

Naso-sinus findings by computed tomography in pediatric chronic dacryocystitis

Hallazgos nasosinuales por tomografía computada en dacriocistitis crónica pediátrica

Luz A. Campos-Navarro^{1*}, Margarita E. Ibarra-Macari¹, Arcelia C. Barrón-Campos²,
Juan M. Moreno-Martínez³, and José A. Almeyda-Farfán²

¹Servicio de Otorrinolaringología y Cirugía de Cabeza y Cuello (CCC), Academia Mexicana de Cirugía, Hospital Ángeles Metropolitano; ²Facultad de Ciencias de la Salud, Universidad Anáhuac México; ³Servicio de Radiología, Unidad Médica de Alta Especialidad, Hospital General Dr. Gaudencio González Garza, Centro Médico Nacional La Raza, Instituto Mexicano del Seguro Social. Ciudad de México, México

Abstract

Objective: To evaluate the preoperative tomographic characteristics of the nose and paranasal sinuses of children with chronic dacryocystitis. **Method:** Prospective, observational, cross-sectional, and descriptive study. CT scans of the paranasal sinuses of patients candidates for endoscopic dacryocystorhinostomy were evaluated for two years. Demographic characteristics, radiological findings, inflammatory processes and anatomical variants were identified using the Lund-Mackay classification. Statistic analysis. Stata 10.0, descriptive analysis, Student's t: mean difference and χ^2 . Logistic studies to estimate the probability between variables. **Results:** 27 men and 11 women ($n = 38$) were included. Of these, 22 had unilateral and 16 bilateral nasolacrimal duct involvement. Lund-Mackay score range: 2-20. Eleven patients had associated pathology. The most affected were anterior and maxillary ethmoidal sinus (69%), osteomeatal complex (68%), posterior ethmoidal (51%). Patients with severe rhinosinusitis are 12 times more likely to develop dacryocystitis than patients with < 12 points. Men presented greater severity, affection, and clinical repercussion. **Conclusions:** There is radiological rhinosinusal involvement in dacryocystitis, which must be evaluated and treated preoperatively to avoid postoperative complications or reinfections.

Keywords: Dacryocystitis. Sinusitis. Computed tomography. Paranasal sinuses. Nasolacrimal duct. Dacryostenosis.

Resumen

Objetivo: Evaluar las características tomográficas preoperatorias de la nariz y los senos paranasales de niños con dacriocistitis crónica. **Método:** Estudio prospectivo, observacional, transversal y descriptivo. Se evaluaron tomografías de senos paranasales de pacientes candidatos a dacriocistorrinostomía endoscópica, durante 2 años. Se identificaron características demográficas, hallazgos radiológicos, procesos inflamatorios y variantes anatómicas, utilizando la clasificación Lund-Mackay. Análisis estadístico con Stata 10.0, análisis descriptivo con t de Student: diferencia medias y χ^2 . Estudios logísticos para estimar la probabilidad entre variables. **Resultados:** Se incluyeron 27 hombres y 11 mujeres ($n = 38$). De ellos, 22 tenían afección del conducto nasolagrimal unilateral y 16 bilateral. Rango de puntuación de Lund-Mackay: 2-20. Once pacientes tuvieron patología asociada. Seno etmoidal anterior y maxilar más afectados (69%), complejo osteomeatal (68%), etmoidal posterior (51%). La probabilidad de que los pacientes con rinosinusitis grave puedan presentar dacriocistitis es 12 veces mayor que en los pacientes con < 12 puntos. Los hombres presentaron mayor gravedad, afectación y repercusión clínica. **Conclusiones:** Existe afección rinosinusal radiológica en la dacriocistitis, que debe ser evaluada y tratada en el preoperatorio para evitar complicaciones o reinfecciones posquirúrgicas.

Palabras clave: Dacriocistitis. Sinusitis. Tomografía computada. Senos paranasales. Conducto nasolagrimal. Dacriostenosis.

