ORIGINAL STUDY

Observational study of retinal sensitivity in a healthy population: computer analysis of the visual field.

Studio osservazionale sulla sensibilità retinica in una popolazione sana: analisi computerizzata del campo visivo.

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Abstract - A fundamental technique in ophthalmology is the assessment of retinal sensitivity through static, computerized perimetry. This technique is used to analyze visual function and diagnose numerous optic nerve and retinal pathologies. It allows for precise measurement of retinal sensitivity at various points in the visual field, providing essential data for identifying potential alterations. The employment of high-precision instruments, including ophthalmic projection perimeters, facilitates the acquisition of comprehensive quantitative data, thereby enhancing diagnostic precision. The objective of this study is to establish a reference baseline for retinal sensitivity in young, healthy individuals through the diagnostic interpretation of computerized perimetry, with the aim of standardizing normative values for the age group under study. This observational study was conducted on 118 healthy patients aged between 22 and 31 years. The patients underwent visual field testing to establish normative values for retinal sensitivity and evaluate test reproducibility. The 30-2 protocol was employed, entailing the evaluation of light sensitivity at 76 points distributed up to 30° from the fixation point. The mean deviation (MD), pattern standard deviation (PSD), and reliability indices (fixation loss, false positives, false negatives) were analyzed. The mean values obtained were as follows: The mean deviation (MD) was found to be -0.7 ± 0.4 dB, while the pattern standard deviation (PSD) was determined to be 1.6 ± 0.5 dB. The fixation loss was recorded as 2.1 ± 0.9%, and the false positives were identified as follows: 1.6 ± 0.8%; False negatives: 1.9 ± 1.0%. The data suggest that retinal sensitivity exhibited good stability and high test reproducibility in the examined subjects. These results establish a fundamental reference framework for the early diagnosis of visual field alterations, thereby enhancing the precision of computerized perimetry in clinical practice.

Riassunto - La valutazione della sensibilità retinica mediante perimetria computerizzata statica è una tecnica fondamentale in oftalmologia per l'analisi della funzione visiva e la diagnosi di numerose patologie del nervo ottico e della retina in quanto consente di misurare con precisione la sensibilità retinica in diversi punti del campo visivo, fornendo dati fondamentali per l'identificazione di eventuali alterazioni. L'utilizzo di strumenti ad alta precisione, come i perimetri di proiezione oftalmica, consentono di ottenere dati quantitativi dettagliati, migliorando l'accuratezza diagnostica. Lo scopo del presente studio è fornire una base di riferimento per la sensibilità retinica nei soggetti giovani e sani utilizzando l'interpretazione diagnostica della perimetria computerizzata, al fine di standardizzare i valori normativi per la fascia di età esaminata. Lo studio di tipo osservazionale è stato condotto su 118 pazienti sani di età compresa tra 22 e 31 anni a cui è stata eseguita una campimetria visiva al fine di stabilire i valori normativi della sensibilità retinica e valutare la riproducibilità del test. È stato utilizzato il protocollo 30-2 che prevede la valutazione della sensibilità luminosa in 76 punti distribuiti fino a 30° dal punto di fissazione. Sono stati analizzati Mean Deviation (MD), Pattern Standard Deviation (PSD) e indici di affidabilità (perdita di fissazione, falsi positivi, falsi negativi). I valori medi ottenuti sono stati: Mean Deviation (MD): -0,7 ± 0,4 dB; Pattern Standard Deviation (PSD): 1,6 ± 0,5 dB; Perdita di fissazione: 2,1 ± 0,9%; Falsi positivi: 1,6 ± 0,8%; Falsi negativi: 1,9 ± 1,0%. I dati indicano una buona stabilità della sensibilità retinica e una riproducibilità elevata del test nei soggetti esaminati. Questi risultati forniscono una base di riferimento essenziale per la diagnosi precoce di alterazioni del campo visivo migliorando l'accuratezza della perimetria computerizzata nella pratica clinica.

Keywords: Ophthalmic projection perimeters, early diagnosis of visual field alterations, retinal sensitivity.

Key messages:

- Static computerized perimetry is a technique for analyzing visual function and diagnosing numerous optic nerve and retinal pathologies.
- The clinical significance of these data is evident in their potential as a reference for comparative analysis of pathological results, particularly in conditions such as early glaucoma or cases of optic neuropathy.

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Introduction

Computerized perimetry is a fundamental diagnostic instrument for assessing visual function and retinal sensitivity (1). This technology facilitates the identification of visual field defects in a variety of pathological conditions, including glaucoma (2), optic neuropathies (3), and degenerative retinopathies (4). However, the proper interpretation of the data requires the establishment of normative values derived from healthy populations, thereby facilitating the distinction between physiological variations and pathological ones (5).

