The consistency of diagnostic findings among lacrimal syringing, dacryocystography, and dacryoendoscopy in lacrimal drainage system obstruction

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Research Article

Keywords: Epiphora, Lacrimal drainage system obstruction, Lacrimal syringing, Dacryocystography, Dacryoendoscopy, Weighted Kappa value

Posted Date: October 28th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1966740/v5

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Version of Record: A version of this preprint was published at Clinical Ophthalmology on May 3rd, 2023. See the published version at https://doi.org/10.2147/OPTH.S409662.
Abstract

Aim

To investigate the consistency of diagnostic findings in lacrimal syringing, dacryocystography (DCG), and dacryoendoscopy in the obstruction of the lacrimal drainage system (LDS).

Methods

We retrospectively examined 113 patients (211 LDS) who underwent syringing, DCG, and dacryoendoscopy to evaluate LDS obstruction. LDS obstruction was compared by classifying grade and site into three levels, respectively. The diagnostic consistency between the examinations was assessed by determining the weighted kappa value.

Results

A total of 25 male (49 LDS) and 88 female patients (162 LDS) were included in this study. Obstructions were observed in 77.4%, 60.0%, and 81.3% of LDS by syringing, DCG, and dacryoendoscopy, respectively. Regarding the agreement in obstruction grade, Cohen's kappa value for DCG and dacryoendoscopy was 0.65 (95% confidence interval [CI]: 0.56–0.74). Although DCG diagnosed as patent in 38.4% of all LDS, 47.9% of them revealed partial or complete obstruction by dacryoendoscopy. Meanwhile, DCG and dacryoendoscopy showed consistency in the obstruction site in 77.9% of LDS. When discrepancies were observed between syringing and dacryoendoscopy in detecting the obstruction site, the combined diagnosis of syringing and DCG reached dacryoendoscopy findings at the 99% level.

Conclusions

“Substantial” agreements were found among the three examinations in diagnosing obstruction grade and site (Fleiss κ > 0.6 for both). Then, the highest agreement was observed between syringing and dacryoendoscopy in determining the obstruction site (κ = 0.7). The lowest agreements were observed between syringing and DCG in diagnosing the obstruction grade and site (κ = 0.55 for both).

Highlights

What is already known on this topic

In addition to conventional lacrimal syringing and dacryocystography (DCG), the use of dacryoendoscopy has evolved to examine lacrimal drainage system (LDS) obstruction during recent years, particularly in Northeast Asia. However, little is known about the diagnostic consistency of the dacryoendoscopy among the conventional examinations.
What this study adds

The concordance of the diagnostic results of lacrimal syringing, DCG, and dacryoendoscopy concerning the grade and site of LDS obstruction was evaluated using weighted kappa coefficients.

How this study might affect research, practice, or policy

The usefulness of dacryoendoscopy in the examination of LDS was encouraged. Moreover, it is preferable to utilize DCG and dacryoendoscopy complementarily based on understanding their respective characteristics.

