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Original Article

Effect of adjunctive Xueshuantong capsules on postoperative macular thickness and visual recovery in elderly patients undergoing cataract surgery: a randomized controlled trial

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Abstract: Objective: To assess the effect of adjunctive Xueshuantong capsules on macular thickness and visual recovery in elderly patients after cataract surgery. Methods: A total of 106 elderly patients undergoing phacoemulsification at the First Affiliated Hospital of Nanchang University between November 2024 and November 2025 were enrolled. Among them, 99 completed the study, including 49 in the observation group and 50 in the control group. Both groups received standard postoperative care, and the observation group additionally received Xueshuantong capsules for 3 months. Visual function, ocular surface parameters, quality of life, oxidative stress, and inflammatory markers were assessed at baseline and at 1 and 3 months. Clinical efficacy and adverse events were also compared between groups at 3 months. Results: Over time, both groups showed decreases in intraocular pressure (IOP), central macular thickness (CMT), corneal fluorescein staining (FL), malondialdehyde (MDA), inflammatory markers, and Ocular Surface Disease Index (OSDI) scores, and increases in best-corrected visual acuity (BCVA), tear breakup time (TBUT), Schirmer I test (SIT), glutathione peroxidase (GSH-Px), superoxide dismutase (SOD), and National Eye Institute Visual Functioning Questionnaire-25 (NEI-VFQ-25) scores (all $P < 0.05$). At 3 months, the observation group had higher BCVA, TBUT, SIT, GSH-Px, SOD, and NEI-VFQ-25 scores and lower IOP, CMT, FL, MDA, inflammatory markers, and OSDI scores than the control group (all $P < 0.05$). The clinical efficacy was higher in the observation group ($P < 0.05$), with similar adverse events between the two groups ($P > 0.05$). Conclusion: Adjunctive Xueshuantong capsules improve visual recovery, macular thickness, ocular surface function, and quality of life, and modulates oxidative stress and inflammation with favorable safety.

Keywords: Xueshuantong capsule, senile cataract, macular thickness, visual function, Panax notoginseng saponins

Introduction

Cataracts are the leading cause of blindness worldwide and they predominantly affect older adults. Cataracts are characterized by lens opacification and progressive vision loss [1]. As the population ages, the prevalence of cataracts continues to rise, threatening the eye health of middle-aged and older people [2]. Surgery is currently the primary treatment for cataracts. Due to a small incision and rapid visual recovery, phacoemulsification has become the procedure of choice for most patients [3]. However, as an invasive procedure, surgery inevitably triggers a series of physiological responses. Corneal incisions and intraoperative irrigation fluid can disrupt the blood-aqueous barrier and easily induce an intraocular inflammatory response. Because most cataract patients are elderly individuals with weaker immunity and slower tissue repair, they are at a much higher risk of postoperative complications, including ocular inflammation, infection, macular edema and dry eye [4, 5]. Postoperative macular edema, a major cause of poor visual recovery after cataract surgery, can blur

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vision, impair the quality of daily life, and significantly reduce patient satisfaction with the surgical outcome [6]. Therefore, proper postoperative care for elderly cataract patients can help improve visual recovery and better control postoperative complications.

Eye drops are currently the most common choice for postoperative care after cataract surgery, and doctors usually prescribe steroid eye drops such as dexamethasone or nonsteroidal anti-inflammatory eye drops such as pranoprofen [7]. However, these drugs have a single mechanism of action and cannot address all the ocular problems that occur after surgery. Combining routine medications with drugs that have multiple effects may therefore help patients recover better, and these multi-effect drugs can also improve ocular blood flow and alleviate inflammation. Xueshuantong capsules are a traditional Chinese patent medicine made from total saponins of Panax *notoginseng*, and they have long been used to promote blood flow, remove blood stasis, unblock meridians, and reduce swelling [8]. Previous studies have shown that Xueshuantong capsules exert effects beyond improving blood flow, including anti-inflammatory, antioxidant, and neuroprotective effects [9, 10]. Early ophthalmic studies have also suggested that Xueshuantong capsules may help resolve various vascular and inflammatory disorders of the eye, which has laid a foundation for further research [11, 12]. However, current evidence on the use of Xueshuantong capsules as an adjunctive treatment in elderly patients after cataract surgery is insufficient, and high-quality experimental studies are lacking. Therefore, the effectiveness in improving ocular surface health, enhancing vision, and regulating macular thickness remains incompletely understood.

Based on these considerations, we designed this randomized controlled trial to determine whether adjunctive Xueshuantong capsules could help elderly cataract patients recover better after surgery. We specifically focused on macular thickness, visual recovery, and ocular surface function, which are particularly important for postoperative recovery. This study aimed to help patients achieve better recovery through evidence-based treatment and to improve the level of postoperative care.

