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Perforated punctal plugs for the management of acquired external punctal stenosis

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HIGHLIGHTS

Treatment of pathological tearing by the lacrimal punctal intubation with perforated plugs is a safe and fast treatment method, with an efficacy of 93.2% in our study ($p < 0.001\%$).

ABSTRACT

The study presents the results of treating patients with pathological tearing caused by acquired external punctal stenosis.

Method: 61 eyes of 34 individuals with an average age of 67 were enrolled in the study. A perforated silicone implants were inserted into the narrowed lacrimal punctums, after pathological tearing had been diagnosed using the Munk test, fluorescein disappearance test, and other parameters. Implants has been removed after 3 months.

Results: Overall, a statistically significant ($p < 0.001\%$) reduction in the fluorescein disappearance test was observed in 93.2% of eyes ($n = 55$). None of the patients experienced an exacerbation of excessive tearing. The average score on the fluorescein disappearance test decreased from 3.64 before the procedure to 1.42 after the procedure.

Conclusions: Intubation of the lacrimal punctum with perforated silicone implants is a quick, effective, and safe method for treating pathological tearing in cases of acquired narrowing of the lacrimal punctum.

Key words: acquired punctal stenosis, epiphora, etiology, treatment

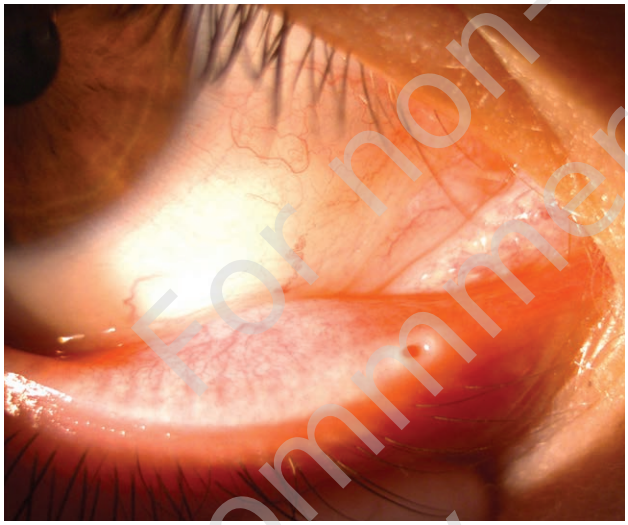
INTRODUCTION

Excessive tearing is a very bothersome condition and significantly reduce the quality of life. It is estimated that acquired narrowing, known as lacrimal punctal stenosis, occurs in 54.3–63.3% of patients seeking ophthalmic care [1–4]. The condition most commonly affects individuals in the 6th and beyond decade of life [4, 5].

The properly developed lacrimal drainage pathways begin with lacrimal puncta, which are small openings located on the lacrimal papillae of the upper and lower eyelids, facing inward towards the semilunar fold (fig. 1).

FIGURE 1

Normal lacrimal punctum.



An ideal lacrimal punctum should have a diameter of 0.2–0.3 mm and a funnel shape [3], although a different shape does not indicate dysfunction. The diameter of the openings changes during blinking [6]. The lacrimal punctum is surrounded by a ring of connective and elastic tissue and fibers of the Horner's muscle. This stabilizes the punctum, and the fibers of the circular muscle of the eye twist the punctum inward and protect it from eversion. The area around the lacrimal papillae is avascular, which is why it appears slightly paler. When the lacrimal punctum is absent, the brighter color of the papilla helps to locate the area where it should be [3].

Continuous, often long-term wiping of tears leads to eyelid ptosis, loosening of eyelid ligaments, inversion of the lacrimal punctum, and sometimes eversion of the entire eyelid (ectropion). Additionally, constant touching of the eyelid during tear wiping promotes the introduction of infection into the conjunctival sac and the development of chronic conjunctivitis and other inflammatory conditions of the eye area. Acquired external punctal stenosis (AEPS) is one of the leading causes of chronic tearing. The pathogenesis of punctal stenosis is complex. The causes of AEPS include eyelid margin inflammation (45–48%), ectropion (23%), use of topical antiglaucoma medications (5%), and unknown causes accounting for nearly 30% of all cases [3–5]. Eyelid margin inflammation is associated with fibrosis of the external orifice, leading to progressive reduction in the diameter of the lacrimal punctum. Chronic eyelid inflammation is the most common cause of eyelid margin inflammation [3]. Ectropion and eversion of the lacrimal punctum cause punctal stenosis, most likely due to drying of the punctum resulting from its displacement from the physiological position. Improper positioning promotes the occurrence of inflammatory conditions, creating a vicious cycle. The more a patient tears up and wipes tears frequently, the more the eyelid loosens and the punctum everts. Other causes of punctal stenosis are listed in table 1.

