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Research Article

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Outcome of Transcanalicular (TC) LASER DCR Compared with External DCR

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Abstract

Aim: To assess the anatomical and functional outcome of transcanalicular LASER DCR compared to external DCR.

Methods: A quasi-study had been carried out in two tertiary eye hospitals of Bangladesh from January 2016 to June 2020. Group A included all patients selected for external DCR, and group B had been selected for transcanalicular laser DCR. Variables included age, gender, anatomical outcome, functional outcome, and surgery-related complications. Statistical analysis had been done by Quick Calcs Graph Pad software.

Results: The total evaluated patients were 112 patients in group A and 41 patients in group B. The anatomical success rate was 93% in group A and 86% in group B. The functional success rate was 86% in group A and noted 83% in group B. Minimal skin scar was observed after six weeks of surgery in 80% cases of group A.

Conclusion: The anatomical success rate is higher in external DCR, but the functional outcomes are almost the same in both groups.

Key words: *Dacryocystitis; Nasolacrimal duct obstruction; External DCR; Transcanalicular LASER DCR; Anatomical and functional outcome*

Abbreviations: DCR: Dacryocystorhinostomy; TC: Transcanalicular; NLD: Nasolacrimal duct; PNADO: Primary acquired nasolacrimal duct obstruction; MMC: Mitomycin-C

Introduction

A Dacryocystorhinostomy (DCR) surgery is making an anastomosis between the lacrimal sac and the nasal cavity at the level of the middle meatus by cutting the intervening bone. This new opening is proximal to the site of nasolacrimal duct obstruction and reestablishes the tear flow into the nose. Different approaches are available for DCR surgery, e.g., external, transnasal, and both. These approaches include external or conventional DCR, Non LASER endoscopic DCR, endoscopic endonasal laser DCR, and transcanalicular laser-assisted DCR. The traditional or external DCR is considered as the standard gold technique for managing acquired nasolacrimal duct obstruction [1-2]. Caldwell first introduced the transnasal DCR in 1893 but did not widely accept it due to complex visualization of the nasal cavity and perioperative bleeding [3]. With the advancement of endoscopic equipment, the endoscopic endonasal approach has popularized with a reasonably good outcome. The LASER assisted endoscopic approach has revolutionized DCR surgery, especially for cosmetic concerns, precise ostium haemostasis, and less surgical morbidity [1-2, 4-7]. Different types of LASER are used in DCR surgery and most useful for minor collateral damage. Diode laser-assisted DCR includes both endoscopic and external approaches and offers many advantages over other LASER DCR and conventional DCR [4-6,8]. Skin incision sparing DCR is the current mainstay of managing congenital and acquired nasolacrimal duct obstruction in young children and adults. We assessed the surgical strategies and compared the outcome of LASER DCR with conventional DCR.

Patients and Methods

This quasi-interventional study had been carried out in Bangladesh Eye Hospital and Institute of Dhaka, Bangladesh, and Vision Eye Hospital, Dhaka, Bangladesh. We started the research in January 2016 and completed it on 30 June 2020. Pre-operative ophthalmic and nasal cavity evaluation and pre-anaesthetic check-up had made in all cases. All cases were divided into two groups; group A and Group B. In Group A, all patients underwent external or conventional dacryocystorhinostomy (External DCR). Group B included all patients who had managed transcanalicular LASER dacryocystorhinostomy (TC-DCR). External DCR was used for all patients with Failed DCR. External DCR and Transcanalicular LASER DCR had offered with counselled potential advantages and disadvantages of surgical procedures for all cases of primary acquired nasolacrimal duct obstruction. TC LASER DCR was costly than external DCR. In our study, the lowest age was 12 years, and the highest was 86 years. This study excluded all patients suspected of lacrimal neoplasm, rhinosporidiosis of the lacrimal sac, and nasal neoplasm. Anatomical success had assessed by the patency of the lacrimal passage on irrigation with normal saline. The operational success had been evaluated by the absence of insignificant epiphora without any ocular and eyelid diseases. Data were collected and analyzed by Graph Pad Quick Calcs Software.

