

Frequency of the Common Canaliculus

A Radiological Study

Bülent Yazıcı, MD; Zeynep Yazıcı, MD

Background: It is frequently stated in the literature that there is a common canaliculus (CC) in the lacrimal drainage system in about 90% of individuals; in the remaining 10%, the upper and lower canaliculi enter the lacrimal sac separately. To our knowledge, there is no quantitative study supporting this assumption.

Objective: To investigate the frequency of the CC and other anatomical types connecting the upper and lower canaliculi to the lacrimal sac.

Materials and Methods: We presumed that there might be 3 different types of anatomical connection between the lacrimal sac and the canaliculi. Digital subtraction macrodacryocystograms obtained from 281 patients with obstructive epiphora were reviewed, and those of 247 patients were included in the study.

These patients were grouped according to the anatomical types.

Results: Dacryocystographies were performed on 153 patients unilaterally and 94 bilaterally. We observed a CC in 321 (94.1%) of 341 lacrimal drainage systems. In 13 lacrimal drainage systems (3.8%), the CC was absent, but the upper and lower canaliculi joined at the wall of the lacrimal sac. In only 7 lacrimal drainage systems (2.0%) did the upper and lower canaliculi enter the sac separately. In 2 patients with bilateral dacryocystograms, a CC was seen on one side but not on the other side.

Conclusions: The frequency of separate drainage of the upper and lower canaliculi into the lacrimal sac is only 2.0%. The CC might not be present bilaterally in all individuals.

Arch Ophthalmol. 2000;118:1381-1385

THE TEARS ENTER the lacrimal sac through the canaliculi. The upper and lower canaliculi join to form a single common canaliculus (CC) 3 to 5 mm long, which opens into the lateral wall of the lacrimal sac.¹ It is usually supposed that about 90% of the population has a CC and that in the remaining 10% the upper and lower canaliculi enter the sac separately.¹⁻⁵ To our knowledge, no study has been carried out to evaluate the validity of this assumption.

Digital subtraction macrodacryocystography (DSM) is the most sensitive method for imaging the lacrimal drainage system (LDS).^{6,7} It displays the anatomical features of the canaliculi in detail and therefore can be used to investigate the frequency of the CC.⁸ In this study, we reviewed the DSMs of patients with obstructive epiphora to ascertain the frequency of the CC and the other types connecting the canaliculi to the sac.

RESULTS

The DSMs of 281 patients were reviewed; those of 247 patients (194 females and 53 males; age range, 15-80 years; mean age, 47 years) were of sufficient quality to evaluate canalicular anatomical features. The DSMs were unilateral in 153 patients and bilateral in 94.

The DSMs revealed a CC in 321 LDSs (94.1%) (**Figure 2**). The CC was absent in 13 LDSs (3.8%), but the upper and lower canaliculi united at a common opening in the wall of the tear sac and drained into the sac via this opening (**Figure 3**). In 7 LDSs (2.0%), a CC or common opening was absent, and the upper and lower canaliculi drained separately into the lacrimal sac (**Figure 4** and **Figure 5** and the **Table**).

Of 247 patients, 232 (93.9%) had a CC, 10 (4.0%) had a common opening, and 3 (1.2%) had separate openings. In 92 of 94 patients with bilateral DSMs, the right and left canalicular anatomical features were identical; in the other 2 patients, the

From the Departments of Ophthalmology (Dr B. Yazıcı) and Radiology (Dr Z. Yazıcı), Uludag University School of Medicine, Bursa, Turkey.

MATERIALS AND METHODS

We reviewed the DSMs of patients with obstructive epiphora performed between February 1, 1994, and June 30, 1999, to display the site and the type of the obstruction in the lacrimal drainage pathway.

Dacryocystograms were obtained only in eyes with epiphora (bilaterally if necessary) by the same physician (Z.Y.). All of the DSMs were performed with digital fluoroscopic equipment (Siemens Polytron 1000 DSA Multiscop; Siemens, Erlangen, Germany) at $\times 2$ magnification. Patients with acute dacryocystitis were included in the study after treatment of the infection. The patient was placed supine, and the lacrimal sac was emptied by digital massage. After topical benoxinate hydrochloride was administered, the inferior canaliculus was cannulated using a lacrimal cannula (Visitec 5811276; BD-Visitec, Sarasota, Fla) connected to an extension tube. After a digital scout radiograph was obtained as a mask, sequential digital images were obtained during the injection of water-soluble contrast medium (Omnipaque, 300 mg/mL; Nycomed, Carrigtohill, Ireland) while viewing the real-time images taken at a rate of 3 exposures per second. The images were then digitally manipulated to obtain ideal images of the LDS, and hard copy images were produced.