Materials and methods

Case selection

We prospectively enrolled elderly patients who underwent phacoemulsification cataract surgery at the First Affiliated Hospital of Nanchang University between November 2024 and November 2025. In this randomized controlled trial, patients were assigned to the control group or the observation group in a 1:1 ratio. The sample size was calculated using the formula from Methods of Medical Research [13]: $n=(Z\alpha+Z\beta)^2\pi_0(1-\pi_0)/\sigma^2$, where $\sigma=(\pi-\pi_0)$, π is the effectiveness coefficient in the observation group, π_0 is the effectiveness coefficient in the control group, $\alpha=0.05$, and $\beta=0.1$. From the corresponding tables, $Z\alpha=1.9609$ and $Z\beta=1.2816$ were obtained. Preliminary experiments yielded $\pi=91.60\%$ and $\pi_0=69.20\%$. The calculated sample size was 45 patients per group. To account for a 10% dropout rate during follow-up, the study planned to recruit 100 participants. Ultimately, 106 patients were enrolled. With SPSS 27.0, a random number table was generated, and the 106 patients were allocated to the control group and the observation group in the order of enrollment, with 53 patients in each group. During the study period, four patients in the observation group withdrew: one was lost to follow-up, two discontinued treatment because of other serious illnesses, and one withdrew voluntarily. Three patients in the control group dropped out: two had poor compliance and one was lost to follow-up. Ultimately, 99 patients completed the trial, including 50 in the control group and 49 in the observation group. This study was approved by the Ethics Committee of the First Affiliated Hospital of Nanchang University (approval number: IIT [2024] Clinical Review No. 625) and complied with the ethical standards of the Declaration of Helsinki.

Diagnostic criteria

According to the Chinese *Adult Cataract Surgery Guidelines,* the diagnostic criteria for cataracts were as follows [14]: (1) painless, progressive vision loss and/or visual quality complaints such as glare, double vision, or reduced color saturation; (2) lens opacity observed by slit-lamp microscopy; (3) decreased

best-corrected visual acuity (BCVA) and/or abnormal functional visual indicators such as contrast sensitivity; and (4) exclusion of other ocular pathologies causing visual impairment, such as glaucoma, macular degeneration, diabetic retinopathy, or optic nerve diseases, by comprehensive ocular examination.

Criteria for inclusion

(1) Aged 65 years or older; (2) met the diagnostic criteria for cataract; (3) first-time occurrence and unilateral involvement; (4) met the indications for phacoemulsification and successfully underwent the surgery at our hospital; (5) no use of immunosuppressants, nonsteroidal anti-inflammatory drugs, or similar medications within 2 months before enrollment; and (6) normal cognitive and communication abilities. All patients and their families signed informed consent forms after being informed about the study.

Criteria for exclusion

(1) Vision loss due to other causes; (2) concomitant ocular diseases such as glaucoma or keratitis; (3) concurrent malignant tumors; (4) concurrent dysfunction of essential systems such as the kidneys or heart; (5) concurrent immune system disorders, coagulation disorders, acute or chronic infections, or psychiatric disorders; (6) allergy to the study drugs.

Dropout and termination criteria

(1) Lost to follow-up; (2) poor compliance and inability to cooperate with the study; (3) voluntary withdrawal; (4) serious adverse reactions or other serious illnesses during the study period.

Methods of treatment

On the first postoperative day, the control group received standard postoperative care, including tobramycin-dexamethasone eye drops (Qilu Pharmaceutical Co., Ltd., National Drug Approval No. H20020497, Specification: 5 ml), 1-2 drops per instillation, 6 times daily, with the frequency gradually reduced every 2 weeks, and pranoprofen eye drops (Guangdong Zhongsheng Pharmaceutical Co., Ltd., National Drug Approval No. H20133099, Specification: 0.1%), 1-2 drops, 4 times daily. The observation group additionally received Xueshuantong capsules (Harbin Zhenbao Pharmaceutical Co., Ltd., National Drug Approval No. Z20025972, Specification: 0.18 g per capsule), one capsule orally 3 times daily, starting on the first postoperative day. Both groups received treatment for 3 months.

Follow-up

Follow-up was conducted through scheduled outpatient visits and telephone communication. All patients were required to attend outpatient follow-up visits at 1 and 3 months after treatment. Telephone follow-ups were conducted in parallel to collect outcome data and information on adverse events during the study period.

Blinding

Because of the oral administration of Xueshuantong capsules, patients and treating physicians could not be blinded to treatment allocation. However, all outcome assessors who evaluated clinical efficacy, visual function, and ocular surface parameters were blinded to group allocation. Efficacy evaluation was performed by independent ophthalmologists who were not involved in patient enrollment or treatment administration.

Observation indicators

Primary endpoints: (1) Clinical efficacy. Clinical efficacy was evaluated at 3 months after treatment according to the *Clinical Disease Diagnosis and Efficacy Assessment Criteria* [15]. Marked improvement: resolution of ocular discomfort symptoms (photophobia, foreign body sensation, stinging); Ocular Surface Disease Index (OSDI) score reduced by ≥ 50% from baseline; Schirmer I test (SIT) value > 10 mm/5 min; tear breakup time (TBUT) significantly prolonged to > 10 s; corneal fluorescein staining (FL) score reduced by ≥ 50% or to 0; and reduced ocular surface damage on slit-lamp examination. Effective: significant reduction in ocular discomfort; OSDI score reduced by ≥ 20% but < 50% from baseline; SIT ≥ 8 mm/5 min; TBUT 5-10 s and prolonged by ≥ 2 s from baseline; FL score reduced by ≥ 1 point but < 50%; and improvement in ocular surface damage on slit-lamp examination. Ineffective: no improvement in ocular discom-