TABLE 1

Etiology of acquired punctal stenosis.

Topical medications	timolol	latanoprost	betaxolol	pilocarpine
	dipivefrine hydrochloride	phenylephrine hydrochloride	prednisolone acetate	echothiophate iodide
	adrenaline	chloramphenicol	tobramycin	indomethacin
	dexamethasone	tropicamide	naphazoline	artificial tears
	mitomycin-C			
Systemic medications	5-fluorouracil	idoxuridine	docetaxel	paclitaxel
Infectious	*Chlamydia trachomatis*	*Human papilloma virus*	*Herpes virus*	*Actinomyces*
Inflammatory	chronic blepharitis	ocular cicatricial pemphigoid	graft-versus-host disease	dry eye syndrom
Neoplastic	peripunctal tumors			
Systemic diseases	acrodermatitis enteropathica		porphyria cutanea tarda	
Other	aging	trauma	idiopathic	
	local irradiation		photodynamic therapy for mascular disease	

FIGURE 2

Slit type.

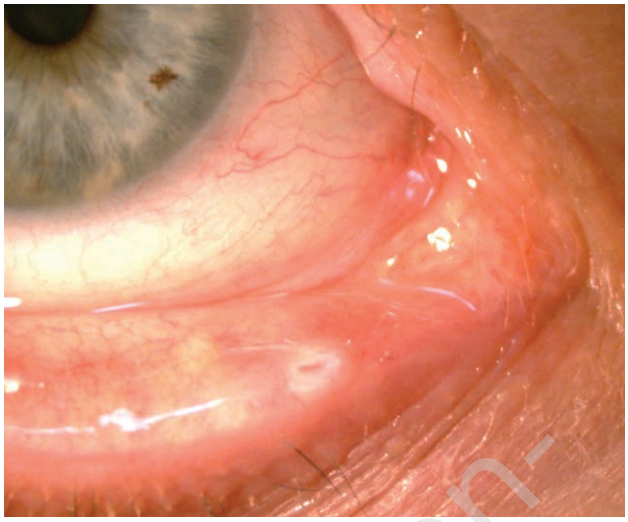


FIGURE 3

Pinpoint.

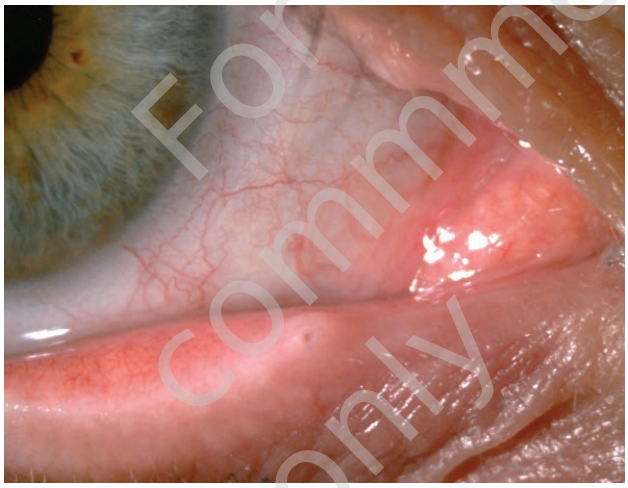


FIGURE 4

Horseshoe.

