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Efficacy of Modified Endoscopic Dacryocystorhinostomy in the Treatment of Chronic Dacryocystitis

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Abstract

Background: Untreated chronic dacryocystitis (CD) can lead to serious ocular complications.
Objectives: This study aimed to analyze the efficacy of modified endoscopic dacryocystorhinostomy (DCR) in the treatment of CD and the effects on ocular surface, inflammatory response, and immune function of patients.
Methods: A retrospective cohort study was conducted to examine the clinical data of 110 patients (110 eyes) with CD who visited The First People's Hospital of Wenling, China, from July 2018 to February 2021, and they were divided into a conventional group (62 patients and 62 eyes underwent conventional DCR) and modified group (48 patients and 48 eyes received modified endoscopic DCR). The perioperative indexes, efficacy, and complications of the two groups were compared, and the changes in ocular surface, inflammatory response, and immune function of the patients before and 3 months after the surgery were observed.
Results: The intraoperative bleeding, hospitalization cost, and 12-h postoperative visual analogue scale (VAS) score were lower, while the operative time and hospitalization time were shorter in modified group than in the conventional group ($P<0.05$). The total treatment efficacy was higher (91.67%) in the modified group than in the conventional group (72.58%), and the recurrence rate was lower in the modified group (4.17%) than in the conventional group [16.13%, $P<0.05$]. The ocular surface symptom scores, Schirmer I test, tear break-up time, degree of tear overflow scores were lower in the modified group than in the conventional group at 3 months postoperatively ($P<0.05$); soluble interleukin-1β, interleukin-6, high-sensitivity C-reactive protein, CD8+ levels were lower, and CD3+, CD4+, CD4+/CD8+ levels were higher in the modified group than in the conventional group at 3 months postoperatively ($P<0.05$). At 3 months postoperatively, the scores of activity impairment, general health, and visual status on the National Eye Institute 25-Item Visual Function Questionnaire were higher in the modified group than those in the conventional group ($P<0.05$). The overall complication rate in the modified group (8.33%) was not different from that in the conventional group [14.52%, $P>0.05$].
Conclusion: Modified DCR has the advantages of short operation time, less trauma, less pain and fewer complications, and is conducive to improving ocular surface function, reducing inflammatory response, and improving immune function and quality of life of patients.

Keywords: Chronic dacryocystitis, Efficacy, Inflammatory response, Modified endoscopic dacryocystorhinostomy, Ocular surface function

1. Background

Chronic dacryocystitis (CD) is a common disease in the department of ophthalmology, mostly caused by blockage of the nasolacrimal duct or anatomical abnormalities, and patients with CD complain of increased eye discharge, recurrent tear overflow, pus overflow, and so on. If left untreated, CD can lead to serious ocular complications, such as orbital cellulitis, keratitis, and acute dacryocystitis (1, 2). Meanwhile, as the condition of CD continues to progress, it can cause local infection of adjacent tissues and organs, damage ocular surface structures, and even endanger the safety of eye surgery. Due to the high recurrence rate after conservative treatment, CD is still primarily treated by surgery to promote lacrimal duct patency and eliminate the inflammation of the lacrimal sac (3). Unblocking the nasolacrimal duct and reconstructing the lacrimal duct are the common strategies for the clinical treatment of CD, among which dacryocystorhinostomy (DCR) is the classic procedure for lacrimal duct reconstruction (4), which can achieve the effect of draining tears by changing the patient's original lacrimal drainage structure and establishing a new channel between the nasal cavity and the lacrimal sac to replace the obstructed nasolacrimal duct (5). However, DCR changes the anatomical structure of the lacrimal duct and has large intraoperative incision, more amount of bleeding, and long operation time, and the intraoperative structure tissue is difficult to expose, which correspondingly increases the risk of postoperative lacrimal duct obstruction and is not conducive to the good prognosis of patients (6). At the same time, it could damage the medial canthal ligament and the lacrimal sac, and there are also problems, such as skin scarring in the lacrimal sac area and a long healing time after the operation; therefore, most patients have difficulty accepting it (7).

