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Original Article

Effect of minimally invasive strabismus surgery under a microscope on tear film function and ocular surface status in strabismus patients

Ruoxin Wang[1,2], Pan Li[1], Min Cai[1], Ying Zhi[1], Yanhong Li[1], Kexin Sang[1,2]

[1]*Department of Ophthalmology, Xi'an First Hospital, Xi'an 710002, Shaanxi, China;* [2]*Shaanxi Ophthalmological Institute, Xi'an 710002, Shaanxi, China*

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Abstract: Objective: To investigate the effects of minimally invasive strabismus surgery (MISS) on tear film function and ocular surface status in patients with strabismus. Methods: We respectively analyzed the clinical data from 173 cases of strabismus patients treated at Xi'an First Hospital from September 2021 to March 2024. The patients were classified into a minimally invasive group (n=91, undergoing MISS) and a conventional group (n=82, undergoing traditional strabismus correction) according to their treatment plans. The general data, treatment efficacy, tear film function, ocular surface status, perioperative indicators, pain, and visual recovery were compared between the two groups. Factors affecting the patients' postoperative recovery were further analyzed according to the treatment effects. Results: The clinical efficacy of the minimally invasive group (95.6%) was significantly higher than the conventional group (68.3%). Visual recovery of the minimally invasive group was also significantly better than the conventional group (*P<0.05*). The minimally invasive group showed superior tear film function and ocular surface health (*P<0.05*). The visual analog scale (VAS) scores for pain were significantly lower in the minimally invasive group at different postoperative time points (*all P<0.05*). Intraoperative blood loss was significantly lower in the minimally invasive group (*P<0.05*), but there was no significant difference in surgical time (*P>0.05*). Logistics analysis identified the tear secretion basal test (SIt), corneal fluorescein staining score (CFS), and treatment regimen as independent factors influencing postoperative recovery status. Conclusion: MISS effectively improves clinical outcomes in strabismus patients, preserves tear film function and ocular surface health, and promotes visual recovery. The SIt, CFS, and treatment regimen are independent factors affecting postoperative recovery in strabismus patients.

Keywords: Minimally invasive strabismus surgery, tear film function, ocular surface status, clinical efficacy, recovery

Introduction

Strabismus is a common ophthalmic condition characterized by the inability to align both eyes on the same target simultaneously, resulting in visual deviation [1]. The prevalence of strabismus is estimated to be between 2% and 4%. It is often associated with amblyopia and diplopia, which may occur independently or concurrently [2, 3]. Children are particularly susceptible to strabismus, as they are more sensitive to vision problems, such as visual deprivation and refractive errors [2]. Early detection and prompt treatment of strabismus in children are crucial to reduce the risk of secondary diplopia, loss of binocular vision, and limited binocular field of vision [4]. When strabismus occurs, the brain may suppress visual input from the strabismic eye to prevent diplopia and visual confusion. If this suppression persists, it may lead to loss of vision in the affected eye and the development of amblyopia [5]. In addition, people with strabismus often experience diplopia, where two overlapping images of the same object are formed on the retina. This occurs because the vision of the strabismic eye is not synchronized with the other eye, resulting in the two eyes receiving inconsistent visual information, seriously affecting the patients' quality of life [6, 7].

Surgical correction is the predominant treatment for strabismus, typically achieved through

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posterior reduction of the rectus muscle. Traditional strabismus correction treatments are usually performed under direct vision. While this provides a more intuitive intraoperative field of view, it may cause several postoperative problems, such as heavy bleeding, muscle suture reactions, poor incision healing, and conjunctival cysts, thereby increasing the risk of complications [8]. Due to individual differences, the rate of reoperation can be as high as about 40% [9]. In recent years, the advancement of microscopic minimally invasive techniques has revolutionized ophthalmic surgery, with microscope-assisted procedures becoming increasingly common in in strabismus correction. The use of microscopes in strabismus correction surgery has greatly improved the precision of the procedure. The magnification provided by the microscope allows surgeons to view the eye's microstructure more clearly, enabling smaller incisions and better positioning away from the corneal limbus, which minimizes postoperative complications [10, 11]. This not only improves the success rate of the surgery but also improves both the quality and safety the procedure, revolutionizing ophthalmic surgery. However, the effect of minimally invasive strabismus surgery (MISS) on restoration of tear film function and ocular surface health in patients with strabismus remains unclear. Given this, this study aimed to investigate the effects of MISS on tear film function and ocular surface status in strabismus patients.

