Comparison of failed and successful dacryocystorhinostomy by using computed tomographic dacryocystography findings

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PURPOSE. To compare the spiral computed tomographic dacryocystography (CT-DCG) findings of failed and successful dacryocystorhinostomies (DCR) and to detect the possible causes of failure before reoperation.
METHODS. Eighteen patients with failed and 15 patients with functional DCR were examined by spiral CT-DCG, a combination of contrast dacryocystography and spiral computed tomography. Radiologists, who were blinded to the clinical status of the patients, measured the diameter of the osteotomy window, evaluated its position relative to the lacrimal sac, and documented any abnormal findings around the osteotomy, which may contribute to the failure of DCR.
RESULTS. Location of the osteotomy window was inappropriate in 83% (15/18) of unsuccessful cases and in 7% (1/15) of successful cases and the difference was statistically significant ($p<0.01$). Presence of the ethmoid air cells medial to the ostium was detected to have a significantly higher frequency in the unsuccessful DCR group (78%, 14/18) than in the successful group (20%, 3/15) ($p<0.01$). The antero-posterior diameter of bony ostium was less than 15 mm in 94% (17/18) of failed DCR cases, but in only 60% (9/15) of successful DCR cases, and the difference was statistically significant ($p<0.05$). Some additional findings that may contribute to the failure were noted in failed cases. There were ethmoid sinusitis in three, concha bullosa in two, nasal polyposis in two, mass in medial canthus in one, and extensive granulation tissue around the rhinostomy in one of the failed cases.
CONCLUSIONS. CT-DCG is a valuable imaging tool to evaluate DCR failures before reoperation. In this series, CT-DCG showed that small size and inappropriate position of osteotomy, and also extension of ethmoid air cells medial to the lacrimal sac, were frequently seen causative factors of DCR failure. (Eur J Ophthalmol 2005; 15: 523-9)

KEY WORDS. Computed tomography, Dacryocystography, Dacryocystorhinostomy, Failure

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INTRODUCTION

Dacryocystorhinostomy (DCR) is a successful surgical procedure in as much as 90% of cases. However, failure occurs in about 5% to 10% of individuals (1-6). Failure of DCR is mainly due to surgical procedure itself, such as small osteotomy size, inappropriate location of the osteotomy window, osseous closure from bone regrowth, faulty opening of the osteotomy into the anterior ethmoidal air cells, or unrecognized concha bullosa (3-8).

Several techniques have been used to demonstrate the nasolacrimal system. Dacryoscintigraphy provides functional information whereas dacryocystography (DCG) is the best modality to show morphologic characteristics of

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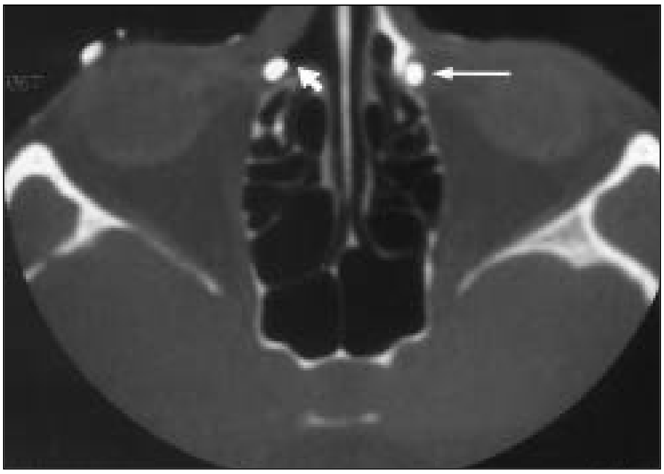

Fig. 1 - A 40-year-old woman with successful right dacryocystorhinostomy; axial computed tomographic dacryocystography image. Right lacrimal sac easily drains into the nasal cavity through an appropriately located osteotomy (short arrow). Long arrow shows the normal lacrimal sac in the left lacrimal fossa.

