

## **EFFECT OF DIFFERENT DRYING TIME/ PAINT PROTECTION AGENT, INCLUSION SUBSTRATES, AND PASSAGE OF TIME ON IRIS COLOR CHANGE**

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*Carla Maria de Almeida Prado Magdalena*

Faculdade de Odontologia de Ribeirão Preto

<https://orcid.org/0000-0003-3010-0785>

*Ana Paula Macedo*

Faculdade de Odontologia de Ribeirão Preto

<https://orcid.org/0000-0002-1064-3523>

*Reinaldo Brito e Dias*

Faculdade de Odontologia da Universidade  
de São Paulo

<https://orcid.org/0000-0001-9951-6186>

*Neide Pena Coto*

Faculdade de Odontologia da Universidade  
de São Paulo

<https://orcid.org/0000-0002-3235-0684>

*Cláudia Helena Lovato da Silva*

Faculdade de Odontologia de Ribeirão Preto

<https://orcid.org/0000-0003-1629-2207>

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**Abstract:** This study evaluated the effect of different drying time of iris paint/paint protection agent, iris inclusion substrates, and passage of time on iris color change. The 120 specimens were divided into six groups (n = 20) according to the drying time (24hr or 1hr)/iris protection agent (cyanoacrylate, cyanoacrylate + polymer; monopoly + polymer). After, the groups were divided into subgroups (n = 10) as a function of the inclusion substrate (wax or thermopolymerizable acrylic resin N1). Acrylic caps were painted with Black, Sepia, and Vandik brown acrylic paint. After the drying time, the irises received a layer of the protection agent and after drying, they were submitted to the first color reading (EasyShade - lighting D65). A sclera pattern was included to obtain sclera in wax and N1 acrylic resin, in which the irises were included and processed. After seven days, the color measurements were performed, the prosthesis were stored in a container with water at 37°C for new readings after 14, 30 and 90 days. Data were analyzed by factorial ANOVA test repeated ( $p < 0.05$ ). The passage of the time significantly influenced the color change of the specimens ( $p < 0.001$ ), with the greatest color variation occurring in the first 7 days. The type of protection agent, drying time and iris inclusion substrate not influenced the color change. The greatest change in color was observed after 7 days, and remained unchanged over 90 days, although the values were considered clinically perceptible.

**Keywords:** 1. Maxillofacial prosthesis; 2. Ocular prosthesis; 3. Color Change; 4. Sealing

## INTRODUCTION

The absence of eye affect the aesthetic, function, emotional control and, consequently the quality of life of the patients (Heindl, Trester, Guo, Zwiener, Sadat et al,

2021; Pine & Pine, 2020). For rehabilitation of the patient, an individualized ocular prosthesis can be indicated, which should become natural on the face when installed, restoring aesthetics, protecting the cavity, returning the contour, filling and tonicity of the eyelids, and conducting the secretions properly (Rezende, 1997; Dos Santos, de Caxias, Bitencourt, Turcio, Pesqueira et al, 2018). Thus, the rehabilitation can contribute in a positive way to the patient's quality of life, restoring their self-esteem and inserting them into society.

Currently, the ocular prosthesis is made from the molding of the anophthalmic cavity and the final piece is obtained in thermopolymerizable acrylic resin (Jain & Jain, 2016; Chinnery, Thompson, Noroozi & Dyer, 2017). To obtain the desired aesthetics, are necessary iris and the sclera with colors and characteristics similar to those of the patient (Bankoti, Singhal, Nair & Chandra, 2016; Ruiters, Sun, de Jong, Politis & Mombaerts, 2016; Alfenas, da Silva, Silveira, Fonseca, de Arruda et al, 2019). However, during the manufacture of the prosthesis, the professional may experience difficulties related to the change in the color of the iris, which may be related to the techniques selected for making it and the characteristics of the materials used (Reis, Brito e Dias & Mesquita Carvalho, 2008; Fernandes, Goiato, Batista & Santos, 2009; Goiato, Moreno, dos Santos, de Carvalho Dekon, Pellizzer, et al, 2010a; Goiato, Santos, Souza, Moreno & Pesqueira, 2010b; Goiato, Santos, Moreno, Gennari-Filho & Pellizzer, 2011a; Goiato, Fernandes, dos Santos, Hadadd, Moreno et al, 2011b; Mundim, Antunes, Sousa, Garcia & Pires-de-Souza, 2012; Moreno, Goiato, Oliveira, Iyda, Haddad et al, 2015; Alfenas et al, 2019). In addition, some clinical situations experienced by this group of researchers suggest that it would be possible that the iris

inclusion in acrylic or wax (substrate) could also interfere with color stability, although, to our knowledge, no study has been performed evaluating this variation factor.

