· Original article ·

The long-term postoperative outcomes for intermittent and constant exotropia

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间歇性外斜视和恒定性外斜视术后远期疗效观察

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摘要

目的:探讨间歇性外斜视、曾有间歇期的恒定性外斜视和无间歇期的恒定性外斜视术后的远期效果。

方法:回顾性分析137例已行斜视手术的间歇性外斜视和恒定性外斜视患者并分为3组。组1:74例间歇性外斜视;组2:38例有间歇期的恒定性外斜视;组3:25例无间歇期的恒定性外斜视。分析比较3组患者术后残余斜视度及立体视恢复情况。平均随访2.2a。

结果:组1、组2、组3的眼位矫正成功率分别为78%、68%、64%(组1 *vs* 组2,$P=0.249$;组1 *vs* 组3,$P=0.153$;组2 *vs* 组3,$P=0.716$)。组1、组2、组3术后获得双眼视者分别有57例(77%)、5例(13%)、1例(4%)(组1 *vs* 组2,$P<0.001$;组1 *vs* 组3,$P<0.001$;组2 *vs* 组3,$P=0.440$)。组1、组2、组3分别有66(89%)、27(71%)、8(32%)例获得粗糙立体视(组1 *vs* 组2,$P=0.015$;组1 *vs* 组3,$P<0.001$;组2 *vs* 组3,$P=0.002$)。获得远立体视者组1、组2、组3分别有29例(56%)、5例(24%)、1例(7%)(组1 *vs* 组2,$P=0.013$;组1 *vs* 组3,$P=0.001$;组2 *vs* 组3,$P=0.366$)。

结论:曾有间歇期的恒定性外斜视患者术后远期粗糙立体视的恢复优于无间歇期的恒定性外斜视,与间歇性外斜视相比,双眼视、粗糙立体视和远立体视的恢复均较差。有间歇期的恒定性外斜视可能错失了最佳治疗时机,早期手术可优化术后感觉功能结果。

关键词:外斜视;远期;术后;立体视;恒定性;间歇性

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Abstract

• AIM: To investigate the long-term outcomes after surgery for intermittent exotropia [X (T)], constant exotropia with a previously intermittent history and constant exotropia without a previously intermittent history.

• METHODS: Totally 137 patients with intermittent exotropia or constant exotropia who had underwent surgery were analyzed retrospectively. They were assigned into three groups: group 1, seventy-four patients with X (T); group 2, thirty-eight constant exotropia patients with a previously intermittent history; group 3, twenty-five constant exotropia patients without a previously intermittent history. The surgical outcomes in the ocular deviation and the recovery of stereoacuity were compared separately among the three groups. The average follow-up time was 2.2 years.

• RESULTS: The successful alignment rates were 78% (group 1), 68% (group 2), 64% (group 3), respectively (group 1 *vs* group 2, $P=0.249$; group 1 *vs* group 3, $P=0.153$; group 2 *vs* group 3, $P=0.716$). Fifty-seven patients (77%) in group 1, five patients (13%) in group 2 and one patient (4%) in group 3 achieved binocularity after surgery (group 1 *vs* group 2, $P<0.001$; group 1 *vs* group 3, $P<0.001$; group 2 *vs* group 3, $P=0.440$). The number of patients who achieved gross stereopsis in group 1, group 2 and group 3 were 66 (89%), 27 (71%), 8 (32%) (group 1 *vs* group 2, $P=0.015$; group 1 *vs* group 3, $P<0.001$; group 2 *vs* group 3, $P=0.002$). Twenty-nine patients (56%) in group 1, 5 patients (24%) in group 2, 1 patients (7%) in group 3 achieved distance stereoacuity (group 1 *vs* group 2, $P=0.013$; group 1 *vs* group 3, $P=0.001$; group 2 *vs* group 3, $P=0.366$).

• CONCLUSION: Patients with constant exotropia who had a intermittent history have a better surgical result compared with those without a intermittence period in

gross stereopsis, but a worse postoperative sensory outcome than patients with X (T) in binocular vision, gross stereopsis, and distant stereoacuity. Constant exotropia patients with a period of X (T) may have missed the optimal timing for treatment, early surgery can optimize the postoperative sensory results.