After reviewing the medical records of patients referred for obstructive epiphora to the Radiology Department of the Uludag University Hospital, Bursa, Turkey, patients whose medical records were available and images were satisfactory to evaluate the canaliculi were included in the study. The images were reviewed by a radiologist and an ophthalmologist together (B.Y. and Z.Y.). Patients who had previous dacryocystorhinostomy or canalicular obstruction were excluded from the study.

We postulated that there might be 3 possible anatomical types connecting the canaliculi to the lacrimal sac. As shown in **Figure 1**, we concluded that a CC existed when a contrast-filled, discrete canalicular segment was observed between the lacrimal sac and the point where the upper and lower canaliculi unite (type A). The opening of the canaliculi to the sac at the point where they meet on the sac wall has been defined as a common opening (type B). In the last type, there is no CC or common opening, and the canaliculi enter the sac from different points (type C).

canaliculi drained into the sac through a CC on one side but separately on the other side.

COMMENT

In textbooks related to lacrimal anatomy and surgery, it is stated that approximately 90% of individuals have a CC; in the remaining 10%, the canaliculi enter the sac separately.^{1,3-5} This approximation is based on an article by Jones,² which does not provide the details of how the figures were obtained. In our study, a CC distinguish-

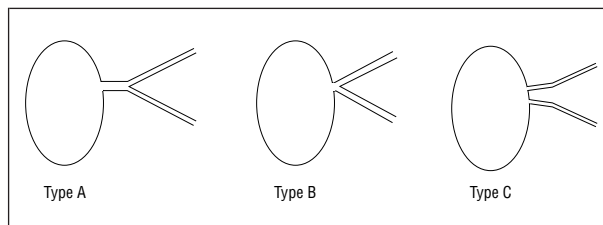


Figure 1. The upper and lower canaliculi can connect to the lacrimal sac by 3 different ways: type A is a common canaliculus, type B is a common opening, and type C is where the upper and lower canaliculi enter the lacrimal sac separately.



Figure 2. Digital subtraction macrodacryocystogram showing a common canaliculus between the lacrimal sac and the point where the upper and lower canaliculi unite.

able on DSM was observed in 94.1% of LDSs. In only 2.0% of LDSs did upper and lower canaliculi enter the lacrimal sac separately, and in 3.8% the canaliculi united at the wall of the sac to form a common opening.

There is uncertainty in the literature about how the canaliculi terminate in the 10% of the population for whom a CC is not present.⁹ The assumption that the canaliculi enter the tear sac separately implies that the canaliculus has its own, distinct opening on the sac wall. However, Hurwitz¹⁰ stated that he has not been able to identify any cases where the canaliculi drain separately into the tear sac. He believes that reports from surgical observations that the canaliculi can enter separately into the sac might be due to false passaging of one or both canaliculi on probing of the canaliculi.⁸ In fact, Jones and Wobig¹¹ report that in 10% of individuals, the canaliculi actually open separately into a "sinus of Maier," which in turn opens into the tear sac instead of directly into the lacrimal sac. According to this description, the lacrimal sac

