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ARTICLE

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Outcome of transcanalicular laser dacryocystorhinostomy with endonasal augmentation in acute versus post-acute dacryocystitis

Ruchi Goel[1]✉, Charu Sagar[1], Smriti Nagpal Gupta[1], Shalin Shah[1], Ayushi Agarwal[1], Priyanka Golhait[1], Sushil Kumar[1] and Raut Akash[1]

OBJECTIVE: To study the outcomes of transcanalicular laser dacryocystorhinostomy (TCL-DCR) with endonasal augmentation in acute versus post-acute dacryocystitis and compare it with external DCR in post-acute settings.

METHODS: A prospective, randomised study was conducted in 90 adult cases of Acute dacryocystitis. All the patients were started on systemic antibiotics and a 4 mm × 4 mm osteotomy was created using TCL-DCR. The osteotomy was enlarged to 8 mm × 8 mm by endonasal augmentation at the same sitting in group 1, after 10 days in group 2 and after 10 days with external DCR in group 3. The cases were assessed for symptomatic relief and complications. Success was defined as functional and anatomical patency at 36 months.

RESULTS: The mean age was 45.33 ± 15.06 years and the male: female ratio was 1:2. The presenting complaints were painful swelling (100%), epiphora or discharge (88.8%), fistula (33%) and fever (6%). The average number of acute episodes was 2.96. The intra-group pain reduction from day 1 to day 4, was significant in all three groups ($p = 0.000$). Intra-operative ($p = 0.015$, $\chi^2 = 8.37$) and post-operative complications ($p = 0.002$, $\chi^2 = 0.002$) were higher in group. Anatomical success was achieved in all the three groups, however, the functional success in Group 3, Group 2 and Group 1 was 100%, 86.7% and 66.7% respectively ($p = 0.002$, $\chi^2 = 12.86$).

CONCLUSIONS: The creation of osteotomy using TCL-DCR provides early relief in symptoms. Single-stage surgery in inflamed tissues is associated with higher complication rates. External DCR in post-acute settings gives the best outcomes with minimal complications, endoscopic augmentation requires a close follow-up.

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INTRODUCTION

Acute dacryocystitis is a painful condition which may progress to sight-threatening infections such as orbital cellulitis, orbital abscess, necrotising fasciitis, osteomyelitis, or cavernous sinus thrombosis [1–3]. The nasolacrimal duct obstruction (NLDO) causes a collection of fluid and distension of lacrimal sac, resulting in kinking of common canaliculus and abscess formation. The poor penetration of antibiotics in the abscess cavity causes progression of infection despite aggressive antibiotic therapy. External dacryocystorhinostomy (Ex-DCR) if performed in the acute stage can result in the spread of infection in tissue planes, septicaemia, excessive bleeding and wound gape [4, 5].

The conventional treatment involves administration of systemic antibiotics, warm compresses and percutaneous drainage of lacrimal sac empyema initially, followed by Ex-DCR in the post-acute phase. The incision and drainage (I&D) of the sac provides pain relief and control of infection [6]. It may however result in the formation of a fistulous tract due to persistence of infection in the stagnated tears in the lacrimal sac due to NLDO [7].

Endoscopic dacryocystorhinostomy has been found to be safe in acute settings, reducing morbidity and economic burden related to multiple courses of systemic antibiotics for recurrent acute attacks [8, 9]. However, there is inconsistency in the success rates of transcanalicular laser DCR (TCL-DCR), endonasal surgical DCR and primary powered endoscopic DCR in acute settings varying from 67 to 94.4% [8, 10–12].

The creation of a passage from the lacrimal sac into the middle meatus using laser energy through transcanalicular approach drains the lacrimal abscess, avoiding the attendant complications related to the I&D performed through the skin incision.

This study was undertaken to evaluate the outcomes of TCL-DCR with endonasal augmentation in acute and post-acute settings and Ex-DCR in post-acute settings.