Information and methodology

General information

One hundred and seventy-three cases (267 eyes) of strabismus patients admitted to Xi'an First Hospital from September 2021 to March 2024 were selected for this study. These patients were divided into a conventional group (n=82 cases, involving 125 eyes) that were treated with traditional strabismus correction, and a minimally invasive group (n=91 cases, involving 142 eyes) that were treated with MISS. The general data of patients in the two groups were collected and compared.

Inclusion and exclusion criteria

Inclusion criteria: (1) Patients diagnosed with strabismus through clinical testing, with a strabismus degree ≥20 Prism Diopter ($^{\Delta}$) as confirmed by the prism alternating cover test [12]; (2) Patients with surgical indications who underwent either traditional or minimally invasive strabismus correction at our hospital; (3) Patients with normal tear film function and ocular surface status; (4) Patients with complete clinical data. Exclusion criteria: (1) Dry eye disease or other ophthalmic diseases; (2) Autoimmune diseases, abnormal coagulation function, or mental illness; (3) Use of drugs affecting the tear film or tear fluid. The study was approved by and executed under the supervision of the Medical Ethics Committee of Xi'an First Hospital.

Methodology

Preoperative examination: Routine ophthalmologic tests, including strabismus, visual acuity, slit lamp examination, fundus evaluation, and lacrimal apparatus function were performed preoperatively for both groups. The extent of the surgery was determined based on the results of each test.

Surgical methods [13, 14]: All patients were given local anesthesia with 2% lidocaine, and the conventional group underwent conventional strabismus correction under naked eye visualization, using a corneal rim trapezoidal conjunctival flap incision. In the minimally invasive group, MISS was performed using Park's incision. The surgical approach consisted of rectus muscle retraction, shortening, displacement, and excision or partial excision of the oblique muscle, with scleral fixation of the folded or repositioned muscle using 6.0 polymyosin sutures, and fixation of the conjunctival flap using 8.0 polymyosin sutures. All patients were practiced according to the preoperatively designed surgical plan. Postoperatively, all patients received anti-inflammatory and anti-infective treatment to promote wound healing.

Main observation indicators

Tear film function assessment [13]: An ocular surface comprehensive analyzer was applied to record the time of first tear break up times (FTBUT), non-invasive tear meniscal height (NITMH), and tear secretion basal test (SIt) of patients in both groups on preoperative and postoperative days 1, 7, and 14, which were used to assess the tear film function.

Assessment of ocular surface status [15, 16]: The ocular surface status was assessed by the ocular redness score and corneal fluorescein staining score (CFS) of patients in the two groups on preoperative and postoperative days 1, 7, and 14. Redness score: the degree of redness was assessed using the comprehensive ocular surface analyzer in both groups, on a scale of 1 to 4, with 1 indicating normal, 2 indicating mild redness, 3 indicating moderate redness, and 4 indicating severe redness. CFS: fluorescein test strips were applied to the conjunctival sacs of the lower eyelid, and corneal epithelial staining was observed using cobalt blue light from the slit lamp. The staining was scored on a scale of 0 to 3, with 0 indicating no corneal epithelium staining, 1 indicating staining in less than 1/3 of the corneal epithelium, 2 indicating staining in less than 1/2 of the corneal epithelium, and 3 indicating staining in more than 1/2 of corneal epithelium. The lower the score, the better the treatment effect.

Secondary observation indicators

Pain assessment [17]: Visual analog scale (VAS) was used to subjectively evaluate the pain level of patients in two groups at postoperative 2 h, 1 d, 7 d, and 14 d. The VAS score ranges from 0 to 10, with higher scores indicating more severe pain.

Visual recovery assessment: Visual recovery was examined by a synoptophore at 30 d postoperatively. Class I: Normal convergence point, ranging from -3° to +3°, and outside this range indicating an abnormal convergence point; Class II, convergence within the normal range, but horizontal convergence from -4° to +15°, and outside or below this range indicating an abnormal convergence or no convergence; Class III, the normal range was the same as the range of class I. A higher class indicates poorer visual recovery. Class I and II were regarded as obvious visual recovery, while Class III was considered as inconspicuous visual recovery.

