

## EXPERIENCE IN NAVIGATION SYSTEM USE IN SURGICAL TREATMENT OF THE TRAUMATIC DACRYOCYSTITIS RECURRENCE (CLINICAL CASE)

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✧ The article presents a clinical case of surgical of a recurrent chronic purulent dacryocystitis of traumatic etiology. Under endoscopic control, the patient underwent a revisional endonasal laser dacryocystorhinostomy with bicanalicular silicone stent. All surgical steps were controlled on the navigation system display. Navigation equipment was used to accurately visualize the structures of the nasal cavity and lacrimal pathways, because the anatomy of this area was changed as a result of the midface trauma and preliminary unsuccessful surgical procedures. During surgery, the functional and anatomical patency of the lacrimal pathways was achieved. Thus, the navigation system is a useful supplementary equipment that allows identifying the lacrimal sac in complex surgical situations, to monitor the state of lacrimal passages and surrounding nasal structures, which ultimately increases the effectiveness and safety of the procedure.

✧ **Keywords:** endoscopic endonasal laser dacryocystorhinostomy; treatment of the obstruction of nasolacrimal duct; navigation system; bicanalicular silicone stent; lacrimal pathways; trauma of midface; trauma of facial skull; chronic purulent dacryocystitis; multispiral computer tomography of lacrimal pathways (MSCT).

## ОПЫТ ПРИМЕНЕНИЯ НАВИГАЦИОННОЙ СИСТЕМЫ В ХИРУРГИЧЕСКОМ ЛЕЧЕНИИ РЕЦИДИВА ТРАВМАТИЧЕСКОГО ДАКРИОЦИСТИТА (КЛИНИЧЕСКОЕ НАБЛЮДЕНИЕ)

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✧ В статье представлен клинический пример хирургического лечения рецидива хронического гнойного дакриоцистита травматической этиологии. Под эндоскопическим контролем была выполнена ревизионная эндоназальная лазерная дакриоцисториностомия с постановкой биканаликулярного силиконового стента. Все этапы операции контролировали на дисплее навигационной станции. Навигационное оборудование применяли для точной визуализации структур полости носа и слезоотводящих путей при изменённой анатомии этой зоны вследствие травмы средней зоны лица и предварительных неудачных оперативных вмешательств. В ходе операции достигнута функциональная и анатомическая проходимость слёзных путей. Таким образом, навигационная станция является полезным вспомогательным инструментом, который позволяет в сложных хирургических ситуациях идентифицировать слёзный мешок, контролировать состояние слезоотводящих путей и окружающих их назальных структур, что в конечном счёте повышает результативность и безопасность вмешательства.

✧ **Ключевые слова:** эндоскопическая эндоназальная лазерная дакриоцисториностомия; лечение обструкций носослёзного канала; навигационная система; биканаликулярный силиконовый стент; слезоотводящие пути; травма средней зоны лица; травма лицевого черепа; хронический гнойный дакриоцистит, мультиспиральная компьютерная томография слезоотводящих путей.

Navigation equipment has been increasingly used in medical practice for the previous 40 years. The initially used navigation systems were large metal structures that occupied an area comparable to that of a living room. With the development of endoscopic endonasal surgery as well as engineering technologies, the interface of navigation equipment has also improved [1]. Contemporary navigation in otorhinolaryngology is represented by the following two options: optical and electromagnetic. The *optical navigation* system comprises an infrared radiation camera. A special marker is attached to the surgical instrument; then, the working instrument is registered in the system by constructing its mathematical model based on the reflected infrared rays. The system determines the location and angle of the tool based on the reflection angle of the signal. Such a triangulation process is similar to the work of the well-known GPS navigation system that is most often used in smartphones or vehicle navigators. The action of *electromagnetic navigation* is similar to that of an optical navigation system. The main difference is the radiator (emitter) that forms an electromagnetic field where the patient's head is located, fixed by a referential frame, and surgical instruments.

Such modern equipment enables us to combine the anatomical structures of the patient with the results of computed tomography/magnetic resonance imaging; this increases the safety of the surgical treatment. When these results are combined, a three-dimensional tomogram is obtained that is visualized on the station screen in real time. The three image windows represent the following three planes: frontal, sagittal and axial, with the endoscope screen displaying in the fourth window. The tip of the instrument is also shown on the screen, and the surgeon can additionally monitor and verify the known landmarks. As in the construction of any mathematical model, an error occurs when comparing the results of radiation studies and the real structures of a patient. The magnitude of the error depends on the operator's accuracy during registration and the resolution capability of the navigation equipment. In order to reduce this error, engineers have developed a special program wherein the exact sizes and shapes of rhinosurgical endoscopic instruments are introduced in advance. Thus, the error of the instruments is reduced to almost zero. In this case, the accuracy of the navigation station is equal to 100%.

For surgical endoscopic interventions on the structures of the facial skeleton of the skull, it is

more suitable to use an electromagnetic navigation station wherein information has already been fed about the instruments used [2]. In otorhinolaryngology, the navigation equipment is used in various cases, such as revision interventions for the structures of the nasal cavity and paranasal sinuses (when there are no known landmarks); neoplasms of the paranasal sinuses (for maximum removal of tumor within healthy tissues); endoscopic endonasal frontal sinus surgery (frontal sinus is the most complicated for transnasal opening); and interdisciplinary surgical interventions [3].