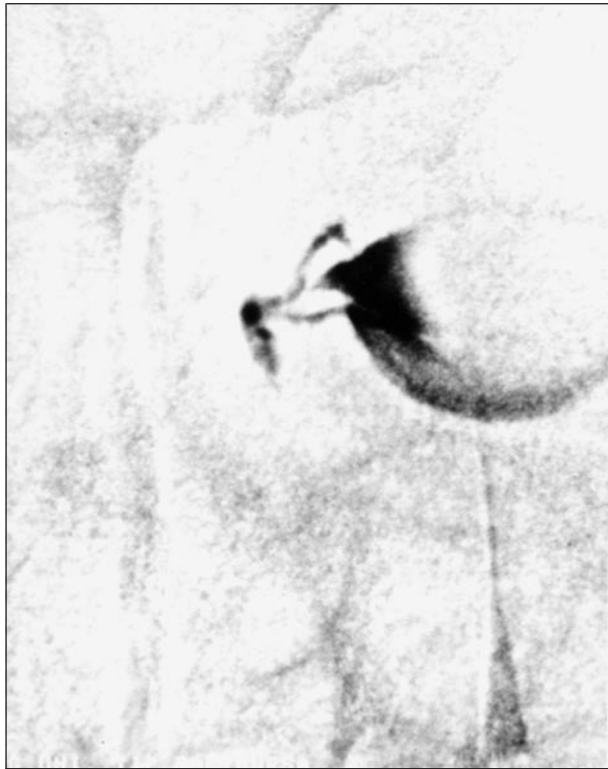


Figure 3. Digital subtraction macrodacryocystogram showing no common canaliculus. The upper and lower canaliculi unite at a common opening and drain into the lacrimal sac through one internal punctum.

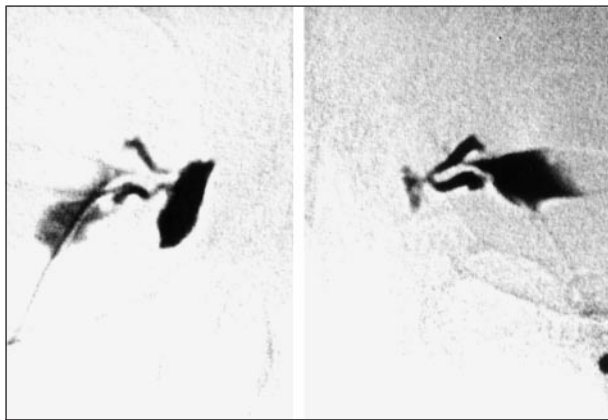


Figure 4. Digital subtraction macrodacryocystograms of both lacrimal drainage systems in one patient showing a common canaliculus on the right side (right) but separate openings on the left side (left).

can have only one common internal opening, and the possibility that the canaliculi might enter the sac separately is excluded.

In this study, we found that there is a CC or common opening in 98% of the LDSs and that both canaliculi drain through a common internal punctum in this group. In the remaining 2% of LDSs, the canaliculi open into the tear sac through 2 separate internal puncta.

The term *sinus of Maier* has been used to describe 3 different anatomical types: (1) the CC itself, (2) the terminal dilation of CC, and (3) a lacrimal sac diverticulum into which the canaliculi open separately, as mentioned previously.^{3,8,11-14} Because of this confusion, we

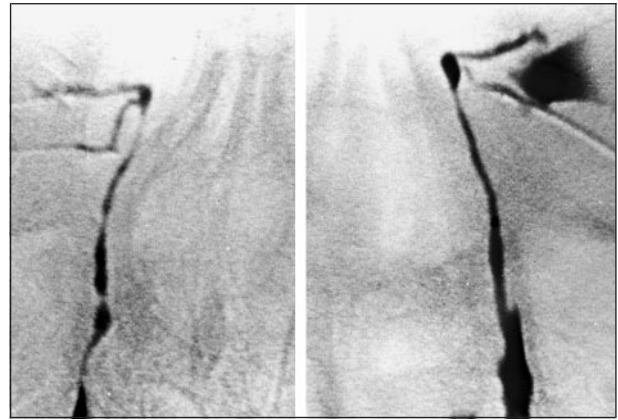


Figure 5. Digital subtraction macrodacryocystograms showing independent canalicular openings into the lacrimal sac bilaterally.

Numbers of Lacrimal Drainage Systems According to Type of Canalicular Connection to the Lacrimal Sac*

Canalicular Anatomy	Lacrimal Drainage Systems, No. (%)		
	On Unilateral DSM (n = 153)	On Bilateral DSM (n = 188)	Total (N = 341)
Type A: common canaliculus	145	176	321 (94.1)
Type B: common opening	7	6	13 (3.8)
Type C: separate openings	1	6	7 (2.0)

*DSM indicates digital subtraction macrodacryocystography.

prefer to use a functional term, common opening, to describe the type in which the CC is absent and the canaliculi unite at the sac wall and drain by one common ostium.