Consulting the literature, is possible to find numerous case reports that describe different techniques, in order to achieve adequate aesthetics and providing patient comfort, however, few report the effects of the techniques employed over time (Choubisa, 2017; Jamayet, Kirangi, Husein & Alam, 2017; Pathak, Pawah, Singh, Yadav & Kundra, 2017; Kulkarni, Kulkarni, Shah & Tomar, 2018; Goiato, Dos Santos, de Sousa Ervolino, Brunetto, de Magalhaes Bertoz et al, 2019; Lanzara, Thakur, Viswambaran & Khattak, 2019; Shrivastava, Shrivastava, Yadav & Gupta, 2020).

Furthermore, another studies related to fabrication techniques investigated the change in color of the iris of the ocular prosthesis under different conditions of painting, storage, polymerization, polishing and aging (Reis et al, 2008; Goiato et al, 2010a; Goiato et al, 2010b; Canadas, Garcia, Consani & Pires-de-Souza, 2010; Goiato et al, 2011a; Goiato et al, 2011b; Mundim et al, 2012; Bannwart, Goiato, dos Santos, Moreno, Pesqueira et al, 2013; Moreno et al, 2015). However, based on our knowledge, no studies were found that evaluated the change in color of the iris of ocular prostheses as a function of paint drying time, different means of protecting the iris painting, using different substrates for inclusion, that can interfere with the final result of the ocular prosthesis.

Thus, this in vitro randomly study evaluated the effect of different drying time of iris paint/paint protection agent, iris inclusion substrate, and passage of time on iris color change. The null hypothesis was that iris color would not be changed by influence of paint drying time/protection agent, iris inclusion substrate, or passage of time.

## MATERIALS AND METHOD

### EXPERIMENTAL DESIGN

Ocular prostheses (n=120) were made according to the specific characteristics of group and subgroup studied (6 groups with n=20; 6 subgroups with n = 10) and color change was analyzed after 7, 14, 30 and 90 days.

The groups varied according to the drying time of the iris paint (1 or 24 hours), iris sealing agent (cyanoacrylate or monopoly associated with colorless polymer) and the subgroups were based in inclusion substrate (acrylic resin or wax) (Figure 1).

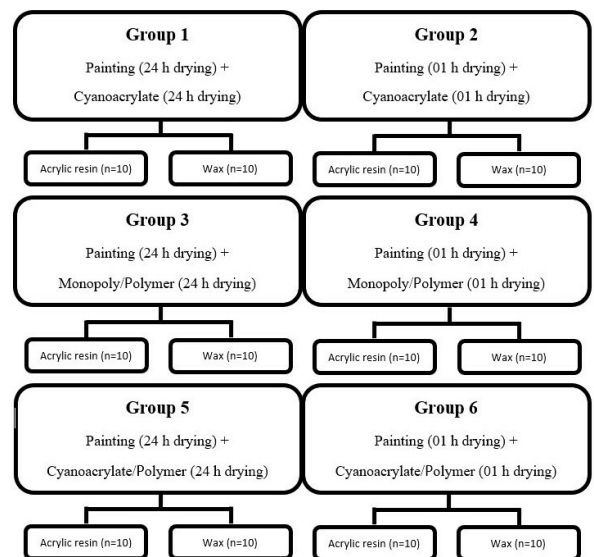


Figure 1 - Flowchart of experimental groups and subgroups.

### SPECIMENS

To obtain the iris, acrylic caps (n=120) for artificial iris (Artigos Odontológicas Clássico Ltda., São Paulo, Brazil) with 11 mm in diameter were painted with acrylic paint (Acrilex, São Bernardo dos Campos, Brazil), being used Black (n° 320) for the pupil and final layer, Sepia (n° 396) for the external halo and Vandik brown (n° 337) for the base color. The caps were randomly distributed for drying the paint for 1 hour or 24 hours.

