Transcanalicular Laser-Assisted Dacryocystorhinostomy

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Introduction

Epiphora, due to primary and secondary nasolacrimal duct obstructions (NLDO), is generally managed by dacryocystorhinostomy (DCR) techniques aiming to reconstruct the lacrimal drainage system. The obstructed outflow pathway is redirected by connecting the lacrimal sac to the middle nasal cavity to relieve symptoms. External dacryocystorhinostomy (EX-DCR) is the standard surgical technique for the treatment of NLDO, described first by Toti in 1904 [1]. Dupuy-Dutemps and Bourguet modified it in 1921 with the introduction of the anastomosis of the lacrimal sac and nasal mucosal linings [2]. Despite the published high success rates of EX-DCR exceeding 90% [3–5], the search for a scarless DCR technique that can be performed quickly and with high success rates has continued [6–12].

Development of high-resolution fiber-optic endoscopes and fine endonasal surgical tools in the late 1980s intensified the interest in endoscopic management of lacrimal obstructions, where laser energy could be used to rapidly create a precise and bloodless rhinostomy opening during a scarless technique [13, 14]. Laser energy can be delivered either nasally, as in endonasal laser-assisted DCR (ENL-DCR), or via a probe passed through the canaliculus, referred to as transcanalicular laser-assisted DCR (TCL-DCR). Both techniques allow the surgeon to create the alternative route for lacrimal drainage; however, TCL-DCR is likely safer than ENL-DCR, as the laser beam is directed toward the nose and away from the orbit. In Fig. 46.1a, TCL-DCR is schematically presented.

Endoscopic DCR procedures avoid the external scar as well but necessitate additional surgical equipment and visualization systems. Laser delivery systems facilitate the precise removal of bone and soft tissues and minimize bleeding while creating the rhinostomy during endoscopic lacrimal techniques. However, the cost and maintenance of these devices are high. Laser safety measures also deserve maximum attention in surgical rooms.

Historical Perspective

Jack published the first transcanalicular DCR in 1963 [15]. In 1992, Levin and Silkiss studied laser endocanalicular DCRs on cadavers [16, 17], while Christenbury performed the first TCL-DCR with argon laser assistance on patients with NLDO [18]. Various laser wavelengths have been utilized to create the rhinostomy in lacrimal surgery, such as neodymium:YAG (Nd:YAG) laser [19–24], holmium:yttrium-aluminum-garnet (Ho:YAG) laser [25–27], potassium-tytanyl-phosphate (KTP) laser [28, 29], and erbium:YAG (Er:YAG) laser [30].

The use of solid-state diode laser for lacrimal surgery was first reported in 1994 by Mchugh, and an interventional case series of TCL-DCR with high success was reported by Eloy in 2000 [31, 32]. The diode laser subsequently gained popularity among other laser delivery devices, possibly due to relatively lower costs of buying and maintenance. TCL-DCR continues to remain the subject of many ongoing studies [26, 32–39].

Management of Epiphora via TCL-DCR

Transcanalicular laser-assisted DCR is performed with the assistance of nasal endoscopy to visualize the aiming beam and laser probe in the middle meatus during lacrimal surgery. The laser delivers focal energy to open the rhinostomy site, for the management of NLDO as explained below. The major advantages of TCL-DCR are briefly listed in Table 46.1.

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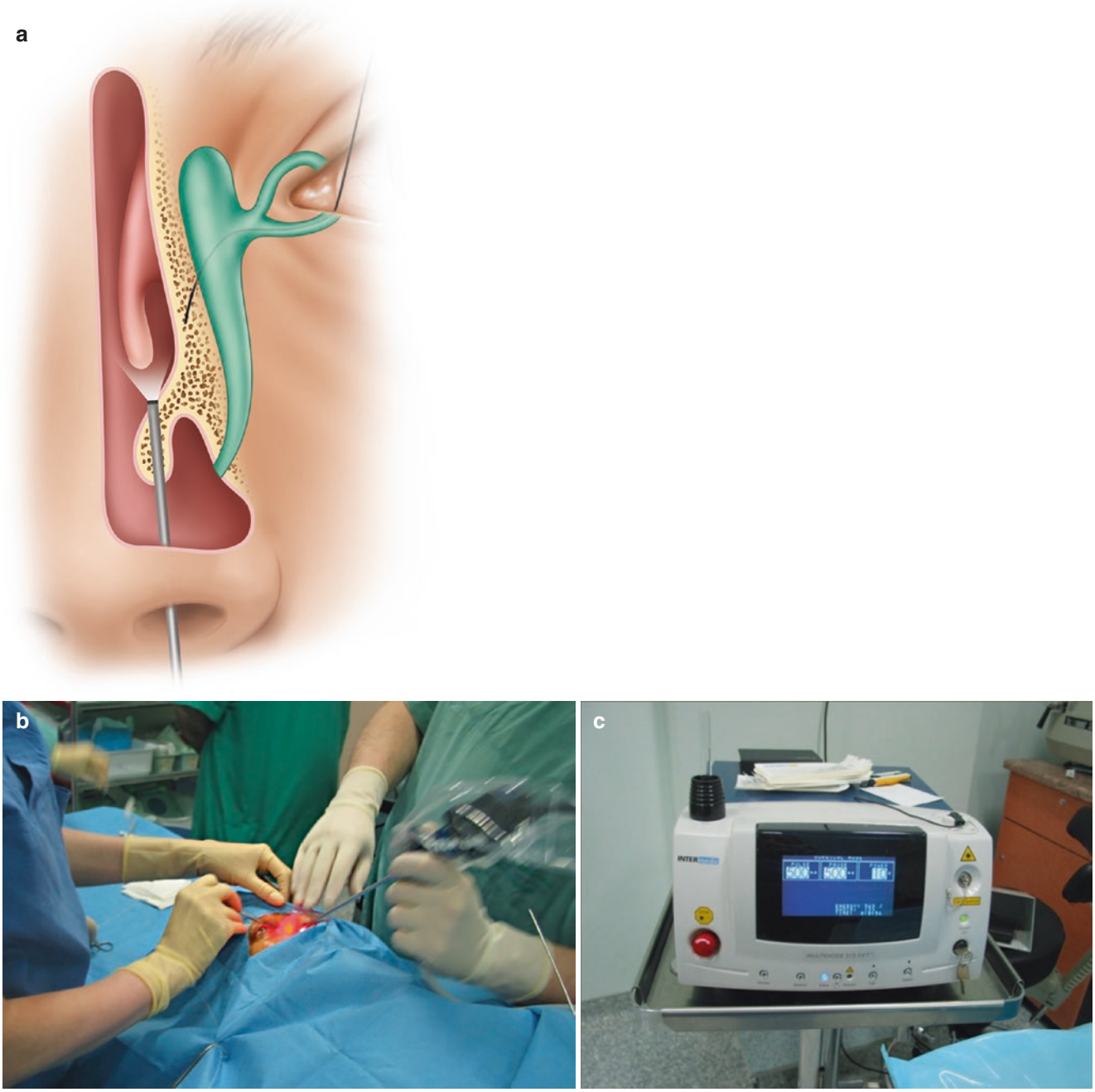

