Open Access

Original Article

Comparison of a Measuring Scale With Hertel's Exophthalmometer in a Pakistani Adult Population

Usman Tariq, Muhammad Shahid, Fawad Ahmad Khan, M Kamran Haider, Muhammad Jahanzaib, Abdul Rauf

Department of Ophthalmology, Armed Forces Institute of Ophthalmology Rawalpindi/National University of Medical Sciences (NUMS) Pakistan

ABSTRACT

Objective: To compare Measuring Scale (Modified Luedde's exophthalmometer) values with Hertel's exophthalmometer and assess their correlation and interchangeability in clinical practice.

Study Design: Cross-sectional study

Place and Duration of Study: Armed Forces Institute of Ophthalmology (AFIO), Rawalpindi, Pakistan, from Nov 2023 to Apr 2024.

Methodology: A total of 26 patients were enrolled in the study. Exophthalmometry was performed using a Measuring Scale and Hertel's exophthalmometer on the right eye of adult participants on the same day. Exophthalmometry readings were obtained and analyzed using paired sample t-tests and Bland–Altman plots.

Results: A total of 26 participants were included with a median age of 55 years, with an interquartile range (IQR) of 37-62 years. Mean Hertel's and Measuring Scale values were 17.81±1.96 mm and 17.77±2.02 mm, respectively. There was no statistical difference between Hertel's and measuring scale (modified Luedde's exophthalmometer) measurements (p=0.753).

Conclusion: Hertel's and Scale measurements are reasonably similar, and there is a statistically significant correlation between the Exophthalmometry measurements observed. Therefore, they can be used interchangeably clinically in resource-limited settings.

Keywords: Exophthalmos, Exophthalmometry, Hertel's, Luedde's, Measuring scale

How to Cite This Article: *Tariq U, Shahid M, Khan FA, Haider MK, Jahanzaib M, Rauf A. Comparison of a Measuring Scale with Hertel's Exophthalmometer in a Pakistani Adult Population. Pak Armed Forces Med J 2025; 76(Suppl-1): S68-S71. DOI: https://doi.org/10.51253/pafmj.v76iSUPPL-1.12213*

INTRODUCTION

Exophthalmometry is a clinical assessment of the vertical distance between the apex of the cornea and the lateral orbital margin. It is a vital tool in the assessment of orbital diseases, especially dysthyroid orbitopathy, orbital tumors, and orbital trauma. It is a vital clinical test in terms of diagnosis as well as to assess progression and response to therapy. Normal values are regarded as those between 12 mm and 20 mm, and values greater than 20mm or asymmetry of >02mm between two eyes.[1] Changes in proptosis are more important than the absolute values. Orbit is a tightly packed cavity, and therefore any inflammation or increase in size leads to anterior displacement of orbital content. Proptosis leads to exposure of orbital contents and, as a result, cornea, leading to exposure keratopathy and putting a stretch on the optic nerve and resultant optic neuropathy, leading to a loss of vision.[2,3] The term 'dystopia' is reserved for orbital displacement in the coronal plane.[4] Clinical assessment is immediately warranted due to the nature of causes, which are potentially sight-threatening and life-threatening, and an urgent diagnosis is mandatory in new-onset proptosis.[5]

Accurate measurement of proptosis is a challenge due to lack of a standardized measurement method. Digital photography has traditionally employed a cost-effective, touchless approach and offers a permanent record and comparison over time.[6] In the clinic, readily available measurement is using the most a measuring scale. The measuring scale is kept at the lateral orbital margin, and the position of the corneal apex is noted. The principle of scale is based on Luedde's exophthalmometer, which is a transparent lateral orbital margin-based exophthalmometer. It is inexpensive, fast, and easy; it is repeatable but plagued by a lack of objectivity.[7] The gold standard is the Hertel exophthalmometer due to its objectivity and repeatability. Hertel is inexpensive and portable, which comprises a sliding scale. It is kept at the lateral orbital rim, and the proptosis is assessed utilizing two mirrors. Repeatability, standardization, and consistency vary, however, across different examiners.[8] Naugle's exophthalmometer is a newly developed instrument that utilizes superior and inferior orbital rims instead of the lateral orbital rim.[9] Computed tomography Scan (CT) is an objective

Correspondence: Dr Usman Tariq, Department of Ophthalmology, Armed Forces Institute of Ophthalmology Rawalpindi Pakistan

Received: 10 May 2024; revision received: 11 Jan 2025; accepted: 15 Jan 2025

method of measurement of proptosis, but exposes patients to hazardous radiation. The accuracy and reliability of clinical Exophthalmometry compared to traditional methods and CT imaging remain a subject of debate.[10]

Therefore, an inexpensive, readily available instrument is required to measure with reasonable accuracy and repeatability. This study aims to assess the relative efficacy of transparent measuring scale readings with Hertle's exophthalmometer for the measurement of proptosis.

