ORIGINAL ARTICLE

Nasolacrimal duct office probing in children under the age of 12 months: Cure rate and cost evaluation

Sondage du canal lacrymo-nasal au cabinet chez les enfants de moins de 12 mois : taux de guérison et évaluation des coûts

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KEYWORDS
Probing; Nasolacrimal duct; Children; Cost

Summary

Introduction. — Controversy exists regarding the treatment of infants with symptomatic nasolacrimal duct obstruction. One philosophy advocates “early” nasolacrimal duct probing, generally in the office — a relatively common approach in France, while others prefer to wait until the age of 12 months to offer a procedure under general anesthesia. The goal of this study is to report results of immediate office probing for congenital nasolacrimal duct obstruction (CNLDO) under age 1 year in terms of efficacy and cost.

Methods. — A retrospective study was performed on 329 patients (443 eyes) treated by probing for CNLDO under the age of 12 months age. A single probing was performed at the first visit in the office under topical anesthesia without sedation. In order to determine the factors

\textsuperscript{*} Results of this study were presented in part at the ESOPRS (European Society of Ophthalmic Plastic and Reconstructive Surgery) conference, Barcelona, Spain, September 19–21, 2013.

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associated with failure of probing, univariate analysis was performed using the Student t-test, Pearson’s, homogeneity Chi² or Fisher’s exact tests. For cost evaluation, hypothetical estimates of spontaneous resolution month by month were used according to data in the literature, along with health insurance reimbursement data.

Results. — The ages of the patients ranged from 2 to 11 months (mean 7.0 ± SD 2.3). The overall success rate for cure by immediate office probing was 76.7%. Unilateral CNLDO had an 80.4% success rate whereas bilateral CNLDO had a 73.2% success rate for each eye (P = 0.09). Discharge during probing was associated with failed probing (P = 0.02). The cost for the spontaneous resolution strategy was 1.56 times higher than for the immediate probing strategy. A strategy which would apply the spontaneous resolution strategy for children ≤ 5 months and the probing strategy to children > 5 months would be the most cost-effective.

Conclusions. — Immediate office probing between the ages of 5 to 12 months is a safe, effective method to relieve CNLDO and is the most cost-effective.

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Introduction

Congenital nasolacrimal duct obstruction (CNLDO) affects 6% of the pediatric population [1]. Epiphora is the main, but least specific presenting sign. More specific signs include the presence of high tear meniscus and mucoid discharge that may cause crusting of the eyelid margins and skin erythema. The most widely recommended form of medical management utilizes moist, warm soaks and sac massage, along with use of ophthalmic antibiotic when mucopurulent discharge occurs [2]. Without treatment, a small percentage of the cases may progress to acute dacryocystitis and cellulitis [3].

There is considerable controversy amongst ophthalmologists as to the management of epiphora in infants. In general, there are two schools of thought: the wait-and-see approach (i.e. conservative therapy), and the interventionist approach (i.e. probing). This dichotomy is due to the occurrence of spontaneous resolution of epiphora in the young infant and the good results of early probing [4,5]. The physician has to choose between early probing in an infant who has a high likelihood of spontaneous resolution or no immediate treatment with potential surgical treatment later under general anesthesia.

MacEwen and Young studied a cohort of 4792 infants in order to determine the natural history of epiphora during the first year of life: one can calculate that at 6 months of age 75% of eyes still obstructed will clear by 1 year of age, and at 9 months 36% of those still obstructed will clear...
Office-probing before age of one year

by one year of age [5]. Other groups reported resolution of symptoms for 80% to 96% of eyes before the age of one year and a few additional ducts will open spontaneously in the second year [6–8].

Lacrimal probing is regarded as a reliable first procedure, with a success rate of 78 to 97% before the age of 1 year [4,9–13]. Moreover, early probing may lead to earlier relief of epiphora and discharge and may then help to alleviate the anxiety for parents and irritability of the child [14,15].

The aim of this study is to report our series of 443 eyes under the age of 12 months age that had only one immediate probing under topical anesthesia, in the office, using papoose-style immobilization, to evaluate the cost impact.

Material and methods

Eligibility criteria

This study followed the tenets of the Declaration of Helsinki. The medical records of patients less than 12 months who had the diagnosis of CLNLD0 between January 1, 2003 and December 31, 2008 were reviewed. The diagnosis of CNLDO was historical and clinical, as evidenced by epiphora beginning during the first few weeks of life, increased tear lake size or tear pooling, recurrent mucopurulent discharge, and reflux of contents of the lacrimal sac on pressure. Patients with facial trauma, trisomy-21, or congenital craniofacial abnormalities were not included in the study. We found 398 patients with the diagnosis of CLNLD0. Of the 398 patients, 3 patients were excluded due to dacrocyele of the lacrimal sac, 5 patients were excluded due to acute dacryocystis, and 4 patients were excluded for punctual agenesis. Fifty-seven other patients were excluded because the clinical signs were minor (no or rare discharge and/or slight epiphora and no reflux of contents of the lacrimal sac). In total, nasolacrimal duct probing was the primary treatment method for 329 patients.

