

Treatment choice in dacryostenosis based on single-photon emission computed tomography and X-ray computed tomography findings

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Aim — to develop surgical indications in dacryostenosis within the vertical portion of lacrimal pathways that would consider findings of single-photon emission computed tomography (SPECT) combined with X-ray computed tomography (CT). **Material and methods.** A total of 96 patients with isolated vertical-portion dacryostenosis (127 cases) were enrolled. The examination included collecting Munk's scores for epiphora, optical coherence tomography of the lower tear meniscus, lacrimal scintigraphy, and SPECT/CT. Group 1 (40 cases) was composed of patients with lacrimal obstruction on CT, group 2 (87 cases) — of those whose lacrimal pathways proved passable. There were also 3 patients (4 cases) from group 1, whose lacrimal pathways, despite being blocked on CT, were still passable on SPECT. Surgeries performed in group 1 were endoscopic endonasal dacryocystorhinostomy (DCR) (36 cases) and pathways recanalization with bicanalicular intubation and balloon dacryoplasty (DCP) (4 cases). In group 2, all patients (87 cases) underwent recanalization with bicanalicular intubation (supplemented with balloon DCP in 32 cases). Surgical results were evaluated 8-12 months after the treatment. In group 2, particular attention was paid to the concordance in locations of dacryostenosis provided by CT and SPECT scans. **Results.** Favorable outcomes of endoscopic endonasal DCR were obtained in as many as 32 cases from group 1 (88.9%), while in 4 cases (12.1%) the condition relapsed. Of those patients whose stenosis was not complete on SPECT, 3 cases (75.0%) improved, 1 (25.0%) — relapsed. In group 2, favorable outcomes were obtained in 65 cases (74.7%), relapses were 22 (25.3%). A high concordance in stenosis locations by CT and SPECT was noted in 60 cases of those who improved (92.3%) and 3 cases of those who relapsed (13.6%). **Conclusion.** The value of information provided by SPECT/CT has proved high in patients with nasolacrimal duct stenosis or obstruction. A combined scan allows to establish causal relationships between anatomical changes and functional failure of lacrimal pathways and to make an optimal treatment choice.

Keywords: SPECT/CT, single-photon emission computed tomography, computed tomography, dacryostenosis, dacryocystitis, recanalization of lacrimal pathways, lacrimal intubation, balloon dacryoplasty.

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High-tech examination methods, such as lacrimal scintigraphy and multi-slice computed tomography (CT) with contrasting of lacrimal pathways, have proved highly objective and informative in patients with lacrimal drainage system pathology [1-6]. They are both used to improve the overall quality of research in this field and can supplant routine methods that do not always meet modern requirements for patient assessment. However, despite being considered the most important imaging technique for objective evaluation of the anatomy of lacrimal pathways and neighbouring structures, CT lacks information on their functional status [1-3, 5].

To date, lacrimal scintigraphy remains the only method able to provide accurate and objective evaluation of the functional integrity of the lacrimal drainage system with quantitative assessment of the pharmaceutical elimination rate from lacrimal pathways [1, 4, 6]. Interpretation of the results in patients with tear flow disturbances is, however, complicated due to the wide variation in elimination half-life values in the uncompromised population [4, 6, 8]. Moreover, lacrimal scintigraphy does not allow localization of the site of obstruction [4, 6, 9]. Therefore, we regard scintigraphic findings only as an objective criterion for the evaluation of treatment effectiveness in an individual patient [4, 8, 9].

Single-photon emission computed tomography (SPECT) is another method of functional diagnostics that shows spatial distribution of the radioactive pharmaceutical through a multiplane γ -camera. The method is currently part of many algorithms of patient assessment but, as yet, has not been introduced into dacryological practice. In 2012, there was a report by A. Kemeny-Beke et al. [10] on SPECT/CT in a patient with lacrimal drainage system pathology. In 2014, we presented our own results of the use of SPECT/CT in healthy volunteers and dacryostenosis patients. It was shown that the method does not provide any quantitative information on tear drainage, but allows identification of the locus of drug accumulation, thus enabling qualitative description of the state of the system. Moreover, SPECT alone does not allow evaluation of anatomical changes in lacrimal pathways, but with SPECT/CT one can study lacrimal pathways anatomy, visualize sites of pathological changes, and perform functional assessment at the same time [11].

