Trans-Canalicular Diode Laser Dacryocystorhinostomy: Technical Variations and Results

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Objective: To confirm the usefulness of the trans-canalicular laser approach of lachrymal obstructions.

Material and method: We carried out an observational, prospective, non-randomized interventional study on 150 consecutive eyes treated, between March 2004 and March 2005, using a trans-canalicular approach with a diode laser, under endonasal endoscopic control. We studied 2 groups of 75 eyes: in group I we did not use lachrymal silicone intubation nor mitomycin C; in group II we used mitomycin C and bicanalicular lachrymal intubation. Mean follow-up period has been 16 months.

Results: Positive lachrymal irrigation was present in 67/75 eyes in group I and in 71/75 eyes in group II. Clinical improvement was found in 69/75 eyes in group I and in 73/75 in group II.

Conclusions: Technical variations as lachrymal intubation or use of mitomycin C have not demonstrate significant differences. Our results indicate that the transcanalicular approach with diode is effective, with minimal local and general morbidity.

Key words: Lachrymal obstruction. Treatment. Dacryocystorhinostomy. Diode laser. Trans-canalicular surgery.

Dacriocistorrinostomía transcanalicular con láser diodo: variaciones técnicas y resultados

Objetivo: Confirmar la efectividad del abordaje transcanalicular con láser de la vía lagrimal.

Material y método: Se realizó estudio intervencionista, observacional y prospectivo no aleatorizado, realizado entre marzo de 2004 y marzo de 2005, de 150 ojos consecutivos intervenidos por abordaje transcanalicular con láser diodo, con control endoscópico nasal. Se estudiaron 2 grupos de 75 ojos: en el grupo I no se utilizó mitomicina C ni sonda lagrimal; en el grupo II se utilizó mitomicina C y se dejó sonda bicanalicular de silicona. El promedio de seguimiento ha sido de 16 meses.

Resultados: Se mantuvo una irrigación positiva en 67/ 75 ojos del grupo I y en 71/75 de los del grupo II. Clínicamente se observó mejoría clínica en 69/75 ojos del grupo I y en 73/75 del grupo II.

Conclusiones: Las variaciones técnicas en cuanto a intubación lagrimal o uso de mitomicina C no demuestran diferencias significativas. Nuestros resultados indican que el abordaje transcanalicular con láser diodo es efectivo, con mínima morbilidad local y general.

Palabras clave: Obstrucción lagrimal. Tratamiento. Dacriocistorrinostomía. Láser diodo. Cirugía transcanalicular.

INTRODUCTION

When a patient consults for chronic epiphora and we find, on examination, an occlusion of the lachrymal system, we must face the difficulty of not being able to offer him/her a technique that will guarantee that the problem will be solved in all cases. The possibilities run from forced dilation with or without intubation, which is useful in congenital

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Received Abril 24, 2006. Accepted for publication October 18, 2006. obstructions, but are of almost no use in adults¹⁻³, all the way, of course, to refraining from treating the problem if that is what our patient wants. Another alternative, for cases with recurrent infections but with general contraindications precluding complex manoeuvres, may be the removal of the lachrymal sac. However, we currently have enough options available to use that we can attempt to achieve functional recovery of the lachrymal drainage system.

In the historical reviews, we are reminded that the dacryocystorhinostomy (DCR) using the classical external approach as treatment for lachrymal obstruction was first described by Toti in 1904, with subsequent modifications added by Dupuy-Dutemps and by Bourget in 1921, who described suturing the mucosal flaps. Caldwell had begun

	Eyes (n)	Patients (n)	F/M Ratio*	Mean Age†	Bilaterality
Group I	75	64	47/17; 2.76/1	67.02 (68.66F/62.5M)	11/75 (14.66%)
Group II	75	65	49/16; 3.06/1	67.23 (69.01F/61.8M)	10/75 (13.33%)
Total	150	129	96/33; 2.99/1	67,12	21/150 (14%)

Table 1. Demographic Characteristics of the Working Groups

*There were no significant differences between the two groups (χ^2 , p = 0.99).

†There were no significant differences between the two groups (z test for comparison of means, alpha error = 0.05).

the endonasal approach for lachrymal surgery in 1893, finding himself most limited by the difficulty involved in handling the structures in question as a result of the technical and optical limitations; West and Polyak continued with this approach in 1908 and 1910, with Spanish followers such as Hinojar or Casadesus⁴.

