Review

Positioning of iris in an ocular prosthesis: A systematic review

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Abstract

Aim: To evaluate different methods, techniques, and concepts documented in the literature to assess iris positioning accurately to the related dimensions needed to effectuate maxillofacial rehabilitation of ocular prosthesis.

Settings and Design: This systematic review was conducted as per the PRISMA guidelines which is the most opted reporting protocol.

Materials and Methods: Two electronic databases PubMed and Cochrane Library) were searched for manuscripts published from 1969 till September 30, 2019. An electronic search (of peer review restricted to English language dental literature was conducted to identify the relevant scientific article on iris positioning in maxillofacial prostheses. Two observers independently read the abstracts and selected 17 full text articles fulfilling the inclusion criteria.

Statistical Analysis Used: No meta-analysis was conducted due to heterogeneity of data obtained.

Results: All the 17 documented articles related to determination of the iris positioning to perform maxillofacial prosthetic rehabilitation depicting the use of a strip of plastic template, a Boley's gauge, a millimeter ruler, a pupillometer, window light, an ocular locator with fixed caliper, inverted anatomic tracings, a transparent graph grid were reviewed systematically.

Conclusion: Currently, there is no evidence in the form of a systematic review of the available literature discussing the best technique available for perfectly matching the iris positioning. However, the latest techniques making use of digital technology such as digital photography, is believed to be more precise for iris positioning in the ocular prosthesis.

Keywords: Customized scale, facial measurements, graph grid, iris positioning, ocular prosthesis

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INTRODUCTION

"Eyes" are said to be "mirror of the soul." They are an organ of vision, the center of facial expressions and an epitome of cosmetic appearance in human beings. Anophthalmia could be a consequence of carcinoma, trauma, sympathetic ophthalmic, painful blind eye, or congenital defects.[1] Surgical treatment following these clinical situations may indicate

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an orbital evisceration, enucleation, or exenteration.[2,3] A huge psychological impact may be a traumatizing emotional sequel to the patient resulting from such disfigurements. The prosthodontic rehabilitation of such individuals in the form of an ocular prosthesis functions as a modality to repair the lost or the deformed ocular globe.[4]

The major challenge faced by the prosthodontist is of cicatricial retraction, during the fabrication of an ocular prosthesis in the anophthalmia sockets. This happens so because in such situations there is atrophy leading to the modifications in the form of a reduction in the dimensions of the prosthesis to have a perfect contour so that artificial iris will provide realistic, symmetrical, and a natural-appearing gaze.[5]

This problem is more typical when the defect areas are the eyes and the orbital contents, resulting in the gross mutilation of the face. For these types of patients, the basic need in the early and satisfactory rehabilitation of the lost tissues to their normal anatomic form for the overall enhancement of Health-related Quality of Life.[6-9] The surgical reconstruction alone cannot be an alternative towards the satisfactory esthetic rehabilitation of the orbital defects with a total loss of eyelids and the eyeball. Many defects of such types also require some kind of prosthetic rehabilitation.[10] The key to a successful rehabilitation in such cases is the careful preoperative surgical as well as prosthetic planning using a multidisciplinary approach. The answer to this is an ocular prosthesis with a careful and meticulous iris positioning method.[11] Ocular prosthesis can be of two types, a stock and a custom-made prosthesis. Typical stock ocular prostheses are available in a range of standard sizes, contours, forms, and colors. They can be used for a provisional or an immediate postoperative period.[12] Ocular prostheses can be referred to variously as artificial eyes, molded eyes, cosmetic contact shells, cosmetic contact lenses, or spectacle prostheses.[13] Various methods and techniques are documented in the literature to determine the iris positioning to perform maxillofacial prosthetic rehabilitation for example, the use of a plastic strip template, a Boley's gauge, a millimeter ruler, a pupillometer, window light or light reflection viewed symmetrically in the eyes, an ocular locator with fixed caliper, inverted anatomic tracings, a transparent graph grid, computer simulation approach with optical scanning technique, and computer-aided design and a customized scale for assessing the position of the ocular prosthesis.[14]

There are many concepts regarding different iris positioning techniques. However, so far, no systematic reviews on various methods of iris positioning in maxillofacial prostheses have been reported. Hence, the purpose of this document is to review the available literature about iris positioning in maxillofacial prosthetics. The question that this review proposes to answer is to compare and evaluate various methods, techniques, and concepts documented in the literature to position the iris accurately to the related dimensions required to perform maxillofacial rehabilitation of ocular prosthesis.