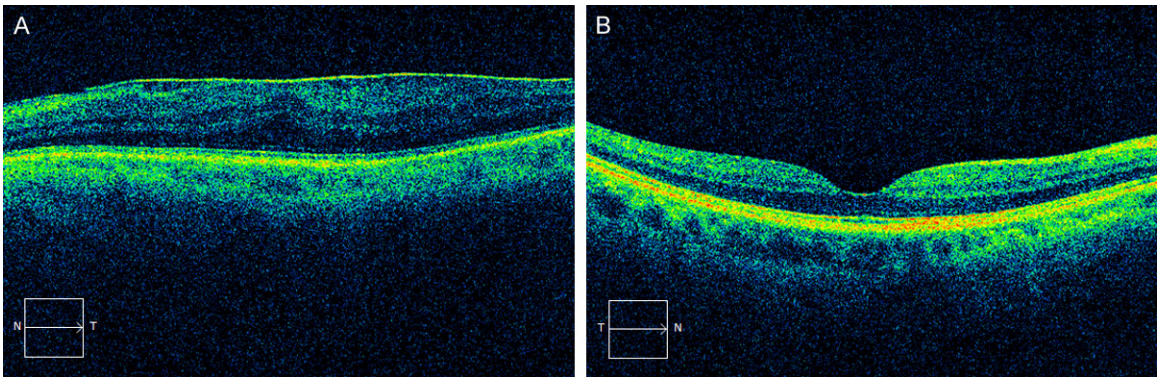


Figure 1. Representative CMT images. A. Increased CMT (416 μm) with loss of the foveal contour. B. Normal foveal contour with normal CMT (238 μm). CMT, central macular thickness.

fort symptoms, no improvement in SIT or TBUT compared with pre-treatment values, and no improvement in ocular surface damage on slit-lamp examination. The overall effective rate was calculated as the number of patients with marked improvement or effective outcomes divided by the total number of patients × 100%.

(2) Visual Function Indicators: Central macular thickness (CMT), best corrected visual acuity (BCVA), intraocular pressure (IOP) function were measured in both groups before treatment and at 1 and 3 months after treatment. CMT was measured using an optical coherence tomography scanner (Optovue, Inc., RTVue-100-2), scanning a 6 mm × 6 mm square area centered on the fovea centralis. BCVA was measured using the International Standard Logarithmic Visual Acuity Chart. IOP was measured using a non-contact tonometer (Nidek Medical Instruments, NT-510/530). **Figure 1** displays representative CMT images from the two groups.

Secondary endpoints: (1) General information. Demographic and clinical data were collected at admission, including sex, age, disease duration, body mass index (BMI), affected eye, diabetes, hypertension, smoking, and alcohol consumption.

(2) Ocular surface parameters. TBUT, SIT, and FL were measured in both groups before treatment and at 1 and 3 months after treatment. TBUT: a 1% potassium fluorescein solution was instilled into the lower conjunctival sac, and the patient was asked to blink three to five times. The tear film was examined under a slit lamp with cobalt blue light, and the time from the last blink to the appearance of the first dark spot on the cornea was recorded with a stopwatch. SIT: the Schirmer I test was used to measure tear production. One end of a 5 mm × 35 mm strip of filter paper was folded 5 mm and placed in the lower conjunctival sac. After the patient kept the eyes closed for 5 minutes, the wetted length of the strip was measured. FL: after the TBUT examination, fluorescein staining in the four corneal quadrants (superior nasal, inferior nasal, superior temporal, and inferior temporal) was assessed under a slit-lamp microscope with cobalt blue light. The scoring criteria were as follows: 0, no fluorescein staining; 1, punctate fluorescein staining; 2, patchy fluorescein staining; and 3, massive fluorescein staining, giving a total score of 0-12 for the four quadrants.

(3) Quality of life scores and ocular symptoms. The OSDI was used to assess ocular symptoms [16], and the National Eye Institute Visual Functioning Questionnaire-25 (NEI-VFQ-25) was used to assess quality of life [17]. Both questionnaires were administered by independent research assistants in a quiet environment, and patients completed them independently without assistance. The Chinese version of the OSDI has demonstrated good reliability and validity in previous studies [18]. It comprises 12 items assessing common ocular discomforts, including dryness, photophobia, discomfort, and burning sensations. Each item is scored by symptom frequency on a scale from 0 (“never”) to 4 (“all the time”), with higher scores indicating more severe symptoms. The Chinese version of the NEI-VFQ-25 has been validated in Chinese patients with ocular disor-

ders [17]. It comprises 25 items covering three domains: visual impairment, general health status, and mobility impairment. Each domain is scored from 0 to 100, with higher scores indicating better quality of life.

(4) Oxidative stress markers. Serum levels of glutathione peroxidase (GSH-Px), superoxide dismutase (SOD), and malondialdehyde (MDA) were measured before treatment and at 1 and 3 months after treatment. For each test, 3-5 mL of fasting venous blood was collected in the morning. Blood samples were centrifuged at 3,000 rpm for 15 minutes to separate serum, which was then stored at -20°C until analysis. Serum SOD, MDA, and GSH-Px levels were measured by enzyme-linked immunosorbent assay (ELISA) using kits supplied by Shanghai Keaibo Biotechnology Co., Ltd.

