

Povidone-Iodine Is Used to Cover the Cornea with a Viscoelastic Agent before Disinfection to Prevent Diabetic Cataracts in Patients with Diabetes Postoperative Dry Eye and Ocular Surface Injuries

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Abstract

Objective: To investigate the protective effect of povidone-iodine (PVP-I) on postoperative dry eye and ocular surface injury in patients with diabetic cataract by using a viscoelastic agent to cover the cornea before irrigation of the conjunctival sac. **Methods:** Prospective case-control study. The subjects of the study were patients diagnosed with diabetic cataract at Jingzhou Central Hospital from March 2023 to October 2023, and were divided into two groups according to admission time: 21 cases (21 eyes) in the experimental group and 22 cases (22 eyes) in the control group. The conjunctival sac was routinely flushed with PVP-I. The bacterial culture of the conjunctival sac before and after surgery, tear film break-up time (BUT), tear secretion test, corneal fluorescein staining score, and self-conscious symptom score were observed 1 day, 1 week, and 1 month before surgery. **Results:** There was no significant difference in the rate of conjunctival cyst carriers between the two groups before and after irrigation ($P > 0.05$). The self-perceived symptom scores of the experimental group were lower than those of the control group at 1 week and 1 month after operation, and the difference was statistically significant ($P < 0.05$). There was no significant difference in tear secretion at 1 day, 1 week, and 1 month after surgery ($P > 0.05$). The difference was statistically significant ($P < 0.05$), and the corneal fluorescence staining score of the experimental group was lower than that of the control group at 1 day, 1 week, and 1 month after surgery. The difference was statistically significant ($P < 0.05$). **Conclusion:** The use of a viscoelastic agent to cover the cornea of patients with dia-

betic cataract before povidone-iodine disinfection did not affect the effect of povidone-iodine disinfection and could promote the recovery of ocular surface function. However, it has little effect on tear production.

Keywords

Diabetic Cataract, Dry Eye, Povidone-Iodine, Viscoelastic Agent

1. Introduction

With the increasing incidence of diabetes mellitus (DM) and the continuous development of cataract removal surgery, patients' expectations for postoperative vision and quality of life are also increasing, and the incidence of postoperative dry eye syndrome (DES) and ocular surface damage caused by various mechanisms in diabetic cataract patients is also higher, and the recovery rate of this diabetic ocular surface disease is slower than that of ordinary cataract patients [1], and seriously affects the patient's quality of life and even vision [2] [3]. In recent years, many scholars at home and abroad have applied ophthalmic viscosurgical devices (OVDS) to cataract surgery, and even in diabetic cataract surgery, replacing Balanced Salt Solution (BSS) to moisten the ocular surface of patients, so as to prevent postoperative dry eye [4]-[6]. In addition, studies have confirmed that perioperative povidone-iodine (PVP-I) irrigation of the conjunctival sac has certain toxic effects on the corneal epithelium, such as decreased tear film stability, persistent corneal epithelial damage, and even keratitis [7], especially for patients with DM. Therefore, this study proposed using viscoelastic agents to protect the cornea of patients before PVP-I flushing, aiming to explore whether OVDS can protect the ocular surface of patients without affecting its disinfection effect, and provide a theoretical basis for improving patients' postoperative vision and quality of life.

2. Objects and Methods

2.1. Objects

A total of 43 cases (43 eyes) diagnosed with diabetic cataract in Jingzhou Central Hospital from March 2023 to October 2023 were collected, including 17 males (17 eyes) and 26 females (26 eyes), aged 52 - 80 years. All patients had diabetes mellitus for 5-8 years, glycosylated hemoglobin less than 7.8 mmol/L before surgery, fasting blood glucose less than 8.0 mmol/L during hospitalization, and blood glucose less than 10 mmol/L 2 h after three meals. During the follow-up period, the patient's blood glucose was monitored, and if the blood glucose was not well controlled, the cataract was removed according to the Emery nuclear stiffness grade between grade II~III. The operation time of all patients was not more than 15 min, and the phacoemulsification time was no more than 5 min. A history of ocular surface disease, trauma, surgery, and tear secretion were excluded from patients

with systemic diseases. According to the principle of randomization, they were divided into two groups, namely 21 cases (21 eyes) in the experimental group and 22 cases in the control group (22 eyes), in which the experimental group covered the cornea with viscoelastic agent for protection before flushing the conjunctival sac with PVP-I, and the control group PVP-I was routinely used to flush the conjunctival sac. All patients signed the informed consent form, and this study has been approved by the hospital ethics committee.