• KEYWORDS: exotropia; long-term; postoperative; stereoacuity; constant; intermittent
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INTRODUCTION

Intermittent exotropia [X (T)] is the most frequent type of strabismus[1-2]. The fusion and accommodative convergence function of it gradually weakened with the increasing age, lastly lose compensatory ability and deteriorate to constant exotropia. Constant exotropia can be classified as that with a previous intermittent history and that without a history of intermittency. Some studies found that some patients with constant exotropia had postoperatively achieved binocularity including near and distant stereoacuity, but they did not explain whether these patients had a intermittence history or not[3-7]. Wu and Sun[8] reported that near stereoacuity significantly improved three months after surgery in X (T) and constant exotropia with a previously intermittent history, but distant stereoacuity had no significantly improvement. The surgical result of constant exotropia patients with a period of intermittence was better than those without a intermittent period in gross stereopsis, however, none of patients with constant exotropia achieved binocular function one year after operation[9]. Few studies describe the long-term results after surgery for constant exotropia.

The aim of this paper is to investigate and compare the long-term outcomes after surgery for X (T) and constant exotropia with a previous intermittence period and those without a intermittent history.

SUBJECTS AND METHODS

Patients with intermittentexotropia or constant exotropia who underwent strabismus surgery between January 2008 and December 2012 in the Affiliated Hospital of Qingdao University were recruited and were split into three groups: group 1, X (T); group 2, constant exotropia with a previously intermittent period; group 3, constant exotropia without a previously intermittent history. The inclusion criterion were that patients who had accurate diagnosis and more complete examination results before surgery. Four years was the minimum age for inclusion. The previous history of X (T) was acquired through medical records. If the medica materials of constant exotropia patients included one of the following records that (1) with increasing age, the angle of exodeviation increased; (2) the angle of deviation became apparent when they were lacking concentration, or fatigued; (3) one eye usually squinted in bright light, they were thought to have a previously intermittent history. The patients or their guardians would be asked again if the intermittent period could not be sure when they came to review. Our exclusion criteria were systemic or neurologic impairment, co-existent ocular disease, co-existent vertical strabismus, insufficient convergence and a previous strabismus operation. The angle of deviation with near (33cm) and distant (5m) fixation were measured with the prism and alternate cover test. A horizontal deviation ≤10 prism diopters (PD, exo or eso) with fixation on a target at near (33cm) and at distance (5m) was considered as successful ocular alignment. Near stereoacuity was assessed with the Yan's stereogram and Titmus test. The results of Yan's stereogram shall prevail in this paper. Bifixation was defined as a stereoacuity ≤60s of arc. Gross stereopsis was defined as a stereoacuity ≤800s of arc. Distance stereoacuity was tested with synoptophore. Having 3 level function (including simultaneous perception, fusion and stereopsis) completely was considered as normal distance stereoacuity. The mean length of follow-up was 2.2 years.

Statistical analyses were performed with the statistical software SPSS version 17.0. The analysis of variance, LSD-*t* test, chi-square test, or Fisher's exact test were used to compare the results, where appropriate. *P*-value of <0.05 was considered statistically significant.

RESULTS

Our study had a total of 137 patients, including 71 males and 66 females, the age ranged from 4 to 40. There were 74 patients (37 male, 37 female) in group 1, 38 (19 male, 19 female) in group 2 and 25 (15 male, 10 female) in group 3. There were fifteen patients with congenital exotropia in group 3 and seven patients with a constant exodeviation who had no apparent intermittent period were found in their early year of life. Although other 3 patients with constant exodeviation were found later in their life, no clear intermittent period were observed because of their negligent.

Compared with patients in group 2 and group 3, those in group 1 had a younger ageat the time of surgery (group 1 *vs* group 2, $P=0.003$; group 1 *vs* group 3, $P=0.002$, LSD-*t* test), a less preoperative exodeviation (group 1 *vs* group 2, near: $P<0.001$; distant: $P=0.002$; group 1 *vs* group 3; near: $P<0.001$; distant: $P<0.001$, LSD-*t* test), and a shorter duration of strabismus than group 3 (group 1 *vs* group 3, $P<0.001$, LSD-*t* test), however, no significantly different was shown in group 1 and group 2 (group 1 *vs* group 2, $P=0.425$, LSD-*t* test). While patients in group 3 had a longer duration of strabismus (group 2 *vs* group 3, $P<0.001$, LSD-*t* test) and a larger preoperative deviation (group 2 *vs* group 3, near: $P=0.022$; distant: $P=0.003$, LSD-*t* test) compared with patients in group 2. About age at surgery of patients, group 2 and group 3 showed no difference (group 2 *vs* group 3, $P=0.655$, LSD-*t* test) (Table 1).

