotropia, there is debate whether over- or undercorrection in the initial postoperative alignment is associated with surgical success.[12,16,18,19]

In our study, early esodeviation of $\leq 10^{\Delta}$ of esodeviation was associated with the best alignment. We suggest that the reduced convergence effect and the smaller degree of postoperative exodrift in adults compared to children could account for this result. Burian and Spivey[19] reported that the degree of exodeviation appears greater as the patient grows older because the convergence mechanism weakens with age. As an individual ages, the size of the manifest deviation becomes greater compared to that in childhood. Our study also showed that the degree of exodeviation at near fixation appears larger than at distant fixation.

Ruttum[10] reported a tendency toward greater postoperative exodrift with a larger initial overcorrection and less exodrift with a smaller overcorrection and with undercorrection in patients 2-68 years of age (median, 6.5 years). Park and Kim[20] showed that the rate of exodrift correlated with the size of the preoperative deviation and the amount of the initial postoperative overcorrection in patients with a mean age of 6.49 $\pm$ 3.05 years. Kim and Hwang[21]

reported that initial overcorrection of ≥20$^{\Delta}$ was reduced to ≤10$^{\Delta}$ within 4 weeks postoperatively in patients with a median age of 6.0 years. In our study, patients with an alignment of >10$^{\Delta}$ of esodeviation at postoperative week 1 showed a mean exodrift of 9.5$^{\Delta}$ within 3 months of surgery, and 64% of these patients remained overcorrected at the final follow-up. This result suggests that exodrift in adults differs from that in children and that an overcorrection of >10$^{\Delta}$ affects the incidence of consecutive esotropia. Although the presence of presbyopia in older patients or accommodation in younger patients may also play a role, there was no significant difference among three surgical outcome groups based on the last measurement.

This study is limited by its retrospective nature, the small number of subjects, and the fact that different surgical methods were involved. There could be a selection bias, because we only included patients followed for more than 1 year; that is, patients with successful or poor results might not return to the clinic. Additionally, the results are based purely on the alignment of the visual axes and do not consider the influence of sensory factors that might affect the angle of deviation postoperatively from fusional effort. We included intermittent and constant exotropic patients, and their different sensorial conditions could influence the surgical outcome.[22] The preoperative and postoperative sensory statuses or stereopsis were not evaluated in this study. Only 2 patients (5.1%) had intolerable diplopia that was present at the last examination, and there were no patients who complained of diplopia in the group

with an immediate overcorrection of <10^{Δ}.

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국문초록

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목적 : 성인 외사시 수술 후 1년 이상 관찰한 결과를 분석하고, 수술 결과에 영향을 미치는 요인에 대하여 알아보고자 하였다.

방법 : 18세 이상의 외사시 환자에서 수술 후 1년 이상 경과 관찰한 환자들의 의무기록을 후향적으로 분석하였다. 수술 후 최종 방문 시 원거리 사시각이 일차 안위에서 5프리즘디옵터($^{\Delta}$) 이내의 내편위, 정위 혹은 10^{Δ} 이내 외편위인 경우를 성공군, 5^{Δ}를 초과하는 내편위를 과교정군, 10^{Δ}를 초과하는 외편위를 재발군으로 정의하였다. 과교정군과 재발군을 묶어 실패군으로 정의하였다. 환자의 임상양상, 수술방법, 수술 직후 및 1주 후 사시각 등의 요인을 분석하였다.

결과 : 총 39명의 환자 중 외사시 성공군이 28명(72%), 과교정군 7명(18%), 재발군 4명(10%)이었으며, 수술 1주 후 사시각(10^{Δ} 이내의 과교정)만이 수술 성공과 유의한 상관관계를 보였다.

결론 : 성인 외사시에서 수술 성공률은 72%였으며, 수술 1주 후 10^{Δ} 이내의 과교정 상태가 최종 성공률이 높았다.

주요어 : 외사시, 성인, 사시 수술, 외편위

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