With the increasing updates and adoption of endoscopic technology, endoscopic DCR is widely used in clinical treatment (8). This procedure can effectively improve the clarity of the surgical field, avoid the problems of facial scarring and trauma, and reduce the blindness of the surgical operation (9). A multicenter survey found that the surgical success rate of DCR for acute dacryocystitis was 94.4% (10). Since endoscopic DCR could not achieve sutured alignment anastomosis, improper treatment is prone

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to complications (e.g., scar atresia and granulomatosis), and the risk of postoperative recurrence and surgical failure is also high.

Modified endoscopic DCR is performed under a nasal endoscope, which can improve the clarity of the surgical visual field, establish suitable bone foramina, facilitate the formation of the large nasal mucosal flap, and then form a wide new lacrimal duct, avoid the occurrence of adverse events, such as the lacrimal duct obstruction by callus and granulation tissue caused by lacrimal duct stenosis, and improve the clinical prognosis of patients. At the same time, the medial canthus ligament is not cut during the operation, which can effectively avoid the position change of the inner canthus caused by the operation and protect the normal physiological structure of the lacrimal sac; inserting catheter instead of tamponade can effectively improve lacrimal duct patency after surgery, reduce the incidence of postoperative adverse stress reactions caused by nasal congestion and other symptoms, and correspondingly improve the patient's sleep quality and living standards.

2. Objectives

To improve the efficacy of DCR and reduce the risk of postoperative recurrence, this study reports the efficacy of modified endoscopic DCR and its effects on the ocular surface, inflammatory response, and immune function.

3. Methods

3.1. Clinical data

A retrospective cohort study of 110 patients (110 eyes) with CD who visited The First People's Hospital of Wenling, China, from July 2018 to February 2021 was conducted, and patients were divided into a conventional group (62 cases and 62 eyes) and modified group (48 cases and 48 eyes) according to different procedures. This study was approved by the Ethics Committee of The First People's Hospital of Wenling (No. KY-2021-2053-01). Signed written informed consents were obtained from all participants before the study.

Patients meeting the following inclusion criteria were included in this study: patients who met the diagnostic criteria for CD in Chinese Ophthalmology (11) and confirmed by lacrimal flushing; patients with one eye affected; patients who received no treatment prior to 1 month of admission; patient with complete clinical data.

Patients with the following conditions were excluded from the study: patients with tears caused by miscellaneous eyelashes, ectropion, inverted eyelids, trichiasis, and so on; patients with tears caused by abnormal tear dynamics due to weakened orbicularis muscle function or loose skin; patients accompanied by congenital lacrimal duct abnormalities, such as lack of nasolacrimal ducts and tubule atresia; patients with acute dacryocystitis, traumatic dacryocystitis, common lacrimal duct obstruction, canaliculus stenosis; patients with severe nasal septum deviation, severe atrophic rhinitis; patients with nasal tumors, deformities, polyps; accompanied by coagulation dysfunction, severe bleeding tendency and surgical contraindications; patients combined with severe vital organ dysfunction, mental disease, autoimmune disease, infectious disease, hematopoietic system disease; pregnancy or lactation.

3.2. Methods

(1) Conventional group. Antibiotic eye solution was given 3 days before the surgery to prevent infection; 1% furacilin nasal drops (Shanghai Yunjia Huangpu Pharmaceutical Co. Ltd., No. 170923) were administrated into the nasal cavity. Nasal mucosal surface anesthesia and infiltration anesthesia were performed in the supine position. A curved incision of approximately 15-20 mm in length was made at the medial canthus. The subcutaneous periosteum and tissues were bluntly separated, and the anterior lacrimal crest and medial canthal ligament were fully exposed and clipped. The fossa is bluntly separated and externally pushed to the posterior lacrimal crest, and the septal cardboard of the medial wall of the lacrimal sac is poked through with the aid of curved vascular forceps to fully expose the nasal mucosa. The "]" and "[" shaped incisions were made on the nasal mucosa and the inner wall of the lacrimal sac, respectively, and the nasal cavity was filled with vaseline gauze via the incisions. The anterior flap of the nasal mucosa and the lacrimal sac were sutured with 6-0 nylon thread, three stitches were intermittently sutured, and the skin was intermittently sutured with 5-0 filament suture, followed by compression bandaging for 1 day.