Surgical techniques

Anaesthesia

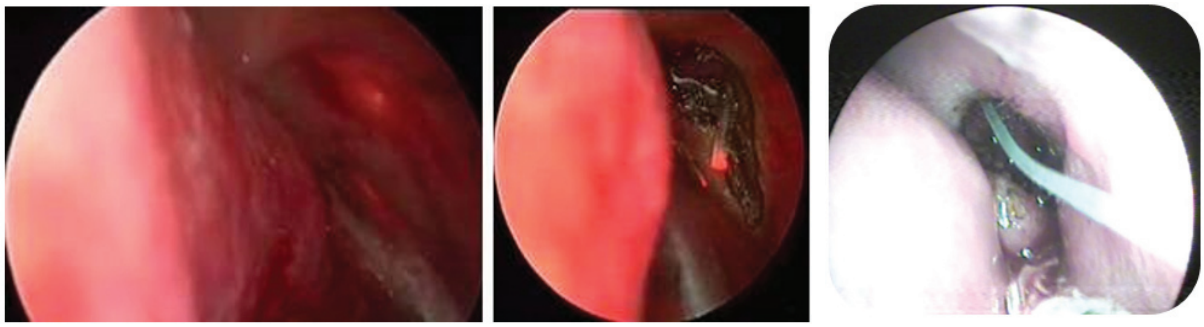
Most of the patients were operated by local anaesthesia (LA) with intravenous sedation; only two cases of the group A were operated by general anaesthesia. We had used a mixture of Hyaluronidase (1500IU) mixed with bupivacaine HCL 0.5% (5 mg/ml) and lidocaine (2%) with epinephrine (0.0005%) as LA. We used plain lidocaine (2%) for hypertensive patients with chronic dacryocystitis. The LA had been injected as Infratrochlear nerve block, infraorbital nerve block, ethmoidal nerve block, and dorsal nasal nerve block for DCR. Intravenous sedation with 1 to 2 ml of Midazolam 1 mg/ml and Fentanyl 0.5 to 2 mcg/kg over 1-2 minutes. We sprayed 10% lignocaine solution in the nasal cavity to reduce the sensitization of nasal mucosa. In all cases, a qualified anaesthetist was present during surgery to administer intravenous drugs and monitor the patients' vitals.

Nasal Packing: a 10-15cm ribbon Gause socked with 2% Lignocaine jelly, oxymetazoline nasal drop, Inj. Adrenaline 1 ml and introduced as a posterior nasal pack throughout the surgery, and introduced an anterior nasal packing (3-4 cm) to the middle meatus at least 5 minutes to the taught nasal mucosa and for hemostasis purpose as nasal packing.

TC LASER DCR

The TC LASER DCR system includes a 980 mm wavelength Diode LASER with a 600 µm fibre optic probe, a 0° angle rigid camera-mounted nasal endoscope. The LASER fibre optic probe was used for this procedure through the canaliculi to the sac. After punctual dilatation with Nettleship punctum dilator, the laser probe was inserted horizontally into the sac through the upper punctum and canalicular system and then advanced obliquely (about 60° to 70°) vertically downward, medially and backwards, nearly the same as in lacrimal probing. Then, the probe had been pushed till the felt stiff resistance along the nasolacrimal duct to the lateral wall of the nasal cavity. A 4 mm diameter, 20 cm long, 0° angled rigid camera-mounted nasal endoscope was introduced into the nasal cavity to visualize the laser glow of the pilot beam. The properly focused red

