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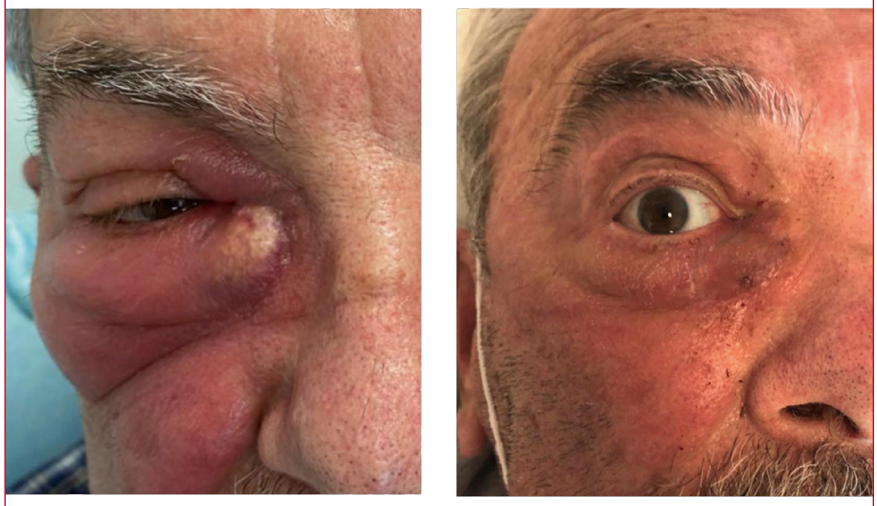
REVIEW

A critical update on endoscopic dacryocystorhinostomy



Cover figure. A case of recurrent acute dacryocystitis: before and 48 hours after endonasal dacryocystorhinostomy.

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Summary

Objective. Endoscopic dacryocystorhinostomy (endo-DCR) is becoming a workhorse in the management of distal lacrimal duct obstruction. It yields success rates comparable to external DCR, with the advantage of no external scars. However, it requires multidisciplinary expertise and many uncertainties in terms of proper indications, technique, and perioperative management still exist.

Methods. Systematic review of the literature in the last 5 years using PubMed and Google Scholar.

Results. A total of 66 articles were included. Many technical modifications and surgical refinements have been proposed, but a formal comparison of the various techniques is hampered by methodological heterogeneity. The use of local anaesthesia and perioperative adjunctive techniques to reduce the risk of restenosis are also gaining popularity even if the level of evidence remains weak.

Conclusions. Endo-DCR offers satisfactory clinical outcomes even though there are many grey areas that need to be addressed in future high-quality studies.

Key words: dacryocystorhinostomy, endoscopic dacryocystorhinostomy, DCR, lacrimal duct obstruction, rhinology

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Introduction

Dacryocystorhinostomy (DCR), whether performed by transnasal endoscopy (endo-DCR) or by external approaches (ext-DCR), is the cornerstone in the treatment of distal lacrimal duct obstruction [1]. Its clinical effectiveness has been confirmed by several meta-analyses for both primary and revision cases, and the long-term success rates range from 89% to 94%, irrespective of the surgical approach or technique chosen, or the adjunctive methods used [2-4]. Endoscopic endonasal techniques have gained much popularity because of their non-invasiveness, favourable cosmetic results, and functional outcomes which are comparable to classic external trans-facial approaches. They are also able to address concomitant nasal pathology that may favour the obstruction, yet they require multidisciplinary expertise in both ophthalmology and rhinology/otorhinolaryngology [2]. The myriad of technological advances from high-definition endoscopes to the use of powered instruments has increased the diffusion of endo-DCR techniques. The literature is flourishing in this field and the present review aims to critically discuss the published evidence in the last five years on the medical and surgical management of endo-DCR. Furthermore, the current limitations and perspectives will be also highlighted.

Materials and methods

The present paper has been prepared following the recommendations of the PRISMA statement, and a modified PRISMA flowchart is given in Figure 1 [5]. The figure was generated using the freeware and web-based Shiny application that is made available by the group of Haddaway et al [6]. No institutional review board approval was deemed necessary for the present review because no patient data was used. The Medline PubMed and Google Scholar databases were used to write the review with the searching period from January, 1st 2018 to June, 1st 2023. The following bibliographic string was used: "dacryocystorhinostomy OR DCR". All pertinent articles were included after careful reading of the titles and abstracts. Full texts of the included articles were then retrieved by two authors (LGL and ERDZ) and quantitative and qualitative data were summarised accordingly. Abstracts were initially sorted by the specific techniques (external versus endonasal) that were exclusively or predominantly used in each article. We then excluded all non-relevant (*e.g.*, ext-DCR) or off-topic papers; studies other than original articles or reviews, case series/reports, or written in languages other than English-French-Italian; papers investigating paediatric patients with congenital nasolacrimal duct obstruction.