MATERIALS AND METHODS

This prospective, randomised and comparative study was conducted in 90 eyes of 90 adult patients suffering from Acute dacryocystitis presenting to Oculoplasty clinic at a tertiary care centre, New Delhi from September 1,

[1]Department of Ophthalmology, Guru Nanak Eye Centre (Associated with Maulana Azad Medical College), New Delhi, India. ✉email: gruchi1@rediffmail.com

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2016, to March 31, 2018. Institutional ethics committee approval was taken and the study was carried out in accordance with guidelines of the Declaration of Helsinki. Acute dacryocystitis was defined as painful distension of the lacrimal sac with medial canthal inflammation. Exclusion criteria included the previous history of DCR surgery, patients with nasal pathologies like allergic rhinitis, nasal polyp, neoplasia, severe high deviated nasal septum, lid or canalicular abnormalities and ocular surface disorders likely to cause reflex hyper lacrimation. The subjects were enroled after obtaining informed, written consent and were randomly allocated into three groups using computer software (Research Randomiser).

A detailed history of onset, duration of discharge, swelling, pain and fever was taken and previous interventions and recurrences were noted. A complete general physical, nasal and ocular examination was performed. The medial canthal area was examined for any swelling, fistulous opening or scar mark. All patients were started on tab amoxicillin–clavulanic acid 625 mg 8 hourly.

Group 1, underwent TCL-DCR with endonasal augmentation in the acute stage. In group 2 endonasal augmentation and in group 3 Ex-DCR was performed in the post-acute phase, 10 days after a course of systemic antibiotics and creation of 4 mm × 4 mm osteotomy through transcanalicular route, using Appasamy LASER DCR 980 nm Super Diode 15W in continuous mode. The recruitment of patients is given in the flow chart (Fig. 1).

SURGICAL TECHNIQUE

All surgeries were performed as a day-care procedure under local anaesthesia by a single experienced surgeon (RG). Intramuscular diclofenac 75 mg and promethazine 25 mg were administered prior to surgery and the ipsilateral nasal cavity was packed with ribbon gauze soaked in 4% lignocaine with 1 ml of 1:10,000 adrenaline. Topical 4% lignocaine drops were instilled in the affected eye and local infiltration was performed with 2% lignocaine, 1:80,000 adrenaline, bupivacaine 0.75% and hyaluronidase 25 IU/ml. The lacrimal sac contents were aspirated using 22G needle for gram staining and culture sensitivity. The upper punctum was dilated with a Nettleship punctum dilator and 0.4 mm silicon-coated fibre-optic cable of 980 nm Diode Laser was introduced through the upper canaliculus into the sac. The nasal pack was removed and the aiming beam was visualised through a zero degree nasal endoscope. Laser energy was delivered at 8W continuous mode to vaporise the lacrimal sac mucosa and the underlying bone to create a 4 mm × 4 mm opening.

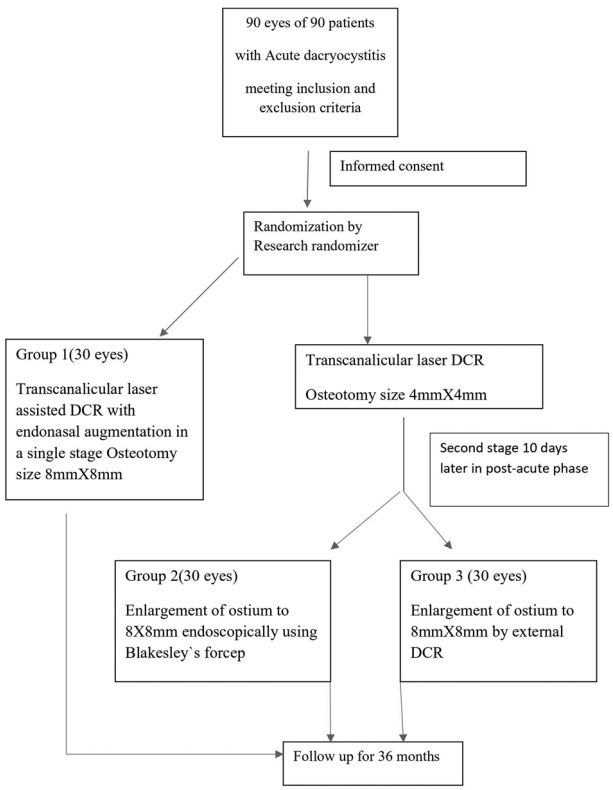

Fig. 1 Flow chart Recruitment of study participants into the three groups. Flow chart showing recruitment of study participants.