Perioperative indicators: Perioperative indicators, including operation time and intraoperative blood loss, were recorded for both groups.

Criteria for assessing efficacy [18]

The clinical efficacy of the two groups was assessed on day 28 post-surgery based on the correction of the eye position. Excellence: the eye position was corrected immediately after surgery, and the degree of strabismus was $\leq\pm10^{\Delta}$ as measured by prism examination; Effective: the postoperative eye position showed significant improvement compared with the preoperative examination, with strabismus degrees between $\pm10^{\Delta}<$ strabismus $\leq\pm20^{\Delta}$ after prism examination; Invalid: there was no significant improvement compared with the preoperative position in eye position, and the degree of strabismus was $>\pm20^{\Delta}$ by prism examination, indicating the correction did not meet the above standards. The total effective rate = (Excellence + effective) number of cases/total number of cases × 100%.

Logistic analysis of the relationship between different indicators and poor recovery in patients with strabismus

According to the efficacy assessment criteria, the two groups of patients were reclassified into an effective group (30 cases) and an ineffective group (143 cases). The relationship between baseline data, tear film function, ocular surface status, perioperative period and treatment method of the two groups and the patients' poor postoperative recovery were analyzed by logistic regression analysis, and the risk factors affecting the patients' poor recovery were identified.

Statistical analysis

Data were analyzed using GraphPad 7. Measurement data were expressed as mean ± standard deviation (Mean ± SD), and comparisons between groups were made using independent samples t-test. Comparisons between multiple groups were analyzed using one-way ANOVA. Pairwise comparisons were performed using the LSD-t test, and multiple time point expressions were used repeated measures ANOVA. Bonferroni was used for post inspection. Statistical differences were indicated when $P<0.05$.

Results

Comparison of general data between the two groups of patients

There were no significant differences in age, sex, type of strabismus, affected eye(s), or

Table 1. Comparison of baseline data between the two groups of patients

		Conventional group (n=82)	Minimally invasive group (n=91)	t/χ^2 value	*P* value
Age (yrs. $\overline{X}\pm s$)		33.43±16.64	30.13±15.12	-0.742	0.459
Sex [cases (%)]	Male	39 (47.6)	48 (52.7)	0.464	0.496
	Female	43 (52.4)	43 (47.3)		
Type of Strabismus [cases (%)]	Esotropia	40 (48.8)	42 (46.2)	0.119	0.730
	Exotropia	42 (51.2)	49 (53.8)		
Affected eyes [cases (%)]	Bilateral	43 (52.4)	51 (56.0)	0.226	0.635
	Unilateral	39 (47.6)	40 (44.0)		
Degrees of strabismus ($^{\Delta}$)		67.15±20.72	61.12±23.49	-1.777	0.076

Note: Strabismus degree measured based on prism, representing the angle at which the eye of sight deviates from normal, in units of delta ($^{\Delta}$).

degree of strabismus between the two groups (*P>0.05*) (**Table 1**).

Comparison of tear film function between the two groups of patients

Comparing the recovery of tear film function between the two groups, it was found that FTBUT (6.08s *vs.* 4.94s; 7.99s *vs.* 6.98s; and 10.21s *vs.* 9.73s) and SIt (4.96 mm/5 min *vs.* 3.05 mm/5 min; 7.79 mm/5 min *vs.* 5.99 mm/5 min; and 10.88 mm/5 min *vs.* 7.91 mm/5 min) in the minimally invasive group were significantly higher than those in the conventional group at 1 d, 7 d, and 14 d postoperatively (*all P<0.05*); however, there were no significant difference before treatment (4.87s *vs.* 4.66s; 3.19 mm/5 min *vs.* 3.10 mm/5 min) (*P>0.05*) (**Figure 1A**, **1C**). NITMH (0.20 mm *vs.* 0.15 mm; and 0.35 mm vs. 0.25 mm, respectively) in the minimally invasive group was higher than that in the conventional group at 1 d and 7 d postoperatively (*P<0.05*), and there was no significant difference before treatment and at 14 d postoperatively (0.15 mm *vs.* 0.14 mm; 0.43 mm *vs.* 0.42 mm) (*P>0.05*) (**Figure 1B**).

