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Comparison of Trans-Canalicular and External Dacryocystorhinostomy for Naso-lacrimal Duct Obstruction

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Abstract

Background: External dacryocystorhinostomy (EX-DCR) is the gold-standard treatment for nasolacrimal duct obstruction. However, less invasive procedures, such as transcanalicular DCR (TC-DCR), are being explored for comparable outcomes with fewer complications.

Objective: To compare the efficacy and surgical outcomes of various transcanalicular DCR techniques with those of conventional external DCR in patients with partial or complete nasolacrimal duct obstruction

Patients and Methods: A prospective study was conducted on 100 eyes diagnosed with nasolacrimal duct obstruction. Patients were divided into five groups:

• **Group A** : Conventional EX-DCR

• **Group B–E**: Four variations of TC-DCR involving different placements of Silicone tube limbs into the nasal cavity with or without skin incision

The outcomes assessed included surgical duration, intraoperative bleeding, anatomical and functional success (patency of irrigation and resolution of epiphora), and postoperative complications.

Results: The mean surgical duration was significantly longer in the EX-DCR (74.55±11.42 min) than in the TC-DCR group (range: 17.5–25 min). Intraoperative bleeding was significantly higher in EX-DCR. Functional and anatomical success rates were comparable across the groups, with patients in Group C reporting the highest early postoperative satisfaction.

Conclusion: TC-DCR is a minimally invasive, effective alternative to EX-DCR for selected cases of nasolacrimal duct ob-

struction, with similar success rates and reduced surgical morbidity.

Keywords: Trans-Canalicular Dacryocystorhinostomy; Naso-Lacrimal Duct Obstruction; External Dacryocystorhinostomy; Lid Anomalies

Introduction

During a dacryocystorhinostomy (DCR) procedure, the intervening bone is removed to create an anastomosis between the nasal cavity and the lacrimal sac at the level of the middle meatus. The nasolacrimal duct blockage (NLDO) location is close to this new opening, which restores the tear flow into the nose [1].

For DCR surgery, many techniques are available, including external, transnasal, and both. These methods include transcanalicular laser-assisted DCR, non-laser endoscopic DCR, endoscopic endonasal laser DCR, and external or conventional DCR. When it comes to addressing acquired NLDO, the conventional or external DCR is regarded as the gold standard [2].

The transnasal DCR was initially presented by Caldwell in 1893, but because nasal cavity visibility and postoperative hemorrhage, it was not generally used. The popularity of the endoscopic endonasal technique has increased with the development of endoscopic technology, and the results have been comparatively favorable. DCR surgery has been transformed by the LASER aided endoscopic method, particularly in terms of accurate ostium hemostasis, decreased surgical morbidity, and esthetic issues [3].

In DCR surgery, many LASER kinds are used, with the most effective ones being for little collateral damage. With several benefits over previous LASER DCR and traditional DCR, diode laser-assisted DCR incorporates both endoscopic and exterior techniques [4].

First reported in 1974, transcanalicular DCR represents a significant advancement in these alterations, offering benefits for conserving time and energy by using The Silicone tubes in the nose cause very little pain, and Not a disfiguring scar on top of It is simple to understand, do, and repeat [5].

The Saif technique [6-10] in transcanalicular dacryocystorhinostomy (TC-DCR) represents a pivotal advancement in the surgical management of nasolacrimal duct obstruction. Originally developed and introduced by Prof. Sayed S E.H. Saif [6-10] in the 1979, this method offers a minimally invasive alternative to conventional external DCR by establishing a direct lacrimal sac--nasal cavity connection through the canaliculi without the need for external incisions or laser energy. The technique utilizes Silicone tube intubation with precise placement through the nasolacrimal duct and middle meatus, ensuring adequate drainage and anatomical patency while minimizing operative trauma, bleeding, and scarring. The simplicity, repeatability, and efficiency of the Saif technique make it especially valuable in both resource-limited settings and patients for whom cosmetic outcomes are a concern [6-10].

Aim of the Work

The aim of this study is to compare the efficacy, safety, and outcomes of different surgical techniques for the management of nasolacrimal duct (NLD) obstruction, including conventional external dacryocystorhinostomy (DCR) and various trans-canalicular approaches. The study evaluates anatomical and functional success rates, intraoperative and postoperative complications, and patient satisfaction across the different procedures. This comparison aims to determine the most effective and minimally invasive technique suitable for a wide age range of patients with primary acquired NLD obstruction.