*Correspondence:

Luz A. Campos-Navarro

E-mail: camposanahuacori@gmail.com

2444-0507/© 2021 Academia Mexicana de Cirugía. Published by Permanyer. This is an open access article under the terms of the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Date of reception: 09-12-2020

Date of acceptance: 11-03-2021

DOI: 10.24875/CIRUE.M23000431

Cir Cir (Eng). 2023;91(1):84-90

Contents available at PubMed

www.cirugiaycirujanos.com

Introduction

In cases of chronic dacryocystitis, which involve inflammation of the sac and nasolacrimal duct for over 6 months, surgical treatment is required for some patients. The surgical technique often used is either open or endoscopic, but before deciding what the proper therapeutic approach is and regardless of its etiology, it is of paramount importance to assess the anatomical and pathological conditions of the lacrimal apparatus and paranasal sinuses—closely related structures—using computed tomography (CT) of the nose and paranasal sinuses. Multiple imaging modalities, such as dacryocystography, 3D images¹, CT dacryocystography, and magnetic resonance imaging^{2,3}, can be used to study both the sac and the lacrimal passage. Nonetheless, high-resolution CT plays a crucial role in the evaluation of patients, providing a map of the region of interest eligible for endoscopic surgery. The technological advancements made that have improved the quality of the CT scan have allowed us to conduct comprehensive assessments and make effective decisions, thus avoiding unnecessary treatments and reducing the extent of the lesion. Over the past decade, there has been a growing interest in endoscopic facial surgery with a focus on minimally invasive approaches, leading to a lower morbidity rate.

The management of the lacrimal system has proven to be effective and safe. However, it requires a thorough evaluation of the nasosinusal condition, including CT imaging. Correlating preoperative images and clinical findings allows the surgeon to consider suitable surgical options, leading to fewer complications and optimal resolution of the clinical condition⁴.

To identify and understand the facial areas requiring special care, proper understanding of the anatomy and its variants through imaging is essential. These variants can be stratified based on the Lund-Mackay classification⁵.

In the surgical planning of patients with dacryocystitis or dacryostenosis, studies often focus on evaluating the lacrimal sac and surrounding structures. However, while treating multiple pediatric patients, it has been confirmed that some were not only carriers of dacryocystitis but also had concomitant rhinosinusitis, raising the question of whether the lacrimal obstructive process may have contributed to exacerbating a surrounding infection, thus requiring control to avoid complications or recurrences. Therefore, we decided to conduct the present study to identify the characteristics of the sac

and the incidence rate of sinusitis as a comorbidity among the pediatric population.

The Lund-Mackay system is the most widely used method to stage rhinosinusitis in clinical trials⁵. This method was developed as an evaluation tool to facilitate therapeutic decision-making in the mid-1980s⁶. The system uses CT images to study paranasal sinuses. Each group of sinuses is classified as 0 (complete absence of opacity), 1 (partial opacity), and 2 (total opacity). The sum of these scores results in a value ranging from 0 to 24.

Various anatomical variants can be identified, such as the absence of frontal sinus, the presence of concha bullosa, the paradoxical curvature of the middle turbinate, the existence of Haller cells, the inverted uncinate process, and the pneumatized agger nasi.

The history of previous surgery is rated as either 0 or 1, and current symptoms are assessed on a scale from 0 to 10. However, it is not taken into consideration in the overall score of the classification of tomographic findings.

In addition to the imaging findings, surgical observations, such as the presence of polyps, purulent secretions, mucosal edema, scarring, and synechiae, are graded on a scale from 0 to 2 each⁷.

Method

This was a prospective, observational, descriptive, and cross-sectional study. Patient recruitment and treatment were conducted over a 2-year period. The following inclusion criteria were considered: a) pediatric patients (under 16 years) of both sexes; b) with a clinical diagnosis of unilateral or bilateral chronic dacryostenosis; c) scheduled for endoscopic dacryocystorhinostomy surgery; d) evaluated preoperatively with high-resolution helical CT scans in axial and coronal views of the nose and paranasal sinuses, specifically requested for the surgical procedure; e) beneficiaries of the center; f) no prior surgical treatment in the region of interest or ocular area, no congenital or traumatic alterations affecting the anatomy or nasal or sinus anatomy or known carriers of rhinosinusitis with previous rhinosinusal treatments; and g) with consent from the patient's family or tutor to participate in the study after written prior informed consent. Patients with incomplete studies, lost studies, or technical problems resulting in poor image quality were excluded.