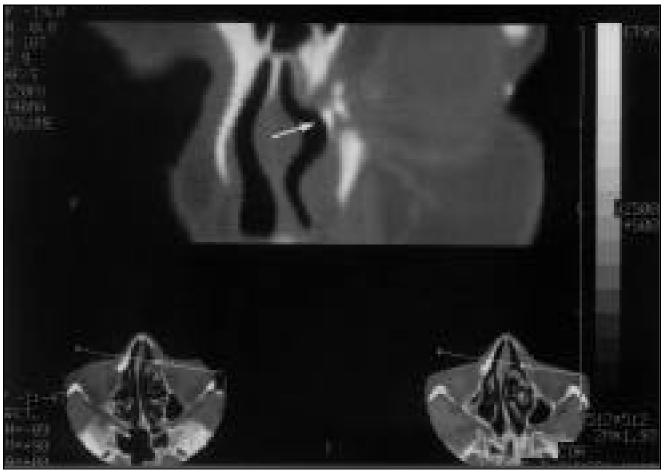

Fig. 2 - A 17-year-old woman with successful left dacryocystorhinostomy; oblique coronal reformatted computed tomographic dacryocystography image. Radiopaque material easily drains from the lacrimal sac into the left nasal cavity through an appropriate osteotomy (arrow).

the nasolacrimal system (9-11). Computerized tomography (CT) is a valuable technique for imaging the bone and soft tissue structures of the face and orbit. By combining contrast DCG and spiral computed tomography (CT-DCG) it is possible to show the relationship between the nasolacrimal drainage system and the surrounding bone and soft tissue structures. This combined imaging technique is indicated in the assessment of complex lacrimal problems such as medial canthal tumors, maxillo-facial fractures, and complications of paranasal sinus surgery, and also is indicated in the planning of endoscopic intranasal DCR (12-16).

The purpose of this study was to evaluate the causes of DCR failures by spiral CT-DCG, which combines the advantages of contrast DCG and CT. We compared the spiral CT-DCG findings of failed DCR cases with those of successful DCR cases and aimed to obtain information that may be useful in reoperation planning.

MATERIALS AND METHODS

In this study, 18 unsuccessful DCR cases were examined by spiral CT-DCG. Fifteen patients with successful DCR had the same examination as the control group. The study was approved by the investigation review board of our hospital and a written consent was obtained from each of the patients.

We performed CT examination of nasolacrimal drainage system after topical application of iopromide (300 mg iodine/mL) as the radiopaque material, which is a routinely used intravenous contrast agent (14). Before the application of the contrast material topically, a gentle massage to the medial canthus was performed to empty the lacrimal sac, hence the contrast material can easily fill in. Contrast agent was instilled to the eye with a rate of 1 or 2 drop/min for 4-6 minutes in each subject. Spiral CT examination was performed in axial plane by Hitachi 950-SR Spiral CT machine with a 2 mm/rotation table index and 1 mm reconstruction thickness. Using these axial images, coronal images were reformatted by multiplanar reconstruction technique and three-dimensional images were reconstructed by surface shading technique.

Radiologists, blinded to the clinical status of patients, measured the diameter of osteotomy window and evaluated the position of the window relative to the lacrimal sac in each case. If more than half of the lacrimal sac is faced with the osteotomy window medially, then the osteotomy localization is considered as appropriate (Figs. 1, 2, and 3). Radiologists also evaluated the relation of the anterior ethmoidal air cells with the lacrimal fossa and noted if the air cells extend up to the medial side of the lacrimal sac. Ethmoid air cells were considered to be extending to the medial side of the lacrimal sac if the anterior aspect of the ethmoid air cells reached the center of the sac. They also documented any abnormal findings

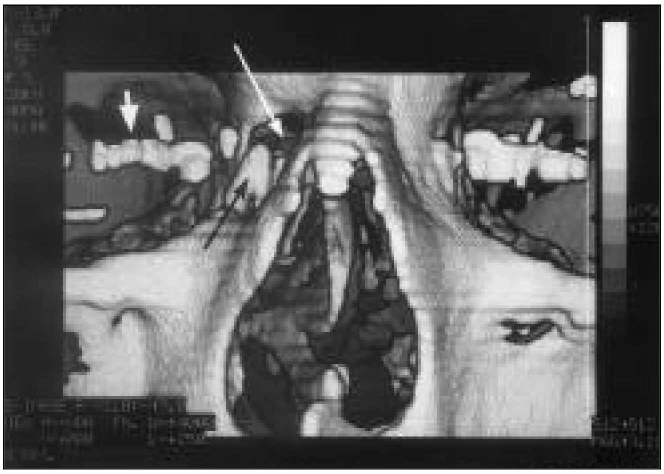

Fig. 3 - A 29-year-old man with successful right dacryocystorhinostomy; three-dimensional image reconstructed from axial spiral computed tomographic dacryocystography images. Position of the osteotomy window (long white arrow) relative to the lacrimal sac (black arrow) is quite appropriate and radiopaque easily drains from the lacrimal sac into the nasal cavity. Short white arrow shows the radiopaque in the conjunctival sac.

