Comparison of Refined Cylindrical Axis by Straddling and Autorefractometer: A Clinical Study

Ophthalmol Pak. - Official Journal of College of Ophthalmology & Allied Vision Sciences

OPEN ACCESS

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ABSTRACT

Purpose: To compare two cylindrical refinements i.e. autorefractometer and straddling by taking patients response.

Methodology: Study protocols was approved by Ethical Review Board of National Eye Centre, Lahore. A proforma based nonrandomized interventional method of study was conducted in National Eye Centre Lahore from August 2025 to September 2025. The size of obtained sample was 91 that included young healthy adults of age 18-35 having 1.00-3.00 D of astigmatism. Auto refraction, subjective refraction and then straddling was performed and then response was recorded by taking consent. Exclusion criteria for this study was individual with any ocular pathology. P-value was calculated by using Paired sample T test. Value of <0.05 was considered significant.

Result: No statistically visible significant differences were noted in between the methods (p-value > 0.05). Although minor variations exist in axis measurements, patients' satisfaction remained constant, showing that the interchangeability of the techniques was valid. These results agree with prior studies that stressed the flexibility yet accuracy needed in refractive assessment tools.

Conclusion: The straddling technique offers a reliable, time-efficient alternative to auto-refractometers for cylindrical axis refinement, ensuring comparable accuracy and patient satisfaction.

Keywords: Autorefractometer, Straddling, Astigmatism, Cylindrical Axis

How to cite this article: Sattar H, Munir A. Comparison of Refined Cylindrical Axis by Straddling and Autorefractometer: A Clinical Study. Opthalmol. Pak. 2025;15(4):132-137.
DOI: https://doi.org/10.62276/OphthalmolPak.15.04.214

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Received: 27-11-2025
Accepted: 13-12-2025

INTRODUCTION

A common type of issue that impairs visual integrity is refractive errors. They occur when the optical media along with the structure of your eye prevents light from properly focussing on the retina. They are myopia, hyperopia and astigmatism. Astigmatism is the most common refractive error followed by hyperopia and myopia[1].It can coexist with either farsightedness or near-sightedness. When light beams enter the front of the eye with astigmatism, they do not refract correctly on retina causing hazy vision up close and at a distance, because the cornea is not perfectly rounded.[2,3] Patients with astigmatism experience changes in contrast sensitivity and visual acuity in all light conditions. Patients may experience diplopia, eyestrain, and distorted vision if their condition is not treated.[4]

Dioptres are used to measure astigmatism. The cylinder gauges your level of astigmatism, or how uneven or flat your cornea is whereas the location of astigmatism on the cornea is indicated by the axis.[5,6] Astigmatism is diagnosed after a comprehensive eye examination. The examination includes visual acuity, refraction and maybe topography or keratometry also.[7] After determining the astigmatism, correction is calculated. Next comes the refining of calculated prescription. To get a sharper and clearer image, spherical error is typically adjusted and modified after cylindrical astigmatism has been addressed. The cylindrical correction can be purified in a number of ways i.e. Astigmatic fan and block technique, Jackson cross-cylinder technique, Astigmatic clock dial and fogging technique, Straddling technique etc.[8]

Manual streak retinoscopy was still up to date, the most accurate technique to estimate refractive status of children but not in adults.[9] This research emphasized on the efficacy of straddling technique which is a technique of retinoscope used to refine cylindrical correction's axis which has not been explored yet.

METHODOLOGY

The research protocols were approved by ERB of NECL, Lahore. A proforma based cross-sectional study was conducted in National Eye Centre Lahore from August 2025 to September 2025. The size of obtained sample was 91 by WHO formula $n = \frac{z^2{}_{1-\frac{\alpha}{5}} P(1-P)^2}{d^2}$ where 1-α(confidence level)= 95, P(anticipated population proportion)= 0.62, d(absolute precision required)= 0.10, n(sample size)= 91). It included young healthy adults of age 18-35 having 1.00-3.00 D of astigmatism. Anyone with any ocular surface disease or any other eye pathology was excluded. First informed consent was taken from all the participants and the procedure was thoroughly explained. Then auto refraction was performed to get refractive status of the participant. Then subjective refraction was performed to get the best corrected sphere and cylindrical power. Then straddling was performed to check and refine the axis and then a response was recorded for both eyes separately. In response the preference was asked for better vision, in between the autorefractometer axis and straddling axis, if any difference was noted. Exclusion criteria for this study was individual with any ocular pathology. Data was analysed by SPSS 26.00 to get results.All dependent and independent variables were kept in mind. Qualitative variables were presented as frequencies and percentages. All the quantitative variables were presented as means, ranks and standard deviations. P value was calculated by using Mann-Whitney U test. P value<0.05 was considered significant.

RESULTS

In my study , there were 91 participants , in which 32 were females and 59 were males with age of 18-35 years. Participants with no past history of ocular disease made up the population. First the objective refraction(Autorefraction) was done. Then subjective refraction was performed to get best sphere and best diopteric cylinder appreciated. Then Straddling was performed to get refined axis. Then response was recorded with both Autoref axis and Straddling axis.