Fig. 46.1 (**a**) Schematic illustration of the transcanalicular laser DCR. The laser fiber-optic probe is introduced through the inferior punctum and canaliculus until a hard bony stop is felt. The aiming beam is turned on and visualized transmucosally in the nasal cavity with the endoscope, typically at the level anterior to the middle turbinate. (**b**) Performing TCL-DCR surgery with the Multidiode S30 OFT (INTERMEDIC Inc., Spain). (**c**) Multidiode S30 OFT (INTERMEDIC Inc., Spain)

Table 46.1 Advantages of transcanalicular laser-assisted dacryocystorhinostomy (TCL-DCR)

Avoids a facial scar
Minimal trauma to medial canthal structures
Less bleeding, particularly useful in patients on anticoagulation
Faster intraoperative time
Shorter recovery time

Diagnostic Evaluation and Patient Selection for TCL-DCR

Patients with nasolacrimal drainage system obstructions typically present to clinic with epiphora and/or dacryocystitis. A large tear lake with mucoid or purulent discharge is a

common sign of nasolacrimal duct obstruction. All patients with a history of tearing and/or dacryocystitis must be evaluated via a clinical work-up and ophthalmic examination to rule out other causes of epiphora, such as blepharitis, conjunctivitis, keratitis, eyelid malpositions or laxity, and orbicularis oculi muscle weakness. The lacrimal sac area should be palpated for a mass and/or copious mucopurulent reflux, indicating a dacryocele (dacryocystocele). If a dacryocele is evident, it would be anticipated that the enlarged lacrimal sac flaps would need to be trimmed down for a successful DCR. Therefore, such patients may not be appropriate candidates for minimally invasive techniques, or the sac flaps would require adequate shortening transnasally during the endoscopic surgery.

The puncta and lacrimal canaliculi must be evaluated if canaliculitis is suspected. Definitive treatment of this condition typically requires canaliculotomy for drainage and curettage.

When considering the transcanalicular approach, office lacrimal irrigation to evaluate its patency and to determine the level of any obstruction in the proximal drainage system is mandatory.

Nasal cavity examination by the surgeon may identify intranasal pathologies such as hypertrophic or bullous middle turbinate, nasal polyps, and septal deviation. In patients with narrow nasal cavities, endoscopic surgery may be more challenging to perform.

A ^{99m}Tc-DTPA (diethylenetriaminepentaacetic acid) dacryoscintigraphy scan can be considered for patients with a history of tearing despite patent lacrimal irrigation, as this may detect functional epiphora in addition to a prolonged dye disappearance test. In contrast, dacryocystography (DCG) can be helpful to diagnose an anatomic etiology for outflow obstruction, such as a filling defect from a lacrimal sac mass, foreign bodies, or dacryolith. Dilated or undersized fibrotic sacs can be detected by DCG and be helpful in the differential diagnosis.

Punctal and/or canalicular stenosis, history of nasal and/or lacrimal surgery, naso-orbital trauma, congenital nasolacrimal duct occlusion, and previous transconjunctival blepharoplasty are important risk factors to elicit before TCL-DCR.

In some instances, TCL-DCR may not be easily performed in patients with prominent frontal processes and wide dorsum nasi, as the manipulation of the laser probe is limited. The use of pediatric TCL-DCR surgery is controversial due to the risk of significant fibrosis caused by heat convection. Table 46.2 summarizes the contraindications for TCL-DCR.

Table 46.2 Contraindications for transcanalicular laser-assisted dacryocystorhinostomy (TCL-DCR)

Suspected lacrimal system and midfacial neoplasms
Proximal lacrimal drainage apparatus pathology
Nasal pathologies that limit visualization
Suspected dacryolithiasis or intrasaccal foreign body
Granulomatous diseases
Collagen tissue disorders
Acute dacryocystitis[a] and lacrimal sac abscess[a]
Large dacryoceles[a]
Lacrimal fistulae[a]
Children[a]
Previous lacrimal surgery of unknown indication[a]
Accidental and/or surgical trauma to midface and orbital bony structures[a]
Allergic and/or atrophic rhinitis[a]

[a]Denotes relative contraindications for TCL-DCR

Surgery

TCL-DCR surgery with diode laser assistance has become increasingly popular worldwide (Fig. 46.1a–c). This technique can be performed under local anesthesia, with or without sedation, or under general anesthesia.

Preoperative Preparation Premedication to aid in hemostasis and analgesia is performed with 0.05% xylometazoline +1% lidocaine nasal spray and nasal cavity packing using absorbent sponges soaked in xylometazoline 0.05% with 1:200,000 epinephrine. The uncinate process mucosa and medial canthal area are infiltrated with approximately 1–4 ml of 1:1 volume 1% lidocaine HCl with 0.0125 mg/ml adrenaline and 0.05% bupivacaine HCl. An acrylic corneal protector is placed to protect cornea. Laser safety rules must be strictly applied to prevent operating room hazards and patient or staff injuries.

Surgical Steps

Surgery is performed with a clean setup and sterile draping. The 980 nanometer (nm) wavelength diode laser is delivered via a silica-silica polyamide laser fiber optic. The Multidiode S30 OFT laser delivery device (INTERMEDIC Inc., Spain), equipped with a 600 μm silica-silica polyamide laser fiber optic is displayed in Fig. 46.1c.

The preferred total caliper of the probe with the sleeve is between 300 and 600 microns. Laser settings are adjusted for each patient, ranging between 8 and 12 W power range, 350–500 milliseconds pulse time, and 350–500 milliseconds pause duration between pulses to use the lowest amount of energy sufficient to create an osteotomy.

The diode laser fiber optic is passed through the canaliculus into the lacrimal sac, until the bright transillumination of the aiming beam can be seen via a nasal endoscope with a 0° or 30° angle (Fig. 46.2a). An anteriorly located ethmoidal cell may prevent direct access to the nasal cavity, or ethmoidal