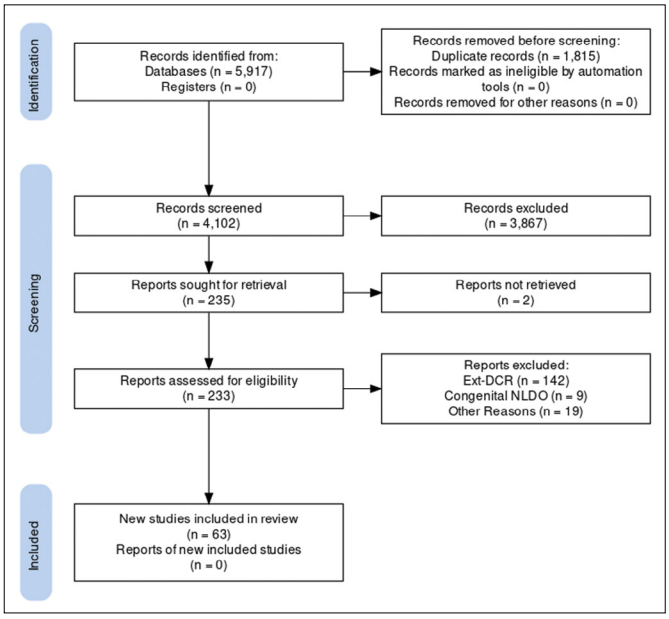

Figure 1. Identification of studies via databases and registers.

The search strategy retrieved a total of 5,917 articles and, after applying the selection criteria and checking through the reference lists of the relevant studies, a total of 66 full texts were analysed (Fig. 1). Quantitative and qualitative data regarding surgical outcomes were summarised and systematically reported in tables.

Results

Optimal setting, timing, and perioperative management of patients with endo-DCR

In-office sinus surgery procedures have seen a steep rise in their use in the last decade given the well-known advantages of using local anaesthesia (LA) including faster recovery and lower costs [7]. Endo-DCR is no exception to this trend and its favourable outcomes are presented by three recent experiences [8-10]. In the first report, 84.6% of 77 patients showed complete resolution of epiphora, and LA (*i.e.*, skin and intranasal infiltration plus neurosurgical cottonoids soaked in 5% cocaine) was used along deep sedation (propofol + fentanyl + midazolam) [8]. Another group of authors performed an analysis of periprocedural pain with a simple Visual Analogue Scale (VAS) in 106 cases. They reported moderate pain (VAS 5-6) in 20.6% and no or mild pain for the remaining of the group with LA only; instead, no pain (VAS 0-2) was reported by all 14 patients who had LA + sedation (in this series, with pethidine and fentanyl) [9]. Thirdly, Zhao et al. re-

cently randomised 90 endo-DCRs into two groups (LA with dexmedetomidine + dezocine as adjuvants, N = 45) and a general anaesthesia (GA) group: the former type of anaesthesia showed more stable haemodynamics and was associated with lower VAS immediately after awakening and at 1, 2, 6, and 12 h postoperatively. Additionally, LA and sedation showed a lower incidence of postoperative agitation, nausea, and vomiting compared to GA [10]. Regarding procedural complications related to the use of LA, accidental ingestion of nasal packing gauze and a potential risk of fire, when intranasal diathermy is used close to oxygen-delivering prongs, have been reported [8]. Provokingly, in a recent case report of an endo-DCR under GA, the rupture of an intracranial aneurysm was associated with submucosal local infiltration with tetracaine and adrenaline (1:20,000) [11]. Summing this up, a meta-analysis in 2022 including over 3200 endo-DCRs performed with GA and/or LA demonstrated that, even when powered instruments were used, a significant difference in success rates was noted between LA + sedation (85.1%, CI 77.8-90.4%), and GA (90.8%, CI 88.8-92.4%): however, due to the low number of publications, no conclusive statements were made [12].

