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ORIGINAL ARTICLE / ÖZGÜN ARAŞTIRMA

Magnetic resonance dacryocystography: Its role in the diagnosis and treatment plan of lacrimal drainage system obstructions

Manyetik rezonans dakriyosistografi: Lakrimal drenaj sistemi tıkanıklıklarının tanı ve tedavi planlamasındaki yeri

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ABSTRACT

Objective: To evaluate the role of magnetic resonance dacryocystography (MR-DCG) technique in patients with obstruction of lacrimal drainage system.

Methods: A total of 40 patients who had presented to the ophthalmology clinic were suspected to have obstruction of lacrimal drainage system, were evaluated with MR-DCG after instillation of 0.5% Gd-DTPA conjunctival contrast medium. Dacryocystorhinostomy (DCR) was performed in patients who were found to have lacrimal drainage system obstruction on either side on MR-DCG.

Results: Obstruction of lacrimal drainage system was successfully detected in a total of 49 eyes of 40 patients undergoing examination with MR-DCG. The MR-DCG findings of 29 nasolacrimal systems were compared with the intraoperative findings in 28 out of 40 patients who had undergone the DCR operation. The sensitivity of MR-DCG was determined as 100% and specificity as 96.7% for identification of nasolacrimal system obstruction when compared with the intraoperative findings, and MR-DCG was found to detect obstruction with high accuracy.

Conclusion: MR-DCG has a high success rate in detection of lacrimal drainage system obstructions and the level and cause of the obstruction.

Key words: Dacryocystorhinostomy, lacrimal stenosis, MR-dacryocystography

ÖZET

Amaç: Lakrimal drenaj sistemi tıkanıklığı olan hastalarda Manyetik Rezonans dakriosistografi (MR-DSG) tekniğinin rolü ve etkinliğinin tartışılması amaçlanmıştır.

Yöntemler: Göz hastalıkları kliniğine lakrimal drenaj sistem tıkanıklığını düşündüren klinik bulgular ile başvuran toplam 40 hasta % 0.5 Gd-DTPA konjunktival kontrast madde instilasyonu sonrası MR-DSG ile değerlendirildi. MR-DSG'de lakrimal drenaj sisteminde tıkanıklık tespit edilen hastalara, dakriosistorinostomi(DSR) cerrahisi uygulandı.

Bulgular: MR-DSG ile incelediğimiz 40 hastada toplam 49 gözde lakrimal drenaj sistemi tıkanıklığı başarı ile saptandı. Çalışmaya alınan 40 hastanın 28'i, MR-DSG'de stenoz saptanan toplam 49 lakrimal drenaj sisteminin 29'una DSR operasyonu yapıldı. Operasyon bulgularıyla karşılaştırıldığında lakrimal drenaj sistemi tıkanıklığını tanımlamada MR-DSG'nin sensitivitesi %100, spesifitesi ise %96.7 olup lakrimal drenaj sistemi tıkanıklığını yüksek doğrulukla tespit edebildiği saptandı.

Sonuç: MR-DSG lakrimal drenaj sistemi tıkanıklıklarında, tıkanıklığın seviyesini ve nedenini saptamada yüksek başarı oranlarına sahiptir.

Anahtar kelimeler: Dakriosistorinostomi, Lakrimal stenoz, MR dakriyosistografi

INTRODUCTION

The lacrimal drainage system is composed of superior and inferior canaliculi carrying the lacrima (tears) to the nasal cavity, common canaliculus, lacrimal sac and the nasolacrimal canal. The nasolacrimal canal is located in the bony canal extending to the meatus nasi inferior distally, the canal being formed by the maxilla, lacrimal bone and the inferior nasal concha [1]. There are three anatomical stenoses in the lacrimal drainage system, namely the common canaliculus and lacrimal sac union (Rosenmuller valve), lacrimal sac neck (Krause valve), and the nasal cavity opening (Hasner valve). These valves are composed of mucosal plicae. Stenoses and obstructions are usually seen at these ste-

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nosis levels [2,3]. Identification of the cause and the level of stenosis is of importance in determining the proper treatment method in lacrimal drainage system obstructions. Various diagnostic methods such as conventional dacryocystography, computed tomography (CT) dacryocystography, dacryoscintigraphy and MR-DCG are used beside the physical examination and punctum lavage in the preoperative assessment of cases admitted with the complaint of epiphora. MR has been used for this purpose since 1993 [4].