After the project was authorized by the research and ethics committee, and after clinical evaluation and CT

assessment, the study proceeded to look for and identify anatomical and pathological findings on both the nose and paranasal sinus CT scans performed with a Siemens Somatom AR system and a Magic View SIE-MENS image viewing station. The CT scan was interpreted by an expert radiologist and an otolaryngologist. The study included the characteristics, development, and pneumatization of ethmoid, sphenoid, maxillary, and frontal sinuses based on age, inflammatory processes, patency of the ostium, anatomical changes, and nasolacrimal duct conditions, among others. The findings were classified using the Lund-Mackay scale.

Results

A total of 38 patients who were scheduled for dacryocystorhinostomy. CT scans of the nose and paranasal sinuses were performed. The patients' mean age of 5.7 years (standard deviation, ± 2.8 years) and age range from 2 to 12 years. Patients were boys (27 [71%]), and girls (11 [29%]) (Table 1).

The site of chronic dacryocystitis due to congenital stenosis was determined as bilateral in 15 cases (40%), right-sided in 13 (34%), and left-sided in 10 (26%). In males, the incidence rate of bilateral dacryocystitis was slightly higher (10 cases). However, the statistical analysis did not show any significant differences in the presence of dacryocystitis between the two sexes ($p = 0.99$) or predominance of one side over the other ($p = 0.38$).

In the clinical assessment, most patients did not show any comorbidities. In 27 children (72%), eye conditions were the only disease found, and given the patient's age, in 5 children (13%), adenoid hypertrophy was associated with rhinosinusual signs given the age of the patient. Additionally, 3 children (8%) showed a deviated septum, 2 (5%) turbinal hypertrophy, and 1 (3%) allergic rhinitis, that were identified as contributing factors to the disease. There was a statistically significant difference between those with an associated condition and those without one ($p = 0.03$).

Clinical findings

Regarding the clinical findings, although they were not the objective of the study, intercurrent tearing, yellowish and thick discharges, and conjunctival injection were identified in 100% of the patients during acute episodes, which improved with medical therapy with antibiotics, ocular hygiene, and massage. In some cases, given the presence of intercurrent abscesses

Table 1. Overall characteristics of the population (n = 38)

Age (years)	No. of patients	Percentage
2	1	3%
3	8	24%
4	10	26%
5	2	5%
6	4	11%
7	2	5%
8	4	11%
9	2	5%
10	2	5%
11	1	3%
12	2	5%

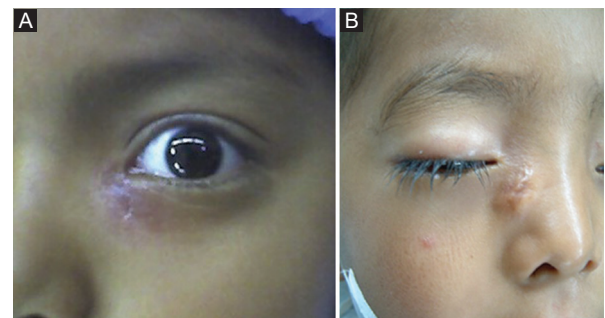


Figure 1. Scar changes A: in the inner corner of the eye. B: in the lacrimal sac.

in the lacrimal sac, classical inflammatory changes were seen during the acute phase: warmth, redness, and hyperemia, which resolved with scarring in the area (Fig. 1). Rhinoscopy revealed the presence of thick yellowish rhinorrhea of different amounts in 30 patients (79%) in the nasal passages and, in some cases, through the middle meatus, along with nasal congestion and hyperemia. All patients received antibiotic treatment and nasal washes for control prior to surgery. Figure 2 shows the intraoperative appearance of the lacrimal sac opening with a very thick and hard to eliminate mucopurulent secretion.