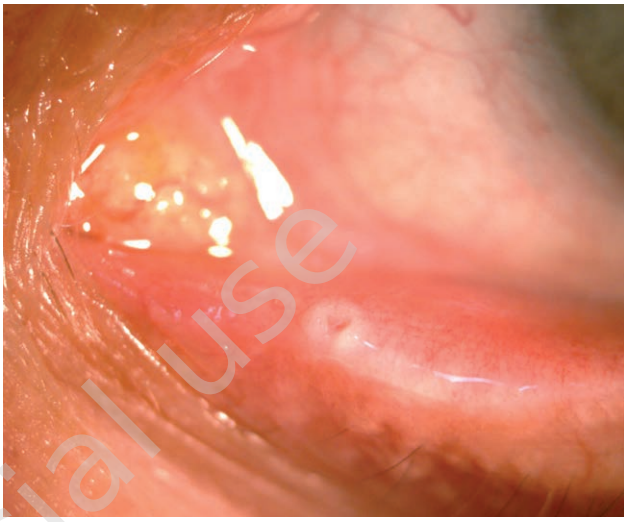
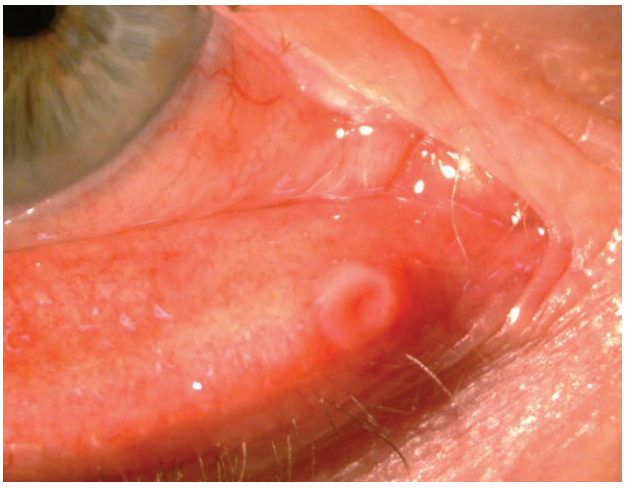


FIGURE 5

Allergic.



In summary, the narrowing of lacrimal puncta is most commonly associated with fibrosis of the sphincter or ring of the punctum, as well as age-related involutional changes that lead to tissue laxity and improper eyelid positioning. Lacrimal punctal disease can take various forms. Nadeem et al. [2] applied an anatomical classification of narrowed puncta based on clinical appearance and described them as: slit type (fig. 2), pinpoint (fig. 3), horseshoe (fig. 4), allergic (fig. 5), closed (fig. 6), and covered by conjunctival folds (fig. 7).

The preferred approach is the physical widening of the lacrimal punctum. Currently, the most commonly performed procedure for restoring the patency of the puncta is temporary intubation with perforated silicone implants [7, 8]. In the literature, reports can be found on the treatment using mini-Monka® stent, Masterka, perforated plug implants (FCI Ophthalmics, Issy-Les-Moulineaux, France) [1]. Other classical methods are i.e. punctal dilation with dilators, punctoplasty using single/two/three-incision techniques, microsurgical punctoplasty, electrocauterization, and laser treatment. Each abovementioned method has its advantages and disadvantages, and currently, there is no established therapeutic approach.

MATERIALS AND METHODS

This is a retrospective study conducted on 61 eyes of 34 individuals. The procedure performed on them was the implantation of a perforated implant into the narrowed lower lacrimal punctum. Medical history and physical ex-

FIGURE 6

Closed.

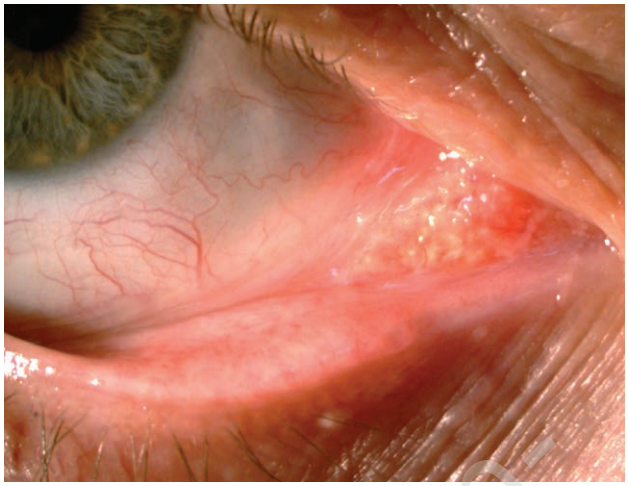
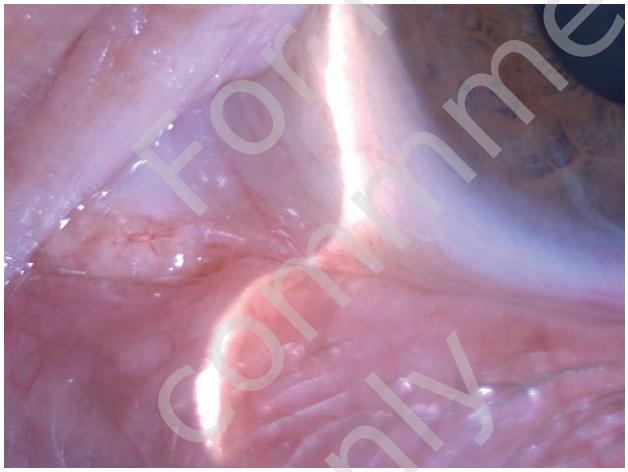


