Long-term success rate of transcanalicular laser dacryocystorhinostomy*

Dolgoročna uspešnost transkanalikularne laserske dakriocistorinostomije*

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Abstract

Background: We present a prospective, non-comparative, non-randomized case series study of 179 consecutive transcanalicular laser dacryocystorhinostomy (TCL-DCR) procedures in 176 patients. We analyzed the success rate, complications and causes of failure of this procedure.

Patients and methods: 176 patients with functional nasolacrimal duct stenosis or complete obstruction were included in the study. The procedure was performed under general anaesthesia, and the nasal mucosa was anaemised. The site of osteotomy was determined by transillumination of the lateral nasal wall from the lacrimal sac. We achieved osteotomy by applying laser light via an optic fibre. We used a 980 nm diode laser with power of 20 W. We inserted a silicone stent as the last step. Procedure success was determined by the absence of epiphora (subjective), or by patency of the lacrimal drainage system on irrigation (objective).

Results: Since December 2005, we performed 179 successive EL-DCR with silicone stent intubation in 176 patients . The average procedure time was 12 minutes, and 245 J of laser energy on average was needed. The silicone stents were removed 3–6 months after surgery. We observed absence of epiphora and a patent nasolacrimal duct on irrigation in 146 out of 179 treated eyes. This yields a success rate of 82 % at an average follow-up time of 16 months.

Conclusions: The 980 nm EL-DCR with silicone stent intubation is a new contribution to the developments in the field of lacrimal surgery. It is a minimally invasive, and quick procedure, yielding results comparable to classic DCR, and is better than other endoscopic DCR procedures.

Izvleček

Izhodišča: V članku predstavljamo minimalno invazivno kirurško metodo odpravljanja zapore solznih izvodil: transkanalikularno lasersko dakriocistorinostomijo (TKL-DCR). Metodo TKL--DCR smo razvili v letu 2005 na naši ustanovi. V prospektivni študiji 179 zaporednih opravljenih posegov TKL-DCR smo ugotavljali dolgoročno uspešnost metode, pogostost in vrsto zapletov ter vzroke za neuspeh.

Bolniki in metode: V študijo smo vključili 176 bolnikov z delno ali popolno zaporo solznih izvodil, pri treh od njih smo TKL-DCR opravili obojestransko, skupaj 179 posegov. Med njimi je bilo 128 žensk in 48 moških, povprečna starost je bila 59 let (razpon 13–84 let). TKL-DCR smo opravili v splošni anesteziji, nosno sluznico na strani zapore solznih izvodil smo anemizirali. V primeru nejasne diagnoze smo opravili endoskopski pregled solznih izvodil od solznega punktuma navzdol in tako ugotovili vzrok in mesto zapore. Mesto osteotomije smo določili tako, da smo preko solzne vrečke s svetlobno sondo presvetlili medialno steno le-te. S pomočjo ročnika smo vstavili optično vlakno in z obsevanjem z lasersko svetlobo predrli kost in sluznico od solze vrečke do srednjega nosnega hodnika in ustvarili odprtino premera 5 mm za odtekanje solz mimo zapore v nazolakrimalnem duktusu. Uporabili smo izvor laserske svetlobe z valovno dolžino 980 nm in močjo 10 W. Na koncu posega smo v solzna izvodila vstavili silikonsko cevko. Merilo uspešnosti posega sta bila odsotnost solzenja (subjektivno) in prehodnost solznih izvodil ob prebrizganju (objektivno).

Rezultati: V vseh 179 primerih smo poseg uspešno zaključili. Na mestu osteotomije nismo opazili karbonizacije tkiva ali pomembnih krvavitev iz nosne sluznice. Pri 89 bolnikih smo opazili prehodno rdečino in otekanje spodnje veke na strani posega. V povprečju smo potrebovali 245

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J laserske energije, da smo ustvarili osteotomijo premera 5 mm. Povprečen čas posega je bil 12 minut. Silikonske cevke smo odstranili 3–6 mesecev po posegu. Pri 146 od skupno 179 zdravljenih očeh smo opazili odsotnost motečega solzenja in prehodnost solznih izvodil, kar pomeni 82 % uspešnost, ob povprečnem času spremljanja 16 mesecev (razpon 3–36 mesecev). Pri 33 neuspešnih primerih smo ugotovili sledeče vzroke ponovne zapore: prezgodnji izpad ali odstranitev silikonske cevke v 11 primerih, zarastline nosne sluznice v 10 primerih, vezivna zarastlina na mestu osteotomije v 8 primerih, zapora v področju nad solzno vrečko v 4 primerih.