Table 1 Preoperative clinical characteristics of all the patients $\bar{x}\pm s$

Groups	*n*	[1]Age at surgery (a)	[2]Duration of exotropia (a)	[3]Deviation (near, PD)	[4]Deviatio (distant, PD)
Group 1	74	10.31±6.15	4.65±4.99	48.78±20.90	42.70±20.48
Group 2	38	14.55±7.55	5.50±4.18	65.26±24.69	58.16±23.84
Group 3	25	15.36±8.45	11.52±7.40	78.72±24.15	77.40±36.72

Using theanalysis of variance and LSD-*t* test for the comparison of data. [1]group 1 *vs* group 2, $P=0.003$; group 1 *vs* group 3, $P=0.002$; group 2 *vs* group 3, $P=0.655$; [2]group 1 *vs* group 2, $P=0.425$; group 1 *vs* group 3, $P<0.001$; group 2 *vs* group 3, $P<0.001$; [3]group 1 *vs* group 2, $P<0.001$; group 1 *vs* group 3, $P<0.001$; group 2 *vs* group 3, $P=0.022$; [4]group 1 *vs* group 2, $P=0.002$; group 1 *vs* group 3, $P<0.001$; group 2 *vs* group 3, $P=0.003$. Group 1 = Intermittent exotropia; Group 2 = Constant exotropia with a previously intermittent history; Group 3 = Constant exotropia without a previously intermittent history.

Motor Alignment Of all the patients who came to review, 100 (73%) achieved successful ocular alignment: group 1 had 58 patients (78%), group 2 had 26 (68%), and group 3 had 16 (64%). There were no significant difference among the three groups (group 1 *vs* group 2, $P=0.249$; group 1 *vs* group 3, $P=0.153$; group 2 *vs* group 3, $P=0.716$, Chi-square test).

Results of Yan's Stereogram Of all the cases, 63 (46%) achieved binocular vision: 57 (77%) in group 1, 5 (13%) in group 2, and 1 (4%) in group 3, with significantly different found between group 1 and the two constant exotropia groups (group 1 *vs* group 2, $P<0.001$, Chi-square test; group 1 *vs* group 3, $P<0.001$, Continuity Adj. Chi-square test), but no significantly different was exhibited between the two constant exotropia groups (group 2 *vs* group 3, $P=0.440$, Continuity Adj. Chi-square test). However, there were patients achieved bifixation after surgery in all the three groups. The binocular vision of patients in group 1 had significant improvement after surgery compared with that preoperative ($P<0.001$, Chi-square test), while no significant improvement in group 2 and group 3 (group 2: $P=0.709$, group 3: $P=1.000$, Continuity Adj. Chi-square test) (Table 2). Of the patients, 101 (74%) achieved gross stereopsis, and 36 (26%) showed no stereo. Totally 66 patients (89%) in group 1, 27 patients (71%) in group 2, 8 patients (32%) in group 3 achieved gross stereopsis, respectively (group 1 *vs* group 2, $P=0.015$; group 1 *vs* group 3, $P<0.001$; group 2 *vs* group 3, $P=0.002$, Chi-square test). Although constant exotropia patients with a previously intermittent period have a worse postoperative sensory result than X (T) in gross stereopsis, they have a better surgical outcome compared with those without a previous intermittence history.

Results of Titmus Stereoacuity Test Sixty patients (81%) in group 1, 9 patients (24%) in group 2, 3 patients (12%) in group 3 achieved bifixation (group 1 *vs* group 2, $P<0.001$, Chi-square test; group 1 *vs* group 3, $P<0.001$; group 2 *vs* group 3, $P=0.408$, Continuity Adj. Chi-square test). Of all the patients achieved gross stereopsis after operation, group 1 had 68 (92%), group 2 had 29 (76%), group 3 had 10 (40%) (group 1 *vs* group 2, $P=0.022$, Chi-square test; group 1 *vs* group 3, $P<0.001$; group 2 *vs* group 3, $P=0.04$, Chi-square test). The statistical conclusion were consist with that of Yan's stereoacuity test, but the rates were higher.

