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Title: Comparison of Agreement and Accuracy Using Binocular Wavefront Optometer with Autorefractor and Phoropter

Authors and Affiliations:
Suqi Xian[1*], Yifan Tang[1*], Peng Ji[2], Hongsheng Bi[2], Qingbao Wang[1], Xiaofan Wang[1], Li Li[1]

[1]Shandong University of Traditional Chinese Medicine
[2]Affiliated Eye Hospital of Shandong University of Traditional Chinese Medicine, Shandong Clinical Medicine Research Center

***These authors contributed equally to this work**

Corresponding Authors:
Peng Ji (ji6605@126.com)
Email Addresses for All Authors:
Suqi Xian (17860504846@163.com)
Yifan Tang (793701712@qq.com)
Peng Ji (ji6605@126.com)
Hongsheng Bi (hongshengbi1@163.com)
Qingbao Wang (1259396392@qq.com)
Xiaofan Wang (wxff28@163.com)
Li Li (2022111387@sdutcm.edu.cn)

Author Questionnaire

1. **Microscopy**: Does your protocol require the use of a dissecting or stereomicroscope for performing a complex dissection, microinjection technique, or something similar? **No**

2. **Software:** Does the part of your protocol being filmed include step-by-step descriptions of software usage? **Yes, all done**

Videographer: Please film all shots labelled SCREEN

3. **Filming location:** Will the filming need to take place in multiple locations? **No**

Current Protocol Length
Number of Steps: 08
Number of Shots: 19

Introduction

Videographer: Obtain headshots for all authors available at the filming location.

1.1. **Suqi Xian:** This study evaluates the binocular wavefront optometer's agreement and accuracy versus autorefractor and phoropter in postoperative refractive surgery patients, verifying its standardized protocol for enhanced accuracy and clinical utility.

1.1.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera.

What research gap are you addressing with your protocol?

1.2. **Peng Ji:** This protocol addresses the lack of precise refractive protocols for post-surgery patients, enabling measurements at finer intervals with enhanced accuracy and promoting wider clinical adoption.

1.2.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera.

What advantage does your protocol offer compared to other techniques?

1.3. **Peng Ji:** Our protocol delivers more accurate refractive measurements, allows expression at smaller measurement intervals, and enhances visual quality compared to conventional methods.

1.3.1. INTERVIEW: Named Talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B.roll:3.4*

Videographer: Obtain headshots for all authors available at the filming location.

Ethics Title Card

This research has been approved by the Medical Ethics Committee of the Affiliated Eye Hospital of Shandong University of Traditional Chinese Medicine

Protocol

2. Binocular Refraction Using a Wavefront Optometer Interface

Demonstrator: Suqi Xian

2.1. To begin, obtain a binocular wavefront optometer **[1].** Click the **Start Test** button to automatically calibrate the detection distance and measure objective refraction in 0.05 diopter increments **[2]**.
Videographer: Please film all shots labelled SCREEN

2.1.1. Talent holding a binocular wavefront optometer.

2.1.2. SCREEN: Shot of the **Start Test** button being clicked and the automated calibration process, with the detection distance and refraction values are being seen.

2.2. Click on **Electronic Software** to simulate occluding the right eye **[1]**. Instruct the participant to use the left eye to view, without identifying, the 20/20 *(Twenty-twenty)* line of optotypes **[2]**.

2.2.1. SCREEN: The **Electronic Software** interface is being clicked.

2.2.2. Talent pointing to the 20/20 line while instructing the participant to view it with the left eye only.

2.3. To perform the red-green duo-chrome test, select **Green Clear** if the green background appears clearer to simulate adding a positive sphere lens **[1]**, or click **Red Clear** if the red background appears clearer to simulate adding a negative sphere lens **[2-TXT**].