Zaključek: TKL-DCR z 980 nm diodnim laserjem je nov poseg na področju minimalno invazivne kirurgije lakrimalnega sistema. Poseg je kratek in povzroča minimalno okvaro tkiv, bolniki ga dobro prenašajo. Uspešnost opisane metode TKL-DCR je primerljiva s klasično DCR *ab externo* in je enaka ali višja od primerljivih endoskopskih metod DCR.

Introduction

Dacryocystorhinostomy (DCR) is a surgical procedure used to treat lacrimal obstruction at the level of the lacrimal sac or nasolacrimal duct. It is based on the formation of a new opening between the nasal cavity and the lacrimal sac, enabling tears to bypass the obstruction. The result of a patent opening is the relief of epiphora and discharge; in some cases, functional epiphora despite a patent nasolacrimal duct is possible.

The oldest mention of lacrimal surgery is the Codex of Hammurabi from 1760 BC, which contains a reference to surgical treatment of lacrimal sac abscess and fistula. Later descriptions come from Hippocrates, Celsus and other Greek and Roman texts. After the fall of the Roman Empire much of the medical knowledge moved to the Arab world, although with little or no progress in lacrimal surgery. The same holds true for the middle ages and the renaissance.[1-3]

The modern era of lacrimal surgery begins in the early 18th century. In 1724 Platner described the procedure in which a golden cannula was inserted through the lacrimal punctum. In 1904 Toti published his report on surgical treatment of dacryocystitis, which was a significant step in the development of DCR *ab externo*.[4] Killian described the first intranasal approach to DCR[5] in 1889.

Transnasal endoscopic DCR (TE-DCR) was first performed by Caldwell in 1893, but was soon abandoned due to difficult visualization and numerous complications.[6] However, with the advent of new technology permitting better visualization, used in endoscopic sinus surgery, TE-DCR has been revived.[7] The advantages of TE-DCR over external DCR are:[8] no skin incision with a resulting scar; a shorter procedure time and patient recovery period.

Due to the above mentioned advantages over the classical approach, TE-DCR has become the treatment of choice for obstructions at the level of lacrimal sac or nasolacrimal duct and a revision procedure for failed classical DCR.

The last step in the development of a less traumatic DCR is the endocanalicular/transcanalicular approach. In this approach, first described in 1963 by Jack, a probe is inserted through the lower lacrimal punctum via the canaliculus into the lacrimal sac following the anatomical pathway of tear outflow.[9] Osteotomy is performed either by a mechanical drill or delivery of laser energy through an optic fiber, which is inserted within the probe.[10]

Lasers with several different wavelengths have been used to perform osteotomy as part of the DCR procedure, mostly as part of a transnasal approach: Holmium:Yttrium-Aluminium-Garnet (Ho:YAG) laser, potassium-tytanyl-phosphate (KTP) laser, Neodymium:YAG (Nd:YAG) laser, Erbium:YAG (Er:YAG) laser, and diode laser. Advantages of laser surgical technique over mechanical DCR techniques include: precise cutting and removal of tissue by ablation, minimal trauma to adjacent tissue, and above all, the possibility to perform the procedure through an anatomical pathway.

The first cadaveric studies in the early 1990's proved that osteotomy of lacrimal bone can be achieved by means of laser

energy delivered through an optic fibre by transnasal or transcanalicular approach.[11-13] The prefixes endo- or trans are used as synonyms and mean insertion of an optic fibre inside the lumen of the lacrimal canaliculus and saccus. The authors suggest the term transcanalicular laser DCR, TCL-DCR in short, because the endoscope is inserted into the lumen of the canaliculus, but the obstruction is by-passed across (*trans*) the medial wall of the lacrimal sac and not by opening the lumen of the nasolacrimal duct itself, as the prefix *endo* implies. The first laser described for clinical use in DCR procedure was the KTP laser in 1993,[14] followed by the use of Ho:YAG laser and the Nd:YAG laser in the period from 1994–1998, either with a TE-DCR[15] or TCL-DCR.[16-19] The first descriptions of a TCL-DCR with an Er:YAG laser date back to the years 1997 and 1998.[20,21] The use of a diode laser for TCL-DCR was first reported in 2000, and later in 2004.[22-24] Diode laser assisted DCR is the topic of several current papers, and this laser seems to offer specific advantages for DCR.[25-29]