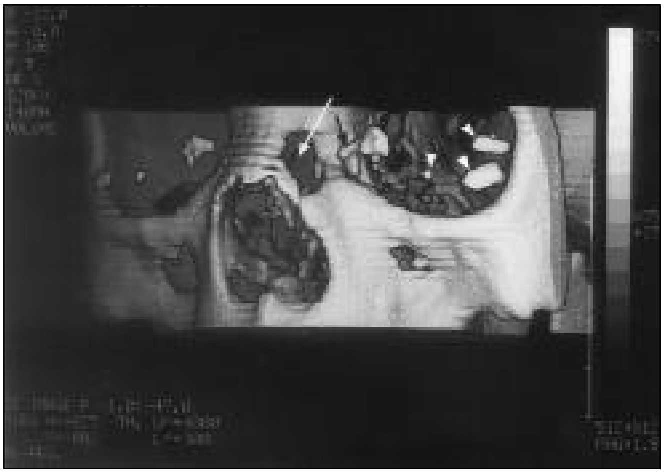

Fig. 4 - A 57-year-old woman with failed left dacryocystorhinostomy; three-dimensional image reconstructed from axial spiral computed tomographic dacryocystography images. Osteotomy window (white arrow) is located anterior to the lacrimal fossa and lacrimal sac (black arrow). Arrowheads show the radiopaque in the conjunctival sac.

that may interfere with the success of the operation.

Failed and successful DCR groups were compared regarding the size (as below or above a threshold diameter of 15 mm and 10 mm) and location (as appropriate or inappropriate) of the osteotomy window and presence of ethmoid air cells just medial to the osteotomy. Fisher's exact test was used in statistical analysis.

RESULTS

The age range was 12 to 65 years (average 43 years) in the failed DCR group and 4 to 67 years (average 30 years) in the control group. Fifteen patients were female (83%) and 3 (17%) were male in the failed DCR group and 11 (73%) were female and 4 (27%) were male in the control group. Eight of the unsuccessful surgeries were in the right eye (44%) and 10 were in the left eye (56%). In the control group, 9 were in the right eye (60%) and 6 were in the left eye (40%). In one of the unsuccessful DCR cases failure was after the second and in another one it was after the third operation.

The localization of the osteotomy window was inappropriate in 15/18 (83%) of the unsuccessful cases (Fig. 4) while it was inappropriate in only 1/15 patients in the control group (7 %). The difference was statistically significant ($p<0.01$). In 15 failed DCR cases with inappropriate osteotomy location, osteotomy window was located anterior to the lacrimal sac in 8 patients (53%), inferior in 3 (20%), antero-superior in 2 (13%), superior in 1 (7%), and antero-inferior in 1 case (7%). Only one patient in the successful DCR group has an osteotomy location interpreted as inappropriate and the window was located antero-inferior to the lacrimal sac in that case. He was a 13-year-old boy with congenital dacryostenosis and he had a DCR operation 6 years before the CT-DCG examination. In this functional DCR case, bone regrowth from the posterior edge of the osteotomy was thought to be the reason of interpreting the position of osteotomy as inappropriate.

The anterior ethmoid air cells were extending to the medial side of the lacrimal sac in 14/18 (78%) of the cases in the failed DCR group and in 3/15 (20%) of the control group. The difference was statistically significant ($p<0.01$).

The mean antero-posterior (A-P) diameter of the bony ostium was 10.1 mm (diameters ranged from 6.3 to 15.7 mm) in the unsuccessful DCR group and 13.3 mm (diameters ranged from 7.9 to 16.7 mm) in the control group.

We divided both the failed and successful DCR groups into those with an A-P diameter of bony ostium more than 15 mm and those with a diameter equal to or less than 15 mm, since 15 mm was mentioned as a recommended diameter in the literature (2). In 94% (17/18) of failed DCR cases A-P diameter of bony ostium was less than 15 mm, whereas it was less than 15 mm in only 60% (9/15) of successful DCR cases. The difference was statistically significant ($p<0.05$).