FIGURE 7

Covered by conjunctival folds.



aminations were conducted on patients treated at the Orbita Medical Center and the Military Institute of Aviation Medicine in Warsaw. Patients were informed about the purpose of the meeting and provided informed consent to participate in the study.

The inclusion criterium for the study were underwent treatment for acquired punctal stenosis using punctoplasty with implantation of a perforated implant into the lower lacrimal punctum at the aforementioned medical centers. All procedures were performed under local anesthesia with 2% lidocaine on an outpatient basis by the same surgeon. Microscopic assistance was used during the procedures to minimize tissue damage. The punctal dilation was performed very gently and uniformly for all patients using a prepared and calibrated dilator (fig. 8, 9).

This approach minimized the risk of iatrogenic damage to the punctal tissue and implant extrusion due to excessive dilation. After removing the sterile packaging, a 1.5 mm diameter and 2 mm length implant (pre-loaded PVP perforated plug J.A Bernard, MD by FCI) was implanted using a factory-prepared guide (fig. 10, 11). The procedure concluded with the application of local antibiotic eye drops.

Patients were invited for follow-up visits at various time intervals after the procedure. The maximum follow-up period was 347 days, and the minimum was 186 days. Exclusion criteria included comorbidities that prevented the objective assessment of treatment effectiveness. As a result, one patient was excluded from the study due to persistent tearing despite patent lacrimal drainage after the procedure, which was attributed to a defensive mechanism, reflex tearing caused by uncontrolled glaucoma and unresponsive to pharmacological treatment. One patient withdrew from the study during a follow-up visit. Ultimately, 59 eyes be-

FIGURE 8, 9

Lacrimal punctal dilator. The arrow indicates the marker that facilitates the dilation of the punctum to the physiological diameter.

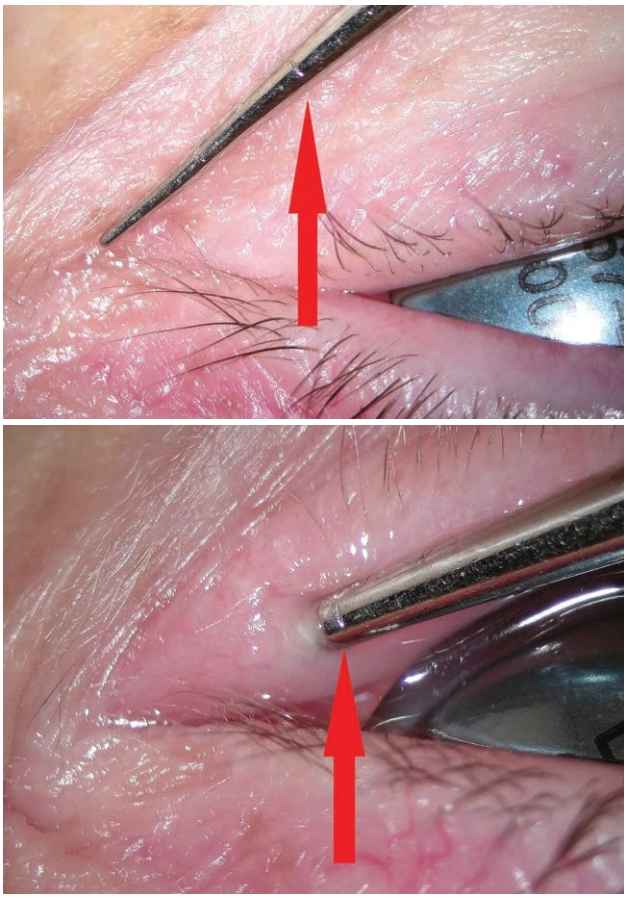


FIGURE 10

Implant on the guide.