We do not know how the presence or the type of the CC affects the clinical course of nasolacrimal duct obstruction. It has been thought that sac retention in nasolacrimal duct obstruction, as seen in lacrimal sac mucocele and congenital dacryocystocele, occurs in patients without a CC.^{11,15} Results of a recent study¹⁶ suggest that kinking of the CC due to compression of the dilated sac may better explain sac enlargement.

The absence of a CC has been considered an important variance that can affect the results of some surgical procedures. In the repair of canalicular laceration in the absence of CC, the method of bicanicular-annular stent placement using a pigtail or similar type of probe has not been advised.¹⁷⁻¹⁹ The uncertainty as to whether there is only one internal punctum can create a problem in surgery, especially on probing of the canaliculi or silicon intubation at the time of dacryocystorhinostomy.²⁰ The natural axes of the canaliculi can be significantly distorted during probing.²¹ Particularly when advancing the metallic probe through the canaliculus is difficult, the probe might show the tendency of coming out from a different point in the lacrimal wall than the previous probe, and a false passage through the canaliculi into the lacrimal sac can be created easily. It should

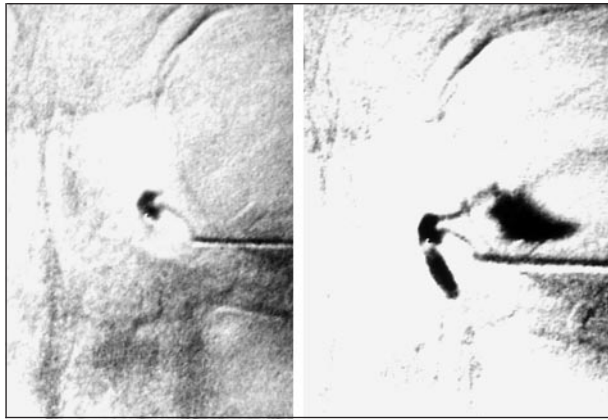


Figure 6. When the canaliculi open separately to the lacrimal sac, as seen on digital subtraction macrodacryocystograms, the lacrimal sac fills with contrast first (left) and the upper canaliculus fills subsequently (right).

be considered that the anatomical variation where the upper and lower canaliculi drain separately into the tear sac is seen rarely, in about 2% of the cases, less than the previously accepted figure of 10% of patients.

In 1911, Schaeffer²² lucidly described 3 different ways in which the canaliculi communicate with the lacrimal sac. He pointed out that the CC is the usual way of communication; moreover, the canaliculi can empty separately into a diverticulum of the lacrimal sac (sinus of Maier). In the rare case, there is neither a CC nor a diverticulum; the canaliculi empty separately into the lacrimal sac. We found quantitative data about the frequency of CC in 3 studies. Tucker et al¹⁶ did not observe a CC in 2 of 12 rigid plastic casts of the lacrimal outflow system. In these specimens, the upper and lower canaliculi independently entered the lacrimal sac. In a study²³ using computed tomographic dacryocystography, a CC was noted bilaterally in all 11 patients. In the third study²⁴ using microscopic anatomical analysis, the CC was identified in 6 LDSs of 5 adult cadavers.

Improvements in dacryocystography have enabled better visualization of the lacrimal system and the canaliculi in particular.^{25,26} During contrast injection, the real-time, sequential, digitally subtracted images are displayed on a television monitor and each phase is minimized by an initial slow injection rate. The canalicular anatomical type can be evaluated better in the early phases of dacryocystography, during which the lacrimal sac is not distended completely with contrast media yet. Magnification can be increased by digital manipulation to obtain good detail of the canalicular system. In the case of the CC or common opening, the contrast media frequently opacified the upper canaliculus before the sac in dacryocystography. However, in type C, the lacrimal sac always filled with radiopaque contrast just after the cannulated lower canaliculus, and the upper canaliculus filled subsequently (**Figure 6**).