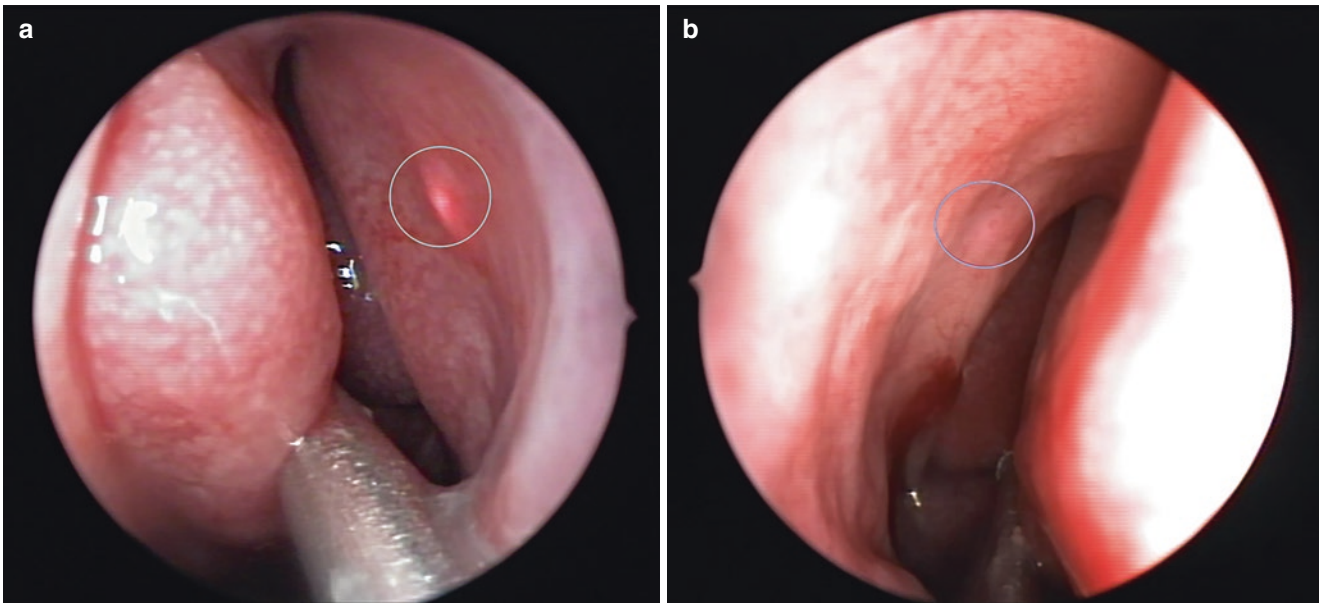

Fig. 46.2 (**a**) Bright transillumination of the aiming beam (in blue circle) is seen when the tip is in the lacrimal sac posterior to the uncinate process. (**b**) The aiming beam (in blue circle) is dull when not in the sac, or there is an intervening ethmoidal air cell between the sac and nasal cavity

cells may be entered instead. The aiming beam is dull in these cases (Fig. 46.2b).

The surgical steps of TCL-DCR are demonstrated in Fig. 46.3a–d. The upper canaliculus is typically the preferred entrance as long as the aiming beam is clearly visible across the middle turbinate. Infracture or medialization of the middle turbinate may be necessary in some cases for better view of the lateral nasal wall (Fig. 46.4). A bullous or large middle concha may be partially resected to debulk its volume to prevent functional blockage of the ostium (Fig. 46.5).

Laser energy is the delivered until the large bony opening is created, at least 5 mm in diameter. The ostium can then be further enlarged with rongeurs through the nasal cavity to decrease the amount of laser energy delivered. A can opener type of laser application (Fig. 46.6) may also decrease the total laser energy. The rhinostomy is opened by the removal of the sac mucosa-lacrimal bone-nasal mucosa button created.

In a patient with a wide dorsum nasi, the frontal process of the maxillary bone is generally thick. In these patients, it should be kept in mind that the total laser energy delivered to open a large enough rhinostomy would be quite high and could cause extensive thermal damage to the neighboring tissues.

It is also recommended to minimize the in-out maneuvers with the laser probe through the canaliculi in order to avoid trauma to the delicate endothelial lining of the proximal drainage system. The debris around the osteotomy is preferably removed transnasally with a Takahashi endo-forceps and backbiting rongeur. Once the carbonized debris (Fig. 46.7) is cleared around the ostium, bicanalicular silicone intubation is performed to facilitate healthy endocanalicular epithelialization.

Adjunctive antifibrotic agents applied during TCL-DCR should be applied precisely to the ostium via an irrigation cannula, followed by copious irrigation of the ocular surface. A dry surgical sponge is placed in the nasal ostium during this procedure to minimize contact of the healthy nasal mucosa from the antifibrotic agent. The lacrimal tract can then be irrigated with 0.2% dexamethasone and 2% gentamycin mixture or 0.9% NaCl solution.

Occasionally, the surgeon may choose to convert to a conventional external DCR with skin approach if an adequately sized bony ostium could not be created via TCL-DCR. The common technical and intraoperative difficulties in performing TCL-DCR are listed in Table 46.3.