In this study, it was aimed to discuss the efficacy of the MR-DCG technique following Gd-DTPA instillation onto the conjunctiva in the diagnosis of obstruction of lacrimal drainage system and its role in the treatment plan in patients presenting with the complaint of epiphora and who were suspected to have an obstruction in the lacrimal drainage system in punctum lavage.

METHODS

A total of 40 patients (34 females-85% and 6 males-15%) aged between 20-74 years who had presented to the ophthalmology clinic with the complaint of epiphora between May 2004 and February 2011, who had undergone MR-DCG constituted the study group. Patients who were suspected to have obstruction of lacrimal drainage system were evaluated with high resolution MRI using head coil by obtaining T1-weighted, fat-saturated T2-weighted sequences at the transverse plane and 3D-T1 sequences on the coronal plane following bilateral 0.5% Gd-DTPA conjunctival contrast medium instillation. We used 8-10 drops of contrast medium for each eye and we asked the patient to blink eyes to facilitate filling of lacrimal canals. In our study, the conjunctival contrast medium instillation was performed bilaterally, even in patients who had unilateral symptoms. Thereby, we aimed to evaluate the nasolacrimal system contrast medium flow properties comparatively and to exclude contralateral nasolacrimal canal pathologies. The nasolacrimal system, the area from the level of the superior canaliculus to the level of the inferior concha to which the nasolacrimal canal opens, was included in the examination area. The orbita and the paranasal sinuses were also included in the examination area for potential pathologies. All of the patients were informed about MR study and informed consent was obtained. Patients were also informed about the possible side effects of the contrast medium and advised to contact the researchers if the notice any complaints.

The presence of obstruction, the level of obstruction and additional pathologies if present were determined. T1-weighted and fat-saturated T2-weighted sequences were obtained in the transverse plane for potential additional pathologies in cases in whom filling defects in the lacrimal gland were observed. MR-DCG was evaluated through discussion and consensus of two experienced radiologist. The nasolacrimal system in which contrast medium was observed in normal calibration and in which the contrast medium flow from the meatus nasi inferior to the nasal cavity was observed, was considered patent (figure 1).

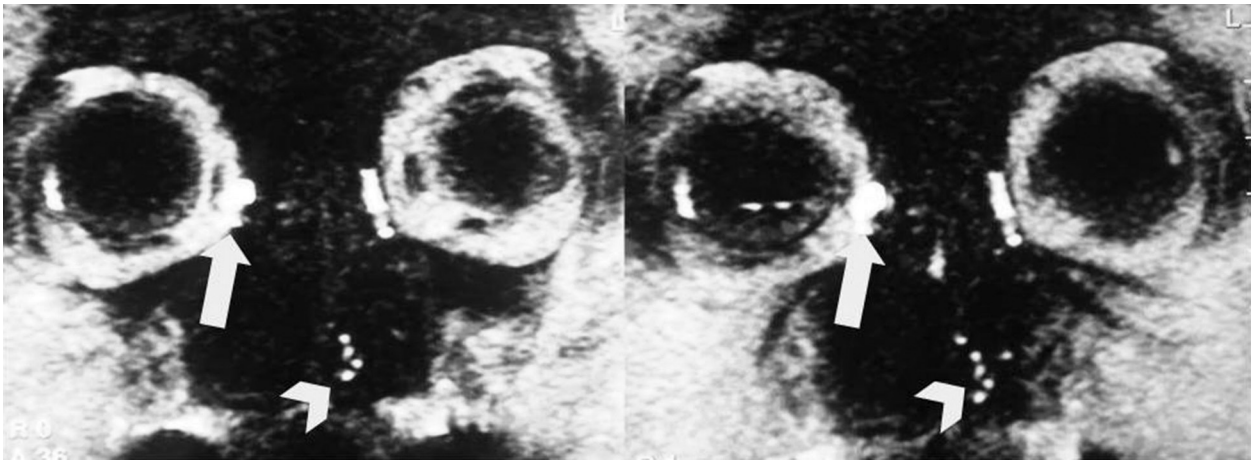

Figure 1. Obstruction is present near the sac entrance on the right (at the level of the Rosenmuller valve, level 1) in the nasolacrimal system (arrow). The nasolacrimal system is patent on the left and contrast medium is seen to pass to the nasal cavity (arrow-head).