Then, the excess paint on the side surface was removed with a multi-laminated cutter

(Edenta, Hauptstrasse, Switzerland) and the protection agent was applied. A drop of cyanoacrylate (Super Bonder, Henkel, Düsseldorf, Germany) or monopoly was placed in the center of the painted surface and spread over the surface and sides with a blunt instrument, obtaining a thin layer. The monopoly was prepared at the Oral Rehabilitation Research Laboratory Of the School of Dentistry of Ribeirão Preto, through manipulation of the 24 mL of thermopolymerizable monomer and 6 g of colorless polymer (Clássico, Artigos Odontológicas Clássico Ltda. Campo Limpo Paulista, Brazil) in a water bath at 50°C for 30 minutes, until obtaining a viscous and colorless substance.

For the groups 3, 4, 5 and 6, after application of the agent, the irises were immersed in the colorless thermopolymerizable polymer for 1 second, forming a thin and uniform layer of powder. Then, the caps were taken to drying in an oven (De Leo & Cia Ltda, Porto Alegre, Brazil) at 37°C at 1 hour or 24 hours, and submitted to the first color reading.

For obtain of the substrate in acrylic resin or wax, shell-shaped pattern in thermopolymerizable acrylic resin (Artigos Odontológicas Clássico Ltda. Campo Limpo Paulista, Brazil) was included in in metal muffles nº 3 (OGP Produtos Odontologicos Ltda, São Paulo, Brazil) with gypsum (Asfer, Indústria Química Ltda, São Caetano do Sul, Brazil).

The thermopolymerizable acrylic resin (color N1, Artigos Odontológicos Clássico Ltda. Campo Limpo Paulista, Brazil) was manipulated, packed into the molds, pressed and polymerized following the manufacturer's instructions. After polymerization, the specimens were finished and polished with a handpiece (Dabi Atlante, Ribeirão Preto, Brazil), multi-laminated cutters (Maxicut,

Malleifer AS, Ballaiguer, Switzerland) and sandpaper strips.

For obtain the sclera in wax, the plaster casts were hydrated in water and the plasticized wax (Polidental, São Paulo, Brazil) was poured into the mold. The muffle was closed and, after the wax had completely cooled, the wax sclera was finished with sharp instruments and the surfaces were polished with cotton dampened in neutral detergent.

Both in resin sclera and wax sclera, a central point was located by the intersection of two lines drawn on the longitudinal and sagittal axes of the convex surface. From this point, a circular cavity of 11 mm in diameter by 3 mm in depth was opened for the inclusion of the iris. For specimens in N1 acrylic resin, the cavity was opened with a carbide drill nº 703 (Angelus Indústria de Produtos Odontológicas S/A, Londrina, Brazil) and the iris was fixed with a small amount of acrylic resin. For the wax specimens, the cavity was opened with a Lecron spatula (Duflex Instrumentos, Juiz de Fora, Brazil) and the iris was fixed with plasticized wax.

The sclera/iris set was included in muffle nº 3 with gypsum. The muffle with the resin pattern was opened and the sclera/iris set was removed. The muffle with the wax pattern was opened, the wax was removed and the iris was held in position in the muffle. The gypsum was isolated, the thermopolymerizable acrylic resin N1 was manipulated according to the manufacturer's instructions, placed into the mold, pressed and polymerized following the same protocol described above. The specimens now had the sclera in thermopolymerizable acrylic resin with the iris fixed, and thus received the same final procedures.

A 3 mm thick layer was removed (carbide drill nº 703) from the convex surface of the sclera to seal the sclera/iris set with colorless acrylic resin. The gypsum molds were isolated,

the specimens were repositioned and the colorless thermopolymerizable acrylic resin was manipulated, deposited in the counter muffle and polymerized according to the manufacturer's instructions. The muffle was closed, pressed, and polymerized, following the protocol previously described. After polymerization, the ocular prosthesis was removed and were finished and polished with a handpiece (Dabi Atlante, Ribeirão Preto, Brazil), multi-laminated cutters (Maxicut, Malleifer AS, Ballaiguer, Switzerland), sandpaper strip (Norton, Norton Saint-Gobain, Guarulhos, Brazil), and polished with felt discs, pumice stone and white from Spain in bench polisher (Nova OGP Indústria e Comércio Eireli, Curitiba, Brazil).

