Iris Color Change Using Nd: YAG Laser; a pilot in vivo study

ARTICLE INFO

Article Type

a pilot in vivo study

Authors
Hamidreza Hasani[1,2], Shayan Mardi [3*], Mohadeseh Rastgookoorandeh [2]

[1] Eye Research Center, The Five Senses Institute, Rasoul Akram Hospital, Iran University of Medical Sciences, Tehran, Iran
[2] Department of Ophthalmology, Madani Hospital, Alborz University of Medical Sciences, Karaj, Iran
[3] Student Research Committee, Arak University of Medical Sciences, Arak, Iran

Corresponding Author:
Shayan Mardi, MD
Student Research Committee, Arak University of Medical Sciences, Arak, Iran
Email: p.mardi.med@gmail.com
Tel: +989120560191

Received: 06 August, 2022
Accepted: 01 September, 2022
e Published: 25 March, 2023

Article History

ABSTRACT

Introduction: The present study aims to investigate the immediate discoloration effects of Nd: YAG laser on the surface of sheep iris. In this regard, the iris of a domestic sheep was extracted, and an Nd: YAG dual-frequency laser was applied to the surface of the iris. The laser wavelength setting was 532 nm, energy of 1.5 mJ, a spot size of 800 microns, and one pulse per burst. At the end of the procedure, the targeted spots were stained without iris penetration, resulting in lighter iris color. When a 20D concave lens was placed between the target and the laser source, the spots became larger in size and scattered the treatment.

Results:
As a result, this study showed that the Nd: YAG dual-frequency laser could effectively change and brighten the iris, leading to iris discoloration.

Keywords: YAG laser, Iris Color Change, Ovis aries

[DOI: 10.61186/sjrm.7.2.113]

تغییر رنگ عنبیه با استفاده از لیزر ;Nd: YAG یک مطالعه آزمایشی in vivo

حمیدرضا حسنی[۱و۲]، شایان مردی[۳*]، محدثه راستگوکورنده[۲]

[۱] مرکز تحقیقات چشم، موسسه حواس پنجگانه، بیمارستان رسول اکرم، دانشگاه علوم پزشکی ایران، تهران، ایران
[۲] گروه چشم پزشکی، بیمارستان مدنی، دانشگاه علوم پزشکی البرز، کرج، ایران
[۳] کمیته تحقیقات دانشجویی، دانشگاه علوم پزشکی اراک، اراک، ایران

چکیده

مقدمه: هدف از مطالعه حاضر بررسی اثرات تغییر رنگ فوی لیزر Nd:YAG بر سطح عنبیه گوسفند است. در این راستا، عنبیه یک گوسفند اهلی استخراج شد و لیزر دو فرکانس Nd: YAG بر روی سطح عنبیه اعمال شد. تنظیم طول موج لیزر ۵۳۲ نانومتر، انرژی ۱،۵ میلی ژول، اندازه نقطه ۸۰۰ میکرون و یک پالس در هر انفجار بود. در پایان عمل، لکه های مورد نظر بدون نفوذ عنبیه رنگ آمیزی شدند و در نتیجه رنگ عنبیه روشن تر شد. هنگامی که یک عدسی مقعر ۲۰ بعدی بین هدف و منبع لیزر قرار گرفت، لکه ها از نظر اندازه بزرگتر شدند و درمان را پراکنده کردند.

نتیجه گیری: در نتیجه، این مطالعه نشان داد که لیزر دو فرکانس Nd: YAG می تواند به طور موثر عنبیه را تغییر داده و روشن کند و منجر به تغییر رنگ عنبیه شود.

کلید واژه‌ها: لیزر YAG، تغییر رنگ عنبیه، Ovis aries

تاریخ دریافت: ۱۴۰۱/۰۵/۱۵
تاریخ پذیرش: ۱۴۰۱/۰۶/۱۰
*نویسنده مسئول: دکتر شایان مردی
کمیته تحقیقات دانشجویی، دانشکده پزشکی، دانشگاه علوم پزشکی اراک، اراک، ایران.

[DOI: 10.61186/sjrm.7.2.113]

Introduction

The Iris is a pigmented structure of the eye mainly responsible for controlling the amount of light reaching the retina. It contains two primary layers, a pigmented fibrovascular layer anteriorly and a non-pigmented layer or stroma posteriorly. Eye color is characterized by the melanin density of the iris and anterior pigmented layer [1].

