EVALUATION OF THE LACRIMAL SYSTEM BY RADIOLOGICAL METHODS*

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Abstract **The authors perform a revisional and iconographic study of the lacrimal system by means of radiological methods, namely, conventional radiography, linear tomography, computed tomography and magnetic resonance imaging. Image methods are essential to define diagnosis and therapy, considering that besides demonstrating alterations of the lacrimal system, they may indicate the patients with better prognosis associated with the surgical approach. Considering the lower cost, lower radiation dose, low rate of complications, and level of information that can be obtained dacryocystography by means of linear tomography is recommended as the initial investigation method.**

Keywords: Dacryocystography; Lacrimal system; Obstruction of the lacrimal system.

Resumo *Avaliação da via lacrimal pelos métodos radiológicos.*

Os autores realizam um estudo revisional e iconográfico das vias lacrimais através dos métodos radiológicos, sendo eles a radiografia convencional, a tomografia linear, a tomografia computadorizada e a ressonância magnética. Os métodos de imagem são fundamentais para definir diagnóstico e terapia, pois, além de demonstrarem as alterações das vias lacrimais, sugerem quais os pacientes que terão melhor prognóstico com a abordagem cirúrgica. Pelo seu custo mais baixo, menor dose de radiação, baixo índice de complicações e pela informação que pode ser obtida, recomenda-se que a dacriocistografia por tomografia linear seja o método inicial de investigação.

Unitermos: Dacriocistografia; Via lacrimal; Obstrução da via lacrimal.

INTRODUCTION

The main indication for the evaluation of the lacrimal pathways is epiphora which is the excessive tearing of any etiology. It may originate in the excessive tear production, resulting in inadequate evaporation and drainage due to the large volume of tears. Another even more common situation is epiphora caused by the inefficient tears drainage secondary to the partial or complete obstruction of the lacrimal system[1,2].

Other processes requiring radiological investigation are diverticula, fistulas, perior intraluminal masses and obstruction secondary to surgical intervention[3].

Imaging study of the lacrimal system in patients with epiphora allows the diagnosis of lacrimal obstructions and their possible complications and, from the therapeutic point of view, is relevant, since it provides safer information for indicating the surgery and the type of procedure to be performed [4].

The aims of the present study are to demonstrate imaging methods available for assessment of the lacrimal pathways and the reasoning of the imaging study which we consider as the method of choice.

ANATOMY OF THE LACRIMAL PATHWAYS

Each lacrimal drainage system is formed by lower and upper lacrimal canaliculi, common canaliculus, lacrimal sac, and nasolacrimal duct. The tear penetrates the lacrimal pathway through the lower and upper lacrimal ostia (lacrimal point), minute orifices (0.3 mm in diameter) seen on the medial margin of the lower and upper eyelids[5] (Figure 1).

The lower and upper lacrimal canaliculi present a vertical portion measuring 2 mm, and a horizontal portion measuring about 8 mm. As the horizontal portion meets the vertical one, its internal diameter increases, achieving 2 mm[2,6].

The junction of the lower and upper lacrimal canaliculi occurs in 90% of patients, constituting the common canaliculus, also termed Maier's sinus or ampulla of lacrimal canaliculus. In the other 10%, the canaliculi connect the lacrimal sac independently. The Maier's sinus meets the lateral wall of the lacrimal sac at the level of the junction between the upper and

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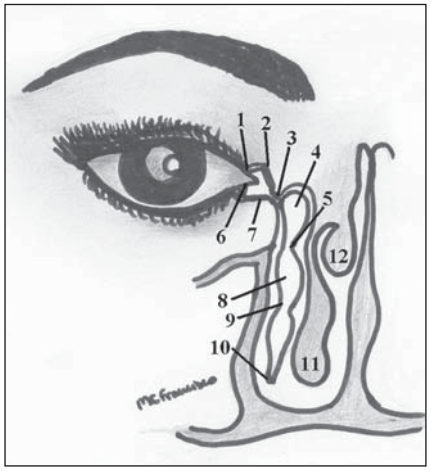