Generally, a difference of ± 5-10 degrees was noted and ocassionally not, but the subjective response did not showed any significant difference between the two exposures to different axis in either eye. Both axis were equally appreciated by all the research participants.

Table # 1: Test Statistics

	R.E	L.E
Mann-Whitney U	3917.5	3807.5
p-value	0.53	0.414

The p-value (0.530) is greater than the significance threshold (e.g., 0.05), indicating no statistically appreciable difference in between the autorefractor and straddling cylinder methods for right eye axis measurements. Also the p-value (0.414) is also above 0.05, suggesting no statistically significant difference between the two methods for left eye axis measurements.

Table # 2: Ranks

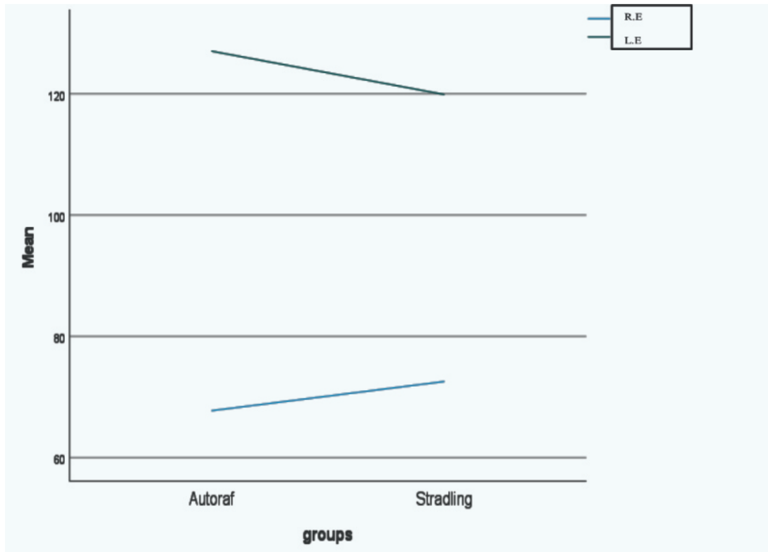
	p-value	Groups	N	Mean Rank	Sum of Ranks
		Autoref	91	89.05	8103.5
R.E	0.53	**Straddling**	91	93.95	8549.5
		Total	182		
		Autoref	91	94.16	8568.5
L.E	0.414	**Straddling**	91	87.81	7902.5
		Total	182		

Table # 3: Statistical Analysis of Autorefractometer and Straddling

Descriptive Data	Eye	N	Min	Max	Mean	Standard Deviation	p-value
Autoref Statistics	**R.E**	91	5	180	67.75	57.77	0.53
	L.E	91	5	180	127	51.742	0.414
Straddling Statistics	**R.E**	91	5	180	72.09	57.807	0.53
	L.E	91	5	180	119.9	55.571	0.414

Table 3 elaborates that:

- Both methods show a wide range of axis values (5° to 180°) for both eyes, indicating variability in the population's refractive errors.
- Mean cylinder axis values differ slightly between the methods, but variability (as shown by standard deviations) is similar.



The report mentions a line graph for mean cylinder axis values by groups, which could visually illustrate the similarity in axis measurements between the two methods. If provided, this graph would reinforce the conclusion that differences between methods are minimal

DISCUSSION

The comparison of refined cylindrical axis measurements using straddling and autorefractometer techniques, with patient responses serving as the gold standard, is a critical area of research in optometry. This study aims to evaluate the effectiveness of these two methods in non-cycloplegic patients, revealing no significant difference in outcomes. This discussion synthesizes findings from various studies that explore similar methodologies, the reliability of different refractive error measurement techniques, and the implications of these findings for clinical practice.

Straddling and autorefractometry are two prevalent methods for assessing cylindrical refractive errors. Straddling involves subjective assessment where the patient's feedback is integral to determining the optimal cylindrical axis. In contrast, autorefractometry provides an objective measurement based on automated optical systems. The reliability of these techniques has been a subject of various studies, particularly in non-cycloplegic conditions where the eye's natural state is preserved.

My results showed no significant difference in outcomes of both methods where a 100% result was achieved with a p-value of 0.530 and 0.414 in R eye and L eye respectively, reinforcing the outcome.