One of the determinant factors affecting an individual's subjective sense of appearance is eye color. Cosmetic contact lenses, Keratopigmentation, and iris prosthesis are among the most widely introduced techniques for eye color change. Each method has significant risks for a purely cosmetic benefit [2-4].

Nd: YAG laser is widely used in ophthalmology. Peripheral iridotomy with Nd: YAG laser is the preferred procedure for treating angle-closure glaucoma, which directly targets pigmented cells and melanin [5]. Iris depigmentation and sectoral iris atrophy are undesirable changes that may appear due to this procedure [6]. Thus, the iris color on the atrophic area looks lighter. These side effects could potentially be useful for both cosmetic and therapeutic purposes.

The maximum absorption coefficient for melanin pigment is between the spectrum with the wavelength range of 400- 600 nm [7].

Therefore, a 532 nm wavelength Nd: YAG laser was applied in the present study.

A few pieces of research have been conducted on iris color change using lasers, and there is a need to perform more studies on this method.

The present study aims to apply a double-frequency 532 nm Nd: YAG laser to assess the immediate changes in the iris color of an extracted domestic sheep iris.

Methods

Animals Globe

A mammal with anterior segment biometric characteristics resembling the human eye was studied to select the best-fit animal eye globe. The globe of domestic sheep (Ovis aries), a quadrupedal, even-toed ungulate (Artiodactyla) ruminant mammal [8] with a mean globe axial length (AL) of 23.5 mm, equatorial diameter of 25.92 mm, anterior chamber depth (ACD) of 2.81 mm, and ACD/AL of 0.12 mm was selected [9].

Iris extraction

The two previously enucleated eyes of adult female sheep (ewe) cadavers killed for purposes other than this experiment were used, and the globes were kept in 0.09 % normal saline at 10° C for 12 hours. The color of both irides was dark brown. An ophthalmic knife was utilized to make a 360-degree incision at the limbus site to extract the iris. Then the cornea and aqueous humor were removed to approach the iris. The ARVO (Association for Research in Vision and Ophthalmology) guidelines were followed for each procedure. Institutional Animal Ethical Committee (IAEC) guidelines were respected.

Laser device

A double-frequency Nd: YAG laser SYL 9000 (LIGHTMED Corporation, USA, CA) was applied on a slit lamp biomicroscope, with a wavelength of 532 nm, energy of 1.5 mj, and spot size of 800 microns. Thirty single pulse shots were burst on an area with 3 * 3 mm2 on both extracted irises.

Assessment

A slit lamp biomicroscope was used to observe and capture an image of the irises before and after the procedure. The spot sizes were measured using a caliper.

Procedure

The extracted globes were placed at an appropriate distance from the laser. Then the shots burst as shown in Figure 1. This procedure was repeated for the fellow iris.

Results

On slit-lamp examination, the iris depigmentation was observed immediately following the procedure with minimal iris penetration and no perforation. Then, to expand the affected area on the iris with the same laser beam, a 20 D concave lens was placed between the target (iris) and the laser source to measure the spot size (Figures 2-4). The spot size was measured before and after the procedure using a caliper; it was extended significantly up to approximately 200 microns as the color changed.

Discussion

Along with recent advances in therapeutic ophthalmology, there is a demand for cosmetic ophthalmology. Eye color is one of the key

[DOI: 10.61186/sjrm.7.2.113]

features of one’s appearance. Having lighter eye colors, especially green and blue, is often desired [10].

The most common and easiest way to temporarily change eye color is to wear cosmetic contact lenses. There are significant risks to wearing improperly fitted cosmetic contact lenses, which are often purchased online without a prescription. Infectious keratitis, perforation, and endophthalmitis are all potential risks of inappropriate use. Allergic reactions to the lens material or lens cleansing solution are also concerning [11]. Above all, one of the most critical limitations of contact lenses is limited longevity. For safety, they should be replaced frequently; however, many users over-wear them and inadequately clean or disinfect them [2]. The high cost is also another important issue.

Another introduced method for eye discoloration is Keratopigmentation. In this method, pigments are injected into the corneal stroma to change the cosmetic appearance of the eye [3]. Allergic reactions, keratitis, infection, color changes over time, and unnatural appearance are among the undesired consequences of this method. Besides, people with systemic diseases such as collagen vascular diseases and congenital metabolic disorders are not eligible candidates for this technique [3,12,13].