It is unlikely to misinterpret the CC on a dacryocystogram because it appears as a contrast-filled, separate segment on the film. In the cases that we interpreted as type B, upper and lower canaliculi were joining with a narrow angle at the level of the lacrimal sac wall. In this group, the cases with dilated lacrimal sacs might have a short CC that could be obscured by the sac. In 4

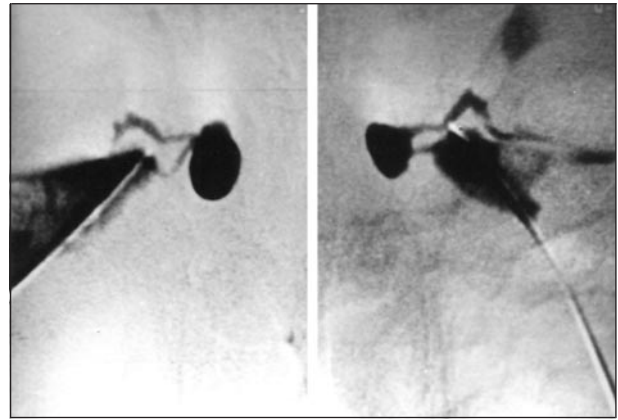


Figure 7. Left, In the late phases of digital subtraction macrodacryocystography, a large sac might obscure a short common canaliculus, as seen on the right side of this patient. Right, On the left side of the same patient, the upper and lower canaliculi appear nearly parallel to each other while entering the sac independently.

of our 13 LDSs with type B, the lacrimal sacs were dilated rather than normal. It is also unlikely to confuse type C with the other types on dacryocystograms. In type C, as the canaliculi approach the lacrimal sac their courses become nearly parallel to each other and they remain separate on the sac wall (**Figure 7**).

We do not think that the fact that our sample consisted of patients with nasolacrimal duct obstruction could cause a false conclusion in the frequency of CC. To our knowledge, a correlation between the different types of CC and the anatomical obstruction of the lacrimal drainage pathway has not been established in the literature.

In conclusion, the results of our study show that the upper and lower canaliculi enter the lacrimal sac separately in only approximately 2% of patients examined by DSM. Rarely, the canalicular anatomical features might not be identical in both eyes.

Accepted for publication February 10, 2000.

We thank Dale R. Meyer, MD, Lions Eye Institute, Albany, NY, for reviewing the manuscript, and Nadeem Ishaque, PhD, GE Corporate Research & Development, Schenectady, NY, for technical help.

Corresponding author: Bülent Yazıcı, MD, Department of Ophthalmology, Uludağ University School of Medicine, Gorukle Campus, 16059 Bursa, Turkey (e-mail: byazici@uludag.edu.tr).

REFERENCES

1. Linberg JV. Surgical anatomy of the lacrimal system. In: Linberg JV, ed. *Lacrimal Surgery*. New York, NY: Churchill Livingstone Inc; 1988:1-18. *Contemporary Issues in Ophthalmology*, vol 5.
2. Jones LT. An anatomical approach to problems of the eyelids and lacrimal apparatus. *Arch Ophthalmol*. 1961;66:111-124.
3. Kikkawa DO, Lemke BN. Orbital and eyelid anatomy. In: Dortzbach RK, ed. *Ophthalmic Plastic Surgery: Prevention and Management of Complications*. New York, NY: Raven Press; 1994:1-29.
4. Nowinski TS. Anatomy and physiology of the lacrimal system. In: Bosniak S, ed. *Principles and Practice of Ophthalmic Plastic and Reconstructive Surgery*. Philadelphia, Pa: WB Saunders Co; 1996:731-747.
5. Dale DL. Embryology, anatomy, and physiology of the lacrimal drainage system. In: Stephenson CM, ed. *Ophthalmic Plastic, Reconstructive, and Orbital Surgery*. Boston, Mass: Butterworth-Heinemann; 1997:19-30.