Method

This Non-randomized Comparative Study was conducted on 100 eyes of 100 patients aged 6 to 60 years, of both sexes, who presented with clinical criteria of nasolacrimal duct (NLD) obstruction. All methods were performed in accordance with the relevant guidelines and regulations, including the Declaration of Helsinki and institutional standards for human research as approved by the Faculty of Medicine, Beni-Suef University Research Ethical Committee (FMBSUREC/08032022/KESBA). Informed written consent was obtained from all participants.

Exclusion Criteria Included

- Previous dacryocystorhinostomy (DCR) surgery
- Lid anomalies or malposition
- Ocular surface diseases such as pemphigoid
- Lacrimal gland or sac tumors
- Acute dacryocystitis

Patients were divided into five groups based on the surgical procedure used:

- **Group A**: Conventional external DCR
- **Group B**: Trans-canalicular DCR – Procedure I
- **Group C**: Trans-canalicular DCR – Procedure II
- **Group D**: Trans-canalicular DCR – Procedure III
- **Group E**: Trans-canalicular DCR – Procedure IV

All patients underwent:

- Complete medical and ophthalmic history
- Full ophthalmic examination
- Regurgitation test
- Dye disappearance test
- Jones dye tests (Jones I and II)
- Lacrimal probing and irrigation
- ENT consultation

Surgical Technique

All surgical procedures were performed under appropriate anesthesia (local or general, depending on patient age and cooperation). Surgical technique selection was guided by surgeon assessment, anatomical factors, and predefined group allocation. Ex-DCR procedures were performed by M.A.S, whereas TC-DCR procedures were performed by M.Y.S. S...

Group A – Conventional External Dacryocystorhinostomy (Dcr)

A standard external DCR was performed via a vertical skin incision near the medial canthus. The lacrimal sac was exposed by blunt dissection. A bony ostium was created in the lacrimal bone using Kerrison rongeurs or a drill to expose the nasal mucosa. An anastomosis was established between the lacrimal sac and nasal mucosa using sutures. A silicone bicanalicular stent was placed in all cases and left in situ for 3–6 months (Figure 1 A). The skin was closed with fine sutures.

Group B-E–Transcanalicular Dacryocystorhinostomy (TC-DCR) Saif Technique [7-10]

The Saif technique is a minimally invasive, non-laser-based method of performing transcanalicular dacryocystorhinostomy (TC-DCR) for the treatment of distal nasolacrimal duct obstruction. It utilizes mechanical access and Silicone intubation (figure 1 B-C) without the need for external skin incisions (except in select modifications), laser energy, or endoscopy. The technique emphasizes anatomical precision, patient comfort, and ease of reproducibility.

Standard Surgical Steps (Figure 2 A-E)

Punctal and Canalicular Dilation: (Figure 2 A) A punctal dilator is gently used to enlarge both the upper and lower puncta and canaliculi.

Probing and Obstruction Assessment: (Figure 2 B) A Bowman probe is used to evaluate the type and extent of obstruction (partial or complete, distal only).

Creation of Sac-to-Nasal Access: (Figure 2 c) The medial wall of the lacrimal sac is perforated with a Nettleship dilator to establish a passage into the nasal cavity, targeting the middle meatus. Storz Silicone tubing is introduced by the wires (Figure 2 D – G) according to the procedural variation (I–IV), (Figure 3 A-G) ensuring proper drainage and patency. (Figure 4: Storz Silicone tubes).

Securing the Stent: The distal ends of the tubing are tied inside the nasal cavity to prevent displacement.(figure 1 G). After 6 months, the tube is removed non-surgically. The external loop is cut and the patient is instructed to compress the opposite nasal side and perform a forceful blow to exteriorize the tube for extraction with nasal forceps or hemostats.

Procedural Variations: (Figure 3 A-E)

- **Group B Procedure I (Figure 3 B):** A loop is formed using both the upper and lower canaliculi .Both limbs of the Silicone tube are passed into the middle meatus through the created osteotomy, ensuring a direct drainage pathway from the lacrimal sac into the nasal cavity.

- **Group C Procedure II (Figure 3 C):** A loop is formed using both the upper and lower canaliculi .One limb of the Silicone tube is passed through the nasolacrimal duct (NLD) and the other limb through the middle meatus, allowing dual-pathway drainage and increased stability.