The obstruction levels in the nasolacrimal system were evaluated in the three levels based on the MR-DCG criteria recommended by Hoffman et al. [5]. Obstructions at the common canaliculi and lacrimal sac union (at the level of the Rosenmuller valve) were numbered as level 1, obstructions at the lacrimal sac neck (at the level of the Krause valve) were numbered as level 2, and obstructions at the nasal cavity opening (at the level of the Hasner valve) were numbered as level 3.

The sensitivity of MR-DCG in detection of nasolacrimal stenosis was evaluated based on the DCR operation findings.

In the retrospective analysis, 8 patients were found to have undergone dacryoscintigraphy before MR-DCG. The dacryoscintigraphy findings and the MR-DCG findings of these 8 patients were compared.

Of the patients in whom nasolacrimal stenosis was detected on either side on MR-DCG, 28 (70%) underwent DCR.

RESULTS

Eighty nasolacrimal systems were evalauted in 40 patients that we examined with MR-DCG. No adverse effects occured during and after the conjunctival contrast medium instillation. Obstruction of lacrimal drainage system was detected in a total of 49 eyes and was detected on the right in 16 patients, on the left in 15 patients, bilateral in 9 patients.

Obstruction of lacrimal drainage system was detected on the same side on MR-DCG in 15 patients in whom obstruction findings were observed in the right nasolacrimal gland in punctum lavage, and in 15 patients in whom obstruction findings were observed in the left nasolacrimal canal. Bilateral obstruction was observed on the MR-DCG of 2 patients in whom obstruction was observed on the right in punctum lavage and MR-DCG of 3 patients in whom obstruction findings were observed on the left. Bilateral obstruction was found on the MR-DCG of 4 out of 5 patients in whom bilateral obstruction findings were observed in punctum lavage, and right obstruction of lacrimal drainage system was found in one patient. Obstruction of lacrimal drainage system was detected on 43 sides in punctum lavage consistent with MR-DCG. The results of punctum lavage were consistent with the results of MR-DCG in 87.7% of the patients; however, punctum lavage is not sufficient for detection of the obstruction level and the causative pathology, but it may be used as the first method used in evaluating lacrimal drainage system obstruction in the outpatient clinical setting.

Eight patients underwent dacryoscintigraphy and consistent with MR-DCG, obstruction of lacrimal drainage system was detected on the left in 3 patients, on the right in 2 patients and bilateral was detected in one patient. On MR-DCG, a partial passage was detected in the late period on dacryoscintigraphy in 2 patients in whom right obstruction had been determined in the distal part of the nasolacrimal canal on MR-DCG.

The obstruction site was at the sac entrance, in other words at the level of the Rosenmuller valve in 17 (34.69%) obstruction observed on MR-DCG; the obstruction was at the sac or canal union in 26 (53.06%), and at the end of the canal or around the Hasner valve in 6 (12.24%) (figure 2).

Mucocele was observed as the cause of obstruction in the lacrimal canal in 14 (35%) patients, and bilateral mucocele was detected in one patient (figure 3). Furthermore, mucosal thickening in ethmoidal cells or maxillary sinuses, and sinusitic changes characterized with fluid intensities were seen in the vast majority of the patients.