MATERIALS AND METHODS

This systematic review was conducted following the PRISMA guidlines. The PICO format was applied to formulate a focus question and accordingly a systematic search strategy was outlined for the study [Table 1].

Review Question

The following PICO question was used to frame the search strategy:

- Population- Patients with anophthalmic defects requiring an ocular prosthesis.
- Intervention- Patients rehabilitated with ocular prosthesis using various methods for iris positioning.
- Comparison- Various techniques for rehabilitation of an ocular prosthesis including all the conventional and digital methods of iris positioning.

- Outcome-

Primary outcome- Accuracy of the iris positioning of the ocular prosthesis as defined by the authors

Secondary Outcome-

1. Patients perception regarding the esthetic outcome of the ocular prosthesis.
2. Feasibility of Maxillofacial Prosthodontist about the ease of fabrication and precision of iris positioning.

Literature search

Two electronic databases (PubMed and Cochrane Library) were explored for manuscripts published from 1969 till September 30, 2019. Two reviewers were appointed to screen the titles and abstract independently. Full texts of articles that fulfilled the inclusion criteria were obtained. The final search was done manually from the selected articles for the cross-references and citations, to include all relevant articles and to improve the electronic search.

After the electronic and manual search, PubMed provided, 122 articles whereas Cochrane Library showed no systematic review published on this topic so far. The total number of articles that were displayed for the search

Table 1: Systematic search strategy

Systematic search strategy	Protocol followed
Focus question	Population Patients with ocular defects seeking prosthetic rehabilitation in the form of ocular prosthesis Intervention Various techniques for iris positioning in an ocular prosthesis Comparison Advantages of newer techniques over earlier techniques for iris positioning Outcome To select the best technique available for orientation of the iris accurately in a particular case
Search combination	"Positioning" and "Iris" and "Ocular Prosthesis"
Electronic database searched	PubMed/Medline, Cochrane library
Inclusion criteria	Language of publication English All article types (case reports, techniques, RCTs) Articles related only to iris positioning in an prosthetic eye
Exclusion criteria	Language of publication other than English Articles related to any other step of fabrication of ocular prosthesis other than iris positioning such as impression making, mold preparation, method for customize ocular prosthesis, color matching, materials for ocular prosthesis

RCT: Randomized controlled trial

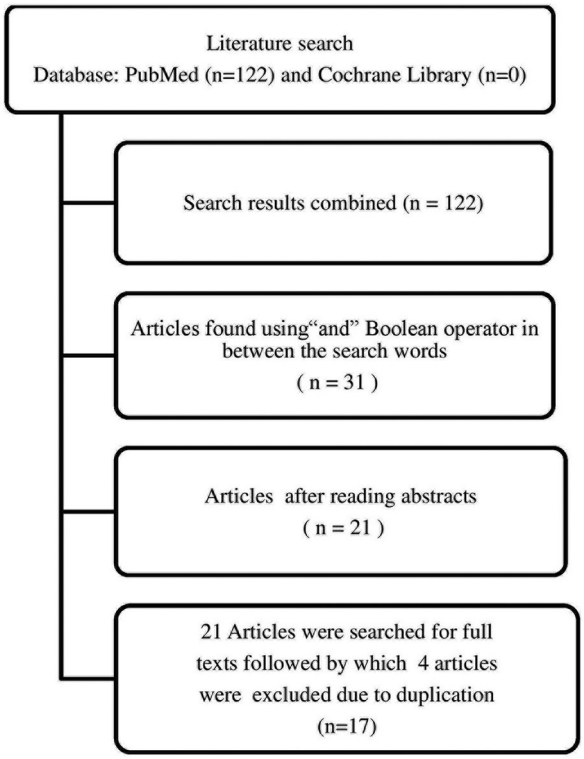

Figure 1: Flowchart of the studies

"Positioning" AND "Iris" AND "Ocular Prosthesis" in advance search was 31. After a complete analysis of the title and abstract of these 31 articles only 21 articles were found to be relevant to the topic and fulfilled the inclusion criteria selected for the systematic review.