The main technical obstacle in TCL-DCR is the delivery of a sufficiently powerful laser beam via a relatively narrow optical fibre, which in turn fits into an endocanalicular probe. Several laser wavelengths successfully comply with this requirement. Yet there are other considerations to take into account, mainly unwanted collateral heating of the probe and residual thermal damage to the target tissue. Based on theoretical and our own preclinical studies, the 980 nm diode laser seems to adequately fulfil all of the above requirements.

The purpose of our prospective study was to analyze the success rate of TCL-DCR with a 980 nm diode laser on a series of 179 successive procedures.

Patients and methods

Inclusion criteria were: congenital or acquired nasolacrimal duct stenosis and restenosis after TE-DCR. A complete ophthalmic examination was performed to rule out other causes of watery eyes: blepharitis, ectropion, entropion, lagophthalmos, trichiasis, conjunctivitis, conjunctivochalasis, keratitis. We performed a Jones dye test and irrigation of the lacrimal pathways. All patients underwent an imaging study (contrast dacryocystorhinography and/or computer tomography) to determine the exact level of obstruction and to evaluate bone thickness. A rhinologic examination was performed to rule out concomitant nasal pathology, e.g. septum deviation, concha bullosa, nasal polyposis. Patients with concomitant nasal pathology were first referred for rhinologic treatment. We obtained an informed consent by the patients, and the study was approved by the national medical ethics committee.

We used a 980 nm diode laser (Opto-Light 25, Optotek d.o.o., Ljubljana, Slovenia), in repetitive pulse mode. The laser settings were: power 10 W, pulse length 90 ms and pause between pulses 50 ms. Laser light was delivered through a 0.2 mm optic fibre, which in turn was inserted into a canalicular probe with an irrigation channel.

The procedure was performed under general anaesthesia. The nasal mucosa of the lateral nasal wall was anaemized by packing with gauze soaked in 5 % cocaine solution or other nasal decongestant (naphasoline) and infiltration with a solution of epinephrine 1:100.000. An endoscope was inserted through the previously dilated lacrimal punctum and an endoscopic examination of the lacrimal canaliculi and lacrimal sac followed in cases of unclear site of obstruction. We determined the site of osteotomy (just anterior and inferior to the attachment of the middle nasal concha) by looking into the nasal cavity with a speculum or endoscope and simultaneous transillumination of the lateral nasal wall from the side of the saccus. We performed an infraction of the middle nasal concha in cases of limited view. Osteotomy was achieved by applying the laser beam via an optic fibre, which we inserted into the lacrimal sac with a probe. Irrigation with 0.9 % saline solution of the endocanalicular probe was used to prevent overheating of the probe. The size of osteotomy was controlled using a nasal speculum or endoscope. Once an opening of at least 5 mm in diameter was achieved, application of laser

energy ceased. The next step in the procedure consisted of intubation with a bicanalicular silicone stent (F.C.I., Paris, France) in the first 44 procedures and with two monocanalicular tubes (F.C.I., Paris, France) in all the following procedures. Packing of the nasal cavity was performed in case of mucosal bleeding. Post-operative treatment included Dexamethasone-Neomycin-Polymyxin B (Maxitrol; S.A. Alcon-Covreur N.V., Puurs, Belgium) eye drops and nasal drops three times daily for three weeks on the treated side as well as 0.9 % saline solution six times daily for six weeks applied to the nose on the treated side.

Follow-up examinations were scheduled for the first day, second day, first week post-op, 3–8 months after surgery and at the termination of the study in November 2008. Patency of the nasolacrimal duct was determined as absence of epiphora and/or successful irrigation of the lacrimal passages. We measured procedure time (defined as the time from anaemisation of nasal mucosa to the fixation of silicone stents), the total amount of laser energy, and carbonisation of the nasal mucosa.