light glow of the laser (pilot) beam in the middle meatus (Figure 1a). The LASER glow will reveal the thinnest portion of the lacrimal bone, which is anterior and inferior to the insertion of the middle turbinate. The middle turbinate medialization is vital for good exposure and protection from LASER heat. A continuous contact mode of a diode laser with 980 nm wavelength has been used to create a nasolacrimal osteotomy by ablating the bone and mucosal tissues by pushing the beam towards the nasal cavity applying 3-4 watts of power. Both the pilot beam and 980 nm delivered laser energy through the same LASER optical fibre. This procedure was repeated through the lower punctum and canaliculi to extend the ostium. The osteotomy was enlarged up to 7-8 mm vertically and 5 mm horizontally by pulling up followed by pushing down the laser probe in a seesaw movement (Figure 1b). A bi-canalicular silicone lacrimal stent was introduced through both canaliculi (Figure -2) and fixed to the medial wall of the anterior nares in all cases, and kept in situ up to 6 weeks of surgery. After removing all nasal packing, a piece of merocel pack (compressed dehydrated sponge composed of hydroxylated polyvinyl acetate) was introduced into the space between the middle turbinate and the newly created osteotomy to prevent adhesion of the middle turbinate and to prevent the postoperative hemostasis and kept it for seven days.



1a **1b** **2**

Figure 1a-B: *The LASER glow is shown through the thinnest portion of the lacrimal bone,* ***b.*** *An osteotomy is created at the level of the middle meatus by a multimode diode laser beam.*

Figure 2: *Intubation of bicanalicular silicone DCR tube after LASER DCR.*

External DCR

A J-shaped incision was given to all cases to achieve minimal or no skin scar postoperatively. Dissection had made and identified the medial palpebral ligament, making a lacrimal mucosal flap, and then created a bone osteotomy by cutting the intervening bone. The nasal mucosal flap had prepared and made an anastomosis between the nasal and lacrimal mucosal flap by 6-0 vicryl (Figure-3). Used Mitomycin C (0.02%), particularly in between the mucosal and lacrimal flaps with a surgical sponge/cotton pledge for 3 minutes and then rinsed. MMC had been used in patients who had excessive granulation tissue at the surgical site. Silicone intubation was introduced in all cases and kept in the nasal cavity for six weeks of surgery. We placed a nasal pack with antibiotic ointment at the end of the surgery for 24 hours.

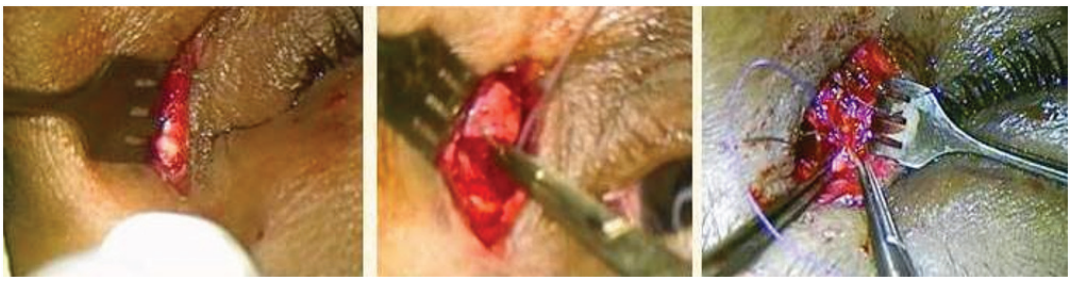


Figure 3: *Exposure of the medial palpebral ligament following skin incision, creating the nasal mucosal flap, intubation of a DCR tube, and an anastomosis of Lacrimal sac mucosa and Nasal mucosal flap to the external DCR.*