The subsequent development of microsurgical and endoscopic techniques have made it possible for endonasal techniques to become commonplace in lachrymal obstruction surgery. The most frequent approaches differ in the optical aids used and in the technique applied to eliminate the nasal bone wall, varying from endoscopy assisted surgery to microsurgery, and from drilling the bony wall to osteotomy with a chisel, and using different types of lasers in order to vaporize the wall, all with ample references in the literature⁵⁻¹⁵. More recently, Song et al^{16,17} described in 1994 the technique involving placement of lachrymal stents as an alternative to surgery, with varying results^{18,19}.

Our constant aim in treating the obstruction of the lachrymal drainage system has been to find the simplest and least aggressive techniques possible, while maintaining a good long-term functional result in individuals with lachrymal obstruction.

To this end we began a line of work with which we seek to define the place, indications, variations and possibilities of trans-canalicular diode laser in the treatment of obstructions of the lachrymal drainage system, starting with the initial experiences obtained by other authors^{20,21}. The diode laser used applies a wavelength of 980 nm, with a good ratio between penetration and minimal injury resulting from beam dispersion, which makes it possible to advance well through the different tissues (fluid, sac wall, bone and mucosa), with good coagulation and without any distance thermal effect, in comparison with other lasers used, although progress must be made with regard to contact with structures²⁰⁻²².

MATERIAL AND METHOD

A prospective, observational and interventionist, nonrandomized study was conducted that included 2 groups of consecutively treated, non-randomized patient samples, between March 2004 and March 2005. One hundred and fifty eyes from 129 patients distributed into 2 groups of 75 eyes were studied. We have summarized the demographic characteristics of each group in Table 1.

Group I was made up of 64 patients, 47 (73.44%) were female and 17 (26.56%) were male, with a mean age of 67.02



Figure 1. Placement of the guidewire at the level of superior canaliculus, pointing toward the nasal wall through the sac.

years (68.66 for the females, 62.5 for the males). There were eleven bilateral cases. These patients underwent surgery between March and October 2004.

Group II comprised 65 patients, 49 (75.38%) female and 16 (24.62%) male, with a mean age of 67.23 years (69.01 for the females, 61.8 for the males). There were ten bilateral cases. These patients underwent surgery between November 2004 and March 2005.

The first patients to undergo surgery using this technique between November 2003 and March 2004, with more or less satisfactory results²³, were rejected in an attempt to eliminate any learning curve factor. Likewise, the secondary cases treated for relapse of any prior technique were not included either.

Diagnosis was based on the clinical history, largely founded on searching for a history of acute episodes, as well as the time of evolution, and on the basic ophthalmologic examination, including evaluation of visual acuity, biomicroscopy, intraocular pressure and an examination of the fundus oculi.

The lachrymal duct was examined by irrigating it and the duct was evaluated by the same specialist surgeon in all cases. The dacryocystographic radiological study was only performed in cases in which doubts remained subsequent to irrigation.

All the cases underwent surgery with topical ocular anaesthesia with eye drops containing tetracaine hydrochlorate and oxybuprocaine; topical nasal anaesthesia consisted of tetracaine with adrenaline and local anaesthesia was achieved by infiltration of the internal edge with 2% lidocaine and 0.5% bupivacaine with adrenaline 1:200,000.



Figura 3. Location of the laser guide light on the lateral wall of the nose.



Figure 3. Execution of a broad endonasal opening by means of successive impacts.

Sedation was administered as per patient-reported discomfort.

A gallium-aluminium-arsenide diode laser was used with a 980 nm wavelength, using a 600 μ m guidewire. After dilating the superior lachrymal punctum, the guidewire was inserted through the superior canaliculus until it reached the wall of the sac (Figure 1). By means of endonasal endoscopy, the laser guide light was identified to assure that it advanced in the proper direction (Figure 2). We worked continuously at 10 W potency, taking care to not prolong each impact too much so as to avoid overheating the structures. Once the nasal fossa was reached, the ostium was broadened (Figure 3). We prefer to perform large openings that cover the entire height of the lachrymal bone



Figure 4. Final opening with silicone probe in place.

(approximately 12 mm high and 4-5 mm deep) in the lateral nasal wall (Figure 4). The average number of shots, laser exposure time and average final energy used are analyzed in the Results section.