RESULTS

Results of data extraction

The Full text of these 21 articles was obtained and after a thorough assessment by both the reviewers for these 21 articles independently 4 articles were eliminated as they showed duplication (similar methods with minor changes). Thus the final sample size obtained for this systematic review was 17 articles [Figure 1].

Results of included studies

The methods and techniques involved for iris positioning in ocular prosthesis that were included in this systematic review were pupillometer by Roberts, facial measurements using anatomic landmarks by Brown, window light by Joneja *et al*., visual assessment by Helene James *et al*., ocular locator by McArthur, inverted anatomic tracings by Nusinov *et al*., graph grid method by Guttal *et al*., Boleys gauge by Manvi *et al*., grid cutouts placed on spectacle frame by Pai *et al*., customized scale by Gupta et al., use of CAD/CAM by Bi *et al*., modified Hanau wide-view spring bow by Shetty *et al*., customized frame spring bow assembly by Chamaria *et al*., pupillary distance (PD) ruler by Bhochhibhoya *et al*., digital photograph by Dasgupta *et al*., and optical vernier interpupillary distance (IPD) ruler by Chihargo and Syafrinani.

DISCUSSION

Rehabilitating patients with an ocular defect is a challenging task for a Prosthodontist. To achieve esthetic in an ocular prosthesis, the precise positioning of the iris is cardinal.[15] Fabricating prosthetic eye has been recognized by humans since the antediluvian. Various case reports are documented in the literature regarding the iris positioning in the prosthetic eye.[14] But no systematic review so far has been undertaken on this topic. The present systematic review is focused on different techniques and customized instruments for positioning of iris accurately in a prosthetic eye. Articles from 1969 till October 2019, that fulfilled the inclusion criteria for this study were included in this systematic review [Table 2].

Roberts in 1969 introduced an instrument pupillometer for iris positing in the prosthetic eye, with the pupil as a fixation point that worked by resting two plastic rotatable discs having scale markings, on the bridge of the nose.[16] But the use of a pupillometer in a small clinical set up was not possible [Figure 2]. Brown in 1970 took the facial measurements of different facial anatomic landmarks to orient iris in the prosthetic globe[17] [Figure 3]. Joneja *et al*. made use of the window light to adjust the iris.[18] James *et al*. painted iris and "lensed" it in the cornea with clear acrylic. He assembled iris and cornea and positioned it into a wax pattern and modified till satisfactory esthetics was achieved.[19] All these methods of iris positioning I, e facial measurements, visual perceptions and use of window light methods were subjective in nature and may bias the operator to accurately position the iris. So a trend of more objective methods came into the picture.

McArthur used the ocular locator for iris centering.[20] He positioned an Ocular locator on the face of the patient so that the marked midline and horizontal lines are superimposed over the markings made on the patient's face to trace the anatomy of the eye [Figure 4]. Nusinov *et al*. presented an inverted anatomic tracings method to predict the iris position.[21] Lines were marked on face and

Table 2: Studies regarding Iris positioning in ocular prosthesis

Study	Year	Technique (instrument)
Roberts *et al*.	1969	Pupillometer
Brown *et al*.	1970	Facial measurements using anatomic landmarks
Joneja OP *et al*.	1976	Window light
Helene James *et al*.	1976	Visual Assessment
McArthur *et al*.	1977	Ocular locator
Nusinov *et al*.	1988	Inverted anatomic tracings
Guttal *et al*.	2007	Graph grid method
Manvi S *et al*.	2008	Boleys gauge
Pai *et al*.	2010	Grid cutouts placed on spectacle frame
Gupta *et al*	2013	Customized scale
Yunpen Bi *et al*.	2013	CAD/CAM
Shetty PP *et al*.	2017	Modified Hanau wide-view spring bow
Chamaria *et al*.	2017	Customized frame spring bow assembly
Bhochhibhoya *et al*.	2019	Pupillary distance ruler.
Dasgupta *et al*.	2019	Digital photograph
Chihargo *et al*.	2019	Optical vernier IPD ruler
Lanzara *et al*.	2019	Electronic vernier caliper