The ostium was enlarged to 8 mm × 8 mm in all three groups surgically. In groups 1 and 2 enlargement was done endoscopically using 45° Weil Blakesley's forceps in the same sitting and after 10 days respectively. In group 3, Ex- DCR was performed after 10 days. After completion of the surgery, the nasal cavity was packed using a solution of 2% lignocaine with adrenaline 1:80,000.

Post-operative regimen and assessment

The post-operative regimen included tab amoxicillin–clavulanic acid 625 mg 8 hourly for 5 days and tab serratiopeptidase 10 mg thrice a day for 7 days, topical ofloxacin 0.3% 6 hourly for 2 weeks and oxymetazoline 0.05% thrice a day thrice a day for 10 days. Group 2 and 3 patients received an additional course of tab amoxicillin–clavulanic acid after the second stage. Tab ibuprofen 400 mg was given as per pain scoring. Antibiotic was changed if resistance was reported on culture sensitivity. Suture removal was done on the 10th day in group 3.

The patients were followed up on: Day 1, Day 4, Day 7, every 2 weeks till 2 months, then 6 monthly till 36 months. Complications like bleeding, infection, pain, lid oedema or any other complaints were noted. Regular syringing was performed to check the patency and Munk scoring was used to assess the watering. Pain scoring was done using the Visual Analogue Scale (0.5 and 10 indicating none, moderate and worst pain respectively) on days 1, 4 and 7 post-operatively.

A successful outcome was defined as both, anatomical patency on syringing and functional success in terms of relief in pain, swelling and epiphora at the end of 36 months. An independent observer, blinded to the group allocation, followed up cases from 4th week to 36 months.

Statistical methods

Descriptive analysis of age were performed in terms of mean and standard deviation. The categorical variables were reported as percentages. Chi- square test was used to compare the complications and success rates of the three groups. Annova test and post hoc analysis was performed to estimate the intergroup difference. The intra-group pain scores were evaluated using paired *t* test. *P* value of <0.05 was considered significant. The analysis was performed using statistical software package IBM SPSS statistics 25.0 (IBM, Chicago, IL).

RESULTS

The mean age was 45.33 ± 15.06 years and the male: female ratio was 1:2. The right eye was affected in 60 and left in 30 patients. The presenting complaints were painful swelling in 90 eyes (100%), epiphora or discharge in 80 eyes (88.8%), fistula in 30 eyes (33%) and fever in 5 cases (6%). The average number of acute episodes on presentation was 2.96. All the patients had received one or multiple courses of systemic cephalosporins or amoxicillin–clavulanic acid prior to presentation. A large sac swelling was observed in 36 eyes (40%). Difficulty in inserting the fibre optic through the canaliculus was encountered in 21 cases. The intra-group pain reduction from day 1 to day 4, was significant in all three groups ($p = 0.000$ by paired *t* test).

The intergroup difference between pain scores in the three groups on day 1 and day 4 was insignificant ($p = 0.146$, $p = 0.665$, $p = 0.221$ respectively). The intergroup difference in pain reduction from day 1 to day 4 between group 1 versus group 2, group 1 versus group 3 and group 2 versus group 3 was not significant ($p = 0.055$, $p = 0.197$, $p = 0.518$ respectively by post hoc test).

Table 1. Complications and success rates in the three groups.

		Group 1 (%) $n = 30$	Group 2 (%) $n = 30$	Group 3 (%) $n = 30$	Chi Square (χ^2)	*P* value
Complications						
Intra-operative	Excessive bleeding	13.3	0.0	0.0	8.37	**0.015**
	Laser burn	13.3	0.0	0.0	8.37	**0.015**
Early post-operative (≤7 days)	Periorbital edema	60.0	33.3	13.3	14.35	**0.001**
Late post-operative (>7 days)	Swelling	20.0	0.0	0.0	12.86	**0.002**
	Watering	6.7	13.3	0.0	4.29	0.117
	Discharge	6.7	13.3	0.0	4.29	0.117
Success rates						
Functional	Present	66.7	86.7	100.0	12.86	**0.002** Group 1 versus Group 3
Anatomical	Present	100	100	100		

Bold values indicate statistical significance.