Figure 1. Schematic representation of lacrimal pathways: 1. upper lacrimal ostium; 2. upper lacrimal canaliculus; 3. common lacrimal canaliculus; 4. lacrimal sac; 5. Krause's valve; 6. lower lacrimal ostium; 7. lower lacrimal canaliculus; 8. nasolacrimal duct; 9. Taillefer's valve; 10. Hasner's valve; 11. lower nasal concha; 12. middle nasal concha.

middle thirds. This opening is guarded by a fold of mucous membrane called Rosenmüller's valve[2,6]. Some authors question the existence of this valve, arguing that it is just an angulation of about 58º formed by the junction between the common canaliculus and the lacrimal sac[5].

The lacrimal sac is lodged in a deep groove formed by the lacrimal bone. It is the wider portion of the lacrimal pathway and measures about 4–8 mm in anteroposterior diameter, 1–2 mm transversally, and 10–12 mm in length. At its distal end there is a fold of mucous membrane denominated Krause's valve. Below this valve, the lacrimal pathway continues as the nasolacrimal duct through an extent of 12–18 mm (10 mm through the bone nasolacrimal canal), up to the inferior nasal meatus. In the middle of the intra-osseous portion of the nasolacrimal duct there is a fold of mucous membrane called Taillefer's valve, and, at the end of the duct, the Hasner's valve[6,7].

LACRIMAL PATHWAYS EVALUATION

The first contrast-enhanced radiographs of the lacrimal pathways were performed by Ewing in 1909[8], utilizing a bismuth subnitrate solution, aiming at demonstrating a lacrimal abscess.

Currently, the lacrimal pathways study is divided into functional and anatomical evaluations. The functional evaluation is performed by means of staining tests, scintigraphy and magnetic resonance imaging. The anatomical evaluation is performed by means of dacryocystography with conventional radiographs, linear computed tomography and magnetic resonance imaging[1].

Dacryocystography

Dacryocystography demonstrates the lacrimal pathways by means of radiography after contrast agent injection[1]. Currently, oil-soluble and water-soluble contrast media are available. The oil-soluble contrast media are more slowly eliminated, however they tend to obstruct the lacrimal ducts, particularly if they present with some alteration. Also, they may cause a false appearance polycystic sac, since the oil is poorly miscible with the lacrimal secretion[9]. Oil-soluble contrast media should not be utilized in the suspicion of tumors, traumatism or fistulae, considering the risk of leakage and permanence in the subcutaneous tissue for many years, inducing the formation of granulomas[10].

Other studies report that the use of water-soluble contrast media result in more real information because of its characteristics (pH and viscosity, for example) more similar to tears. In a normal lacrimal pathway, the contrast medium completely disappears after ten minutes. Contrast medium traces may be found only in the nasopharinx[9,11].

Initially, the patient is submitted to panoramic radiography of the face. Anesthetic eye drops are instilled, lacrimal canaliculi are characterized and, after contrast medium administration, radiographic images acquisition is performed (Figure 2). Additional views, with different degrees of obliquity may be obtained to demonstrate the lacrimal pathways.

Although this study is inexpensive and easy to perform, with low radiation dose, and allowing the identification of the site of obstruction, presence or not of lacrimal pathways dilatation and some alteration of adjacent structures, dacryocystography may present some inconclusive results[1] (Figure 3).

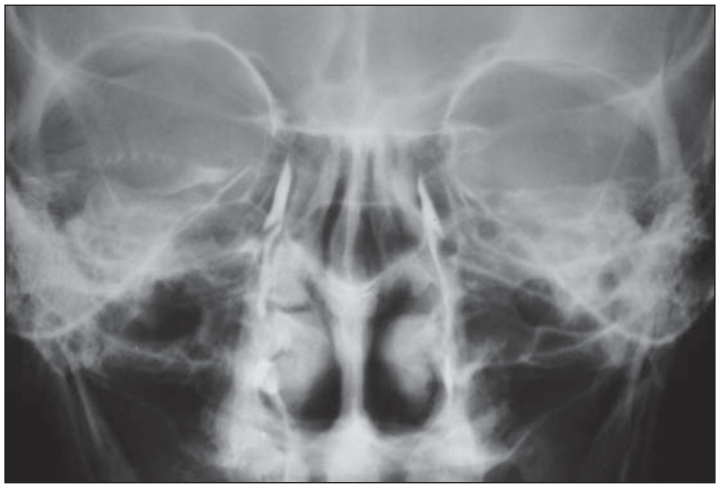

Figure 2. Conventional dacryocystography. Normal.

