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CT-anatomy of the nasolacrimal sac and duct

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Summary: Recent developments in ophthalmology such as balloon dilatation, stent implantation, laser therapy and endoscopy of the lacrimal drainage system raise the need for a detailed anatomical knowledge of this system. In this study morphometric measurements of the lacrimal drainage system were performed with thin-section axial computed tomography (CT) examinations in 147 patients with no signs of pathology related to the lacrimal drainage system. The mean length of the nasolacrimal duct measured 11.2 ± 2.6mm (range: 6-21 mm), the narrowest diameter was 3.7 ± 0.7 mm (range: 2-7 mm). The mean length of the nasolacrimal sac was 11.8 ± 2.5 mm (range: 6-18 mm). The width of the nasolacrimal sac did not exceed 4 mm unless filled with air. In 43 (29.3%) of the subjects air was visible within the nasolacrimal sac or duct. The knowledge of the morphometry of the lacrimal drainage system enables the ophthalmologist to plan intervention on the lacrimal drainage system precisely and avoid unnecessary manipulations.

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Anatomie du sac et du conduit lacrymo-nasaux en tomodensitométrie

Résumé : Les récents progrès en ophtalmologie tels que la dilatation par ballonnet, la pose de sondes, les traitements au laser, l'endoscopie du système lacrymal accroissent la nécessité d'une connaissance anatomique précise de ce système ; dans cette étude morphométrique, les mesures du système de drainage lacrymal ont été réalisées par tomodensitométrie en coupes fines (CT) ; l'étude portait sur 147 patients indemnes de toute pathologie du système de drainage lacrymal. La longueur moyenne du conduit lacrymal était de 11,2 ± 2,6 mm (limites : 6-21 mm) ; le diamètre le plus réduit était de 3,7 ± 0,7 mm (limites : 2-7 mm). La longueur moyenne du sac lacrymo-nasal était de 11,8 mm ± 2,5 mm (limites 6-18 mm) ; la largeur du sac n'excédait pas 4 mm, en dehors d'un remplissage par l'air. La présence d'air a été décelée dans le sac ou le conduit chez 43 sujets (29,3 %). La connaissance de la morphométrie du système de drainage lacrymal permet à l'ophtalmologiste de planifier avec précision une intervention sur le système en évitant des manœuvres intempestives.

Key words: Nasolacrimal — Sac, duct, canal — Lacrimal drainage system — Anatomy — Computed tomography

Tears collect at the lacrimal lake at the inner canthus and are drained through the lacrimal puncta, the lacrimal canaliculi, the nasolacrimal sac and the nasolacrimal duct into the inferior nasal meatus. The nasolacrimal duct runs through the (osseous) nasolacrimal canal. This lower lacrimal drainage system may be involved in various pathologic processes that frequently result in obstruction [1, 3]. Recent diagnostic and therapeutic developments such as endoscopy, stent impantation and balloon dilatation of the nasolacrimal sac and duct require a detailed anatomical knowledge of the drainage system to plan the intervention exactly [4, 5, 7, 8]. The purpose of this study was to establish baseline anatomic standards and describe anatomical variations of the nasolacrimal sac and duct with thin-section computed tomography (CT).

Material and methods

Axial computed tomography (Somatom Plus 4, Siemens, Erlangen, Germany) of the head was performed in 147 patients (mean age: 58 ± 21 years, range: 19-84, 80 female and 67 male). The patients were studied because of various problems (mainly intracerebral, concerning posterior fossa pathologies) that were not related to the lacrimal system, the orbit, the paranasal sinuses, or the nasal cavity to ensure that they could be regarded as normal with respect to the lacrimal drainage system. Moreover, exclusion criteria were