There were no intra-operative complications in groups 2 and 3 (Table 1, Fig. 2). Excessive bleeding and laser burn occurred in four cases of Group 1 ($p = 0.015$, $\chi^2 = 8.37$). The bleeding was controlled by nasal packing and intramuscular injection of 250 mg ethamsylate. The laser burn healed within a week with daily dressing with 5% povidone-iodine. Forty percent cases in groups 1, 66.7% patients in group 2 and 86.7% patients in group 3 had no complication at all ($p = 0.001$, $\chi^2 = 29.83$).

Periorbital oedema was observed in the early post-operative period (≤7 post-operative days) in all the groups but was more in Group 1, 60% ($p = 0.001$, $\chi^2 = 14.35$).

In the late post-operative phase, the swelling was significantly higher (20%) in group 1 as compared to the other two groups ($p = 0.002$, $\chi^2 = 0.002$). The difference in occurrence of watering and discharge was not statistically significant in the three groups ($p = 0.117$).

The lacrimal sac aspirates showed growth on culture in 48 patients, 91.67% (44 of 48) of the isolated bacteria were resistant to the Penicillin group of drugs (Table 2).

Anatomical success was achieved in all the three groups, however, the functional success in Group 3, Group 2 and Group 1 was 100%, 86.7% and 66.7% respectively ($p = 0.002$, $\chi^2 = 12.86$). The patients with functional failure were due to sump syndrome between 10 and 24 weeks and were managed with endoscopic enlargement of the ostium with Blakesley's forceps.

DISCUSSION

Acute dacryocystitis has been recognised as a 'high-risk category' for DCR, resulting in variable outcomes due to the acute inflammatory state [13, 14]. Traditional surgical intervention with Ext-DCR in post-acute settings is being replaced by endoscopic DCR in the acute phase [8–15]. This study was performed to assess the outcome of TCL-DCR with endonasal augmentation in acute and post-acute phase and compare it with the gold standard Ext-DCR in the post-acute phase. To avoid the possibility of creation of a fistulous tract, the lacrimal sac was drained through an opening created by transcanalicular diode laser into the middle meatus.

The mean age in the present study was 45.33 ± 15.06 years, similar to ref. [16] the third decade being reported by other authors [8, 9, 17]. Female preponderance was noted as in previous reports [9, 15–17].

The presenting complaints in our study were painful swelling (100%), epiphora or discharge (88.8%), fistula (33%) and fever (6%). Ali et al. reported swelling (84.4%), discharge (40.3%), epiphora (1.1%) and fever (5.8%) as presenting symptoms [15].

Besides difficult insertion of laser fibre-optic probe in 21 cases because of local inflammation and skin excoriation, no significant challenge was encountered in the creation of laser osteotomy. Aspiration of lacrimal sac prior to the passage of fibre-optic probe eased visualisation of the punctum in large swellings. Four cases in Group 1 had excessive bleeding during endoscopic instrument enlargement of the ostium. Since diode laser achieves tissue dissection with minimum haemorrhage [18], bleeding occurred due to nasal mucosal damage caused by the instrumental manipulation of the inflamed tissues. Chisty et al. also observed greater intra-operative bleeding than routine cases, in a prospective study of powered endoscopic DCR in 21 patients with acute dacryocystitis [8].

Four patients in group 1 had charring of the medial canthal skin by the laser (Fig. 2). Though laser was used to create the initial 4 mm × 4 mm osteotomy, similar to the other 2 groups, prolonged manipulation in inflamed tissues could have resulted in skin excoriation in group 1.

Post-operative pain, assessed using a visual analogue scale showed a significant reduction by the 4th post-operative day in all three groups. This early resolution could be attributed to the establishment of patency, combating the stagnation and thereby augmenting the effect of antibiotics. Similar early resolution of pain has been reported in various studies [9, 10, 15, 16].