Sarawade & Mankari conducted a comparative research between streak retinoscopy and autorefractometry, concluding that autorefractometry provided more consistent results in estimating cylindrical powers and axes in non-cycloplegic patients. The spherical power estimated by retinoscopy and AR was accurate for 87.6% and 43.4% of the eyes respectively while 12.4% and 56.6% of the eyes respectively didn't appreciated the correction. The cylindrical power on the other hand, as calculated by retinoscopy and AR was appreciated by 57% and 78.6% of the eyes respectively. The axis given by retinoscopy and AR were accepted by 60.6% and 72.8% of the eyes respectively, which opposes with the findings of our study because they just kept streak retinoscopy in interest without exploring straddling technique.[9]

In another study, Guha et al. explored the differences between cycloplaegic auto refraction and retinoscopy in children. The study comprised the only left eyes of 294 subject children. It was 8.22 ± 3.47 years old on average. Clinically visible significant differences were observed in 13.22% of Group 1 eyes, 15.09% of Group 2 eyes, and 20.90% of Group 3 eyes. Children under six years old were more likely to have clinically significant differences (25%) than older children (9.19%). There were no statistically visible differences between any of the groups when comparing the power vector values obtained by auto refraction and retinoscopy for the spherical, cylindrical, spherical equivalent, and length components which aligns with our result.[10]

In another study, Kim et al. investigated the impact of induced astigmatism on static posture and found that variations in cylindrical axis direction significantly influenced patient outcomes. Twenty participants, totally corrected by subjective refraction (mean age, 23.4 ± 2.70 years), took part. Cylindrical lenses of +0.50, +1.00, +1.50, +2.00, +3.00, +4.00, and +5.00 D were employed to create simple myopic astigmatism situations. The TETRAX biofeedback system was used to analyse changes in the autumn risk index. For every circumstance, measurements were taken for 32 seconds. The fall risk index rose dramatically. This highlights the importance of precise cylindrical axis measurement in clinical settings, as even minor discrepancies can affect the overall visual performance[11].

In another study, Zhang et al. presented a reliable method for evaluating cylindrical errors, emphasizing the need for high precision in measurements. Their work underscores the importance of accurate cylindrical axis determination in both subjective and objective methods, reinforcing the relevance of our findings that show no significant difference between straddling and autorefractometry.[12]

In another study, Barrio et al. reviewed outcomes from small incision lenticule extraction (SMILE) for correcting myopic astigmatism, noting that accurate preoperative measurements of cylindrical axes are crucial for successful surgical outcomes. This further emphasizes the clinical significance of our study's findings regarding measurement techniques[13]

The reliability of autorefractometry compared to subjective methods has been a focal point in several studies:

Zhao et al. examined the influence of measurement errors in cylindrical coordinate systems, demonstrating that systematic errors can significantly affect the accuracy of cylindrical measurements. Their findings suggest that while autorefractometry is generally reliable, careful calibration and understanding of potential errors are essential for optimal results[14] whereas in retinoscopy, only the examiner skills come in handy.

In another study, Liu et al. focused on the measurement and evaluation of cylindricity deviations, employing methods that could be adapted for assessing cylindrical refractive errors. Their work illustrates the complexities involved in achieving precise measurements, which is pertinent to understanding the nuances of both straddling and autorefractometry[15].

In another study, Sun et al. developed a cylindrical profile measurement model that accounts for systematic errors, reinforcing the need for robust methodologies in cylindrical measurements. Their findings resonate with our study, highlighting the importance of precision in both subjective and objective measurement techniques[16].

The results of our study, which indicate no significant difference between straddling and autorefractometry, also have important implications for clinical practice. The choice of measurement technique may depend on the specific context and patient needs:

Zheng et al. discussed the experimental research on shape reconstruction in cylindrical materials, emphasizing the importance of accurate measurements in various applications. This parallels the necessity for precise cylindrical axis measurements in optometry, as inaccuracies can lead to suboptimal patient outcomes[17]

Bai et al. highlighted the use of advanced technologies for roundness measurement, suggesting that innovations in measurement techniques could enhance the accuracy of cylindrical assessments in optometry. This aligns with our findings that both traditional and modern techniques can yield comparable results[18]

Wang et al. focused on error correction in high-precision measurements, which is crucial in ensuring the reliability of cylindrical measurements in clinical settings. Their work supports the notion that both straddling and autorefractometry can be effectively utilized, provided that appropriate error correction methods are applied[19]

Adamczak et al. evaluated the accuracy of various measurement methods, concluding that while subjective methods have their place, objective techniques like autorefractometry can provide reliable results. This supports our findings that both methods are valid for refining cylindrical axis measurements[20]

The comparison of refined cylindrical axis measurements using straddling and autorefractometry, with patient responses as the gold standard, reveals no significant differences in outcomes. This finding is supported by a robust body of literature that underscores the reliability of both measurement techniques in non-cycloplegic patients. The implications of these results are significant for clinical practice, suggesting that practitioners can confidently utilize either method based on patient needs and specific clinical contexts.

Conflict Of Interest: None to declare.

Ethical Approval: The study was approved by the Institutional Review Board / Ethical Review Board on 09.08.2025, National Eye Center Lahore.

Authors' Contributions:

Huzaifa Abdul Sattar: Concept, Design, Literature search, Data analysis, Statistical analysis, Manuscript editing.

Aimen Munir: Concept, Design, Data acquisition, Data analysis, Manuscript preparation, Manuscript review.

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