METHODOLOGY

This comparative cross-sectional study was conducted in the Armed Forces Institute of Ophthalmology (AFIO), Rawalpindi, Pakistan, in oculoplastic clinic, from Nov 23 to Apr 24. Nonprobability convenient sampling technique was used. The sample size of 26 was calculated using online software (OpenEpi), keeping two sided Confidence interval (1-a) at 95%, a power (1-b) of 80%, and the reported prevalence of proptosis in a case of thyroid eye disease to be 64.1%.[11] Permission of the institutional review board and ethical committee was granted (vide letter No 309/ERC/AFIO).

Inclusion Criteria: Patients of either gender with ages ranging from 19 to 70 years presented to the Outpatient Department of our hospital who were screened for proptosis at AFIO with intact lateral orbital rim.

Exclusion Criteria: Patients with a history of corneal surgery, trauma affecting the lateral orbital rim, oculoplastic intervention, prior history of thyroid eye disease, sinusitis, or orbital inflammatory pathology affecting paranasal sinuses or orbit were excluded from the study.

After obtaining informed consent, eligible participants underwent Exophthalmometry using both Hertle's exophthalmometer and a single measuring transparent scale (modified Luedde's exophthalmometer) devices on the same day by a consultant ophthalmologist who was blind to the nature and outcomes of the study, minimizing the variations in measurement. Scale was first kept at the lateral orbital margin while the patient fixated at a distant target with eyes in the primary position. The corneal apex was located through the transparent scale at the right angle, and the value corresponding to the corneal apex was noted. Measurement was followed by Hertel's exophthalmometer reading while keeping both lateral orbital margin footplates on the lateral orbital margin. Three measurements were taken, and the mean measurement was noted, keeping the same Value by a consultant ophthalmologist blind to this study. Only the right eye values were included in our study for standardization of the values. Data was collected and recorded in a standardized format by a resident ophthalmologist, ensuring accuracy and consistency. The difference in values was calculated mean difference was expressed. A disparity of >1.5mm clinically between the two observed values was considered a significant disagreement. The primary outcome measure was a comparison of Exophthalmometry values obtained from the Hertel's and Measuring Scale. Statistical Package of Social Sciences (IBM SPSS version 23) was used to analyze the data. Qualitative variables were expressed as frequency and percentages. The normality of the data was checked. Measurements using a measuring scale and Hertle's exophthalmometer were found to be normally distributed and expressed as mean ± SD. Age was not normally distributed and expressed as Median (IQR). Paired sample t-test was used to compare means, and a *p*-value of <0.05 was considered statistically significant.

RESULTS

A total of 26 participants were enrolled in the study, with a median age of 55.0 years (IQR 37.0-62.0 years). Out of 26, 14 (53.8%) were males, while 12(46.2%) were females. The mean Hertel's Exophthalmometry value was 17.81±1.96 mm, while the measuring scale (modified Luedde's exophthalmometer) mean value was 17.77±2.02 mm. There was a complete agreement between Hertel's and Measuring scale in 12(46.0%) patients, while Hertel's Exophthalmometry overestimated values were in 08(30.8%) patients, and measuring scale overestimated values in 6(23.1%) patients. The maximum difference between the two instruments was ±1mm. Scale values were underestimated as compared to Hertel's exophthalmometer, with a mean difference of -0.38 ± 0.61 mm.

There was no statistically significant difference between measurements from Hertel's exophthalmometer and the Measuring scale ($p = 0.753$). A Bland–Altman plot was employed to examine the discrepancy between measurements obtained from Hertel's and the measuring Scale for Exophthalmometry.

DISCUSSION

The authors aimed to find out whether an easy and inexpensive tool can be used interchangeably with an expensive and not readily available Hertle's exophthalmometer. In this study, an excellent correlation was found between Hertel's Exophthalmometry and a measuring scale/modified Luedde's exophthalmometer. Moreover, almost half the patients (approx. 46%) exhibited a complete agreement between the two methods, and the rest had an error ≤1mm. A mean difference of -0.38 ± 0.61 mm was calculated, which indicated a slight tendency for the measuring scale to underestimate values compared to Hertel's; however, it was not statistically significant (p = 0.753).