Results

A total of 153 patients were evaluated in this study, including male (49.7%), and female (50.3%). Over all mean age was 47.99 years. Primary acquired nasolacrimal duct obstruction was found (PANDO) on sac patency test in 109 (71.2%) cases, and others (28.7%) was associated with failed DCR. patients. In group A, the total number of patients was 112, with 55% female and 45% male. 68 (60.7%) patients presented with PANDO, and 44 (39.3%) patients presented with failed DCR. In 112 patients, Comorbidities were in 73 (65%) patients. 24 (21.4%) Patients had taken blood thinner medication like Ecospirin, Clopidogrel. The age range was 12 years to 86 years and the mean age was 56.23 years. In Group B, all 41 patients had presented with PANDO. Comorbidities were in only 5 (12.2%) cases. The female was 27 (65.8%) cases, and the male was 14 (34.2%). The age ranges from 24 years to 67 years, and the mean age was 42.76 years. The mean operating time was 46.34 minutes in group A and 22.37 minutes in group B patients. The anatomical success rate had been found in 104 cases (93%). Although, the functional success rate had been noted in 96 (86%) cases of the group A in one-year follow-up time (Table-1). The anatomical and functional success rate was observed in 34 (83%) patients who managed by TC-LASER DCR (Group B). A Sign and binomial test had been calculated and the P-value was highly significant (<0.0001) in both groups.

Variables	Group-A	Group-B
Demographic profiles		
Age Range (Year)	12 to 86	24 to 67
Mean Age (Year)	56.23	42.76
Male	62 (55%)	14 (34%)
Female	50 (45%)	27 (66%)
Clinical Profiole		
PANDO	68 (60.7%)	41 (100%)
Failed DCR	44 (39.3%)	00 (0%)
Comobidities	73 (65.2%)	05 (12.2%)
H/o Anticoagulant drug	24 (21.4%)	04 (24.4%)
Outcomes		
Mean surgery time	46.34 minutes	22.37 minutes
Anatomical Success	104 (93%)	34 (83%)
Functional Success	96 (86%)	34 (83%)
Anatomical Fialure	08 (07%)	07 (17%)
Functional Failure	16 (14%)	07 (17%)

Table 1: *Distribution of demographic profiles, clinical profiles, and outcome profiles of both groups.*

In group A, anatomical success and functional success were observed in 97% and 92.6% patients, respectively, who had presented with PANDO. The ultimate functional outcome was achieved in 75% cases who need re-DCR (Table-2). Faint or minimal skin scar was noted in 80% of cases after six weeks of external DCR surgery (Figure-4) but reduced to only 12% after three months of surgery. No skin scar in the instances of LASER DCR surgery (Figure-5). One wound dehiscence following external DCR had managed. Minimal postoperative nasal bleeding had noted in 20% of cases of group A and 2% cases of group B. Complained moderate postoperative pain was up to 4 days of surgery in Group A and two days in group A patients. Felt minimal pain up to 10 days of surgery in group A and up to 7 days in group B patients. There was no scarring on the skin wound dehiscence in group B patients.

Ext DCR	No. (%)	Anatomical success	Functional Success	Anatomical Failure	Functional Failure
PANDO	68	66 (97%)	63 (92.6%)	02(3%)	05 (7.4%)
Failed DCR	44	38 (86.4%)	33 (75%)	06 (13.6%)	11 (25%)

Table 2: *Distribution of outcomes among different clinical entities of the group A patients.*

The failure rate was 7% in external DCR cases (group A) and 17% in TC-LASER DCR cases (group B). The success rate depends on patients co-operation during surgery, the clinical condition of the lacrimal drainage system and nasal cavity, surgical experience, instrumental facilities, preoperative evaluation and management, and comorbidities. Per-operative bleeding was more in hypertension and ischaemic heart disease (IHD) patients taking Anti-coagulant medication. LASER DCR was usually selected for cases of primary acquired nasolacrimal duct obstruction, especially in the younger age group and those who were sensitive to cosmetic concern. However, few cases (12.2%) of older adults and comorbidity patients with PANDO had been operated by LASER DCR to drain the tear from the eye to nasal cavity with minimal surgical trauma and minimum operative time.

