Case Series Study

Journal Of Clinical & Medical Images Case Reports

Open Access, Volume - 2

Evaluation of plasma-assisted noninvasive surgery (PANIS) effect on punctal occlusion after multiple consecutive treatments; A clinical case series

Farhad Nejat*; Khosrow Jadidi; Shima Eghtedari; Nazanin-sadat Nabavi

Vision health research center, Tehran, Iran.

Received Date : Apr 13, 2022
Accepted Date : May 26, 2022
Published Date : Jun 10, 2022
Archived : www.jcmimagescasereports.org

***Corresponding Author:** Farhad Nejat, Vision health research center, Tehran, Iran. Tel: +989124014938.
Email: Fanejat@yahoo.com

Abstract

Background: The current study aims to evaluate the plasma-assisted noninvasive surgery (PANIS) as a novel technique for punctal occlusion to attain a long-term stricture of the punctum.
Methods: This study involved 10 eyes from 10 female patients with grade 3 and 4 severity of dry eye disease (DED) based on the Delphi Panel scheme of dry eye. The punctal occlusion was conducted using the fusion mechanism of plasma spots using the white handpiece of plexr device. One single surgeon implemented the procedure three times at 2 weeks intervals. This office-based technique was assessed with acuity parameters, dry eye tests, and patient satisfaction evaluated by OSDI questionnaire before, and one month and six months after the procedure.
Results: A remarkable improvement was observed in tear meniscus height (TMH) and tear break-up time (TBUT) in quite all patients. The visual parameters and intraocular pressure (IOP) had not considerably changed but CFS decreased due to more tear stability in the 6 months. The OSDI questionnaire scores of all patients had obviously reduced after the procedure. After all sessions, patients reached a quite long-term stricture in their puncta, whereas no complication or side-effects were reported after a 6-month follow-up.
Conclusions: Findings of this clinical case serial study led to a novel therapy method for DED that results in the punctum stricture for months, using the PANIS method as an effective, safe, office-based, easy, and inexpensive approach where recalcitrance to the medical therapy occurs.
Trial registration: This study registered in Semnan University of medical science, Semnan, Iran identified by IR.SEMUMS.REC.1398.319.

Keywords: Punctal occlusion; punctal stricture; dry eye disease (DED); plasma; PAINSmethod; ocular surface disorders.

Introduction

Occluding tear drainage system is known as a mechanical blocking procedure of punctum to preserve natural tear for a longer time [1]. Punctal occlusion is an underutilized therapy for treating dry eye disease (DED) [2] that can be an option when the prescribed medications are no longer ameliorating the complaints and symptoms in patients [3]. Dry eye can occur due to immoderate tear evaporation or tear deficiency [4-6] and have a deleterious consequent on the visual function and life quality in DED patients [7]. DED-conflicted patients suffer from signs including, but not limited to, irritation, burning, redness, photophobia, visual disturbance, and foreign body sensation [8, 9]. The age-related prevalence is 5 to 35 percent in a many countries and 27.7% in Iran [10-13]. Risk factors include advanced age, smoking, low relative humidity, excessive screen-exposure, refractive surgery, and certain drugs [14-18]. Depending on the severity, warm compresses to the eyelids, omega-3 nutritional diet, medical therapy including artificial tear, topical cyclosporine, autologous serum drops, short term topical antibiotics, and some corticosteroids are prescribed to relieve the symptoms of DED [19-21]. Punctal occlusion is suggested as a good remedy for cases that the above-mentioned approaches were inadequate [16, 22]. In recent years, plasma (the fourth state of matter following solid, liquid, and gas) has appeared potential to be utilized in many fields of medicine. One novel approach for producing reactive components of oxygen and nitrogen, is non-thermal atmospheric pressure plasma, which is employed in sterilization, dentistry, oncology, pharmacology, wound healing, and cancer therapy [4, 5]. First time, Nejat et al. evaluated the safety of applying atmospheric low-temperature plasma (ALTP) on rabbits' eyes and after a one-month and six-month follow-up, histopathological examinations revealed the safety of this novel technique on the

Citation: Farhad Nejat. Evaluation of plasma-assisted noninvasive surgery (PANIS) effect on punctal occlusion after multiple consecutive treatments; a clinical case series. J Clin Med Img Case Rep. 2022; 2(3): 1168.

conjunctiva [23, 24]. Thus, they initiate a case series studies, applying plasma with a plexr device for conjunctival cyst, pinguecula ablation, conjunctivochalasis treatment, and dry eye treatment by one-session punctal occlusion and their results approved the efficacy of the plasma-assisted noninvasive surgery (PANIS) [25-28].