6. Galloway JE, Kavic TA, Raflo GT. Digital subtraction macrodacryocystography: a new method of lacrimal system imaging. *Ophthalmology*. 1984;91:956-962.
7. Hurwitz JJ, Victor WH. The role of sophisticated radiological testing in the assessment and management of epiphora. *Ophthalmology*. 1985;92:407-413.
8. Cowen D, Hurwitz JJ. Anatomy of the lacrimal drainage system. In: Hurwitz JJ, ed. *The Lacrimal System*. Philadelphia, Pa: Lippincott-Raven Publishers; 1996: 15-21.
9. Duke-Elder S, Wybar KC. Lacrimal apparatus. In: Duke-Elder S, ed. *System of Ophthalmology*. St Louis, Mo: CV Mosby Co; 1974:559-581.
10. Hurwitz JJ. Punctum and canaliculus. In: Hornblass A, ed. *Oculoplastic, Orbital and Reconstructive Surgery*. Baltimore, Md: Williams & Wilkins; 1990:1381-1393.
11. Jones LT, Wobig JL. Tear sac foreign bodies and tumors. In: *Surgery of the Eyelids and Lacrimal System*. Birmingham, Ala: Aesculapius Publishing Co; 1976: 185-193.
12. Veirs ER. Anatomy and embryology of the lacrimal system. In: *Lacrimal Disorders*. St Louis, Mo: CV Mosby Co; 1976:1-12.
13. Wolff E. Ocular appendages. In: *The Anatomy of the Eye and Orbit*. 7th ed. Philadelphia, Pa: WB Saunders Co; 1976:181-237.
14. Jones LT, Wobig JL. The lacrimal system. In: *Surgery of the Eyelids and Lacrimal System*. Birmingham, Ala: Aesculapius Publishing Co; 1976:57-70.
15. Harris GJ, DiClementi D. Congenital dacryocystocele. *Arch Ophthalmol*. 1982; 100:1763-1765.
16. Tucker NA, Tucker SM, Linberg JV. The anatomy of the common canaliculus. *Arch Ophthalmol*. 1996;114:1231-1234.
17. Walter WL. The use of the pigtail probe for silicone intubation of the injured canaliculus. *Ophthalmic Surg*. 1982;13:488-492.
18. Reifler DM. Management of canalicular laceration. *Surv Ophthalmol*. 1991;36: 113-132.
19. Jordan DR, Nerad JA, Tse DT. The pigtail probe, revisited. *Ophthalmology*. 1990; 97:512-519.
20. Hurwitz JJ. Dacryocystorhinostomy. In: Hurwitz JJ, ed. *The Lacrimal System*. Philadelphia, Pa: Lippincott-Raven Publishers; 1996:261-296.
21. Hecht S. Dacryocystorhinostomy. In: Guibor P, Smith B, eds. *Contemporary Oculoplastic Surgery*. New York, NY: Stratton Intercontinental Medical Book Corp; 1974:41-54.
22. Schaeffer JP. Variations in the anatomy of the naso-lachrymal passages. *Ann Surg*. 1911;54:148-152.
23. Caldemeyer KS, Stockberger SM, Broderick LS. Topical contrast-enhanced CT and MR dacryocystography: imaging the lacrimal drainage apparatus of healthy volunteers. *AJR Am J Roentgenol*. 1998;171:1501-1504.
24. Kurihashi K, Imada M, Yamashita A. Anatomical analysis of the human lacrimal drainage pathway under an operating microscope. *Int Ophthalmol*. 1991;15:411-416.
25. Montecalvo RM, Zegel HG, Barnett FJ, et al. Evaluation of the lacrimal apparatus with digital subtraction macrodacryocystography. *Radiographics*. 1990;10:483-490.
26. King SJ, Haigh SF. Technical report: digital subtraction dacryocystography. *Clin Radiol*. 1990;42:351-353.

IN OTHER AMA JOURNALS

ARCHIVES OF NEUROLOGY

Recurrent Orbital Myositis: Report of a Familial Incidence

Iris Maurer, MD; Stephan Zierz, MD

Background: In orbital myositis, painful diplopia develops owing to an enlargement of the extraocular muscles. Diagnosis is established based on history, clinical manifestations, and therapeutic response to steroids, with the findings of magnetic resonance imaging providing additional information.

Observation: We observed a family in which 4 members had an ophthalmopathy suggestive of orbital myositis. The affected members are a sibling pair (female and male) and 2 children of the brothers of their father's father.

Conclusion: The familial incidence suggests a potential genetic predisposition in the development of orbital myositis. (1999;56:1407-1409)

Reprints: Iris Maurer, MD, Psychiatrische Klinik, Universitätsklinik Jena, Philosophenweg 3, 07740 Jena, Germany.