2.2. Methods

Conventional ophthalmic disinfection and draping are performed. After the eyelid is opened with an eyelid opener, the patient is instructed to look upwards to expose the lower fornix, and the surgeon uses a sterile wet cotton swab from the patient's inner canthus to the lateral canthus of the operative eye, gently wiping the conjunctival sac and the surface of the palpebral conjunctiva from the inside to the outside, while avoiding contact with the patient's eyelashes and eyelid margin. Immediately after sampling, a smear on the Colombian petri dish was performed. The experimental group covered the cornea with OVDS for protection before rinsing the conjunctival sac with PVP-I, and then rinsed the conjunctival sac with BSS after 15 seconds Clean [8]. Again, the conjunctival sac specimen was collected using a sterile wet cotton swab. The control group routinely flushed the conjunctival sac with PVP-I for 15 seconds, then flushed the residual PVP-I with BSS, and then collected conjunctival sac specimens using a sterile wet cotton swab. Both groups of patients were operated on by the same experienced cataract physician. At 11:00 a.m., a 2.8 mm limbal main incision was made, and an auxiliary incision was made at 2:00 a.m. The surgery was completed by conventional capsular tearing, water separation, phacoemulsification in the capsular split, aspiration of the lens cortex, implantation of an intraocular lens in the posterior chamber, injection of cefuroxime into the anterior chamber, and hydro orifice.

Bacterial culture of the conjunctival sac: After the sample is collected, it will be sent to the laboratory department for culture, and the number of colonies will be measured, and the culture process will be recorded.

Ocular surface examination: All patients were tested at four time points: before surgery, 1 day after surgery, 1 week after surgery, and 1 month after surgery, and various indicators of the ocular surface were analyzed, including:

Conscious symptom score: ask the patient about eye symptoms before and after surgery, including: foreign body sensation, photophobia, itching, eye pain, dry eyes, eye heaviness, blurred vision, eye fatigue, eye discharge, and tearing—a total of 10 items. Each item is scored from 0 to 3 points, and the evaluation is carried out according to the severity and frequency of symptoms, as follows: 0 points for no symptoms, 1 point for occasional symptoms, 2 points for transient and mild symptoms, and 3 points for obvious persistent symptoms.

Tear secretion: Fold the strip (5 mm × 35 mm) along the indentation and hang the folded part in the middle and middle 1/3 of the lower eyelid. Ask the patient

to gently close their eyes, wait 5 minutes, then remove the filter paper and read the measurement [9].

Tear film break-up time (BUT): Apply moist fluorescein sodium ophthalmic test paper to the conjunctival sac, ask the patient to blink 3 - 4 times, check the tear film break-up time under the slit lamp, and take 3 measurements to calculate the average.

Corneal fluorescent staining score: The staining method is the same as BUT. Scoring criteria: the cornea is divided into 4 quadrants, each quadrant is 0 - 3 points, and no punctate staining is 0 points; there are 1 - 5 punctate stainings for 1 point; there are 5 - 10 punctate stainings for 2 points; >10 punctate stainings or plaque staining is a score of 3, and the 4 regional scores are added to the staining score of the whole corneal fluorescein.

2.3. Analytical Methods and Statistical Processing

Statistical analysis was performed using SPSS 27.0 software. The Fisher exact probability method was used to analyze positive results of bacterial culture in the conjunctival sac in both groups.

The mean \pm standard deviation (SDD) was used for comparison between groups at different time points.

3. Outcome

In this study, all patients had successful surgery without obvious adverse reactions or complications. None of the patients had postoperative intraocular infection during the postoperative follow-up. One patient who did not complete the follow-up was excluded from each of the two groups, and the results were as follows.

3.1. Results of Bacterial Culture of the Conjunctival Sac

From **Table 1**, it can be seen that there was no significant difference in the rate of conjunctival cyst carriers between the two groups before and after irrigation ($P > 0.05$).

Table 1. Comparison of specimen culture results between the two groups before and after rinsing (N).

Constituencies	Experimental group (22).		Constituencies	Control group (23).	
	Number of positive cases	Number of negative cases Number of negative cases Number of negative cases		Number of positive cases	Number of negative cases Number of negative cases Number of negative cases
Before rinsing	1	21	Before rinsing	1	22
After rinsing	0	22	After rinsing	0	23

3.2. Results of Ocular Surface Examination

From **Table 2**, it can be concluded that the self-perceived symptom score of the experimental group was lower than that of the control group at 1 week and 1

month after operation, and the difference was statistically significant ($P < 0.05$). The score of self-perceived symptoms in the experimental group basically returned to the preoperative level at 1 month after operation, and there was no significant difference compared with 1 day before surgery ($P > 0.05$). The score of self-perceived symptoms in the control group increased at 1 month after operation compared with 1 day before operation, and the difference was statistically significant ($P < 0.05$).