As of when to perform an endo-DCR procedure, sound new evidence supports upfront operation in case of acute abscess or dacryocystitis. A small (43 patients) prospective randomised controlled trial from Finland demonstrated that "acute" endo-DCR (within 1 week from diagnosis) demonstrated no significant differences compared to delayed operations, in terms of lacrimal symptoms, syringing test, dye test, or use of resources at 18 months. The acute group, however, needed fewer analgesics than the delayed endo-DCR group with a median of 3 *versus* 10.5 days (p = 0.03) [13]. Another study compared "very early" endo-DCR (within 3 days from the diagnosis) versus delayed ext-DCR, in adjunct with the same systemic antibiotics. By randomising 41 eyes, Pakdel et al. reported comparable anatomic and functional results, complications, and overall success between the two groups, but with a shorter duration of local cellulitis in the "very early" group [14]. Complications (mostly skin fistula) were more frequent in the late DCR group from a large series from China (176 patients) that demonstrated significantly superior long-term outcomes when "urgent endo-DCR" (< 48 hours) was chosen [15]. Finally, another retrospective study of 123 patients from South Korea reinforced the superiority of an aggressive upfront approach: in a sub-analysis, the time to symptom resolution, length of hospital stay, and duration of antibiotics were significantly shorter for the endo-DCR within 3 days compared to those receiving the operation between 4 to 7 days after diagnosis [16]. Simultaneous bilateral endo-DCR is seldom required, but in a recent analysis of 128 cases where 13 were bilateral (26 sides), no significant differences emerged in terms of success and with the obvious advantages of sparing a second surgery [17].

As for the adjunctive treatments after endo-DCR, results on the use of stents are conflicting with two recent reports showing that routine placement of a lacrimal stent did not improve outcomes in either long-standing obstructions nor in cases of acute dacryocystitis [18,19]. From a review of the literature in 2021, the intraoperative use of mitomycin C seems useful only in revision ext-DCR, and more recently, a meta-analysis on 739 eyes showed that the intraoperative application of hyaluronic acid significantly increased the success rate of endo-DCR (odds ratio = 3.27, 95% CI 2.15-4.98) [20,21].

The usefulness of steroids in reducing the risk of restenosis after endo-DCR is a more complex issue because of the different routes of administration. For instance, Chen et al. presented their experience with the intranasal placement of a steroid-soaked absorbable gelatin sponge to be left in the operated cavity. This work was retrospective and not randomised, but it appeared that significant improvement with this method was obtained (242 patients, a 92.5% success rate in the 55 with the sponge *versus* 83.6% in the group without) [22]. Since intranasal haemostasis is often required after this procedure, an interesting experience on 407 eyes from South Korea showed that triamcinolone-soaked nasal packing was significantly superior to standard hygroscopic foams in terms of 6-month functional success (95 *vs* 89.3%, p = 0.033), equivalent in terms of anatomical patency (96 *vs* 92.7%, p = 0.149), and associated with a lower incidence of granulations (10 *vs* 20.4%, p = 0.003) [23]. If packing is not needed as in mucosal preserving techniques, some authors discourage its use since it remains unproven that packing is associated with lower rates of postoperative synechiae, granulomas, or bleeding complications (all non-significant in a recent retrospective study where bio-packs were used) [24]. Intuitively, thorough and regular endoscopic debridement after 2 weeks demonstrated a trend for better functional success (84.1% in the group without subsequent debridement *versus* 97.7% in those with debridement, p = 0.058) [25]. Finally, regarding adjunctive steroids, a small series was published where 23 patients were randomised to use intranasal triamcinolone spray for 3 months postoperatively versus a control group of 25 after endo-DCR with stents. The success rates were not significantly different and treatment adherence was not assessed, but the authors used the lacrimal symptom questionnaire and reported significantly better results with the use of steroids [26].

Regarding the use of prophylactic antibiotics, a retrospective multi-institutional series of 331 endo-DCR cases performed at Boston Universities found that their use may be beneficial only when patients had a recent (within two weeks of surgery) or active dacryocystitis; in all other scenarios, their data do not support the routine use of antibiotic prophylaxis [27]. These findings were also partially confirmed by a series of 152 patients from New York City where a history of dacryocystitis did not constitute a risk factor for postoperative infection [28].