(5) Inflammatory markers. Serum levels of C-reactive protein (CRP), tumor necrosis factor-α (TNF-α), and interleukin-6 (IL-6) were measured at the same time points using the same ELISA method and kits (Shanghai Keaibo Biotechnology Co., Ltd.).

(6) Adverse events. Adverse events, including nausea, vomiting, rash, subconjunctival hemorrhage, and eye pain, were recorded in both groups during the study period. The incidence of adverse events was calculated as the number of patients with adverse events divided by the total number of patients × 100%.

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics 27.0 (IBM Corp., Armonk, NY, USA), and GraphPad Prism 10.1.2 was used for data visualization. Baseline characteristics were compared between groups using the chi-square test for categorical variables and independent-sample t-tests for continuous variables. Visual function indicators (IOP, BCVA, CMT), ocular surface parameters (TBUT, SIT, FL), oxidative stress markers (SOD, MDA, GSH-Px), inflammatory markers (CRP, TNF-α, IL-6), and questionnaire scores (OSDI, NEI-VFQ-25) were analyzed as follows: within-group changes across the three time points (baseline, 1 month, and 3 months) were assessed using paired-sample t-tests, and between-group comparisons at each time point were performed using independent-sample t-tests. Clinical efficacy was compared between groups using the chi-square test. Adverse event rates were compared using the chi-square test or Fisher's exact test, as appropriate. Continuous variables are presented as mean ± standard deviation, and categorical variables as frequencies (percentages). A two-tailed *P*-value < 0.05 was considered statistically significant. Given the exploratory nature of this study, no adjustments for multiple comparisons (e.g., Bonferroni correction) were applied; therefore, the reported *P*-values are uncorrected and should be interpreted with caution.

Results

Comparison of general data

As shown in **Table 1**, the two groups were well matched at baseline, with no significant differences in general characteristics (all $P > 0.05$).

Comparison of visual function indicators

Before treatment, IOP was 21.33±2.00 mmHg in the observation group and 21.28±1.97 mmHg in the control group ($P > 0.05$). BCVA was 0.30±0.05 and 0.31±0.06, respectively ($P > 0.05$), and CMT was 365.32±55.46 μm and 363.88±58.49 μm, respectively ($P > 0.05$). Over the treatment period, IOP and CMT decreased and BCVA increased in both groups (all $P < 0.05$). At 1 month, no significant differences were found between the two groups in any of these measures ($P > 0.05$). At 3 months, the observation group exhibited significantly higher BCVA and lower IOP and CMT than the control group (all $P < 0.05$), as shown in **Figure 2**.

Comparison of ocular surface parameters

Before treatment, TBUT was 4.67±1.12 s in the observation group and 4.75±1.20 s in the control group ($P > 0.05$). SIT was 6.10±1.09 mm/5 min and 6.08±1.13 mm/5 min, respectively ($P > 0.05$), and the FL score was 2.85±0.16 and 2.84±0.15, respectively ($P > 0.05$). Over the treatment period, TBUT and SIT increased and FL scores decreased in both groups (all $P < 0.05$). At 1 month, the observation group had higher TBUT and SIT than the control group ($P < 0.05$), whereas FL scores did not differ significantly between the two groups ($P > 0.05$). At 3 months, the observation group

Table 1. Comparison of general data [n (%), mean ± SD]

Indicators		Observation group (n=49)	Control group (n=50)	t/χ^2	*P*
Gender	Male	25 (51.02)	23 (46.00)	0.250	0.617
	Female	24 (48.98)	27 (54.00)		
Age (years)		72.67±2.38	72.10±2.63	1.129	0.262
BMI (kg/m^2)		22.63±2.44	23.16±2.35	-1.103	0.273
Duration (years)		3.49±1.16	3.52±1.15	-0.128	0.898
Affected eye	Left eye	24 (48.98)	23 (46.00)	0.088	0.767
	Right eye	25 (51.02)	27 (54.00)		
Diabetes	Yes	22 (44.90)	20 (40.00)	0.243	0.622
	No	27 (55.10)	30 (60.00)		
Hypertension	Yes	15 (30.61)	17 (34.00)	0.130	0.719
	No	34 (69.39)	33 (66.00)		
Smoking	Yes	23 (46.94)	22 (44.00)	0.086	0.769
	No	26 (53.06)	28 (56.00)		
Drinking	Yes	22 (44.90)	20 (40.00)	0.243	0.622
	No	27 (55.10)	30 (60.00)		

Note: BMI, body mass index.