IPD: Interpupillary distance, CAD: Computer aided design, CAM:Computer aided manufacturing

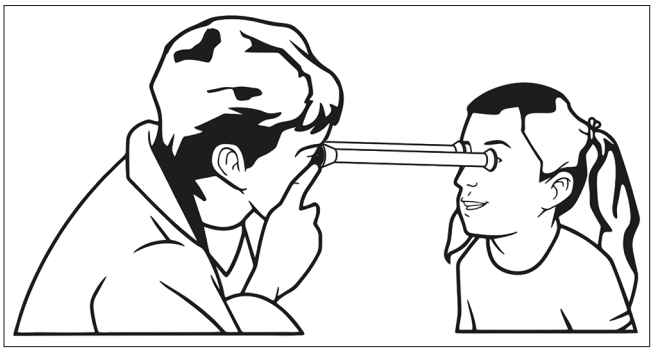

Figure 2: Pupillometer

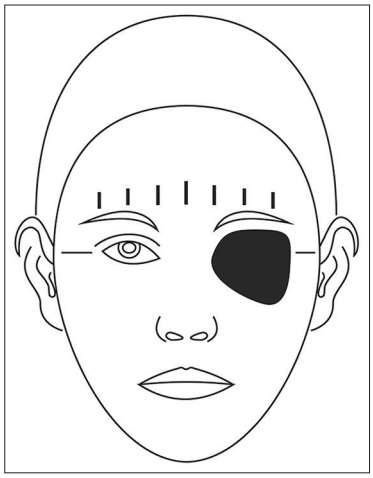

Figure 3: Facial measurements using Anatomic landmarks

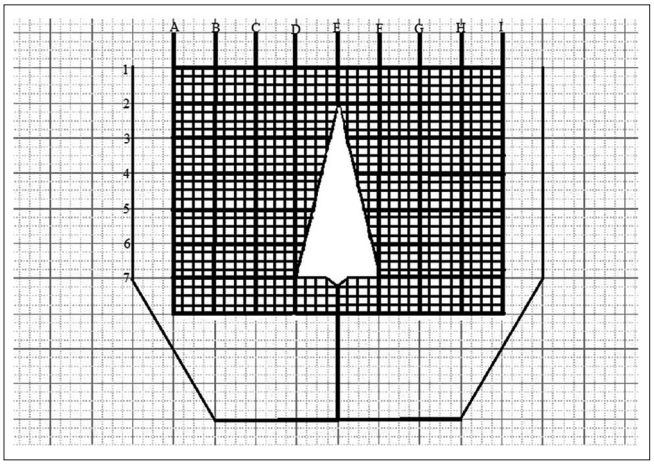

Figure 4: Ocular locator

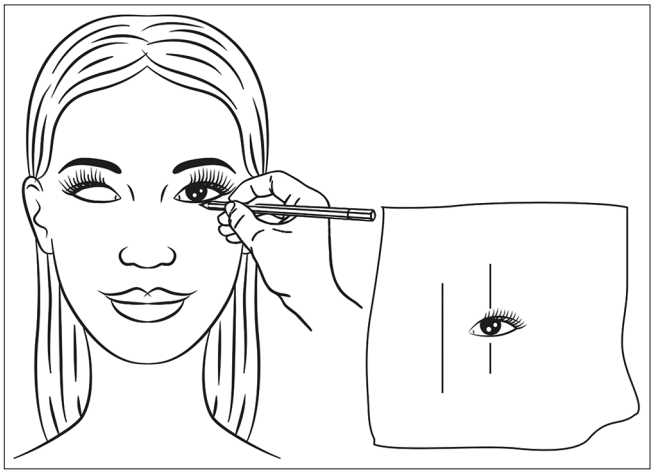

Figure 5: Inverted anatomic tracings

orbital anatomy was traced and transferred to the acetate sheet. It was then inverted over the defect and iris was oriented [Figure 5]. Supriya *et al*. used boleys gauge to accurately orient iris in a prosthetic eye.[22]

Guttal *et al*. utilized a grid template to place the iris accurately [Figure 6]. The use of a transparent graph grid is a simple and reliable method for iris positioning compared to visual assessment.[23] But this method requires an assistant to hold the graph and is subjective to inter-observer error.