- **Group D Procedure III (Figure 3 D):** A loop of Silicone tubing is formed within the lacrimal sac, with both limbs

exiting through the middle meatus, minimizing manipulation of the NLD and supporting direct sac-to-nasal flow.

- **Group E Procedure IV (Figure 3 E):** One limb is passed into the middle meatus, and the other through the NLD. A loop is formed using both the upper and lower canaliculi, and an external Nelaton catheter is introduced via a small skin incision to the middle meatus to facilitate sac access, large osteotomy and stent guidance.

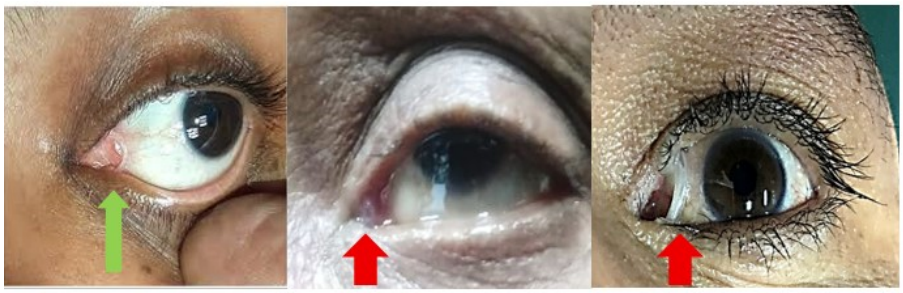

Figure 1: a: Silicone tube in place for group 1, B&C: Silicone tube for TC-DCR GROUP B-E

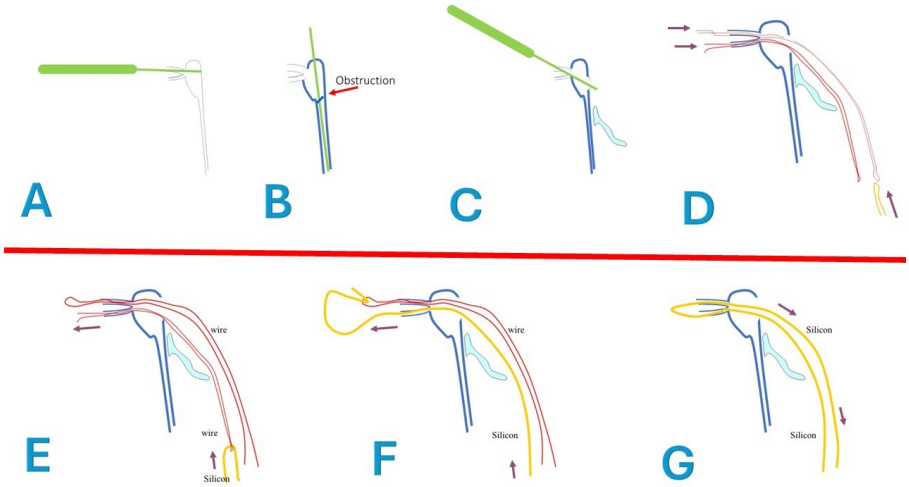

Figure 2: surgical steps, Silicone tubes (yellow color), wires (red color) , dilators (green color

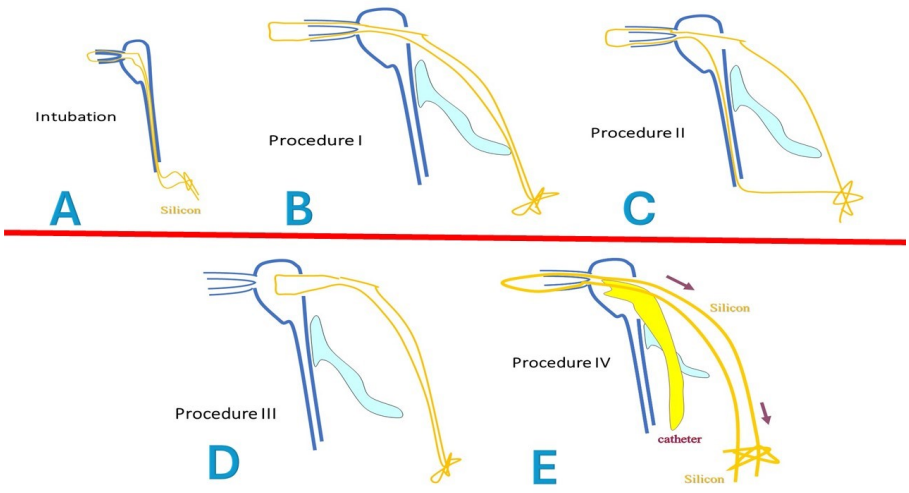

Figure 3: surgical procedures and variations

Figure 4: Storz Silicone Tubing, Different sizes available. The diameter used: 0.76 mm (inner) x 1.65 mm (outer), double-armed Crawford design, 300 mm length