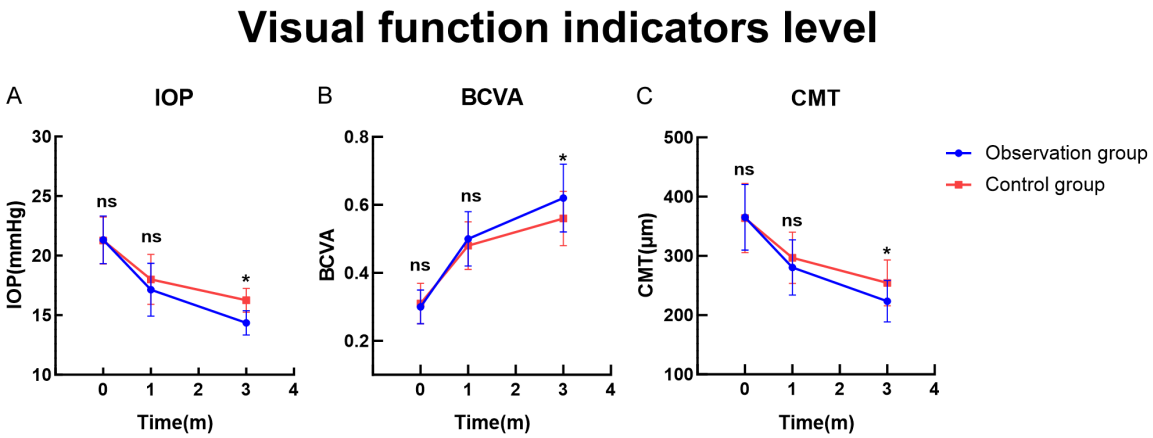


Figure 2. Comparison of visual function indicators between the two groups. A. IOP (intraocular pressure); B. BCVA (best-corrected visual acuity); C. CMT (central macular thickness). ns indicates no significant difference versus the control group; *P < 0.05.

showed higher TBUT and SIT and lower FL scores than the control group (all P < 0.05), as shown in **Figure 3**.

Comparison of quality of life scores and ocular symptoms

At baseline, the OSDI score was 37.29±8.88 in the observation group and 36.74±8.90 in the control group (P > 0.05). The NEI-VFQ-25 subscale scores were also comparable between the two groups: visual impairment, 65.35±8.20 vs 66.12±8.41 (P > 0.05); general health status, 50.39±8.78 vs 51.12±7.69 (P > 0.05); and mobility impairment, 71.41±8.87 vs 71.33±8.21 (P > 0.05). Over time, OSDI scores decreased and NEI-VFQ-25 subscale scores increased progressively in both groups (all P < 0.05). At each follow-up visit, the observation group had lower OSDI scores and higher NEI-VFQ-25 subscale scores than the control group (all P < 0.05; **Figure 4**).

Comparison of oxidative stress markers

Before treatment, SOD was 86.35±14.20 ng/mL in the observation group and 88.72±13.60 ng/mL in the control group (P > 0.05).

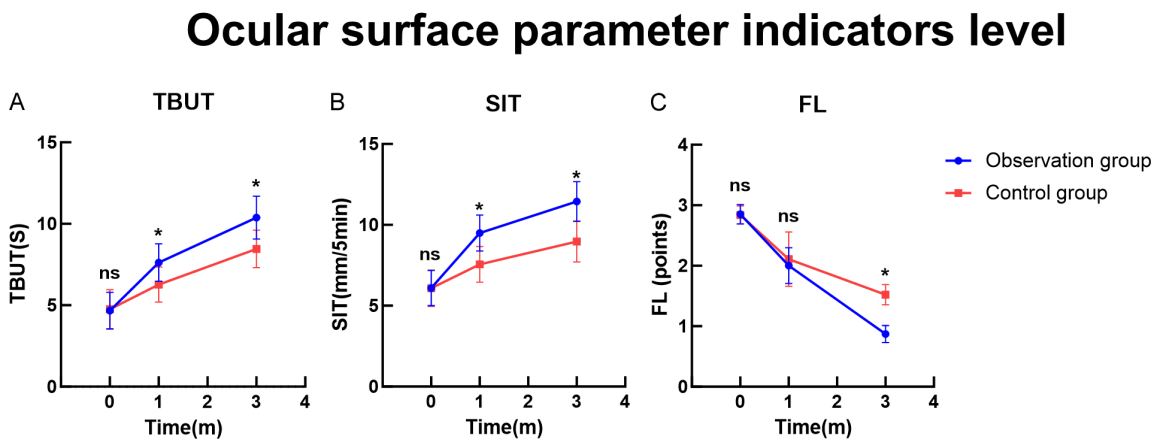


Figure 3. Comparison of ocular surface parameters between the two groups. A. TBUT (tear breakup time); B. SIT (Schirmer I test); C. FL (corneal fluorescein staining). ns, no significant difference versus the control group; *P < 0.05.