In the same regard, the present study assesses an innovative method to strict punctum to increase tear stability in the ocular surface for the long term to treat DED.

Materials and Methods

Study design

The research protocol was approved by the medical ethics committee of the Semnan University of Medical Sciences, IR.SEMUMS.REC.1398.319. Written informed consent was obtained from all included subjects after delivering an oral explanation of the nature and possible consequences of the procedure. The research adhered to the tenets of the Declaration of Helsinki. The current study included 10 eyes of 10 female Participants (4 left eyes and 6 right eyes), the mean age was 39.9 years old and diagnosed with severe dry eye based on the Delphi Panel dry eye severity grading scheme (2021).

Surgical technique

The procedure was conducted under local anesthesia. For this purpose, 3 drops of tetracaine 0.5% eye drop (Sina Daro, Tehran, Iran) was instilled in each eye at 5 minute intervals for 15 minutes. While patients were placed behind the slit-lamp, punctal occlusion was performed using the white handpiece (Table 1) of the plasma generator device (Plexr, GMV s.r.l Grottaferrata, Italy). Applying one or two plasma spots on the punctum causes occluding for 2 to 5 days and this procedure was repeated for 3 consecutive times with a two-week interval (see the supplementary video). One surgeon (Dr. Farhad Nejat) performed the procedure on all subjects. The patients reported no intraoperative and postoperative complications. The patients continued their previous lubricating medications after surgery.

Table 1: *Characteristics of Plexr device.*

Parameters	Values
Working gas Air	Air
Power supply	Docking station = 24 V
Hand pieces:	Handpieces: embedded inductive charger = 5 V
Max output	≤ 2 W
Max working voltage	≤ 1.3 kVPP
Output frequency	(70–80) kHz
Handpiece types:	
White*	V peak to peak = 500 V, Power = 0.7 W, Frequency = 75 kHz
Green	V peak to peak = 600 V, Power = 1 W, Frequency = 75 kHz
Red	V peak to peak = 700 V, Power = 2 W, Frequency = 75 kHz
Maximum absorbed power	120 W
Applicator electrode	Stainless steel sterile disposable needle
Risk classification of the device	IIb**(Medium-high risk)

*In the current study, the white handpiece was used.
**This classification relates to the Non-invasive medical devices within the field of dermatology.

Ocular examinations

To scrutinize the efficacy of PANIS method, 9 parameters were measured before the procedure, and 1 month and 6 months after 3 times punctal occlusion. The examinations concluded refraction, uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), ocular surface disease index (OSDI) (final scores ranges from 0 to 100), intraocular pressure (IOP), and dry eye tests including tear breakup time (TBUT), tear meniscus height (TMH), corneal fluorescein staining (CFS) using the National Eye Institute/Industry (NEI) grading scale, and Schirmer test. IOP was performed using a rebound tonometer (iCare Finland Oy, Vantaa, Finland). TBUT, TMH, and CFS were measured by a handheld ocular surface analyzer (OSA-VET, SBM Sistemi, Torino, Italy).

Results

Comparing the values of preoperative and 6-month postoperative parameters shows significant improvement in tear meniscus height (TMH) and tear break-up time (TBUT) in all cases. As was expected, uncorrected distance visual acuity (UDVA) and corrected distance visual acuity (CDVA) had no remarkable changes. Five patients exhibited 1 grade diminution, four patients exhibited 2 grades diminution, and one patient exhibited 3 grades diminution in corneal fluorescein staining (CFS). The Schirmer test in all participants increased considerably. In the preoperative examinations, the mean OSDI score of all patients was 64.93 which was down trended to 6.33 in the postoperative examinations (**Table 2**). These results revealed that the stricture could help remaining the natural tear on the ocular surface, and also that the amelioration process could be reducing the volume of tears coming out of the eyes (**Figure 1**).