Introduction

The lacrimal drainage system (LDS) extends from the lacrimal punctum to the lower opening of the nasolacrimal duct on the lateral wall of the inferior nasal meatus. LDS obstruction can develop at any level along the lacrimal outflow pathway: at the punctum, canaliculus, lacrimal sac, nasolacrimal duct, and nasal ostium.[1] LDS obstruction is generally diagnosed using lacrimal syringing, probing with a lacrimal bougie, and dacryocystography (DCG) to determine the degree and site of obstruction. Syringing is a practical test evaluating LDS obstruction and providing valuable information on the presence, localization, and nature of the obstruction. Syringing can evaluate whether the canaliculus, lacrimal sac, and nasolacrimal duct are qualitatively patent, partially, or completely obstructed.[2] DCG has played a primary role in diagnosing LDS obstruction since Ewing first reported in the early twentieth century.[3 4] DCG is a classic and valuable test and remains the primary method to evaluate LDS obstruction. The basic idea of DCG is to find the site where the contrast agent is occluded first and to diagnose that site as the obstructed level. The LDS obstruction level is classified into presaccal obstruction, in which the contrast agent does not reach the lacrimal sac, and postsaccal obstruction, in which the contrast agent reaches the lacrimal sac. Dacryoendoscopy is one of the examinations rapidly developed in recent years. [5] Furthermore, treatments of LDS obstructions using the dacryoendoscope have remarkably increased over the past two decades particularly in East Asia, including Japan, Korea, and the Philippines.[6-9] East Asians have relatively flat facial features, with a less elevated superior orbital rim than other ethnic groups, which may allow relatively easy manipulation of a dacryoendoscope.[10] Another contribution is that the development of bent-tip and curved probes facilitates observation until the end of the nasolacrimal duct in patients who cannot be observed using conventional straight-type probes (Supplementary Figure 1). As the first-generation lacrimal endoscope, Cohen et al. introduced the dacryoscopy in 1979.[11] As the second-generation lacrimal endoscope, Ashenhurst and Hurwitz’s canaliculoscope was introduced in 1991, and Fein’s endoscopy of the lacrimal outflow system was introduced in 1992. All of these are flexible fiber endoscopes.[12 13] As the third-generation lacrimal endoscope, Emmerich’s rigid fiber endoscope (dacryoendoscope) was developed in 1997, and a bent-type
rigid fiberoptic endoscope was developed in 2002. [14 15] These third-generation dacryoendoscopes are distinctive because tips of the second-generation flexible lacrimal endoscope are covered with rigid metal probes. Moreover, third-generations are equipped with a channel for water irrigation, a laser probe, and a micro-drill to allow the performance of microsurgery in the LDS. Because of its shape, the bent-type dacryoendoscope can easily be inserted into the nasolacrimal duct and reach the opening on the inferior nasal meatus. However, as the probe is bent, it cannot be equipped with a laser or micro-drill. Hence, recanalization surgery using a bent-type dacryoendoscope involves perforating the obstructed site by pushing a catheter capped on the probe's tip and placing a silicone tube stent on the released lacrimal pathway. [7-9 16 17]

The consistency of diagnostic results from several examination methods of the LDS obstruction is an important question that should be investigated. Then, the medical records of 113 patients who underwent syringing, DCG, and dacryoendoscopy for the preoperative evaluation of the LDS obstruction were retrospectively evaluated. This study investigated the consistency of the diagnostic findings based on the grade of obstruction and obstruction site of the LDS between these three types of examinations.

Methods

Patient selection

The protocol and consent forms for the study were approved by the institutional review board of Ehime University (ethical approval no. 1601003). The study was recorded with the University Hospital Medical Information Network Clinical Trials Registry (UMIN 000025180). Each patient provided documented informed consent before registration. All procedures used in this study were performed under the tenets of the Helsinki Declaration.

This study retrospectively investigated 113 patients (211 LDS) who underwent lacrimal syringing, DCG, and dacryoendoscopy for preoperative evaluation of the LDS obstruction at Ehime University Hospital from January 2021 to March 2022. These examinations were performed by three ophthalmologists (TK, AM, and AS) with 10, 4, and 14 years of experience in dacryoendoscopic surgeries, respectively. The grade and site of LDS obstruction, as diagnosed by three examinations, were compared. The grade of obstruction was evaluated in three levels: patent, partial obstruction, and complete obstruction. The obstruction site was classified into three types: without, presaccal, and postsaccal obstructions. The agreement between these tests was assessed by calculating the weighted kappa coefficient. Patients with a history of systemic chemotherapy with 5-fluorouracil, docetaxel, or idoxuridine were excluded from the statistical analysis. Patients with a history of radiation therapy to the cranial region or posttraumatic bone deformity were excluded from this study. Patients who underwent previous LDS surgery, such as recanalization surgery or dacryocystorhinostomy (DCR), were also excluded; hence, all patients were preoperatively evaluated for the initial surgery for the LDS obstruction.
Lacrimal syringing (syringing)

If the punctum was small, a punctum dilator was used. Saline was injected through the upper and lower punctum using a 23-G cannula and determined if it reached the nasal cavity. If the saline did not reach the nasal cavity, *complete obstruction* in the LDS was considered. Resistance during syringing and the presence of reflux and its properties were examined. *Partial obstruction* was characterized by partial irrigation into the nasal cavity with some extent of reflux. When serous reflux material was observed, canaliculus, common canaliculus, or upper lacrimal sac obstruction was considered. When viscous reflux material occurred, obstruction at the distal sites, such as the lacrimal sac or nasolacrimal duct, was considered. The communication between the upper and lower canaliculus was also determined. Reflux from the punctum opposite to the injecting side was considered a common canaliculus or upper lacrimal sac obstruction. Direct reflux of saline from the injecting punctum was considered canaliculus obstruction. Failure to irrigate fluid into the nose combined with the failure to advance the cannula to the lacrimal fossa was diagnosed as complete obstruction of the canaliculus. Then a bougie was inserted from the punctum to measure the occlusion distance to the hard stop.[18]