Pai *et al*. in 2010 used eyewear with a graph grid attached to its glass lens [Figure 7]. He outlined the normal eye and related it with markings of anatomical structures. The graphic cutout of the normal eye was rotated over the eyewear lens of the defected eye to make a mirror image and the iris orientation was done.[24] Dasgupta *et al*. also designed spectacles with transparent gridded acrylic glasses similar to Kestenbaum glasses to orient iris in a prosthetic eye.[25] This method of using gridded spectacles is simple, requires less armamentarium and less chairside time. Moreover mounting the graph grid on eyewear reduces the need for assistance and is stable unlike the graph grid held in hands in front of the face.

Chamaria *et al*. customized an acrylic resin frame with a graph grid assembly, attached to a face bow for iris positioning [Figure 8]. A scale was fastened to face bow with the help of caps of the ballpoint pen to measure the position of iris on the normal eye that was passed on the scleral wax-up of the defect side-eye.[26] Shetty *et al*. used Hanau Spring bow to orient iris by reversing the U shaped metal frame of the spring bow in a manner that orbital pointer was secured at the lower border of the left ala of the nose which also acted as third references point [Figure 9]. Transfer clamp assembly along with 2 paper clips and graduated scale attached to face bow fork was used to measure and orient the iris in a prosthetic eye.[27] The advantage of these techniques using face bows is the use of readily available equipment. But this technique making