From **Table 3**, it can be concluded that there was a significant difference in tear film break-up time between the two groups at 1 week and 1 month after surgery ($P < 0.05$), while the tear film break-up time in the experimental group was slightly lower than that at 1 day before surgery ($P > 0.05$), and the tear film break-up time in the control group was significantly lower than that at 1 day before surgery ($P < 0.05$).

From **Table 4**, it was concluded that there was no significant difference in tear secretion between the two groups at 1 day before operation, 1 day after surgery, 1 week after surgery, and 1 month after surgery ($P > 0.05$). There was no significant difference in tear secretion between the experimental group and the control group

Table 2. Comparison of self-conscious symptom scores between the two groups before and after surgery (scores).

Constituencies	Number of eyes	1 day before surgery	1 day postoperatively	1 week postoperatively	1 month postoperatively
Experimental group	21	1.95 ± 1.60	3.19 ± 1.83	3.33 ± 1.85	1.95 ± 2.01
Control group	22	1.73 ± 1.28	3.73 ± 1.70	4.45 ± 1.63	3.95 ± 2.20
t		0.512	-0.997	-2.112	-3.116
P		0.612	0.324	0.041	0.003

Table 3. Comparison of tear film break-up time between the two groups before and after surgery (s).

Constituencies	Number of eyes	Preoperatively	1 day postoperatively	1 week postoperatively	1 month postoperatively
Experimental group	21	4.00 ± 2.45	1.71 ± 0.90	2.62 ± 2.09	3.19 ± 1.86
Control group	22	3.73 ± 2.43	1.64 ± 1.53	1.55 ± 0.91	2.05 ± 1.40
t		0.366	0.202	2.205	2.289
P		0.716	0.841	0.039	0.027

Table 4. Comparison of tear secretion between the two groups before and after surgery (mm/5min).

Constituencies	Number of eyes	Preoperatively	1 day postoperatively	1 week postoperatively	1 month postoperatively
Experimental group	21	8.76 ± 4.89	15.90 ± 8.61	9.48 ± 6.93	9.29 ± 5.88
Control group	22	7.09 ± 3.93	12.32 ± 7.32	7.09 ± 4.55	6.45 ± 3.99
t		1.239	1.474	1.341	1.855
P		0.223	0.148	0.187	0.071

1 month after operation compared with that 1 day before operation ($P > 0.05$).

From **Table 5**, it can be concluded that the corneal fluorescence staining score of the experimental group was lower than that of the control group at 1 day after surgery, 1 week after surgery, and 1 month after operation, and the difference was statistically significant ($P < 0.05$). There was no significant difference in corneal staining score in the experimental group at 1 month after surgery compared with 1 day before operation ($P > 0.05$), and the corneal staining score in the control group was significantly higher at 1 month after surgery than at 1 day before operation ($P < 0.05$).

Table 5. Comparison of corneal fluorescein staining scores between the two groups before and after surgery (scores)

Constituencies	Number of eyes	Preoperatively	1 day postoperatively	1 week postoperatively	1 month postoperatively
Experimental group	21	4.24 ± 3.75	8.71 ± 2.67	8.33 ± 2.99	4.62 ± 2.89
Control group	22	5.23 ± 3.77	10.41 ± 1.84	10.86 ± 1.64	8.95 ± 3.24
t		-0.862	-2.434	-3.462	-4.633
P		0.394	0.019	0.001	<0.001

4. Discussion

At present, the only way to treat cataract is surgery, and with the increasing maturity of cataract technology, more and more patients are pursuing not only improved vision, but also improved quality of vision after surgery. However, multiple studies have shown that about half of patients with DM also have dry eye symptoms, while 15% to 33% of patients over the age of 65 have dry eye symptoms. As a result, dry eye problems caused by DM are of great concern [10]-[12]. Diabetes-related dry eye syndrome may be caused by impaired tear secretion, excessive tear evaporation, and corneal neuropathy [2] [13], along with photophobia, red eye, visual disturbances, localized pain, itching, and in severe cases, persistent corneal epithelial defects and even corneal ulcers [3] [14]. At the same time, Sahu PK *et al.* [15] pointed out that pre-cataract anesthesia, intraoperative incision, mechanical operation, supermammary energy, and postoperative medication can cause related dry eye symptoms such as decreased tear film stability, blurred vision, refractive changes, burning sensation, and foreign body sensation. As a result of these multiple mechanisms, patients with diabetic cataract are more likely to develop corneal epithelial dysfunction after surgery, and the corneal epithelium remains unrepaired after treatment [16]. As a result, corneal epithelium exfoliation, erosion, delayed wound healing, poor visual quality, glare, halos, decreased contrast sensitivity, or ocular discomfort [17] [18] appear, which seriously affects the patient's postoperative vision and quality of life. Therefore, for patients with diabetic cataract, it is more important to protect the ocular surface of the patient during surgery to improve the patient's postoperative comfort, satisfaction, and visual function.