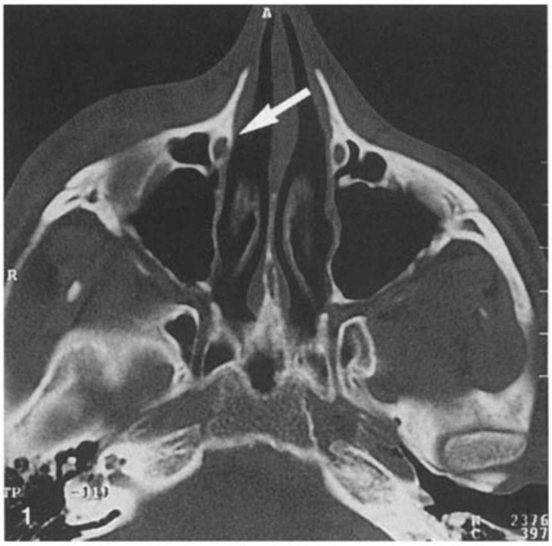

Fig. 1
The nasolacrimal duct (*arrow*) inside the nasolacrimal canal

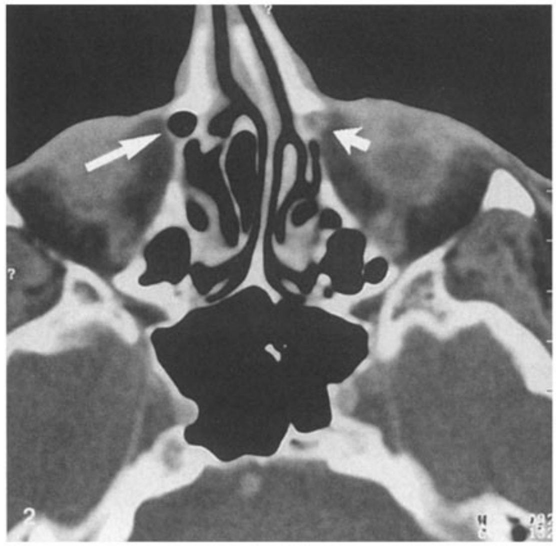

Fig. 2
The left nasolacrimal sac (*short arrow*) appears as a soft tissue density in the lacrimal fossa. Normal finding of an aerated and extended right nasolacrimal sac (*long arrow*)

clinical symptoms of either epiphora or "dry eyes" or infection of the upper airways. Thin-section (2 or 3 mm) consecutive slices were obtained with a matrix of 512^2 parallel to the palato-occipital plane. The images were analyzed on a digital image workstation (Sienet Magic-View 1100, Siemens, Erlangen, Germany). On both sides, the width of the nasolacrimal canal (NLC) was measured at each axial level on which it was visible. For the nasolacrimal duct (NLD) and for the nasolacrimal sac (NLS) lengths measurements were performed on both sides by multiplying the number of consecutive scans showing the NLD and the NLS with the slice thickness. Additionally, multiplanar reformatted (MPR) images were were available in 96 patients. They were obtained in the coronal and sagittal plane of the nasolacrimal canal (NLC) on both sides. The length of the NLD was directly measured on the MPR images on both sides and compared with the length values that were evaluated from the axial slices as described above. Side-differences were defined as the mean difference between corresponding structures (e.g. right and left NLC) for all subjects.

Results

The mean length of the NLD (Fig. 1) for all subjects was 11.1 ± 2.6 mm (range: 6-21 mm). The narrowest transversal diameter of the NLC was 3.8 ± 0.7 mm (range: 2-7 mm) predominately located in the middle and upper portion of the canal. The length of the NLS was 11.8 ± 2.5 mm (range: 6-18 mm). The width of the NLS did not exceed 4 mm unless filled with air (Fig. 2). The maximum diameter of an aerated NLS measured 8mm. Together the sac and duct measured 22.9 ± 3.5 mm (range: 15-33 mm), the intraosseous portion (nasolacrimal canal) constituted 48.1 ± 7.6% (range: 33.3-66.6%) of both sac and duct. The side-differences of the NLD-lengths were 0.4 ± 1.0 mm (range: 0-3 mm), those of the NLS 0.2 ± 0.7 mm (range: 0-3 mm). The side-difference of the narrowest diameter of the NLC measured 0.5 ± 0.6 mm (range: 0-4 mm). MPR length measurements of the NLD corresponded well with the length values evaluated from axial slices (mean difference: 1.0 ± 1.4 mm) (Fig. 3). In 43 subjects (29.3%) air was visible inside the NLS or the NLD, in 19 (12.9%) it occurred bilaterally.