Post-Operative

The Silicone tube was removed after 6 months and was assessed within 3 months from removing the tube. The catheter in group E was removed after 2-3 weeks

All patients undergo full examination in follow up visits on 1 day, one week, one month, 3 months, 6 months, and 9 months to assess surgical and anatomical success.

Anatomical Success: Confirmed lacrimal system patency on irrigation with normal saline and positive Jones II test.

Functional Success: Complete or near-complete resolution of epiphora, defined as Grade 0 or 1 on the Munk Scale [7] during follow-up.

Munk scale as a 5-point grading system based on the frequency of wiping tears:

- **Grade 0**: No epiphora
- **Grade 1**: Occasional epiphora requiring dabbing ≤ once a day
- **Grade 2**: Requires dabbing 2–4 times a day
- **Grade 3**: Requires dabbing 5–10 times a day
- **Grade 4**: Constant epiphora requiring dabbing >10 times a day

Surgical Failure: Persistent epiphora with negative irrigation or symptomatic recurrence

All patients were informed to report immediately in case of any side effect, complain or complication

The tube was removed through cutting it from between the canalicular loop then grasped with a hemostat or nasal forceps from inside the nose.

Statistical Analysis

Recorded data were analyzed using the statistical package for social sciences, version 23.0 (SPSS Inc., Chicago, Illinois, USA). The quantitative data were presented as mean ± standard deviation and ranges. Also, qualitative variables were presented as number and percentages.

Results

This Non-randomized Comparative Study included 100 eyes from patients with canalicular or nasolacrimal duct obstruction, evenly divided into five groups: Group A underwent conventional external DCR (EX-DCR), while Groups B through E underwent four procedural variations of transcanalicular DCR (TC-DCR) using Saif techniques. Baseline demographic and clinical characteristics—including age, sex, laterality, visual acuity, refraction, and fundus findings—showed no statistically significant differences between the groups ($p > 0.05$), ensuring comparability (Table 1). Preoperative diagnostic tests, including dye disappearance, Jones I, and Jones II, were similarly abnormal across all groups, confirming consistent inclusion criteria.

Surgical duration and intraoperative bleeding demonstrated clear advantages of TC-DCR over EX-DCR. Group A had the longest mean operative time (74.55 ± 11.42 minutes), significantly exceeding those of Groups B through E (range: 17.5–25.0 minutes; $p < 0.001$). Group D (loop in sac with both limbs in the middle meatus) had the shortest duration (17.50 ± 5.00 minutes), and Tukey's post hoc analysis confirmed statistically significant differences between Group A and all other groups ($p = 0.001$), as well as between Groups C and E ($p = 0.041$) and Groups D and E ($p = 0.004$) (Table 2). Similarly, intraoperative bleeding was greatest in Group A (110.90 ± 20.54 mL), significantly more than all TC-DCR groups ($p < 0.001$), where blood loss ranged from 43.50 ± 10.14 mL in Group B to 50.50 ± 11.91 mL in Group E. Post hoc comparisons confirmed significant differences between Group A and each TC-DCR group, while no significant bleeding differences were noted among TC-DCR groups themselves.

Postoperative epiphora was evaluated using the Munk scale at multiple intervals. On the first postoperative day, Grade 2 epiphora was predominant across all groups, without statistically significant variation ($p = 0.124$). At one week, however, a significant difference emerged ($p = 0.022$), with Group D demonstrating superior early outcomes—50% of patients had only Grade 1 symptoms, and only 40% remained at Grade 2—suggesting quicker symptomatic relief. At one month, this pattern persisted, with Group E reporting the highest proportion of Grade 1 patients (70%) and Group C the highest Grade 2 frequency (65%) ($p = 0.033$). Tukey's test further highlighted that Group D had statistically better outcomes than Groups C ($p = 0.034$) and E ($p = 0.022$). By three and six months, most patients had transitioned to Grade 0 or 1 epiphora, and differences between groups were no longer statistically significant. At nine months, the majority of patients in all groups (80–85%) had complete resolution of epiphora (Grade 0), with no significant intergroup variation ($p = 0.566$) (Table 3).