(2) Modified group. Before exposing the nasal mucosa, the operation was the same as that of the conventional group except, that the medial canthal ligament was not cut. A "U"-shaped incision was made at the nasal mucosa, and a probe was inserted into the tear duct along the lacrimal point to raise the wall of the internal capsule in the shape of a small cap, then a "]" and "[" shaped incision was made, respectively, and a catheter was inserted through the anastomosis. The skin was sutured, then anterior flap sutures were performed, and the operated eye was bandaged. Postoperatively, dexamethasone (Guangdong Nanguo Pharmaceutical Co., Ltd., No. H44021869) + gentamicin drops (Changchun Dirui Pharmaceutical Co., Ltd., No. H22023549) were administrated for 4 days. The eyes were regularly reviewed after discharge.

3.3. Outcome Measurement

(1) Perioperative indicators. Intraoperative

bleeding, hospitalization cost, operation time, hospitalization time, and pain level at 12 h postoperatively were recorded, and pain level was assessed by visual analog scale (VAS) with a score of 0-10, representing no pain to severe pain, respectively.

(2) Efficacy. The efficacy criteria were formulated with reference to the "Clinical Disease Diagnosis Based on Cure and Improvement Criteria" (12). If there were no symptoms of pus and tear overflow after treatment, and the tear duct flushing was smooth without resistance feeling, it was considered cured; pus and tear overflow symptoms were reduced, and tear duct flushing was smooth with some resistance feeling was considered as improved; pus and tear overflow symptoms were not reduced, and tear duct flushing was not smooth with obvious resistance was considered as ineffective. Total effective = cure + improvement.

(3) Ocular surface (13). The ocular surface symptom questionnaire covers six items, namely dryness, ocular oxygenation, photophobia, foreign body sensation, burning sensation, and heavy eyelid sensation, on a 0-3 Likert scale and the degree of symptoms was positively correlated with the score. Tear secretion test (Schirmer I test, SIt) criteria: ≥10 mm / 5 min was considered normal, <10 mm / 5 min was considered abnormal. Tear break-up time (BUT) criteria: 10-30 s is normal, <10 s is tear film instability. Tear overflow score: 0: no tear overflow, 1: tear overflow 1-2 times/d, 2: tear overflow 3-4 times/d, 3: tear overflow 5-10 times/d, 4: tear overflow ≥ 11 times/d, and 5: persistent tear overflow. The assessment was performed before surgery and 3 months postoperatively. The score ranged from 0 to 100. The total score of the scale = (total score of all questionnaire questions) × 25/ number of questionnaire questions answered.

(4) Inflammatory response and immune function. 5 mL of fasting peripheral elbow venous blood were collected, centrifuged for 5 min (3000 r/min, r=3 cm), serum was separated, and soluble interleukin-1β (sIL-1β) and interleukin-6 (IL-6) levels were determined by enzyme-linked immunosorbent assay (Shenzhen Xinbosheng Biotechnology Co., Ltd.); the level of high-sensitivity C-reactive protein (hs-CRP) was detected by latex-enhanced immunoturbidimetry (Shanghai Yaji Biotechnology Co., Ltd.). CD3+, CD4+, CD8+ were measured by flow cytometry (Beckman Coulter, USA), and CD4+/CD8+ were calculated. The assessment was performed before surgery and 3 months postoperatively.

(5) Quality of life. The National Eye Institute 25-Item Visual Function Questionnaire (NEI-VFQ-25) (14) consists of 25 items in 3 dimensions (visual status, activity impairment, and general health), each scored 0-4, with a positive correlation between the quality of life. The assessment was performed before surgery and 3 months postoperatively, with 5-6 ratings: A-F, according to the weight ratio set by different items, answers were scored on a scale of "100, 75, 50, 25, 0, missing" or "0, 25, 50, 75, 100". The average score of all valid items is the score of healthy life quality measured, and the score ranges from 0-100 (15).

(6) Complications. The nasal mucosa injury, bleeding, infection, swelling, and so on. were recorded.