In conclusion, the most recent meta-analysis on post-surgical medical adjunctive treatments dates to 2020 and included 18 papers on 3,590 external or endoscopic procedures [29]. Given the lack of adequate data, the authors were able to carry out a meta-analysis only on endo-DCR outcomes and found no significant evidence for the use of nasal steroids ($p = 0.58$), oral antibiotics ($p = 0.45$), or nasal decongestants ($p = 0.27$) [29]. Of note, the heterogeneity of the doses used and methods of administering adjunctive treatments as well as the lack of a standardised system to assess outcomes are still present in the current literature.

What is the best technique to perform DCR?

Endoscopic DCR is an effective surgical procedure whatever method is chosen, as reported in the review in 2020 by Vinciguerra et al. who analysed the pooled mean success rate of mechanical and powered endo-DCR, and established that there are no differences in outcomes ($p = 0.43$). In addition, mucosal flap preservation did not provide superior results ($p = 0.14$) [4].

However, the quest for the optimal technique persists, with emphasis placed on mucosal flap preservation, correct endonasal identification of the duct, use of flaps, type of powered instrument used to create the rhinostomy, management of concurrent nasal pathology, and treatment for concurrent canalicular and distal obstruction of the lacrimal pathway.

Regarding the former aspect, a study of 71 eyes proposed a "middle uncinate process approach" as a safer and more effective method (it is unclear compared to which technique), with a reported symptomatic success rate of 97.2%. This approach resulted in reduced surgical duration, precise localisation of the lacrimal sac, minimal bleeding, and eliminated the need for dilation tube insertion [30]. Another variation of "classic" endo-DCR, named "retrograde" endo-DCR, was described by Alicandri-Ciufelli and colleagues [31]. This modified approach is meant to be a safe procedure, even in patients with challenging anatomical conditions, because it allows easier identification of the lowermost part of the nasolacrimal duct, specifically at the level of the anterior insertion of the inferior turbinate. In most cases, at this level only a very thin shell of bone is present, and the duct is then followed upward along its course until the surgeon is able to unequivocally drill along the lacrimal pathway [31]. Similarly, the "endonasal endoscopic nasolacrimal duct dissection" involved the removal of the bony structure covering the nasolacrimal duct, until it is marsupialised with nasal mucosa. In fact, according to Chang et al, postoperative outcomes, specifically resolution of epiphora, were comparable to those achieved with conventional endo-DCR. Furthermore, no major complications were reported intra- or postoperatively, although the authors did not report the operative time for this extended dissection [32]. Finally, others have focused on the preoperative radiological identification of the duct: Ciger et al. found that the maxillary line-lacrimal sac anterior border distance was positively associated with the decrease in the duration of surgery ($p = 0.000$, $r = 0.840$) and the nasolacrimal duct obstruction symptom score (NLDO-SS) obtained after surgery ($p = 0.041$, $r = -0.276$). However, the differences are negligible since the standard deviation of this distance is 1 mm [33].

In 2022, Wang et al. proposed a modified seamless endoscopic dacryocystorhinostomy: the regular "I"-shaped incision was replaced by a "C"-shaped incision near the lateral bone window, and a gelatin sponge was applied at the confluence of the lacrimal sac and nasal mucosa, without any suture [34]. They performed this approach in 32 patients, which was associated with a significantly shortened operation time and reduced bleeding compared to the 22 patients who underwent routine endo-DCR ($p < 0.05$). After 6 months of follow-up, the efficacy rate was significantly higher in the modified group than in the routine group (96.9 *vs* 68.2%; $p < 0.05$) [34]. Endoscopic suturing and knotting-dacryocystorhinostomy is another proposal where the lacrimal sac mucosa is sutured with the nasal mucosa by tying knots under endoscopic view, without the use of a stent or mitomycin C [35]. According to the proposing authors, this technique yielded anatomical and functional results that were unchanged during the 2-year follow-up period without serious complications. The endoscopic evaluation found that all patients showed a patent ostium and normal healing of the flaps after 4 weeks. The Munk scores decreased significantly at 6 months postoperatively compared to preoperative scores ($p < 0.001$) [35].

Several articles have explored the issue of the type of flaps and the method of harvesting. The lobulated pedicled nasal mucosa flap technique without stenting had a 100% anatomical patency success rate and a 94% symptomatic cure rate (63/67 patients), and there were no instances of complications in the experience of the proponents [36]. In another

study, the modified double-flap technique showed a lower recurrence rate compared to the single-flap technique: in a cohort of 77 cases the double flap covering the exposed lacrimal bone reduces postoperative obstruction over the nasolacrimal duct and ostium (recurrence rate of 3.2% in the double-flap group compared to 23.9% in the single-flap group, p = 0.022) [37]. In the latest proposal, a clubhead-shaped nasal mucoperiosteal flap was combined with a posteriorly hinged lacrimal flap to create a tension-free anastomosis with the surrounding mucoperiosteum, although this technically demanding technique was only used in 8 cases, all with satisfactory outcomes [38].