In the group I patients, mitomycin C was not used nor was a silicone lachrymal probe placed. A bicanalicular silicon probe was left in place in group II and a 4% mitomycin C lens (0.04 mg/100 ml) was put in place for 5 min over the nasal ostium.

Patients were discharged after a 2-h post-operative control period. The same post-operative treatment was given to both groups, with antibiotic-corticoid eyedrops every 8 h in the eye that had been operated on and topical nasal corticoids. Between 15 and 20 days later the eyedrops were replaced by another non-steroid anti-inflammatory eyedrop solution, in case of local discomfort.

Check-ups were performed at 24 h, 7 days and every 15 days for the first three months; subsequently patients were monitored every month for 18 months. The clinical course was evaluated and nasal endoscopy performed at each check-up. When in doubt as to the permeability of the ostium, lachrymal irrigation was carried out. The lachrymal probe was removed at 4 months in Group II patients.

We have assessed tolerance to treatment using a visual analogue scale for pain assessment from 0 (no pain) to 10 (intolerable pain), procedure parameters, technical success (taken to mean anatomic permeability as assessed by means of tear drainage after treatment and follow-up) and, principally, patient-rated clinical success (subjective assessment: complete improvement/absence of symptoms; improvement compared to pre-operative clinical symptoms, but not complete improvement; no change; worse versus pre-operative symptomatology), evaluating the possible difference in outcomes between the two treatment groups.

	Impacts, Mean*	Exposure to Laser (s), Mean*	Total Energy (J), Mean*	Operating Time (min), Mean†	Irrigation Permeability, 18 Months‡
Group I	27.96	21.97	199.53	20.4	67/75 (89.33%)
Group II	26.80	20.61	199.97	28.13	71/75 (94.67%)
Total	27.38	21.29	199.75	24.27	138/150 (92.00%)

Table 2. Technical Parameters and Technical Outcome

*There were no significant differences between the two groups (z test for comparison of means, alpha error = 0.05).

+Significant for z, with alpha error = 0.05.

 \pm There were no significant differences between the two groups ($\chi^2 p = 0.99$).

Table 3. Technical Outcome in Relation to Clinical Outcome

	Irrigation Permeability, 18 Months	Complete Improvement	Partial Improvement	No Change
Group I	67/75 (89.33%)	66/75 (88.00%)	3/75 (4.00%)	6/75 (8.00%)
Group II	71/75 (94.67%)	70/75 (93.33%)	3/75 (4.00%)	2/75 (2.67%)
Total	138/150 (92.00%)	136/150 (90.67%)	6/150 (4.00%)	8/150 (5.33%)

There were no significant differences between the two groups (χ^2 , p = 0.99).

RESULTS

Table 1 summarizes the general parameters and the characteristics of the 2 treatment groups. We have not found any statistically significant differences in the populational parameters of both groups insofar as mean age or gender distribution are concerned.

The reason for consultation was epiphora, which was isolated in 137 eyes (69 from Group I and 68 from Group II) and associated with episodes of acute dacryocystitis in 13 eyes (6 from Group I and 7 from Group II).

In 143 eyes (71 from Group I and 72 from Group II), lachrymal irrigation through the inferior canaliculus refluxed through the superior canaliculus and through the same puncta in 13 cases (4 from Group I and 3 from Group II).

Dacryocystography was carried out in 95 eyes (61 from Group I and 34 from Group II). Of the 90 eyes presenting complete lachrymal occlusion, 84 were postsaccal (54 from Group I and 30 from Group II) and 6 were presaccal (5 from Group I and 1 from Group II). A remaining filiform passage of contrast medium into the nasal fossa was seen in 5 eyes (2 from Group I and 3 from Group II).

Table 2 presents an analysis of the technical parameters and the outcome upon examination at 18 months.

The mean figures for the treatment parameters (total number of impacts, total laser exposure time and total energy used) do not reveal significant inter-group differences either (analysis of the means for 2 samples with unequal variances by means of the t-test with an alpha error value = 0.05).

The average number of impacts was 27.38 (range, 15-62), with an average laser exposure time of 21.29 (12-42) s. This means that the average time per impact was 0.78 s.

The mean total laser energy used was 199.75 J, without significant differences between the 2 treatment groups.

With this exposure, the osteotomies achieved average 10.73 (7-14) mm in diameter, measured on the images by reference to the size of the laser fibre (0.6 mm).