Color readings were performed with an Easy Shade device (VITA, Bad Säckingen, Germany), in a light chamber (Macbeth Spectra Light, New York, USA) and with D65 lighting (1- Natural lighting, wavelength range ~ 380 at 780 nm – Gretagmacbeth, 6500, F20T12 / 65, 20W, USA; 2- Ultraviolet illumination, wavelength range ~340 to 400 nm – UV-A Sylvania, Blacklight Blue, F30T8 / BLB, 30W, USA) that simulates daylight. For the standardization and control of the reading, a matrix of two parts was made, one of silicone to contain the sclera/iris pattern and another in colorless acrylic resin to fit over the matrix/sclera/iris set, which contained an opening for so that only the light from the device falls on the iris. The active tip of the device was positioned at a 45° angle to the surface of the iris, and 5 readings were realized per specimen, being one in each quadrants and one central, in the periods after 7 days, 14 days, 30 days and 90 days of confection of the prosthesis (Figure 2).

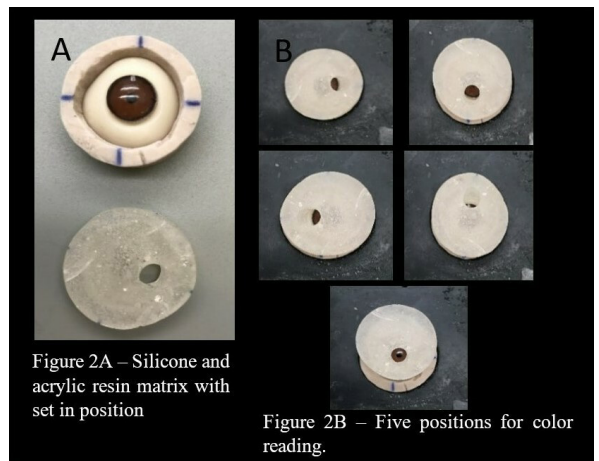


Figure 2 – Methodology development for color measurement.

The color change was based in the values of the first measurement obtained after paint and calculated by the color difference between times using the parameter,  $\Delta E$  with the CIE-LAB system. The color alteration between each specimen and each time, in terms of  $L^*$ ,  $a^*$  and  $b^*$ , was calculated by the formula:  $\Delta E_{ab} = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}$ .

### Data analysis

The normal (Levene test) and homogeneous distribution of the data (Shapiro-Wilks test) was verified. The comparison of the means was conducted by factorial ANOVA test of repeated measures using SPSS 21.0 statistical software (IBM Corp. Released 2012, IBM SPSS Statistics for Windows, Version 21.0 - Armonk, NY, IBM Corp). All tests were performed with a confidence level of 95%.

### RESULTS

The color change was significantly influenced by passage of time ( $p < 0.001$ ). The color change was not influenced by protection agent/drying time ( $p = 0.995$ ) or by the substrate ( $p = 0.799$ ) and there was no interaction between the factors ( $p = 0.239$ ). The greatest color variation occurred in the first



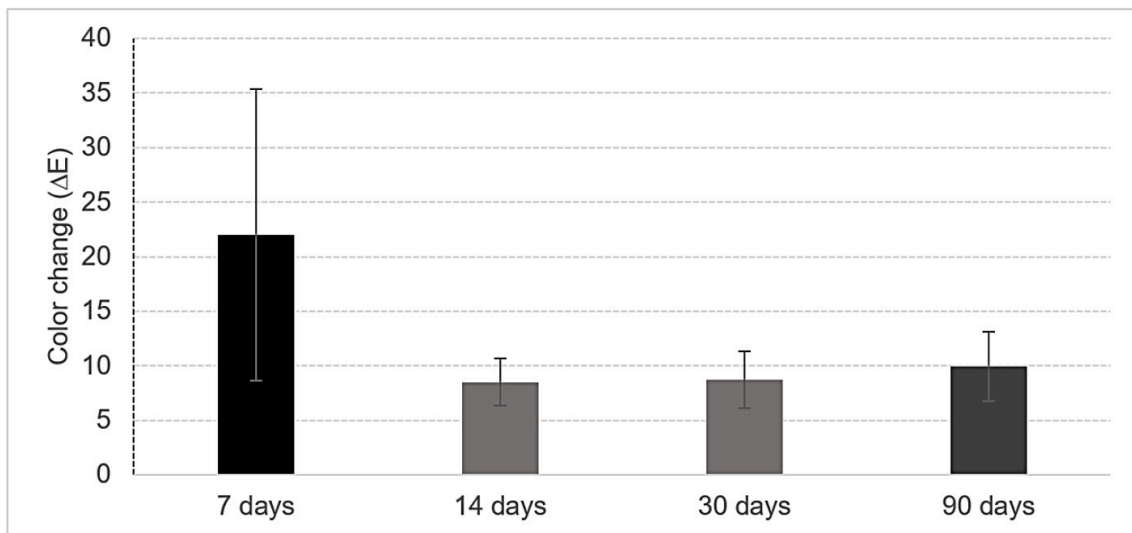


Figure 3 – Comparison of the mean and standard deviation (SD) of the color change (DE) influenced by passage of the time.