DCR operation was performed on 28 of 40 patients (70%), 29 of 49 sides (59.1%) on which obstruction was detected on MR-DCG. Consistent with MRI findings, these patients had obstruction of lacrimal drainage system and inflammation, and pus and mucopurulent secretion were observed as the cause of stenosis intraoperatively in 12 patients (12 sides). The complaint of epiphora was seen to have regressed on the postoperative follow-ups. DCR operation was repeated in one patient due to recurrence of the complaints, and recurrence was not seen on the postoperative follow-ups in this patient. One patient underwent bilateral DCR as the complaints were bilateral, despite unilateral obstruction having been reported on MR-DCG, and lacrimal drainage system obstruction was detected intraoperatively on the side which had been reported to be normal on MR-DCG.

Figure 2. Obstruction levels on the coronal plain on MR-DCG imagings. **(A)** Obstruction is observed at the common canaliculus-lacrimal sac union on the right (at the level of the Rosenmuller valve, level 1) (arrow), contrast medium passage is present and the nasolacrimal system is patent on the left (arrow-head). **(B)** obstruction at the level of the lacrimal sac on the right (level 2)(arrow-head) and mild dilation in the lacrimal sac, obstruction is observed at the level of the lacrimal sac - nasolacrimal canal union (at the level of the Krause valve) is observed on the left (level 2) (arrow). (C) contrast medium is observed in the lower and upper punctum and the common canaliculus on the right; however, contrast medium passage to the lacrimal sac is not observed (level 1) (arrow-head),on the left, there is irregularity in the nasolacrimal canal and obstruction is present at the nasal cavity opening at the distal (at the level of the Hasner valve) (level 3) (arrow).

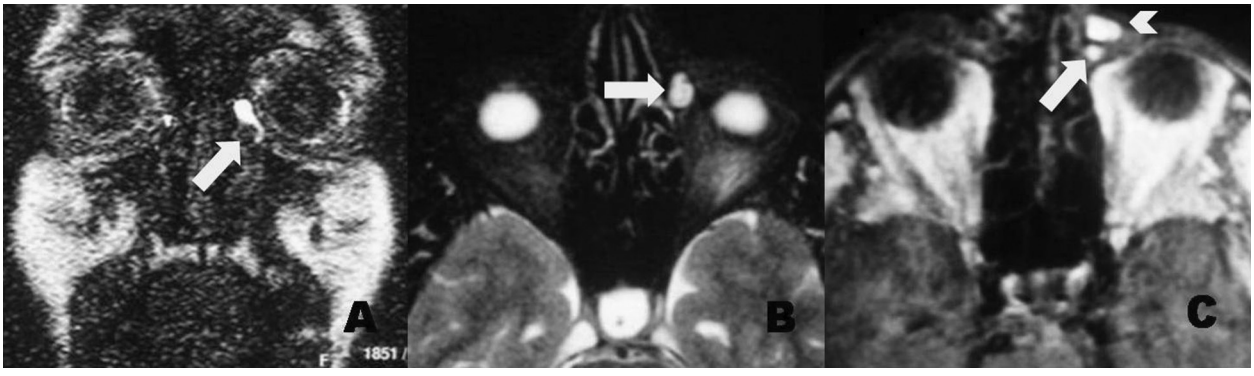

Figure 3. (**A)** On MR-DCG, obstruction is observed at the common canaliculus-lacrimal sac union on the right in the coronal plain; on the left, obstruction is observed at the lacrimal sac-nasolacrimal canal union; lacrimal sac dilation and filling defect in the distal part are observed (arrow). **(B)** On T2-SPIR imagings, there is a hypodense appearance consistent with mucocele at the stenotic level on the left (arrow). (C) Dilation in the lacrimal sac (arrow), mucocele is observed (arrow-head) on the left in T1 images obtained after conjunctival contrast medium instillation.

When compared with the operation findings, the sensitivity of MR-DCG was determined as 100%, and the specificity as 96.7% for detection of nasolacrimal system stenosis, and MR-DCG was found to detect stenosis with high accuracy.

DISCUSSION

Epiphora is a condition in which the passage of lacrima from the nasolacrimal system is insufficient or blocked and lacrimation is seen secondarily to this. Epiphora is a common problem in the general population with a prevalence of 3% [5,6]. Inflammation, tumor, facial trauma, paranasal sinus surgery, radiation and congenital anomalies play a role in the etiology of epiphora. Nasolacrimal system obstruction may be partial or complete. DCR, dacryoplasty, nasolacrimal stenting, transluminal balloon dilatation and irrigation are the methods used for treatment of lacrimal drainage system obstruction.