In the context of flap-preserving techniques, there has been debate in the literature concerning the use of fibrin glue. In this regard, a recently published retrospective study reported that the surgical success rate was significantly higher in the fibrin glue anastomosis group (95.5%) than in the non-fibrin glue group (84.8%; p = 0.041), whereas the complication rate was similar in both groups (p = 0.99) [39].

It has not been definitively established whether mucosal flap preservation techniques offer any advantages over non-preserving techniques [40-43]. The surgical success rate was not significantly different between endo-DCR with and without mucosal flap preservation in a population of 107 patients (82.1% without flap *vs* 86.8% with flap, p = 0.478) [40]. Moreover, the complication rates between the two procedures were comparable, indicating that there is no discernible advantage in incorporating flap preservation [40]. Likewise, in another study, long-term results suggest that mucosal flap preservation does not seem to be required to achieve successful outcomes in endo-DCR [41]. Indeed, powered endoscopic DCR without preservation of mucosal flaps achieved complete resolution of epiphora in 93.1% of primary procedures and 68.8% of revision procedures. During endoscopic evaluation, objective anatomic patency was confirmed in 98% [41]. Conversely, in a prospective randomised controlled trial, the group of patients undergoing a double mucosal flaps technique showed more satisfactory outcomes in terms of success rate compared to the group without flap preservation (97.9% compared to 89.6%, p = 0.092). The mucosal healing rate was also reported to be superior (p = 0.025) [42]. Adding further confusion, in the 2023 study of Vatansever et al. mucosa-sparing surgery with a modified inverted U flap offered a significantly higher functional success rate compared to endo-DCR without mucosal flap and with less granulation tissue (p = 0.02) [43].

In the cases of concomitant proximal and distal obstruction, the application of a Castroviejo double-ended lacrimal dilator to facilitate the classic Jones tube insertion was recently described by Woo et al. [44]. After being inserted, the lacrimal dilator created a direct fistula from the conjunctiva to the nasal cavity through the bony ostium: the Pyrex tube is then inserted into the fistula with a guidewire and secured in place by suturing. The success rate of this procedure was 73.4% and no serious complications were reported [44]. A complex yet innovative approach was described by Ushio et al. in 2021, called conjunctivoductivo-dacryocystorhinostomy. This procedure involves an anastomosis of the conjunctiva and nasolacrimal duct without leaving any facial scars or foreign bodies in semi-permanent detention. Since the tip of the severed nasolacrimal duct is withdrawn back into the conjunctiva and directly sutured to the incision, the procedure did not necessitate the placement of a Jones tube [45].

The question of the clinical significance of preexisting nasal septal deviations remains unanswered. In a recent study, a concomitant septoplasty yields surgical success and associated complications equivalent to those of endo-DCR alone (no difference in anatomical success and functional success, p = 0.76 and p = 0.18, respectively) [46]. However, in a systematic review by Kim et al. in 2020, performing a concurrent septoplasty or the use of a mucosal-preserving technique (irrespectively of the flap design) was judged as emerging (levels of evidence B and C) options to increase the chance of success of endo-DCR [20].

As technology advances, novel instruments are being experimented also with endonasal endoscopic surgery. The effect of the modified flap suture anastomosis technique using a Sonopet ultrasonic bone aspirator was retrospectively compared to that using a diamond burr in patients with nasolacrimal duct obstruction [47]. The rates of successful suturing during the operation and of a large diameter of the lacrimal ostium 3 months after the operation were significantly higher in cases where the Sonopet was used [47]. A robot-assisted endoscope positioning system that allows for hands-free visualisation of the surgical field was proposed in 2020. This device features a mechatronic holding arm and is driven by a foot pedal that can be precisely controlled. The surgeon can maintain bimanual instrumentation, which allegedly facilitated the dissection, but the report remains very preliminary [48].

A minimally-invasive alternative procedure is transcanalicular microdrill dacryoplasty: this is a variation of the external laser DCR where, under GA, the use of a 0.38 mm microdrill was reported to yield an 84% success rate with a very low rate of complications (0.2% of heavy postoperative bleeding) and 57.5% of patients presented full resolution of symptoms [49].