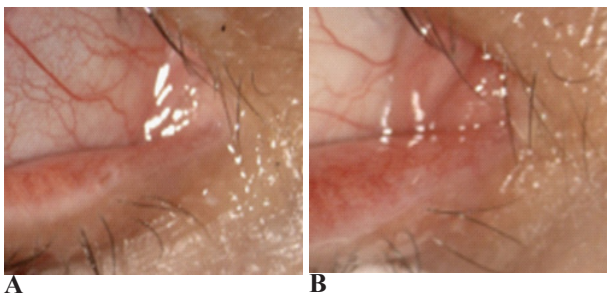

Figure 1: *a) Before plasma procedure, b) 6 months after plasma procedure.*

Table 2: *Patient's ophthalmic characteristics.*

Case number		UCVA	RE			BCVA	TBUT	TMH	CFS	schirmer	IOP	OSDI
			Sphere	cylinder	Axis							
#1	Pre	1	Plano	-0.25	110	1	4	0.05	1	9	19	50
	Post-op (1 month)	1	Plano	-0.25	110	1	6	0.12	0	11	20	22/2
	Post-op (6 months)	1	Plano	-0.25	110	1	10	0.23	0	15	18	11/36
#2	Pre	0.3	-1.00	-0.75	180	1	2	0.08	2	9	15	68/18
	Post-op (1 month)	0.4	-1.25	-0.75	180	1	4	0.16	1	16	14	43/5
	Post-op (6 months)	-0.3	-1	-0.75	180	1	7	0.3	0	19	14	2/27
#3	Pre	0.1	-3	-0.5	165	1	2	0.04	2	10	12	72/72
	Post-op (1 month)	0.2	-3	-0.75	165	1	6	0.18	1	13	15	24/5
	Post-op (6 months)	0.2	-3	-0.75	165	1	8	0.28	0	16	14	9/09
#4	Pre	0.2	-3.50	-0.5	125	1	4	0.11	2	11	8	42/5
	Post-op (1 month)	0.2	-2.75	-0.75	115	1	4	0.2	0	13	13	18/6
	Post-op (6 months)	0.2	-3.25	-0.75	125	1	5	0.25	0	18	12	3/125
#5	Pre	0.8	Plano	-1	180	1	2	0.01	2	5	11	81/81
	Post-op (1 month)	0.8	Plano	-0.75	180	1	5	0.2	1	8	14	34/5
	Post-op (6 months)	0.9	Plano	-0.75	180	1	7	0.23	0	15	12	6/81
#6	Pre	1	Plano	-0.25	170	1	4	0.18	1	10	10	52
	Post-op (1 month)	1	Plano	-0.25	170	1	7	0.21	0	14	11	38
	Post-op (6 months)	1	Plano	-0.25	170	1	8	0.25	0	17	11	10/3
#7	Pre	0.3	+2	-4	160	0.8	3	0.12	1	9	8	77
	Post-op (1 month)	0.3	+2	-4	160	0.8	5	0.2	0	11	14	29/7
	Post-op (6 months)	0.3	+2	-4	160	0.8	8	0.25	0	15	15	8/4
#8	Pre	0.6	+2.50	-0.50	145	1	4	0.12	1	7	12	71/8
	Post-op (1 month)	0.6	+2.50	-0.25	145	1	6	0.22	0	15	14	14
	Post-op (6 months)	0.6	+2.50	-0.5	145	1	8	0.27	0	18	12	3/2
#9	Pre	0.7	-0.75	-0.75	15	1	3	0.04	3	6	10	91/66
	Post-op (1 month)	0.7	-0.75	-0.5	15	1	6	0.16	2	9	12	18/3
	Post-op (6 months)	0.7	-0.75	-0.5	15	1	9	0.23	0	15	11	4/3
#10	Pre	0.5	-1.75	-0.5	135	1	3	0.16	1	8	10	41/66
	Post-op (1 month)	0.5	-1.5	-0/5	135	1	5	0.2	0	9	13	27/7
	Post-op (6 months)	0.5	-1.5	-0.5	135	1	8	0.24	0	11	10	4/5