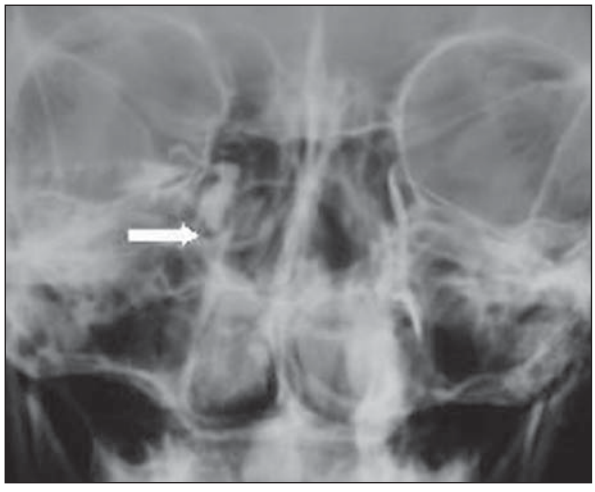

Figure 3. Conventional dacryocystography. Complete obstruction of the right lacrimal pathway at the level of the Krause's valve (arrow). Pervious and morphologically normal left lacrimal pathway.

Linear tomography-dacryocystography

The demonstration of the lacrimal pathways also may be performed by means of linear tomography.

The technique is very similar to the conventional dacryocystography, starting with facial radiographs and instillation of anesthetic eye drops. Lacrimal canaliculi are characterized and the patient's head is fixed. After collimation restricted to the area of interest, the water-soluble contrast medium is administered and, simultaneously, the acquisition of linear tomographic images is performed. Generally, four images are sufficient to demonstrate the lacrimal pathways. The water-soluble contrast medium is chosen for the already mentioned reasons.

Some authors[9,12] recommend a bilateral evaluation to allow the comparison with the contralateral pathway and mainly for detecting asymptomatic alterations. We agree with this technique, since in experienced hands, the cannulation of lacrimal canaliculi is very fast and painless, besides allowing an early diagnosis in a significant number of cases, avoiding a new exposure of the patient to ionizing radiation and additional onus. All the patients will benefit from the comparison with the contralateral pathway, a significant factor in some diagnostic circumstances. With this technique, Takano & Mendonça[9] have found alterations in 8.3% of asymptomatic contralateral lacrimal pathways.

Linear tomography-dacryocystography is inexpensive and easy to perform in comparison with the most recent methods and with lower radiation dose than computed tomography. This method allows demonstrating lacrimal canaliculi (Figure 4), the site of obstruction, lacrimal pathways dilatation (Figure 5), fistulae (Figure 6), lacrimal calculi (Figure 7), a higher number of alterations in adjacent structures than the conventional dacryocystography and, in experienced hands, does not present inconclusive results and complications.

This method does not present metal or paramagnetic artifacts (Figure 8).

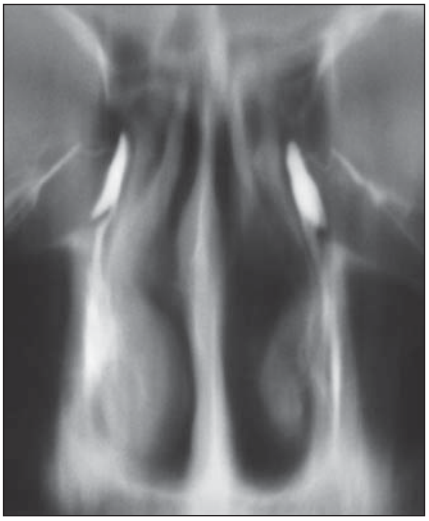

Figure 4. Linear CT dacryocystography. Morphologically normal lacrimal pathways. Better visualization of lacrimal canaliculi than the conventional dacryocystography.