Anatomical success, defined by positive irrigation and Jones II testing at nine months, was observed in 85% of patients in Groups A, C, and D, 90% in Group B, and 80% in Group E, with no statistically significant differences ($p = 0.941$). Functional success, based on subjective epiphora resolution (Grade 0 or 1), mirrored anatomical outcomes and showed no significant difference between groups at final follow-up (table 4).

Postoperative complications were infrequent and not significantly different between groups ($p = 0.505$). Granuloma formation occurred in 15% of patients in Groups B, C, D, and E, but was absent in Group A. Only one case of postoperative infection was reported, in Group A. One case of early tube extrusion occurred in Group E. At the nine-month follow-up, residual epiphora was present in 15–20% of patients across all groups ($p = 0.980$), and anatomical patency on irrigation was confirmed in 80–90% of cases (Table 5).

In summary, transcanalicular DCR techniques demonstrated significantly shorter operative times and less intraoperative bleeding compared to conventional EX-DCR. Functional and anatomical success rates were comparable across all procedures, with Group D showing superior early symptom relief. All TC-DCR techniques proved to be safe and effective alternatives, with low complication rates and excellent long-term outcomes.

Table 1: Comparison between Groups According To Demographic Data, Side, Jones I, Jones II and Compliant

Demographic data		Group A	Group B	Group C	Group D	Group E	Test value	P
		(n=20)	(n=20)	(n=20)	(no=20)	(n=20)		
Age (years)		35.55±10.97	30.10±8.76	34.40±10.06	33.00±10.30	32.05±8.96	2.0767	0.126
Sex	Female	11 (55.0%)	12 (60.0%)	12 (60.0%)	12 (60.0%)	13(65.0%)	0.417	0.981
	Male	9 (45.0%)	8 (40.0%)	8 (40.0%)	8 (40.0%)	7 (35.0%)		
VA	20/20	15 (75.0%)	19 (95.0%)	16 (80.0%)	19 (95.0%)	19 (95.0%)	7.864	0.447
	20/25	4 (20.0%)	1 (5.0%)	3 (15.0%)	1 (5.0%)	1 (5.0%)		
	20/30	1 (5.0%)	0 (0.0%)	1 (5.0%)	0 (0.0%)	0 (0.0%)		
Refraction		-0.41±0.41	-0.93±0.44	-1.38±0.32	-1.88±0.41	-1.14±0.33	0.856	0.496
Fundus		19 (95.0%)	20 (100.0%)	20(100.0%)	20(100.0%)	20(100.0%)	4.04	0.401
Normal								
NPDR		1 (5.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)		
Abnormal Dye disappearance test		20 (100.0%)	20 (100.0%)	20(100.0%)	20(100.0%)	20(100.0%)	0	1
Side	Left	12 (60.0%)	8 (40.0%)	7 (35.0%)	8 (40.0%)	11 (55.0%)	3.784	0.436
	Right	8 (40.0%)	12 (60.0%)	13 (65.0%)	12 (60.0%)	9 (45.0%)		
Jones I		0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0	1
Jones II		20 (100.0%)	20 (100.0%)	20(100.0%)	20 (100.0%)	20(100.0%)	0	1
Compliant								
Discharge		1 (5.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4.04	0.401
Epiphora		20 (100.0%)	20 (100.0%)	20 (100.0%)	20 (100.0%)	20 (100.0%)	0	1
Mucocele		2 (10.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	8.163	0.086

Data were presented as mean ±SD or frequency%. VA: Visual acuity, NPDR: Nonproliferative Diabetic Retinopathy.