Results

From November 2005 to November 2008, we performed 179 successive EL-DCR procedures with silicone stent intubation in 176 patients; 3 patients underwent bilateral procedures. There were 128 females and 48 males (average age 59 years, range 13–84 yrs). The average procedure time was 12 minutes (range 8–35 minutes). The average total amount of delivered laser energy to produce a 5 mm wide osteotomy was 205 J (range 170–685 J). We did not notice any charring or carbonisation of the nasal mucosa. We noticed swelling of the ipsilateral lower eyelid in 89 cases, and bruising in 4 cases. The swelling usually resolved in a day or two, and bruising was visible for approximately a week.

We removed the silicone stents on average 4 months after surgery (range 3–6 months). In 11 patients, the silicone stents were removed accidentally while rubbing the eye or cleaning the nose. No other complications were noted.

The patients were re-examined at the end of the study (November 2008), the average follow-up time was 16 months (range 3–36 months). We observed absence of epiphora and a patent nasolacrimal duct on irrigation in 146 out of 179 treated eyes. This yields a success rate of 82 %.

Discussion

The aim of development in the field of DCR is to shorten the procedure time, to shorten patient recovery period, to decrease complication rate, to avoid surgical skin and mucosal scars, and to make the procedure possible on an outpatient basis, under local anaesthesia.[8] On the other hand, Toti's classic external approach with a 90–95 % success rate remains the golden standard, compared to the 80–85 % success rate of trasnasal DCR procedures and 70–80 % success rate of transcanalicular laser DCR.[30,31]

TCL-DCR is a minimally invasive surgical procedure. It takes advantage of accessing the operating field through anatomic pathways – the lacrimal canaliculus. This contributes greatly to minimizing trauma to the surrounding tissue and avoiding unnecessary surgical skin scars. The procedure has a fast learning curve and we believe it is even easier to learn than the classical or TE-DCR. However, as in all endoscopic surgeries, the surgeon must have mastered the classical approach first, to be able to use it in the case of intraoperative complications.

Of course, there are certain disadvantages of this procedure,such as handling of the laser and the costs of it. A second endoscope for endonasal control as well as basic rhinologic surgery training are strongly recommended. We strongly advise all patients with gross anomalies in nasal anatomy to undergo rhinologic treatment first.

When compared to an *ex-vivo* study of the effects of the 980 nm laser beam on chicken breast bone we noticed the following similarities (from our own unpublished data): there was very limited thermal damage to the surrounding tissue, there was no carbonisation of the bone, and irrigation of

the laser probe resulted in limited heating of the probe. On the other hand, we needed less than 100 J of laser energy to produce a 5 mm osteotomy in chicken breastbone as compared to an average of 205 J in TCL-DCR.

One of the main open questions is adequate osteotomy size, as restenosis at the site of osteotomy is one of the leading causes of long-term failure in DCR.[32] An osteotomy of more than 10 mm in diameter can be routinely achieved by the classic approach, and a slightly smaller osteotomy of 7–9 mm is achieved by a transnasal approach.[30] The osteotomy size in our series was 5 mm on average. We believe this is sufficient when using our technique, as there is minimal trauma to the surrounding mucosa and connective tissue, resulting in less postoperative mucosal scarring. An interesting CT study by Yazici and Yazici showed that the final nasal ostium size 6 months after surgery is in no correlation with osteotomy size at the time of surgery and suturing of mucosal flaps, measuring from 3.1 to 3.8 mm in width.[33] Other factors beside osteotomy size must play a more important role in the development of restenosis, and we believe this to be tissue trauma with subsequent inflammatory response and scarring.

The patients from our study reported little or no postoperative pain and were discharged the first or second day after surgery, which is a great advantage over classical DCR. The extent of eyelid swelling and bruising was also significantly lesser than in classical or endonasal DCR.

The success rate of endonasal diode laser assisted DCR in our study is among the highest reported for any DCR procedure other than classical DCR.[25,26,34-39] We explain this by minimal trauma to tissue, which results in minimal postoperative inflammation and scarring. Additionally, in cases of restenosis, the procedure can be easily repeated, as there is no scarring of the lacrimal pathways or alterations in the anatomical relations. Some studies suggest, that in the future this procedure could even be performed under local anaesthesia.[40,41]

Conclusions

The 980 nm EL-DCR with bicanalicular intubation is a new contribution to the developments in the field of lacrimal surgery. It is a minimally invasive and quick procedure, yielding results comparable to classic DCR, and is better than TE-DCR or other endoscopic laser DCR procedures. It facilitates a short patient recovery period, a shorter procedure time and avoidance of a skin scar. In the future, we plan to perform the procedure under local anaesthesia, on an outpatient basis.