Discussion

Punctal occlusion is an appropriate therapeutic method to relieve symptoms in patients with moderate to severe aqueous tear deficiency dry eye who have rejected artificial tears or any other medical prescriptions [29-32]. Since tear can provide many indices such as vitamin A that are necessary for cornea, occluding or stricture will be a good survival for ocular surface dryness [33, 34]. Doughty et al. showed that in 13,517 DED patients, mild complaints about dry eye symptoms are 1 in 4 and severe complaints is 1 in 225 which can raise the adverse effects on their life quality [35, 36]. Patients with severe criteria could be treated with temporary [37] or permanent punctal occlusion [38]. Liu and Sadhan reported a good result for permanent punctal occlusion showing long-term tear stability. They removed the punctum's epithelium and the vertical portion of the canaliculus, then bared punctum occluded by 6-0 chromic suture [39]. In another study by Knapp et al., the final analyses on 90 puncta proved that deep

cauterization is more effective than superficial blocking [40]. Furthermore, the research conducted by Vrabec et al. on 73 puncta disclosed that thermal cautery for occluding punctum has a longer effect over argon laser [41, 42, 43]. Another study with 10 eyes claimed that succinylated collagen punctal plugs (SCPP) preserve aqueous on the ocular surface for 14 days [44]. Temporary collagen punctal plugs have been introduced as a pre-permanent punctal closure to prevent epiphora or any possible complication after total occluding [2, 45, 46]. Plasma medicine application is increasingly developing in many fields day by day. Plasma is the fourth state of matter after solid, liquid, and gas, contains reactive species, and in some plasma generators present as ionizing the air [47].

Moreover, Sotiris et al. evaluated plasma in the dermatologic field by applying plasma on 80 patients' eyelids with a plexr device and showed that atmospheric low-temperature plasma (ALTP) can play an important role in altered nonsurgical blepharoplasty [48-50]. Thereafter, Nejat et al. brought plasma technology in the ophthalmic field and assessed the safety of applying plasma on rabbit's eye. After 1 month and 6 months follow-up, their results indicated that plasma exposure to the ocular surface has no complications [23, 24]. Evaluating plasma efficacy continued in the treatment of conjunctivochalasis, pinguecula, conjunctival cyst, and DED treatment with temporary punctal occlusion and it is noteworthy that in their case series, after 6 months follow-up, plasma-assisted noninvasive surgery (PANIS) proved to be a fast, office-based, easy, safe, and effective method in treating several ocular surface disorders. In the current study, Nejat et al. presented a novel technique for long-term punctal stricture that causes more tears on the ocular surface besides avoiding epiphora which is the most frequent occluding complication. To ensure the result, a study with a high sample size and longer follow-up is suggested.

Conclusion

In conclusion, plasma-assisted noninvasive surgery (PANIS) can be a fast, easy, safe, office-based, effective, and inexpensive method for long-term punctal stricture which is a novel approach for severe DED treatment and also prevention of possible epiphora simultaneously. This therapy might cure some patients with severe DED who are not demanding any permanent or invasive treatment.

Acknowledgment: None declared.

Conflict of interests: None declared.

Funding Source: None declared.

References

1. Ervin AM, A Law, and AD Pucker. Punctal occlusion for dry eye syndrome: summary of a Cochrane systematic review. British Journal of Ophthalmology. 2019; 103(3): 301-306.

2. Cohen EJ, Punctal occlusion. Archives of Ophthalmology. 1999; 117(3): 389-390.

3. Dohlman CH. Punctal occlusion in keratoconjunctivitis sicca. Ophthalmology. 1978; 85(12): 1277-1281.

4. Lemp MA. and GN Foulks. The definition and classification of dry eye disease. Ocul Surf. 2007; 5(2): 75-92.

5. Laroussi M. Low temperature plasma-based sterilization: overview and state-of-the-art. Plasma processes and polymers. 2005; 2(5): 391-400.