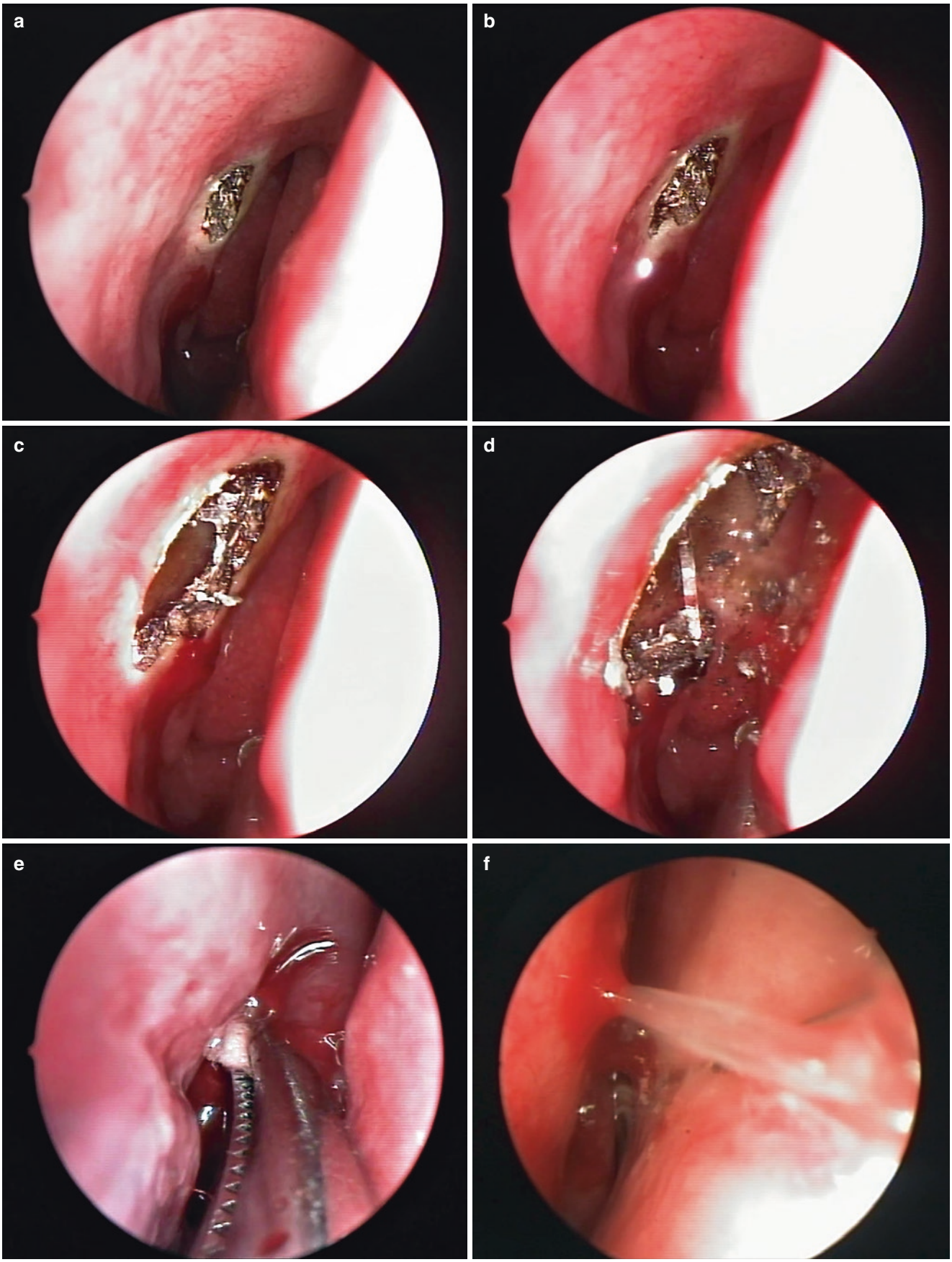

Fig. 46.3 Surgical steps of TCL-DCR: (**a**) rhinostomy, initial opening; (**b**) aiming beam in the lacrimal sac; (**c**) rhinostomy, mid-surgery; (**d**) probe tip in the lacrimal sac entering the nasal cavity next to the middle turbinate; (**e**) antifibrotic agent application to the rhinostomy site; (**f**) rhinostomy site and silicone tube

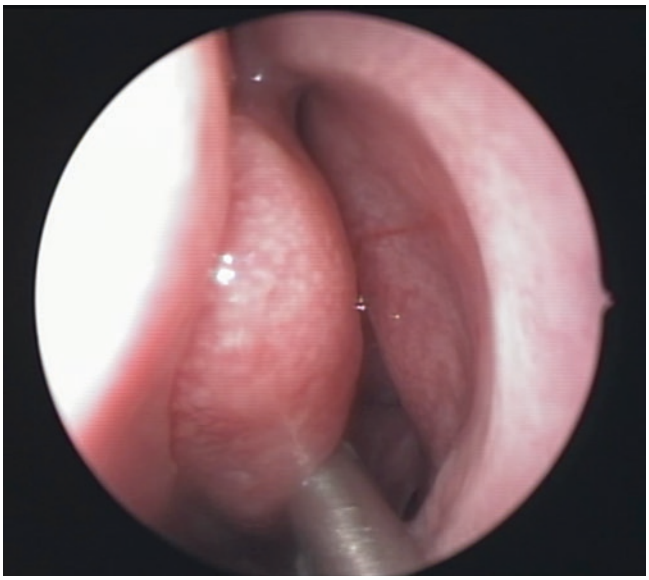

Fig. 46.4 Middle turbinate is medialized

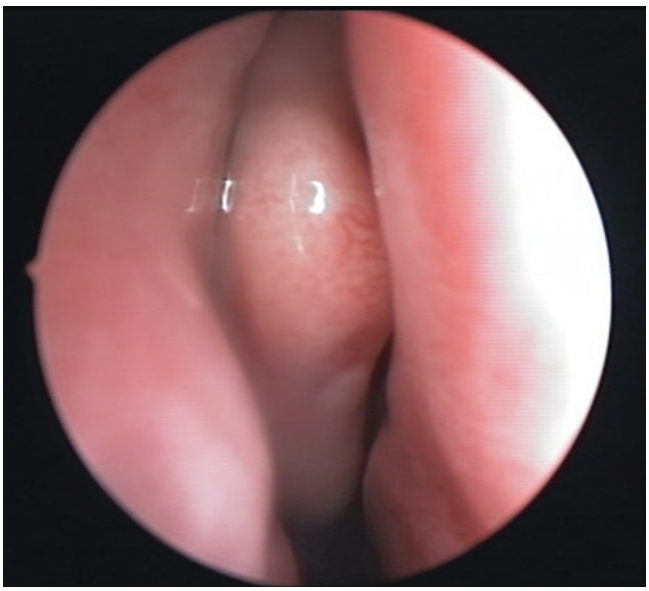

Fig. 46.5 A large bullous concha is seen

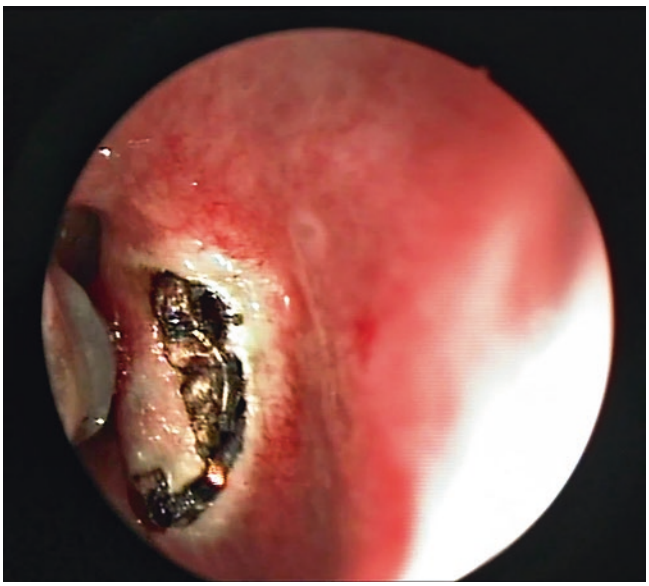

Fig. 46.6 A can opener-type laser application is shown

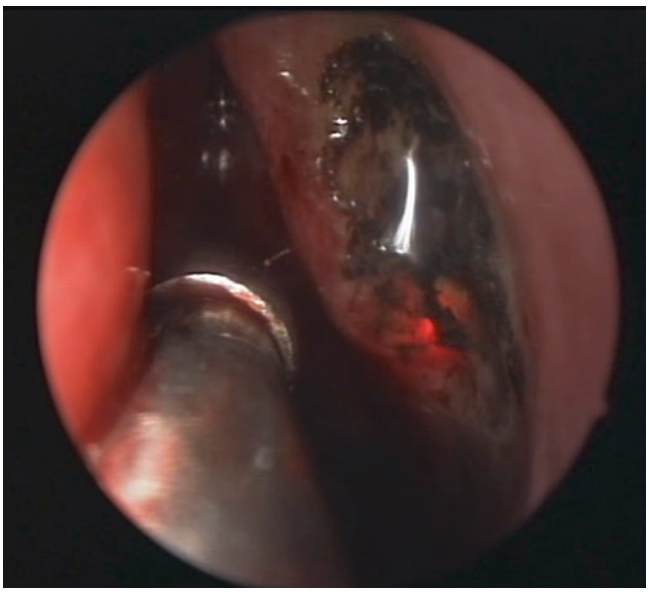

Fig. 46.7 Enlarging the rhinostomy following laser ablation. The carbonized debris is cleared around the ostium