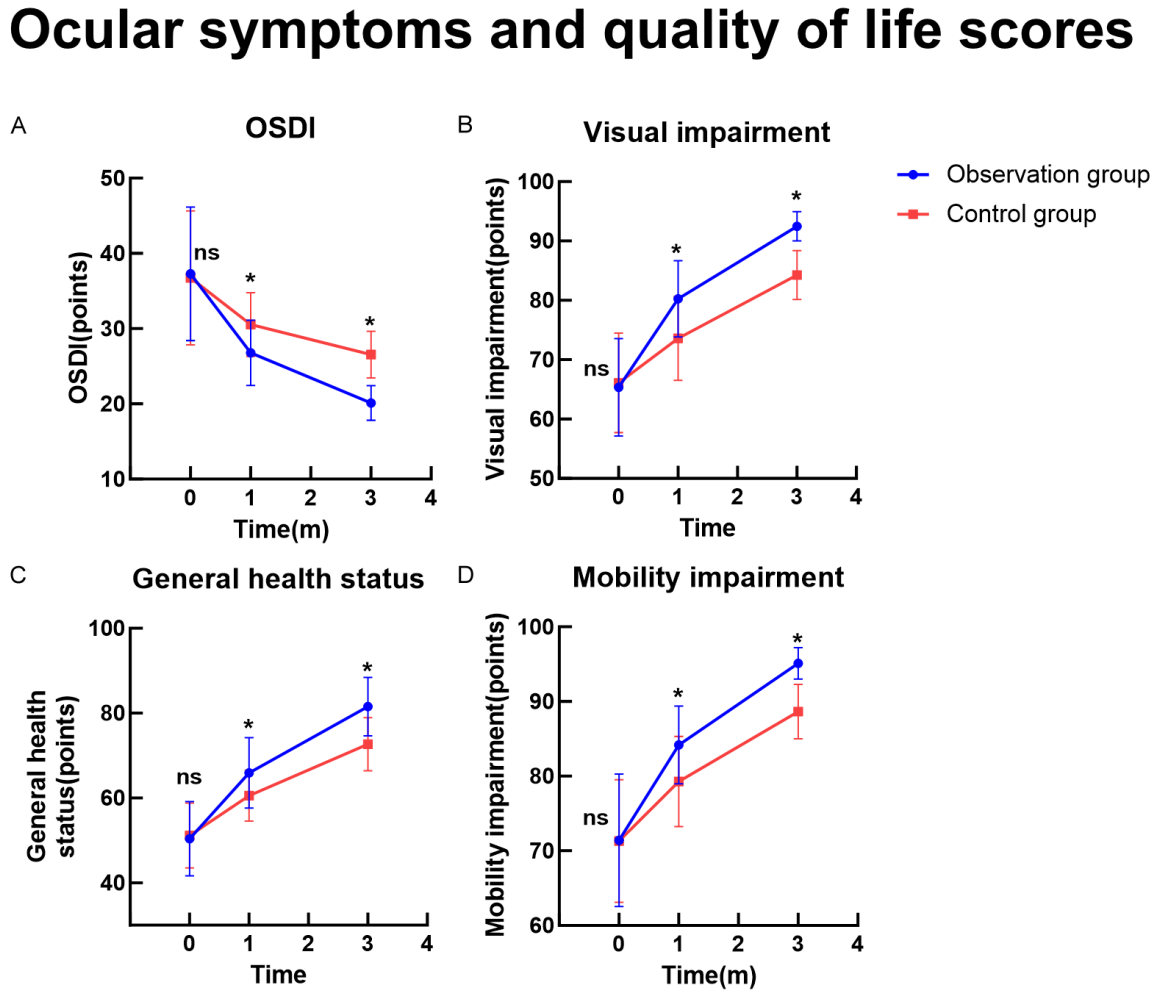


Figure 4. Comparison of quality of life scores and ocular symptoms between the two groups. A. OSDI (Ocular Surface Disease Index); B. Visual impairment; C. General health status; D. Mobility impairment. ns, no significant difference versus the control group; *P < 0.05.

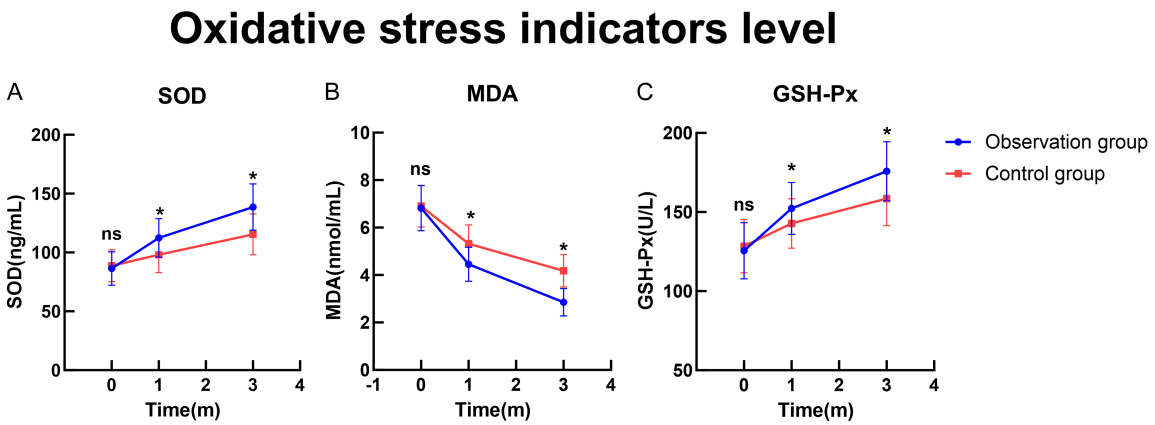


Figure 5. Comparison of oxidative stress markers between the two groups. A. SOD (superoxide dismutase); B. MDA (malondialdehyde); C. GSH-Px (glutathione peroxidase). ns indicates no significant difference versus the control group; *$P < 0.05$.