All patients were fresh referrals to our secondary-care institutional practice. We confirmed that epiphora and/or conjunctival discharge has been present the first few weeks after the birth.

Immediate office probing

Immediate probing was defined by a probing at the first visit. In all cases, nasolacrimal duct probing was accomplished under topical anesthesia in the office. The infant was first immobilized using mummy-style. Irrigation was never performed to confirm a patent nasolacrimal system. The inferior turbinate was never fractured. For all patients, a single experienced oculoplastic surgeon performed probing.

A narrow nasolacrimal duct was characterized by a lack of resistance to the probe until it entered the nasolacrimal duct, at which point the probe was felt to be fitting snugly within the nasolacrimal duct.

After probing, patients were given antibiotic drops (Tobrex®, Alcon) to be applied three times daily for one week. In cases of reflux of contents of the lacrimal sac during the probing, oral antibiotics (amoxicillin only or amoxicillin-clavulanate) during 5 days were prescribed as well.

Follow-up

Success of nasolacrimal duct probing was defined as a complete remission of symptoms and signs. Parents received systematic postoperative follow-up at 4 weeks by phone. Patients considered successful were instructed to continue routine medical care with their primary care physician and contact us if signs or symptoms of CNLDO recurred later. If the first probing failed, a second probing or silicone intubation was proposed depending on the age of the child but this strategy was not included in the current study.

Statistical analysis

In order to determine the factors associated with failure of probing, univariate analysis was performed using the Pearson’s Chi² test and homogeneity Chi². Statistical significance was set at $P < 0.05$.

Cost evaluation

For cost evaluation we explored the relative costs of the two prevailing strategies, the wait-and-see group (conservative therapy) and the interventionist group (probing). We thus used the hypothetical estimate of spontaneous resolution month by month according to the data of the natural history of epiphora described by MacEwen and Young and the number of cases of successful probing in our study [5]. In case of failure in the conservative therapy or probing, we assumed the cost of silicone intubation under general anesthesia. We hypothesized that no second probing was proposed and no failure was observed after silicone intubation treatment. This cost evaluation was run from the payer’s perspective i.e., the national health insurance and did not include costs of missed wages, childcare, or travel. We based cost on the following charges: for the wait-and-see group, we calculated 28 € for the initial visit, 1415 € for the silicone intubation under general anesthesia in ambulatory surgery for those children who had persistent epiphora after the age of 12 months and 28 € for the removal of the silicone intubation 6 to 8 weeks later in the office. For the interventionist group, we calculated 28 € for the initial visit including immediate office probing, 1415 € for the silicone intubation under general anesthesia in a short-stay surgical setting for those children who had failure of the initial probing in the office and 28 € for the removal of the silicone intubation 6 to 8 weeks later. Drops were not included in the fees. A decision tree was used to compute the costs for 2 prevailing strategies for treating CNLDO in children evaluated under 12 months of age (TreeAge pro® 2008). In addition, a third strategy considering conservative or probing according to age was explored.

Results

Baseline characteristics

Immediate office probing was performed at the first visit on 329 patients with CNLDO. Among the patients, 166 were female and 163 were male. In 106 patients (32.2%) the right eye, in 109 (33.1%) the left eye and in 114 (34.6%) both eyes...
were involved. Overall 443 eyes were analyzed for probing for CNLDO.

The ages of the patients ranged 2 from 11 months (mean 7.0±SD 2.3). Four patients (6 eyes) were aged 2 months, 108 patients (150 eyes) were aged 3–5 months, 143 patients (188 eyes) were aged 6–8 months and 74 patients (99 eyes) were aged 9–11 months. The mean age at first probing was 7 months ± SD 2.3 months.

Of the 443 eyes, 22 (4.9%) were found to have a narrow nasolacrimal duct and 42 (9.5%) were found to have reflux of contents of the lacrimal sac during probing.

No complications were noted during or after probing; in particular, there were no cases of inferior punctual trauma or false passage. Minor and benign epistaxis was noted immediately after probing in 12 eyes (2.7%).

**Primary outcome**

The overall success rate for cure by immediate office probing was 76.7% (95% Confidence interval, 72.8–80.7). The success rate by age is described in Table 1. There was no decrease in the cure rate after the age of 6 or 9 months (P=0.86 by the Chi² of homogeneity test).