DCG

Patients with acute dacryocystitis and allergic to contrast media or iodine were excluded from examination. After topical anesthesia with 4% lidocaine instillation, the lacrimal pathway was washed with saline at pre-examination. The contrast agent utilized was a nonionic, water-soluble agent (1–2 mL; Omnipaque 300 [iohexol]; GE Healthcare, Tokyo, Japan). The contrast agent was manually injected slowly through the upper and lower punctum until the patient reported that the solution reached the nasal antrum or until the contrast agent backflow from the punctum. We performed bilateral DCG to examine unaffected sides even with one-sided LDS obstruction. The image capture was performed with cone-beam computed tomography (CBCT) within 10 min after injecting the contrast medium. CBCT-DCG images were acquired using a three-dimensional Accuitomo F17 (Morita, Kyoto, Japan). Imaging conditions were a scan time of 17.5 s and X-ray output of 90 kV and 8.0 mA. Image manipulation was made using dedicated computer software (i-Dixel 2.0; Morita, Kyoto, Japan). The DCG images were evaluated by an ophthalmologist and a radiologist, the latter was wholly blinded to all other information about the patient.

Dacryoendoscopy

Patients with acute dacryocystitis were excluded as an indication for dacryoendoscopy. The patient was placed in a supine position on the procedural bed, and topical ocular surface and lacrimal duct anesthesia were administered using 4% lidocaine. If necessary,
subcutaneous infiltration anesthesia around the punctum and inner canthus was added with 2% lidocaine with epinephrine. The punctum was dilated with a punctum dilator, then a bent-type rigid dacryoendoscope (CK-10, Fibertech, Tokyo) was inserted through the upper and lower punctum. As irrigating with saline through the water channel, the probe passed through the canaliculus and common canaliculus, reaching the lacrimal sac from the internal common punctum. Then, the probe was rotated 90° inferiorly to view the lacrimal sac, nasolacrimal duct, and nasolacrimal duct opening. Partial obstruction was defined as a narrowing lumen that prevents the passage of the 0.9-mm caliber probe of the dacryoendoscope while the LDS was still patent. In patients with partial or complete LDS obstruction, the site, grade, and characteristics of the obstructed area were recorded. In the preoperative endoscopic examination, we did not puncture the obstructed site but only observed the lesion.

Statistical analysis

Inter-rater reliability analysis was performed between dependent samples of two kinds of examinations, i.e., syringing and DCG, syringing and dacryoendoscopy, and DCG and dacryoendoscopy. For this purpose, Cohen’s kappa was calculated, a measure of the agreement between two dependent categorical samples. Furthermore, inter-rater reliability analysis was performed between dependent samples of three examinations: syringing, DCG, and dacryoendoscopy. For this purpose, the Fleiss kappa was calculated, a measure of the agreement between more than two dependent categorical samples. To interpret the calculated kappa values, the table of Landis and Koch was used as a guide (Table 1)[19]. All statistical analyses were performed online statistics calculator DATAtab (Graz, Austria. URL https://datatab.net).

Results

The mean age of patients was 71.3 (standard deviation [SD] = 13.7) years. A total of 25 male patients (49 LDS) and 88 female patients (162 LDS) were included in this study. The mean duration of preoperative obstruction was 19.1 (SD = 52.7) months. The duration of preoperative obstruction was defined as the period of chronic epiphora as described in the patient’s questionnaire.

Agreement of examinations regarding the obstruction grade

The number of LDS regarding the obstruction grade diagnosed by syringing, DCG, and dacryoendoscopy is listed in Table 2. The agreement in diagnosing the obstruction grade of three examinations: syringing, DCG, and dacryoendoscopy is listed in Table 3. Fleiss’ kappa coefficient to diagnose the grade of obstruction among the three tests was 0.61 (standard error [SE] = 0.03, 95% CI = 0.55–0.67, p < 0.001). The agreement between the three examinations was “substantial” according to the Landis and Koch’s classification shown in Table 1.
**Syringing and DCG**

Cohen's kappa value of concordance between the two tests, syringing and DCG, for the agreement in diagnosing the obstruction grade was determined to be $\kappa = 0.55$ ($SE = 0.05$, $95\% CI = 0.46–0.65$, $p < 0.001$), indicating a “moderate” agreement (Table 3 and Supplementary Table 1, top). A total of 194 diagnoses of syringing and DCG were examined, and the agreement of patent, partial, and complete obstruction in the two tests was 44, 21, and 73 LDS, respectively. Overall, the percentage of syringing and DCG diagnoses consistent with each other was 71.1%. Conversely, totally 34 (17.5%) LDS diagnosed with partial or complete obstruction by syringing were diagnosed as patent by DCG, indicating a discrepancy between the two diagnoses.

