Minimal chronic glaucoma risk after laser iridoplasty, demonstrated by tonography

Pedro Grimaldos Ruiz (doctor.grimaldos@eyecos.eu)
University of Valencia
Victoria Roko
University of Valencia

Research Article

Keywords: Photoablative cosmetic iridoplasty, eye color change, iris heterochromia, iris nevus, tonography, pigmentary chronic glaucoma, ocular cosmetics

Posted Date: June 9th, 2023

DOI: https://doi.org/10.21203/rs.3.rs-3025793/v1

Abstract

PURPOSE: To demonstrate that the risk of developing chronic pigmentary glaucoma following photoablative cosmetic iridoplasty (PCI) is minimal. To achieve this we employ the Grimaldos-Honan tonography.

DESIGN: Prospective and comparative clinical study on intraocular pressures, before and after PCI.

METHOD: A total of 560 patients were included in this study, consisting of healthy individuals over the age of 18. The patient population included cases of heterochromia, including congenital (7%), acquired (1%), trauma-related (0.5%), surgical (0.25%), nevus-related (0.25%), and cosmetic cases (91%). In our study, we employed the Tomey FT 1000 non-contact air tonometer to measure intraocular pressure (IOP) before and after the Grimaldos-Honan test. The procedure involves applying controlled pressure to the right eye using a Honan balloon for a duration of two minutes, while the left eye serves as a control. After removing the balloon, IOP is measured again within five minutes using the same tonometer in both eyes. This allows us to compare the pressure changes between the eye where the balloon was applied and the control eye.

RESULTS: When comparing the right eye pressure before and after the Grimaldos-Honan test, Wilcoxon test showed a statistically significant difference, with a p-value <2.2e-16 and a mean decrease of 1.749. In contrast, the tests comparing the pressure in the left eye before and after the Grimaldos-Honan test did not yield significant values. Both the Wilcoxon test and T-test showed p-values of 0.8589 and 0.5405, respectively, suggesting minimal differences and no significant effect on the pressure values in the eye without balloon application (mean decrease of -0.036). Furthermore, we compared the percentage decrease in right eye pressure (13.38) with the percentage decrease in left eye pressure (-1.01). Both the T-test and Wilcoxon test demonstrated statistically significant results, with p-values < 2.2e-16 and a mean difference of 14.39%. Investigating potential influences, we examined the impact of initial pigmentary degree and treatment phase number on the pressure differences between the right and left eyes. The Kruskal-Wallis test revealed no statistically significant differences in the percentage decrease in right eye pressure among patients with different pigmentary degrees (2 - 5) p-value of 0.2569 or treatment phases (1 - 5) p-value 0.3115, indicating that these factors did not affect the pressure reduction rate. For patients undergoing laser treatment, we analyzed the intraocular pressures of the right and left eyes before and after one full phase of laser treatment. No significant differences were found in the pressures of either eye before and after laser treatment, suggesting that the procedure did not significantly affect intraocular pressure (p-values > 0.5731).

CONCLUSION: Pigmentary glaucoma occurs when pigment from the iris is released and deposited onto the trabecular meshwork, leading to obstruction of the outflow pathway and increased resistance to aqueous humor drainage. This results in elevated intraocular pressure (IOP) levels, which can cause irreversible damage to the optic nerve. To prevent blockage of flow and maintain appropriate pressures, post-laser care is crucial. Patients are advised to maintain an upright posture after the procedure to allow residual pigment to settle in the inferior quadrant through gravity. This helps prevent further migration of

pigment into the anterior chamber and promotes localized deposition. The recruitment of macrophages and phagocytes also plays a role in eliminating deposited pigment. Gonioscopy, particularly 360-degree imaging, provides insights into the distribution of pigment deposition, which aligns with the postural treatment approach. Additionally, a waiting period of 4 to 6 months is recommended before initiating subsequent laser interventions to allow for iris stromal homeostasis and healing processes. The Grimaldos-Honan tonography method is utilized to evaluate changes in IOP before and after laser treatment, providing valuable data for monitoring the effectiveness and safety of the procedure. This comprehensive approach, including clinical history assessment, regular IOP monitoring, tonography, and gonioscopy, contributes to personalized management of pigmentary glaucoma and improved treatment outcomes.

INTRODUCTION

Pigmentary disorders of the iris, such as heterochromia, have traditionally been treated with invasive techniques such as intraocular lenses or keratopigmentation (1, 2). However, these procedures have often resulted in serious complications (glaucoma, uveitis, corneal damage) and artificial-looking results (3, 4).

In 2011, we began research to develop a new technique: Photoablative Cosmetic Iridoplasty (PCI) which aimed to treat pigmentary disorders of the iris and achieve purely cosmetic results in a safe and effective manner (5).

A comparative study of four types of lasers was conducted to determine the most effective and safe option. Between 2013 and 2016, 1,328 eyes were treated with these four lasers. The study found that the 532-nm Crystal Q-switched Nd: Yag laser with 3–4 ns pulses demonstrated the best levels of efficacy, safety, and predictability. As a result, this laser was selected for all iris depigmentation treatments since 2017. During this period, no cases of vision loss were reported. Visual acuity and intraocular pressure also showed no significant differences after the treatments (5).

The indications to apply PCI have been alterations in iris pigmentation, which have included unilateral or bilateral, partial or complete, congenital heterochromia, single or multiple nevus, and acquired causes, secondary to trauma, surgical complications (cataracts), and due to iatrogenesis from the abuse of prostaglandin eye drops to lengthen eyelashes (Fig. 1). The most frequent reasons for interested patients were purely aesthetic (close to 91% of the total), without the presence of heterochromia (5).

Before the procedure, a detailed clinical history is taken, followed by an ophthalmologic examination using the Analyzer IRIZ (Eyecos) (Fig. 2). This program provides data on pigmentation grade, colorimetry, iris pachymetry, and 3D topography, which are used to plan the treatment. The Predictor IRIZ software (Eyecos) is used to show the patient the expected results based on their eye, skin, and hair pigmentation, as well as that of their parents.

We provide patients with appropriate classification based on their pigment level, ranging from grade 1 to grade 5. Since 2017, the utilization of the Nd: Yag 532 nm (3–4 ns) laser exclusively allowed us to

consider grade IV pigmentation as eligible candidates. Therefore, a second classification was introduced to include individuals with very dark eyes (grade V) (Fig. 3), establishing a new admission. Depending on the grade and amount of pigment in the eye, a minimum number of phases is determined to achieve the desired outcome, which may be subject to adjustment as the treatment progresses. Each phase consists of four consecutive daily sessions, which are repeated every 4–6 months until finalization (5).

The medication prior to the procedure includes drops of diclofenac-sodium and timolol maleate every 8 hours starting two days before the procedure. This is necessary to prevent inflammatory reactions and pressure peaks (acute complications during the SLT technique). Anesthetic drops and pilocarpine drops are applied if necessary, to keep pupils miotic during the procedure.

The procedure is performed with the 532-nm Crystal Q-switched laser, with 3–4 ns pulses, commonly used in selective laser trabeculoplasty (SLT). The laser's effects are painless, although the light from the slit-lamp may cause discomfort.

Following the procedure, both steroidal and nonsteroidal oral anti-inflammatories are prescribed, and the frequency of eye drops is increased to every 3 hours until midnight. Following the final session, the dose decreases to three times a day for only 1 week, and then we add artificial tears with sodium heparin every 8 hours for 3 months. The topical anti-inflammatory and antihypertensive treatment lasts only one week, to avoid any type of discomfort.