It is generally known that comprehensive and objective diagnostic tests are crucial for adequate and effective treatment. However, as it comes to dacryostenoses, both

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diagnosis and treatment are still a problem to be solved. The reason is that the value of information provided by popular diagnostic tests is low and treatment methods are not always pathogenetically proven and clinically reasonable.

Dacryocystorhinostomy (DCR) — a radical, but traumatizing treatment method — remains the most effective option for dacryostenoses [12-14]. Patient outcomes after attempted restoration of natural tear pathways are yet not good enough [14, 15]. At the same time, the modern trend towards minimal invasion and tissue saving necessitates the extension of the scope of this type of surgery in dacryology with consequent development of clear indications. The use of SPECT/CT, in our opinion, can contribute to a significant extent.

Thus, the aim of the present study was to develop indications to particular types of surgery for dacryostenosis within the vertical portion of lacrimal pathways that would consider SPECT/CT findings.

Material and methods

A total of 96 patients with isolated vertical-portion dacryostenosis were enrolled into the clinical study. Women were 64, men — 32. Patient age ranged from 31 to 64 years and averaged 53.45 ± 15.42 years. In them, 127 surgeries were performed. The study was part of a bigger research topic and got approval from the local ethics committee. Prior to the study, informed consents were obtained from all patients.

The examination consisted of a standard ophthalmological assessment and dacryological tests, including collection of Munk's scores for epiphora, optical coherence tomography of the lower tear meniscus, and lacrimal scintigraphy.

Every patient was also referred to a radioisotope laboratory for SPECT/CT (Symbia T16 machine, Siemens, Germany). Fifteen minutes before the scan, he/she received a drop of Tc-99m *per technetate* solution into the conjunctival sac. The tracer activity was 0.7 MBq. The patient was placed on the table in the standard supine position for assessment of the spatial distribution of the drug — SPECT (**Fig. 1**). Without moving the patient, lacrimal pathways were contrasted through cannulation of the lower canaliculus. Moreover, a drop of a radiopaque agent was instilled into the conjunctival sac after filling of the lacrimal pathways. CT scan was performed with the following settings: 0.75 mm slice thickness, 130 kV voltage, 50 mA current, 5-6 sec exposure, and radiation load 0.6-0.8 mSv.

The two scans were then registered on a Syngo workplace (Siemens, Germany).

Depending on the results of CT scans, the patients were divided into two groups. Group 1 (40 cases) consisted of 32 patients with lacrimal obstruction on CT, group 2 (78 patients, 87 cases) — of those, whose lacrimal pathways proved partially passable.

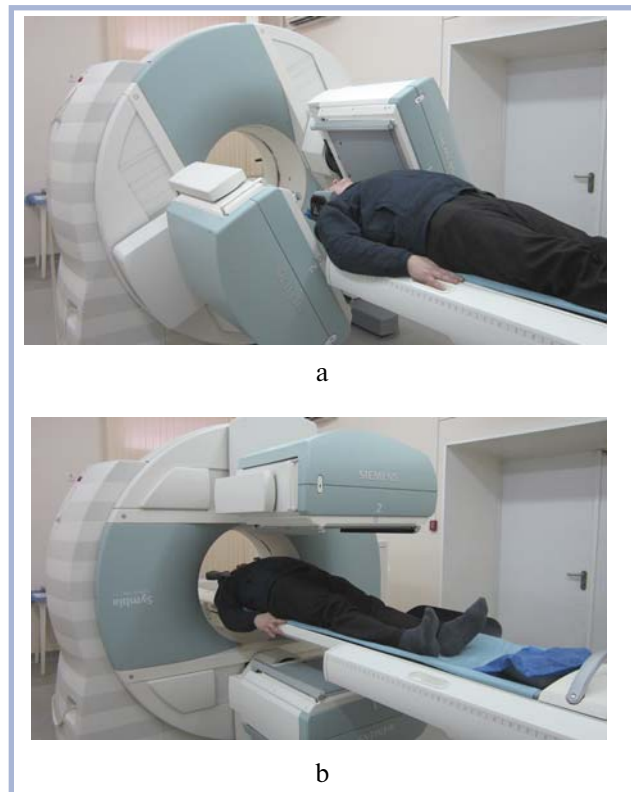


Fig. 1. Patient assessment on Symbia T16 tomograph (Siemens, Germany)

a — SPECT part; b — CT part.