3.4. Statistical Analysis

The SPSS software version 23.0 (IBM, Armonk, NY, USA) was used, and the measurement data conforming to the normal distribution were expressed as (mean ± SD) and were examined using independent sample t-test and paired t test; the count data were expressed as rate (%) and examined by Chi-square test. A $P<0.05$ was considered statistically significant.

4. Results

4.1. Baseline data

The conventional group included 20 males and 42 females; aged 19-76 years, with a mean age of (49.26±4.76) years; duration of 1-9 years, and a mean of (4.65±1.34) years; 30 left eyes and 32 right eyes. The modified group included 16 males and 32 females; aged 21-74 years, with a mean age of (48.03±3.98) years; duration of 1-8 years, and a mean of (3.99±1.28) years; 23 left eyes and 25 right eyes. The baseline data of both groups were comparable ($P>0.05$).

4.2. Perioperative indicators

The intraoperative bleeding, hospitalization cost, and 12-h postoperative VAS score of the modified group were lower than those of the conventional group. Moreover, the operation time and hospitalization time were shorter than those of the conventional group ($P<0.05$), indicating that modified DCR has the advantages of shorter operation time, less trauma, and less pain (Table 1).

4.3. Therapeutic efficacy, recurrence rate

The total effective rate of treatment in the modified group (91.67%) was higher than that in the conventional group (72.58%), and the recurrence rate (4.17%) was lower than that in the conventional group [16.13%, $P<0.05$], indicating that modified DCR was significantly effective in treating CD, leading to a good prognosis and low recurrence rate (Table 2).

4.4. Ocular surface

There was no statistically significant difference in the preoperative ocular surface score, SIt, BUT, and tear overflow scores between two groups ($P>0.05$). The ocular surface score, SIt, BUT, and tear overflow score were lower in the modified group than in the

Table 1. Comparison of perioperative indicators (Mean ± SD)

Indicators	Conventional group (n=62)	Modified group (n=48)	*P-value**
Intraoperative bleeding volume (mL)	22.03±5.64	14.98±3.86	<0.001
Operative time (min)	75.26±7.82	40.65±6.08	<0.001
Hospitalization cost (RMB)	2436.23±89.64	1185.29±74.93	<0.001
Length of hospitalization (d)	10.32±3.38	3.28±1.08	<0.001
Postoperative 12 h VAS score (points)	3.65±0.75	1.96±0.48	<0.001

* Independent sample t-test
Note: VAS: visual analogue scale

Table 2. Comparison of efficacy and recurrence rate between the two groups [n (%)]

Efficacy	Conventional group (n=62)	Modified group (n=48)	*P-value*
Cure	10 (16.13)	18 (37.50)	
Improvement	35 (56.45)	26 (54.17)	
Ineffective	17 (27.42)	4 (8.33)	
Total effective rate	45 (72.58)	44 (91.67)	0.012*
Recurrence rate	10 (16.13)	2 (4.17)	0.046*

***** Chi-square test

conventional group 3 months after surgery (P<0.05), showing that the modified DCR improves the ocular surface function of the patients (Figure 1).

4.5. Inflammatory response

The difference in preoperative serum sIL-1β, IL-6, and hs-CRP levels was not statistically significant between the two groups (P>0.05). The sIL-1β, IL-6, and hs-CRP levels in the modified group were lower than those in the conventional group 3 months after surgery (P<0.05), which showed that modified DCR could reduce the inflammatory response of the patients (Figure 2).

4.6. T lymphocyte subsets

The CD3+, CD4+, CD8+, and CD4+/CD8+ in the modified group were not statistically significant compared with the conventional group preoperatively (P>0.05). The CD3+, CD4+, and CD4+/CD8+ in the modified group were higher, and CD8+ was lower than those in the conventional group at 3 months after the operation (P<0.05), suggesting the modified DCR could improve the immune function (Figure 3).

4.7. Quality of life

The differences in the preoperative NEI-VFQ-25 scores were not statistically significant between the two groups (P>0.05). The scores of the NEI-VFQ-25 scale were higher in the modified group than in the conventional group; 3 months after surgery (P<0.05), demonstrating that modified DCR could improve patients' quality of life (Table 3).