Despite its benefits, there are some complications associated with laser iridoplasty, always slight and short term duration (5):

- Acute high IOP occurs when there is a sudden blockage of the drainage of aqueous humor fluid from the eye, which leads to a rise in intraocular pressure.
- Acute depot: refers to lower pigmentation deposition that disappears over time, or a minimum rest remains attached to the lower iris.
- Microhemorrhage: stromal micro bleedings that are auto-resolved within a few seconds with the help of ocular pressure.
- Acute iritis: it is the inflammation of the anterior portion of the uvea, which can cause eye redness, discomfort or achiness in the affected eye, sensitivity to light, and decreased vision.
- Corneal edema: occurs when the endothelium cells of the cornea stop working, which leads to swelling in the cornea.
- Anisocoria, which is the medical term for asymmetric pupils, can be caused by lots of conditions, including laser iridoplasty.

By far, of all the complications associated with laser iridoplasty, chronic pigmentary glaucoma is the most feared. Pigmentary chronic glaucoma is a secondary glaucoma caused by pigment dispersion síndrome (6,7). This disease is characterized by detachment of posterior iris pigments (melanin), which are trapped in the aqueous humor drainage system, causing its obstruction. When melanin becomes

trapped in the trabecular meshwork or in any other structure of the drainage system, it prevents aqueous humor from flowing or being absorbed correctly and a significant increase in intraocular pressure occurs. The elevated IOP levels constant or fluctuating damage the optic nerve causing irreversible damage.

Our study was finally focused on demonstrating that the risk of glaucoma following laser iridoplasty is minimal. To achieve this goal, we conducted a tonography study.

METHODS

The selection of patients for our study was carried out in healthy individuals, over 18 years of age, which included cases of congenital heterochromia (7%), acquired heterochromia secondary to topical medication (1%), heterochromia due to trauma (0.5%) or surgery (0.25%), nevus (0.25%) and cosmetic cases (91%). The exclusion criteria were strict: patients under 18 years old, those with personal or family history of glaucoma, chronic ocular pathology such as uveitis, iritis, retinopathy, or trauma, systemic inflammatory, infectious, or oncological diseases, chronic vascular diseases such as diabetes or Raynaud, autoimmune diseases such as rheumatoid arthritis, Crohn's disease, ulcerous colitis, Behcet disease, lupus erythematosus, or multiple sclerosis, serious psychological disorders or psychiatric diseases such as depression, bipolar disorder, or obsessive-compulsive disorders, and patients with body dysmorphia disorder in particular. We also rejected cases with specific medical allergies or intolerances, as well as those with chronic consumption of anabolic steroids, hormones, or drugs (5).

A total of 560 patients were included in our study. The average age of patients was 35.66 years, with the youngest patient being 18 years old and the oldest 66 years old. Regarding degrees of pigmentation, we admitted cases in grades II - V. In addition, patient selection was independent of the number of phases previously undergone, ranging from 1 to 5 inclusive. Finally, for the study, we had a total of 288 women and 272 men. Among them, 27 individuals belonged to grade 2, 300 to grade 3, 204 to grade 4, and 29 to grade 5. Regarding the treatment phases, we had 282 participants in phase 1, 113 in phase 2, 87 in phase 3, 59 in phase 4 and 19 in phase 5.

In our study, we utilized the Tomey FT 1000 non-contact air tonometer to measure intraocular pressure before and after a procedure known as the Grimaldos-Honan test (Fig. 4). Following the initial intraocular pressure measurement with the Tomey, a pressure is applied to the right eye using a Honan balloon. A small gauze is placed between the right eye and the balloon to prevent contact and allergic reactions in patients allergic to rubber. The balloon is left at a pressure of no more than 40 mmHg for a duration of two minutes, timed with a clock. The patient remains seated and resting for the full duration of the two-minute period. Following this, the Honan balloon is removed, and intraocular pressure is measured again, no more than five minutes after the balloon is removed. This second measurement is also taken using the Tomey. Intraocular pressure is measured in both eyes during both occasions, enabling us to compare the pressure variation between the eye that received the Honan balloon application and the eye that did not.

All pressure measurements are recorded in our database, and we manually calculate the percentage reduction in pressure between the first and second measurements in both eyes. We also took note of

valuable information to later conduct this study: medical record number, gender (male or female), age, initial degree of pigmentation, current phase number, initial treatment date, intraocular pressure measured in the right eye and left eye before the Grimaldos-Honan test and intraocular pressures in the right and left eyes after the Grimaldos-Honan test.

For the statistical analysis, we used R Studio software. We imported our database from Excel into R Studio, allowing us to access and manipulate the data efficiently. We selected specific fields required for each corresponding test, ensuring accurate and targeted analysis. In addition, we also utilized R Studio to create the majority of our graphical visualizations. The software's extensive library of packages and functions allowed us to generate high-quality and informative graphs that effectively represented our data. For certain specific graphs, we utilized Excel in conjunction with our database to create customized visualizations.

RESULTS

First, we checked the normality of the variables using the Shapiro Test, to determine if they followed a normal distribution or not. The Shapiro Test results were as follow: right eye pressure before Grimaldos-Honan test (p-value 0.0006951), left eye pressure before Grimaldos-Honan test (p-value 0.0004018), right eye pressure after Grimaldos-Honan test (p-value 2.647e-06), left eye pressure after Grimaldos-Honan test (p-value 0.0003327), percentage decrease in right eye pressure (p-value 1.63e-13) and percentage decrease in left eye pressure (p-value 1.134e-12). These highly significant p-values indicate that the variables do not follow a normal distribution. Therefore, non-parametric tests should be used for data analysis.

Our initial comparison focused on the right eye pressure before and after the Grimaldos-Honan test. Using both non-parametric tests (Wilcoxon Test) and parametric tests (T-Test) the p-value was < 2.2e-16, with a mean decrease of 1.749. These results indicate a statistically significant difference, confirming what we expected: the pressures in the right eye are lower after applying the Honan balloon.

In contrast, when we performed the same tests comparing the pressure in the left eye before and after the Grimaldos-Honan test, the values were not significant: Wilcoxon test (p-value 0.8589) and T-test (p-value 0.5405). This shows that in the eye where we did not apply pressure with the Honan's balloon, the pressure values were not significantly affected and had minimal differences (mean decrease of -0.036).

Next, we compared the percentage decrease in right eye pressure (13.38) with the percentage decrease in left eye pressure (-1.01). Both the T-test and Wilcoxon test showed statistically significant results with p-values < 2.2e-16. The difference between the means was 14.39% (Fig. 5).

Given the significant differences observed between the right and left eyes, we further investigated whether these differences were influenced by the initial pigmentary degree and the treatment phase number. The Kruskal-Wallis test (non-parametric) revealed no statistically significant differences in the percentage decrease in right eye pressure among patients with different pigmentary degrees (2–5), with a p-value of

0.2569. This suggests that the percentage decrease in pressure is not influenced by the amount of melanin present in the iris (Fig. 6).

The same test was used to compare the percentage decrease in right eye pressure based on the number of treatment phases (1–5). The results were also non-significant, with a p-value of 0.3115. These numbers confirm that regardless of the duration of PCI treatment, the pressure values in the right eye continue to decrease at a similar rate (Fig. 7).

Since our patients return for a second treatment phase after 4–6 months, we selected a sample of 117 patients who had not undergone laser treatment yet to monitor their intraocular pressures. We measured their pressures before starting the first laser phase and before starting the second laser phase within 4–6 months. Using a T-Test, we compared the intraocular pressures of the right and left eyes before and after one full phase of laser treatment. No significant differences were found in the right eye pressures before (mean 12.79) and after (mean 12.89) with a p-value 0.6056, with a mean difference of -0.0983. The same was observed in the left eye, with a pre-laser mean of 12.60 and a post-laser mean of 12.48, resulting in a p-value of 0.5731 and a mean difference of 0.1153 (Fig. 8).