Discussion

The lacrimal drainage system can be involved by various pathologic processes such as inflammation, abscess formation, tumor infiltration or traumatic injuries [1, 3]. In common, these situations often lead to obstruction. Recent developments in ophthalmology have established minimal-invasive procedures to either diagnose or treat these stenoses. They include endoscopy, laser therapy, stent implantation and balloon dilatation [4-7]. These procedures are associated with an instrumentation which has to correspond to the anatomical structures exactly. The diameters of possible balloons and stents should correspond to the diameters of the nasolacrimal sac and duct to prevent either damage of the soft tissue structures and dislocation of the stent. The knowledge of the length of the nasolacrimal canal may be necessary to choose the optimal technical devices (e.g. stents) that may be implanted without irritating the NLS or the membranous part of the NLD. Therefore, these procedures raise the need for a detailed anatomical and morphometric knowledge of the lacrimal drainage system.

Because of its excellent contrast between bony structures and soft or fat tissues, thin-section axial CT is an effective imaging modality to evaluate the structures related to the lower lacrimal drainage system and the surrounding tissue [6].

The NLS lies within the lacrimal fossa, a bony depression in the mediocaudal orbital wall (Fig. 4), between the anterior (formed by the lacrimal process of the maxillary bone) and the posterior lacrimal crest (formed by the lacrimal bone) [2]. CT differentiates the frontal process of the maxillary bone from the thinner lacrimal bone due to the marked difference in the cortical thickness (on "bone window" settings). Medially the NLS is related to the ethmoidal cells and

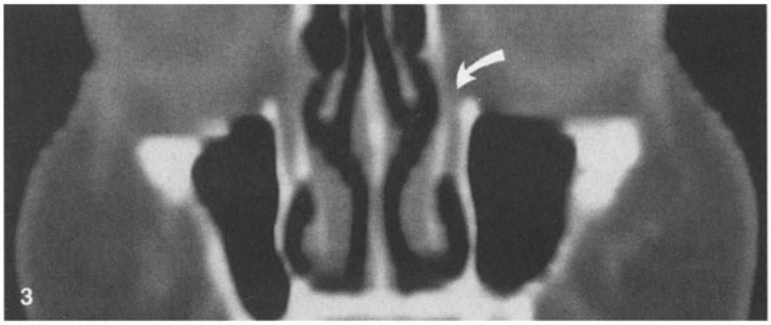

Fig. 3
Coronal reformatted image of the nasolacrimal canal (*arrow*)

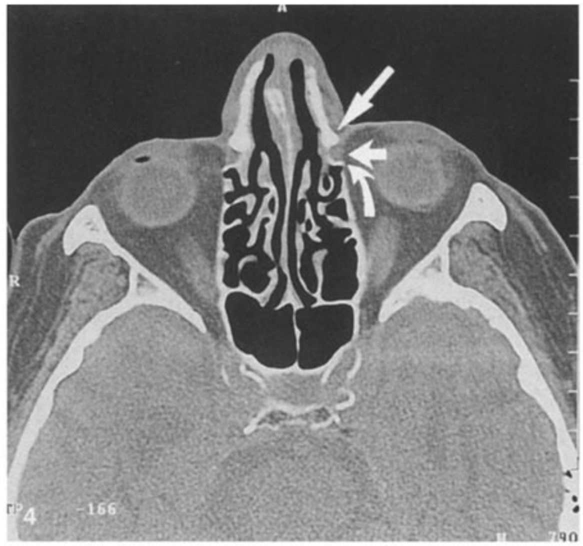

Fig. 4
The lacrimal fossa (*short arrow*) lies between the anterior (*long arrow*) and the posterior (*curved arrow*) lacrimal crest

the middle nasal meatus. On CT the NLS appears as a soft tissue density between the anterior and posterior lacrimal crest. Its diameter does not exceed 4 mm, when filled with air it may be distended. Thus, an aerated and dilated NLS should not be misinterpreted as pathologic.