Table-I: Descriptive Statistics of the study participants, Age, gender, Measuring Scale (n=26)

Parameters (n=26)	Values
Age (median ± IQR)	55.00 (IQR 37-62) years
Gender n (%) Male Female	 14 (53.8%) 12 (46.2%)
Measuring Scale (Mean ± SD)	17.77 ± 2.02 mm
Hertle's exophthalmometer (Mean ± SD)	17.81 ± 1.96 mm

IQR – Interquartile Range

Table-II: Comparison of Exophthalmometry devices (n=26)

Parameter	Exophthalmometry devices		Mean Difference mm	p-Value
	Before Hertel's Scale Values mm n= 26	After Hertel's Scale Values mm n= 26		
Proptosis Measurements	17.81 ± 1.96	17.77 ± 2.02	-0.38 ± 0.61	0.753

Similarly, Delmas *et al.*, also compared Hertel's vs Luedde's vs CT scan in the measurement of proptosis and inter-examiner variability.[12] They found out that Luedde also underestimated the value as compared to Hertel's exophthalmometer. In contrast to our study, they, however, found Luedde's exophthalmometer less accurate than Hertel's. However, their study design was based on subjectivity, which may account for the differences. De Juan *et al.*, also compared the above three variables, and they found that Luedde's and Hertel's revealed comparable results in the measurement of proptosis, and the value of Luedde's Exophthalmometry was more comparable to CT scan readings than Hertel's Exophthalmometry readings.[13] They concluded that Luedde's exophthalmometer and Hertel's exophthalmometer can be used interchangeably.

Pereira *et al.*, have used Luedde's exophthalmometer for population-based studies in India to assess the proptosis in the normal population in India. In contrast to our study, mean Exophthalmometry values in their study were lower approx.[14-15] mm as compared to 17mm in our study. This can be because our data set represented the patients who reported for screening of proptosis.14 Also, there is evidence that there are racial disparities between different racial groups in Exophthalmometry, as evident by Nightingale *et al.*, who also used Luedde's exophthalmometer in their study.[15]

It was found that CT-scan is the most reliable tool as compared to clinical Exophthalmometry. Similarly, Sun *et al.*, also found CT-scan to be a more reliable tool as compared to the exophthalmometer.[16] Krassas *et al.*, found CT and Hertel's Exophthalmometry to have similar findings and found the values to be reproducible.[17] In our study, since we have not compared directly with a CT scan, exposing the normal population to the hazards of a CT scan is not justified if there is no reasonable doubt or integrity of the globe is compromised. Since multiple studies show a significant correlation between Luedde's Hertel's and CT scan, Steinberger *et al.*, found Luedde's exophthalmometer values to be comparable; Luedde's appears to be equally good in measuring proptosis. Orbital reconstruction following orbital trauma, tissue sacrifice from cancer resection, or other tissue loss poses a unique challenge for surgeons. Factors to consider include the patient's systemic health status, potential for adjuvant radiation, final composition, and strength of the graft, infection risk, graft rejection, status of visual function, and cosmetic outcome. In settings where a permanent artificial implant is avoided due to exposure or infection risk, potential tissue utilized includes xenografts, allografts, and autografts, each with variable benefits and drawbacks, depending on the surgical goals of the repair.[19] However, there should be a double blind RCT to observe these differences and infer the results accordingly. Finally, despite minor discrepancies, Luedde's exophthalmometer remains a reliable option, providing clinicians with a practical and inexpensive tool for clinical assessment.

To our knowledge, our study is the first study that specifically assesses the efficacy of Luedde's exophthalmometry with Hertel's in our population. Similarly, in our study, bias was minimized by having the examination done by a senior faculty member and blinding to the study. Similarly, only the right eye of the adult population was included to take away the age-related changes in exophthalmometry and to minimize anatomical variations between eyes.

LIMITATION OF STUDY

Limitations of our study are the cross-sectional study design, selection and information bias, unexplored confounding variables including gender, age, and a limited Sample size.

CONCLUSION

While Hertel's exophthalmometry remains the gold standard for clinical measurement of proptosis, the measuring scale (modified Luedde's exophthalmometer) can serve as an inexpensive, easy-to-use, convenient, and reasonably accurate alternative to Hertel's exophthalmometer, particularly in limited resource settings.

Conflict of Interest: None.

Funding Source: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

UT & MS: Data acquisition, data analysis, critical review, approval of the final version to be published.