7 days. After 14 and 30 days there was color stability and at 90 days the change increased in relation to the two previous periods, but was smaller than that observed in 7 days (Figure 3).

## DISCUSSION

The success of prosthetic rehabilitation of the anophthalmic cavity can be considered when harmony of shape, movement and color similar to the remaining eye is achieved. Specifically in relation to color, the iris has fundamental importance, but it reproduce depends on the skill and discipline of the professional (Alfenas et al, 2019) as well technique and material used. Factors such as the material of the iris (painting on cardboard or acrylic, printing the photographic image), type of paint, drying time of the paint, iris protection material, polymerization medium and cycle, can interfere with the final result (Reis et al, 2008; Fernandes et al, 2009; Goiato et al, 2010a; Goiato et al, 2010b; Goiato et al, 2011a; Goiato et al, 2011b; Mundim et al, 2012; Moreno et al, 2015; Alfenas et al, 2019). In relation to the substrate of the iris inclusion,

no studies were found reporting the impact of this factor on iris color change. Thus, the objectives of this study were to evaluate the effect of different drying time of iris paint/ paint protection agent, iris inclusion substrate, and passage of time on iris color change.

Based on the results, the null hypothesis was partially rejected, since color was influenced only by passage of time (7, 14, 30, and 90 days). The reading performed after 7 days of obtaining the prostheses indicated a greater change in color than the other periods. This result supports the idea that the protection agents and the paint, independent of the drying time may have reacted with the resin during the thermopolymerizable process, becoming unstable soon after confection and stabilizing over time. Unlike this study, where no difference was found between 1 or 24 hours for drying, Pereira (2007) recommends a minimum drying time of 24 hours to minimize the possibility of color change. The change in color of the iris of the ocular prosthesis, soon after fabrication, was also observed by another authors (Reis et al, 2008; Goiato et al, 2010a;

Canadas et al, 2010; Goiato et al, 2011a; Bannwart et al, 2013; Moreno et al, 2015). In addition, studies that evaluated this change after confection and simulating the time passage by accelerated aging (Reis et al, 2008; Fernandes et al, 2009; Goiato et al, 2010a; Canadas et al, 2010; Goiato et al, 2011b) also found color change.

Studies also show that acrylic paint and brown color are stable over time and with changes at clinically acceptable levels (Reis et al, 2008; Mundim et al, 2012). In our work, the comparison was performed with the initial color, after painting the iris, so, even if after 14 days the change has stabilized, the values obtained are above the clinically acceptable. In according with literature, color changes above 3.7 are noticeable and may influence aesthetics (Johnston & Kao, 1989). Regardless of the analysis of the color parameters, in  $L^*$   $a^*$   $b^*$  separately, what is possible to be done by the CIELab system is important that the iris have color stability.

When analyzing the color change regarding the substrate, the wax did not influence a greater color change in the groups, as expected. The hypothesis would be that during the resin pressing over the iris after removing the wax, the amount of resin would be greater compared to the amount of resin used to fix the iris already in the acrylic resin pattern. This difference in material volume could cause the traction of the paint due to the greater contraction of the resin, thus generating the detachment of the paint from the base of the acrylic cap and the mirroring effect.

Studies that evaluated the polymerization time and medium, accelerated aging, the type of paint and drying medium associated with color change were found (Reis et al, 2008; Fernandes et al, 2009; Goiato et al, 2010a; Goiato et al, 2010b; Goiato et al, 2011a; Goiato et al, 2011b; Mundim et al, 2012; Moreno

et al, 2015; Alfenas et al, 2019). However, the discussion for this property when the substrate are compared is limited due to the absence of studies that included the analysis of the substrate in their methodologies