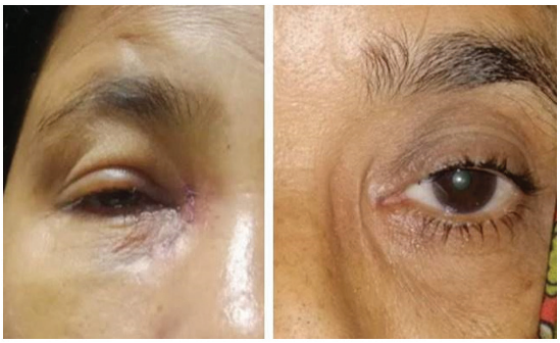


Figure 4: *Minimal skin scar at the incision site after 7 days of external DCR and 6 weeks after External DCR surgery.*

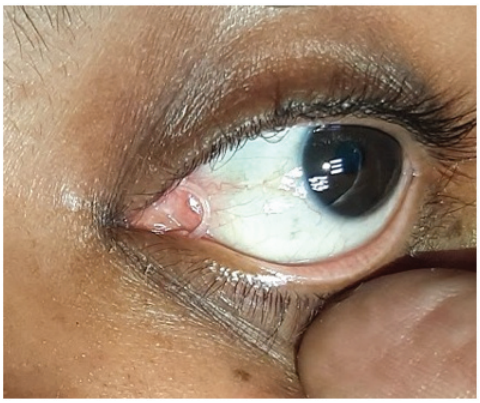


Figure 5: *No skin scar after LASER DCR surgery and intubation in situ after 6 weeks of TC LASER DCR.*

Discussion

External DCR is a highly successful and gold standard operation for nasolacrimal duct obstruction (NLDO). It is also an effective procedure in revision surgery for all types of failed DCR cases [9-12]. In recent days, minimally invasive techniques and new technology-based endoscopic approaches have reported high success rates [13-17]. Both Endoscopic endonasal DCR and Transcanalicular LASR DCR procedures are the choice of surgery to avoid skin scars. There is no possibility for skin scarring, wound infection, or wound dehiscence. These procedures require additional high-cost surgical equipment and visual systems and need experience in endoscope handling. Skin incision sparing LASER DCR or Endoscopic DCR is helping to preserve the lacrimal pump function by keeping the medial canthal tendon and canalicular system intact. Having minimal perioperative bleeding rate, short duration of surgery times, and quick rehabilitation time [18-21]. Transcanalicular LASER DCR is a safe and fast operative procedure with low morbidity and well-tolerated in primary acquired nasolacrimal duct obstruction. Compared to External DCR, Transcanalicular LASER DCR could do under local anaesthesia with intravenous sedation. It involves precise cutting and removal of bone, lacrimal, and nasal mucosa by ablation and creating a new opening. It is almost bloodless, less time-consuming DCR surgery, leaves no skin scars, preserves ligaments and muscles of the internal canthus, and keeps physiological lacrimal pump function. TC-laser DCR causes minimum pain and minimum nasal bleeding [13,19,22-23].