FAK & MKH: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

MJ & AR: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Ahmad SS, Anwar R, Khan MA, Usmani N. Evaluation of proptosis: a primer. Ophthalmol 2021; 15(1): 26. doi: https://doi.org/10.17925/OPHT.2021.15.1.26
2. Lee ACH, Kahaly GJ. Pathophysiology of thyroid-associated orbitopathy. Best Pract Res Clin Endocrinol Metab 2023; 37(2): 101620. https://doi.org/10.1016/j.beem.2022.101620
3. Butt S, Patel BC. Exophthalmos. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan. Available from: https://www.ncbi.nlm.nih.gov/books/NBK559323/
4. Topilow NJ, Tran AQ, Koo EB, Alabiad CR. Etiologies of Proptosis: A review. Intern Med Rev 2020; 6(3): 10.18103/imr.v6i3.852. https://doi:10.18103/imr.v6i3.852.
5. Diao J, Chen X, Shen Y, Li J, Chen Y, He L, et al. Research progress and application of artificial intelligence in thyroid-associated ophthalmopathy. Front Endocrinol 2023; 15: 1-11. http://dx.doi.org/10.3389/fcell.2023.1124775
6. Denisova K, Barmettler A. Evaluating the thyroid eye disease patient. Int Ophthalmol Clin 2021; 61(2): 33-52. https://doi/10.1097/IIO.0000000000000351
7. Lam AKC, Lam C, Leung W, Hung P. Intra-observer and inter-observer variation of Hertel exophthalmometry. Ophthalmic Physiol Opt 2009; 29(4): 472–476. http://dx.doi.org/10.1111/j.1475-1313.2008.00617.x
8. Revankar S, Mehta A. Determination of exophthalmometry values in the North Indian population. Indian J Ophthalmol 2022; 70(8): 3083-3087. http://dx.doi.org/10.4103/ijo.IJO_489_22
9. Schlund M, Lutz JC, Sentucq C, Bouet B, Ferri J, Nicot R. Prediction of Post-Traumatic Enophthalmos Based on Orbital Volume Measurements: A Systematic Review. J Oral Maxillofac Surg 2020; 78(11): 2032–2041. http://dx.doi.org/10.1016/j.joms.2020.05.049
10. Das S, Muralidhar A, Tiple S. Clinical profile of thyroid eye disease and factors predictive of disease severity. Indian J Ophthalmol 2020; 68(8): 1629-1634. http://dx.doi.org/10.4103/ijo.IJO_104_20
11. Traiwanatham S, Sirinvaravong S, Plengvidhya N, Wongsripuemtet J, Lertlam S. RF35 | PSAT262 Comparative Study of Hertel Exophthalmometer and Luedde Exophthalmometer Versus Computed Tomography for Measurement of Proptosis in Normal Subjects. J Endocr Soc 2022; 6(Supplement_1): A860–A861. http://dx.doi.org/10.1210/jendso/bvac150.1779
12. Delmas J, Loustau JM, Martin S, Bourmault L, Adenis JP, Robert PY. Comparative study of 3 exophthalmometers and computed tomographic biometry. Eur J Ophthalmol 2018; 28(2): 144–149. http://dx.doi.org/10.5301/ejo.5001049
13. de Juan E. Racial Differences in Normal Values of Proptosis. Arch Intern Med 1980; 140(9): 1230-1231. http://dx.doi.org/10.1001/archinte.1980.00330200106028
14. Pereira T de S, Kuniyoshi CH, Leite C de A, Gebrim EMMS, Monteiro MLR, Pieroni Gonçalves AC. A Comparative Study of Clinical vs. Digital Exophthalmometry Measurement Methods. J Ophthalmol 2020;2020: 1397410. http://dx.doi.org/10.1155/2020/1397410
15. Nightingale CL, Shakib K. Analysis of contemporary tools for the measurement of enophthalmos: a PRISMA-driven systematic review. Br J Oral Maxillofac Surg 2019; 57(9): 904-912. https://doi:10.1016/j.bjoms.2019.06.026.
16. Sun R, Yin Z, Li L, Zhou H, Song X, Li Y. A novel method of measuring proptosis with computed tomography. Acta Radiologica 2023; 64(9): 2603–2610. http://dx.doi.org/10.1177/02841851231187859
17. Krassas GE, Boboridis KG, Wiersinga WM. Re: "Clinical Features and Treatment of Graves Ophthalmopathy in Pediatric Patients." Ophthal Plast Reconstr Surg 2006; 22(5): 405–406. http://dx.doi.org/10.1097/01.iop.0000237095.37109.55
18. Steinberger EE, Vogt AZ, Tan JF. Skin and Bone: Intact Fish Skin to Reconstruct Traumatic Orbital Floor and Wall Defects. Ophthal Plast Reconstr Surg 2024: 40(3): e78-e80. https://doi:10.1097/IOP.0000000000002594

....