Comparison of ocular surface status between the two groups of patients

Comparing the ocular surface status of the two groups, it was found that the CFS (1.79 mm *vs.* 1.93 mm; 1.04 mm vs. 1.59 mm; and 0.73 mm vs. 0.89 mm) in the minimally invasive group were significantly lower than those in the conventional group at 1 d, 7 d, and 14 d postoperatively (*P<0.05*), and there was no significant difference before treatment (2.27 mm vs. 2.15 mm) (*P>0.05*) (**Figure 1D**). Ocular redness score (3.01 *vs.* 3.62; 1.98 vs. 2.73) of the minimally invasive group showed significantly lower scores than those in the conventional group at 1 d and 7 d postoperatively (*P<0.05*), but there was no significant difference at 14 d (1.13 *vs.* 1.27) (*P>0.05*) (**Figure 1E**).

Comparison of postoperative visual recovery between the two groups of patients

The postoperative visual recovery rate was significantly higher in the minimally invasive group (88 cases, 96.7%) than that in the conventional group (60 cases, 73.2%) (*P<0.05*) (**Table 2**).

Comparison of postoperative pain between the two groups of patients

The VAS scores of the minimally invasive group (5.97, 4.88 and 1.92) were significantly lower than those of the conventional group (7.00, 6.02 and 2.89) at 2 h, 1 d, and 7 d postoperatively (*P<0.05*), but there was no significant difference at 14 d (0.99 *vs.* 1.04) (*P>0.05*) (**Figure 2A**).

Comparison of perioperative indicators between the two groups of patients

There was no significant difference in the operation time between the two groups (35.54 min *vs.* 35.03 min) (*P>0.05*). However, the minimally invasive group had significantly less intraoperative blood loss (7.10 mL) compared to the conventional group (12.09 mL) (*P<0.05*) (**Figure 2B**, **2C**).

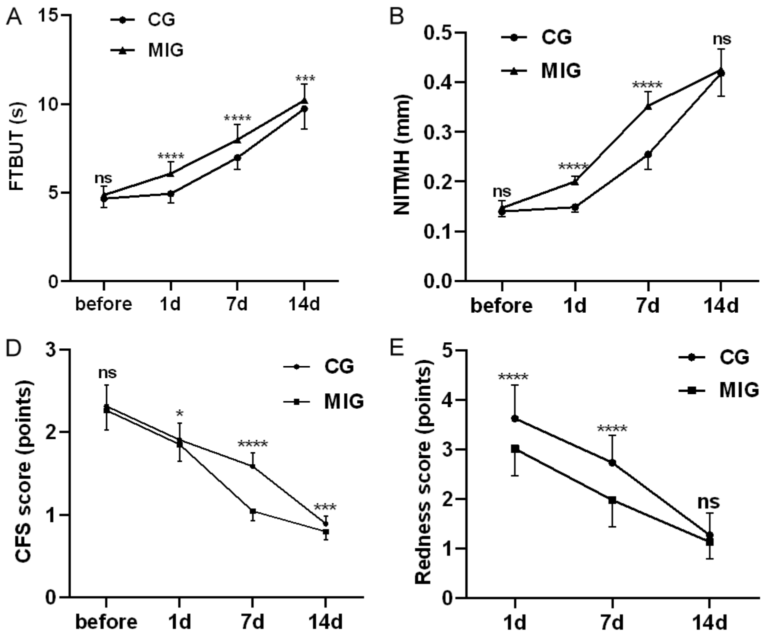

Figure 1. Comparison of tear film function and ocular surface status between the two groups before and 1 d, 7 d, and 14 d after surgery. Note: A: Comparison of first tear break up times (FTBUT); B: Comparison of non-invasive tear meniscal heights (NTMH); C: Comparison of tear secretion basal test (SIt); D: Comparison of corneal fluorescein staining (CFS) scores; E: Comparison of ocular redness scores. nsP>0.05, *P<0.05, **P<0.01, ***P<0.001, ****P<0.0001.