Table 2: Comparison between Groups According to Duration of Surgery in Minutes and Intraoperative Bleeding (Ml)

	Group A	Group B	Group C	Group D	Group E	Test value	P
	(n=20)	(n=20)	(n=20)	(no=20)	(n=20)		
Duration of surgery (min.)	74.55±11.42	22.30±11.06	19.75±3.81	17.50±5.00	25.00±5.38	180.112	<0.001*
Multiple comparison using Tukey's test						p-value	
Conventional Open DCR (Ga)			TC-DCR procedure I (Gb)			0.001**	
			TC-DCRprocedure II (Gc)			0.001**	

			TC-DCRprocedure III (Gd)			**0.001****	
			TC-DCRprocedure IV (Ge)			**0.001****	
TC-DCR procedure I (Gb)			TC-DCR procedure II (Gc)			0.317	
			TC-DCR procedure III (Gd)			0.061	
			TC-DCR procedure IV (Ge)			0.289	
TC-DCR procedure II (Gc)			TC-DCR procedure III (Gd)			0.377	
			TC-DCR procedure IV (Ge)			**0.041***	
TC-DCR procedure III (Gd)			TC-DCR procedure IV (Ge)			**0.004***	
Intraoperative bleeding (ml)	110.90±20.54	43.50±10.14	46.50±10.14	50.25±7.69	50.50±11.91	97.436	**<0.001***
Multiple comparison using Tukey's test						**p-value**	
Conventional Open DCR (Ga)			**TC-DCR procedure I (Gb)**			**<0.001****	
			TC-DCR procedure II (Gc)			**<0.001****	
			TC-DCR procedure III (Gd)			**<0.001****	
			TC-DCR procedure IV (Ge)			**<0.001****	
TC-DCR procedure I (Gb)			**TC-DCR procedure II (Gc)**			0.463	
			TC-DCR procedure III (Gd)			0.101	
			TC-DCR procedure IV (Ge)			0.089	
TC-DCR procedure II (Gc)			**TC-DCR procedure III (Gd)**			0.359	
			TC-DCR procedure IV (Ge)			0.328	
TC-DCR procedure III (Gd)			**TC-DCR procedure IV (Ge)**			0.951	

Using: One way Analysis of Variance test was performed for Mean ± SD & Multiple comparison between groups through Post Hoc test: Tukey's test p-value >0.05 is insignificant; *p-value <0.05 is significant; **p-value <0.001 is highly significant

Table 3: Comparison Between Groups According to Postoperative Patient's Satisfaction Epiphora According to Munk Scale Grading For Epiphora

		Group A	**Group B**	**Group C**	**Group D**	**Group E**	**Test value**	**P**
Postoperative Epiphora		**(n=20)**	**(n=20)**	**(n=20)**	**(no=20)**	**(n=20)**		
After 1 day	**Grade 1**	4 (20.0%)	1 (5.0%)	2 (10.0%)	9 (45.0%)	2 (10.0%)	17.726	0.124
	Grade 2	13 (65.0%)	15 (75.0%)	14 (70.0%)	8 (40.0%)	14 (70.0%)		
	Grade 3	2 (10.0%)	4 (20.0%)	4 (20.0%)	3 (15.0%)	3 (15.0%)		
	Grade 4	1 (5.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (5.0%)		
After 1 week	**Grade 1**	5 (25.0%)	3 (15.0%)	3 (15.0%)	10 (50.0%)	2 (10.0%)		
	Grade 2	12 (60.0%)	14 (70.0%)	16 (80.0%)	8 (40.0%)	14 (70.0%)	13.832	0.022*
	Grade 3	3 (15.0%)	3 (15.0%)	1 (5.0%)	2 (10.0%)	4 (20.0%)		
After 1 month	**Grade 0**	1 (5.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)		
	Grade 1	9 (45.0%)	6 (30.0%)	6 (30.0%)	13 (65.0%)	14 (70.0%)		

	Grade 2	7 (35.0%)	11 (55.0%)	13 (65.0%)	5 (25.0%)	2 (10.0%)	22.379	0.033*
	Grade 3	3 (15.0%)	3 (15.0%)	1 (5.0%)	2 (10.0%)	4 (20.0%)		
After 3 months	**Grade 0**	1 (5.0%)	2 (10.0%)	1 (5.0%)	0 (0.0%)	0 (0.0%)		
	Grade 1	12 (60.0%)	12 (60.0%)	10 (50.0%)	13 (65.0%)	15 (75.0%)		
	Grade 2	4 (20.0%)	3 (15.0%)	8 (40.0%)	5 (25.0%)	1 (5.0%)	12.945	0.373
	Grade 3	3 (15.0%)	3 (15.0%)	1 (5.0%)	2 (10.0%)	4 (20.0%)		
After 6 months	**Grade 0**	6 (30.0%)	3 (15.0%)	1 (5.0%)	6 (30.0%)	5 (25.0%)	14.825	0.251
	Grade 1	11 (55.0%)	14 (70.0%)	16 (80.0%)	11 (55.0%)	11 (55.0%)		
	Grade 2	0 (0.0%)	0 (0.0%)	3 (15.0%)	1 (5.0%)	2 (10.0%)		
	Grade 3	3 (15.0%)	3 (15.0%)	0 (0.0%)	2 (10.0%)	2 (10.0%)		
After 9 months	**Grade 0**	16 (80.0%)	17 (85.0%)	17 (85.0%)	17 (85.0%)	16 (80.0%)	10.572	0.566
	Grade 1	1 (5.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)		
	Grade 2	0 (0.0%)	2 (10.0%)	3 (15.0%)	1 (5.0%)	2 (10.0%)		
	Grade 3	3 (15.0%)	1 (5.0%)	0 (0.0%)	2 (10.0%)	2 (10.0%)		