Furthermore, we calculated and compared the mean pressure of both eyes before and after the laser using the same T-Test and found no significant differences (p-value 0.9586 and a mean difference of -0.008547). This suggests that laser iridoplasty treatment in patients does not have a significant impact on intraocular pressure (Fig. 9).

DISCUSSION

The pathogenesis of pigmentary glaucoma involves the release and deposition of pigment from the iris onto the trabecular meshwork. Pigment granules obstruct the outflow pathway, leading to increased resistance to aqueous humor drainage and subsequent elevation of IOP. The elevated IOP levels constant or fluctuating damage the optic nerve causing irreversible damage (6,7).

While we acknowledge the possibility of angle trabecular blockage following PCI, leading to chronic pigmentary glaucoma, the frequency of such cases in our clinical practice, is minimal. We believe post-laser treatment care is an essential aspect to achieve this. Patients are advised to maintain an upright posture for 5 to 6 hours following the procedure, facilitating the gravitational settling of any residual pigment in the inferior quadrant. This postural adjustment helps prevent further migration of pigment into the anterior chamber, contributing to a more localized deposition pattern. This process also involves the recruitment of macrophages and phagocytes, which play a crucial role in the anti-inflammatory response eliminating deposited pigment within the trabecular meshwork and anterior chamber (5).

Gonioscopy, particularly 360-degree imaging, offers valuable insights into the distribution of pigment deposition. After Cosmetic Laser Iridoplasty, melanin pigment is released into the anterior chamber from the iris surface, but the typical gonioscopic pattern típically reveals lower trabecular meshwork pigmentation, only about 70 degrees, remaining free the 290 upper degrees (Fig. 10). We also appreciate

a minimal loose pigment in the anterior chamber. This observation is consistent with the postural treatment approach, where gravity causes the pigment to settle inferiorly (5).

After PCI, we understand the importance of a waiting period of 4 to 6 months before initiating subsequent laser interventions. This practice is based on the principles of iris stromal homeostasis and healing processes (5).

The stages of wound healing proceed in an organized way and follow four processes: hemostasis, inflammation, proliferation and maturation. Although the stages of wound healing are linear, wounds can progress backward or forward depending on internal and external patient conditions. After you get injured, homeostasis begins in which your blood vessels are closed, and the platelets create substances that help stop bleeding through clotting. The body responds to trauma by raising the level of inflammation. The blood vessels dilate after homeostasis is achieved. This allows white blood cells, nutrients, enzymes, antibodies, and other beneficial elements to reach the affected area to accelerate wound healing. New healthy granulation tissue replaces the wound. It is important that your blood vessels receive enough nutrients and oxygen to form granulation tissue. The tissue consists of a mixture of collagen and extracellular matrix, which helps develop a new network of blood vessels. Maturation or remodeling is the end stage of the wound healing process. It takes place soon after your wound has closed up. During this stage, functional fibroblasts will replace nonfunctional ones and the number of blood vessels in the area will also decrease gradually.

Regarding tonometry, the Reichert tonography technique has conventionally been employed and provides fast and accurate tonometry and optional tonography functions. The probe tip, which floats on an air bearing, is gently touched to the anesthetized cornea and a precisely regulated flow of filtered air applies force to the tip. A small (5 mm diameter) fenestrated membrane permits the air to flow through vents in the tip until it conforms to the shape of the cornea. Increasing pressure is continually applied to the cornea until the force being applied is equal to the pressure in the anterior chamber. When these forces are in balance a pneumatic sensor records the intraocular pressure. In pulse tonometry mode, the ocular pulse waveform is charted and recorded along with IOP.

However, in our study, we developed and utilized the Grimaldos-Honan tonography method, which offers a complementary approach to measuring IOP. We believe the Grimaldos-Honan tonography method has demonstrated its utility in evaluating changes in IOP before and after laser treatment, providing valuable data for monitoring the effectiveness and security of PCI (5). Our statistical analysis yielded conclusive results that support this information. In addition, the Grimaldos-Honan test is a simple technique that does not require a significant amount of time. It can be easily performed in a medical practice without the need of expensive technology. Furthermore, this test is non-invasive and comfortable for patients, as it does not cause any discomfort or inconvenience.

In addition to the Grimaldos-Honan tonography, our approach to PCI treatment is founded on several pillars that ensure the safety and efficacy of the procedure. We place great emphasis on obtaining an extensive clinical history, which helps us understand each patient's unique characteristics and potential

risk factors. Additionally, we regularly monitor intraocular pressure throughout the entire laser treatment period, enabling us to assess the treatment's impact accurately. Tonography provides valuable insights into IOP changes and guides our decision-making process. Although not performed routinely, gonioscopy serves as an essential tool for research purposes, allowing us to investigate the distribution of pigment deposition and further refine our treatment strategies. Given the genetic basis of glaucoma, we also recommend genetic testing for open-angle glaucoma in patients with a family history or a predisposition to elevated intraocular pressure. These comprehensive approaches collectively contribute to a more holistic and personalized management of pigmentary glaucoma, enhancing treatment outcomes and patient care (5).

Declarations

ACKNOWLEDGMENTS

I would like to express my sincere thanks to the staff of the Eyecos clinic, who have worked tirelessly in this laborious study, as well as to collaborating researchers, as pathologists, geneticists, programmers, optical engineers, industrial engineers, physicists and mathematicians, designers, photographers, technicians, and endless self-sacrificing professionals.

COMPLIANCE WITH ETHICAL STANDARDS

To: Piergiorgio Neri, MD Editor of International Ophthalmology

Barcelona (Spain), Jun 2023

Dear Dr. Piergiorgio Neri,

MINIMAL CHRONIC GLAUCOMA RISK AFTER LASER IRIDOPLASTY, DEMONSTRATED BY TONOGRAPHY

AUTHORS: PEDRO GRIMALDOS, M.D., Ph.D. VICTORIA ROKO, M.D.

DISCLOSURE OF POTENTIAL CONFLICTS OF INTEREST:

Authors declare that was not funded by any institution or company.

Authors declare that he has no conflict of interest.

RESEARCH INVOLVING HUMAN PARTICIPANTS OR ANIMALS:

Authors declare that all procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Authors declare that Informed consent was obtained from all individual participants included in the study.

Authors declare that this article does not contain any studies with animals performed by author.

References

1. Galvis V, Tello A, Corrales M. Postoperative results of cosmetic iris implants. J Cataract Refract Surg 2016; 42: 1518-26.
2. Shah R, Randleman J. New color iris implants. Ophthalmology 2012; 119:1495-1495.e2.
3. Hoguet A, Ritterband D, Koplin R, et al. Serious ocular complications of cosmetic iris implants in 14 eyes. J Cataract Refract Surg 2012; 38: 387-93.
4. Mansour A, Ahmed II, Eadie B, et al. Iritis, glaucoma and corneal decompensation associated with Bright Ocular cosmetic iris implant. Br J Ophthalmol 2016; 100: 1098-101.
5. Grimaldos, P. Photoablative cosmetic iridoplasty: effective, safe, and predictable—eye color change in 1176 eyes. International Ophthalmology 2021; 41:1381–1393.
6. Zeppieri, M. Pigment dispersion syndrome: A brief overview 2022; J Clin Transl Res. Oct 31; 8(5): 344–350.
7. Scuderi, S; Contestabile, M.T.; Scuderi, L; Librando, A; Fenicia, V; Rahimi,S Pigment dispersion syndrome and pigmentary glaucoma: a review and update 2019; Int Ophthalmol Jul;39(7):1651-1662.

Figures

Figure 1

Left: Outcomes of cosmetic indications, according to degree of pigmentation. The most frequent indication for PCI is purely cosmetic. In grades I, II and III, we almost always get bluish, more or less bright

results. In contrast, in highly pigmented eyes (grade IV) we usually achieve bluish-gray results. Here we see the look of a patient treated with grade III.