4.8. Complications

The overall complication rate in the modified group (8.33%) was not statistically significant (P>0.05) compared with the conventional group (14.52%), showing that the modified DCR was safer (Table 4).

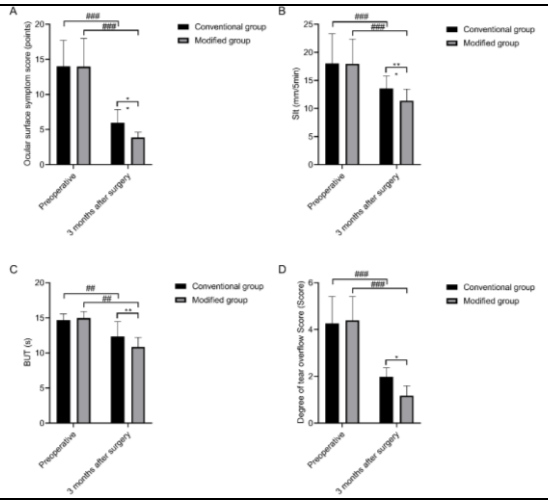

Figure 1. Comparison of ocular surface between two groups. (A) Ocular surface scores were significantly lower in the modified group than in the conventional group at 3 months after the surgery; (B) SIt was significantly lower in the modified group than in the conventional group at 3 months after surgery; (C) BUT was significantly lower in the modified group than in the conventional group at 3 months after surgery; (D) Tear overflow scores were significantly lower in the modified group than in the conventional group at 3 months after surgery. Note: SIt: Schirmer I test; BUT: tear break-up time. Compared with the conventional group, *P < 0.05, **P < 0.01, ***P < 0.001; compared within the same group before surgery, ##P < 0.01, ###P < 0.001

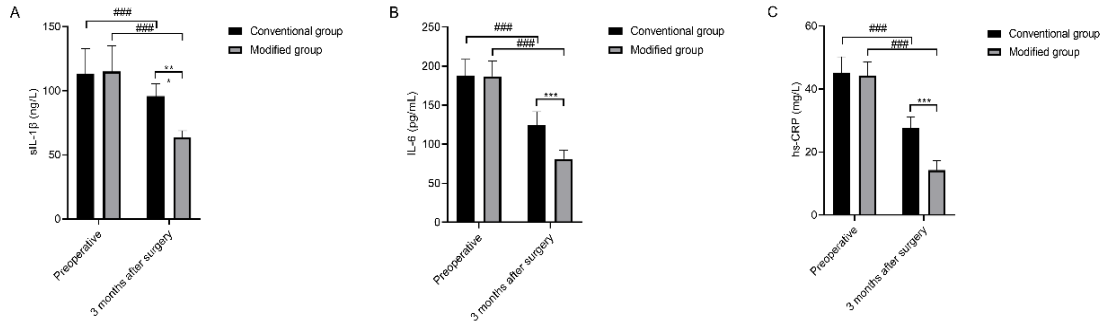

Figure 2. Comparison of inflammatory response between the two groups. (A) sIL-1β was significantly lower in the modified group than in the conventional group, 3 months after surgery; (B) IL-6 was significantly lower in the modified group than in the conventional group 3 months after surgery; (C) hs-CRP was significantly lower in the modified group than in the conventional group 3 months after surgery. Note: sIL-1β: soluble interleukin-1β; IL-6: interleukin-6; hs-CRP: high-sensitivity C-reactive protein. Compared with the conventional group, ***$P < 0.001$; compared within the same group, ###$P < 0.001$