Caudally the NLS directly develops into the NLD, which lies within the NLC mainly formed by the lacrimal sulcus of the maxillary bone. At the cranial and lateral end it is edged by the lacrimal bone, infero-medially it is shaped by the lacrimal process of the inferior nasal turbinate [2]. Although CT clearly depicts the bony structures related to the lacrimal canal, the sutures between the different bones are too small to allow their exact differentiation. Laterally the NLC is related to the maxillary sinus, medially to the middle and inferior nasal meatus. On CT images the NLD presents as a soft tissue density that usually fills the whole NLC unless filled with air. The caudal parts of the duct may run underneath the nasal mucosa for a variable distance (membranous part) until it ends at the valve of Hasner which opens into the inferior nasal meatus app. 1cm behind the anterior end of the inferior turbinate.

The intraosseous part (NLC) constitutes half of the lower lacrimal drainage system (NLD and NLS), but this may vary between 33-67%. The direction of the NLS and NLD, both of which are anatomically valveless, is dorso-caudal. Long sacs and ducts usually tend to run parallel, while shorter ones converge medially.

Apart from the direct visualization of the lacrimal drainage system, thin section CT offers simultaneous information about the surrounding tissue. This may be particularly important in complex pathologies such as fractures, abscess formation or tumor infiltration and for the planning of surgical procedures [6]. These pathologic processes may mask the structures of the lower lacrimal drainage system and frequently they cannot be differentiated at all. That is why the knowledge of the normal course of these structures may be particularly important to assess their involvement in complex pathologies.

Conclusion

Minimal invasive techniques in the management of pathologies related to the lower lacrimal drainage system have to be based on a detailed anatomical knowledge of the system. This study may contribute to the establishment of morphometric baseline standards that are necessary for the precise planning of the intervention and for the construction and use of adequate technical devices.

References

1. Casper DS, CHI TL, Trokel SL (1993) Orbital lacrimal system disorders. In: Orbital diseases: imaging and analysis. Thieme, Stuttgart New York, pp 277-304
2. Hafferl A, Thiel W (1969) Tränenapparat. In: Lehrbuch der Topographischen Anatomie, 3rd edn. Springer, Berlin Heidelberg New York, pp 117-122
3. Hurwitz JJ (1996) Diseases of the sac and duct. In: The lacrimal system. Lippincott-Raven, Philadelphia, pp 117-138
4. Metson R, Woog JJ, Puliafito CA (1994) Endoscopic laser dacryocystorhinostomy. Laryngoscope 104: 269-274
5. Robinson R, Turner N, Brettle P, Chell PB, Chavda SV, Murray PI (1993) The treatment of epiphora with balloon dacryosytoplasty. Eye 7: 687-690
6. Russel EJ, Czervionke L, Huckman M, Daniels D, McLachlan D (1985) CT of the inferomedial orbit and the lacrimal drainage apparatus: normal and pathologic anatomy. AJR 145: 1147-1154
7. Song HY, Ahn HS, Park CK, Kwon SH, Kim CS, Choi KC (1993) Complete obstruction of the nasolacrimal system: part II. Treatment with expandible metallic stents. Radiology 186: 372-376
8. Weidenbecher M, Hosemann W, Buhr W (1994) Endoscopic endonasal dacryocystorhinostomy: results in 56 patients. Ann Otol Rhinol Laryngol 103: 363-367

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