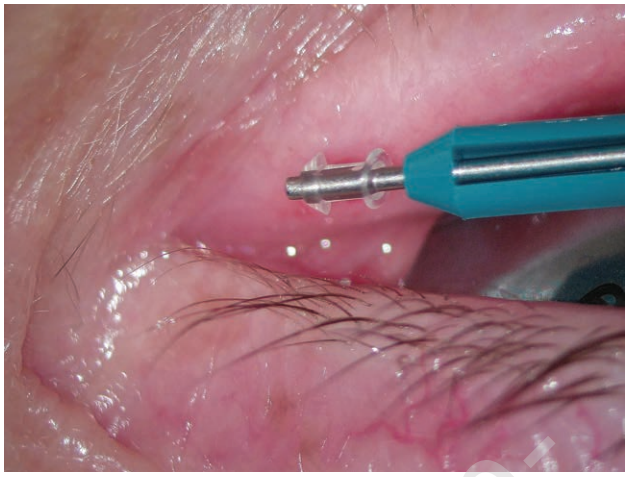
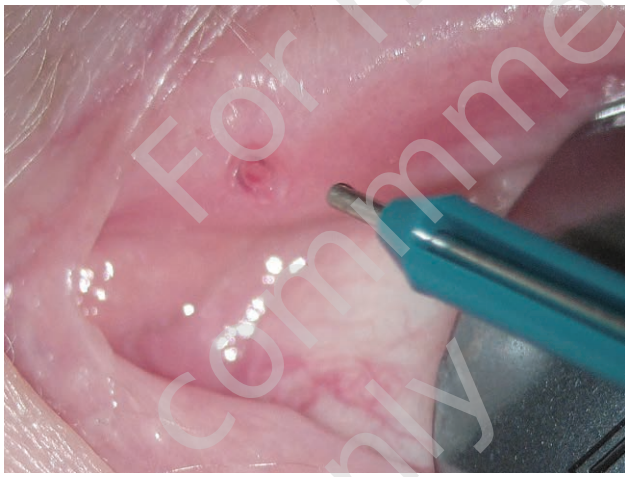


FIGURE 11

Implant inserted into the punctum.



longing to 32 patients were included in the analysis, with 68.8% being female (n = 22). The mean age of the patients was 67.28 years (minimum 40, maximum 90 years). Their demographic data are presented in the chart (fig. 15).

The study was based on the results of the physical examination conducted during the qualification for the procedure and the follow-up visit. Additionally, during the follow-up visit, patients were asked about their subjective satisfaction with the treatment, assessed on an 11-point scale, where 0 indicated no satisfaction and continuous occurrence of pathological tearing, and 10 indicated maximum satisfaction and resolution of all excessive tearing symptoms. The physical examination included, among others, assessment of the eyelids using a slit lamp, lower eyelid laxity test, assessment of medial canthal laxity, fluorescein disappearance test (DDT), canalicular test, and reflux test. The DDT results were reported on a scale of 1 to 4.

FIGURE 12

Narrowing of the lower lacrimal punctum before treatment.

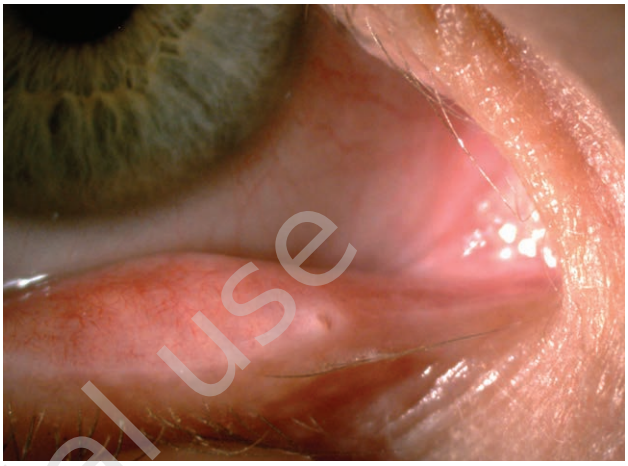


FIGURE 13

Intubated punctum.