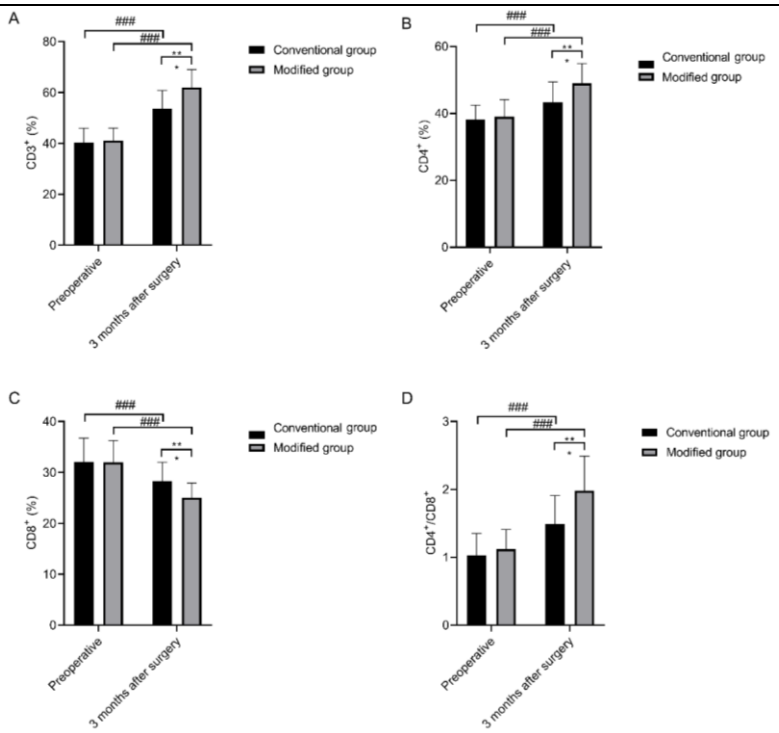

Figure 3. Comparison of changes in T lymphocyte subpopulations between two groups. (A) The CD3+ of the modified group was significantly higher than that of the conventional group at 3 months after the operation; (B) the CD4+ of the modified group was significantly higher than that of the conventional group at 3 months after the operation; (C) the CD8+ of the modified group was significantly lower than that of the conventional group at 3 months after the operation; (D) The CD4+/CD8+ of the modified group was significantly higher than that of the conventional group at 3 months after the operation. Note: Compared with the conventional group, ***$P < 0.001$; compared within the same group, ###$P < 0.001$

6. Conclusion

With the continuous updating of endoscopic minimally invasive technology, endoscopic DCR has been transformed from a "naked eye operation" to a fine microsurgery with minimal invasiveness and visibility, which can quickly and effectively control the inflammatory response of the lacrimal sac and surrounding tissues, truly achieve mucosa-to-mucosa anastomosis, and keep the tear pump in a natural state without facial scarring (16). However, lacrimal duct restenosis or obstruction may occur after endoscopic DCR, and it is difficult to maintain long-term anastomotic patency (17). In this study, modified endoscopic DCR was used to treat CD, and the results showed that it had the advantages of a short operation time, less trauma, less pain, and fewer complications, and was beneficial to improve the ocular surface function, reducing inflammatory response, and improving immune function and quality of life of the patients.

In this study, we found that the perioperative

Table 3. Comparison of NEI-VFQ-25 scale scores between the two groups (Mean ± SD, points)

Item		Conventional group (n=62)	Modified group (n=48)	*P-value**
Activity impairment	Pre-operative	73.62±4.65	72.86±4.97	0.411
	3 months after surgery	84.39±5.57	90.34±6.48	<0.001
P-value		<0.001	<0.001	
General health	Pre-operative	50.97±5.63	49.27±4.86	0.099
	3 months after surgery	57.73±6.39	64.48±8.11	<0.001
P-value		<0.001	<0.001	
Visual acuity	Pre-operative	80.36±7.62	79.32±8.15	0.493
	3 months after surgery	86.97±8.15	93.34±5.16	＜0.001
P-value		<0.001	<0.001	

* Between groups comparison, independent sample t-test, ** Pre- and post-operation comparison, paired t-test

Table 4. Comparison of complications between the two groups [n (%)]

Complications	Conventional group (n=62)	Modified group (n=48)	*P-value**
Nasal mucosa injury	3 (4.84)	2 (4.17)	
Hemorrhage	2 (3.23)	1 (2.08)	
Infection	2 (3.23)	0	
Swelling	2 (3.23)	1 (2.08)	
Total	9 (14.52)	4 (8.33)	0.31