In addition, balloon dacryoplasty (BD) is another option and a recent systematic review by Poignet et al. evaluated its results with and without silicone tube insertion [50]. BD seems to

be significantly more successful for partial nasolacrimal duct obstruction (success rate of 73.2%), while it is not effective for complete obstruction, with a disappointing success rate of 36.6%. The main complication is the high recurrence rate [50]. Lastly, the use of chitosan-based dressing after endo-DCR with balloon dilation was associated with improved subjective and anatomical outcomes, compared to bioresorbable polyurethane packing versus no packing ($p = 0.049$), and reduced the need for revision surgery [51].

In conclusion, despite the variety of modified approaches, flaps or alternative procedures to classic endo-DCR, a retrospective analysis performed by Kumar et al. revealed that there are no significant differences in success rates, recurrences, or complications of various techniques at 3 or 6 months of follow-up. Moreover, BD was the technique associated with the shortest surgical time [52].

Reasons for and management of failures after primary DCR

Despite all the aforementioned techniques, a failure rate of approximately 10% is still present after endo-DCR, but the surgical or clinical factors contributing to procedural failure are not well defined. In an interesting retrospective research, significant correlations emerged between surgical failure and the presence of diabetes mellitus (that was also related to granulations) and allergy to medications. More obviously, granulations or adhesions in the osteotomy site correlated with surgical failure ($p < 0.001$). No correlations emerged for factors such as post-traumatic stenosis, previous nasolacrimal surgery, or the use of a stent [53]. In another retrospective review, a significant correlation was observed between the lack of clinical improvement and several factors, including age, systemic conditions (including diabetes mellitus), or coexisting ophthalmological diseases and the time since the onset of the obstruction. Additionally, intraoperative findings such as a thickened lacrimal mucosa and the absence of flow when the sac is marsupialised were predictors of poor outcomes [54]. Using multivariate analysis, Cohen et al. conducted a study to assess the 5- and 10-year success rates of endo-DCR and its associated covariates. They found that rates decreased over time and that long-term failure

Table I. Extreme and rare settings observed in endo-DCR studies.

No.	Author	Year	Study design	Sample size	Setting	Management	Outcome
1	Hsu et al. [61]	2022	Case report	1	Patient with a history of Caldwell-Luc surgery who developed considerable postoperative changes, reported epiphora in the last 5 years	Endo-DCR was performed with the aid of nasal forceps and a 20-gauge vitreoretinal fiberoptic endoilluminator	Complete resolution of symptoms and no signs of recurrence after 6 months
2	Gupta et al. [62]	2021	Case report	1	Blepharophimosis-ptosis-epicanthus inversus syndrome with congenital nasolacrimal duct obstruction	Endo-DCR	Not known
3	Sagar et al. [63]	2018	A case report and review of 18 cases	A case report and review of 18 cases	Primary nasolacrimal sac tuberculosis in a 15-year-old girl who presented with bilateral epiphora	Endo-DCR and anti-tubercular therapy (ATT). Treatment of tubercular dacryocystitis is ATT with surgery reserved for cases who remain epiphoric after medical treatment	Right eye epiphora improved while the left eye showed partial block due to synechia. Synechia release was done and patency was established
4	Song et al. [64]	2020	Case report	1	Localised amyloidosis involving the nasolacrimal duct and lacrimal sac	Endo-DCR and resection of multiple masses	One-year follow-up found no recurrence
5	Nassif et al. [65]	2022	Case report	1	Sinonasal sarcoidosis with nasolacrimal duct obstruction and dacryocystitis	Endo-DCR	4 months postoperative follow-up showed resolution of nasal and ophthalmic symptoms
6	Azhdam et al. [66]	2021	Case report	1	Angioleiomyoma of the nasolacrimal duct	Endoscopic excision of the lesion along with medial maxillectomy and dacryocystorhinostomy	Resolution of the epiphora

Table II. Unusual complications observed in endo-DCR studies.