Regarding the protective agent associated with the drying time, the results did not indicate influence of this factor on the color change of the iris, suggesting that both cyanoacrylate and monopoly may be indicated. Consulting the literature, there are indications for the application of different agents as a way of protecting the paint, such as varnish (Bannwart et al, 2013), white glue based on vinyl acetate polymer, monopoly and cyanoacrylate (Pereira, 2007). Cyanoacrylate is a low-viscosity, colorless and non-water-soluble liquid adhesive agent and is used in medicine and dentistry with different applications (BinMahfooz & Qutub, 2018; Borie, Rosas, Kuramochi, Etcheberry, Olate et al, 2019; Loffroy, Mouillot, Bardou & Chevallier 2020), presenting good bond to acrylic resin when used as a paint protection agent. Its polymerization is fast when in contact with water, air and surfaces, with an adhesion time of less than 20 seconds when in contact with plastic (Weber & Chapman, 1984). An important advantage is the low cost. Although cyanoacrylate has all these advantages, Pereira (2007) comparing vinyl acetate polymer glue and cyanoacrylate as protections for painting found a different result. The vinyl acetate polymer glue was superior to cyanoacrylate in terms of waterproofing the paint, presenting the paint layer practically intact, defined and in contact with the other materials, when analyzed by electron microscopy.

Monopoly is a mixture of colorless polymer saturated with thermopolymerizable monomer, obtained by mixing the components in a water bath (Bankoti et al, 2016), however this process needed to be

carried out with caution as the monomer is highly volatile and can cause irritation on skin, eyes and intoxications. The product can be purchased commercially, via import, which can affect costs.

The adequate color of the iris is one of the most important factors for the acceptance of the prosthetic device by the patient. The changes in this characteristic lead to the need for early replacement of the prosthesis, even if its adaptation is still good (Raizada & Rani, 2007). Therefore, the follow-up of the patient must be performed periodically. In clinical practice, this group experienced situations where color changes occurred soon after the installation of the prostheses and, after keeping them in water at 37°C, the color returned to normal.

## REFERENCES

- Alfenas, E. R., da Silva, J., Silveira, M., Fonseca, M., de Arruda, J., & Moreno, A. (2019). A Painting Technique Using Ceramic Pigments for the Artificial Iris of an Ocular Prosthesis Guided by Applying Newton's Color Wheel. *Journal of prosthodontics: official journal of the American College of Prosthodontists*, 28(2), e822–e825. <https://doi.org/10.1111/jopr.12919>.
- Bankoti, P., Singhal, M. K., Nair, C., & Chandra, P. (2016). Characterization of an eye prosthesis using monopoly syrup. *Indian journal of dental research: official publication of Indian Society for Dental Research*, 27(5), 553–558. <https://doi.org/10.4103/0970-9290.195684>.
- Bannwart, L. C., Goiato, M. C., dos Santos, D. M., Moreno, A., Pesqueira, A. A., Haddad, M. F., Andreotti, A. M., & de Medeiros, R. A. (2013). Chromatic changes to artificial irises produced using different techniques. *Journal of biomedical optics*, 18(5), 58002. <https://doi.org/10.1117/1.JBO.18.5.058002>.
- BinMahfooz, A. M., & Qutub, O. A. (2018). Effect of Surface Treatments and Adhesive Materials on the Shear Bond Strength of Artificial Denture Teeth to Denture Base Resins. *The journal of contemporary dental practice*, 19(6), 631–636.
- Borie, E., Rosas, E., Kuramochi, G., Etcheberry, S., Olate, S., & Weber, B. (2019). Oral Applications of Cyanoacrylate Adhesives: A Literature Review. *BioMed research international*, 2019, 8217602. <https://doi.org/10.1155/2019/8217602>.
- Canadas, M. D., Garcia, L. F., Consani, S., & Pires-de-Souza, F. C. (2010). Color stability, surface roughness, and surface porosity of acrylic resins for eye sclera polymerized by different heat sources. *Journal of prosthodontics : official journal of the American College of Prosthodontists*, 19(1), 52–57. <https://doi.org/10.1111/j.1532-849X.2009.00522.x>.
- Chinnery H, Thompson SBN, Noroozi S, Dyer B. (2017). Scoping review of the development of artificial eyes throughout the years. *Edorium J Disabil Rehabil*. 3:1–10.
- Choubisa D. (2017). A simplified approach to rehabilitate an ocular defect: Ocular prosthesis. *Journal of Indian Prosthodontic Society*, 17(1), 89–94. <https://doi.org/10.4103/0972-4052.179260>.
- Dos Santos, D. M., de Caxias, F. P., Bitencourt, S. B., Turcio, K. H., Pesqueira, A. A., & Goiato, M. C. (2018). Oral rehabilitation of patients after maxillectomy. A systematic review. *The British journal of oral & maxillofacial surgery*, 56(4), 256–266. <https://doi.org/10.1016/j.bjoms.2018.03.001>.