Table 2. Comparison of postoperative visual recovery between two groups of patients

	Class I	Class II	Class III	Visual recovery
Conventional group (n=82)	27 (32.9)	33 (40.3)	22 (26.8)	60 (73.2)
Minimally invasive group (n=91)	51 (56.0)	37 (40.7)	3 (3.3)	88 (96.7)
t/χ^2 value				19.320
P value				<0.001

Comparison of clinical efficacy between the two groups of patients

The total effective rate in the minimally invasive group (95.6%) was significantly higher than that in the conventional group (68.3%) (*P<0.05*) (**Table 3**).

Logistics regression analysis of risk factors for poor recovery in patients

General data analysis of patients with different recovery conditions: All patients were divided into effective and ineffective groups according to the clinical effect, including 143 patients in the effective group and 30 patients in the ineffective group. No significant difference were found between the groups in terms of age, sex, type of strabismus, affected eyes, FTBUT, NITMH, and Surgical time (all P>0.05). However, the degree of strabismus (61.31$^{\Delta}$ *vs.* 76.72$^{\Delta}$), blood loss (9.17 ml vs. 10.83 ml) and CFS (2.15 mm *vs.* 2.50 mm) in the effective group were significantly lower than those in the ineffective group, and the SIt (3.18 mm/5 min *vs.* 2.87 mm/5 min) was higher than the ineffective group. In addition, the two groups showed statistically significant differences in visual recovery and treatment method (P<0.05) (**Table 4**).

Univariate analysis of factors affecting patient recovery: Univariate analysis revealed that the degree of strabismus (OR=0.981, *P=0.041*), SIt (OR=2.221, *P=0.044*), CFS (OR=0.172, *P<0.001*), blood loss (OR=0.905, P=0.041), and treatment regimen (OR=0.099, *P<0.001*) were significantly associated with poor postoperative recovery (**Table 5**).

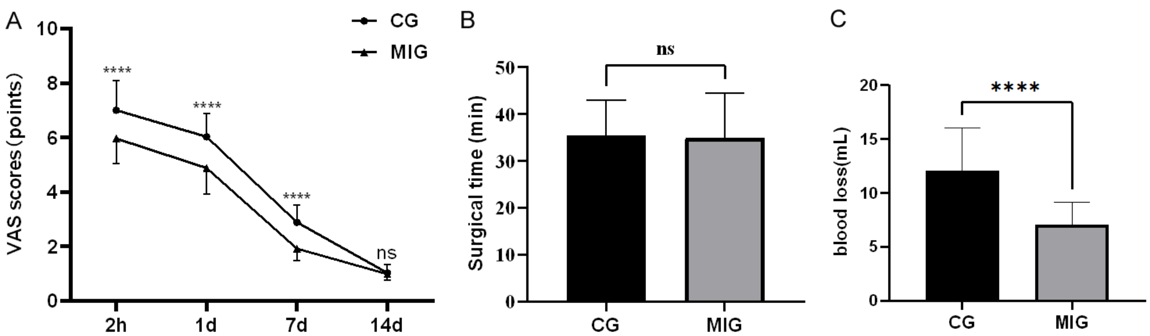

Figure 2. Comparison of VAS scores and perioperative indicators between the two groups of patients. Note: A: Comparison of Visual analog scale (VAS) at 2 h, 1 d, 7 d, and 14 d postoperatively; B: Comparison of perioperative surgical time; C: Comparison of perioperative blood loss. NsP>0.05, ****P<0.0001.

Table 3. Comparison of clinical outcomes between the two groups

	Excellent	Effective	Invalid	Total effective rate (%)
Conventional group (n=82)	31 (37.8)	25 (30.5)	26 (31.7)	56 (68.3)
Minimally invasive group (n=91)	57 (62.6)	30 (33.0)	4 (4.4)	87 (95.6)
t/χ^2 value				22.45
P value				<0.001

Table 4. Comparison of baseline data between patients with different effectiveness