Middle: Cosmetic results in cases of nevi, before and after PCI. In this composition we can see the excellent cosmetic results obtained in three cases of large nevi, including half of the iris (below). If we achieve the removal of the pigment near the limbus and the pupil, the final appearance is almost perfect. The color underlying the original nevus is similar to the rest of the iris, so an equality is obtained between the two eyes of the patient.

Right: Results in cases of trauma (above), complicated cataract surgery (middle) and abuse of topical prostaglandins(down). Among the main acquired causes of heterochromia are those secondary to complicated eye surgeries, such as congenital cataracts (above), those due to eye trauma with secondary hyperpigmentation (medium), and above all, those secondary to the abuse of drops with prostaglandins (Latisse®) (below). In these indications, the PCI achieves excellent results, although after several phases of sessions, in certain patients.

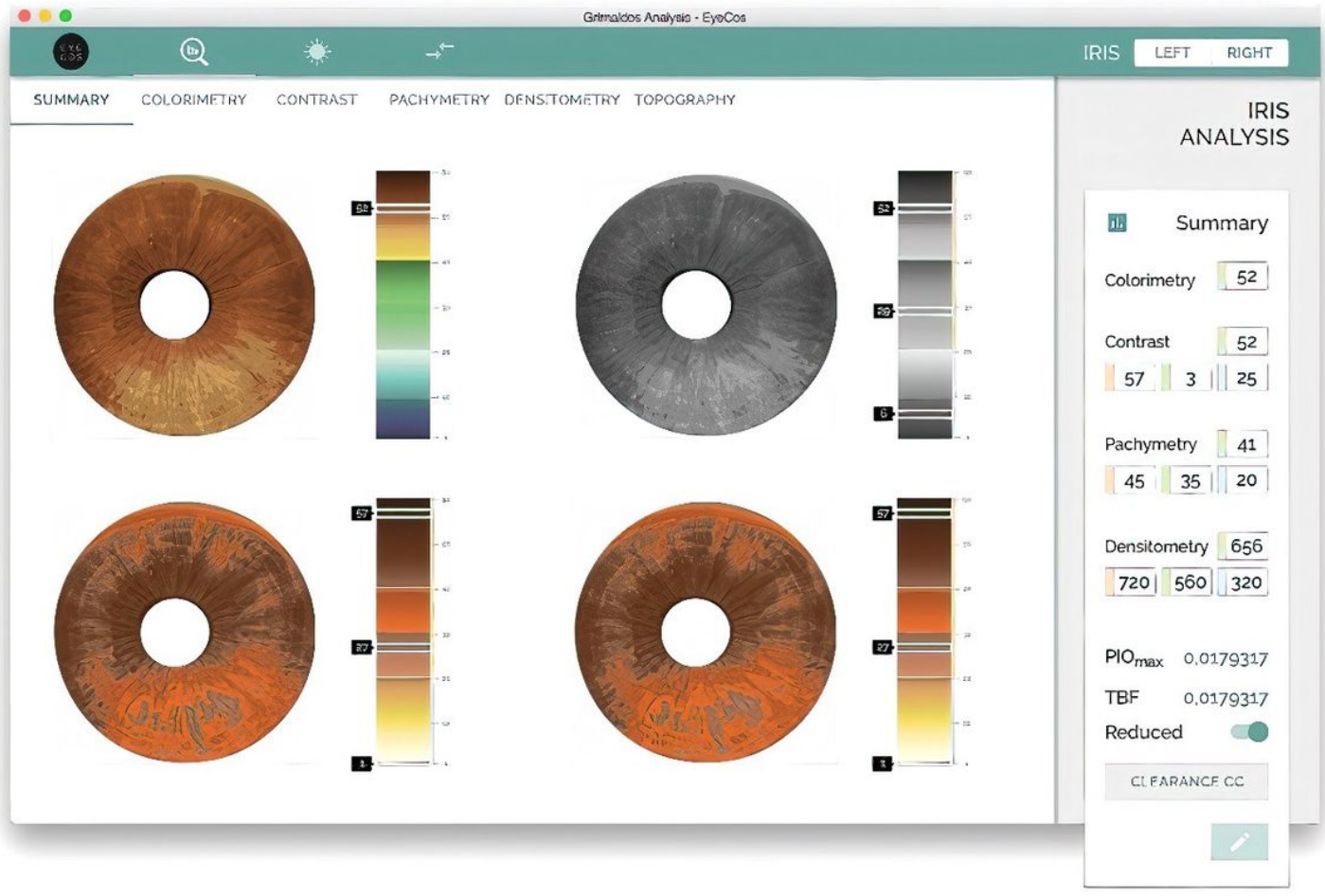


Figure 2

Eyecos Iris Summary: Pigmentation grade, colorimetry, color contrast, pachymetry, topography and physio-dynamic parameters of aqueous humor (maximum pressure, clearance curve and trabecular

blocking factor). Using Eyecos IRÎZ Scanner with the Analyzer program, we automatically obtain 4 graphs that describe the anterior pigmentary layer of the iris. In addition, Analyzer calculates the essential physiodynamic parameters of aqueous humor in the anterior chamber, to guarantee the safety of the procedure. The Eyecos Iris Summary is the key piece to perform accurate PCI procedures.