2.3.1. SCREEN: The Green Clear button is being pressed when green background is clearer.

2.3.2. SCREEN: **Red Clear** is being pressed when red background is clearer. **TXT: Do not adjust the lens on both backgrounds and click the "Equal Clarity" button**

2.4. Next, perform the Jackson cross-cylinder test by using the electronic software to simulate two honeycomb pictures **[1]**. Click **Picture 1 clear** or **Picture 2 clear** to simulate adjusting the axis in 1-degree increments, then select **equal clarity** until the participant observes equal clarity in both pictures **[2]**.

2.4.1. SCREEN: Show the Jackson cross-cylinder interface displaying two honeycomb patterns.

2.4.2. SCREEN: The axis is being adjusted in 1-degree steps until the images appear

equally clear.

2.5. Now click to simulate adding a 0.10 diopter negative cylinder lens if the first picture appears clearer **[1]** or a 0.05 diopter positive cylinder lens if the second picture appears clearer **[2]**. Adjust until both pictures appear equally clear then select **Equal Clarity** to determine the cylinder **[3-TXT]**.

2.5.1. SCREEN: Show selection of 0.10 diopter negative cylinder lens after clarity in the first picture.

2.5.2. SCREEN: Show selection of 0.05 diopter positive cylinder lens after clarity in the second picture.

2.5.3. SCREEN: Show stepwise adjustments being made until clarity in both images is equal. **TXT: Repeat test for the right eye**

2.6. Once done, ask participants to observe two separate lines of optotypes **[1]**. Click **Upper Sharper** if the top line appears clearer **[2]** or **Lower Sharper** if the bottom line appears clearer **[3]**. Continue this process until equal clarity is reported to complete the binocular balance test **[4]**.

2.6.1. Talent presenting two lines of optotypes to the participant.

2.6.2. SCREEN: **Upper Sharper** is being selected according to participant feedback.

2.6.3. SCREEN: **Lower Sharper** being selected according to participant feedback

2.6.4. SCREEN: Show the adjustment sequence continuing until equal clarity is achieved.

2.7. Now, simulate adding a positive lens to fog both eyes **[1]**. Gradually increase the negative sphere lens until the participant reports no further improvement in visual acuity **[2]**.

2.7.1. SCREEN: Show positive lens fog being applied to both eyes.

2.7.2. SCREEN: Show incremental increase of the negative sphere lens until the participant confirms no further improvement.

2.8. Lastly, perform the duo-chrome test for both eyes **[1]**. Click **Red Clear** or **Green Clear** and adjust until equal clarity is seen in red and green backgrounds. If the clarity of red and green is not equal, select the most negative sphere lens where red no longer changes to green **[2]**.

2.8.1. SCREEN: Display the red-green duo-chrome test interface for both eyes.

2.8.2. SCREEN: Highlight the selection of the most negative sphere lens at the point where red clarity cannot be changed to green.

Results

3. Results

3.1. At 1 month postoperatively, 98.4% of eyes achieved 20/20 or better best corrected visual acuity using both the binocular wavefront optometer and the phoropter **[1]**.

3.1.1. LAB MEDIA: Figure 1. *Video editor: Highlight both the green and gray bars*.

3.2. A significantly higher proportion of eyes reached 20/16 or better with the binocular wavefront optometer compared to the phoropter **[1]**.

3.2.1. LAB MEDIA: Figure 1. *Video editor: Highlight the green bars labeled 20/16*

3.3. There were no significant differences between the binocular wavefront optometer and the autorefractor in objective measurements of sphere, J0 *(J-Zero)*, J45 *(J-Forty-Five)*, and spherical equivalent **[1]**.

3.3.1. LAB MEDIA: Table 1. *Video editor: Highlight the "Binocular wavefront optometer "and " Autorefractor" columns*

3.4. For subjective refraction, the sphere measurement differed significantly between the binocular wavefront optometer and phoropter **[1]**, while J0, J45, and spherical equivalent did not show significant differences **[2]**.