Radiological assessment

According to the Lund-Mackay classification, the maximum score to assess the extent and severity of

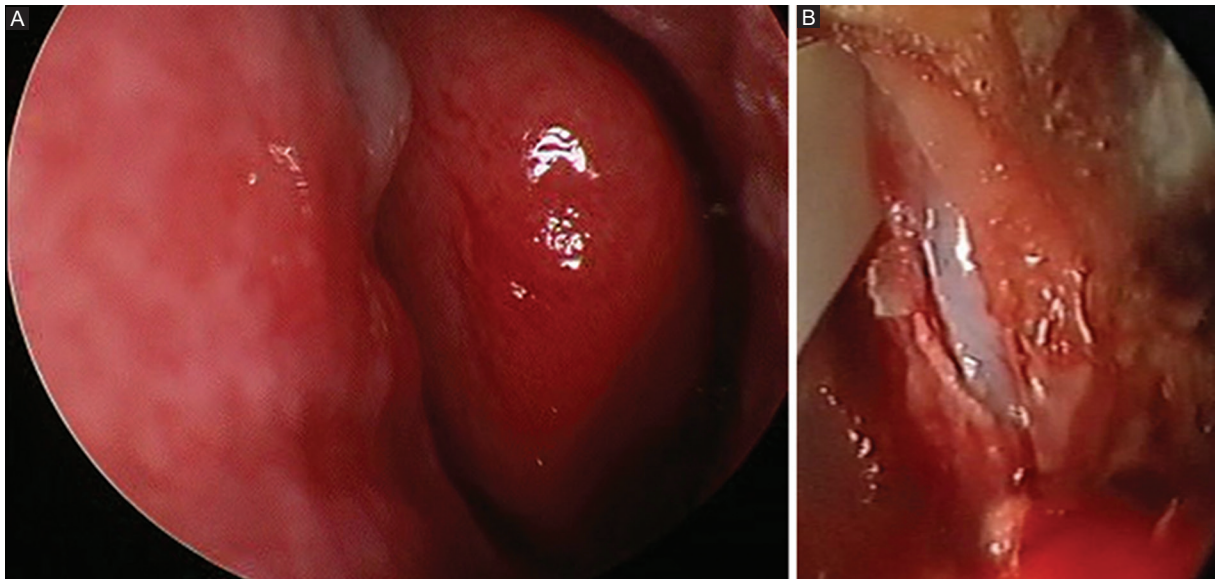


Figure 2. **A:** endonasal endoscopic view showing mucosal congestion and hyperemia. **B:** after opening the lacrimal sac, abundant mucopurulent secretion can be seen.

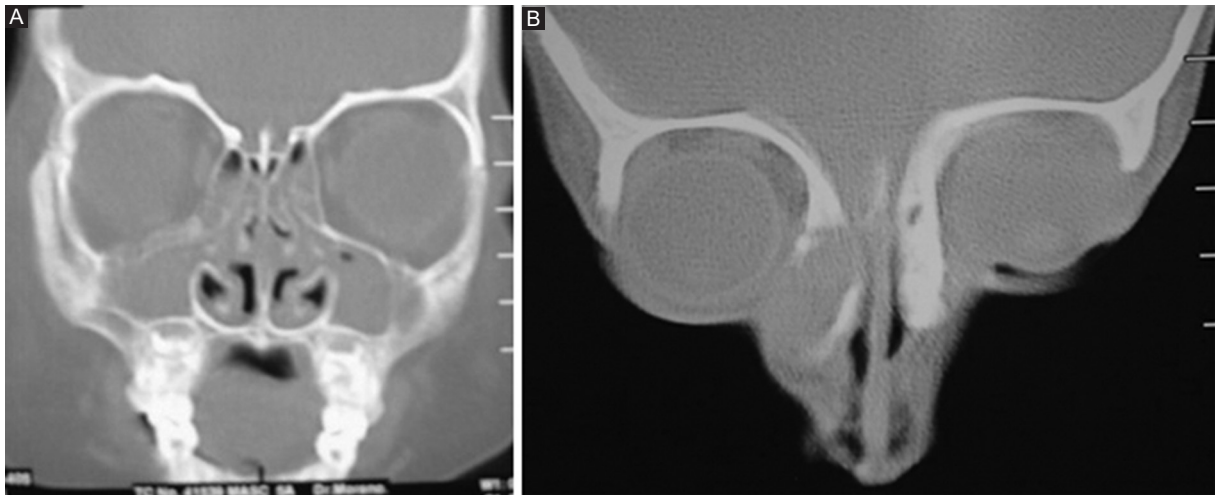


Figure 3. **A:** coronal computed tomography scan showing total opacity of the bilateral ethmoidal and maxillary paranasal sinuses. **B:** dilated lacrimal sac filled with soft tissue density.

the inflammatory process detected in the CT scans of paranasal sinuses was between 0 and 12 in 29 patients (76%), while the remaining 9 patients (24%) scored over 13 points. The score range went from 2 to 20 points (Table 2). The right side was more frequently and severely damaged. Most children with right-sided dacryocystitis (54%) scored 5 in the Lund-Mackay scale, 3 children scored > 8 points, and 3 < 4 points.