		Effective group (n=143)	Ineffective group (n=30)	t/χ^2 value	*P* value
Age (yrs. $\bar{X}$±s)		32.04±15.39	30.07±18.32	0.972	0.332
Sex [cases (%)]	Male	74 (0.52)	13 (0.43)	0.702	0.402
	Female	69 (0.48)	17 (0.57)		
Type of strabismus [cases (%)]	Esotropia	67 (0.47)	15 (0.5)	0.098	0.754
	Exotropia	76 (0.53)	15 (0.5)		
Affected eyes [cases (%)]	Bilateral	77 (0.54)	17 (0.57)	0.080	0.778
	Unilateral	66 (0.46)	13 (0.43)		
Degrees of strabismus ($^{\Delta}$)		61.31±22.34	76.72±17.85	-2.011	0.045
Tear film function	FTBUT (s)	4.77±0.58	4.63±0.56	0.806	0.341
	NITMH (mm)	0.14±0.02	0.14±0.02	0.104	0.917
	SIt (mm/5 min)	3.18±0.50	2.87±0.52	2.013	0.044
Ocular surface status	CFS (points)	2.15±0.36	2.50±0.51	-3.037	<0.001
Visual recovery	Conspicuous	141 (0.99)	7 (0.03)	113.638	<0.001
	Inconspicuous	2 (0.01)	23 (0.97)		
Perioperative indicators	Surgical Time (min)	35.20±9.11	35.63±5.29	-0.356	0.723
	Blood loss (ml)	9.17±4.00	10.83±3.66	-2.446	0.014
Treatment	Legacy	87 (0.61)	4 (0.13)	22.446	<0.001
	Minimally invasive	56 (0.39)	26 (0.87)		

Note: Strabismus degree measured based on prism, representing the angle at which the eye of sight deviates from normal, in units of delta ($^{\Delta}$). FTBUT: first tear break up times; NITMH: non-invasive tear meniscal height; SIt: tear secretion basal test; CFS: corneal fluorescein staining score.

Multifactorial analysis of factors affecting patient recovery: The degree of strabismus, SIt, CFS, Blood loss, and treatment were included in the multivariate Logistics regression analysis. The results showed that the SIt (OR=3.642, *P=0.010*), CFS (OR=0.141, *P<0.001*), and treat-

Table 5. Univariate analysis of factors affecting patients' postoperative recovery indicators

Factors	β	S.E.	P	OR	95% CI
Age	0.008	0.013	0.537	1.008	0.983-1.034
Sexes	0.338	0.405	0.403	1.402	0.637-3.150
Types of Strabismus	-0.126	0.402	0.754	0.882	0.399-1.949
Affected eyes	-0.114	0.405	0.778	0.892	0.397-1.966
Degrees of strabismus	-0.019	0.010	0.041	0.981	0.962-0.999
FTBUT	0.408	0.347	0.240	1.503	0.760-2.982
NITMH	-0.811	0.882	0.358	0.444	0.059-2.206
SIt	0.798	0.396	0.044	2.221	1.028-4.903
CFS	-1.759	0.435	<0.001	0.172	0.072-0.403
Surgical time	-0.006	0.024	0.799	0.994	0.949-1.041
Blood loss	-0.099	0.049	0.041	0.905	0.822-0.996
Treatment	-2.312	0.564	<0.001	0.099	0.028-0.271

Note: FTBUT: first tear break up times; NITRH: non-invasive tear meniscal height; SIt: tear secretion basal test; CFS: corneal fluorescein staining score.

Table 6. Multifactorial analysis of indicators affecting patients' postoperative recovery

Factor	β	S.E.	P	OR	95% CI
Degrees of strabismus	-0.021	0.012	0.082	0.979	0.954-1.002
SIt	1.293	0.500	0.010	3.642	1.411-10.185
CFS	-1.958	0.521	<0.001	0.141	0.048-0.382
Blood loss	0.067	0.067	0.314	1.070	0.940-1.226
Treatment	-2.660	0.689	<0.001	0.070	0.016-0.248

Note: SIt: tear secretion basal test; CFS: corneal fluorescein staining score.

ment method (OR=0.070, $P<0.001$) were independent factors influencing patient's postoperative recovery (**Table 6**).