References

1. Hughes SM. The history of lacrimal surgery. Adv Ophthal Plastic & Reconstruct Surgery 1986; 5: 139–68.
2. Werb A. The history and development of lacrimal surgery in England and Europe. Adv Ophthal Plastic & Reconstruct Surgery 1986; 5: 233–40.
3. Vasquéz RJ. History of lacrimal surgery. In: Lindberg JV, ed. Contemporary issues in ophthalmology Vol 5. Lacrimal surgery. New York: Churchill Livingston; 1988. p. 315–36.
4. Toti A. Nuovo metodo conservatore di cure radicale delle supporazioni croniche del sacco lacrymale. Clin Med Firenze 1904; 10: 385–9.
5. Mahmood S, Sadiq A. A short history of lacrimal surgery. CME Journal Ophthalmology 2001; 5(3): 76–8. Available at: http://www.rila.co.uk/issues/full/download/60b91149a8390c2ba2c9033c405910ee793220.pdf. Accessed December 29, 2007.
6. Caldwell GW. Two new operations for obstruction of the nasal duct with preservation of the canaliculi. Am J Ophthalmol 1893; 10: 189.
7. Kennedy DW. Functional endoscopic sinus surgery: technique. Arch Otolaringol 1985; 111: 643–9.
8. Malhotra R, Wright M, Olver JM. A consideration of the time taken to do dacryo-cystorhinostomy (DCR) surgery. Eye 2003; 17: 691–6.
9. Jack MK. Dacryocystorhinostomy. Description of a transcanalicular method. Am J Ophthalmol 1963; 56: 974–7.
10. Haefliger IO, Piffaretti JM. Lacrimal drainage system endoscopic examination and surgery through the lacrimal punctum. Klin Monatsbl Augenheilkd 2001; 218: 384–7.
11. Massaro BM, Gonnering RS, Harris GJ. Endonasal laser dacryocystorhinostomy. A new approach to nasolacrimal duct obstruction. Arch Ophthalmol 1990; 108: 1172–6.
12. Silkiss RZ, Axelrod RN, Iwach AG, Vassiliadis A, Hennings DR. Transcanalicular THC:YAG dacryocystorhinostomy. Ophthalmic Surg 1992; 23: 351–3.
13. Levin PS, Stormo Gipson DJ. Endocanalicular laser-assisted dacryocystorhinostomy. An anatomic study. Arch Ophthalmol 1992; 110: 1488–90.