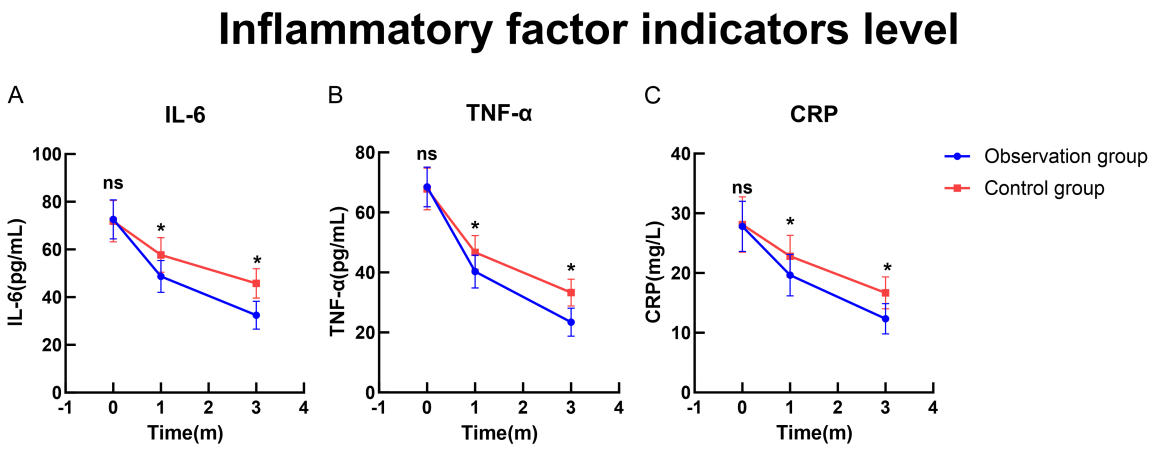


Figure 6. Comparison of inflammatory markers between the two groups. A. IL-6 (interleukin-6); B. TNF-α (tumor necrosis factor-α); C. CRP (C-reactive protein). ns, no significant difference versus the control group; *$P < 0.05$.

MDA was 6.82±0.95 nmol/mL and 6.90±0.88 nmol/mL, respectively ($P > 0.05$), and GSH-Px was 125.60±17.85 U/L and 128.40±16.90 U/L, respectively ($P > 0.05$). Over time, MDA decreased and SOD and GSH-Px increased in both groups (all $P < 0.05$). At each follow-up visit, the observation group had lower MDA and higher SOD and GSH-Px levels than the control group (all $P < 0.05$; **Figure 5**).

Comparison of inflammatory markers

Before treatment, CRP was 27.82±4.20 mg/L in the observation group and 28.13±4.65 mg/L in the control group ($P > 0.05$). IL-6 was 72.65±8.19 pg/mL and 71.85±8.70 pg/mL, respectively ($P > 0.05$), and TNF-α was 68.52±6.61 pg/mL and 67.84±6.96 pg/mL, respectively ($P > 0.05$). Over time, CRP, IL-6, and TNF-α levels decreased progressively in both groups (all $P < 0.05$). At each follow-up visit, the observation group had lower levels of all three inflammatory markers than the control group (all $P < 0.05$; **Figure 6**).

Comparison of clinical efficacy

As shown in **Table 2**, the overall effective rate was significantly higher in the observation group than in the control group ($P < 0.05$).

Comparison of adverse events

Adverse events were recorded throughout the trial. The incidence of adverse events was comparable between the two groups ($P > 0.05$).

Table 2. Comparison of clinical efficacy [n (%)]

Group	Marked improvement	Effective	Ineffective	Overall effective rate
Observation group (n=49)	26 (53.06)	19 (38.78)	4 (8.16)	45 (91.84)
Control group (n=50)	18 (36.00)	18 (36.00)	14 (28.00)	36 (72.00)
χ^2				6.546
P				0.011

Table 3. Comparison of adverse events

Group	Types of adverse events (n)	Number of adverse events (%)
Observation group (n=49)	Subconjunctival hemorrhage (2), rash (1), eye pain (2)	5 (10.20)
Control group (n=50)	Nausea (2), vomiting (1), eye pain (1)	4 (8.00)
χ^2		0.145
P		0.703

The specific types of adverse events in the two groups are shown in **Table 3**.

Discussion

Senile cataracts result from lens aging and various factors that cause lens opacification and impaired vision. The pathogenesis mainly involves lens protein denaturation and oxidative stress [19, 20]. Although patients who undergo phacoemulsification can usually recover good vision, the surgery can disrupt the smoothness of the ocular surface and impair tear film stability, often leading to dry eye [21]. It can also cause local inflammation, metabolic disturbances, and corneal nerve damage [16]. Therefore, optimizing postoperative care for elderly cataract patients is particularly important for improving treatment outcomes and long-term recovery. Xueshuantong capsules may be a good option in this regard, because they promote blood circulation, resolve blood stasis, and exert anti-inflammatory and antioxidant effects, all of which are beneficial to ocular health. In this trial, we evaluated the effects of Xueshuantong capsules on postoperative macular thickness and visual recovery in elderly cataract patients. The observation group, which received Xueshuantong capsules combined with standard postoperative care, showed greater improvement in ocular surface function and vision than the control group.