**Factors associated with failure**

Unilateral CNLDO had an 80.4% (173/215) success rate whereas bilateral CNLDO had a 73.2% (167/228) success rate (P=0.09). Absence of discharge during probing had a 78.3% (314/401) success rate whereas presence of discharge during probing had a 61.9% (26/42) success rate (P=0.02) (Table 2).

Probing with a narrow nasolacrimal duct was successful in 8 eyes (36.3%).

**Cost evaluation**

Table 3 shows the relative success rates and cost of the two prevailing strategies, the wait-and-see group (i.e. conservative therapy) and the interventionist group (i.e. probing) month by month using our data with respect to the number of eyes. Under the age of 4 months conservative therapy is more cost-efficient in our institution. After 5 months, probing is more cost-efficient than conservative therapy. Globally, we calculated that conservative therapy is 1.56 more expensive than probing. We then applied a decision tree to these data to compute the costs for 2 prevailing strategies. The cost for conservative treatment was calculated at 567 € per eye and the cost for probing was calculated at 363 € per eye (Fig. 1). A third strategy which would apply the conservative strategy for children <5 months and the probing strategy to children >5 months would cost even less e.g. 317 € than the “immediate office probing for all eyes”.

With respect to only unilateral cases (215 eyes), we calculated that conservative therapy is globally 1.89 more expensive than probing. We also found that after 5 months, probing is more cost-efficient than conservative therapy for unilateral cases.

Since some patients had bilateral CNLDO, cost of medical care should be calculated per patient and not per eye because success in one eye only is a failure as silicone intubation under general anesthesia would be necessary to treat the unsuccessful eye. Thus we calculated the costs with respect to the number of patients: cost for conservative treatment was calculated at 1.48 times more expensive than cost for probing.

**Discussion**

In recent years, there has been heightened discussion regarding optimal care of congenital nasolacrimal duct obstruction (CNLDO). Analyzing consecutive cases of CT facial series over a 16-month period, Moscato et al. showed that the increases in height, diameter and volume of the nasolacrimal duct obstruction occur primarily in the first 6 months of life suggesting that spontaneous resolution of such obstruction in normal infants may be linked to this

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Initial probing successful.</th>
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<tbody>
<tr>
<td></td>
<td>Number of eyes</td>
</tr>
<tr>
<td>2 months</td>
<td>6</td>
</tr>
<tr>
<td>3–5 months</td>
<td>150</td>
</tr>
<tr>
<td>6–8 months</td>
<td>188</td>
</tr>
<tr>
<td>9–11 months</td>
<td>99</td>
</tr>
<tr>
<td>Total</td>
<td>443</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Factors associated with successful probing.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Success</td>
</tr>
<tr>
<td></td>
<td>n=340</td>
</tr>
<tr>
<td>Age, mean (SD), months</td>
<td>7.0 (2.3)</td>
</tr>
<tr>
<td>Unilateral</td>
<td>173 (50.8%)</td>
</tr>
<tr>
<td>Bilateral</td>
<td>167 (49.1%)</td>
</tr>
<tr>
<td>No discharge during probing</td>
<td>314 (92.3%)</td>
</tr>
<tr>
<td>Discharge during probing</td>
<td>26 (7.6%)</td>
</tr>
</tbody>
</table>
Office-probing before age of one year

Table 3  Relative cost of the two prevailing strategies.

<table>
<thead>
<tr>
<th>Age (months)</th>
<th>Nb of cases (n)</th>
<th>Success of probing (%)</th>
<th>Success with no probing (%)</th>
<th>Ratio comparing fees for conservative strategy to fees for probing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>6</td>
<td>67</td>
<td>93</td>
<td>0.25</td>
</tr>
<tr>
<td>3</td>
<td>31</td>
<td>74</td>
<td>90</td>
<td>0.43</td>
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<tr>
<td>4</td>
<td>66</td>
<td>74</td>
<td>86</td>
<td>0.57</td>
</tr>
<tr>
<td>5</td>
<td>53</td>
<td>85</td>
<td>82</td>
<td>1.17</td>
</tr>
<tr>
<td>6</td>
<td>64</td>
<td>80</td>
<td>75</td>
<td>1.21</td>
</tr>
<tr>
<td>7</td>
<td>75</td>
<td>72</td>
<td>64</td>
<td>1.26</td>
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<tr>
<td>8</td>
<td>49</td>
<td>81</td>
<td>49</td>
<td>2.61</td>
</tr>
<tr>
<td>9</td>
<td>41</td>
<td>71</td>
<td>36</td>
<td>2.11</td>
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<tr>
<td>10</td>
<td>34</td>
<td>80</td>
<td>23</td>
<td>3.50</td>
</tr>
<tr>
<td>11</td>
<td>24</td>
<td>75</td>
<td>5</td>
<td>3.60</td>
</tr>
</tbody>
</table>

\( ^a \) In our study.