In recent years, technological advances have led to substantial improvements in the reliability of computerized perimetry. Contemporary projection perimeters employ high-precision digital technologies to measure retinal sensitivity, thereby facilitating the generation of detailed visual field mappings with high spatial resolution and real-time fixation monitoring. This approach serves to mitigate the risk of systematic errors (6). Recent studies have analyzed the reproducibility of perimetry in healthy subjects (7), demonstrating that tests such as the Humphrey 30-2 Sita Fast protocol (8) can provide reliable data, with a percentage of reliable tests greater than 80% in specific age groups (9). However, factors such as the learning effect can influence results, making adaptation strategies necessary to ensure greater reproducibility (10).

Concurrently, novel methodologies have been investigated to enhance the precision of visual field assessment, encompassing kinetic perimetry in virtual reality. This technology, which utilizes immersive headsets and eye-tracking, has demonstrated considerable promise in enhancing measurement precision and mitigating individual variability associated with head movements and postural artifacts (11).

Notwithstanding these advances, there are still gaps in the definition of normative values in healthy populations, particularly concerning specific retinal sensitivity parameters (12) and interindividual variability. The present study aims to analyze visual field parameters in a healthy population using computerized perimetry with the 30-2 protocol. The objective of this study is to furnish comprehensive normative data to enhance the diagnostic precision and clinical interpretation of results in individuals afflicted with ocular diseases.

Materials and Methods

The study design is of a transversal observational type. The study was conducted on a sample of 118 healthy subjects. The subjects were subjected to computerized campimetry with static stimulus presentation methods. The inclusion criteria were as follows: subjects were required to be between the ages of 22 and 31 years, to have uncorrected visual acuity of 10/10, and to be free of ocular or systemic pathologies that could affect the visual field. Additionally, subjects were required to have refractive defects not exceeding ±2 diopters. The exclusion criteria included the following: a previous diagnosis of ocular pathologies (e.g., glaucoma, optic neuropathies, retinopathies); the presence of opacity of dioptric media (e.g., early cataracts); and high variability of perimetric data (false positives >15%). The cluster was subsequently divided into two equivalent subgroups, designated numerically (59 subjects) and by sex (male only), that differed only in age, with group A comprising subjects between the ages of 22 and 26 and group B comprising subjects between the ages of 27 and 31.

The visual fields were performed with the same computerized projection perimeter, using the 30-2 protocol (analysis of 76 points in the central visual field up to 30°). The statistical analysis was carried out with PeriData software version 3.8.0.3, and the following were analyzed: The mean deviation (MD) is defined as the mean difference of retinal sensitivity compared to a normal model. The pattern standard deviation (PSD) is defined as the highlight of local variations of retinal sensitivity. The reliability index (including loss of fixation, false positives, and false negatives) is defined as the measure of reliability. The standard deviation, also known as mean square deviation (SD), is defined as the typical distance of the results from the mean. All examinations were conducted in a room with controlled lighting, with pauses between tests to reduce visual fatigue. The results obtained with the PeriData software are presented in ***Tab. 1*** and illustrated in ***Fig. 1***.

Tab. 1 – Results processed by PeriData software.

Parameter	A Group (59 patients) – Average ± DS	B Group (59 patients) – Average ± DS	Total (118 patients) – Average ± DS
MD (dB)	-0,6 ± 0,3	-0,8 ± 0,4	-0,7 ± 0,4
PSD (dB)	1,5 ± 0,4	1,7 ± 0,5	1,6 ± 0,5
Loss of fixation (%)	2,0 ± 0,8	2,2 ± 0,9	2,1 ± 0,9
False positives (%)	1,5 ± 0,7	1,7 ± 0,8	1,6 ± 0,8
False negatives (%)	1,8 ± 0,9	2,0 ± 1,1	1,9 ± 1,0

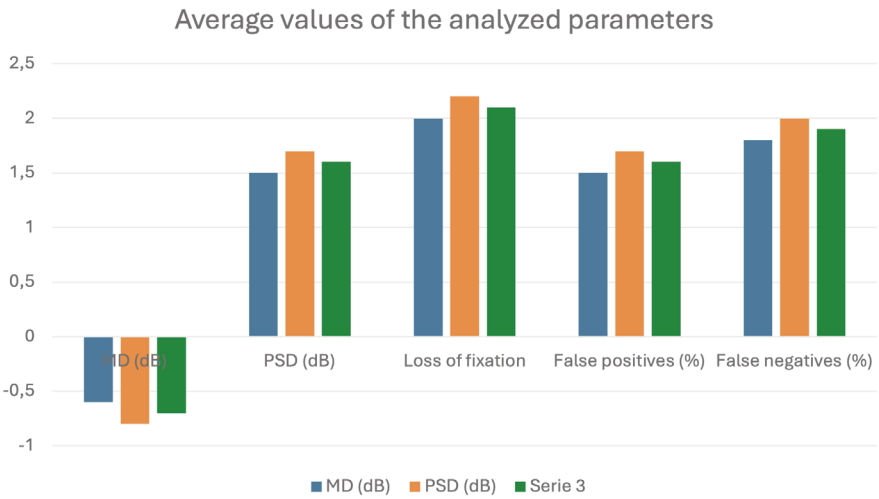

Fig. 1 – Graphical representation of PeriData software results.