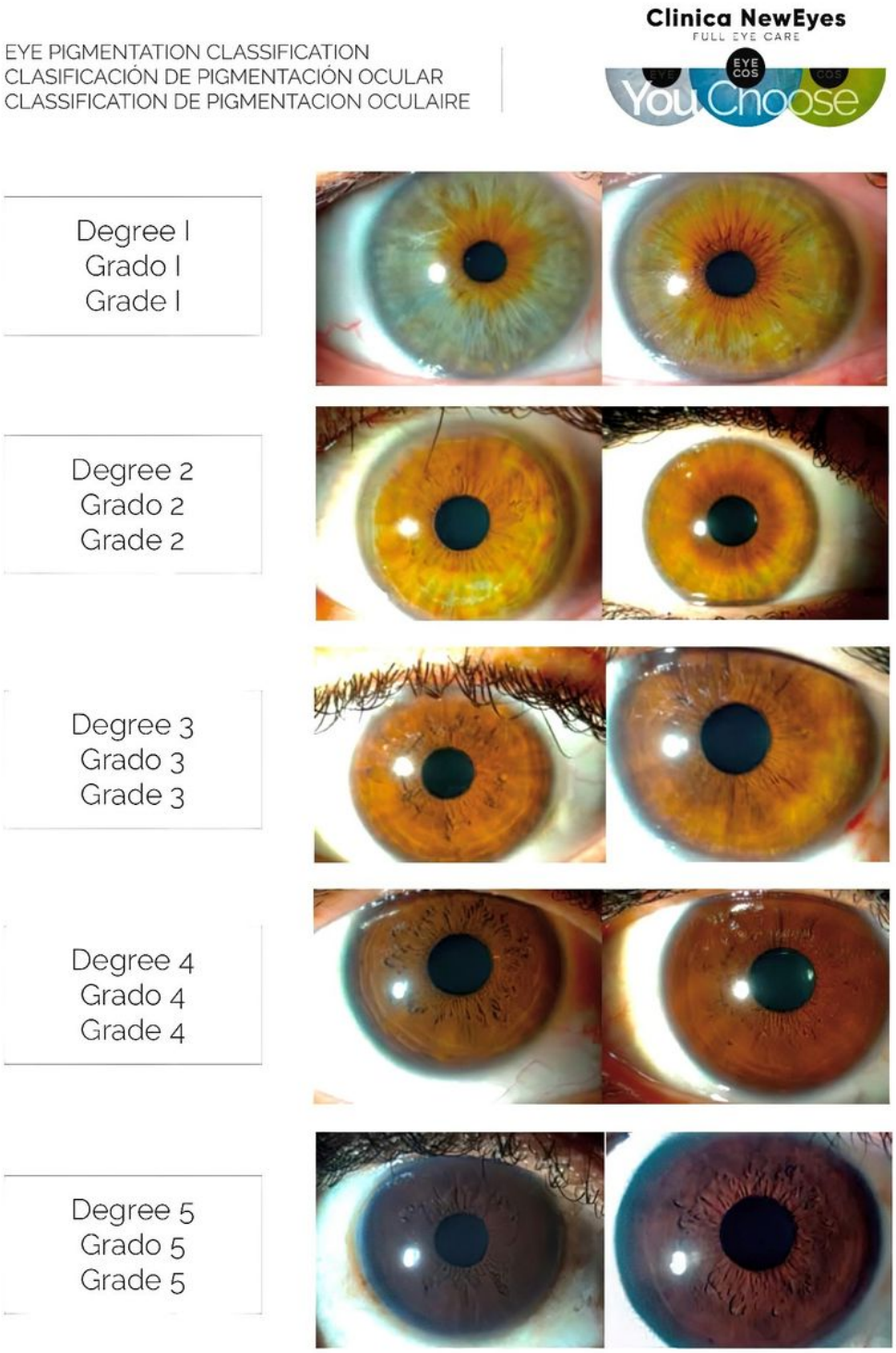


Figure 3

The Martin-Schultz scale, developed from the Martin scale, is one standard color scale commonly used in physical anthropology to establish more or less precisely the eye color of an individual; it was created by the anthropologists Rudolf Martin and Bruno K Schultz and in the fi rst half of the 20th century. The scale consists of 20 colors (from light blue to dark brown-black) that correspond to the diff erent eye colors observed in nature due to the amount of melanin in the iris. In order to have a simpler and practical table, we fi rst introduced a four levels classifi cation, and later a new one with fi ve levels, from less to more pigmentation.

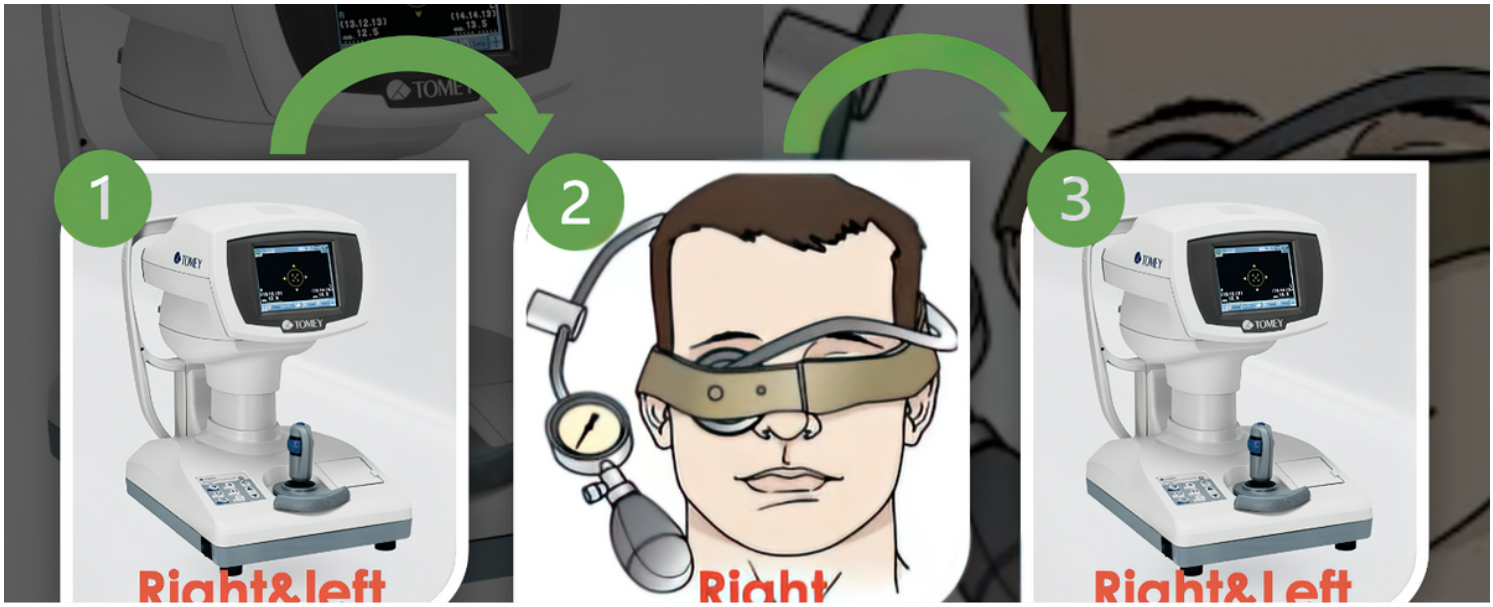


Figure 4

Following the initial intraocular pressure measurement with the Tomey, a pressure is applied to the right eye using a Honan balloon. A small gauze is placed between the right eye and the balloon to prevent contact and allergic reactions in patients allergic to rubber. The balloon is left at a pressure of no more than 40 mmHg for a duration of two minutes, timed with a clock. The patient remains seated and resting for the full duration of the two-minute period. Following this, the Honan balloon is removed, and intraocular pressure is measured again, no more than five minutes after the balloon is removed. This second measurement is also taken using the Tomey. Intraocular pressure is measured in both eyes during both occasions, enabling us to compare the pressure variation between the eye that received the Honan balloon application and the eye that did not.