The post-operative complications of laser-assisted DCR in chronic dacryocystitis includes periorbital oedema, ecchymoses, haematoma formation, canalicular erosion, nasal synechiae, nasocutaneous fistula, granulation tissue formation as well as thermal injury to the canaliculus [19–22]. In the present series, 18 patients had periorbital oedema in the early post-operative period, which was significantly more in group 1, possibly due to the longer duration of surgery in comparison to the other groups.

The commonest bacteria isolated from the lacrimal sac aspirate in our study was *Staphylococcus aureus* and all the pathogenic bacteria showed resistance to the penicillin group. Lee and Woog observed that 27.3% of cases were resistant to the penicillin group of drugs and were taking antibiotics for long periods [12]. In a report by Mills et al. the frequency of MRSA in acute cases was greater than that in chronic dacryocystitis [23]. Barrett et al. in a retrospective multicentric study of 39 cases of acquired lacrimal sac fistula after I&D for dacryocystitis found resistance to prescribed antibiotics in 10% cases [7]. Non-penetrance of antibiotics in the lacrimal abscess and high rates of antibiotic

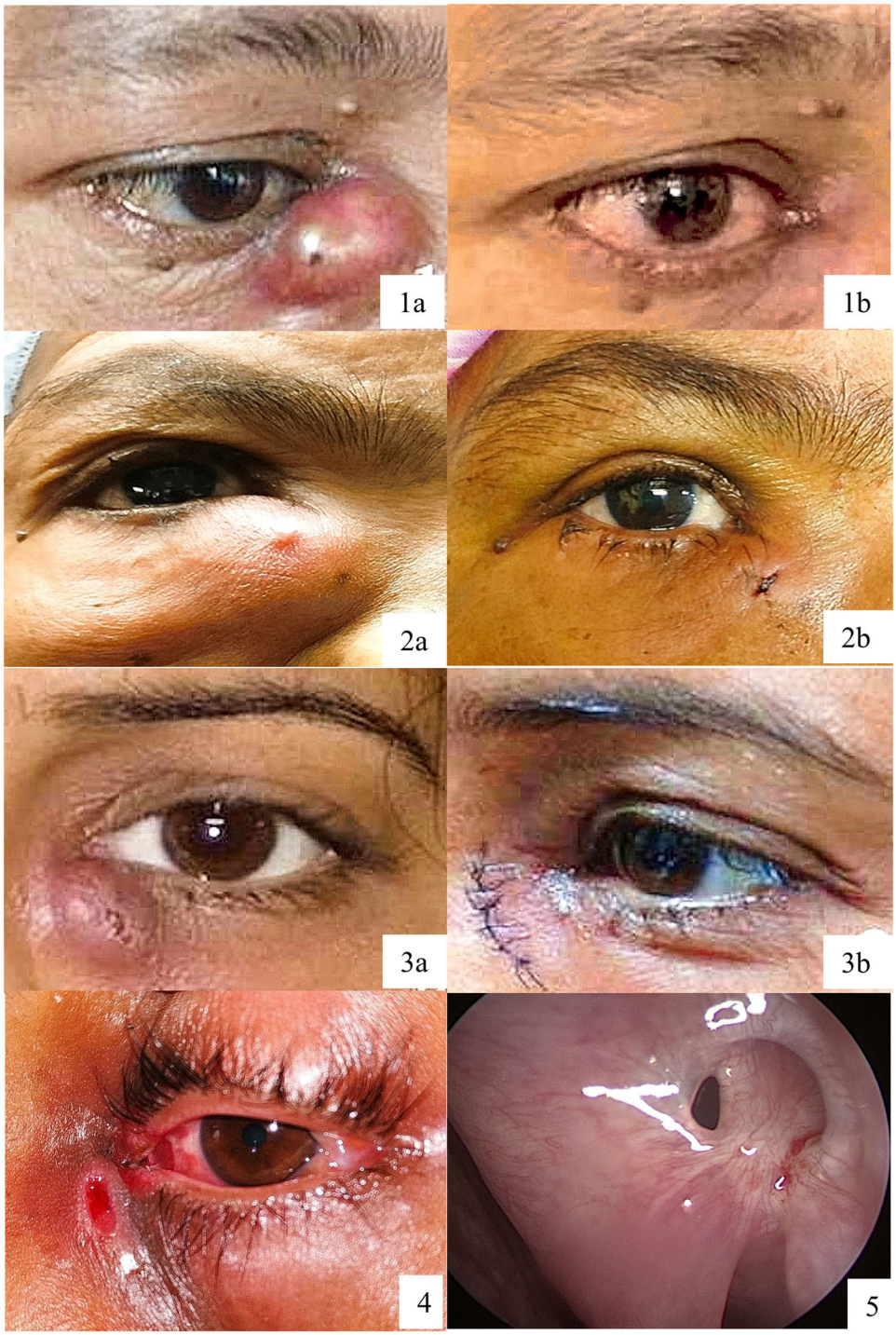

Fig. 2 Pre and post-operative clinical images in the three groups. Clinical image of group 1 case 1 (**a**) preoperative 1 (**b**) post-operative seventh day. Clinical image of group 2 case 2 (**a**) preoperative 2 (**b**) post-operative seventh day. Clinical image of group 3 case 3 (**a**) preoperative 3 (**b**) post-operative seventh day. 4 Clinical image of group 1 case showing laser burn on first post-operative day. 5 Endoscopic view of osteotomy seen in group 1 case at 4 weeks.

resistance may be responsible for non-resolution of infection despite multiple courses of antibiotic therapy.