**Syringing and dacryoendoscopy**

A total of 207 diagnoses of syringing and dacryoendoscopy were examined, and the agreement of patent, partial, and complete obstruction in the two tests was observed in 35, 38, and 88 LDS, respectively. Overall, the percentage of matched syringing and dacryoendoscopy diagnoses was 77.8%. Cohen's kappa value of concordance between the two tests, syringing and dacryoendoscopy, for the agreement in the obstruction grade was determined to be $\kappa = 0.65$ ($SE = 0.05$, $95\% CI = 0.56–0.74$, $p < 0.001$), indicating a “substantial” agreement (Table 3 and Supplementary Table 1, middle). Meanwhile, 10 LDS (4.8%) diagnosed as patent by syringing were diagnosed with partial obstruction by dacryoendoscopy, indicating a discrepancy between the diagnoses of two examinations.

**DCG and dacryoendoscopy**

Cohen's kappa value of the agreement between DCG and dacryoendoscopy diagnoses was determined to be $\kappa = 0.65$ ($SE = 0.05$, $95\% CI = 0.56–0.74$, $p < 0.001$), indicating “substantial” agreement based on the diagnosis of the obstruction grade (Table 3 and Supplementary Table 1, bottom). Assessment of 190 diagnoses from both methods revealed 38, 37, and 70 LDS of concordance for patent, partial, and complete obstruction, respectively, and overall, the percentage of agreement between DCG and dacryoendoscopy was 76.3%. Conversely, DCG results showed that totally 73 LDS as patent, albeit 27 (37.0%) and 8 (11.0%) of them were diagnosed with partial and complete obstruction in dacryoendoscopy, respectively, indicating a discrepancy in diagnostic results between the two examinations.

**Agreement of examinations regarding the obstruction site**
The number of LDS based on the obstruction site diagnosed by syringing, DCG, and dacryoendoscopy is listed in Table 4. The agreement in diagnosing the obstruction site of syringing, DCG, and dacryoendoscopy is listed in Table 5. Fleiss' kappa coefficient to diagnose the obstruction site among the three tests was 0.62 (SE = 0.03, 95% CI = 0.57–0.68, p < 0.001). According to Landis and Koch's classification in Table 1, the agreement among the three preoperative examinations to detect the obstruction site was “substantial.”

**Syringing and DCG**

Cohen's kappa value of agreement between the two tests, syringing and DCG, for the diagnosis of the obstruction site, was determined to be \( \kappa = 0.55 \) (SE = 0.05, 95% CI = 0.45–0.64, p < 0.001), indicating a “moderate” agreement (Table 5 and Supplementary Table 2, top). A review of 194 diagnostic results demonstrated 44, 28, and 62 concordances for without, presaccal, and postsaccal obstruction between the two examinations, respectively. Overall, the percentage of concordance between syringing and DCG results was 69.1%. Meanwhile, a total of 34 (17.5%) LDS diagnosed with pre- or postsaccal obstruction by syringing were diagnosed with no obstruction by DCG. Moreover, 22 (11.3%) LDS diagnosed with presaccal obstruction by syringing were diagnosed with postsaccal obstruction by DCG, indicating a diagnostic discrepancy between the two examinations.

**Syringing and dacryoendoscopy**

Cohen's kappa value of agreement between syringing and dacryoendoscopy for the diagnosis of the obstruction site was determined to be \( \kappa = 0.7 \) (SE = 0.04, 95% CI = 0.62–0.78, p < 0.001), indicating a “substantial” agreement (Table 5 and Supplementary Table 2, middle). A review of 207 diagnostic results identified 35, 65, and 67 LDS with concordance between syringing and dacryoendoscopy for without, presaccal, and postsaccal obstruction, respectively. In total, the percentage of concordance between syringing and dacryoendoscopy diagnoses was 80.7%. In contrast, 20 (9.7%) LDS were diagnosed with presaccal obstruction by syringing but with postsaccal obstruction by dacryoendoscopy. Also, 8 (3.9%) LDS were diagnosed with postsaccal obstruction by dacryoendoscopy, regardless of the absence of obstruction by syringing.