Group 1 underwent endoscopic endonasal DCR (36 cases) according to the technique described in our previous publications [12]. In 4 cases from group 1 (residual lumen) and in all the 87 cases from group 2, pathway recanalization with bicanalicular intubation was performed according to another original technique described earlier [16]. Balloon dacryoplasty (DCP) was additionally performed in 32 cases [17, 18].

Implants were removed 12 weeks after insertion. The patients were followed up 8-12 weeks after the end of the treatment.

Surgical results were evaluated using the following criteria: “recovery” — 0 Munk's scores for epiphora, 50% or greater reduction of the ocular surface half-life of the radiopharmaceutical, and 0.30 mm or lower tear meniscus by OCT; “improvement” — reduction of Munk's scores for epiphora, 49% or smaller reduction of the ocular surface half-life of the radiopharmaceutical, and height reduction of the tear meniscus by OCT; “relapse” — the absence of change or increase in Munk's scores, the absence of change or increase in the ocular surface half-life of the radiopharmaceutical, and the absence of change or increase in height of the tear meniscus by OCT. An outcome was considered favorable, if the patient “recovered” or “improved”.

In group 2, we also calculated the rate of concordance between the sites of dacryostenosis by CT and ra-

diopharmaceutical retention by SPECT for patients with favorable outcomes and those, whose condition relapsed.

For statistical management of data, LibreOffice 4.4.2.2 and SOFA Statistics 1.4.4 software was used.

Results and discussion

Favorable outcomes of endoscopic endonasal DCR were obtained in as many as 32 cases from group 1 (88.9%), while in 4 cases (12.1%) the condition relapsed. It should be noted that in 3 patients (4 cases) residual lumen of lacrimal pathways was revealed on SPECT scans, despite the seemingly total obstruction on CT. These patients received recanalization with balloon dacryoplasty. Improvement was achieved in 3 cases (75.0%), 1 case relapsed (25.0%).

In group 2, favorable outcomes were obtained in 65 cases (74.7%), relapses were 22 (25.3%). A high concordance in stenosis locations by CT and SPECT was noted in 60 cases of those, who improved (92.3%) and 3 cases of those, who relapsed (13.6%). The effectiveness of the procedures differed reliably between the groups ($p < 0.1$). The data is presented in **Figure 2**.

Figure 3 shows scans of patient X (54 years of age). The CT part contains signs of dacryostenosis at the level of the neck of the lacrimal sac with suprastenotic dilation. On SPECT, however, there is a lot of activity at the nasolacrimal orifice. The patient underwent recanalization of lacrimal pathways with bicanalicular intubation, nevertheless, the symptoms returned.

Dacryocystorinostomy is the most common type of lacrimal surgery and has proved highly effective. Thus, in our study, favorable results were obtained in as many as 88.9% of cases. Advancements in techniques and instruments enable rapid surgical performance and cosmetic results. At the same time, creation of an unnatural anastomosis between the lacrimal sac and nasal cavity is nothing physiological and cannot be regarded as “func-

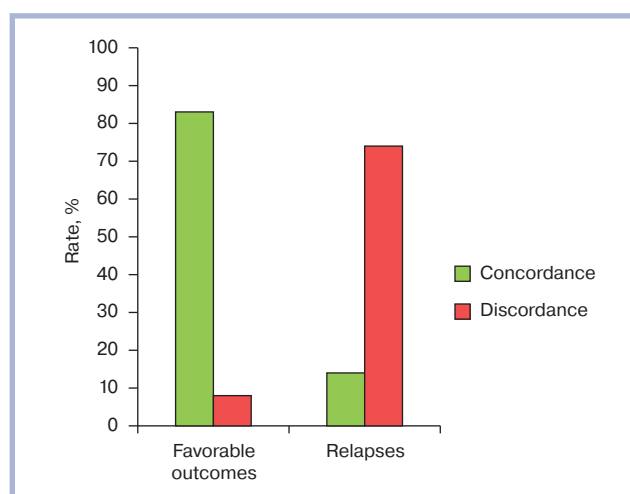


Fig. 2. Rate of concordance/discordance between SPECT and CT data in group 2 with account to treatment modality

tional surgery”. Moreover, such operations are rather complicated and in many cases cannot be performed in a particular patient due to his/her poor somatic condition.