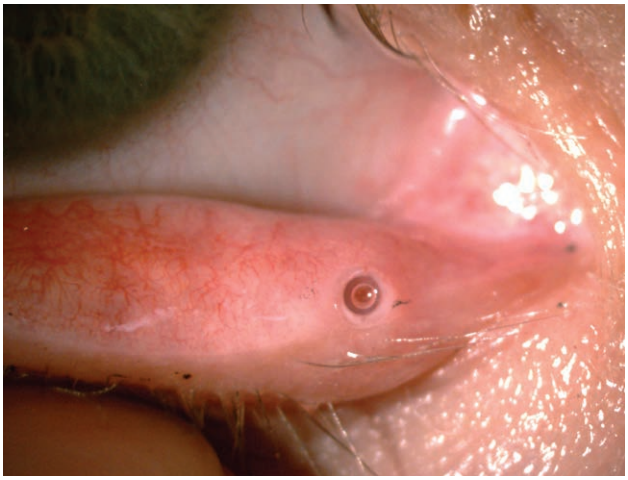
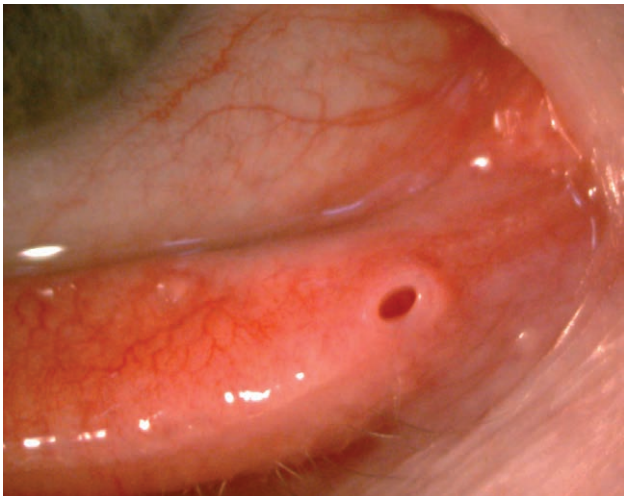


FIGURE 14

Punctum after implant removal.



Statistical analysis was performed using R programming language version 4.1.2 (R Core Team, Vienna, Austria). The Mann-Whitney-Wilcoxon U-test was used for equality of medians.

RESULTS

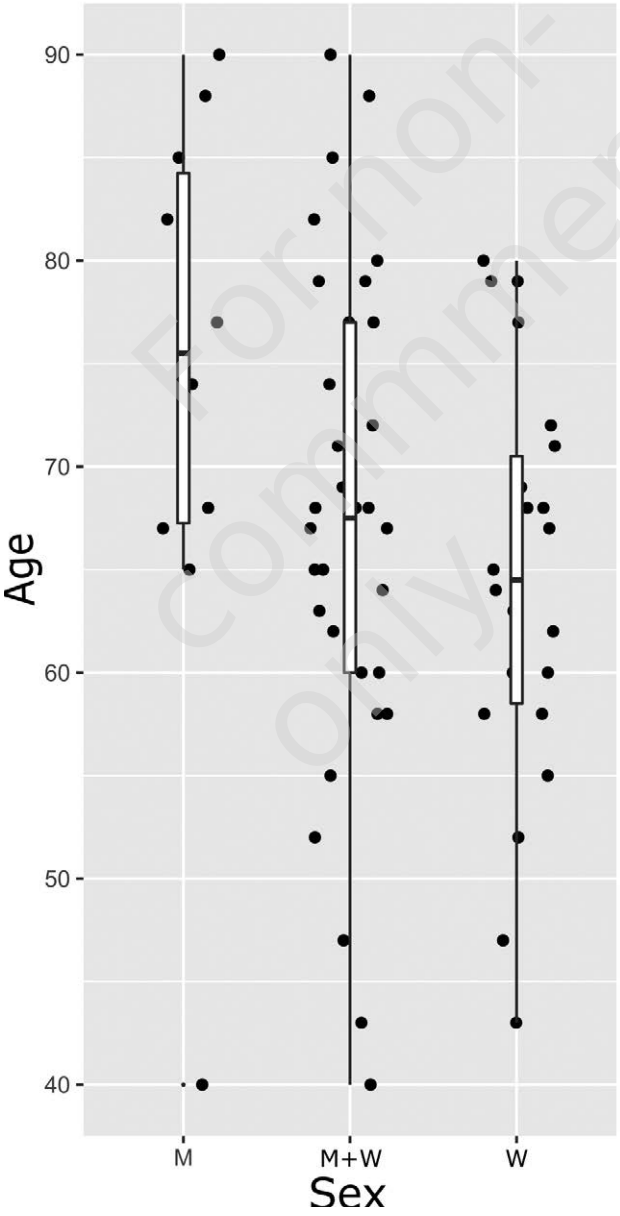
As a result of the applied treatment, most patients experienced a reduction in pathological tearing (assessed based on the fluorescein disappearance test, DDT). Complete resolution of excessive tearing symptoms was achieved in 93.8% of the participants (n = 30, for both eyes), corresponding to 93.2% of the eyes (n = 55). Furthermore, none of the patients experienced a worsening of the outcome. The median DDT score for both eyes before the procedure was 4, and after the procedure, it was 1 (fig. 16).