6. Bron AJ. Diagnosis of dry eye. Survey of ophthalmology, 2001; 45: S221-S226.

7. O'Neil EC, et al., Advances in dry eye disease treatment. Current opinion in ophthalmology, 2019; 30(3): 166.

8. Marshall LL and JM Roach. Treatment of dry eye disease. The Consultant Pharmacist®, 2016. 31(2): 96-106.

9. Hovanesian JA, SS Shah and RK Maloney. Symptoms of dry eye and recurrent erosion syndrome after refractive surgery. Journal of Cataract & Refractive Surgery, 2001; 27(4): 577-584.

10. Smith JA. The epidemiology of dry eye disease. Acta Ophthalmologica Scandinavica, 2007. 85.

11. Hantera MM. Trends in Dry Eye Disease Management Worldwide. Clinical Ophthalmology (Auckland, NZ), 2021; 15: 165.

12. Hashemi H, et al. Prevalence of dry eye syndrome in an adult population. Clinical & experimental ophthalmology, 2014; 42(3): 242-248.

13. Najafi L, et al. Dry eye and its correlation to diabetes microvascular complications in people with type 2 diabetes mellitus. Journal of Diabetes and its Complications, 2013; 27(5): 459-462.

14. Rouen PA and ML White. Dry eye disease: prevalence, assessment, and management. Home healthcare now, 2018; 36(2): 74-83.

15. Buckley R. Assessment and management of dry eye disease. Eye, 2018; 32(2): 200-203.

16. Gayton JL. Etiology, prevalence, and treatment of dry eye disease. Clinical ophthalmology (Auckland, NZ), 2009; 3: 405.

17. Clayton JA. Dry eye. New England Journal of Medicine, 2018; 378(23): 2212-2223.

18. Moss SE, R Klein, and BE Klein. Prevalence of and risk factors for dry eye syndrome. Archives of ophthalmology, 2000; 118(9): 1264-1268.

19. Burstein N. The effects of topical drugs and preservatives on the tears and corneal epithelium in dry eye. Transactions of the ophthalmological societies of the United Kingdom, 1985; 104: 402-409.

20. Giannaccare G, et al. Efficacy of omega-3 fatty acid supplementation for treatment of dry eye disease: a meta-analysis of randomized clinical trials. Cornea, 2019; 38(5): 565-573.

21. Wilson SE and HD Perry. Long-term resolution of chronic dry eye symptoms and signs after topical cyclosporine treatment. Ophthalmology, 2007; 114(1): 76-79.

22. Calonge M. The treatment of dry eye. Survey of ophthalmology, 2001; 45: S227-S239.

23. Nejat F, et al. Safety evaluation of the atmospheric low-temperature plasma (ALTP) on the conjunctiva: an animal study and histopathological findings; 6-month follow-up. BMC

ophthalmology, 2021; 21(1): 1-7.

24. Nejat F, et al. Safety evaluation of the plasma on ocular surface tissue: an animal study and histopathological findings. Clinical Plasma Medicine, 2019; 14: 100084.

25. Nejat F, et al. A Novel Approach to Treatment of Conjunctival Cyst Ablation Using Atmospheric Low-Temperature Plasma. Clinical Ophthalmology (Auckland, NZ), 2020. 14: 2525.

26. Jadidi K, et al. Evaluation of plasma assisted noninvasive surgery (PANIS) as a new approach for the treatment of conjunctivochalasis; a clinical case series. Expert Review of Ophthalmology, 2021: 1-6.

27. Nejat F, et al. A Novel Approach to Treatment of Pinguecula Using Atmospheric Low-temperature Plasma: A Clinical Case Series. American Journal of Clinical and Experimental Medicine, 2021. 9(5): 148-152.