Endoscopic surgical and transcanalicular multidiode laser DCR have been shown to have comparable success rates and complications in primary acquired nasolacrimal duct obstruction (PANDO) [24]. Madge et al. proposed superiority of mechanical endonasal DCR with cold steel instruments over laser-assisted techniques for osteotomy creation in acute dacryocystitis [11]. The low success rates of 67% at 11 months, after TCL-DCR using Holmium:YAG laser [10] were attributed to small size and improper placement of ostium [17]. Lombardi et al. used diamond burr (4 mm) with intermittent saline irrigation to reduce heat damage to soft tissues [14]. Lee and Woog used a hybrid technique, powered drill and then YAG laser to create the ostium [12]. To minimise laser-induced thermal injury we created the initial 4 mm × 4 mm osteotomy with diode laser and subsequent enlargement to 8 mm × 8 mm was done with Blakesley's forceps.

Table 2. Microbiological isolates from lacrimal sac aspirates and their antibiotic resistance.

S. No	Organism	Patients	Sensitive	Resistance
1	*Klebsiella spp*	8	Gentamicin, piperacillin + tazobactam, amikacin, ceftriaxone, ciprofloxacin, imipenem	Amoxicillin–clavulanic acid
2	*MRSA*	8	Teicoplanin, vancomycin, erythromycin, clindamycin, linezolid	Penicillin
3	*MSSA*	20	Erthromycin, clindamycin, gentamicin, linezolid, vancomycin	Penicillin
5	*E. coli*	4	Colistin, imipenem intermediate sensitivity to gentamicin, meropenem	Amoxycillin
6	*Acinetobacter spp*	4	Ciprofloxacin, piperacillin + tazobactam	Amoxicillin–clavulanic acid, amikacin, imipenem
7	*CoNS*	4		

MRSA methicillin-resistant staphylococcus aureus, *MSSA* methicillin-susceptible staphylococcus aureus, *E. coli* Escherichia coli, *CoNS* coagulase negative staphylococci.

Table 3. Review of success rates of previous studies on endoscopic DCR in Acute dacryocystitis.

S. no	Author, ref.	Follow-up (average)	Procedure	Anatomical success	Functional success
1.	Naik and Naik [25]	6 months	Endonasal surgical DCR + intubation	92.3%	92.3%
2.	Lombardi et al. [14]	29 months	Endonasal surgical DCR + intubation	96.2%	96.2%
3.	Kamal et al. [9]	6 months	Powered endoscopic DCR + MMC + intubation	95%	90%
4.	Chisty et al. [8]	15.4 months	Powered endoscopic DCR + MMC + intubation	85.7%	80.9%
5.	Joshi and Deshpande [17]	61.7 months	Endonasal surgical DCR	82.1%	
6.	Li et al. [27]	12 months	Powered + surgical endonasal DCR + MMC + intubation	87.5%	87.5%

MMC Mitomycin C.