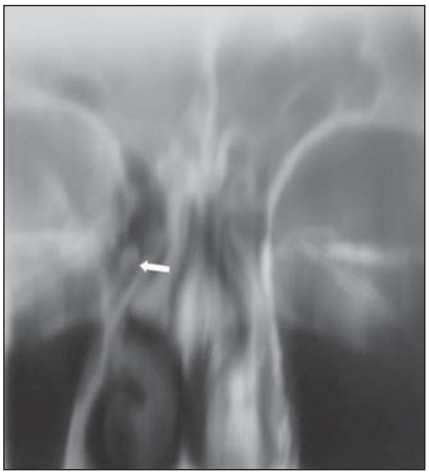

Figure 5. Linear CT dacryocystography. Complete obstruction of right Rosenmüller's valve (arrow) with dilatation of the corresponding Maier's sinus.

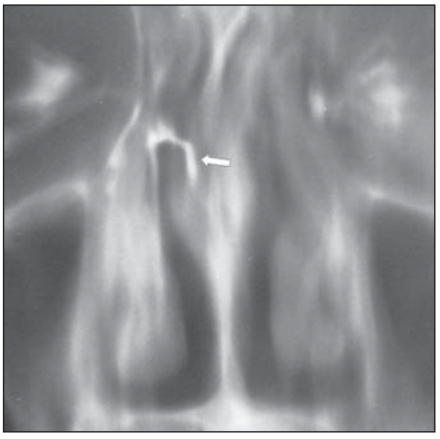

Figure 6. Linear CT dacryocystography. Fistulous route originating in the right lacrimal sac and ending in the right middle nasal meatus.

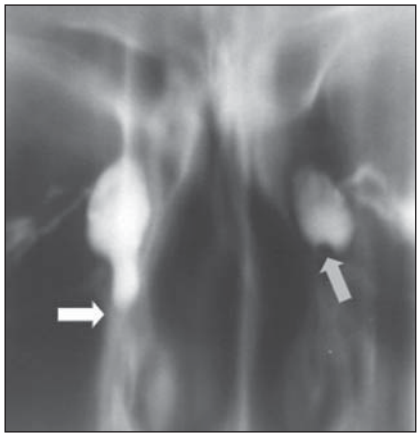

Figure 7. Linear CT dacryocystography. Complete obstruction of the right lacrimal pathway at the level of the Taillefer's valve (white arrow). Note the image of a round filling failure produced by a radiotransparent calculus (gray arrow) obstructing the left lacrimal pathway at the level of the Krause's valve.

Computed tomography dacryocystography

Computed tomography dacryocystography allows the documentation not only of lacrimal pathways, but also of adjacent bones and soft tissues[13].

Anesthetic eye drops are instilled with the patient supine. The lacrimal canaliculi are cannulated, and the patient´s head is fixed. Acquisition of helical axial images is performed simultaneously with the injection of water-soluble contrast medium. This set of images may be three-dimensionally reconstructed (Figures 9 and 10), facilitating the images interpretation by other specialists accustomed to interpreting coronal images.

The comparison with the previous methods demonstrates that CT dacryocystography is a very expensive method, demanding a high radiation dose, although is extremely useful in the diagnosis of lacrimal pathways obstruction associated with intranasal diseases, facial fractures and maxillofacial tumors[14,15].