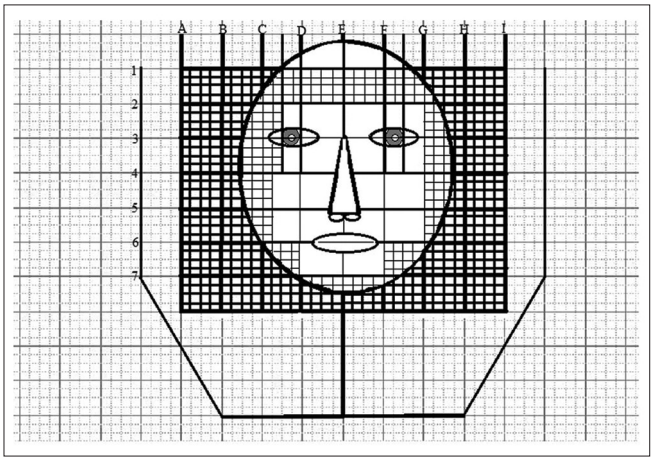

Figure 6: Graph grid method

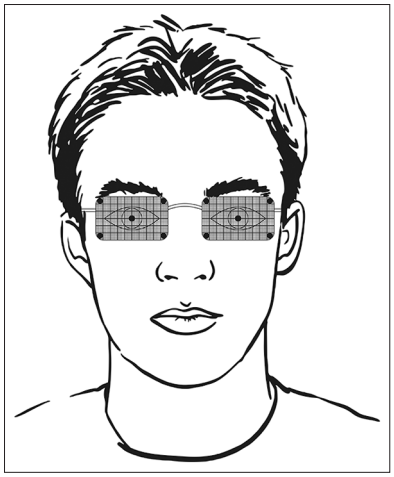

Figure 7: Grid cutouts placed on spectacle frame

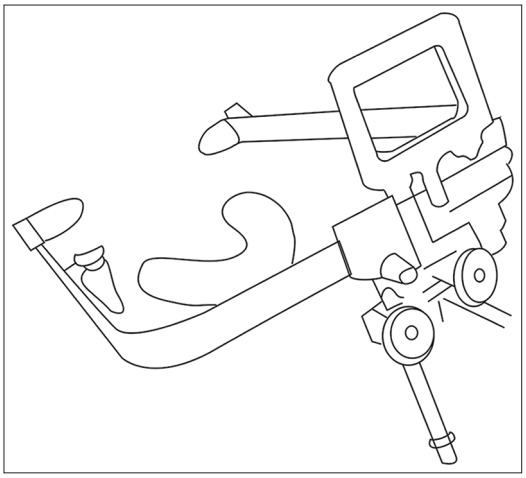

Figure 8: Graph grid frame attached to spring bow

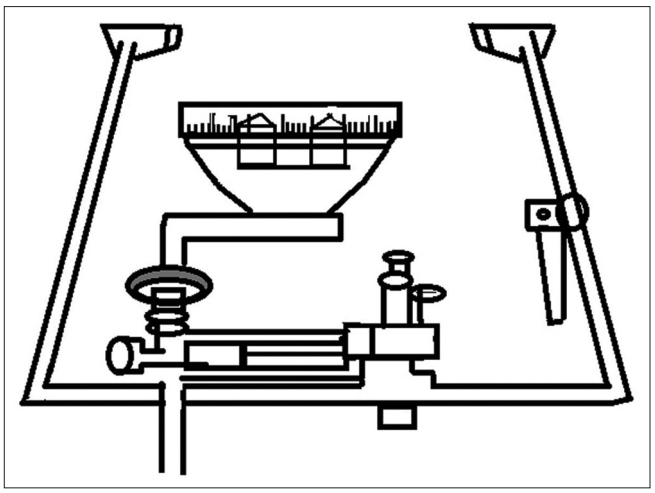

Figure 9: Modified Hanau wide-view spring bow

use of face bows can not be used in patients without ear as face bow stabilization is mandatory for accuracy.

Gupta *et al*. used a customized scale for iris positioning[28] [Figure 10]. This scale had markings from zero to four from left to right on top and vice a Versa at the bottom that helped to orient iris in all the three plans i.e., mediolaterally, superio-inferiorly and anteroposteriorly. This method does not use a common reference plane to orient iris, this feature helped this scale to be used successfully in patients with facial asymmetry. However, the construction of such a customized scale is not only tedious but also has chances of fabrication errors.

To overcome such problems and to remove the observer bias that subsists with conventional techniques objectively prefabricated scales were tried. Bhochhibhoya *et al*. in 2019 used PD ruler to position the iris in eye prosthesis[29] [Figure 11]. PD scale is a graduated scale in a horizontal plane that was related to the axis of the patient's nose to measure papillary distances and mediolateral proportions of normal eye's iris and the same measurements were transferred on defect area to position the iris in a prosthetic eye. This technique proved to be economic and required minimal skills. As this technique measures the location of both the irises simultaneously taking a common reference plane, it failed to be useful in facial asymmetry cases.

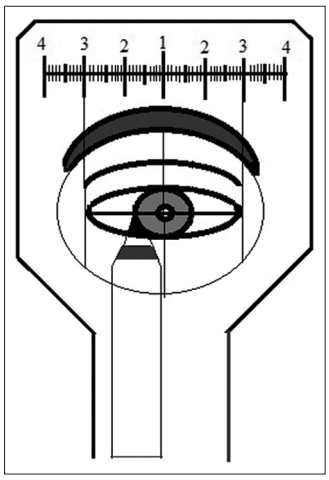

Figure 10: Customized scale

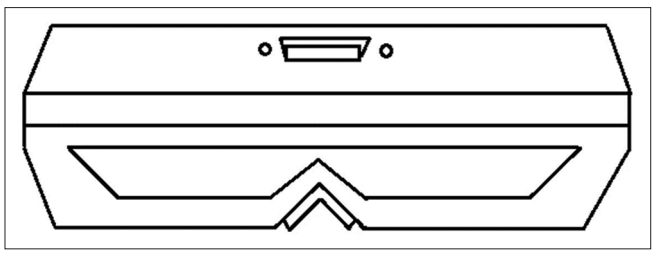

Figure 12: Optical vernier interpupillary distance ruler

Chihargo and Syafrinani in 2019 used an IPD ruler to orient the iris in symmetry with the adjacent normal eye[30] [Figure 12]. Lanzara *et al*. did iris positioning by marking the references on the patient's face and recording those with the help of electronic vernier caliper[31] [Figure 13]. Objective measurement for assessing iris position proved to be beneficial over the subjective once. The use of such appliances or tools with millimeter scales provides accurate measurements for the centering of iris. Moreover, they are affordable, comfortable to the patients, easy to use and recommended for clinical usages in small setups.