The mean surgical time, measured from the start of the dilation of the lachrymal punctum till the surgical field was raised, was 20.40 (10-35) minutes in group I and 28.13 (15-40) minutes in group II. This difference in the mean value is due to the manoeuvres to place the bicanalicular silicone probe (the time during which mitomycin C was applied in group II has not been taken into account as it does not correspond to surgical manoeuvres, strictly speaking).

It was possible to complete all of the cases using the transcanalicular route and no impacts have been applied in any case from the nasal fossa towards the sac.

Technical success and the persistence of permeability to irrigation was assessed at the end of a follow-up period 18 months at the clinic; this was possible in 138 eyes (92% of the cases). In the other 12 eyes (16%) it was not possible to demonstrate permeability to irrigation. By groups: in group I, nasal permeability was observed in 67 eyes (89.33%), while irrigation was negative in 8 (10.66%); in group II, 71 eyes (94.66%) remained permeable and the other 4 (5.33%) presented negative irrigation. The technical parameters and results are summarized in Table 2.

Regardless of the anatomical success, greater importance was given to the degree of clinical satisfaction expressed by the patients. Thus, in 136 eyes (90.67%), they reported complete remission of the symptoms, with total absence of epiphora; in 6 eyes (4.00%), improvement was reported with respect to the clinical discomfort present prior to the operation, although some epiphora still remained; no change was reported in 8 eyes (5.33%). None of the patients reported a worsening of their symptoms with regard to the prior situation. Four patients referred to an improvement without demonstration of anatomical permeability, coinciding with cases that had previously presented bouts of acute dacryocystitis that were not reproduced in any of them following the operation. The distribution of clinical results by groups is shown in Table 3. In our series, we have not

been able to demonstrate significant differences between the 2 treatment groups in terms of their long-term results.

The complications found include extrusion of the bicanalicular silicone probe in 2 patients from group II and the persistence of a prior dacryocele with permeability of the ostium in one other case.

In the 12 eyes that presented anatomical failure, the cause was seen to be a closure of the ostium at the level of the nasal mucosa in 9 cases (7 in group I and 2 in group II), and the presentation of synechiae between the head of the middle turbinate and the lateral nasal wall in 3 other cases (1 in group I and 2 in group II). The mean post-operative time for the presentation of lachrymal closure has been 46 days, and the latest occurred 6 months after surgery. Failures due to synechias between the head of the middle turbinate and the nasal wall presented a very early closure, between 7 and 20 days after the operation (or after the removal of the lachrymal catheter in group II). In the cases with fibrous reaction and closure of the ostium, the failure appears later on (after 92 days on average). All of the cases that were permeable after 6 months have continued in this way until the follow-up visits after 18 months and later.

DISCUSSION

Our results with the technique described are better than those obtained by other authors in the treatment of lachrymal obstructions with a range of techniques using other types of laser¹³⁻¹⁵ and are comparable to those obtained with diode laser by other groups^{20,21}.

External surgery is a technique widely used throughout history and experienced surgeons have achieved good results. In the long term, their results are those under closest scrutiny as this has been the gold standard for years, and for many authors it still provides the best results, despite the wide-ranging studies and discussions in the field. Nonetheless, its disadvantages in the need for manipulation and possible damage to the local structures are well known. The endonasal approach has provided a route that is more respectful of the palpebral structures palpebral structures and the internal edge, with less tissue lesion, and more control of the endonasal structures and their relationship with the new route created^{5-8,24}. This latter aspect may be relevant in cases of variations in the normal nasal anatomy, as these may interfere in the proper operation of an external dacryocystorhinostomy and could be overlooked as the cause of surgical failure. The long-term results of the endonasal approach are well-known, although they are also the subject of wide-ranging studies comparing it with the external approach²⁵⁻²⁷. We cannot, however, avoid the need for general anaesthesia if what we pursue is a sufficiently wide endonasal ostium.

The technique we are using has allowed us to complete procedures with local anaesthesia and very good tolerance by the patients, with no or minimal discomfort, minimizing general morbidity and extending the indication of a functional treatment to patients we would not otherwise have been able to treat because of their general status.