**DCG and dacryoendoscopy**

Cohen's kappa value of concordance between DCG and dacryoendoscopy results to diagnose the obstructed site was determined to be \( \kappa = 0.66 \) (SE = 0.05, 95% CI = 0.57–0.75, p < 0.001), indicating a “substantial” agreement was found between these examinations (Table 5 and Supplementary Table 2, bottom). A total of 190 diagnoses were examined, concordance of without, presaccal, and postsaccal
obstruction in DCG and dacryoendoscopy was observed in 38, 28, and 82 LDS, respectively. The overall rate of concordance between DCG and dacryoendoscopy diagnostic results was 77.9%. Conversely, totally 35 (18.4%) LDS were diagnosed with presaccal or postsaccal obstruction by dacryoendoscopy, whereas DCG found no obstruction.

Discussion

In the current study, the highest agreement in detecting the obstruction grade was between syringing and dacryoendoscopy and DCG and dacryoendoscopy. Both these Cohen's kappa were 0.65 (95% CI: 0.56–0.74). Conversely, syringing and DCG had the lowest kappa, 0.55 (95% CI: 0.46–0.65). A previous study by Bae et al. also reported the highest agreement between dacryoendoscopy and DCG and the lowest agreement between syringing and DCG to detect the obstruction grade of LDS, which reflects a consistent finding with the overall trend of our results.[20] Regarding the agreement in the obstruction site, the highest agreement was found between syringing and dacryoendoscopy, with a kappa value of 0.7 (95% CI: 0.62–0.78). The lowest was syringing and DCG, with a kappa value of 0.55 (95% CI: 0.45–0.64).

The first-line treatment for postsaccal obstruction is DCR. Various approaches have been proposed to treat presaccal obstruction, depending on whether the obstruction is proximal or distal and solidity of obstruction. Patients with stenosis or incomplete obstruction are mainly treated with canalicular stenting and intubation. Meanwhile, if the obstruction is persistent and solid and reconstructive surgery is not feasible, a conjunctivodacryocystorhinostomy using a Pyrex glass tube (Jones tube) will be selected. Thus, different surgical methods for presaccal obstruction are selected based on the obstruction characteristics.[21 22] Therefore, an accurate diagnosis of the obstructed site is essential to select the proper surgical method in the LDS obstruction.

In our data, the diagnostic sensitivity and specificity for identifying presaccal obstruction in the syringing test were 89% and 82%, respectively. Syringing detected lesions in the postsaccal region, whereas dacryoendoscopy detected lesions in the presaccal region in 6 (2.9%) out of 207 LDS, including 2 with common canaliculus obstruction (CCO) and 4 with common canaliculus stenosis (CCS). We investigated how DCG evaluated in these 6 cases in which disagreements were found between syringing and dacryoendoscopy. Then, DCG adequately diagnosed as presaccal obstructions in 2 out of 6 cases. Collectively, the combination of syringing and DCG was consistent with dacryoendoscopic findings in 98.6% presaccal obstructions.

Moreover, the diagnostic sensitivity and specificity of syringing to identify postsaccal obstruction in the current study were 71% and 95%, respectively. 20 of 207 (9.7%) LDS in which the presaccal lesion was diagnosed by syringing, albeit the postsaccal lesion was observed by dacryoendoscopy (Supplementary Table 2, middle). Among them, 13 LDS had stenosis or obstruction in lacrimal sacs, 6 LDS had stenosis or obstruction in nasolacrimal ducts, and 1 had dacryolith formation. In these conflicted 20 LDS, we examined whether DCG could adequately diagnose a postsaccal lesion, and found that DCG detected the
presence of a postsaccal lesion in 18 of these 20 conflicted diagnoses. Collectively, the combination of syringing and DCG was consistent with dacryoendoscopic findings in 99% of postsaccal obstructions.