28. Farhad Nejat KJ, Shima Eghtedari, Nazanin-Sadat Nabavi. Evaluation of efficacy of plasma assisted noninvasive surgery (PANIS) as a novel approach for temporary punctal occlusion: a clinical case series. SCIREA Journal of Clinical Medicine, 2021; 6(6): 421-432.

29. Liu Z and SC Pflugfelder. Corneal surface regularity and the effect of artificial tears in aqueous tear deficiency. Ophthalmology, 1999; 106(5): 939-943.

30. Begley CG, et al. Use of the dry eye questionnaire to measure symptoms of ocular irritation in patients with aqueous tear deficient dry eye. Cornea, 2002; 21(7): 664-670.

31. Goto E, et al. Improved functional visual acuity after punctal occlusion in dry eye patients. American journal of ophthalmology, 2003; 135(5): 704-705.

32. Latifi G, et al. Changes in Corneal Subbasal Nerves after Punctal Occlusion in Dry Eye Disease. Current Eye Research, 2021; 46(6): 777-783.

33. Tsubota K, Y Satake, and J Shimazaki. Treatment of severe dry eye. Lancet, 1996; 348(9020): 123.

34. Chen F, et al. Tear meniscus volume in dry eye after punctal occlusion. Investigative ophthalmology & visual science, 2010; 51(4): 1965-1969.

35. Schaumberg DA, et al. Prevalence of dry eye syndrome among US women. American journal of ophthalmology, 2003; 136(2): 318-326.

36. Doughty MJ, et al. A patient questionnaire approach to estimating the prevalence of dry eye symptoms in patients presenting to optometric practices across Canada. Optometry and vision science: official publication of the American Academy of Optometry, 1997; 74(8): 624-631.

37. Baxter SA and PR Laibson. Punctal plugs in the management of dry eyes. The ocular surface, 2004; 2(4): 255-265.

38. Tuberville A, W Frederick, and T Wood. Punctal occlusion in tear deficiency syndromes. Ophthalmology, 1982; 89(10): 1170-1172.

39. Liu D and Y Sadhan. Surgical punctal occlusion: a prospective study. British Journal of Ophthalmology, 2002; 86(9): 1031-1034.

40. Knapp ME, et al. A comparison of two methods of punctal occlusion. American journal of ophthalmology, 1989; 108(3): 315-318.

41. Vrabec MP, SH Elsing, and PA Aitken. A prospective, randomized comparison of thermal cautery and argon laser for permanent punctal occlusion. American journal of ophthalmology, 1993; 116(4): 469-471.

42. Benson DR, PB Hemmady, and RW Snyder. Efficacy of laser punctal occlusion. Ophthalmology, 1992; 99(4): 618-621.

43. Balaram M, DA Schaumberg, and MR Dana. Efficacy and tolerability outcomes after punctal occlusion with silicone plugs in dry eye syndrome. American journal of ophthalmology, 2001; 131(1): 30-36.

44. Hadassah J, et al. Preparation and clinical evaluation of succinylated collagen punctal plugs in dry eye syndrome: a pilot study. Ophthalmic research, 2010; 43(4): 185-192.

45. Glatt HJ. Failure of collagen plugs to predict epiphora after permanent punctal occlusion. SLACK Incorporated Thorofare, NJ. 1992.

46. Chen M and SY Choi. Preliminary outcomes of temporary collagen punctal plugs for patients with dry eye and glaucoma. Medical Hypothesis, Discovery and Innovation in Ophthalmology, 2020; 9(1): 56.

47. Fridman G, et al. Applied plasma medicine. Plasma processes and polymers, 2008; 5(6): 503-533.

48. Kong MG, et al. Plasma medicine: an introductory review. new Journal of Physics, 2009; 11(11): 115012.

49. Rossi E, et al. Clinical and confocal microscopy study of plasma exeresis for nonsurgical blepharoplasty of the upper eyelid: a pilot study. Dermatologic surgery, 2018; 44(2): 283-290.

50. Sotiris TG, G Nikolaos and G Irini. New treatment with plasma exeresis for non-surgical blepharoplasty. EC Ophthalmology, 2017; 5(4): 156-159.