The term recanalization represents a group of minimally invasive interventions that involve mechanical dilation of the lacrimal pathways and insertion of temporary lacrimal implants, if necessary. The overall effectiveness of recanalization procedures is lower than that of DCR. Thus, in the present study, favorable results were obtained in 74.7% of cases, which agrees with our previous data and other authors’ reports [15, 16, 19]. Balloon dacryoplasty, as an extra measure, also enables high-pressure dilation of the stenotic region. According to our previous results, dacryoplasty, if performed additionally to recanalization, in many cases increases its effect [17, 18, 20]. L. Gerbaud et al. [21] have also proved that recanalization is more cost-effective than DCR in all cases, including ambulatory care.

In our opinion, restoration of natural flow of tears, if effective enough, is physiological and, thus, more preferable as a treatment option.

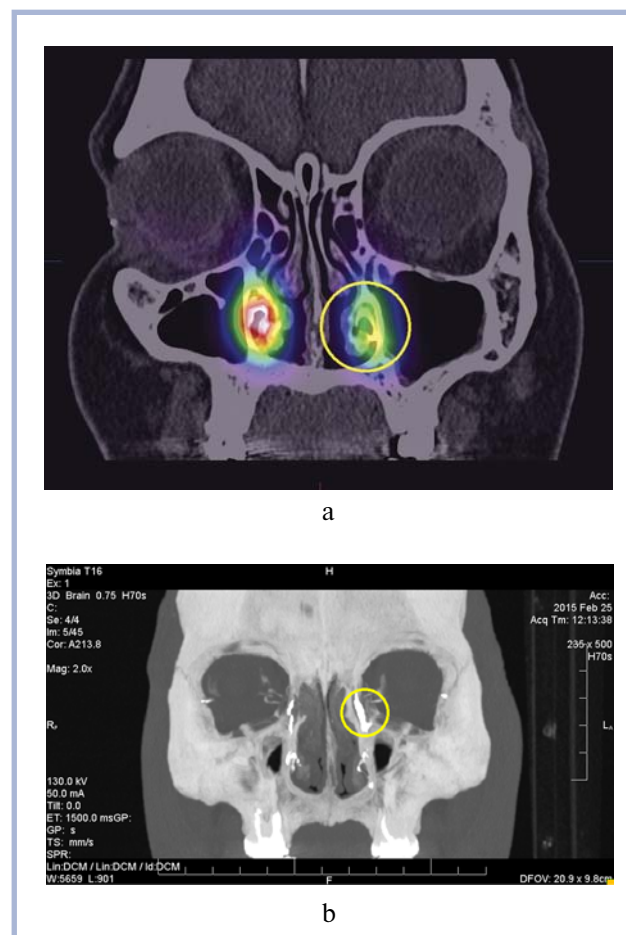


Fig. 3. SPECT/CT and CT only images of patient X. Coronal reconstruction.

Explained in text.

a — Fused SPECT/CT data; the locus of increased activity is marked with a yellow circle; b — CT only data; the site of stenosis and suprastenotic ectasia are marked with a yellow circle.

As already mentioned, among patients with CT signs of lacrimal pathways obstruction there were 4 cases (10%) that demonstrated residual flow of the radiopharmaceutical down into the nasal cavity, enabling us to perform recanalization with balloon dacryoplasty and bicanalicular intubation instead of DCR.