Data were presented as mean ±SD or frequency%.x2: Chi-square test for Number (%) or Fisher's exact test, when appropriate--value >0.05 is insignificant; *p-value <0.05 is significant; **p-value <0.001 is highly significant

Table 4: Multiple Comparisons Using Tukey's Test

		Postoperative patients satisfaction	
Multiple comparison using Tukey's test		**1 week**	**1 month**
		p-value	**p-value**
Conventional Open DCR (Ga)	**TC-DCR procedure I (Gb)**	0.721	0.477
	TC-DCR procedure II (Gc)	0.355	0.221
	TC-DCR procedure III (Gd)	0.264	0.52
	TC-DCR procedure IV (Ge)	0.453	0.171
TC-DCR procedure I (Gb)	**TC-DCR procedure II (Gc)**	0.567	0.558
	TC-DCR procedure III (Gd)	0.061	0.081
	TC-DCR procedure IV (Ge)	0.841	**0.008***
TC-DCR procedure II (Gc)	**TC-DCR procedure III (Gd)**	0.034*	**0.039***
	TC-DCR procedure IV (Ge)	0.344	**0.002***
TC-DCR procedure III (Gd)	**TC-DCR procedure IV (Ge)**	**0.022***	0.369

Table 5: Comparison Between Groups According To Post-Operative Complications, Post-Operative Epiphora And Post-Operative Irrigation

	Group A (n=20)	Group B (n=20)	Group C (n=20)	Group D (no=20)	Group E (n=20)	Test value	P-Value
Post-operative complications	**1 (5.0%)**	**3**	**3**	**3**	**4**		
		-15.00%	**-15.00%**	**-15.00%**	**-20.00%**		
Granuloma	0 (0.0%)	3 (15.0%)	3 (15.0%)	3 (15.0%)	3 (15.0%)		
Infection	1 (5.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)		
Large tube extruded after one month	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (5.0%)	11.279	0.505
Post-operative epiphora	4 (20.0%)	3 (15.0%)	3 (15.0%)	3 (15.0%)	4 (20.0%)	0.425	0.98
Post-operative irrigation	17 (85.0%)	18 (90.0%)	17 (85.0%)	17 (85.0%)	16 (80.0%)	0.784	0.941

Discussion

External dacryocystorhinostomy (EX-DCR) has long been considered the gold standard in the management of nasolacrimal duct obstruction (NLDO), largely due to its high success rates. However, the evolution of minimally invasive alternatives such as transcanalicular dacryocystorhinostomy (TC-DCR) has prompted a shift toward procedures that minimize surgical trauma while maintaining comparable outcomes. Our study contributes to this ongoing shift by evaluating the outcomes of four variations of TC-DCR based on the principles originally described by[10], a pioneer in this field whose non-laser, mechanically-guided techniques date back to the 1970s and 1980s [6-10].

The current study found that all TC-DCR variations resulted in significantly shorter operative times and reduced intraoperative bleeding when compared to EX-DCR. These results are consistent with prior studies. For example, [12] reported a mean operative time of 8–25 minutes for transcanalicular laser DCR (TCL-DCR), while EX-DCR averaged around 54 minutes [12]. Our study corroborates these findings, with the mean duration in TC-DCR groups ranging from 17.5 to 25.0 minutes and a significantly longer duration in the EX-DCR group (74.55 ± 11.42 minutes). Likewise, [13] reported similar findings, with EX-DCR averaging 78 minutes [13].