In diagnosing the obstruction grade, dacryoendoscopy detected partial obstruction in 10 (22.2%) of 45 LDS in which no obstruction was found by lacrimal syringing test (Supplementary Table 1, middle). In 2 of these 10 LDS, partial obstruction was adequately confirmed by DCG, but the remaining 8 LDS had still diagnosed without obstruction. Hence, dacryoendoscopy observed a stenotic level that was difficult to detect for either syringing or DCG. One of the pitfalls of DCG might confer that it sometimes misses partial obstruction. In 73 of 190 LDS, DCG diagnosed no obstruction, whereas 27 (36.9%) of them revealed partial obstruction by dacryoendoscopy (Supplementary Table 1, bottom). The breakdown of these 27 inconsistent LDS included 16 with CCS, 4 with dacryolith, and 5 with stenosis of the lacrimal sac or nasolacrimal duct. It should be noted that even though some LDS were diagnosed with complete obstruction in dacryoendoscopy, DCG demonstrated that the contrast medium reached the nasal cavity, and the lesion was diagnosed as partial obstruction by DCG. This indicates that even though the lesion appeared visually completely obstructed by dacryoendoscopy, a contrast medium sometimes passed through the site and detected as not anatomically obstructed, suggesting that the diagnosis of partial or complete obstruction may contradict depending on the examination method, which also contributed to a discrepancy between DCG and dacryoendoscopic diagnosis.

With advances in fiberoptic systems, dacryoendoscopes commonly used nowadays offer image quality of 10,000–15,000 pixels. Lesions such as inflammatory findings in the mucosa, granulation, foreign bodies, and dacryoliths can be visualized. Since no radiation is used, there is no risk of radiation exposure to patients. Meanwhile, DCG is a practical examination that provides information on the bones and sinuses surrounding the LDS, which endoscopy cannot observe. It is preferable to utilize DCG and dacryoendoscopy complementarily based on the understanding of their respective characteristics.

Several limitations are included in this study. This was a retrospective observational cohort study with certain selection biases. Firstly, not all patients received all three kinds of examinations. For example, patients with a history of contrast media or iodine allergy did not undergo DCG and only underwent syringing and dacryoendoscopy. When a patient’s punctum or canaliculus was too tightly stenosed to insert a dacryoendoscope, only syringing and DCG were performed. Therefore, the number of LDS examined differed among the respective inspections. Secondly, dacryoendoscopy has become a standard method for LDS inspection in Northeast Asia, but not worldwide. Therefore, there are still few similar research reports for reference.

In conclusion, lacrimal syringing, DCG, and dacryoendoscopy for LDS obstruction showed that diagnoses of the obstruction grade and site among the three examinations were in “substantial” agreement with Fleiss kappa coefficients (κ = 0.61 and 0.62, respectively). Concerning the agreement in diagnosing the LDS obstruction grade, DCG and dacryoendoscopy and syringing and dacryoendoscopy were the highest (κ = 0.65 for both), albeit syringing and DCG was the lowest (κ = 0.55). Meanwhile, as for the obstruction site, syringing and dacryoendoscopy (κ = 0.7), DCG and dacryoendoscopy (κ = 0.66), and syringing and
DCG ($\kappa = 0.55$) were higher, in that order. Moreover, detecting the obstruction site, the combined diagnosis of syringing and DCG was consistent with dacryoendoscopic findings at the 99% level.

**Declarations**

**Acknowledgments**

The study was supported by the Japan Society for the Promotion of Science Postdoctoral Fellowship for Research Abroad (Kaitoku-NIH, #24112 to JN). The funding source had no role in the study design, data collection, analysis, publication decision, or manuscript preparation.

**Conflict of interest**

The authors declare that they do not have any competing interests and are solely responsible for the content and writing of the paper.

**Author contributions**

JN contributed to the conception, data extraction, analysis, and drafting. TK, AM, and AS worked on practical examinations, data extraction, result interpretation, and manuscript drafting. TK, AM, and AS provided statistical advice. NM and AS were responsible for the general management of the study and critically revised the protocol and main manuscript.

**Data availability**

The datasets analyzed in the current study are available from the corresponding author (JN) on reasonable requests.

**References**


**Abbreviations**

CCO, common canalicular obstruction; CCS, common canalicular stenosis; CI, confidence interval; DCG, dacryocystography; DCR, dacryocystorhinostomy; LDS, Lacrimal drainage system; SD, standard deviation; SE, standard error

**Tables**

Table 1. Interpretation of the calculated Kappa coefficient.