As limitations, this study may point to the fact that light colors such as blue and green were not evaluated, as well as the no use of other types of painting material such as oil paint or ceramic pigments. Furthermore, a more in-depth analysis of all color parameters can contribute to clinical decision making. Therefore, future studies including these variations and analyzes are still needed.

## CONCLUSION

Based on the results obtained, the type of protection agent, drying time and iris inclusion substrate no influenced the color change. The greatest change in color was observed after 7 days, and remained unchanged over 90 days, although the values were considered clinically perceptible.



Fernandes, A. U., Goiato, M. C., Batista, M. A., & Santos, D. M. (2009). Color alteration of the paint used for iris painting in ocular prostheses. *Brazilian oral research*, 23(4), 386–392. <https://doi.org/10.1590/s1806-83242009000400007>.

Goiato, M. C., Dos Santos, D. M., de Sousa Ervolino, I. C., Brunetto, J. L., de Magalhaes Bertoz, A. P., & de Moraes Melo Neto, C. L. (2019). Prosthetic Rehabilitation of an Eye Globe: Case Report. *Medical archives (Sarajevo, Bosnia and Herzegovina)*, 73(6), 433–435.

Goiato, M. C., Santos, D. M., Souza, J. F., Moreno, A., & Pesqueira, A. A. (2010). Chromatic stability of acrylic resins of artificial eyes submitted to accelerated aging and polishing. *Journal of applied oral science: revista FOB*, 18(6), 641–645. <https://doi.org/10.1590/s1678-77572010000600018>. B

Goiato, M. C., Santos, D. M., Moreno, A., Gennari-Filho, H., & Pellizzer, E. P. (2011). Evaluation of the color stability of two techniques for reproducing artificial irides after microwave polymerization. *Journal of applied oral science: revista FOB*, 19(3), 200–203. <https://doi.org/10.1590/s1678-77572011000300004>. A

Goiato, M. C., Fernandes, A. Ú., dos Santos, D. M., Hadadd, M. F., Moreno, A., & Pesqueira, A. A. (2011). Alteration of blue pigment in artificial iris in ocular prosthesis: effect of paint, drying method and artificial aging. *Contact lens & anterior eye: the journal of the British Contact Lens Association*, 34(1), 22–25. <https://doi.org/10.1016/j.clae.2010.10.005>. B

Goiato, M. C., Moreno, A., dos Santos, D. M., de Carvalho Dekon, S. F., Pellizzer, E. P., & Pesqueira, A. A. (2010). Effect of polymerization and accelerated aging on iris color stability of ocular prosthesis. *Contact lens & anterior eye: the journal of the British Contact Lens Association*, 33(5), 215–218. <https://doi.org/10.1016/j.clae.2010.04.004>. A

Heindl, L. M., Trester, M., Guo, Y., Zwiener, F., Sadat, N., Pine, N. S., Pine, K. R., Traweger, A., & Rokohl, A. C. (2021). Anxiety and depression in patients wearing prosthetic eyes. *Graefes's archive for clinical and experimental ophthalmology = Albrecht von Graefes Archiv fur klinische und experimentelle Ophthalmologie*, 259(2), 495–503. <https://doi.org/10.1007/s00417-020-04908-0>.

Jain, S., & Jain, P. (2016). Rehabilitation of orbital cavity after orbital exenteration using polymethyl methacrylate orbital prosthesis. *Journal of Indian Prosthodontic Society*, 16(1), 100–104. <https://doi.org/10.4103/0972-4052.167944>.

Jamayet, N. B., Kirangi, J. K., Husein, A., & Alam, M. K. (2017). A comparative assessment of prosthetic outcome on enucleation and evisceration in three different etiological eye defects: A case series. *European journal of dentistry*, 11(1), 130–134. <https://doi.org/10.4103/1305-7456.202636>.

Johnston, W. M., & Kao, E. C. (1989). Assessment of appearance match by visual observation and clinical colorimetry. *Journal of dental research*, 68(5), 819–822. <https://doi.org/10.1177/00220345890680051301>.