Nasolacrimal system imaging, determination of the stenosis level and grade, and detection of the pathology causing obstruction are important in the surgical treatment plan and success of the operation [7,8]. Many diagnostic methods such as conventional dacryocystography, CT-dacryocystography,

dacryoscintigraphy and MR-DCG may be used besides physical examination and punctum lavage in the preoperative assessment of cases suspected as having lacrimal drainage system obstruction.

In punctum lavage, saline is administered to the upper and lower lacrimal canals through access from the upper and lower punctum and the obstruction in the drainage system is investigated. There is relative stenosis if a strong pressure is required to push the piston during lavage. There is functional stenosis if passage is present and there is mechanic stenosis if passage is not present. A leak of saline back from the punctum at which lavage is performed is in favor of canaliculus stenosis. Leak of fluid that is given from one punctum back from another indicates common canaliculus stenosis or lacrimal sac obstruction. If some part of the fluid comes from the other punctum and some part passess to the nasal cavity, usually the ampullary part of the common canaliculus is stenotic. If the serum coming back out is seen to be mixed with mucus, obstruction is usually within the lacrimal sac [9]. İn our study the results of punctum lavage were consistent with the results of MR-DCG in 87.7% of the patients. Punctum lavage may be used as the first method to evaluate lacrimal drainage system obstruction, however, it is not sufficient for detection of the obstruction level and the causative pathology.

Dacryocystography performed after contrast medium instillation in the lacrimal sac with canaliculus catheterization through the punctum is the most commonly used technique for imaging nasolacrimal canal obstructions. It may show the morphological structure of the nasolacrimal canal, be it congenital or acquired stenosis, and the stenosis level [10,11]. Dacryocystography is insufficient to demonstrate the relationship between the neighboring tissues and the nasolacrimal canal, radiation exposure of the lens and requirement for canaliculus catheterization are disadvantages. Because of these disadvantages are used less frequently in our clinic.

The standard CT technique is valuable for imaging the bone structures of the lacrimal drainage system. However, the CT-dacryocystography method performed through opaque material injection via lacrimal canaliculus catheterization through the punctum for assessment of the obstruction site, size and shape of the sac and other accompanying pathologies, is superior to the standard CT in the assessment of lacrimal canal pathologies. Bone structures may be evaluated and also paranasal pathologies that may lead to nasolacrimal canal stenosis may be detected with CT-dacryocytography [8,12]. The nasolacrimal canal may be evaluated non-invasively following topical contrast medium instillation without lacrimal canaliculus catheterization, with topical CT dacryocystography. In this way, development of an iatrogenic trauma that may occur due to canaliculus catheterization and posttraumatic scar is eliminated. Moreover, it is a more comfortable technique which may be applied without requiring local anesthesia and sedation in pediatric patients [13]. CT-dacryocystography is visualized to the adjacent bone anatomy more successful than MR-DCG, especially in patients suspected bone pathology are used, but less frequently than MR-DCG in our clinic because of ionizing radiation exposure of the lens.

In dacryoscintigraphy, the passage of the radioactive substance instilled into the fornix (technetium 99) from the lacrimal ducts is evaluated with a gamma camera. It is important in the assessment of functional obstructions. Dacryoscintigraphy can be performed for differentiating between stenosis and occlusion, especially in patients who have the complaint of epiphora and whose dacryocystography tests reveal normal results. While dacryocystography shows the anatomy of the lacrimal excretory system, dacryoscintigraphy provides information about the physiology of lacrimal flow dynamics [10,13,14,15]. İn our study eight patients underwent dacryoscintigraphy and consistent with MR-DCG. On MR-DCG, a partial passage was detected in the late period on dacryoscintigraphy in 2 patients in whom obstruction had been determined in the distal part of the right nasolacrimal canal on MR-DCG. This finding suggests that the sensitivity of MR-DCG is lower in the discrimination of severe stenosis from complete obstruction.