Table 46.3 Difficulties in performing TCL-DCR

Requires additional equipment and tools
Indirect visualization of surgical site
Limited surgical space
Nasal and canalicular pathologies may affect the surgical outcome
Prominent frontal process of maxilla and/or saddle nose may limit probe manipulation

Postoperative Care

After surgery, eye patching for 4 hours with sterile antibiotic and corticosteroid drops is often advised. Although rarely necessary, nasal packing can be removed later that day or the following day if used. Cold compresses used frequently in

the first 24 hours after surgery help decrease pain and edema. Topical, and occasionally systemic, antibiotics are prescribed for 1 week. Nasal and ocular steroids and nasal saline spray are continued for 3 weeks postoperatively. Follow-up visits are recommended at postoperative day 1, day 3, week 1, month 1, and every 3 months until the end of the first postoperative year to check for recurrence of symptoms or infection. The ostium is examined, and any debris clogging the ostium removed if still present after the first postoperative week. The patency of the new rhinostomy is assessed by dye disappearance test (DDT), or lacrimal irrigation if the DDT is fluorescein-negative intranasally. Bicanalicular stents are typically removed between 1 and 3 months postoperatively.

Tissue Response to Laser in TCL-DCR

Laser wavelength, laser power and energy, method of application (contact or noncontact), application mode (continuous, burst, or pulsed), and tissue properties play important roles in the tissue response to laser [39]. Several studies have assessed the histological effects of different wavelength lasers on various tissues [40–44]. Scanning electron microscopy studies revealed large coagulation zones underneath the ablated hypertrophic inferior nasal turbinates following Nd:YAG and diode lasers. The coagulation effect was noted to be minimal with CO_2 lasers, whereas the ablative effect of CO_2 was the most precise [45].

In vitro thermal tissue effects induced by contact application of fiber-guided lasers, such as Ho:YAG, Nd:YAG, and diode lasers (830, 940 nm), which are similar to those used for endocanalicular DCR approaches, revealed that the 830 nm diode laser created the widest ablation zones.

Although the 810–980 nm diode laser, operating in wavelengths near the infrared part of the light spectrum, is highly absorbed by melanin and hemoglobin to provide good hemostasis, the coagulative effect of the contact mode was less than the noncontact mode of the 830 nm diode laser and contact mode of the Ho:YAG laser [41, 44].

Histopathologically, inflammation and reepithelialization are delayed when lasers are used, as compared to the steel scalpel, as shown on guinea pig oral mucosa. Complete reepithelialization occurred by the end of the first week with the scalpel, compared to the fourth week with CO_2 laser. Resolution of inflammation was also delayed up to 4 weeks with lasers and bipolar cautery, compared to resolution of inflammation by the second week when using the scalpel [42, 43, 46]. The most extensive coagulation damage with delayed reepithelialization was noted with Nd:YAG applications, and more prominent inflammatory infiltration was seen in Nd:YAG and combined CO2-Nd:YAG wounds compared to CO_2 and non-laser wounds [43, 47].

Briefly, the 2940 nm Er:YAG and 2140 nm Ho:YAG lasers have good bone ablation properties with limited coagulative effects [48]. The 532 nm KTP laser has both good cutting and coagulating properties. The 1064 nm Nd:YAG laser can lead to significant collateral damage in spite of its good ablative effect. Diode lasers in the 830–980 nm wavelength segment have demonstrated both good cutting and coagulating effects with less collateral damage and are more effective in the noncontact mode. Due to these characteristics, combined with its applicability via fiber probes ranging between 0.4 and 1.0 mm and fiber-optic tips that confine the laser energy to the tip, the diode laser has gained popularity in endocanalicular nasolacrimal surgery [49]. Newer compact and more easily operated diode laser delivery systems are also available, which enable the surgeon to mobilize the device if needed (Fig. 46.1c).

However, based on the current data available in peer-reviewed literature, it is unclear whether a particular laser source provides a significant advantage over the others with respect to clinical outcomes [24, 39, 49]. Practically speaking, laser assistance in lacrimal surgery enables precise, bloodless, easy, and fast ablation of the mucosa-bone-mucosa tissues at the rhinostomy site with minimal trauma to adjacent tissues. Adequate coagulation is achieved in the well-vascularized nasal mucosa; however, some degree of heat is conveyed to the vicinity of the surgical site.

The advantages of diode lasers are therefore reported as its ability to deliver a sufficiently powerful laser beam via a relatively narrow optical fiber with less collateral heat spread and less residual thermal damage to tissue.

Surgical Outcome of TCL-DCR

Functional success after lacrimal drainage surgery is assessed by the recovery of patency by lacrimal irrigation and the resolution of epiphora and dacryocystitis. Anatomical success describes an unobstructed ostium and lacrimal pathway but may be paradoxically accompanied by ongoing symptoms of obstruction.

Success rates reported for TCL-DCR with erbium:YAG [30], neodymium:YAG, and holmium:YAG lasers are 75%, between 64% and 85%, and between 47% and 82.5%, respectively [19–26]. However, these studies are not comparable due to the variable demographics of the study groups, number of patients, and follow-up periods.

Despite the limited number of published articles involving laser-assisted lacrimal surgery, the increasing number of solid-state diode laser delivery devices in ophthalmology and otolaryngology worldwide has led to more studies of diode laser-assisted TCL-DCR since first published by Eloy in 2000 [33–37]. The success rates of diode laser-assisted TCL-DCR for treating primary NLDO in adults range from

34% [50] to 95.2% [51]. The majority of these interventional case series report the success rates of TCL-DCR higher than 80%, close to the success rates of EX-DCR of 90–98% [3, 52] and endonasal DCR, which are between 61% and 100% [53–60]. Several studies comparing the outcome of EX-DCR and TCL-DCR with diode laser assistance revealed functional success of 89–95.4% for EX- DCR versus 73.7–84% for TCL-DCR [61–63]. A similar study by Ajalloueyan reported 92.6% success for EX-DCR and 93.4% for TCL-DCR, with less hemorrhage and shorter surgical times (19 versus 67 minutes) noted in the diode laser TCL-DCR group [64]. The shorter operative time of diode laser-assisted TCL-DCR (approximately 20 minutes) versus EX- DCR (60–90 minutes) has also been confirmed by others [61, 62, 65]. Piedrola compared diode laser-assisted techniques for transcanalicular and transnasal DCRs with similar outcomes [66].

Piaton then introduced the use of mitomycin-C (MMC) as an adjunct in Ho:YAG and Nd:YAG laser-assisted TCL-DCR [19, 23]. Henson used 0.4 mg/ml MMC for 5 minutes during 40 diode laser TCL-DCR procedures and reported a success rate of 87.5% after 12 months [67]. Henson then stated that "the cicatricial closure of the ostium can still occur even with a single intraoperative application of MMC." By applying multiple applications of MMC (0.4 mg/ml for 5 minutes) postoperatively after TCL-DCR, he then found higher success rates of 92.8% after 12 months in 125 diode laser-assisted TCL-DCR surgeries [68]. In general, although antifibrotic agents such as MMC and 5-FU have demonstrated potential benefits, the published data in laser-assisted DCR are not consistent, and high doses of adjunctive MMC applications during and/or after TCL-DCR may damage ocular and nasal surfaces [69–72].