The possibility of peforming our technique through the endocanalicular route, progressing towards the nasal fossa and, therefore, keeping away from the ocular structures and limiting the lesion caused at the treatment zone by minimizing local morbidity. In line with studies already published^{20,21}, we used the approach through the punctum and canaliculus superior, leaving the canaliculus inferior free to avoid a possible lesion. Progresion by means of the flexible 0.6 mm (600 µm) probe reduces the damage to the canaliculus at the same time as it eliminates, by not using metal guidewires, the retrogade transmission of heat that might cauterize the canaliculus and the superior punctum, something to be avoided. This progression is achieved by following the normal course of the lachrymal probe, a manoeuvre that ophthalmologists are already accustomed to. We feel it is very important to control the duration of each impact, as well as the number of impacts administered to avoid thermal effects.

The 980 nm laser diode offers a good balance between its capacity to penetrate tissue and the reduced lesions due to beam divergence around the punctum treated, although it is advisable to advance by contact with the structures to avoid impacts at a distance.

Entrance into the nasal fossa is controlled by nasal endoscopic tracking of the tip of the red laser guide through backlighting. This ensures that we progress in the correct direction. It is recommended to protect the endonasal structures by using a nasal dissector to avoid thermal lesion as afar as possible. Nonetheless, treatment may on occasions be applied simultaneously with the same laser diode terminal at different power settings, in order to act on nasal alterations, such as hypertrophy of the head of the turbinate, and provide greater space in the treated area.

Once the initial communication with the nasal fossa has been achieved, it is fundamental to obtain a wide opening. With an average of 27 impacts, we have achieved osteotomies with a mean diameter of practically 11 mm. We continue to believe that it will be essential to obtain wide osteotomies, whatever the technique used, as the retraction of the nasal mucosa on healing is going to reduce the diameter in all cases. Furthermore, we feel it is important to extend the osteotomies towards the bottom part of the lachrymal sac as far as possible in order to avoid the sink effect following surgery.

We have not needed to complement the lachrymal opening endonasally towards the sac in any of our patients. On the one hand, we have not encountered any particular difficulty in performing a good front-to-back lower opening from the endocanalicular route by vapourizing practically all of the lachrymal bone. On the other hand, while the fibre we use is for treatment by contact, the thermal effect at a short distance from the tip is not negligible and therefore, in an attempt to extend the osteotomy backwards from the nasal fossa towards the sac, it might be possible to involve not just the eyeball but the external wall of the lachrymal sac, favouring a fibrosis that would reduce the possibilities of success for our procedure. This distance effect of the tip of the wire can be seen when treating endonasal structures, as we can coagulate the mucosa with the tip when treating 34 mm away from it.

We prefer to use the laser in continuous mode instead of pulses as reported by other authors^{20,21}. In our hands, in order to progress in a controlled manner at all times, this mode is more precise that using pulses through regulating the duration of the impact to avoid excessive overheating of neighbouring structures. We have not detected post-operative oedemas or lesions in canaliculi or eyelids of any patient. It is possible that some of the heat-related problems described with other types of laser may be linked to the need to use metal guidewires, something unnecessary with diode laser.

Only 2 patients presented extrusion of the bicanalicular catheter, due to local manoeuvres, with a loop appearing before the eyes and subsequent expulsion of the probe through the nose as they had cut the loop without consulting. Incidents with lachrymal catheters are reported in practically all series in lachrymal surgery, either through accidental movements or else through the induction of inflammatory granulomas in the lachrymal punctum or in the nose^{12,20,21}.

In general, we believe that the medium-term results with trans-canalicular techniques using diode laser are acceptable. It is a not very aggressive technique, simple and speedy to perform, once the learning curve has been overcome.

The contraindications cited include acute dacryocystitis or presaccal obstructions, although some authors have published results in presaccal obstructions²⁸ or in acute cases²⁹, with limited long-term functional outcomes. The absence of lachrymal puncta or the presence of tumours in the lachrymal route continue to be a contraindication for these techniques.

In addition, we must acknowledge the disadvantage represented by the high cost of the equipment needed to perform this technique.

At the present time, we have enough options available to be able to consider a functional solution in all cases of lachrymal obstruction. No technique can ensure long-term success in all patients, but there are several techniques with a comparable degree of efficacy.

Trans-canalicular dacryocystorhinostomy with diode laser is a simple and speedy technique, with minimal local lesions, minimal general morbidity for patients and an acceptable degree of efficacy in the medium term. Due to its characteristics, we feel that it is a technique that can be repeated in those cases where a good outcome is not initially achieved.

Its fundamental indication seems to be in primary noninflammatory postsaccal cases, although we feel that subsequent studies may extend these indications.

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