There was also a relief in subjective symptoms (assessed based on individual satisfaction with the treatment). Patients reported a satisfaction score greater than or equal to 5 for 84.7% of the eyes (n = 50), a satisfaction score greater than or equal to 8 for 69.5% of the eyes (n = 41), and the mean satisfaction score was 7.6 (median = 8) (fig. 17).

The mean DDT values significantly decreased ($p < 0.001\%$) from 3.64 before the procedure to 1.25 at the end of the observation period for the right eye and from 3.65 before the procedure to 1.42 at the end of the observation period for the left eye.

FIGURE 15

Patients' demographic data.

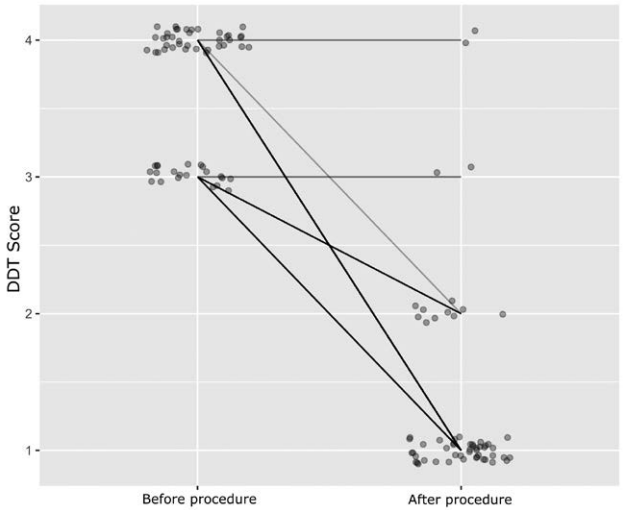


CONCLUSIONS

Excessive tearing caused by external punctal stenosis is a significant factor in the deterioration of the quality of life for ophthalmic patients. A high tear meniscus forms an additional prismatic lens on the eyelid margin, which alters the eye's optics. When patients look downward, they "look through tears" and experience significant visual impairment. Patients complain that they cannot read, write, or work normally. Punctal stenosis leads to eye wiping up to 30 times a day, requiring several packs of tissues daily. Constantly wiping tears also hinders the performance of normal daily activities. Patients don't always have a free hand to wipe away excess tears, and tasks like driving,

FIGURE 16

The results of the fluorescein disappearance test, before and after the procedure.

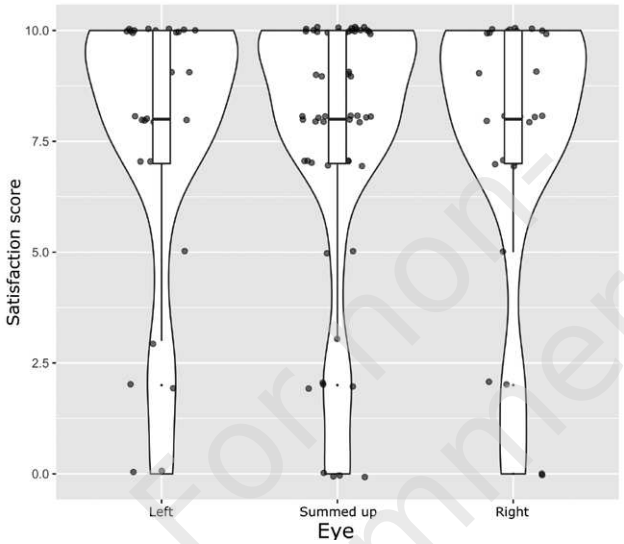


operating devices, shopping, or walking stairs with both hands occupied can be dangerous. It should be noted that a gold standard therapeutic approach for punctal stenosis has not been established yet [9].

Silicone punctal plug implantation is a quick and easy procedure that can be performed under local anesthesia.