Kaynak et al. reported a 60.3% functional success with diode laser-assisted TCL-DCR with intraoperative 0.2 mg/ml MMC applied at the rhinostomy site in a large series of patients with PANDO with 2-year follow-up. The relatively high failure rate was attributed to the overall greater total energy delivered, when compared to similar studies [38].

Low-level diode laser irradiation of cultured human oral mucosa fibroblasts in vitro has been found to lead to an increase in DNA synthesis [73]. In a similar study, laser-patterned microcoagulation using the 980 nm diode laser on the oral mucosa of healthy rabbits demonstrated stimulation of gingival and oral mucosal tissue regeneration. The study concluded that "laser-patterned microcoagulation treatment with the 980nm diode laser is a promising method for treating degenerative diseases of the oral soft tissues," such as gingivitis and gingival recession [74]. With these studies in mind, it can be postulated that the high amount of laser energy used to create a large bony ostium in TCL-DCR may cause increased fibroblastic activity and wound healing, thus contributing to ostium fibrosis and surgical failure. Theoretically, laser delivery systems with irrigating ports may decrease the thermal effect of ablative lasers on the surgical site and surrounding tissues; however, published data is lacking in the ophthalmic literature. One study using a diode laser with an irrigation port for TCL-DCR yielded 83.3% functional success with an average of 245 joules of total energy delivered [37]. The higher success rates may be attributed to the lower heat delivered due to the irrigation system attached to the laser probe, which decreases thermal injury to the rhinostomy site and neighboring tissues.

In TCL-DCR, an inferiorly located rhinostomy of at least 7 mm diameter may sometimes be difficult to achieve by laser ablation only. Aggressive attempts may lead to higher energy delivery and subsequent thermal damage to both mucosal surfaces that may lead to fibrosis and failed TCL-DCR. To decrease the energy delivered and to place the rhinostomy more inferiorly, endonasal mechanical enlargement of the ostium have shown increased success rates. The mechanical removal of the composite mucosal tissue and bone along the rhinostomy circumference also removes the charred tissues as well, leaving raw rhinostomy edges for healing by secondary intention [75, 76].

Middle turbinectomy during TCL-DCR, if necessary, may also increase the success from 71% to 88% [77]. TCL-DCR can also be performed with anastomosed flaps with good success rates, although technically this is much more challenging [78].

The functional success rate of secondary diode laser TCL-DCR has been reported as 80% for treating failed external DCR (27.3-month follow-up). Similarly, patients who had failed TCL-DCR may be treated via subsequent external DCR with 80% success [79].

Uysal reported 100% anatomical success and 85% functional success at the end of 20-month follow-up in a study group of 18 children with NLDO between the ages of 4 and 10 years treated with TCL-DCR [80]. Çakmak reported an 87.5% success rate in eight children with a shorter follow-up of 9 months [81]. It may be that iatrogenic canalicular injury by the laser probe to the delicate proximal drainage system in children may lead to robust fibrosis and proximal lacrimal system obstruction. Generally, the success rate of TCL-DCR for the younger population is lower when compared with an elderly population [82]. TCL-DCR may therefore be considered as a relative contraindication in the pediatric population.

Table 46.4 summarizes the data from studies where various lasers are used in TCL-DCR.

Table 46.4 Outcome of TCL-DCR with various lasers

Author(s)	Year	Laser assisted	No. of eyes	Follow-up (months)	Success rate (%)
Christenbury	1992	Argon	12	–	50
Piaton	1994	Nd:YAG	41	6	75
Dalez et al.	1996	Ho:YAG	26	7	47
Rosen et al.	1997	Nd:YAG	14	20	64
Pearlman et al.	1997	Nd:YAG	49	24	85
Eloy et al.	2000	Diode	26	–	65
Muellner et al.	2001	KTP	48	6	83
Caversaccio et al.	2001	Er:YAG	12	19	75
Piaton et al.	2001	Nd:YAG[a]/Ho:YAG[b]	317	6	63.2
Hofmann et al.	2003	KTP	78	12	83
Alanon et al.	2004	Diode	34	11	94.1
Hong et al.	2005	Nd:YAG	102	9.5	73.6
Alanon et al.	2006	Diode[a]/diode	150[a]/50	15	92[a]/78.2
Henson et al.	2007	Diode[a]	40	12	87.5[a]
Plaza et al.	2007	Diode	25	36	88
Ajalloueyan et al.	2007	Diode	122	18	93.4
Maeso and Sellarès	2007	Diode/diode[a]	75/75[a]	16	92/97[a]
Narioka and Ohashi	2008	Diode	15	27.3	80[c]
Cintra and *A. Lima*	2008	Diode	32	6	88
Cakmak and Yildirim	2010	Diode	8	9	87.5[d] (mean age: 11.25 years)
Uysal et al.	2011	Diode	20	20.5	85[d] (mean age: 6.11 years)
Basmak et al.	2011	Diode/diode[e]	44/47[e]	11/9.2[e]	71/88[e]
Henson et al.	2012	Diode[a]	125[a]	12	92.8[a]
Drnovsek-Olup et al.	2010	Diode	126	6	83.3
Nuhoglu et al.	2012	Diode	42	42	95.2
Derya et al.	2013	Diode	25	7	68
Dogan et al.	2013	Diode/diode[a]	27/30[a]	24	80/84.3[a]
Robert et al.	2013	Diode[f]	7[f]	10	89[f]
Kaynak et al.	2014	Diode[a]	125[a]	24.3	68.2[a](60.3[a])[g]
Taşkıran-Çomez et al.	2014	Diode[a]	34/28[a]	6	79.4[a]
Uludağ et al.	2015	Diode	19	12	73.7
Goel et al.	2016	Diode	30	12	90
Mourya and Rijal	2017	Diode	79[81]	–	90.1

DCR dacryocystorhinostomy, *KTP* potassium titanyl phosphate, *Nd:YAG* neodymium:yttrium-aluminum-garnet, *Er:YAG* erbium:yttrium-aluminum-garnet
[a]Intraoperative adjunctive MMC is applied
[b]Intraoperative adjunctive 5FU is applied
[c]Revision TDL-DCR for failed EX-DCR
[d]Pediatric age group
[e]TCL-DCR with partial anterior middle turbinectomy
[f]Mucosal flaps are done after laser ablation
[g]Functional success rate in the same group

Complications and Failure of TCL-DCR

Canalicular lacerations, punctal slitting, and punctal adhesions are not rare in TCL-DCR (Fig. 46.8a, b).