Bi *et al*. used a 3-dimensional scanning (CAD-CAM) system to record patients' faces to form a 3D facial model.[32] The measurements were recorded and were mirrored on the defect area to position the iris. The advantage of this technique is less length of clinical appointment and fabrication was direct and quick.

Dasgupta *et al*. gave the used digital photography for iris positioning. He took a good quality facial photograph from a camera Digital single-lens reflex [Figure 14]. Clicks were taken in such a manner the flashlight reflected in pupil at the center of the pupil of the normal eye on the photograph and the different measures were then recorded for positioning iris accurately on the photograph itself.[25] These digital methods did not require complex armamentarium and patient cooperation as facial measurements and positioning were done on the photograph. However, the knowledge and skills for using this software are to be developed by professionals to achieve the aesthetic results in an ocular prosthesis.

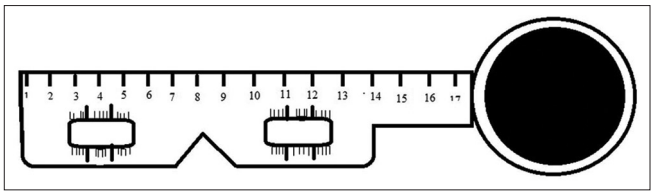

Figure 11: Pupillary distance ruler

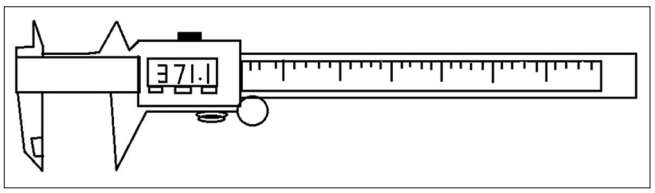

Figure 13: Electronic vernier caliper

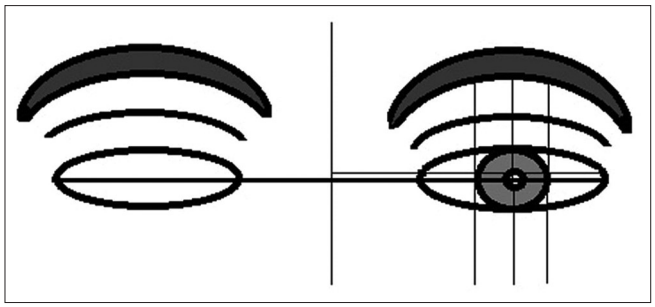

Figure 14: Digital photograph

An attempt to bring all the old and new methods and techniques with their pros and cons for positioning iris precisely in a prosthetic eye has been made in this systematic review to help a clinical to choose the most accurate one.

Currently, there are no randomized control trials studies undertaken with different techniques of iris positioning in a prosthetic eye, to conclude on the best technique available for orienting the iris accurately, so more research in the area and particular Randomized controlled trial studies are indicated to assess the best method or technique for iris orientation. Future research should be done to verify the reliability of these methods and techniques.

Summary

Precise positioning of Iris is a key to the esthetic ocular prosthesis. There are varied techniques to position iris in the prosthetic eye. The newer techniques have surpassed the lacunae of older ones. Due to insufficient count of well-structured and long-term prospective studies, a comment over the longevity in terms of the outcome of the various techniques for iris centering can hardly be given.

CONCLUSION

However, it can be concluded that the digital approach for iris positioning such as digital photography provides an edge over other techniques. It can be considered as the best available technique that can be used even in cases with facial asymmetry and can be used without complex armamentarium, patient cooperation, and assistance.

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Conflicts of interest

There are no conflicts of interest.

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