Recanalization aims at correction of anatomical changes at the site of dacryostenosis. Presumably, such a procedure will be effective if only the tear flow disturbance is due to anatomical narrowing at the same level. Our results support this opinion: the site of anatomical narrowing and the locus of increased activity on SPECT agreed in 60 (92.3%) cases with a favorable outcome and disagreed — in 5 (7.7%) cases. As to the group of unfavorable outcomes, the site of anatomical narrowing and the locus of increased activity on SPECT agreed in 3 (13.6%) cases and disagreed — in 17 (86.4%) cases.

It is worth stressing that a CT scan allows to establish the presence and specify the location of anatomical narrowing, while a SPECT scan can reveal functional disturbance of tear flow, but not its location within the lacrimal pathways. There is, clearly, a certain pattern, according to which post-recanalization relapses developed in patients, whose CT and SPECT data disagreed.

Lacrimal narrowings not associated with functional insufficiency of the lacrimal drainage system are known to exist. These include physiological stenoses at the level of canalicular orifice, neck of the lacrimal sac, and nasolacrimal orifice. One sees no significant accumulation of the radiopharmaceutical in the said anatomical areas [11]. The trick is that pathological narrowings often develop within exactly the same areas as physiological ones. Thus, differential diagnosis between physiological and pathological stenoses of lacrimal pathways is a pressing issue, closely related to identifying indications to differ-

ent types of surgery, including minimally invasive procedures. SPECT and CT performed together are able to identify anatomical narrowing within the lacrimal pathways as well as localize functional retention of the radiopharmaceutical and, therefore, help distinguish between anatomical and functional dacryostenoses.

Conclusion

The value of information provided by SPECT/CT has proved high in patients with clinically evident lacrimal obstruction and dacryostenosis suspects. A combined scan performed before surgery allows to establish causal relationships between anatomical changes and functional insufficiency of the lacrimal pathways and to make an optimal treatment choice. Therefore, the method can be recommended for surgical planning in dacryostenosis patients. At that, a concordance between the anatomical narrowing on CT and the locus of radiopharmaceutical accumulation on SPECT indicates higher predicted effectiveness of a minimally invasive procedure. Residual tear flow revealed by SPECT in patients with CT signs of lacrimal obstruction indicates, perhaps, high predicted effectiveness of recanalization with balloon dacryoplasty.

Author contributions:

Study conception and design — E.A., V.Ya.
Acquisition and handling of data — E.A., I.T., V.Ya.
Statistical analysis of data — V.Ya., N.K.
Drafting of manuscript — E.A., V.Ya.
Critical revision — I.T., N.K.