Recently, there has been increased interest in the use of navigation systems in complex surgical treatment for pathology of the lacrimal passages [4]. In order to restore lacrimation, dacryocystorhinostomy is performed, while the endoscopic endonasal approach ensures safety and high efficiency [5]. Navigation systems are usually not used for primary dacryocystorhinostomy; however, they can be useful for revision interventions as well as complicated cases of secondary acquired obstruction of the lacrimal passages [4]. Several publications in the foreign literature report successful application of navigation systems in the surgical treatment of nasolacrimal duct obstruction. Day et al. reported a 53-year-old man with bilateral obstruction of the nasolacrimal duct that occurred for the second time with prolonged cocaine abuse. The oronasal fistula as well as extensive endoscopic anatomical changes in the nasal cavity required the use of a navigation station to perform endoscopic endonasal dacryocystorhinostomy [6]. In another study, Morley et al. described the case of a 54-year-old patient with left-sided injury of the nasolacrimal duct that occurred after hemimaxillectomy for synonasal carcinoma. The Lester Jones tube was successfully placed in the nasal cavity under endoscopic control using an intraoperative navigation station [7]. Ali et al. reported their experience in using a navigation system for endoscopic endonasal laser dacryocystorhinostomy (EELDCRS). They presented three successful cases of the treatment of secondary acquired nasolacrimal duct obstruction in patients with gross naso-orbital and ethmoid fractures as well as a case of successful surgical treatment of lacrimal passages obstruction in a 16-year-old girl with congenital arhinia and microphthalmia [8, 9].

Russian authors also report a successful outcome of endoscopic dacryocystorhinostomy using the navigation system control in 10 patients with chronic dacryocystitis [10]. The authors note that the use of a navigation system enabled them to determine the

intraoperative position of the lacrimal sac in relation to the bone walls of the nasal cavity, turbinal bones, and paranasal sinuses both with typical anatomical locations and with dislocations. Together with endoscopic imaging, these findings show that it is possible to control the instrument position in potentially dangerous areas of the nasal cavity.

This study aimed to demonstrate the benefits and evaluate the efficiency of using a navigation system (Medtronic) for a specific clinical case when performing EELDCRS.

## MATERIAL AND METHODS

At the first stage before the surgery on the lacrimal ducts (after conventional dacryological tests and examination of the lacrimation pathology), it is necessary to perform multispiral computed tomography with the lacrimal ducts contrasting in the standard position. Computed tomography of the nasal cavity, paranasal sinuses with lacrimal passages contrasting is a well-proven method for visualizing the level of stenosis or obstruction of the lacrimal passages as well as assessing the condition of the surrounding tissues and structures. Three-dimensional reconstruction enables the surgeon to view the image in several projections, increases the diagnostic accuracy, and aids the selection of the optimal surgical approach. The data obtained after performing multispiral computed tomography was downloaded into a navigation station and processed. For surgeries on the structures of the nasal cavity in the otorhinolaryngology clinic, electromagnetic navigation equipment was used. The patient was registered in the system as per the standard algorithm, and the patient's anatomical structures were combined with the digital data. Then, under endoscopic control, EELDCRS was performed. At each stage of the surgical intervention, the localization of the lacrimal sac and instruments was monitored on the navigation station display.

## CLINICAL CASE

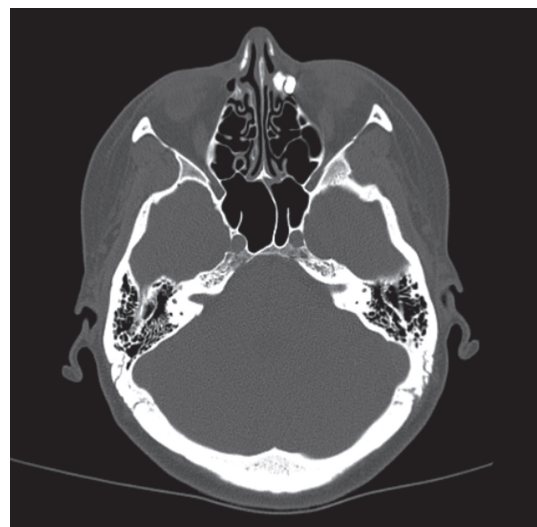
A 39-year-old woman visited the Ophthalmology Clinic of the Academician Pavlov First St. Petersburg State Medical University; she had been experiencing chronic purulent dacryocystitis on the left for 5 years. During the examination, she complained of left-sided lacrimation and purulent discharge from the lacrimal sac with pressure on the inner corner of the eyeball. These symptoms occurred for the first time a month after an injury to the facial middle zone due to a traffic accident in 2016. An examination showed obstruction of the lacrimal passages at the

level of the nasolacrimal duct on the left. In 2016, in a city hospital, she underwent a left-sided dacryocystorhinostomy via the external approach. Three months postoperatively, she started experiencing lacrimation again, with periodic suppuration from the lacrimal openings on the left.