Punctum lavage, dacryocystography, dacryoscintigraphy, and CT-dacryocystography tests have many limitations and disadvantages. Punctum lavage is quite limited in the precise determination of partial stenosis and the stenosis site, in exhibiting the relationship of the neighboring tissues with the nasolacrimal canal, and in detecting the etiology of stenosis. Punctum lavage is not performed during an acute dacryocystitis episode due to edema so as

not to spread the infection [9]. Although dacryocystography enables the demonstration of the lacrimal sac and the nasolacrimal canal, it is insufficient to demonstrate the relationship between the neighboring tissues and the nasolacrimal canal. The major disadvantages are radiation exposure of the lens and requirement for canaliculus catheterization [10,11]. The most important disadvantage of CT-dacryocystography is ionizing radiation exposure of the lens, which is one of the most sensitive tissues to radiation. In addition, iatrogenic trauma and subsequent posttraumatic scar may develop when canaliculus catheterization is performed [12,13]. Inability to provide morphological data, inability to evaluate the orbital soft tissues and the differences between normal transit times and radiation are factors limiting dacryoscintigraphy [13,16].

MR-DCG performed following conjunctival paramagnetic contrast medium instillation enables the demonstration of the nasolacrimal system and the surrounding soft tissues without cannulation and exposure to ionizing radiation. Absence of ionizing radiation exposure and high soft tissue resolution power, and absence of a risk for iatrogenic trauma to the punctum are the superiorities of MR-DCG over conventional dacryocystography and CT-dacryocystography. The lens is one of the most sensitive organs to radiation [8,17]. Bilaterally, the lens is exposed to radiation inevidently in all tests used for nasolacrimal system imaging, except for MR-DCG [18]. Etiopathological factors such as mucosal thickening, mucocele, scar tissue or tumor causing stenosis in the nasolacrimal system may be visualized with MR-DCG. MR-DCG is also an appropriate test used for discrimination between medial and lateral canalicular blockage [19]. Soft tissue pathologies cannot be distinguished in MR-DCG imaging obtained as 3D-T1 in the coronal plain after conjunctival contrast medium instillation. Thus, T1 and T2 weighted images should be added in cases in which mucosal thickening, mass lesion and other soft tissue pathologies are considered.

In our study, no complications were observed before or after the conjunctival paramagnetic contrast medium instillation. Forty patients were successfully evaluated with MR-DCG and diagnostic imagings were obtained. The MR-DCG findings of 29 nasolacrimal systems were compared with the intraoperative findings in 28 out of 40 patients who had undergone the DCR operation. The sensitivity of MR-DCG was determined as 100% and specificity as 96.7% for identification of nasolacrimal system obstruction when compared with the intraoperative findings, and MR-DCG was found to detect obstruction with high accuracy.

Our study has some limitations. The most important one is that the MR-DCG findings could not be compared with the operation findings in 12 patients (20 sides) who were found to have lacrimal drainage system obstruction consistent with the complaints of the patients on MR-DCG, who did not accept to undergo the operation. Dacryoscintigraphy was obtained in only 8 out of 40 patients. While the findings of MR-DCG and dacryoscintigraphy are consistent with each other in 6 out of 8 patients, in 2 patients who were determined to have stenosis in the distal part of the nasolacrimal canal on MR-DCG, partial passage was detected in this area in the late phase. Although MR-DCG and dacryoscintigraphy findings were consistent at a rate of 75% in our study, this finding suggests that the sensitivity of MR-DCG is lower in the discrimination of severe stenosis from complete obstruction. Although functional obstructions have begun to be evaluated using the dynamic MR-DCG technique, the sensitivity of MR-DCG is increasing in the differentiation between stenosis and obstruction [20].

In conclusion, MR-DCG performed after paramagnetic contrast medium instillation onto the conjunctiva is a highly sensitive and well tolerated method in the assessment of lacrimal system patency. The most important advantages of MR-DCG are high resolution power, no requirement for cannulation, and absence of ionizing radiation. MR-DCG and the added T1 and T2 sequences to evaluate soft tissues may be used as the standard orbital imaging protocol in cases in which lacrimal drainage system obstruction or soft tissue pathologies in the nasolacrimal canal and the surrounding tissues are considered based on clinical and examination findings.