Implanting prosthetic iris devices is a relatively new method first used for repairing iris defects and aniridia. Recently, it has been used for cosmetic purposes. Uveitis, glaucoma, corneal edema, and decreased visual acuity are the most threatening risks of this technique [4,14-17].

This study attempted to examine the eye color change by reducing melanin density on the iris using Nd: YAG laser. An apparent change was observed in iris color at targeted spots. This approach can be used for both therapeutic and cosmetic purposes. Heterochromia can occur due to genetics, some diseases, and trauma, including congenital Horner’s syndrome, Parry-Romberg syndrome, Sturge-Weber syndrome, and Waardenburg syndrome [18]. In these cases, Nd: YAG laser depigmentation might be practical to match the pigmentation and color of the non-affected eye to the affected eye [19]. Judicious use of laser might provide treatment with a far lower risk of infectious keratitis and endophthalmitis. In this method, IOP rise is also less compared to other methods like intraocular techniques.

Yildiray Yildirim et al. applied a 532 nm wavelength Nd: YAG doubled frequency laser with 900 µm spot size diameter at three sections in a 2-week interval and observed a depigmentation effect with no serious complications [20].

As the current Nd: YAG lasers are designed for peripheral iridotomy or treating posterior capsule opacification after cataract surgery, they have a relatively narrow focus and cover only a tiny area on the iris. To overcome this issue, we hypothesized that placing a high-power concave lens could be an effective solution due to its diverging potential. We observed that the spot sizes became greater after placing the lens.

© 2019 IrexLaser is a newly introduced technology for permanent eye color change. In this method, the laser is targeted at the thin melanin layer of the iris without any damage to the other parts of the eye in a minimally invasive surgical procedure [21]. In conclusion, this study showed that Nd: YAG laser-assisted eye color change is a novel procedure that could change eye color. Its safety and efficacy have not been proven in human beings. Further investigations should be carried out to clarify its effectiveness and determine the side effects.

Limitations

The procedure was conducted on an animal, and it may not apply to human beings necessarily. Secondly, the iris was extracted completely, so it was not possible to evaluate the laser's side effect on the other parts of the eye. Lack of follow-up, microscopic pathologic evaluation, and small sample size were among other limitations of this study. There is a need to consult with optical technologists to modify the laser settings for this purpose and repeat the procedure.

Funding: none

Conflict of interest: All authors declare no conflict of interest.

References

1. Prota G, Hu D-N, Vincensi MR, McCORMICK SA, NAPOLITANO A. Characterization of melanins in human irides and cultured uveal melanocytes from eyes of different colors. Experimental eye research. 1998;67(3):293-9.
2. Singh S, Satani D, Patel A, Vhankade R. Colored cosmetic contact lenses: an unsafe trend in the younger generation. Cornea. 2012;31(7):777-9.

[DOI: 10.61186/sjrm.7.2.113]