\( ^b \) Data of the natural history of epiphora described by MacEwen and Young [5].

anatomic evolution, in which case probing before the age of 5 months should be avoided [16]. Thus, one strategy advocates nasolacrimal duct probing after the age to 5 or 6 months [17,18]. A second strategy advocates medical management until the infant is approximately 12 months old to allow spontaneous resolution and then propose probing, balloon or silicone intubation under general anesthesia if the NLDO is still symptomatic [19–21]. The current study is a retrospective case series of consecutive patients by a single experienced oculoplastic surgeon in the office under topical anesthesia using nasolacrimal duct probing as the primary treatment method for CNLDO.

Excellent results have been observed after early probing. Success is achieved between 65% and 96% with one to three probing [4,15,22,23]. The overall success rate for cure by immediate office probing was 76.7% in our study. However, many factors are believed to affect the success rate of nasolacrimal probing [9,13,24,25] Bilateral involvement may be a marker of more significant anatomical or physiological variations in the nasolacrimal duct, mucous membrane physiology, or the tear pump mechanism, which may be more difficult to cure with probing. However we did not find that bilaterality had a significant impact on the success rate of immediate probing. Interestingly, we found that

Figure 1. Decision tree to compute the costs for 2 prevailing strategies for treating congenital nasolacrimal duct obstruction (CNLDO) in children evaluated under 12 months of age.
discharge during probing is associated with failed probing ($P = 0.02$). Discharge during probing may reflect a dilated sac and may affect sac function. This point has not been reported in previous studies.

The main advantage of office probing is to avoid general anesthesia because probing may be performed in office without anesthesia [15,26,27]. We performed probing until the age of 12 months if the child could be immobilized using mummy-style. Our success rate is clearly less than that reported in large series by other authors who used general anesthesia [4,9,11,13]. We recognize that probing in the office may be less aggressive that probing under general anesthesia perhaps by a less robust procedure (e.g., probe passed only once). Moreover confirmation of the passage of the probe into the nasal cavity may be optimized by an endoscope under general anesthesia. However we think that, with experience, a "popping" sensation is used to certify a good passage of the probe and false passage is well recognized [28]. It may be argued that office probing is the less traumatic psychologically than general anesthesia for the infant, as the latter may involve blood work being drawn, restraint and mask application during induction, disorientation during emergence from anesthesia, and more prolonged separation from the parents. In our experience, infants undergoing probing stopped crying and relaxed within one or two minutes after the procedure was complete. We do not have experience of topical office probing with intranasal midazolam or propofol [26,29]. However, this medication may decrease the gag reflex, causing increased risk of aspiration in case of bleeding.

In the current climate of scrutiny of healthcare spending, cost analysis for probing in the office before the age of 12 months may contribute to the clinical decision. The advantages of early probing in the office setting are avoidance of general anesthesia, immediate resolution of symptoms, fewer physician visits, fewer antibiotic prescriptions, and avoidance of more costly procedures. Cost issues are complex and multi-faceted, making their precise evaluation difficult. Using our data, we were able to compare the cost of two treatment strategies. We calculated that the cost for conservative treatment is globally 1.56 more expensive than immediate probing. Using our data, according to the 2011 Medicare Fee Schedules in USA, we found that globally the cost for conservative treatment is 1.65 more expensive than immediate probing and we also found that after 5 months, probing is more cost-efficient than conservative therapy (data not shown). In our study, we also calculated that a strategy which would apply the conservative strategy for children ≤ 5 months and the probing strategy to children > 5 months would be the most cost-efficient strategy. Few authors have evaluated the cost evaluation of CLNDO and the results seem to show that probing is cheaper. Wobig stated that the most effective and economical method of treatment is probing between 3 and 10 months of age [28]. For Kasoff and Meyer the total cost of the procedure under general anesthesia is ten times more expensive than office probing [30]. Frick et al. showed that immediate office probing cost less than probing under general anesthesia at spontaneous resolution rates between 50% and 68% [18]. More recently the Pediatric Eye Disease Investigator Group found in a randomized trial of 163 infants aged 6 to less than 10 months with unilateral NLDO that the immediate office-probing approach is likely more cost-effective than observation. However, no infants under the age of 6 months were included [31]. Bias exists and opposite may also be true if other factors are considered as age of the infants [32]. Additionally, we took into account the varying rate of spontaneous resolution i.e. monthly by month using the data reported by MacEwen and Young on the natural history of epiphora, whereas all the other authors used a fixed rate in their calculations [5]. Finally, we calculated costs per patient as opposed to per eye, which reflects more closely the real cost of a strategy.

Disclosure of interest
The authors declare that they have no competing interest.

References
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