The patient was examined by an ophthalmologist, traditional dacryological tests were performed, and a relapse of chronic purulent dacryocystitis on the left was diagnosed.

A series of images with multispiral computed tomography of the lacrimal passages demonstrated that the contrast agent completely filled the lacrimal sac, but did not enter the nasal cavity (Fig. 1). We decided to perform endoscopic endonasal dacryocystorhinostomy using a semiconductor diode laser in contact mode (2017). In the postoperative period, there were no complaints of lacrimation, while a free flow of liquid passed into the nose while rinsing. One year after the endoscopic surgery, the patient noted lacrimation again with periodic suppuration on the left. Relapse of chronic purulent dacryocystitis on the left was diagnosed. Considering the two previous surgical interventions for chronic purulent dacryocystitis of traumatic etiology and the history of an injury to the facial skeleton of the skull, we decided to perform a revision surgery with the placement of a bicanalicular silicone stent under the control of the surgery stages, with the use of navigation equipment.

Surgical intervention (revision EELDCRS in 2018) was performed in an otorhinolaryngology clinic under general anesthesia with the naviga-



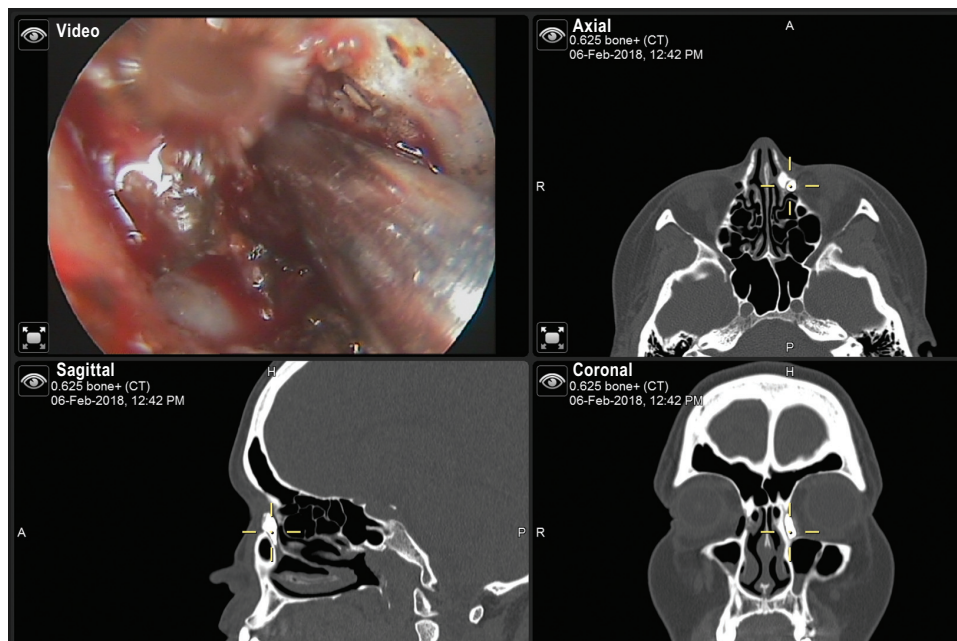
**Fig. 1.** Multispiral computer tomography of nasal cavity, paranasal sinuses with contrast-enhancement of lacrimal pathways

**Рис. 1.** Мультиспиральная компьютерная томография полости носа, околоносовых пазух с контрастированием слёзных путей



**Fig. 2.** General view of operating room with navigation system installed

**Рис. 2.** Общий вид операционной с установкой навигационной системы



**Fig. 3.** The image from navigation station showing X-ray and endoscopic view of nasal cavity and lacrimal pathways

**Рис. 3.** Изображение с навигационной станции, показывающее рентгенологическую и эндоскопическую картину полости носа и слезоотводящих путей

tion system and using a semiconductor laser with a wavelength of 970 nm in the continuous contact mode (Fig. 2).

The cicatricial tissue was excised in the projection of the bone window. Then, the remnants of the bone mass were removed with a drill. At the final stage,

a bicanalicular silicone stent was placed through the upper and lower lacrimal openings, with subsequent fixation of its ends with knots in the nasal cavity. At each stage, the location of the instrument relative to the structures of the nasal cavity was monitored using a navigation station (Fig. 3).

The navigation equipment was used for accurate determination of the structures of the nasal cavity and lacrimal passages under conditions of altered anatomy, and this contributed to accurate planning and safe performance of endoscopic intervention.

There were no complications in the postoperative period. The silicone stent was removed after 3 months. The functional and anatomical patency of the lacrimal passages was preserved at 1 year and 4 months after the surgery. There are no complaints of lacrimation.

## CONCLUSIONS

This navigation station is a useful auxiliary tool to identify the lacrimal sac, lacrimal passages, and the nasal structures surrounding them, in challenging surgical situations; this increases the effectiveness and safety of the intervention and provides good functional results in the postoperative period.

*Transparency of financial activity:* none of the authors has a financial interest in the materials or methods presented.

*The authors have neither conflict of interest nor financial interest.*

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