Intraoperative bleeding was another differentiating factor. Our results showed a markedly higher volume of bleeding in EX-DCR (110.90 ± 20.54 mL) compared to TC-DCR groups (43.5–50.5 mL), aligning with studies such as [4], which emphasize the advantage of endoscopic and minimally invasive approaches in reducing intraoperative morbidity [4].

In terms of anatomical and functional success, our study found that TC-DCR outcomes were comparable to EX-DCR at 9 months, with success rates ranging from 80% to 90%. These findings closely parallel those of [14] who reported anatomical and functional success rates of 84.9% and 83%, respectively, for modified transcanalicular diode laser DCR (MT-DCR) over a long-term follow-up [14]. Similarly, [15] observed functional success rates of 93.2% in EX-DCR and 85.7% in TCL-DCR [15], further supporting the viability of TC-DCR, even in its non-laser form.

Crucially, our study revisits and validates the original Saif technique, particularly its mechanical and Silicone-intubation-based

philosophy, devoid of laser reliance. Prof. Dr. Saif's early publications demonstrated the efficacy of simple yet effective Silicone stenting techniques through the canaliculi, ensuring drainage patency with minimal invasiveness [6-10]. Our findings reinforce the continuing relevance of this approach. For instance, the Saif-derived Procedure III (loop in the sac with both limbs into the middle meatus) yielded the shortest operative duration and the best early postoperative satisfaction (Munk Grade 1 or better in 95% by 1 month), aligning with Saif's goal of a fast, effective, and cosmetically favorable procedure.

When comparing our outcomes with newer laser-based studies, such as those by [16], who reported patency rates dropping to 60.3% at two years for diode-assisted TCL-DCR [16], our results are particularly notable. Despite the absence of laser technology, all four TC-DCR variations in our study demonstrated sustained anatomical patency and functional improvement over 9 months. This challenges the assumption that laser energy is essential for optimal TC-DCR outcomes, as long as meticulous anatomical access and proper Silicone intubation are maintained.

Interestingly, [17] concluded that EX-DCR yielded better objective and subjective outcomes than diode-assisted TC-DCR, reporting a 73.7% success rate at one year for TC-DCR versus 89.5% for EX-DCR [17]. However, our findings suggest that non-laser TC-DCR using Saif's techniques can match or exceed these outcomes with fewer complications and higher early patient satisfaction—especially in Procedure III.

Postoperative complications in our study were minimal across all groups, with no statistically significant difference. Granuloma formation occurred in 15% of TC-DCR cases, tube extrusion in only one case (Group E), and no significant infection-related complications. These rates are in line with reports by [18] and [19], who also found low complication rates in TC-DCR with diode lasers [18-19].

The Munk scale was used to evaluate subjective patient satisfaction, and our use of this validated grading system is supported by its original description by [11]. Its use provided reliable, patient-centered insight into functional recovery and symptom relief. Notably, Grade 0 epiphora was achieved in 80–85% of patients in all groups by 9 months, highlighting the excellent long-term symptomatic relief provided by the procedures.

Finally, from a cost-effectiveness and accessibility standpoint, the Saif techniques—especially in their non-laser forms—offer clear benefits for resource-limited settings. Without the need for expensive diode lasers or endoscopic equipment, these procedures are reproducible and effective when anatomical knowledge and technique are emphasized.

Conclusion

In conclusion, our study affirms that Saif's mechanical transcanalicular techniques, particularly with variations such as sac-loop configurations (Procedure III), remain highly effective alternatives to conventional DCR and even to diode-laser-assisted approaches. Their short operative times, minimal bleeding, and high satisfaction rates—combined with low complication risks—underscore the continued relevance and clinical utility of Prof. Saif's original concepts. As the field moves toward minimally invasive lacrimal surgery, the refinement and broader application of these foundational methods deserve renewed attention in both academic research and clinical practice.

Disclosure Statements

Ethics Approval and Consent to Participate

This study was conducted after obtaining approval from the Ethical Committee of Beni-Suef University Hospitals. Informed

written consent was obtained from all participants prior to inclusion in the study.

Conflict of Interest

The authors declare that they have no conflicts of interest related to this work.

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Authors' Contributions

All authors contributed to the conception, design, data collection, analysis, and drafting of the manuscript. All authors have read and approved the final version of the manuscript.

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Data Availability

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Patient Consent

Written informed consent for participation and publication was obtained from all patients included in the study.

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