Fig. 5 - A 57-year-old woman with failed left dacryocystorhinostomy; axial computed tomographic dacryocystography image. Osteotomy window (arrow) is located anterior to the lacrimal sac (LS). Note the extension of the anterior ethmoidal air cell medial to the lacrimal fossa on the left side. Ethmoidal sinuses are filled with soft tissue density on both sides due to sinusitis (arrowheads).

Fig. 6 - A 12-year-old boy with failed right dacryocystorhinostomy; axial computed tomographic dacryocystography image. Enlarged right lacrimal sac is filled with radiopaque contrast and air (arrow). Osteotomy window is small and located far anterior to the lacrimal fossa (arrowhead). Note the lacrimal bone (A-B line) and large concha bullosa (CB) extending medial to the lacrimal sac.

In 56% (10/18) of the failed DCR cases the A-P diameter of the bony ostium was less than 10 mm, versus 13% (2/15) in successful DCR cases. The difference was statistically significant ($p<0.05$).

The mean vertical diameter of the bony ostium was 9.6 mm (diameters ranged from 4 to 14 mm) in unsuccessful DCR and 11.5 mm (range 9 to 15 mm) in the control group. However, when we compared the vertical diameters of the ostium with the thresholds of both 15 mm and 10 mm, we found no statistically significant difference between the failed and successful DCR cases.

In the failed DCR group, three cases had ethmoidal sinusitis (Fig. 5), two cases had concha bullosa (Fig. 6), and two cases had nasal polyposis. In addition, one case had mass in the medial canthus and another one had significant granulation tissue at the site of rhinostomy. We believed that all of these might have had a role in the failure.

DISCUSSION

The failure of DCR is rare, occurring in less than 10% of the cases in most series (1, 3, 17). The management of unsuccessful DCR poses a therapeutic problem. Identifying the causes of failure may help the surgeon in planning the reoperation and makes it possible to exclude the causative factors before or during the operation.

Several reasons of failure in DCR were reported, including ostium problems such as small size and inappropriate position of osteotomy window, bone regrowth, variations in nasal cavity and paranasal sinuses (e.g., concha bullosa, ethmoidal bullae), lacrimal sac and canalicular problems, tumors, and inflammatory disease (1-7, 17-21).

Welham and Wulc reported that DCR failure was mostly related to ostium problems (3). Out of their 208 failed DCR cases, they found that 111 of them had inappropriate size or location of ostium and 36 cases had more than three causes of failure. Jordan and McDonald reported that they attempted to avoid failure by creating a large ostium with an average diameter of 15 mm and removing enough bone between the medial wall of the lacrimal sac and the nose so that bone could not obstruct the passage (2). For the success of external DCR, most of the authors believe that opening a large osteotomy window and eliminating all of the bone tissue within 5 mm distance from the common canaliculus is essential, as recommended by Jordan and McDonald (1-3, 7).

However, McLachlan et al attributed few failures to the osteotomy in their review of unsuccessful DCRs (18). They also claimed that the size of surgical anastomosis does not correlate with surgical success. Linberg et al reported that the mucosal rhinostomy opening shrunk significantly in the postoperative period and there was no statistically valid correlation between the size of the bony opening and the final size of the healed intranasal ostium (8). In their series of 19 external DCRs the average diameter of bony ostium was 11.84 mm whereas the average diameter of the healed intranasal ostium was only 1.8 mm. Yazici and Yazici reported similar results (22). In this study we measured the A-P diameter of bony ostium on CT images and found that the proportion of cases with a bony ostium of less than 15 mm A-P diameter is significantly higher in the failed DCR group (17/18) than the proportion in the successful DCR group (9/15) ($p<0.05$). There was still a significant difference between failed and successful DCR groups when the threshold diameter of bony ostium was decreased to 10 mm ($p<0.05$). Our result supports Welham and Wulc (3), Jordan and McDonald (2), and other authors who reported the small size of the bony ostium as an important cause of the surgical failure. It was interesting that when we compared the vertical diameters of the bone windows, again with the thresholds of 15 mm and then 10 mm, there was no significant difference between the failed and successful DCR groups.

In 208 secondary surgeries of failed DCR cases, Welham and Wulc reported 67 cases with apparent malposition of bone window (3). They found that in 8 cases the ostium was located too posterior, in 10 cases it was too anterior, in 25 cases too high, and in 24 cases too low. In our study we defined the localization of the osteotomy with its relative position to the lacrimal sac and called the osteotomy localization appropriate if the osteotomy window covered more than half of the lacrimal sac. We found that the osteotomy localization was appropriate in 93% (14/15) of successful cases while it was appropriate in only 17% (3/18) of the failed cases and this difference was statistically significant ($p<0.01$).