Among the patients with right-sided radiological changes on the CT scan, 11 did not show homolateral

ocular involvement; instead, another sinus was affected with an inflammatory process, obtaining scores of 7 and 11 points on the scale used. In contrast, when it comes to left-sided chronic dacryocystitis, 10 children did show homolateral pathology as seen on the images, with variable scores from 2 to 9 points.

The highest number of patients and scores was found in those with bilateral involvement (15 patients) (Fig. 3). In these patients, the changes seen on the CT scan were greater, with scores ranging from 5 to 10, especially on the left side, which was not always the most

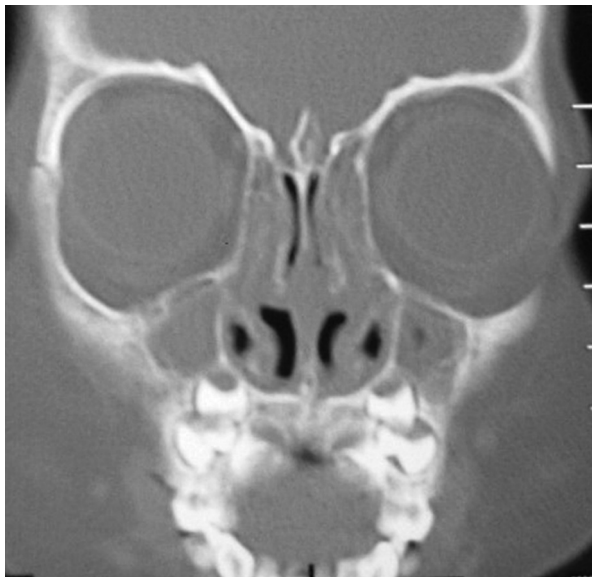


Figure 4. Coronal computed tomography scan showing total opacity of paranasal sinuses in a child with chronic dacryocystitis.

Table 2. Scores obtained on the computed tomography scan based on the Lund-Mackay scale

Lund-Mackay Score	Bilateral	Frequency	Cumulative percentage
2	1	2.63%	2.63%
4	2	2.67%	7.89%
5	13	34.21%	42.11%
8	4	10.53%	52.63%
10	5	13.16%	65.79%
12	4	10.53%	76.32%
13	1	2.63%	78.95%
14	1	2.63%	81.58%
15	1	2.63%	84.21%
16	3	7.89%	92.11%
18	1	2.63%	94.74%
20	2	5.26%	100%
Total	38	100%	100%

clinically diseased one. However, we saw that younger patients had a higher degree of involvement (Fig. 3).

Considering the predominance of chronic rhinosinusitis data in the side damaged, we found that in right-sided dacryocystitis, 13 patients showed bilateral sinusitis with scores of 5 points (7 patients [54%]), 12 points (3 patients [23%]), 8 points (2 patients [15%]), and 4 points (1 patient [8%]).

When dacryocystitis was left-sided, cases of bilateral sinusitis showed scores of 5 points (4 patients [40%]), 8 points (2 patients [20%]), 12 points (1 patient [10%]), 15 points (1 patient [10%]), 4 points (1 patient [10%]), and 2 points (1 patient [10%]).

Finally, in the presence of bilateral dacryocystitis and sinusitis, 5 patients (33%) scored 10 points, 3 patients (20%), 16 points; 2 patients (13%), 20 points; 2 patients (13%), 5 points; 1 patient (7%), 14 points; and 1 patient (7%), 13 points.

Pathology in the osteomeatal complex was identified in 28 patients (74%); of these, 24 patients (63%) on the left side and 28 (74%) on the right side. The most frequently damaged paranasal sinuses were the maxillary and the anterior and posterior ethmoid sinuses.