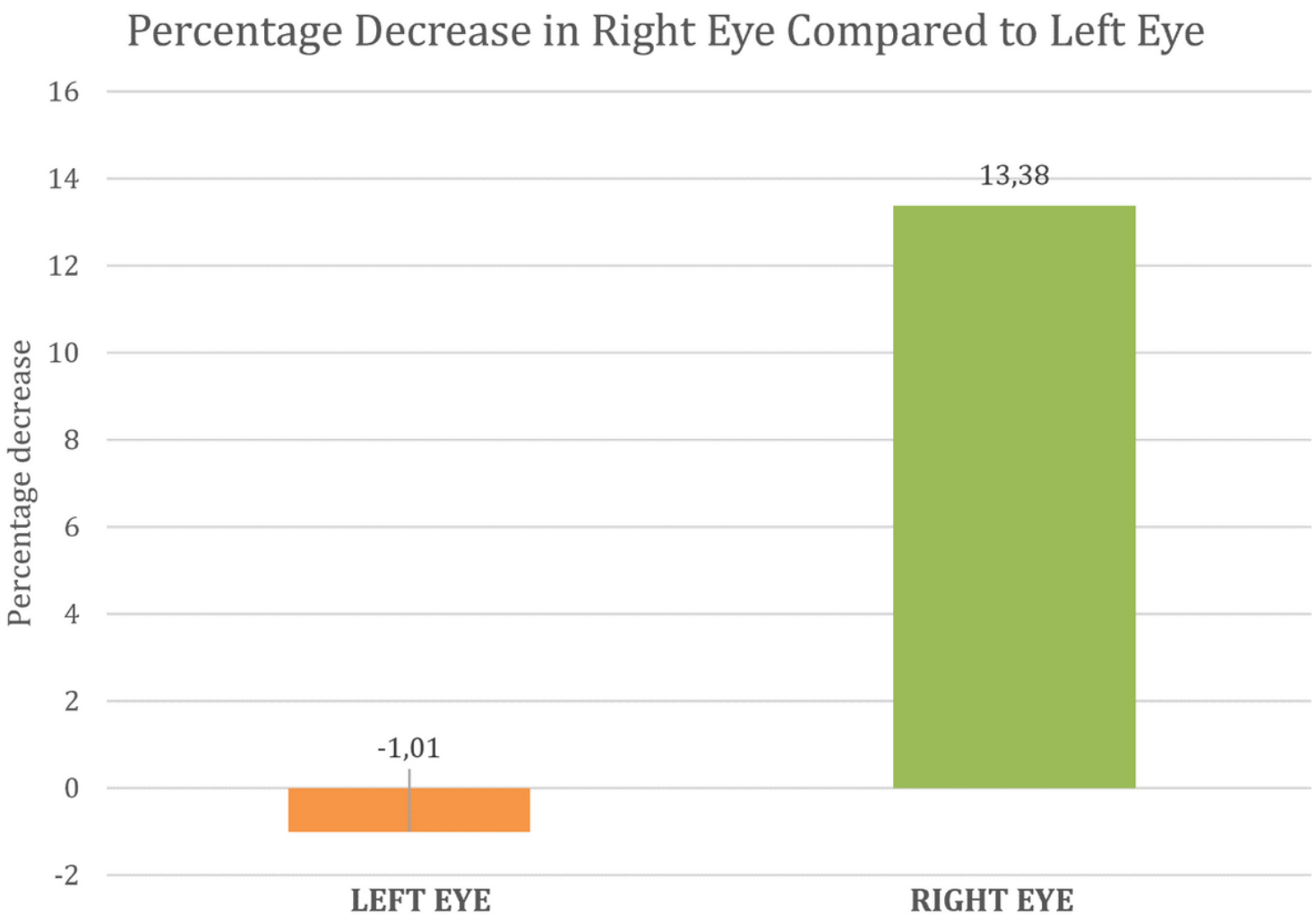


Figure 5

Tonography Grimaldos-Honan: Percentage IOP decrease in right eye compared toleft one. Both the T-test and Wilcoxon test showed statistically significant results with p-values < 2.2e-16. The difference between the means was 14.39%.

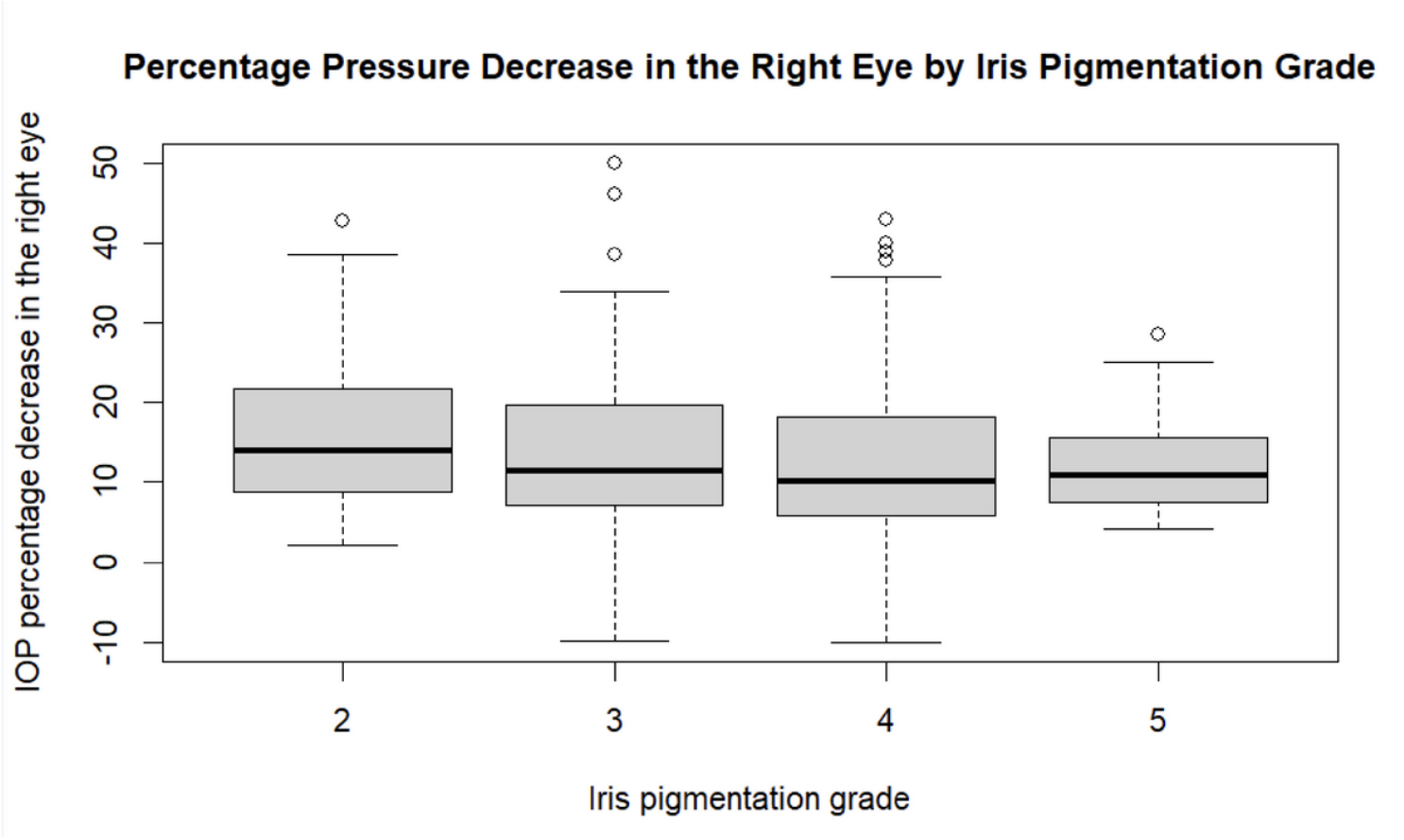


Figure 6

The Kruskal-Wallis test (non-parametric) revealed no statistically significant differences in the percentage decrease in right eye pressure among patients with different pigmentary degrees (2 - 5), with a p-value of 0.2569. This suggests that the percentage decrease in pressure is not influenced by the amount of melanin present in the iris.