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REFERENCES

- 1 Atkova E.L., Beloglazov V.G., El-Saed S.A., Arkhipova E.N. Current possibilities of the tear passage abnormalities diagnostics in lacrimal duct (Review). *Oftalmokhirurgiya*. 2010;(1):58-61. (In Russ.).
- 2 Kul'baev N.D., Nigmatullin R.T., Sheherbakov D.A. The role of computed tomography with 3d function in preparing for dacryocystorhinostomy. *Oftal'mologicheskie vedomosti* 2011;4(3):38-40. (In Russ.).
- 3 Privalova Ye. Algorithm of radiological examination of patients with chronic dacryocystitis (Clinical observation). *Meditinskii vestnik MVD*. 2012;3(58):41-42. (In Russ.).
- 4 Yartsev V.D., At'kova E.L. The diagnostic validity of lacrimal scintigraphy. *Rossiiskii oftal'mologicheskii zhurnal*. 2014;7(2):108-111. (In Russ.).
- 5 Francis IC, Kappagoda MB, Cole IE, Bank L, Dunn GD. Computed tomography of the lacrimal drainage system: retrospective study of 107 cases of dacryostenosis. *Ophthalm Plast Reconstr Surg*. 1999;15(3):217-26.
- 6 Sagili S, Selva D, Malhotra R. Lacrimal scintigraphy: "interpretation more arthanscience" *Orbit*. 2012;31(2):77-85. doi:10.3109/01676830.2011.648797.
- 7 Astakhov IuS, Chachanidze NIu, Novikov SN. Radionuclide imaging of lacrimal duct in health and disease. *Vestnik oftal'mologii*. 1999;115(6):24-25. (In Russ.).
- 8 Atkova E.L., Tomashevskiy I.O., Luchshev A.I., Yartsev V.D. The role of lacrimal scintigraphy in lacrimal drainage function analysis. *Meditinskaya vizualizatsiya*. 2014;(4):7-13. (In Russ.).
- 9 Kotina E.D., Tomashevskiy I.O., Luchshev A.I., At'kova E.L., Yartsev V.D. Use of a new Indis computer program to analyze the results of lacrimal scintigraphy. *Vestnik Rentgenologii i Radiologii*. 2015;(2):23-27. (In Russ.).
- 10 Kemeny-Beke A, Szabados L, Barna S, Varga J, Galuska L, Kettesy B, Gesztelyi R, Juhasz B, Toth L, Berta A, Garai I. Simultaneous dacryocystography and dacryoscintigraphy using SPECT/CT in the diagnosis of nasolacrimal duct obstruction. *Clin Nucl Med*. 2012;37(6):609-610. doi: 10.1097/RLU.0b013e31824d2751.
- 11 At'kova E.L., Tomashevskiy I.O., Luchshev A.I., Yartsev V.D. Single-photon emission computed tomography in combination with X-ray computed tomography in the study of lacrimal passages. First results. *Vestnik Rentgenologii i Radiologii*. 2014;(2):26-30. (In Russ.).
- 12 Atkova E.L., Krakhovetskiy N.N. The influence of the way of dacryostoma plastic formation at effectiveness of endoscopic dacryocystorhinostomy. *Rossiiskaya rinologiya*. 2013;21(2):36-37. (In Russ.).
- 13 Tulebayev R.K., Baymenov A.Zh. Effective modern methods of functional endoscopic dacryocystorhinostomy. *Rossiiskaya otorinolaringologiya*. 2015;3:137-140. (In Russ.).
- 14 Zaidi FH, Symanski S, Olver JM. A clinical trial of endoscopic vs external dacryocystorhinostomy for partial nasolacrimal duct obstruction. *Eye (Lond)*. 2011;25(9):1219-1224. doi: 10.1038/eye.2011.77

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- 15 Yartsev V., Atkova E., Krakhovetskiy N. Modern technology of lacrimal passage restoration in dacryostenosis. *Oftalmokhirurgiya*. 2014;(2):85-91. (In Russ.).
 - 16 At'kova E.L., Yartsev V.D., Krakhovetskiĭ N.N., Root A.O. Minimally invasive surgery for dacryostenosis: modern trends. *Vestnik oftal'mologii*. 2014;130(6):89-97. (In Russ.).
 - 17 At'kova E.L., Yartsev V.D., Krakhovetskiy N.N., Root A.O., Reznikova L.V. First results of balloon dacryoplasty in dacryostenosis. *Oftal'mologicheskie vedomosti*. 2015;8(2):35-40. (In Russ.).
 - 18 At'kova E.L., Yartsev V.D., Krakhovetskiy N.N., Root A.O. Comparative analysis of the results of balloon dacryoplasty for stenoses at different levels of the vertical portion of lacrimal pathways. *Vestnik oftal'mologii*. 2015;131(4):66-73. doi:10.17116/oftalma2015131466-73. (In Russ.).
 - 19 Cho W, Paik J, Yang S. Surgical success rate comparison in functional nasolacrimal duct obstruction: simple lacrimal stent versus endoscopic versus external dacryocystorhinostomy. *European Archives of Oto-Rhino-Laryngology*. 2012;270(2):535-540. doi: 10.1007/s00405-012-2014-7
 - 20 Ali MJ, Naik MN. Efficacy of endoscopic guided anterograde 3 mm balloon dacryoplasty with silicone intubation in treatment of acquired partial nasolacrimal duct obstruction in adults. *Saudi J Ophthalmol*. 2014;28(1):40-43. doi: 10.1016/j.sjopt.2013.12.004.
 - 21 Gerbaud L, Chiambaretta F, Desrumeaux H, Privat C, Doz M, Menerath JM, Guichard C, Garcier JM, Boyer L. Cost efficiency study of lacrimal canal obstruction treatment. *J Radiol*. 2003;84(1):41-46. Received 08.02.2016