FIGURE 17

Patients satisfaction after procedure.



Another advantage of this procedure over surgical methods is the preservation of the punctal closure, resulting in a lower risk of restenosis that could occur during wound healing. In most cases, the implant does not cause any adverse effects related to its presence in the tissue. It rarely induces a foreign body sensation, local irritation, or conjunctival granuloma [7, 8, 10]. Migration and punctal injury can occur during implantation [8]. Patients in our study did not report any discomfort, irritation, or pain after the implantation. The values of the fluorescein disappearance test decreased in 93.8% of patients, and subjective satisfaction with the procedure, rated at 8 or higher on a 11-point scale, was reported for 69.5% of eyes.

Similar conclusions can be found in other studies. Soiberman et al. [3] assessed the effectiveness of the treatment using the same method as symptom relief, with a success rate of 84.1%. Ozgur et al. [8] demonstrated the absence of excessive tearing in 91.1% of patients after 6 months of the procedure. The success rate one year after the procedure was 82.2%. Chang et al. [11] evaluated the treatment effectiveness at 85%. These results indicate that the implantation of punctal plugs is effective in treating excessive tearing. The majority of patients experience a reduction in its severity or complete resolution. Only 17.8% of patients experience recurrence one year after the procedure [8]. The procedure is quick, painless, and significantly improves the quality of life. However, it is important to consider the appropriate patient qualification since the presence of other eye and ocular protective apparatus disorders may prevent achieving the desired therapeutic effect. The effectiveness of this treatment significantly decreases in cases of eyelid laxity and lower eyelid eversion or punctal dislocation. In such cases, corrective procedures to restore proper eyelid position should be performed first.

The effectiveness of treatment with mini-Monka® stents, defined as symptom improvement, is estimated at 82% [3]. The approach of solely dilating the punctal orifice is being abandoned due to its relatively low effectiveness, with just over 50% success in reducing excessive tearing and causing patient discomfort [3, 7]. In cases of complete punctal agenesis, interventional treatment with pigtail probe-assisted intubation of both canaliculi using a silicone stent can be considered. This method allows for the localization of the punctal orifice and relatively safe treatment, effectively combating pathological tearing in 66.7% of cases one year after the procedure [12]. Ordinary microsurgical punctoplasty is associated with a high recurrence rate [2]. In a study comparing the effectiveness of punctal plug implantation for punctal stenosis versus punctoplasty using a three-incision technique, it was shown that plug implantation is a less invasive procedure and better tolerated by patients [13]. On the other hand, punctoplasty using a single-incision technique has a high failure rate due to secondary closure of the punctal orifice. Furthermore, surgical procedures can impair tear drainage due to damage to the physiological function of the punctum and canaliculus [2]. The anatomical success rates achieved with the two-incision and three-incision techniques were 91.1% and 94.1%, respectively [3]. However, functional success was more likely with the two-incision technique (71.4%) compared to the three-incision technique (62.5%). It should be noted that most studies were not conducted on large patient groups, and a direct comparison of the described methods is not possible due to the varied research methodologies. Therefore, based on current knowledge, it is not possible to establish a definitive standard approach, and further research with standardized methodology and larger cohorts is necessary. Ozgur et al. [8], Kashkouli et al. [5], and Offutt et al. [14] also noted a higher prevalence of female patients in their studies (71%, 63.8%, and 70% respectively). Our observations confirm this trend, as women accounted for 68.8% (n = 22) of the patients in our study. Hormonal changes occurring in the body after menopause and anatomically narrower tear drainage pathways in women are considered factors responsible for this disparity [1, 5, 14].

Punctal plug intubation with perforated plugs is a fast, effective, replicable, and safe method for treating pathological tearing in cases of diagnosed acquired punctal stenosis.

Figures: from the authors' own materials.

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Authors' contributions:
Alan Chamernik: study concept development, recruitment of research participants, subjective examination of patients, data analysis, preparation of tables and charts, manuscript preparation; Radosław Różycki: study concept development, objective examination of patients, text editing, provision of images for the text; Katarzyna Różycka: subjective examination of patients, assistance in manuscript preparation; Krystian Bakalarski: subjective examination of patients, assistance in manuscript preparation. All authors have read and approved the final version of the manuscript.

Conflict of interest:
None.

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Ethics:
The content presented in the article complies with the principles of the Helsinki Declaration, EU directives and harmonized requirements for biomedical journals.