3. Galvis V, Tello A. Keratopigmentation: techniques and results. The British journal of ophthalmology. 2012;96(9):1270; author reply -1.
4. Srinivasan S, Ting DS, Snyder ME, Prasad S, Koch HR. Prosthetic iris devices. Canadian journal of ophthalmology Journal canadien d'ophtalmologie. 2014;49(1):6-17.
5. Drake MV. Neodymium: YAG laser iridotomy. Survey of ophthalmology. 1987;32(3):171-7.
6. Loon SC, Chew PT, Oen FT, Chan YH, Wong HT, Seah SK, et al. Iris ischaemic changes and visual outcome after acute primary angle closure. Clinical & experimental ophthalmology. 2005;33(5):473-7.
7. Tanaka Y, Matsuo K. Non-thermal effects of near-infrared irradiation on melanoma. Breakthroughs in Melanoma Research: IntechOpen; 2011.
8. Authors Go. Sheep 2019 [26/09/2019]. Available from: https://en.m.wikipedia.org/wiki/Sheep.
9. Mohammadi SF, Mazouri A, Jabbarvand M, Rahman-A N, Mohammadi A. Sheep practice eye for ophthalmic surgery training in skills laboratory. Journal of Cataract & Refractive Surgery. 2011;37(6):987-91.
10. Amy Hellem; reviewed by Gary Heiting O. Green eyes: The most attractive eye color? [26/09/2019]. Available from: https://www.allaboutvision.com/conditions/eye-color-green.htm.
11. Solomon A. Allergic manifestations of contact lens wearing. Current opinion in allergy and clinical immunology. 2016;16(5):492-7.
12. Al-Shymali O, Rodriguez AE, Amesty MA, Alio JL. Superficial Keratopigmentation: An Alternative Solution for Patients With Cosmetically or Functionally Impaired Eyes. Cornea. 2018.
13. Mannis MJ, Eghbali K, Schwab IR. Keratopigmentation: a review of corneal tattooing. Cornea. 1999;18(6):633-7.
14. Hoguet A, Ritterband D, Koplin R, Wu E, Raviv T, Aljian J, et al. Serious ocular complications of cosmetic iris implants in 14 eyes. Journal of Cataract & Refractive Surgery. 2012;38(3):387-93.
15. Gerding H, Hailemariam S, Timmermann M. Complications after prosthetic iris implantation in a case of traumatic aniridia. Klinische Monatsblatter fur Augenheilkunde. 2013;230(4):323-5.
16. Karatza EC, Burk SE, Snyder ME, Osher RH. Outcomes of prosthetic iris implantation in patients with albinism. Journal of cataract and refractive surgery. 2007;33(10):1763-9.
17. Wolff J. [Prosthetic iris devices]. Der Ophthalmologe : Zeitschrift der Deutschen Ophthalmologischen Gesellschaft. 2011;108(8):714-9.
18. Rennie I. Don't it make my blue eyes brown: heterochromia and other abnormalities of the iris. Eye. 2012;26(1):29.
19. Basoglu A, Çelik U. The Effect of SLT Laser Application on Iris to Treat Sectorial Heterochromia: A Promising Technique. Eye & contact lens. 2018;44:S352-S4.
20. Yildirim Y, Duzgun E, Kar T, Sonmez M, Kucukodaci Z, Ersanli D, et al. Evaluation of color-changing effect and complications after Nd: YAG Laser application on iris surface. Medical science monitor: international medical journal of experimental and clinical research. 2016;22:107.
21. Professionals GoM. IrexLaser 2018 [26/09/2019]. Available from: https://irexlaser.com/about/.

[DOI: 10.61186/sjrm.7.2.113]

Figure 1. Placing extracted iris on the appropriate site for Nd: YAG burst.

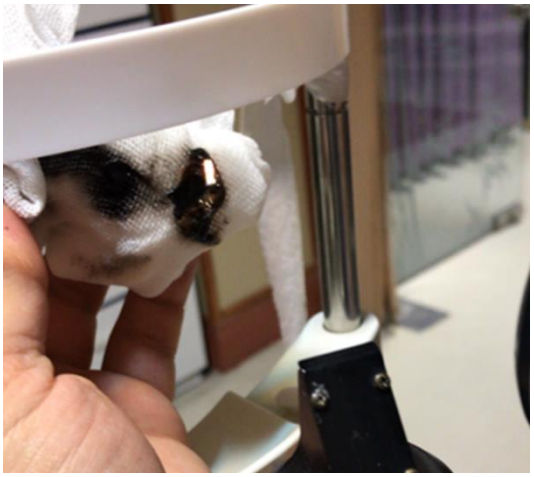
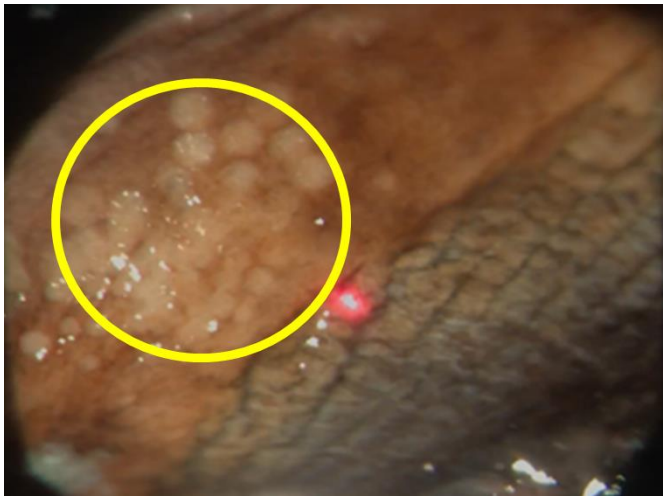


Figure 2. Placing the - 20 D concave lens between the iris and laser.

Figure 3. Macroscopic view, after laser application. See the white dots.

Figure 4. Microscopic view, after laser application. See the white dots.



[DOI: 10.61186/sjrm.7.2.113]