Povidone-iodine, as a water-soluble complex, is considered the most effective preservative to reduce the incidence of postoperative endophthalmitis. At present, it is widely used in ophthalmic surgery and various ocular surface infectious diseases [19], among which cataract surgery is the most widely used. However, it has its own side effects, such as irritation of the eye and periocular area, and even corneal epithelial defects or keratitis, and these symptoms and signs are positively correlated with the frequency, timing, and concentration of use [20]. In ex vivo experiments, even when the PVP-I concentration was reduced to 0.025%, it still had an inhibitory effect on cells, and at a concentration of 0.01%, in vitro fibroblasts were completely inhibited [21]. In rabbit eye experiments, PVP-I at a concentration of 5% can cause damage to corneal epithelium and conjunctival goblet cells, and with the extension of exposure time, the pathophysiological ocular surface changes gradually resemble DES, such as conjunctival squamous metaplasia and punctate loss of corneal epithelium [22]. In cataracts, frequent use of 0.25% PVP-I irrigation of the eye is effective, but in patients with DM or DES, even 0.25% PVP-I can cause damage to the postoperative corneal epithelium, and Fan F *et al.* believe that the use of 0.05% PVP-I in patients with such ocular surface abnormalities can be beneficial for the recovery of dry eye and ocular surface function [8] [23]. Other studies have shown that after repeated topical application of PVP-I, the Schein dry eye questionnaire score increases, tear film parameters deteriorate, and corneal staining scores increase, resulting in postoperative DES, affecting vision and quality of life [24]. However, about 70% of diabetic patients have corneal complications before surgery, and the duration of the disease and the high glycosylated hemoglobin are positively correlated [25] [26], so it is more important to pay attention to the protection of the cornea in the perioperative period, so that patients can achieve better visual results and quality of life after surgery.

Viscoelastic agent, also known as "viscoelastic substance," is an ophthalmic viscoelastic device that is widely used in ophthalmic surgery, such as cataract surgery, eyeball rupture, etc., with adhesive and coating properties, elasticity and rigidity, viscosity and pseudoplasticity, mainly composed of sodium hyaluronate (Sodium hyaluronate, SH) and hydroxypropyl methyl cellulose (HPMC) [27] [28]. In recent years, many foreign scholars in China have used viscoelastic agents instead of balanced salt solutions to moisten the ocular surface of patients during cataract surgery, so as to prevent postoperative dry eye [4] [5]. In addition, OVDS was applied to the ocular surface of patients during cataract surgery, and compared with conventional BSS irrigation, the OVDS coating significantly improved intraoperative clarity and convenience, and the postoperative tear film break-up time, corneal fluorescence staining score, and ocular surface disease index score were also significantly improved [6] [29]. In addition, the recommendations of the Chinese Expert Consensus on the Prevention and Treatment of Cataract Perioperative Dry Eye (2021) also clearly point out that intraoperative intraocular surface application of 2% hydroxypropyl methylcellulose or other special corneal protective agents can effectively prevent postoperative dry eye and corneal epithe-

lial cell damage [30]. In this study, although the pseudoplastic effect of OVDS was only used to isolate the contact between PVP-I and the cornea during flushing of the conjunctivalsac [31], it was found that this modified PVP-I method of flushing the conjunctival sac could effectively accelerate the recovery of patients' perceived symptom scores, tear film break-up time, and corneal staining scores. This may be related to the mechanical isolation of PVP-I from contact with the cornea by OVDS during irrigation of the conjunctival sac by povidone-iodine.

5. Conclusion

In summary, the use of viscoelastic agent to cover the cornea of diabetic cataract patients before PVP-I disinfection did not affect the effect of PVP-I disinfection, and could achieve the effect of protecting the ocular surface of patients. However, due to differences in individual blood glucose levels, it would be more convincing if the two eyes of the same patient could be selected to perform the comparison experiment in order to control for irrelevant variables. Moreover, the sample size of this study is small and the follow-up time is short, and its long-term effect on dry eye and ocular surface and its possible side effects still need to be further studied in more people.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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