CONSISTENCY OF SPECTACLE MEASUREMENTS USING ELECTRONIC DEVICES

by

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ACCEPTED:

Faculty Course Supervisor:

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Doctor of Optometry Senior Paper

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CONSISTENCY OF SPECTACLE MEASUREMENTS USING ELECTRONIC DEVICES

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Matt Austin, Doctoral Candidate

Derek Williams, Doctoral Candidate

5/1/2018

Date

ABSTRACT

Background : The purpose of this project is to determine if one of the electronic devices for taking measurements for a pair of glasses is more accurate than the others for the measurements of pupil distance, segment height, pantoscopic tilt, and vertex distance.

Methods : Data was obtained on 25 participants. The four measurements were obtained using different optical devices and manually. The devices used were the Essilor Visioffice, and two ipad applications called the Optikam and the Spectech. After measurements were obtained, percent error for each device was calculated to determine the most accurate method.

Results : There was not a single method that was the most accurate in all four measurements analyzed. The two best methods were the Spectangle and VisiOffice for pupillary distance. Manual measurement and VisiOffice were the most accurate form to determine vertex distance. Manual measurement was the most accurate method for determining pantoscopic tilt. Lastly, the SpecTech was the most accurate measurement method for segment height.

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CHAPTER 1

INTRODUCTION

In order for prescription spectacle lenses to provide optimal vision and comfort for a patient they must be properly aligned in front of their eyes. If the lens is not properly centered and the patient isn't looking through the optical center, light rays are deviated. This leads to induced prismatic effects that will lead to the patient experiencing asthenopia, blur or headaches[1]. Lens decentration affects stereopsis and fusional vergence, vertical more so than horizontal due to lower vertical fusional ranges[2]. A study observing patients with decentered lenses found fifty percent of those with horizonal misalignment and forty-seven percent with vertical misalignment were symptomatic[3]. Prism adaptation may account for more not being symptomatic.

To ensure lenses are made to appropriately align with the patient's eyes, measurements are taken prior to submitting an order to a lens manufacturer. Some of the measurements that may be recorded are pupillary distance (PD), vertex distance, segment (seg) height and pantoscopic tilt. PD is the horizontal distance between the participant's eyes. Seg height is the vertical distance from the bottom the glasses to the center of the participant's eye. Pantoscopic tilt is the vertical angle at which the lenses in front of the eye are oriented. In aspheric lenses, for every 2 degrees of excess tilt the lens should be decentered 1 millimeter for the patient to remain comfortable due to off axis power errors [4]. Vertex distance is the distance from the back of the glasses to the front of the participant's eye. These measurements all have an impact on comfortably the patient will see out of the glasses.

Currently, there are many different methods to obtain these measurement. Many offices take measurements manually with a ruler and pupillometer. A previous study showed pupillometers also have less error when measuring PDs when compared to ruler employed manual measurements[5]. A separate study have found that pupillometers are a reliably accurate method for measuring PDs[1]. Pupillometers also show good repeatable from examiner to examiner when taking measurements. One study found inter-examiner repeatability was slightly poorer than intra-examiner repeatability[6]. Many studies have proven pupillometers to be accurate and reliable methods, so for an office to invest in an electronic method of measuring it must also be accurate and reliable. Some offices utilize electronic programs to record the measurements. In practice, an office would likely only use one electronic program in their optical. This study will compare the consistency and accuracy of some of the most common electronic programs including the manual method.

CHAPTER 2

METHODS

All measurements were taken with subjects wearing the same frame. The frame was a black plastic frame with dimensions 55-16-140. These measurements were taken in the university eye center on optometry students between the ages of 21 and 29 years old. There were four measurements taken with four different methods. The measurements were for pupil distance, vertex distance, pantoscopic tilt, and segment height. The four methods were manual, Spectangle, SpecTech, and VisiOffice.

For the manual method, pupil distance was measured using a pupillometer set to take pupil measurements at distance. Pantoscopic tilt was then measured by using a pantometer by Shamir. This device attaches to the front of the lens and has a gauge for recording the measurement. To measure vertex distance a distometer was used. For seg height measurements, pupil center was marked on the frame then a ruler was used for measuring.

To record measurements on the SpecTech, there is a plastic piece that mounts onto the front of the eyeglass frame and a picture is then taken. Then on the iPad there are different icons that must be used to mark where pupils are as well as the edges of the frames. Once the icons are in place, the program generates the measurements for PD, pantoscopic tilt, vertex distance, and seg height.

Spectangle is another iPad application. For this program there is a different plastic piece that mounts onto the front of the eyeglass frame. Similar to the SpecTech, a picture is then taken and specific markings must be placed over the pupil and at the edges of the

glasses frame. Once done the program will generate measurements for PD, pantoscopic tilt, vertex distance, and seg height.

VisiOffice is another piece of equipment that takes digital measurements. Unlike the others, this program is not through an iPad app but is it's own stand alone piece of equipment. For this the subject attached a plastic piece to the front of the eyeglasses. This program requires two pictures. A straight on picture and a picture with the subject angled at forty-five degrees. Then there are markers place on the pictures over pupils and at the edge of the glasses frames and digital measurements are then generated.

All four measurements were collected for all four devices with the exception that the Spectangle was unable to measure vertex distance. For measurements that gave a right eye and left eye measurement, we used right eye data to simplify comparison of the data. Averages of each data point were taken for the four measurements and treated as the true value. The percent error for each of the four measurements were calculated by comparing the measurement from the method used to the true value for that measurement.