MRI dacryocystography

Many authors have described MRI applications in the evaluation of lacrimal pathways. MRI is the method of choice for

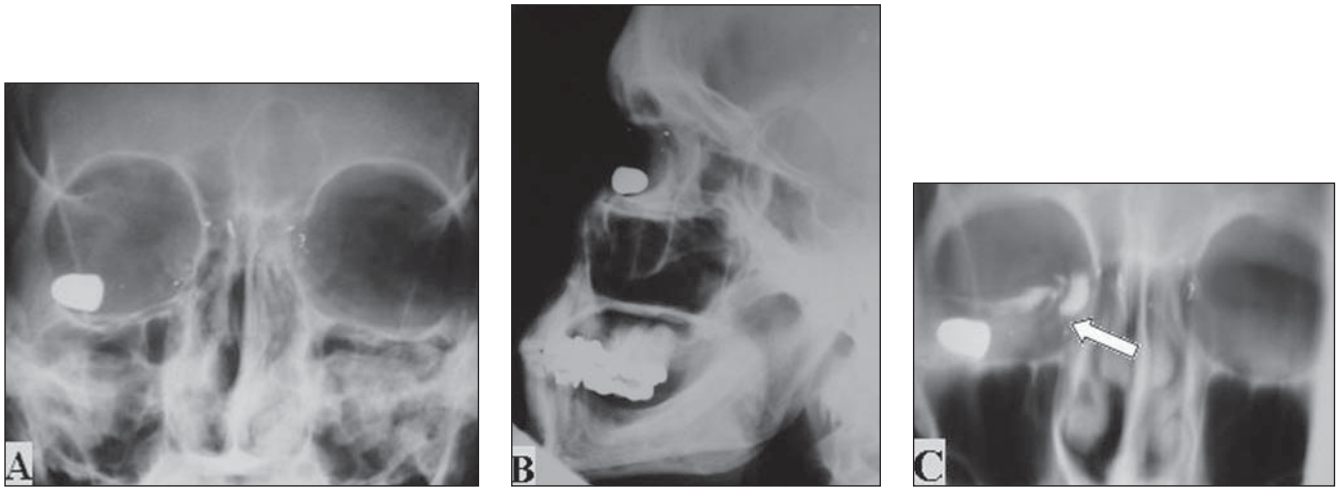

Figure 8. A,B: Facial radiographs before contrast injection show metal fragments from firearm projectile. **C:** Linear CT dacryocystography shows complete obstruction of right lacrimal pathway at the level of the Krause's valve (arrow).