Table 2 Pre- and posto-perative Yan's stereoacuity test outcomes of the patients

Groups	Bifixation	Gross stereopsis	No stereo
Group 1 ($n=74$)			
Preop.	23	62	12
Postop.	57	66	8
Group 2 ($n=38$)			
Preop.	3	14	24
Postop.	5	27	11
Group 3 ($n=25$)			
Preop.	1	5	20
Postop.	1	8	17

Group 1 = Intermittentexotropia; Group 2 = Constant exotropia with a previously intermittent period; Group 3 = Constant exotropia without a previously intermittent period.

Table 3 Pre- and posto-perative normal distance stereoacuity results of the patients

Groups	Group 1	Group 2	Group 3
Preoperative	16	4	1
Postoperative	29	5	1
P	0.010	1.000	1.000

P: Comparison between preoperation and postoperation in the three groups. Using Chi-square test and Continuity Adj. Chi-square test and Fisher exact test. Group 1 = Intermittentexotropia; Group 2 = Constant exotropia with a previously intermittent period; Group 3 = Constant exotropia without a previously intermittent period.

Results of Distance Stereoacuity Of the patients, 52 patients in group 1, 21 in group 2, and 14 in group 3 had complete preoperative records of synoptophore examination results. The pre- and postoperative number of patients who had normal distance stereoacuity were shown in Table 3. The recovery of distance stereoacuity in group 1 had a significant difference compared with that of preoperative ($P=0.010$, Chi-square test). But patients in the two constant exotropia groups had no significant improvement after surgery (group 2: $P=1.000$, Continuity Adj. Chi-square test; group 3: $P=1.000$, Fisher exact test). Twenty-nine patients (56%) in

Table 4 Surgical results of the three groups

Surgical results	Group 1 $n=74$	Group 2 $n=38$	Group 3 $n=25$
[1]Successful motor alignment (≤10PD exo or eso)	58 (78%)	26 (68%)	16 (64%)
[2]Bifixation (stereopsis≤60")	57 (77%)	5 (13%)	1 (4%)
[3]Gross stereopsis (stereopsis≤ 800")	66 (89%)	27 (71%)	8 (32%)
[4]Distance stereoacuity (complete 3 level function)	29 (56%)	5(24%)	1 (7%)

[1]group 1 *vs* group 2; $P=0.249$; group 1 *vs* group 3, $P=0.153$; group 2 *vs* group 3, $P=0.716$, Chi-square test; [2]group 1 *vs* group 2, $P<0.001$; group 1 *vs* group 3, $P<0.001$; group 2 *vs* group 3, $P=0.440$, Continuity Adj. Chi-square test; [3]group 1 *vs* group 2, $P=0.015$; group 1 *vs* group 3, $P<0.001$; group 2 *vs* group 3, $P=0.002$, Chi-square test; [4]group 1 *vs* group 2, $P=0.013$, Chi-square test; group 1 *vs* group 3, $P=0.001$, Continuity Adj. Chi-square test; group 2 *vs* group 3, $P=0.366$, Fisher exact test; Group 1=Intermittentexotropia; Group 2=Constant exotropia with a previously intermittent period; Group 3=Constant exotropia without a previously intermittent period.

group 1, 5 patients (24%) in group 2, 1 patients (7%) in group 3 achieved normal distance stereoacuity after operation (group 1 *vs* group 2, $P=0.013$, Chi-square test; group 1 *vs* group 3, $P=0.001$, Continuity Adj. Chi-square test; group 2 *vs* group 3, $P=0.366$, Fisher exact test). Compared with the two types of constant exotropia patients, X(T) patients had a significantly better sensory result in the distant stereoacuity (Table 4).

DISCUSSION

It is known that intermittentexotropia and constant exotropia are the two most common forms of strabismus. The rate of a successful outcome depends mainly on the criteria defined by authors. Many defined successful alignment as within 10 PD (exo or eso), while others extended the criterion to within 15 PD[10-12]. When the criteria was defined as within 10 PD, Lau FH and associates[11] reported that the successful alignment rates of intermittent exotropia and constant exotropia were 88.2% and 42.9%. Currie *et al*[10] reported that the rate was 77% according to this criteria. The rate increased to 85% when the success was defined as within 15 PD. Some defined successful ocular alignment as within 8 PD (exo or eso). The success rates of X (T), constant exotropia with a previous history of X (T), and constant exotropia without a previous history of X (T) were 79%, 71%, and 67%, respectively[9]. The successful motor alignment rate was not only related to the criteria defined, but also related to the follow-up time and the preoperative deviation and so on. This study defined successful criteria as ≤10 PD, and the rates of group 1, group 2, and group 3 were 78%, 68%, and 64%, respectively, similar to the better surgical results reported by other studies above.