Silicone intubation and Mitomycin C have been used to improve the success rates in endoscopic and non-endoscopic endonasal DCR [8, 9, 11, 12, 15, 25, 26]. Though intubation maintains the patency of the newly formed ostium, stenting has been shown to increase granulation tissue formation, which has been suggested as a cause of failure [27]. Duggal et al. suggested that passage of stents is difficult in acute dacryocystitis and may lead to the formation of false passage [28]. Silicone intubation did not offer additional advantage in TCL-DCR with endonasal augmentation in PANDO [22]. In this study, neither Mitomycin C nor silicone intubation was used.

Variable success rates have been reported in different studies (Table 3). Functional failure in Groups 1 and 2, resulted from sump syndrome between 10 and 24 weeks. Revision with endoscopic surgical enlargement helped in resolution of symptoms in all the cases. The occurrence of sump syndrome in our series could have been due to the distended lacrimal sac in acute dacryocystitis. The larger size of sac, though a disadvantage in TCL-DCR, has been described as being helpful in endoscopic surgical DCR by Lombardi et al. They achieved 96.2% success in their series of 26 patients suffering from acute dacryocystitis with lacrimal sac empyema. They attributed the higher success to wide exposure of lacrimal sac medial wall and use of mucosal flaps to cover the drilled bone. They suggested that larger lacrimal sac flaps allowed sufficient mucosal tissue to cover the bone and reduce the risk of ostium shrinkage and obstruction [14].

Incorporation of saline irrigation with budesonide along with endoscopic sinonasal debridement, post-operatively in acute dacryocystitis is recommended to improve the outcomes of endoscopic DCR [13]. We performed regular post-operative syringing in our patients, which helped to flush out the debris and maintain patency of the newly created passage.

The limitations of the study were small sample size and inability to mask the group 3 patients at the time of final assessment.

To conclude, the creation of osteotomy using TCL-DCR, relieves the stagnation of the lacrimal sac, obviates the risk of fistula formation and provides early relief in symptoms of acute dacryocystitis. Prolonged surgery in inflamed tissues is associated with higher complication rates in a single-stage procedure. Ext-DCR in post-acute setting gives the best outcome with minimal complications even without intubation or application of mitomycin C. Endoscopic surgical augmentation in post-acute settings, gives comparable results, but requires a more meticulous follow-up to enable repeat intervention. A blanket treatment with a penicillin group of drugs is not justifiable due to the large scale emergence of antibiotic resistance.

SUMMARY

What was known before

- Conventional management includes systemic antibiotics, percutaneous I&D followed by Ex-DCR in post-acute phase.
- Percutaneous incision and drainage can lead to fistula formation.
- Endoscopic DCR can be safely performed in acute settings.
- Silicone intubation and Mitomycin-C application increases the success rate of endoscopic DCR in acute settings.

What this study adds

- TCL-DCR can be used as an alternative to I&D for lacrimal sac drainage to provide early symptomatic relief, without the risk of creation of fistulous tract.
- TCL-DCR with nasal augmentation gives comparable success with Ext-DCR in post-acute phase.

- TCL-DCR with nasal augmentation in acute phase results in significantly higher complications and failures than Ext-DCR in post-acute phase.
- TCL-DCR with nasal augmentation mandates close follow-up to enable timely re-interventions.

DATA AVAILABILITY

The datasets generated during the current study are not publicly available, being a part of a university dissertation but are available from the corresponding author on reasonable request.

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AUTHOR CONTRIBUTIONS

Conception and design of the study: RG, CS. Analysis and interpretation of data: RG, CS, SS. Writing the article: RG, CS, SNG. Critical revision and final approval of the article: RG, CS, SNG, AA. Data collection: RG,CS, AA, PG, RA. Provision of materials, patients and resources: RG, CS, SK. Literature search: RG, CS, PG, RA.

COMPETING INTERESTS

The authors report no competing interests. The authors alone are responsible for the content and writing of the paper.

CONSENT FOR PUBLICATION

Informed written consent for publication of their images in printed media has been obtained from all participants.

ADDITIONAL INFORMATION

Correspondence and requests for materials should be addressed to Ruchi Goel.