CHAPTER 3

RESULTS

All four methods of measurement obtained results for pupillary distance, pantoscopic tilt, and segment height. The iPad application for the Spectangle does not have the ability to determine vertex distance. Therefore, vertex was only obtained by the VisiOffice, SpecTech, and manually. The tables below display the standard deviation and average percent error for each measurement for all the methods tested in this study.

Table 1: Pupillary Distance

Measurement Type	Standard Deviation	Average Percent Error
Manual	1.10	1.78%
SpecTech	0.99	1.61%
Spectangle	0.55	0.88%
VisiOffice	0.57	0.92%

Table 2: Pantoscopic Tilt

Measurement Type	Standard Deviation	Average Percent Error
Manual	1.69	24.00%
SpecTech	3.66	49.22%
Spectangle	3.88	51.33%
VisiOffice	2.22	33.43%

Table 3: Vertex Distance

Measurement Type	Standard Deviation	Average Percent Error
Manual	1.72	14.32%
SpecTech	3.92	32.91%
VisiOffice	2.42	19.32%

Table 4: Seg Height

Measurement Type	Standard Deviation	Average Percent Error
Manual	1.69	6.20%
SpecTech	1.04	3.77%
Spectangle	1.29	4.74%
VisiOffice	1.11	4.00%

CHAPTER 4

DISCUSSION

Pupillary distance is the distance between the center of a patient's pupils. This measurement determines where a lens manufacture will put the optical center of a lens. If a patient is not looking through the optical center of a lens the incorrect power and induced prismatic power could be affecting the clarity and comfort of their vision. Previous research has shown electronic forms of measurement have been the most accurate way to measure pupillary distance. This study resulted in similar findings. Manual measurements in this study yielded an average of 1.78% error between all patients; the highest amongst all methods tested. SpecTech yielded the second highest error with 1.61%. The two best methods were the Spectangle and VisiOffice with 0.88% and 0.92% error respectively.

The vertex distance of the lenses is also an important measurement for prescription lenses. As the vertex distance of a lens is altered, so it's the dioptric power of light reaching the front of the cornea. The power is significantly altered in prescriptions greater than ±6.00D with even a small change in the vertex distance.[8] Our research shows that the SpecTech was the least reliable method of measuring vertex distance with error of 32.92%. Manual measurement and VisiOffice were the most accurate form to determine vertex distance with error of 14.32% and 19.32% error respectively.

Pantscopic tilt also needs to be considered when fitting a pair of prescription lenses. When a patients glasses prescription is being determined, the lenses inside the phoropter are perpendicular to the patient's visual axis. However, most lenses in frames

are not positioned perpendicularly which can induce changes in the prescription power of the lens.[4] Based on our research, manual measurement was the most accurate method for determining pantoscopic tilt with error of 24.00%. The second most accurate method was the VisiOffice with error of 33.43%. The SpecTech and Spectangle were the least accurate at determining pantoscopic tilt. Error for these methods were 49.22% and 51.33% respectively. One possible reason for this error is that these methods required the user to take a picture with an iPad application. If the angle at which the user was positioned when taking the picture, this would influence the pantoscopic tilt the application calculates.

Bifocal and progressive lens designs also require a segment height. If this measurement is inaccurate, the patient may be looking through near prescription power in primary gaze.[9] Our research shows that the manual method of measurement was least accurate with 6.20% error and the SpecTech was the most accurate with only 3.77% error.

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Appendix A

IRB Approval Form

Ferris State University

Institutional Review Board (FSU - IRB)

Chair
820 Campus Drive
Ferris State University
Big Rapids. MI 49307
(231) 591-2759
IRB@ferris.edu

Date: Oct 18, 2017

To: James Brady
From: Gregory Wellman, R.Ph, Ph.D, IRB Chair
Re: IRB Application *IRB-FY16-17-17 Consistency of Spectacle Measurements Using Electronic Devices*

The Ferris State University Institutional Review Board (IRB) has reviewed your application for using human subjects in the study, " *Consistency of Spectacle Measurements Using Electronic Devices" (IRB-FY16-17-17)* and Approved this project under Federal Regulations Expedited Review Category 4. Collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving x-rays or microwaves.

Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications.)
6. Collection of data from voice, video, digital, or image recordings made for research purposes.

Approval has an expiration date of one year from the date of this letter . **As such, you may collect data according to the procedures outlined in your application until Oct 18, 2018 .** Should additional time be needed to conduct your approved study, a request for extension must be submitted to the IRB a month prior to its expiration.

Your protocol has been assigned project number IRB-FY16-17-17. Approval mandates that you follow all University policy and procedures, in addition to applicable governmental regulations. Approval applies only to the activities described in the protocol submission; should revisions need to be made, all materials must be reviewed and approved by the IRB prior to initiation. In addition, the IRB must be made aware of any serious and unexpected and/or unanticipated adverse events as well as complaints and non-compliance issues.

Understand that informed consent is a process beginning with a description of the study and participant rights with assurance of participant understanding, followed by a signed consent form. Informed consent must continue throughout the study via a dialogue between the researcher and research participant. Federal regulations require each participant receive a copy of the signed consent document and investigators maintain consent records for a minimum of three years.

As mandated by Title 45 Code of Federal Regulations, Part 46 (45 CFR 46) the IRB requires submission of annual reviews during the life of the research project and a Final Report Form upon study completion. Thank you for your compliance with these guidelines and best wishes for a successful research endeavor. Please let us know if the IRB can be of any future assistance.

Regards,

Gregory Wellman, R.Ph, Ph.D, IRB Chair
Ferris State University Institutional Review Board
Office of Research and Sponsored Programs