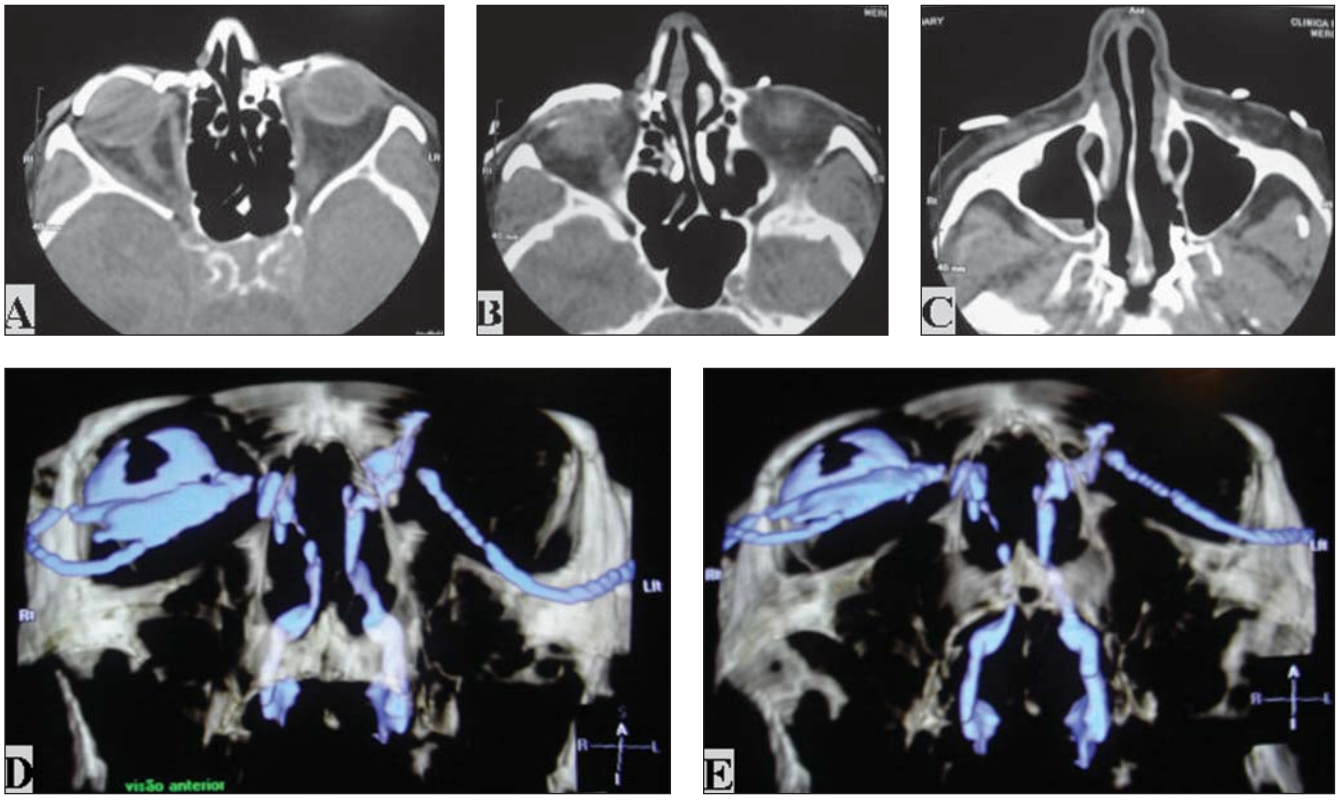

Figure 9. CT dacryocystography. Pervious lacrimal pathways. Right maxillary sinusopathy. **A,B,C:** Axial images. **D,E:** 3D reconstruction.

evaluation of the orbit, since it provides best images of soft tissues. The administration of diluted gadolinium may be performed as follows:

1 – Eyedrops may be instilled into the conjunctival sac of each eye. This is a non-invasive method, allowing a functional evaluation of the lacrimal pathways[16] (Figure 11).

2 – Another alternative is the lacrimal canaliculi catheterization, followed by diluted gadolinium administration (Figure 12). The catheters are removed and coronal, T1-weighted images are acquired. Some authors suggest acquisition of coronal T1- and T2-weighted images with fat-suppression, both before and after contrast medium administration[17].

Some studies report that CT and MRI sensitivity is similar[16,17]. Although MRI is a more expensive method, it does not utilize ionizing radiation, allowing acquisition of 3D images, and providing additional information on adjacent soft tissues. Therefore it may be added to the protocol for study of lacrimal pathways[18].

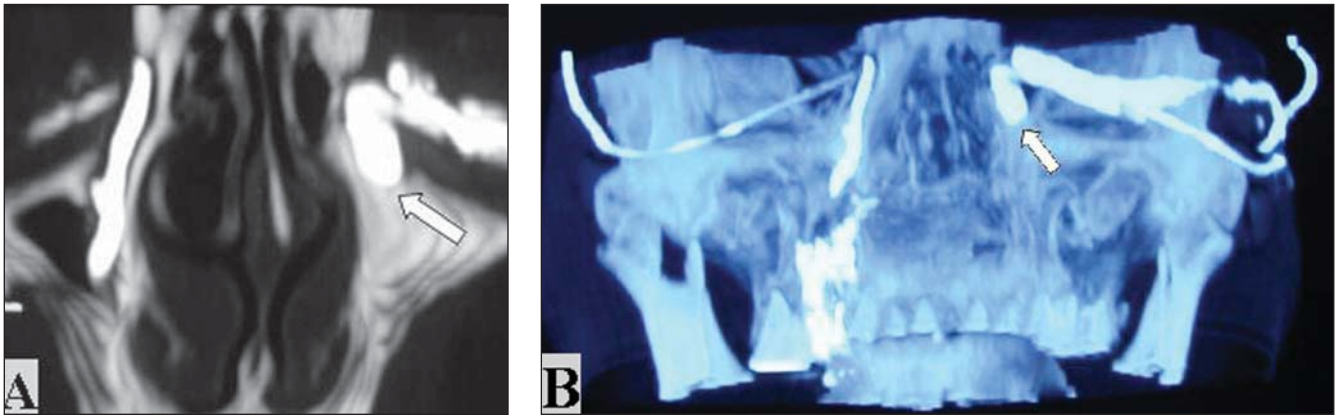

Figure 10. CT dacryocystography. Obstruction of left Krause's valve (arrow). Normal right lacrimal pathway. **A,B,C:** Coronal plane reconstruction.