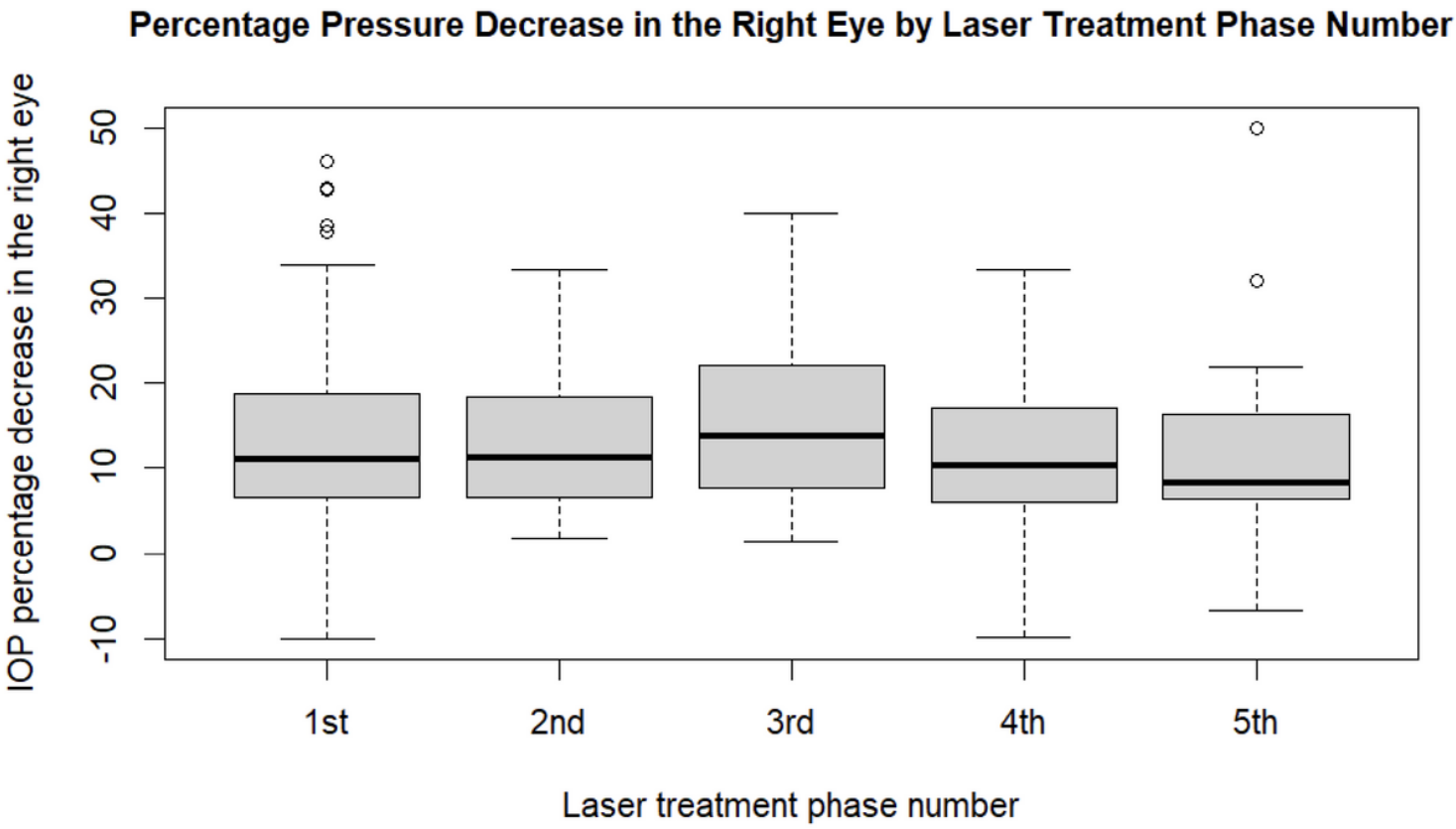


Figure 7

The same test was used to compare the percentage decrease in right eye pressure based on the number of treatment phases (1 - 5). The results were also non-significant, with a p-value of 0.3115. These numbers confirm that regardless of the duration of PCI treatment, the pressure values in the right eye continue to decrease at a similar rate.

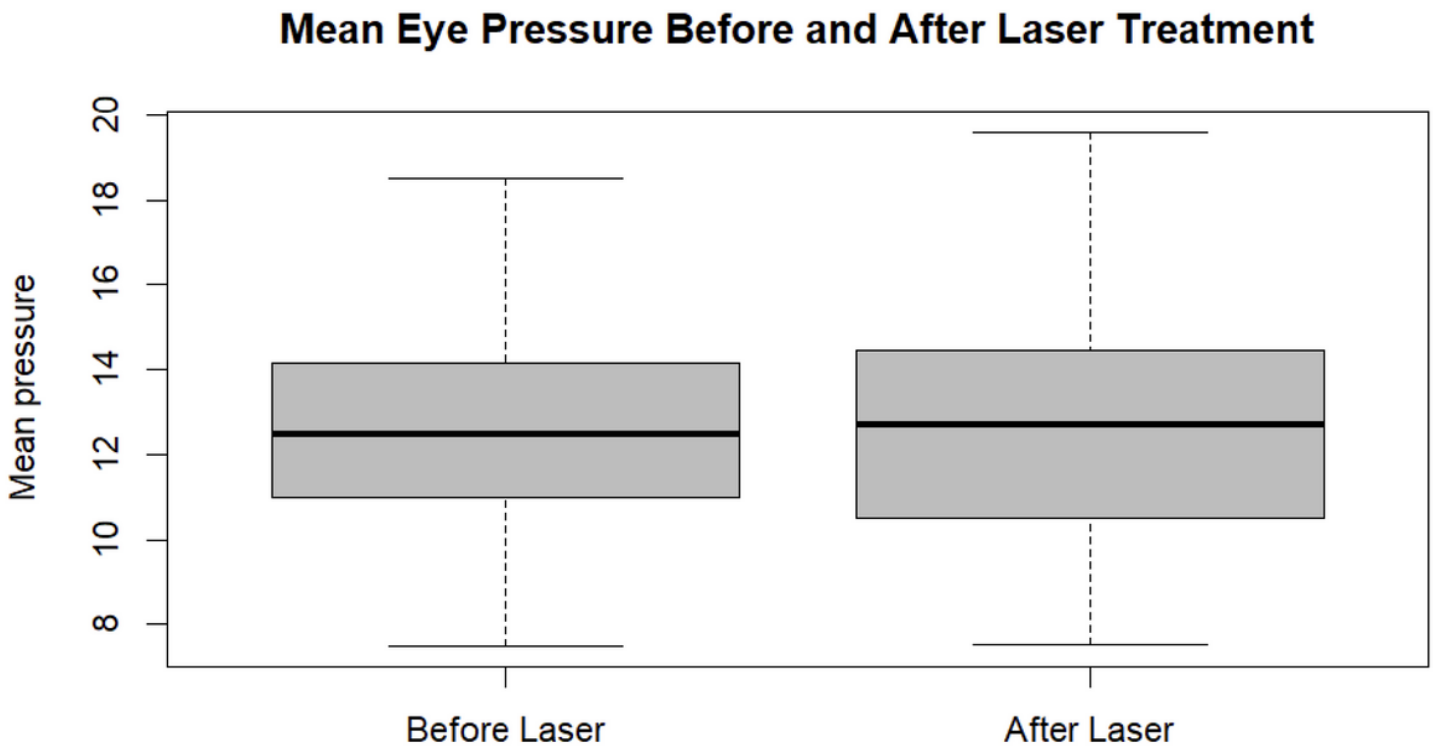
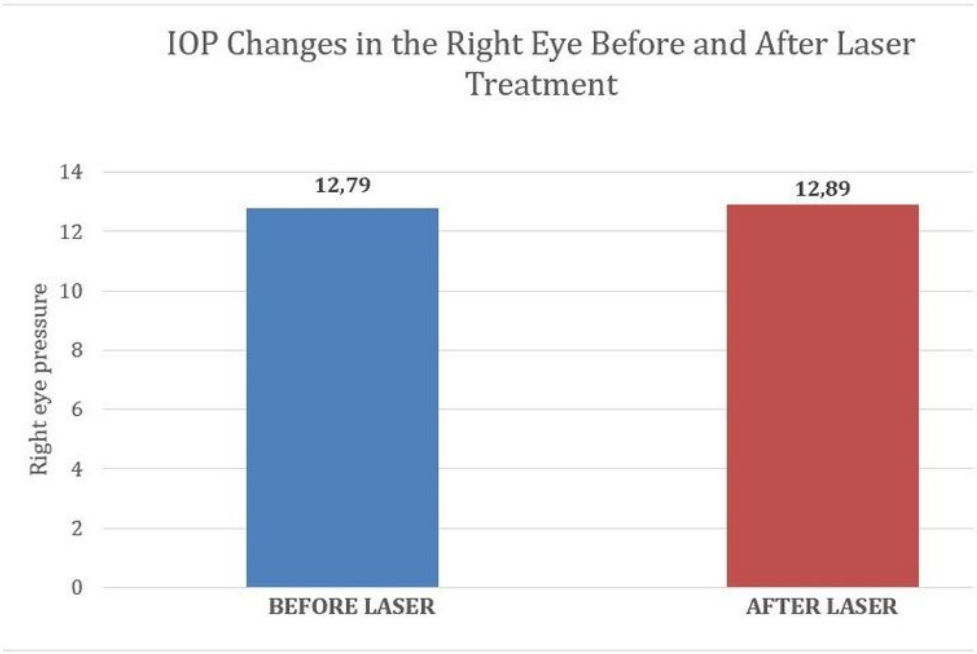


Figure 8

Using a T-Test, we compared the intraocular pressures of the right and left eyes before and after one full phase of laser treatment. No significant differences were found in the right eye pressures before (mean 12.79) and after (mean 12.89) with a p-value 0.6056, with a mean difference of -0.0983. The same was observed in the left eye, with a pre-laser mean of 12.60 and a post-laser mean of 12.48, resulting in a p-value of 0.5731 and a mean difference of 0.1153.