The maxillary sinus was damaged in 25 patients, with peripheral mucosal thickening in 18 patients and complete opacification in 10. The anterior and posterior ethmoid sinuses were damaged in 28 patients, with partial and complete opacification in 13 and 15 patients, respectively. The frontal sinus was damaged in 5 patients, with complete opacification in 4, of the homolateral side of the lacrimal issue. Only 3 patients showed pathology in the sphenoid sinus: mucosal thickening (2) and complete opacification (1) (Fig. 4).

The analysis of results showed that whenever the osteomeatal complex was obstructed, the ethmoid cells were also partially or completely opacified ($p = 0.00$), unlike the association between the levels of obstruction in the frontal ($p = 0.271$) or sphenoid sinuses ($p = 0.45$). Also, an association was found between the obstruction of the osteomeatal complex and the partial or total opacification of the maxillary sinus ($p = 0.00$).

Statistically significant differences ($p = 0.00$) were found in the mean opacity of the anterior ethmoid among individuals with grade 1 compared to grade 2 involvement (22 vs 16). This means that the degree of opacity of the anterior ethmoid was statistically higher in individuals with higher scores on the Lund-Mackay scale.

Similarly, statistically significant differences were found ($p = 0.0001$) in the mean opacity of the maxillary sinus between the group of individuals with grade 1 and grade 2 involvement (22 vs 16). This means that the degree of opacity of the anterior ethmoid sinus was statistically higher in individuals with higher degrees of involvement according to the Lund-Mackay scale.

No statistically significant differences were found in the mean level of opacity between the frontal and the sphenoid sinuses among individuals with different degrees of involvement according to the Lund-Mackay scale.

The mean opacity of all paranasal sinuses was statistically higher ($p = 0.00$) in individuals with a high compared to a low degree of involvement of left paranasal sinuses according to the Lund-Mackay scale.

The logistic analysis showed that sex contributes marginally ($p = 0.094$) to the degree of involvement in patients, being the severity of involvement lower in girls (odds ratio [OR]: 0.28) compared to boys. However, sex *per se* does not contribute to the development of dacryocystitis.

This is consistent with the medical literature available, which suggests that girls have fewer chances (OR, 0.81)^{8,9} than boys to show high values of bilateral rhinosinusitis according to the Lund-Mackay scale ($p = 0.016$). Results suggest that girls have fewer chances (OR, 0.2) of scoring > 12 points on the Lund-Mackay scale ($p = 0.054$). Individuals scoring > 12 points on this scale have 12 times more chances of experiencing dacryocystitis (OR, 13.05; $p = 0.014$).

Discussion

Chronic rhinosinusitis and dacryocystitis are two conditions that often appear together as changes on the CT images specifically obtained to study dacryocystitis.

When dacryocystitis requires endoscopic surgery, the evaluation of the CT images of paranasal sinuses and the nasolacrimal duct is performed comprehensively, because the surgical technique of endoscopic dacryocystectomy directly involves the anterior ethmoid cells, which are part of the group of paranasal sinuses (in addition to frontal and maxillary sinuses) that drain into the middle meatus and create structures and spaces of the osteomeatal complex to avoid complications. Therefore, the interrelation of these structures in an inflammatory process should be seen as part of a whole in the target surgical area.

No studies have been identified in the medical literature available that relate the presence of rhinosinusitis with dacryocystitis, sex or age. No studies have been found either discussing the relationship between anatomical variants and dacryocystitis. In patients with dacryocystitis, the condition of paranasal sinuses is not often

assessed in a standard way, which could exacerbate the clinical picture or limit the response to treatment.

The results obtained in the group we studied drew our attention to the higher frequency of dacryocystitis and rhinosinusitis in boys and the higher prevalence of both conditions in the 3 to 6 years age group.

Some studies suggest that women have a higher risk of chronic rhinosinusitis (CRS), with sex differences in the degree of opacification of paranasal sinuses^{8,9}. Masculine sex has also been associated with higher scores, with 2.7 times more chances of experiencing diffuse sinus involvement compared to females¹⁰, as it was the cases of the present study, which requires further specific research.

We did not find a relationship between the existence of anatomical variant and the presence of dacryocystitis. The severity of rhinosinusitis in patients with dacryocystitis was not a parameter of evaluation. However, a relationship was found between dacryocystitis and the severity of paranasal sinuses disease in the patients studied, which opens further lines of research on the convenience of combined treatments between otorhinolaryngology and ophthalmology to prevent infections during surgery, and even elucidate to what extent the coexistence of both conditions could be a determining factor in the persistence of dacryocystitis or if it could reduce the need for surgery.