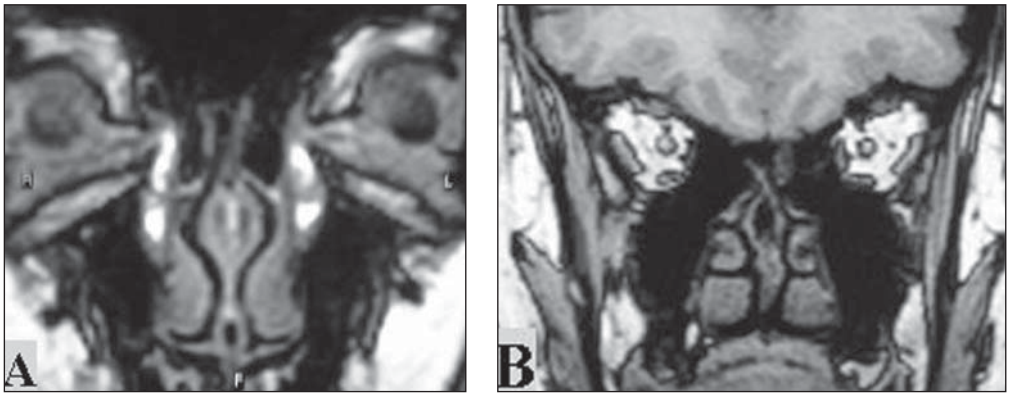

Figure 11. Normal MRI dacryocystography. **A,B:** Coronal, T1-weighted images, after instillation of two gadolinium-containing eye drops into each conjunctival sac, so there is a little chance to acquire a single image demonstrating the whole lacrimal pathway.

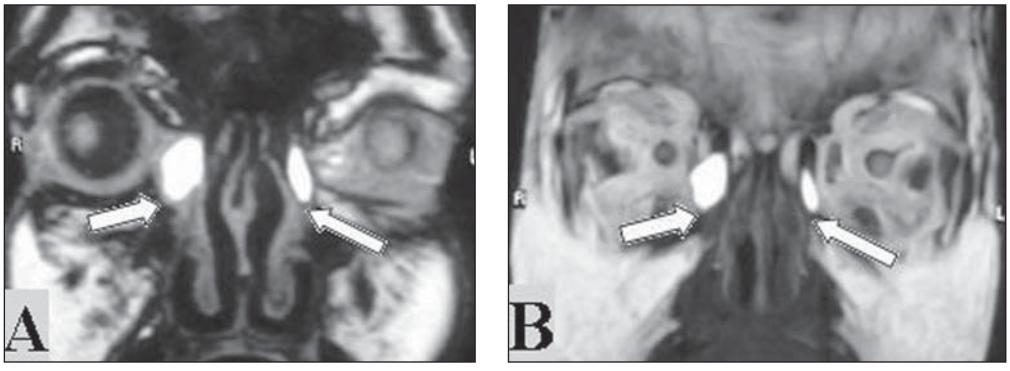

Figure 12. MRI dacryocystography. Initially, lacrimal canaliculi were characterized and diluted gadolinium was administered. Coronal, T1-weighted images were acquired after catheters removal (**A**), such images may be 3D reconstructed (**B**). Complete obstruction of lacrimal pathways at the level of the Krause's valve (arrows).

CONCLUSIONS

The lacrimal system evaluation may be performed by means of several imaging methods. It is up to the physician to choose the most appropriate imaging method, avoiding the delay between the definite diagnosis and the treatment. As an example of first choice, the authors suggest linear CT dacryocystography, leaving the more expensive and less available methods for patients with problems of lacrimal pathways associated with previous history of facial traumas, tumors in the medial portion of the face, intranasal diseases or maxillofacial surgery.

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