* Chi-square test

indexes and post-treatment ocular surface function were better, and the efficacy and NEI-VFQ-25 scale scores were higher, while the recurrence rate was lower in the modified group than that of the conventional group, indicating that modified DCR improves ocular surface function, reduces recurrence rate and pain level, shortens operation time, and improves the quality of life. The reason may be that the modified DCR performed under the nasal endoscope can guarantee the clarity of the surgical field, establish suitable bone holes, help form larger nasal mucosal flaps and wide new tear ducts, and can avoid blockage of the tear duct by granulation tissue and bone scabs induced by lacrimal stenosis. Moreover, the nasal endoscope can be repeatedly examined several times, and the blockage caused by the anastomosis, granulation growth, secretions, blood scabs, and nasal mucosal adhesions at the anastomosis can be treated in a timely manner (18). Unlike the conventional filling of oil gauze, this procedure allows the insertion of a catheter from the anastomosis to reduce stress and inflammatory reactions induced by symptoms, such as nasal congestion, and to enhance postoperative lacrimal patency (5). Intraoperative treatment without cutting the medial canthal ligament can avoid surgical trauma caused by changes in the position of the medial canthus; as a result, safeguarding the normal physiological structure of the lacrimal sac; Lee et al. (19) found that nasal endoscopic operation without cutting the medial canthal ligament can protect the normal physiological structure and function of the lacrimal sac. Meanwhile, this procedure preserves the original physiological structure of the tear sac and reduces the length of the intraoperative incision, which can speed up the process of ocular functional recovery and improve the success rate of early surgery (20). Furthermore, the operation can ensure the space of the fistula, while the mucosal flap and the lacrimal sac are well aligned, and the anastomosis is firm, which prevent the growth of granulation, promotes the epithelialization of the anastomosis, and reduces postoperative recurrence. Banks et al. (21) found that modified DCR shortened postoperative hospitalization and recovery time and avoided the occurrence of lacrimal tract obstruction, which is basically consistent with the findings of this study.

Immune response and inflammatory response play a major role in the pathogenesis of CD, the mucosa and surrounding tissues of the lacrimal sac with long-term chronic infection can produce tissue antigenic mutations, and this autoantigen can release lymphotoxins, stimulate sensitized T cells and induce a chronic inflammatory response through humoral and cellular immune responses (22). The Th1 and Th2 cells are two sub-cell populations of CD4+T cells, and the balance of the two can improve the host's resistance to infection. Yang (23) found that the levels of chemokines, Th1 and Th2 related cytokines, CD4+ and CD8+ cells in the tears of CD patients are higher than those of healthy people, indicating that the immune response may become the target of CD therapy. Ali et al. (24) reported that the ocular surface may affect the inflammatory response of the lacrimal sac and nasolacrimal duct through lacrimal drainage-associated lymphoid tissue (LDALT), and LDALT can significantly affect ocular surface integrity, local immune response, and lymphocyte recirculation, suggesting that CD has a connection with immune imbalance. In the present study, the levels of sIL-1β, IL-6, hs-CRP, and CD8+ in the modified group were lower than those in the conventional group at 3 months after the surgery, and CD3+, CD4+, and CD4+/CD8+ were higher than those in the conventional group, indicating that modified DCR could improve the immune function of patients, correct the immune imbalance, and reduce

the inflammatory response. The reasons may be related to the reduction of local inflammatory activity and improvement of immune function; however, the specific mechanism still needs to be further clarified. There was no significant difference in the total complication rate in the modified group (8.33%) compared with the conventional group (14.52%), which on the one hand, indicates that the modified DCR is safer and has fewer complications; however, on the other hand, the reason may be related to the small sample size.

However, this study also has some limitations. The number of cases in this study is small, and it is a single-center study; therefore, there may be some bias in the data. In the next study, we will expand the number of cases and carry out clinical observation of multi-center study for further demonstration.

6. Conclusion

In conclusion, the modified DCR for CD has the advantages of a shorter operation time, less trauma, less pain, and fewer complications, and is beneficial for improving ocular surface function, reducing the inflammatory response, and improving immune function, and quality of life of patients.

Acknowledgments

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Footnotes

Conflicts of Interest: None.

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