Welham and Wulc were concerned that the presence of adjacent ethmoid air cells increased complications and failures of DCR (3). According to their report, the anterior ethmoid air cells could contribute to scarring of the ostium. Some DCR failures have been attributed to surgeons who have drained the lacrimal sac into the ethmoidal sinuses instead of the nasal cavity.

In our study, regarding the anterior extension of ethmoidal air cells, there was a statistically significant difference between the failed and successful DCR groups ($p<0.01$). Ethmoidal air cells were found to be extending to the medial side of lacrimal sac in 78% (14/18) of the failed DCR cases versus only 20% (3/15) of the successful cases.

The ethmoid sinuses are the first paranasal sinuses to develop. In children their anatomic position and relation with lacrimal sac and nasal cavity are different from that of adults. They reach adult configuration at 12 to 14 years of age (6). It may be thought that the absolute size of the osteotomy should be different for children and adults. In our series there were two children in the control group, one 4 years and the other 13 years old, and only one subject in the failed group at the age of 12 years. Therefore we have insufficient data to discuss DCR in children separately from those of adults.

Several imaging techniques have been used to evaluate the lacrimal drainage system (9-16). These include dacryocystography, dacryoscintigraphy, CT, CT-DCG, MR, and MR-DCG. Recently, Luchtenberg et al used three-dimensional rotation angiography technique to evaluate the stenosis in lacrimal draining system (23). Some of the imaging techniques were reported to be helpful not only in evaluation of primary epiphora but also in evaluation of the failed DCR. Each of these techniques has some advantages and also some limitations.

Amin et al reviewed 104 intubation dacryocystograms of 72 cases with failed DCR and reported that no clear reason for the recurrence of symptoms could be demonstrated in 58% of cases by dacryocystography (11). Mauriello et al investigated the role of orbital CT for evaluation of patients after dacryocystorhinostomy and concluded that when combined with the findings of probing and irrigation, orbital CT helped to formulate a surgical plan after failed DCR (12). Glatt et al examined three cases of failed DCR by CT-DCG technique and reported problems related to the bony ostium and also additional findings such as recurrent nasal polyposis, unresected ethmoidal air cells, and retained metallic clip (1).

Radiologic investigation of the lacrimal system using CT-DCG has excellent capability of displaying both bone and soft tissues. It was developed in response to the preoperative imaging requirements for transnasal endoscopic dacryocystorhinostomy. However, it was also reported to be helpful in the assessment of patients after failed conventional external DCR when the information provided will help to determine the subsequent surgical approach (13).

MR imaging is a valuable technique for evaluation of the orbital cavity because of its superior demonstration capability of soft tissues. Manfre et al found that there was no significant difference between the sensitivities of MR-DCG and CT-DCG in nasolacrimal drainage system obstructions (15). Helies et al compared MR-DCG with CT-DCG in 13 patients with epiphora and concluded that CT-DCG must have been chosen for complex problems of the lacrimal drainage system (24). They claimed that only very rare tumoral pathologies require MR imaging.

We applied the radiopaque material topically into the conjunctival sac instead of catheterizing the lower canaliculus. Topical contrast application is very easy to perform, allows a more physiologic evaluation of the nasolacrimal duct, and increases patient comfort and tolerance (14, 15, 25, 26).

In our study we preferred the spiral technique, which allows continuous imaging of lacrimal system and offers better image quality for coronal image reformats and three-dimensional reconstructions (Figs. 2, 3, and 4).

Comparison of spiral CT-DCG findings of failed and successful DCR patients gave information that helped us understand the failure and plan the reoperation. Comparison revealed that smaller size of the osteotomy window, inappropriate position of the osteotomy relative to the lacrimal sac, and the ethmoid air cells extending anteriorly were all major contributors to the failure, besides the frequently detected additional abnormalities around the osteotomy, such as ethmoidal sinusitis, concha bullosa, and nasal polyposis, all of which might have a role in the failure of DCR.

Spiral CT-DCG examination of failed DCR cases gives valuable information that may have an important role in planning the reoperation. Further study is required to show whether such planning increases the success rate of reoperations.

The authors have no proprietary interest in any aspect of the article.

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