14. Reifler DM. Results of endoscopic KTP laser-assisted dacryocystorhinostomy. Ophthal Plast Reconstr Surg 1993; 9: 231–6.
15. Metson R, Woog JJ, Puliafito CA. Endoscopic laser dacryocystorhinostomy. Laryngoscope 1994; 104 Pt 1: 269–74.
16. Piaton JM, Limon S, Ounnas N, Keller P. Transcanalicular endodacryocystorhinostomy using Neodymium:YAG laser [in French]. J Fr Ophtalmol 1994; 17: 555–67.
17. Dalez D, Lemagne JM. Transcanalicular dacryocystorhinostomy by pulse Holmium-YAG laser [in French]. Bull Soc Belge Ophtalmol 1996; 263: 139–40.
18. Saint Blancat P, Risse JF, Klossek JM, Fontanel JP. Dacryocystorhinostomy using Nd YAG laser by the intracanicular approach [in French]. Rev Laryngol Otol Rhinol (Bord) 1996; 117: 373–6.
19. Woo KI, Moon SH, Kim YD. Transcanalicular laser-assisted revision of failed dacryocystorhinostomy. Ophthalmic Surg Lasers 1998; 29: 451–5.
20. Emmerich KH, Lüchtenberg M, Meyer-Rüsenberg HW, Steinhauer J. Dacryoendoscopy and laser dacryoplasty: technique and results [in German]. Klin Monatsbl Augenheilkd 1997; 211: 375–9.
21. Müllner K. Opening of lacrimal duct stenoses with endoscope and laser [in German]. Ophthalmologe 1998; 95: 490–3.
22. Eloy P, Trussart C, Jouzdani E, Collet S, Rombaux P, Bertrand B. Transcanalicular diode laser assisted dacryocystorhinostomy. Acta Otorhinolaryngol Belg 2000; 54: 157–63.
23. Alañón Fernández MA, Alañón Fernández FJ, Martínez Fernández A, et al. Endonasal and endocanalicular dacryocystorhinostomy by diode laser. Preliminary results [in Spanish]. Acta Otorrinolaringol Esp 2004; 55: 171–6.
24. Alañón Fernández FJ, Alañón Fernández MA, Martinez Fernández A, Cárdenas Lara M. Transcanalicular dacryocystorhinostomy technique using diode laser [in Spanish]. Arch Soc Esp Oftalmol 2004; 79: 325–30.
25. Alañón Fernández MA, Alañón Fernández FJ, Martinez Fernández A, Cárdenas Lara M. Results the application of mitomicyn during endonasal and endocanalicular dacryocystorhinostomy by diode laser [in Spanish]. Acta Otorrinolaringol Esp 2006; 57: 355–8.
26. Hong JE, Hatton MP, Leib ML, Fay AM. Endocanalicular Laser Dacryocystorhinostomy. Analysis of 118 consecutive surgeries. Ophthalmology 2005; 112: 1629–33.
27. Maeso Riera J, Sellarès Fabrés MT. Trans-canalicular diode laser dacryocystorhinostomy: technical variations and results [in Spanish]. Acta Otorrinolaringol Esp 2007; 58: 10–5.
28. Henson RD, Henson RG Jr, Cruz HL Jr, Camara JG. Use of the diode laser with intraoperative mitomycin C in endocanalicular laser dacryocystorhinostomy. Ophthal Plast Reconstr Surg 2007; 23: 134–7.
29. Plaza G, Beteré F, Nogueira A. Transcanalicular dacryocystorhinostomy with diode laser: long-term results. Ophthal Plast Reconstr Surg 2007; 23: 179–82.
30. Olver J. Colour atlas of lacrimal surgery. Oxford: Butterworth-Heinemann; 2002.
31. Mandeville JT, Woog JJ. Obstruction of the lacrimal drainage system. Curr Opin Ophthalmol 2002; 13: 303–9.
32. Linberg JV, Anderson RL, Bumsted RM, Barreras R. Study of intranasal ostium external dacryocystorhinostomy. Arch Ophthalmol 1982; 100: 1758–62.
33. Yazici B, Yazici Z. Final nasolacrimal ostium after external dacrycystorhinostomy. Arch Ophthalmol 2003; 121: 76–80.
34. Ressiniotis T, Voros GM, Kostakis VT, Carrie S, Neoh C. Clinical outcome of endonasal KTP laser assisted dacryocystorhinostomy. BMC Ophthalmol 2005; 5: 2.
35. Pearlman SJ, Michalos P, Leib ML, Moazed KT. Translacrimal transnasal laser-assisted dacryocystorhinostomy. Laryngoscope 1997; 107: 1362–5.
36. Moore WM, Bentley CR, Olver JM. Functional and anatomic results after two types of endoscopic endonasal dacryocystorhinostomy: surgical and holmium laser. Ophthalmology 2002; 109: 1575–82.
37. Patel BC, Phillips B, McLeish WM, Flaharty P, Anderson RL. Transcanalicular neodymium: YAG laser for revision of dacryocystorhinostomy. Ophthalmology 1997; 104: 1191–7.
38. Caversaccio M, Frenz M, Schar P, Hausler R. Endonasal and transcanalicular Er:YAG laser dacryocystorhinostomy. Rhinology 2001; 39: 28–32.
39. Dolman PJ. Comparison of external dacryocystorhinostomy with nonlaser endonasal dacryocystorhinostomy. Ophthalmology 2003; 110: 78–84.
40. Tripathi A, Lesser TH, O'Donnell NP, White S. Local anaesthetic endonasal endoscopic laser dacryocystorhinostomy: analysis of patients' acceptability and various factors affecting the success of this procedure. Eye 2002; 16: 146–9.
41. Fanning GL. Local anaesthesia for dacryocystorhinostomy. Current Anaesthesia & Critical Care 2000; 11: 306–9.