Finally, the tomographic evaluation of patients with dacryocystitis eligible for surgery using the technique of endoscopic dacryorhinocystostomy is crucial to know the state of paranasal sinuses, assess the conditions of the lacrimal pathway more accurately, and avoid complications when performing the procedure^{11,12}.

Conclusions

In our study, the highest incidence rate of dacryocystitis was found in the 3 to 6 years age group. Whenever the osteomeatal complex was obstructed, the paranasal sinuses draining into this substructure were partially or completely damaged, which is explained by the common drainage of this complex. The frontal and sphenoid sinuses are rarely damaged due to their anatomophysiology.

Patients with chronic dacryocystitis may present with 12-fold higher chances of severe rhinosinusitis than patients scoring < 12 points in the Lund-Mackay scale.

The associated nasal comorbidity has no relation to the presence of dacryocystitis, most likely because neither adenoid hypertrophy nor septal deformity directly obstruct the nasolacrimal duct drainage.

There is no known cause that may explain why males are more affected by rhinosinusitis, which is probably a random finding.

Funding

None whatsoever.

Conflicts of interest

None reported.

Ethical disclosures

Protection of human subjects and animals in research. The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Patients' data protection. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

References

1. Lüchtenberg M, Kuhli C, du Mesnil de Rochemont R, Yan B, Ohloff C, Berkefeld J. Three-dimensional rotational dacryocystography for imaging of the lacrimal drainage system and adjacent anatomical structures. *Ophthalmological*. 2005;219:136-41.
2. El-desoky S, Farouk H, Moustafa AN, El-noueam K, Elsabaa A. The role of multi-detector CT dacryocystography in the assessment of naso-lacrimal duct obstruction. *Egypt J Radiol Nucl Med*. 2012;43:397-405.
3. Saraç K, Hepsen IF, Bayramlar H, Uguralp M, Toksoz M, Baysal T. Computed tomography dacryocystography. *Eur J Radiol*. 1995;19:128-31.
4. Pletcher DS, Hoxworth MJ, Goldberg NA, Murr HA, Glastonbury MC. Computed tomography imaging of the paranasal sinuses: direct versus reformatted coronal images. *Otolaryngol Head Neck Surg*. 2008;138:710-4.
5. Lund VJ, Mackay IS. Staging in rhinosinusitis. *Rhinology*. 1993;107:183-4.
6. Milczuk HA, Dalley HA, Wessbacher RW, Richardson MA. Nasal and paranasal sinus anomalies in children with chronic sinusitis. *Laryngoscope*. 1993;103:247-52.
7. Hopkins C, Browne JP, Slack R, Lund V, Brown P. The Lund-Mackay staging system for chronic rhinosinusitis: how is it used and what does it predict? *Otolaryngol Head Neck Surg*. 2007;137:555-61.
8. Kuiper JR, Hirsch AG, Bandeen-Roche K, Sundaresan AS, Tan BK, Kern RC, et al. A new approach to categorization of radiologic inflammation in chronic rhinosinusitis. *PLoS One*. 2020;15:e0235432.
9. Hastan D, Fokkens WJ, Bachert C, Newson RB, Bislimovska J, Bockelbrink A, et al. Rhinosinusitis crónica en Europa: una enfermedad subestimada. Un estudio GA (2) LEN. *Alergia*. 2011;66:1216-23.
10. Dietz de Loos D, Lourijsen ES, Wildeman MAM, Freling NJM, Wolvers MDJ, Reitsma S, et al. Prevalencia de rinosinusitis crónica en la población general basada en radiología y sintomatología de los senos nasales. *J Allergy Clin Immunol*. 2019;143:1207-14.
11. Rathor A, Bhattacharjee A. Correlación clínico-radiológica y papel de la estadificación de la tomografía computarizada en la rinosinusitis crónica. *World J Otorhinolaryngol Head Neck Surg*. 2017;3:169-75.
12. Kapadia MK, Freitag S, Woog JJ. Evaluation and management of congenital nasolacrimal duct obstruction. *Otolaryngol Clin N Am*. 2006;39:959-77.