To comprehensively evaluate postoperative recovery, we assessed several key indicators of visual function. BCVA was used to track visual recovery [22], and CMT was measured to monitor the condition of the macula. An increase in CMT usually indicates macular edema, a common cause of poor vision after cataract surgery, whereas a decrease suggests that edema is subsiding and vision may improve. IOP was also monitored as a safety indicator, because postoperative inflammation or steroid use can elevate IOP, and persistently elevated IOP may lead to glaucoma [23]. Therefore, maintaining normal IOP is important for protecting the optic nerve. At 3 months after treatment, the observation group had better BCVA and lower CMT and IOP than the control group. These results suggest that Xueshuantong capsules may promote visual recovery by improving retinal microcirculation and reducing macular edema. This effect is closely related to the multifactorial pharmacological mechanisms of its main component, saponins from *Panax notoginseng*. First, the blood circulation-stimulating and stasis-eliminating effects of total saponins are manifested as improved microcirculation, vasodilation, and increased blood flow and oxygen supply to tissues [24], which creates a favorable microenvironment for accelerating fluid absorption in macular edema and functional restoration of the retina. Second, their neuroprotective and vascular endothelial protective functions stabilize the blood-retinal barrier and reduce vascular leakage, preventing edema at its source [25, 26]. Thus, we speculate that Xueshuantong capsules may restore vision and alleviate macular edema by improving ocular blood circulation and potentially protecting the blood-retinal barrier, although this inference is indi-

rectly supported by systemic serum biomarkers rather than direct intraocular tissue evidence.

We further evaluated the effect of Xueshuantong capsules on ocular surface function. In the observation group, TBUT and SIT increased and FL scores decreased significantly, indicating that Xueshuantong capsules help restore the ocular surface and alleviate postoperative dry eye. Cataract surgery inevitably damages the ocular surface and disrupts tear film stability, and conventional anti-inflammatory eye drops are of limited benefit in addressing these problems. Xueshuantong capsules may fill this unmet need by alleviating surgery-induced inflammation [25], thereby improving tear film stability and supporting corneal recovery.

To comprehensively elucidate the antioxidant and anti-inflammatory effects of Xueshuantong capsules, we measured serum concentrations of MDA, SOD, and GSH-Px. SOD and GSH-Px are antioxidant enzymes that scavenge harmful free radicals, and higher levels of these enzymes indicate stronger antioxidant capacity [27, 28]. MDA is the end product of lipid peroxidation, and its level reflects the degree of free radical-induced cell membrane damage; lower MDA levels indicate milder oxidative damage [29]. We also observed the anti-inflammatory effects of the drug by monitoring CRP, TNF-α, and IL-6. TNF-α and IL-6 are major drivers of the inflammatory response [30], and CRP, which is produced by the liver, also serves as a marker of systemic inflammation [31]; reductions in these markers suggest that the drug can alleviate inflammation. In the observation group, MDA, IL-6, TNF-α, and CRP decreased, whereas SOD and GSH-Px increased. These results indicate that Xueshuantong capsules attenuate both oxidative stress and inflammation in these patients. Panax notoginseng saponins have been reported to activate antioxidant enzymes such as SOD and GSH-Px, thereby controlling lipid peroxidation and scavenging free radicals [32]. They may also block inflammatory signaling pathways such as the nuclear factor-κB pathway, reducing the release of TNF-α, CRP, and IL-6 [25]. Together, these findings suggest that Xueshuantong capsules may play a multifaceted role in improving postoperative recovery.

Compared with the control group, patients who received Xueshuantong capsules showed better recovery, significantly improved functional scores, and a higher overall effective rate. Furthermore, the observed improvements in OSDI and NEI-VFQ-25 scores appeared to exceed the minimal clinically important difference (MCID), which has been reported as 4.5-7.3 points for OSDI in patients with mild to moderate dry eye disease [33] and 4-6 points for the overall NEI-VFQ-25 score [34], suggesting that the improvements were not only statistically significant but also clinically meaningful. The incidence of adverse events was comparable between the two groups indicating that Xueshuantong capsules are relatively safe as an adjunctive treatment for elderly patients after cataract surgery.

This study has several limitations. First, it was conducted at a single center with a relatively small sample size, which may introduce bias; therefore, larger-scale, multi-center trials are needed to confirm the generalizability of our findings. Second, the observation period was relatively short, precluding firm conclusions on the long-term safety and sustained efficacy of Xueshuantong capsules. Third, the conclusions regarding oxidative stress, inflammatory regulation, and blood-retinal barrier protection were based solely on peripheral serum biomarkers (SOD, MDA, GSH-Px, CRP, TNF-α, and IL-6), which do not directly reflect intraocular or retinal tissue changes; future studies should validate these mechanisms through aqueous humor analysis, vitreous biomarker detection, or animal experiments. Fourth, because patients could not be blinded to the oral administration of Xueshuantong capsules, subjective questionnaire responses (OSDI and NEI-VFQ-25) may have been influenced by expectation bias or placebo effects, despite the outcome assessors being masked to treatment allocation. Lastly, multiple outcome indicators were compared across three time points without adjustment for multiple comparisons, which may have inflated the type I error rate; future confirmatory studies should employ appropriate multiplicity adjustments.

When combined with standard postoperative care, Xueshuantong capsules confer significant benefits to elderly patients who have undergone cataract surgery. In addition to

safely reducing oxidative stress and inflammation, Xueshuantong capsules improve key recovery indicators, including macular thickness, ocular surface health, visual acuity, and quality of life. Therefore, Xueshuantong capsules may serve as an effective adjunctive treatment after cataract surgery, providing evidence for clinical application and further research.

Disclosure of conflict of interest

None.

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