Discussion

Strabismus is a condition characterized by misalignment of the eyes, commonly presenting as inward or outward deviation, and less frequently as upward or downward deviation. While strabismus is most commonly seen in children, it can also affect individuals in other age groups [19]. In addition to causing vision problems, strabismus may lead to social anxiety and self-consciousness problems, with profound effects on the patient's visual health and psychological well-being [20-22]. Mild strabismus may recover through ophthalmic follow-up care. For patients with moderate to severe strabismus, non-surgical treatment, such as prism glasses, super-negative lenses, atropine drops, or ocular intramuscular injections of Botulinum toxin are options. Surgical interventions, including conventional corrective surgery, adjustable suture surgery, and minimally invasive surgery, are commonly used to correct strabismus [19, 23, 24]. It has been demonstrated that minimally invasive techniques can significantly accelerate postoperative recovery by reducing the size of surgical incision, minimizing tissue destruction, and positioning the incision away from the corneal limbus [10, 13, 25].

In this study, the clinical outcome of patients in the minimally invasive group (95.6%) was significantly higher than that of the conventional group (68.3%). Patients who underwent MISS had better postoperative pain levels, perioperative indicators, postoperative recovery of tear film function, and ocular surface status than those who underwent conventional strabismus correction. Minimally invasive surgery has demonstrated distinct advantages in the treatment of strabismus, and these advantages are better realized, especially when assisted by the use of a microscope. The clear field of view provided by the microscope allows for more precise incisions and maneuvers to avoid important blood vessels, making the surgery less invasive and thus significantly reducing intraoperative bleeding and postoperative pain and speeding up the recovery process. The magnification function of the microscope allows the surgeon to recognize anatomical structures more clearly and perform more precise muscle ticking and separation, which not only improves surgical precision but also enhances the cure rate [18]. Li et al. found that the improved Parks incision significantly reduced surgical disruption of the aqueous and mucus layers of the tear film and reduced irritation of the ocular surface, thus reducing postoperative conjunctival scarring, nerve damage, and enhancing postoperative stability of the tear film and ocular surface [9]. However, some studies have shown that there is no significant difference in postoperative complications between microscopic strabismus correction with Parks' incision versus a corneal rim incision, although the former does provide better conjunctival protection [26, 27]. In addition, one key advantage of MISS is the ability to make a small, hidden incision that does not affect facial appearance with almost no trace after healing, which meets the patients' aesthetic expectations for postoperative appearance [14]. These combined advantages make MISS a safe, effective, and aesthetically pleasing treatment option for strabismus, which is expected to be an alternative to conventional strabismus correction.

We further investigated the independent prognostic factors influencing recovery outcomes in patients following strabismus correction. The logistic regression analysis identified SIt, CFS, and treatment methods as independent factors influencing the recovery of patients after strabismus correction. Both SIt and CFS reflect the tear film function and ocular surface status of patients, suggesting that those with better initial tear film function and ocular surface status can experience faster recovery following MISS. Meanwhile, treatment method also significantly affects the patient' postoperative healing process. MISS is more favorable to the patient's postoperative recovery, which is related to the less invasive nature of the minimally invasive surgery and the use of precise incision method. Li et al. found that MISS with modified Park incision improved perioperative indicators, tear film function, and satisfaction and reduced the rate of complications in children, and it is an alternative to conventional treatment for children with external strabismus [9]. Similarly, studies by Parveen et al. [14] and Saxena et al. [28] confirmed that MISS provided better patient comfort, superior aesthetic outcome, and reduced congestion, foreign body sensation, and inflammation.

For the first time, we explored the effects of MISS on patients' tear film function and ocular surface status, and further investigated the factors affecting patients' visual recovery. Still, there are some limitations to this study, such as limited sample size and relatively short follow-up time. Future studies may expand the sample size and extend the follow-up time to further validate the long-term effects and safety of MISS. In addition, an in-depth investigation of the long-term effects of MISS on patients' quality of life and its application in patients with strabismus of different age groups is also worth studying.

Conclusions

MISS is highly effective in treating strabismus, reducing patients' postoperative pain, decreasing the amount of intraoperative hemorrhage, and complication rates, and significantly improving patients' tear film function and ocular surface status, contributing to enhanced overall treatment efficacy. SIt, CFS, and treatment method are independent factors affecting patients' postoperative recovery, providing valuable insights for future treatment of strabismus in the clinical setting.

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Disclosure of conflict of interest

None.

Address correspondence to: Kexin Sang, Department of Ophthalmology, Xi'an First Hospital, No. 30 Fenxiang, Nandajie Street, Beilin District, Xi'an 710-002, Shaanxi, China. E-mail: m18509263902_1@163.com

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