The success rate of external DCR has been reported from over 89% to 98% [10-11, 24-26]. The reported success rates of transcanalicular LASER DCR vary from 52% to 96% [18-19, 22, 26-29]. The surgical success rates are 52%, 56%, 64%, 76%, and 88% in the age group of 20-30 years, 31-40 years, 41-50 years, 51-60 years, and 61-70 years respectively among the patients who underwent transcanalicular laser DCR with silicone tube intubations. The overall success rate is 67% [31]. The mean age was 42.76 years of transcanalicular LASER DCR (group B) in our study. The functional success rate of transcanalicular LASER DCR has been reported from 68% to 80% [8,32-35]. Recent studies have reported that the success rate of transcanalicular laser-assisted DCR with intubations ranges from 73.3% to 94.2% [36]. There are many causes for the failure of LASER DCR. Common causes are stenosis and scarring of the ostium, fibrosis at the new ostium, membrane formation over the new ostium, and canalicular stenosis resulting in obstruction of the nasolacrimal pathway [9-10]. The anatomical success is 97% of external DCR among patients of primary NLD obstruction and 86% in transcanalicular LASER DCR. The functional success rate is 92.6% of external DCR and 86% of LASER DCR. The overall anatomical and functional success rate of external DCR is 93% and 86%, respectively. The operational success rate was higher in primary external DCR (92.6%) than external re-DCR (75%). The overall anatomical success rate was 85% in external re-DCR [37], but our success rate is 86%. There is no significant difference statistically between the functional success rate of external DCR and transcanalicular LASER DCR [34]. Failure of transcanalicular LASER DCR is occurred due to smaller osteotomy compared to external DCR and fibrovascular proliferation, which may cause stenosis and scaring off the new ostium, especially in the younger age group [31]. New techniques and modifications have been made, such as mitomycin-C intraoperatively in LASER-DCR to reduce the formation of fibrovascular proliferation, which increases the success rate up to 93% [22]. Because the number of fibroblasts decreases or the fibroblasts degenerate

with age, which results in less scar tissue formation, the adhesions between the middle turbinate and new osteotomy are among the causes of the failure of LASER DCR [28,38-42]. Strong expression of nasal mucosal heat shock protein 47 also leads to the formation of fibrosis and scar tissue in the young adult patient, which decreases the success rate of LASER DCR [41]. We used a merocel nasal pack between the middle turbinate and the new osteotomy site to prevent adhesion and haemostasis. The osteotomy size was 11.84 mm in diameter at external DCR surgery, but it were reduced to the average size of 1.8 mm by ultrasonic assessment after six months of external DCR surgery [43-44]. We performed a transcanalicular LASER DCR approach due to its better surgical outcome, and the LASER can apply directly to the obstructed site. We present our experience of transcanalicular LASER-assisted DCR using 980 nm diode lasers using fibre-optic cable is used because it offers high absorption of water and oxyhemoglobin, with very efficient vaporization of bone and soft tissue, and achieves almost bloodless DCR surgery. The new osteotome was created just anterior and inferior to the middle turbinate.

Bone fractures heal more quickly in the younger patient than in the older patients due to higher osteoblastic activity. Those mentioned above were the possible factors to reduce the satisfactory laser DCR due to the smaller osteotomy size [31]. In our study, the minimum osteotomy size was 10 mm in length and 10 mm wide in external DCR, and maximum of 8 mm in length and 5 mm in width in transcanalicular LASER DCR. The success rate was higher in external DCR due to the larger osteotomy size. With increasing age, diminished microcirculation contributes to poor tissue regeneration in older patients. The mean operative time was 17.41 minutes in transcanalicular LASER DCR and 49.49 minutes in external DCR [26]. This study showed that the mean surgery time was 46.34 minutes in group A (external DCR) and 22.37 minutes in group B (LASER DCR) patients. Silicone intubation at least six weeks helps increase the success rate of both external DCR and Transcanalicular LASER DCR in our case. A recent study reported no significant difference between the removal of silicone intubation after two weeks and six weeks of DCR surgery [45]. Current ongoing investigations will further clarify the efficacy of these newer techniques and modifications of surgery. Using mitomycin C, silicone intubation, and a piece of merocel nasal pack postoperatively are likely to increase the success rate of DCR. The advantages of external DCR include high success rate due to large osteotomy and can be used for revision surgery after failed DCR. The Success rate is higher in older age rather than younger age due to high fibroblastic activity. We have recently performed the transcanalicular LASER DCR in paediatric NLD obstruction, extreme older age, and revision surgery after failing DCR.

Conclusions

Transcanalicular LASER DCR is a viable surgical option with minimal hazards to external DCR and overall good surgical outcome in primary nasolacrimal duct obstruction. External DCR is still the best treatment option for revision surgery of failed DCR. Few modifications of surgery and advancement of instruments are helping to achieve the greater success rate of LASER DCR.

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