<table>
<thead>
<tr>
<th>Kappa value</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;0.8</td>
<td>Almost Perfect</td>
</tr>
<tr>
<td>&gt;0.6</td>
<td>Substantial</td>
</tr>
<tr>
<td>&gt;0.4</td>
<td>Moderate</td>
</tr>
<tr>
<td>&gt;0.2</td>
<td>Fair</td>
</tr>
<tr>
<td>0-0.2</td>
<td>Slight</td>
</tr>
<tr>
<td>&lt;0</td>
<td>Poor</td>
</tr>
</tbody>
</table>
Table 2. Number of LDS regarding the grade of obstruction diagnosed by syringing, DCG, and dacryoendoscopy

<table>
<thead>
<tr>
<th>Grade of obstruction</th>
<th>Syringing</th>
<th>DCG</th>
<th>Dacryoendoscopy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Patent</td>
<td>48</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>Partial</td>
<td>46</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Complete</td>
<td>118</td>
<td>76</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>212</td>
<td>195</td>
</tr>
</tbody>
</table>

The values represent the number of LDS. Abbreviation: LDS, lacrimal drainage system

Table 3. Agreements in the three preoperative examination diagnoses regarding the obstruction grade

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Agreements in the obstruction grade</th>
<th>κ value</th>
<th>SE</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syringing, DCG, and dacryoendoscopy *</td>
<td>189</td>
<td></td>
<td>0.61</td>
<td>0.03</td>
<td>0.55–0.67</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Syringing and DCG **</td>
<td>194</td>
<td></td>
<td>0.55</td>
<td>0.05</td>
<td>0.46–0.65</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Syringing and dacryoendoscopy **</td>
<td>207</td>
<td></td>
<td>0.65</td>
<td>0.05</td>
<td>0.56–0.74</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>DCG and dacryoendoscopy **</td>
<td>190</td>
<td></td>
<td>0.65</td>
<td>0.05</td>
<td>0.56–0.74</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

n represents the number of LDS. * Inter-rater reliability analysis was performed between dependent samples of syringing, DCG, and dacryoendoscopy. For this purpose, the Fleiss kappa was calculated. ** Inter-rater reliability analysis was performed between dependent samples of two examinations. For this purpose, Cohen’s kappa was calculated. Abbreviations: DCG, dacryocystography; LDS, lacrimal drainage system
Table 4. Number of LDS regarding the obstruction site diagnosed by syringing, DCG, and dacryoendoscopy

<table>
<thead>
<tr>
<th>Obstruction site</th>
<th>Syringing</th>
<th>DCG</th>
<th>Dacryoendoscopy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without obstruction</td>
<td>48 (22.6%)</td>
<td>78 (40%)</td>
<td>39 (18.8%)</td>
</tr>
<tr>
<td>Presaccal obstruction</td>
<td>91 (42.9%)</td>
<td>30 (15.3%)</td>
<td>73 (35.1%)</td>
</tr>
<tr>
<td>Postsaccal obstruction</td>
<td>73 (34.4%)</td>
<td>87 (44.7%)</td>
<td>96 (46.1%)</td>
</tr>
<tr>
<td>Total</td>
<td>212</td>
<td>195</td>
<td>208</td>
</tr>
</tbody>
</table>

The values represent the number of LDS. Abbreviations: DCG, dacryocystography; LDS, lacrimal drainage system

Table 5. The agreements in the three preoperative examination diagnoses regarding the obstruction site

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Agreements in the obstruction site</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>k value</td>
</tr>
<tr>
<td>Syringing, DCG, and dacryoendoscopy *</td>
<td>189</td>
<td>0.62</td>
</tr>
<tr>
<td>Syringing and DCG **</td>
<td>194</td>
<td>0.55</td>
</tr>
<tr>
<td>Syringing and dacryoendoscopy **</td>
<td>207</td>
<td>0.7</td>
</tr>
<tr>
<td>DCG and dacryoendoscopy **</td>
<td>190</td>
<td>0.66</td>
</tr>
</tbody>
</table>

n represents the number of LDS.

* Inter-rater reliability analysis was performed between dependent samples of syringing, DCG, and dacryoendoscopy. For this purpose, the Fleiss kappa was calculated. ** Inter-rater reliability analysis was performed between dependent samples of two examinations. For this purpose, Cohen’s kappa was calculated.

Abbreviation: DCG, dacryocystography; LDS, lacrimal drainage system
Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryMaterials.docx