Due to the oval shape of the lacrimal sac, which is narrower inferiorly, the ability of the surgeon to move the laser probe anteriorly and posteriorly during TCL-DCR becomes more restricted as the probe is advanced more inferiorly, and punctal and canalicular lacerations can occur due to the forced manipulation. Therefore, the final ostium is usually wider superiorly and narrower inferiorly (Fig. 46.9a–f). The narrow inferior part can be easily occluded with mucosal proliferation forming a residual lacrimal sac leading to a sump syndrome. The patient may exhibit a patent ostium by irrigation (due to flow through the opening superiorly) but have functional epiphora. Closure of the ostium due to fibrosis and/or adhesions between the middle turbinate and the ostium are other causes of failure. Excessive thermal injury is a well-known risk factor for nasal mucosal and ostium adhesions.

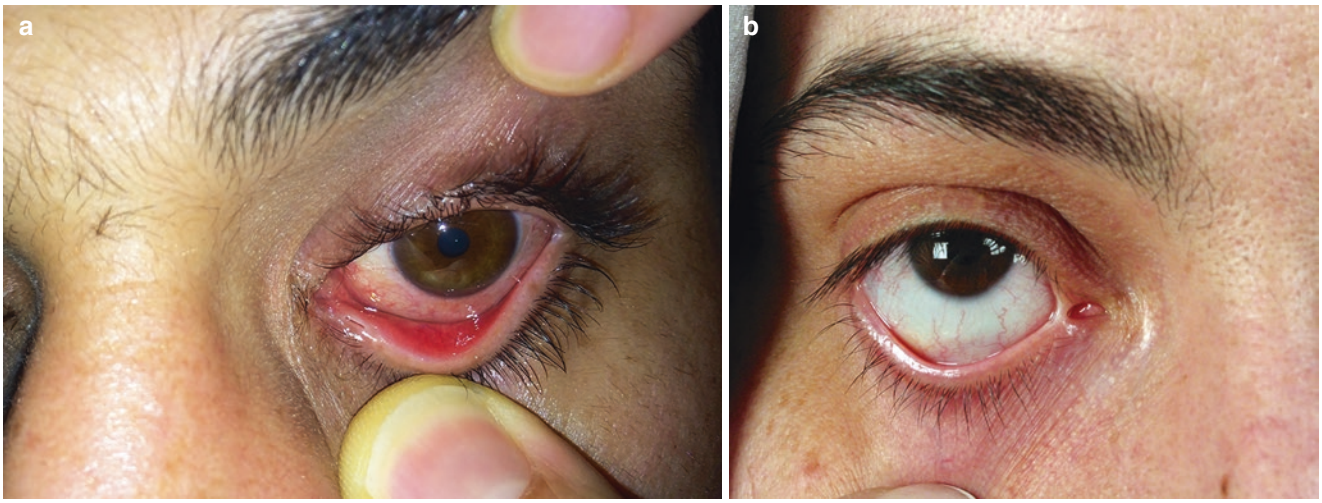

Fig. 46.8 (**a**) Eyelid complications: inferior punctal slitting due to TCL-DCR. (**b**) Eyelid complications: punctal adhesions following TCL-DCR with tight silicone intubation

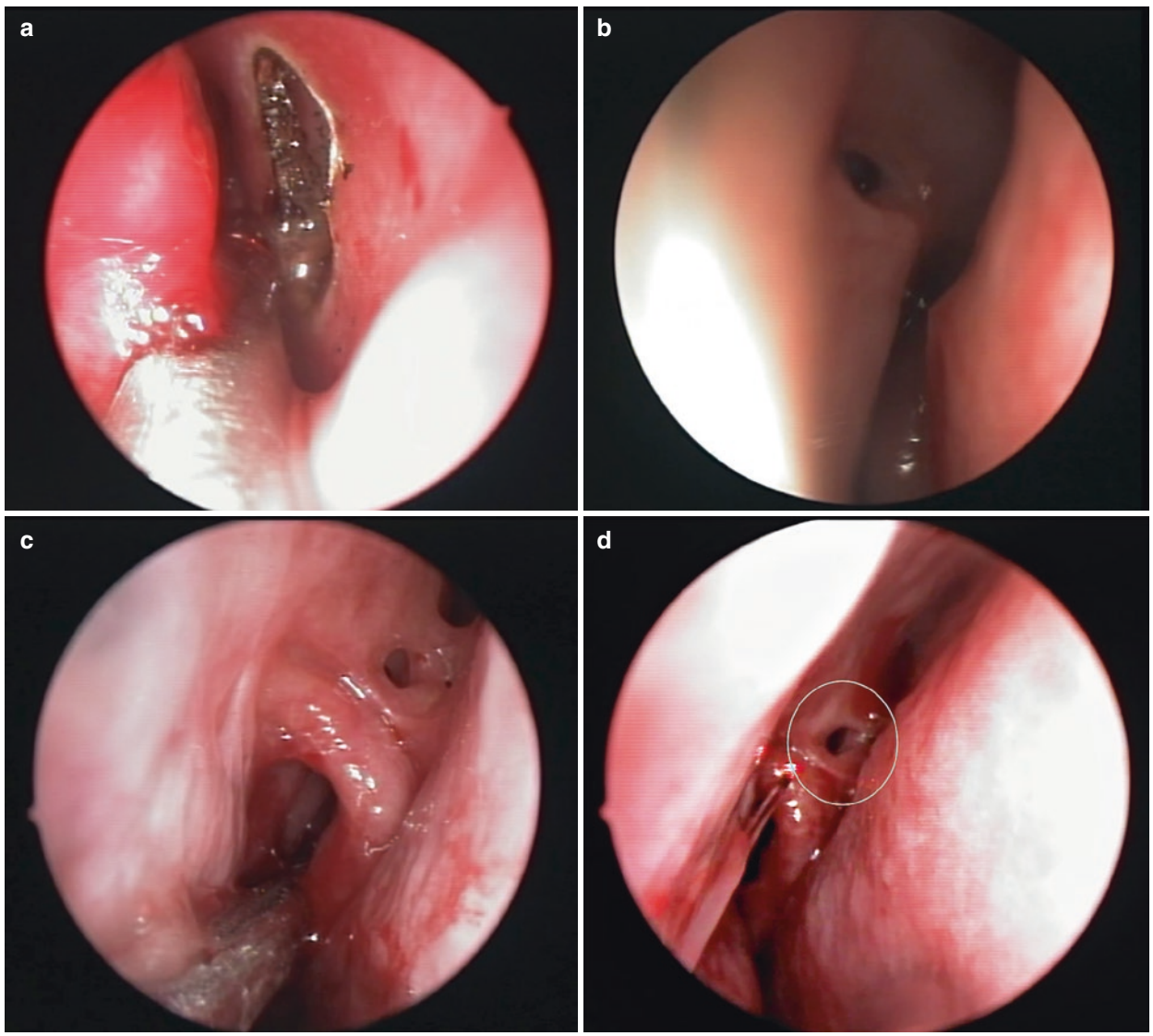

Fig. 46.9 Failure after TCL-DCR: (**a**) the typical upside-down pear-shaped ostium of laser-assisted TCL-DCR; (**b**) sump syndrome in TCL-DCR; (**c**) middle turbinate adhesion to the rhinostomy; (**d**) small pinhole ostium at the 3rd postoperative month; (**e**) false ostium in the anterior ethmoidal cell; (**f**) total closure of the ostium (in blue circle)