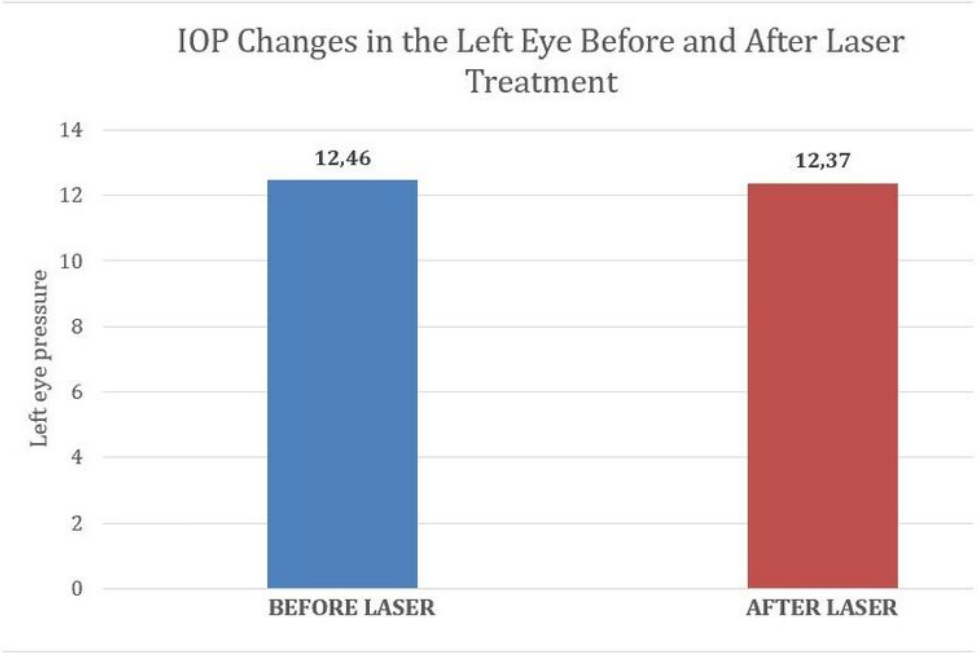


Figure 9

Pressure of both eyes before and after the laser using the same T-Test showed no significant differences (p-value 0.9586 and a mean difference of -0.008547). This suggests that laser iridoplasty treatment in patients does not have a significant impact on intraocular pressure.

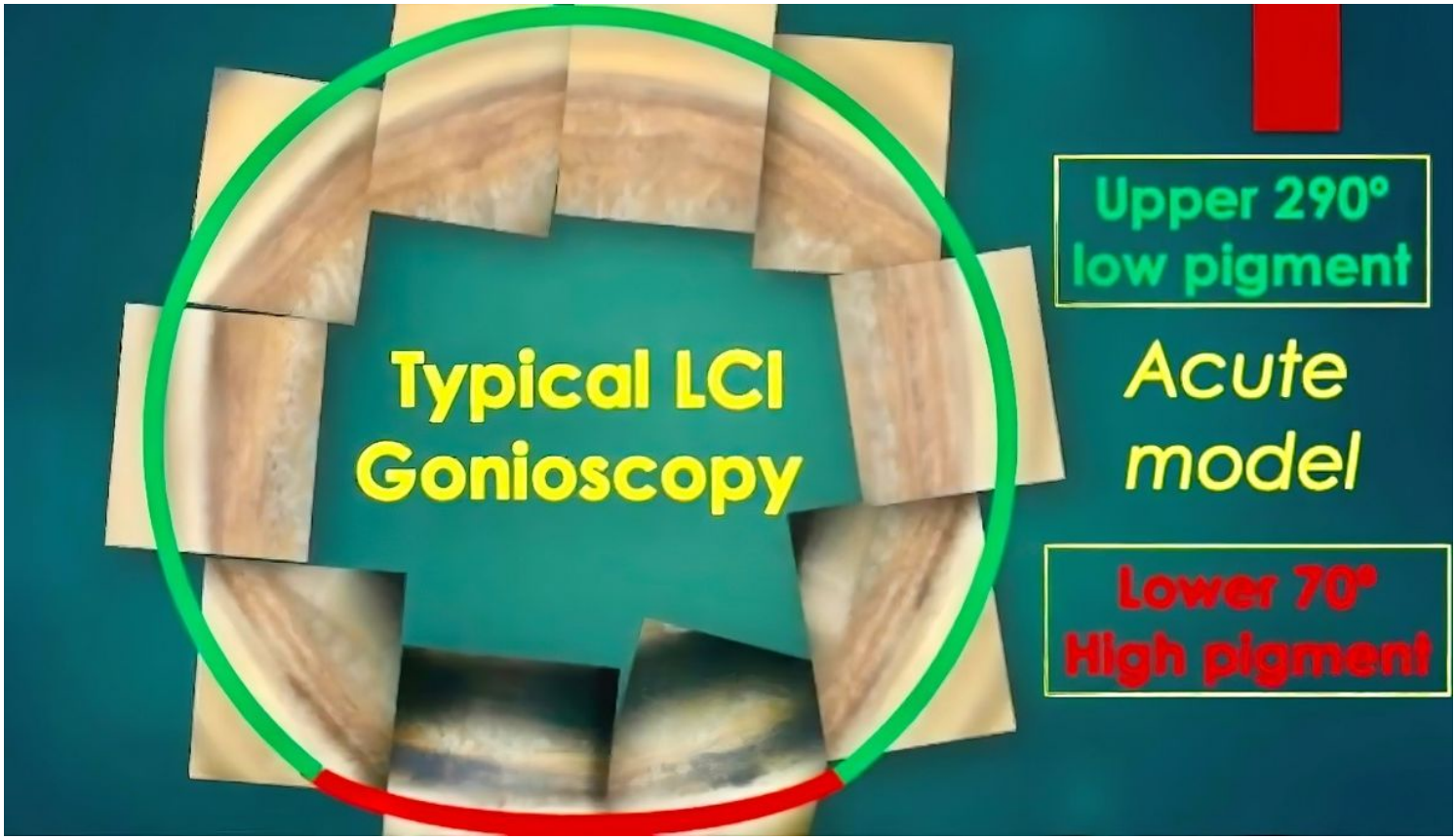


Figure 10

Secondary glaucoma is one that occurs as a consequence of other pathologies, both ocular and systemic. Pigmentary glaucoma is a secondary glaucoma caused by pigment dispersal syndrome. This disease is characterized by detachment of posterior iris pigments (melanin), which are trapped in the aqueous humor drainage system, causing its obstruction. After Cosmetic Laser Iridoplasty, melanin pigment is released into anterior chamber from iris surface, but the typical gonioscopic pattern is just a lower trabecular meshwork pigmentation, only about 70 degrees, remaining free the 290 upper degrees.