Strabismus surgery not only aims at improving the psychosocial function, but importantly aims at maintaining or improving stereopsis functions[13-15]. Opinions vary about the best timing for surgery, but the rationales for the debates focus on the purpose of preserving or achieving superior stereoacuity. Therefor evenly draw contrary theories. Abroms and associates[3] found that patients may achieve superior sensory result with ocular alignment before age 7, before 5 years of strabismus duration. But Hutchinson[16] found that patients may achieve bifixation more easily after age seven, after five years of strabismus duration. Some concerned that persistent overcorrections will lead to amblyopia and a loss of stereoacuity, so they against operate on visually immature patients at their early age[17]. Some favored surgery as soon as the deviation was apparent. While others reserved surgical intervention for obvious decompensation of control or constant deviation[3]. Lau *et al*[11] found that none of the patients with extra-large angle constant exotropia exhibited bifixation pre- and postoperatively. Wu *et al*[9] reported that no patients in the two constant exotropia groups achieved binocular functioning one year after operation even when surgically realigned, but the constant exotropia patients with a previously intermittent achieved a better postoperative outcome in gross stereopsis compared with those without a previous history of X (T). Near stereoacuity of X (T) patients and constant exotropia patients with a previous period of X (T) were significant improvement three months after surgery, but without improvement in distance stereoacuity[18]. Five long-standing constant exotropia patients with large-angle achieved stereopsis after surgery according to the report of Ball *et al*[6]. They all had a previous intermittence history. But a comparison in their study was scarce. Abroms *et al*[3] reported nine patients among 31 patients with constant exotropia achieved binocularity following strabismus surgery. Those who achieved binocular vision had shorter duration of strabismus, however, no statistical significance was reached. These results indicated that early surgeries were advocated for patients with constant exotropia, and those patients also could achieve stereoacuity. In this study, some patients in the two forms of constant exotropia groups achieved stereoacuity, but constant exotropia patients with a previous intermittence history had a better sensory result in gross stereopsis compared with those without a previous intermittence period, and a worse surgical sensory outcome than patients with X (T) in binocular function, gross stereopsis and distance stereoacuity. Constant exotropia patients may have missed the optimal time for treatment. The conclusion was similar to that of Wu *et al*[9]

reported. Different from the results of their study, some constant exotropia patients in this current study achieved bifixation and distant stereoacuity. Even early-onset constant exotropia patients whose postoperative sensory result were not poor[18]. But overall, the rate of regaining stereoacuity for patients with constant exotropia was low[9,19].

Some studies showed that the recovery of nearstereopsis was better than distant stereoacuity. This indicated that the recovery of stereopsis was from near to distant[5,8]. In the present study, the patient with normal distant stereopsis preoperative and postoperative was different. Patient with normal distant stereopsis preoperative lost fusion after surgery which may related to the earlier onset age and unsuccessful motor alignment (> 15 PD). Patient achieved distant stereopsis postoperatively whose onset age was 13 years, had a large range of fusion and successful realignment. This was consistent with the theory that successful motor alignment was the basis of achieving stereopsis[7,20,21]. However, the Yan's testing result of the patient was 800 arc of seconds, the Titmus testing result was 50 arc of seconds. The reasons for the different results are to be studied.

A major limitation of this present study is the limited number of patients. For a clearer understanding of the results, a larger patient group over a more long-term follow-up period study is necessary. However, our study demonstrates that constant exotropia patients, with or without a history of X (T), may achieve bifixation and distant stereopsis, and no statistical difference are found between the two types of constant exotropia patients, but a worse surgical outcome than X (T) patients in bifixation and distant stereopsis. The surgical outcome of gross stereopsis in constant exotropia patients with a intermittent period was better than that in those without a period of intermittence, but worse than that in patients with X (T). The surgical results indicated that constant exotropia patients with a history of intermittency may have missed the optimal time for treatment, early surgery can optimize the postoperative sensory outcomes.

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