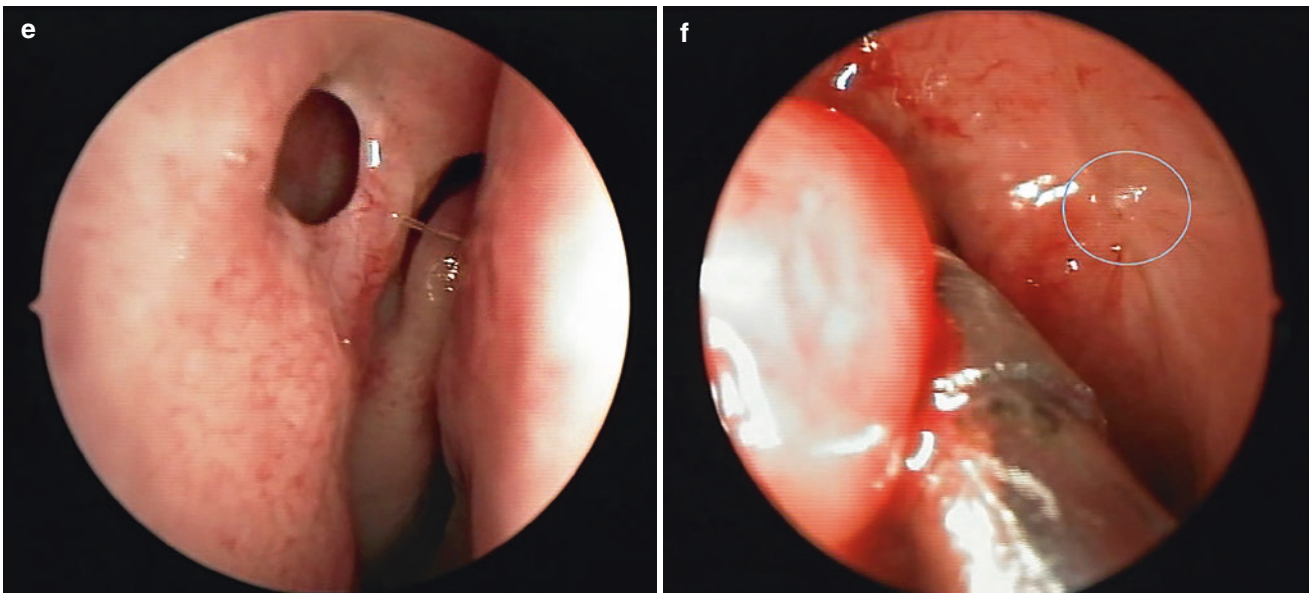

Fig. 46.9 (continued)

Lacrimal system tumors and dacryoliths may be missed using the TCL-DCR approach. Thus, a patient with a missed dacryolith during the TCL-DCR may postoperatively report persistent infection, regional pain, and functional epiphora, and therefore additional exploration is warranted. TCL-DCR would be contraindicated if these etiologies are suspected prior to surgery.

Although the transcanalicular route is a safer method of laser delivery in lacrimal surgery due to its direction away from the eye, there are risks of iatrogenic mechanical injury to the puncta, canaliculi, and/or the common canaliculus by the laser probe and sleeve. Dilating the puncta to enable the passage of the laser probe and/or maneuvering the probe to reach the maximum limits of the sac may cause small tears that subsequently enlarge to canalicular lacerations by the presence of the silicone tubes.

The lasers may also cause thermal canalicular burns and fibrosis that result in narrowing or occlusion of the upper lacrimal drainage system. Such complications may necessitate recanalization surgery with a conjunctivodacryocystorhinostomy with Jones tube.

Kaynak reported tube prolapse or stent loss in 17.7% of patients, which was speculated to be due to the absence of a visible wound that keeps the patient away from the medial canthal area (Fig. 46.10) [38].

Less commonly, tissue necrosis, nasocutaneous fistula at the nasojugal sulcus, and orbital infarction syndrome following diode laser-assisted TCL-DCR have been reported [83, 84].

The possible complications of TCL-DCR are listed in Table 46.5.

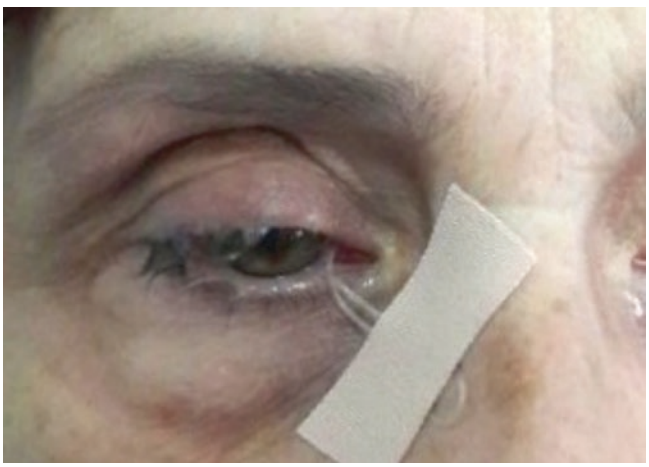

Fig. 46.10 Postoperative patient with tube prolapse after TCL-DCR

Table 46.5 Complications of transcanalicular laser-assisted dacryocystorhinostomy (TCL-DCR)

Thermal and/or mechanical injury to periocular area
Thermal and/or mechanical injury to proximal lacrimal drainage system
Creating false rhinostomy
Thermal injury and subsequent obstruction of maxillary sinus ostium
Intranasal laser injury and consequent adhesions that cause respiratory problems
Undiagnosed or misdiagnosed lacrimal sac pathologies and foreign materials
Trauma to olfactory receptors on nasal mucosae
Permanent desensitization of intranasal mucosa
Orbital infarction syndrome

Conclusion

The relative technical ease, shorter surgery, and rapid recovery time associated with TCL-DCR compared to external DCR have attracted the attention of many surgeons in recent years. The published success rate of TCL-DCR varies widely from 34% to 95.2%. The differences in the number of cases, follow-up time, definition of success, and surgeon variations in the TDL-DCR technique make it difficult to compare these results. The use of silicone stents, endonasal instrumentation, newer lasers, and antifibrotic agents have been reported to increase the success rate of TCL-DCR for the management of NLDO. Failure of TCL-DCR is often due to adhesions between middle turbinate and the ostium, closure of the rhinostomy site due to significant heat spread with resultant fibrosis, or sump syndrome from occlusion of the inferior ostium in the majority of patients. Among the complications of this surgery, patients should also be informed of the possibility of thermal or mechanical injury to the proximal lacrimal drainage apparatus.

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