3.4.1. LAB MEDIA: Table 2. *Video editor: Highlight the first row ("Sphere") under both columns*

3.4.2. LAB MEDIA: Table 2. *Video editor: Highlight the J0, J45, and SE rows*

3.5. Bland-Altman plots showed good agreement between the binocular wavefront optometer and autorefractor for objective sphere **[1]**, J0 **[2]**, J45 **[3]**, and spherical equivalent **[4]**.

3.5.1. LAB MEDIA: Figure 2A. *Video editor: Show the plot and mark dots between the Upper and lower LOA*

3.5.2. LAB MEDIA: Figure 2B. *Video editor: Show the plot and mark dots between the Upper and lower LOA*

3.5.3. LAB MEDIA: Figure 2C. *Video editor: Show the plot and mark dots between the Upper and lower LOA*

3.5.4. LAB MEDIA: Figure 2D. *Video editor: Show the plot and mark dots between the Upper and lower LOA*

3.6. Bland-Altman plots also showed good agreement for subjective measurements between the binocular wavefront optometer and phoropter for sphere **[1]**, J0 **[2]**, J45

[3], and spherical equivalent **[4]**.

3.6.1. LAB MEDIA: Figure 3A. *Video editor: Show the plot and mark dots between the Upper and lower LOA*

3.6.2. LAB MEDIA: Figure 3B. V *Video editor: Show the plot and mark dots between the Upper and lower LOA*

3.6.3. LAB MEDIA: Figure 3C. *Video editor: Show the plot and mark dots between the Upper and lower LOA*

3.6.4. LAB MEDIA: Figure 3D. *Video editor: Show the plot and mark dots between the Upper and lower LOA*

Pronunciation Guide:

1. Binocular

- **Pronunciation link:** https://www.merriam-webster.com/dictionary/binocular
- **IPA (American):** /baɪˈnɑːkjələr/ or /bəˈnɑːkjələr/
- **Phonetic Spelling:** bye-NOK-yuh-ler or buh-NOK-yuh-ler

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2. Wavefront

- **Pronunciation link:** https://www.merriam-webster.com/dictionary/wavefront
- **IPA (American):** /ˈweɪvˌfrʌnt/
- **Phonetic Spelling:** wayv-frunt

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3. Optometer

- **Pronunciation link:** No confirmed link found
- **IPA (American):** /ɑpˈtɑːmɪtər/
- **Phonetic Spelling:** op-TAH-mi-ter

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4. Autorefractor

- **Pronunciation link:** No confirmed link found
- **IPA (American):** /ˌɔtoʊrɪˈfræktər/
- **Phonetic Spelling:** aw-toh-ri-FRAK-ter

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5. Phoropter

- **Pronunciation link:** https://www.merriam-webster.com/dictionary/phoropter
- **IPA (American):** /fəˈrɑːptər/
- **Phonetic Spelling:** fuh-ROP-ter

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6. Diopter

- **Pronunciation link:** https://www.merriam-webster.com/dictionary/diopter
- **IPA (American):** /daɪˈɑːptər/
- **Phonetic Spelling:** dye-OP-ter

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7. Optotypes

- **Pronunciation link:** No confirmed link found
- **IPA (American):** /ˈɑp.toʊˌtaɪps/
- **Phonetic Spelling:** OP-toh-typs

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8. Duo-chrome

- **Pronunciation link:** No confirmed link found
- **IPA (American):** /ˌduː.oʊˈkroʊm/
- **Phonetic Spelling:** doo-oh-KROHM

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9. Jackson cross-cylinder

- **Pronunciation link:** No confirmed link found (compound of “Jackson” + “cross-cylinder”)
- **IPA (American):** /ˈdʒæksən krɔs-ˈsɪlɪndər/
- **Phonetic Spelling:** JAK-suhn kross-SILL-in-der

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10. Bland-Altman

- **Pronunciation link:** No confirmed link found (surname pair)
- **IPA (American):** /blænd ˈɔːltmən/
- **Phonetic Spelling:** bland-AWLT-muhn