No.	Author	Year	Study design	Sample size	Setting/complications	Management
1	Zhang et al. [11]	2023	Case report	1	Intracerebral and subarachnoid haemorrhage secondary to the rupture of an undiagnosed intracranial aneurysm	Stop surgery, stabilisation and recovery
2	Lee et al. [67]	2021	Case report	1	Delayed (after 1 month) unilateral pneumocephalus	Antibiotic therapy
3	Galindo-Ferreiro et al. [68]	2021	Case report	1	Orbital fat necrosis	The patient was given oral antibiotics and steroids for 2 weeks without any significant clinical improvement. Hence, the steroids were withdrawn and after a week, excisional biopsy was performed through a lid crease incision
4	Cheong et al. [69]	2019	Case report	1	Meningoencephalitis	Intravenous antibiotic treatment
5	Gungel et al. [70]	2019	Case report	1	Contralateral vision loss due to Purtscher-like retinopathy	50 mg/0.1 mL of intravitreal tissue plasminogen activator injection
6	Bladen et al. [71]	2020	Retrospective, non-comparative case series	7	Peri-orbital surgical emphysema	Wait and see
7	Bothra et al. [72]	2020	Case report	1	Gossypibioma (retained surgical nasal pack)	Removal under endoscopic guidance followed by triamcinolone acetate injection into the base of the residual granuloma
8	Lee et al. [73]	2020	Case report	1	Optic neuropathy following DCR in a patient with May-Hegglin anomaly	Treated with 1 g/day of intravenous methylprednisolone for 3 days, followed by 1 mg/kg/day of oral prednisone with subsequent dose tapering

at 5 and 10 years after surgery was associated with older age, smoking, postoperative epiphora, and male gender [55]. Regarding radiological predictive factors, in another report patients were categorised into three groups based on the preoperative pneumatisation of their ethmoid sinuses, as determined on computed tomography with dacryocystography. Unfortunately, the success rates were the same in the different radiological categories at 12 months [56].

Several options are available to manage a failed endo-DCR; however, identifying the precise osteotomy site and ensuring lasting patency pose significant challenges even if outcomes for revision cases are comparable to primary cases [57]. An office-based salvage revision for impending rhinostomy failure after endo-DCR, utilising a microdebrider, was found to be effective in a small study. Among the 27 eyes studied, the causes of impending rhinostomy failure included granuloma formation (17/27 eyes), cicatrisation (8/27 eyes), and synechiae formation (2/27 eyes). All cases showed improvement in epiphora at 6 months [58]. An Italian group introduced transnasal balloon-assisted dacryoplasty as a minimally-invasive surgical approach for treating failed DCRs. The procedure demonstrated reliable and stable long-term outcomes with a 100% anatomic success rate and an 85.7% functional success rate in 14 patients. The absence of post-surgical complications, a high success rate, and a short average operative time of 18 minutes make this innovative procedure noteworthy [59]. Finally, Mueller et al. proposed a new technique for revision endo-DCR using a superior pedicled mucosal flap that provides excellent exposure of the maxillary bone and the lacrimal sac. In 13 procedures they achieved a success rate of 100% without complications after a mean follow-up of 26.9 ± 10.3 months [60].

Extreme and rare endo-DCR settings

While conventional DCR is effective in most cases, some patients present with unique anatomical variations or atypical conditions that demand specialised approaches. In such exceptional scenarios, innovative solutions become necessary for successful outcomes. The published evidence in the last 5 years on the extreme and rare endo-DCR settings is reported in Table I.

Unusual complications of endo-DCR

While endo-DCR is a well-established and effective sur-

gery for most patients, there are instances where unusual complications can arise. We delve into some of these uncommon and unexpected complications associated with endonasal DCR. Understanding these atypical issues is crucial to ensure the best possible outcomes.
The published evidence in the last 5 years on the unusual complications of endonasal DCR is reported in Table II.

Conclusions

Endo-DCR is an umbrella term for a myriad of endoscopic procedures aimed at curing distal nasolacrimal duct obstruction with the advantage of no external approaches. Thanks to the availability of high-definition endoscopy and to new powered instruments the success rates are satisfactory, yet a one-technique-fits-all does not exist. In order to favour optimisation of resources and maximise patient satisfaction, a multidisciplinary team is necessary in every hospital wherever endo-DCR is performed.

Conflict of interest statement

All authors declare no conflict of interest.

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Author contributions

LGL, ERDZ: conceptualisation, writing original draft; NC: data collection, supervision; AT: supervision, editing; PL, CM: conceptualisation, supervision.

Ethical consideration

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No IRB approval was necessary due to the retrospective nature of this work. Informed consent: Informed consent was obtained from all individual participants included in the study.

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