REFERENCES

1. Debnam J.M, Esmaeli B, Ginsberg L.E. Imaging characteristics of dacryocystocele diagnosed after surgery for sinonasal canser. AJNR 2007;28:1872-1875.
2. Takehara Y, Isoda H, Kurihashi K, et al. Dynamic MR dacryocystography: a new method for evaluating nasolacrimal duct obstruction. AJR 2000;175:469-473.

3. Kassel EE, Schatz CJ. Lacrimal apparatus. In: Som PM, Curtin HD, eds. Head and neck imaging. St. Louis: Mosby–Year Book, 1996;1129–1183.
4. Goldberg RA, Heinz GW, Chiu L. Gadolinium magnetic resonance imaging dacryocystography. Am J Ophthalmol 1993;115:738–741.
5. Hoffmann KT, Hosten N, Anders N, et al. High-resolution conjunctival contrast-enhanced MRI dacryocystography. Neuroradiology 1999;41:2008-213.
6. Song HY, Lee CO, Park S, et al. Lacrimal canaliculus obstruction: non-surgical treatment with a newly designed polyurethane stent. Radiology 1996;199:280-282.
7. Tanenbaum M, Mccord CD. The lacrimal drainage system. İn: Tasman W, Jaeger EA, editors. Duane's clinical ophthalmology. Revised edition Philadelphia: Lippincott Raven;p. 1996;12-18.
8. Karagülle T, Erden A, Erden İ, Zilelioğlu G. Nasolacrimal system: evaluation with gadolinium-enhanced MR dacryocystography with a three-dimensional fast spoiled gradient-recalled technique, EurRadiol 2002;12:2343-2348.
9. O'dwyer PA, Akova YA. Temel Göz Hastalıkları; 2 th ed. İstanbul: Güneş tıp kitabevleri, part 18, 2011; p. 879-881.
10. Guzek JP, Ching AS, Hoang TA, et al. Clinical and radiological lacrimal testing in patients with epiphora. Ophthalmology 1997;104:1875-1881.
11. Rossamondo RM, Carlton WH, Trueblood JH, Thomas RP. A new method of evaluating lacrimal drainage. Arch Ophthalmol 1972;88:523-525.
12. Waite DW, Whittet HB, Shun-Shin GA. Technical note: computed tomographic dacryocystography. Br J Radiol 1993;66:711-713.
13. Caldemeyer KS, Stockberger SM, Broderick LS. Topical Contrast-Enhanced CT and MR Dacryocystography: Imaging the lacrimal drainage apparatus of healty volunteers. AJR 1998;171:1501-1504.
14. Wearne MJ, Pitts J, Frank J, Rose GE. Comparison of dacryocystography and lacrimal scintigraphy in the diagnosis of functional nasolacrimal duct obstruction Br J Ophthalmol 1999;83:1032-1035.
15. Amanat A, Hilditch TE, Kwok CS. Lacrimal scintigraphy. II. Its role in the diagnosis of epiphora. Br J Ophthalmol 1983;67:720-728.
16. Hahnel S, Jansen O, Zake S, Sartor K. Spiral CT in the diagnosis of stenoses of the nasolacrimal duct system. Rofo 1995;163:210–214.
17. Manfre L, Maria M, Todaro E, et al. MR dacryocystography: Comparison with dacryocystography and CT dacryocystography. Am J Neuroradiol 2000;21:1145-1150.
18. Polito E, Leccisotti A, Menicacci F, et al. Imaging techniques in the diagnosis of lacrimal sac diverticulum. Ophthalmologica 1995;209:228–232.
19. Kirchhıf K, Hahnel S, Jansen O, et al. Gadolinium enhanced magnetic resonance imaging dacryocystography in patients with epiphora. J Comput assist Tomography 2000;2:327-331.
20. Cubuk R, Tasali N, Aydın S, et al. Dynamic MR dacryocystography in patients with epiphora, Eur J Radiol 2010;73:230-233.