Kulkarni, R. S., Kulkarni, P., Shah, R. J., & Tomar, B. (2018). Aesthetically Characterized Ocular Prosthesis. *Journal of the College of Physicians and Surgeons--Pakistan: JCPSP*, 28(6), 476–478. <https://doi.org/10.29271/jcpsp.2018.06.476>.

Lanzara, R., Thakur, A., Viswambaran, M., & Khattak, A. (2019). Fabrication of ocular prosthesis with a digital customization technique - A case report. *Journal of family medicine and primary care*, 8(3), 1239–1242. [https://doi.org/10.4103/jfmpc.jfmpc\\_133\\_19](https://doi.org/10.4103/jfmpc.jfmpc_133_19).

Loffroy, R., Mouillot, T., Bardou, M., & Chevallier, O. (2020). Current role of cyanoacrylate glue transcatheter embolization in the treatment of acute nonvariceal gastrointestinal bleeding. *Expert review of gastroenterology & hepatology*, 14(10), 975–984. <https://doi.org/10.1080/17474124.2020.1790355>.

Moreno, A., Goiato, M. C., Oliveira, K. F., Iyda, M. G., Haddad, M. F., de Carvalho Dekon, S. F., & dos Santos, D. M. (2015). Color stability of the artificial iris button in an ocular prosthesis before and after acrylic resin polymerization. *Contact lens & anterior eye: the journal of the British Contact Lens Association*, 38(6), 414–418. <https://doi.org/10.1016/j.clae.2015.05.003>.

Mundim, F. M., Antunes, P. L., Sousa, A. B., Garcia, L. F., & Pires-de-Souza, F. C. (2012). Influence of artificial accelerated ageing on the colour stability of paints used for ocular prosthesis iris painting. *Gerodontology*, 29(2), e312–e317. <https://doi.org/10.1111/j.1741-2358.2011.00473.x>.

Pathak, C., Pawah, S., Singh, G., Yadav, I., & Kundra, S. (2017). Prosthetic Rehabilitation of Completely Blind Subject with Bilateral Customised Ocular Prosthesis: A Case Report. *Journal of clinical and diagnostic research: JCDR*, 11(1), ZD06–ZD08. <https://doi.org/10.7860/JCDR/2017/24434.9151>.

Pereira SL. (2007). Evaluation of different materials used in prosthetic iris painting sealing and their relation to the acrylic paint. [Dissertação de Mestrado]. São Paulo: Faculdade de Odontologia da Universidade de São Paulo.

Pine, N. S., & Pine, K. R. (2020). Depression, Anxiety and Stress Indicators for Prosthetic Eye Wearers. *Clinical ophthalmology* (Auckland, N.Z.), 14, 1715–1723. <https://doi.org/10.2147/OPTH.S254910>.

Raizada, K., & Rani, D. (2007). Ocular prosthesis. *Contact lens & anterior eye : the journal of the British Contact Lens Association*, 30(3), 152–162. <https://doi.org/10.1016/j.clae.2007.01.002>.

Reis, R. C., Brito e Dias, R., & Mesquita Carvalho, J. C. (2008). Evaluation of iris color stability in ocular prosthesis. *Brazilian dental journal*, 19(4), 370–374. <https://doi.org/10.1590/s0103-64402008000400015>.

Rezende JRV. (1997). Prótese Ocular. In: Rezende Fundamentos da prótese-buco-maxilo-facial. São Paulo: Sarvier.

Ruiters, S., Sun, Y., de Jong, S., Politis, C., & Mombaerts, I. (2016). Computer-aided design and three-dimensional printing in the manufacturing of an ocular prosthesis. *The British journal of ophthalmology*, 100(7), 879–881. <https://doi.org/10.1136/bjophthalmol-2016-308399>.

Shrivastava, K. J., Shrivastava, S., Yadav, N. S., & Gupta, S. (2020). Rehabilitation of unilateral loss of eye with customized ocular prosthesis: Case series. *Indian journal of dental research: official publication of Indian Society for Dental Research*, 31(2), 326–330. [https://doi.org/10.4103/ijdr.IJDR\\_499\\_17](https://doi.org/10.4103/ijdr.IJDR_499_17).

Weber, S. C., & Chapman, M. W. (1984). Adhesives in orthopaedic surgery. A review of the literature and in vitro bonding strengths of bone-bonding agents. *Clinical orthopaedics and related research*, (191), 249–261.