Results

The mean deviation (MD) value was found to be nearly zero in both groups, suggesting that the subjects exhibited maintained retinal sensitivity.

Pattern Standard Deviation (PSD) exhibited slight local variability, consistent with the physiological distribution of retinal sensitivity.

Reliability indices remained within acceptable limits, with an average loss of fixation of 2.1% and a low incidence of false positives (1.6%) and false negatives (1.9%). The mean values of the analyzed parameters are displayed in ***Tab. 1***.

To assess the presence of significant differences between groups A (22-26 years) and B (27-31 years), the Student's t-test for independent samples was applied. The evaluation encompassed five distinct parameters: The following factors must be taken into consideration: mean deviation (MD), pattern standard deviation (PSD), loss of fixation, false positives, and false negatives. The results of the student t-test are presented in ***Tab. 2***, ***Fig. 2.***

The analysis indicated that MD and PSD exhibited substantial disparities between the groups under consideration. The value of MD, representing a global measure of retinal sensitivity, was more negative in group B than in group A, suggesting a slight decline in sensitivity with age. PSD, which is a measure of local variability in sensitivity, also demonstrated a significant difference between the groups, thereby confirming possible variations in the distribution of retinal sensitivity as a function of age ***(Fig. 2)***.

The reliability indices (loss of fixation, false positives, and false negatives) demonstrated no statistically significant differences, thereby suggesting that the quality of the tests performed on the two groups was comparable...

Discussion

The findings suggest that computerized visual field analysis can provide reliable measurements of retinal sensitivity in a

Tab. 2 – Comparison between groups A and B by Student's t-test.

Parameter	t	p-value	Significance (p<0,05)
MD	3,07	0,0026	si
PSD	-2,40	0,0180	si
Loss of fixation	-1,28	0,205	no
False positives	-1,45	0,151	no
False negatives	-1,08	0,282	no

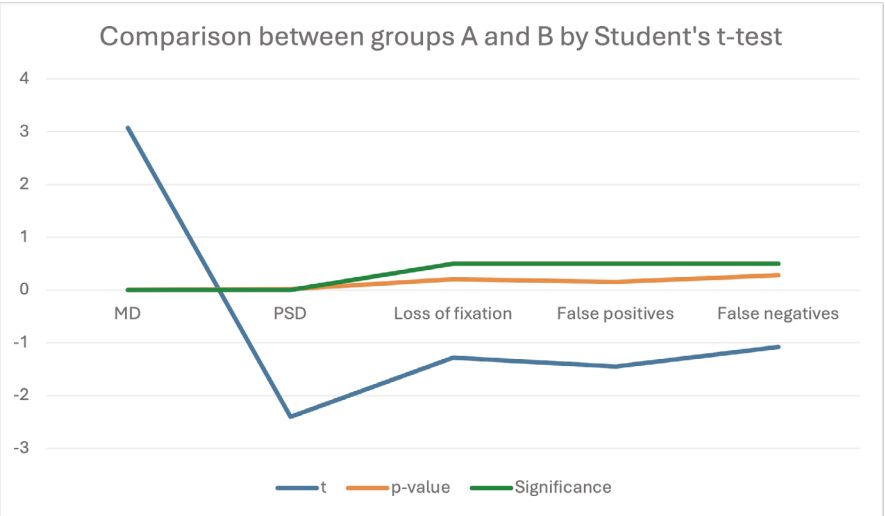

Fig. 2 – Distribution of Student's t-test t-values for each parameter.

healthy and young population. The MD and PSD values obtained from this analysis were consistent with expected values in the absence of pathologies (13). The clinical significance of these data lies in their usefulness as a reference for comparing pathological findings, particularly in conditions such as early glaucoma or optic neuropathies (14). The young population under analysis exhibited a homogeneous retinal sensitivity and mean deviation (MD) values that generally approximated 0. However, significant variations from these standards could be indicative of initial alterations to the visual field (15).

The t-student test revealed significant disparities in MD and PSD parameters between the two age groups, suggesting that age may influence certain aspects of retinal sensitivity. However, the reliability indices remained consistent, thereby substantiating the study's conclusion regarding the robustness of the measurement. Future studies with a larger sample could further explore the impact of age on retinal sensitivity. Additionally, a comparison with other perimeters could enhance the validity of the data collected and the establishment of normality standards. The analysis of 118 visual campimetries with a computerized campimeter established a baseline for retinal sensitivity in young and healthy subjects, thereby confirming the reliability of the visual field measurement instrument.

In consideration of the study's limitations, the sample size, while substantial, could be augmented to encompass a wider range of interindividual variability. Moreover, the lack of a comparison with other perimetric instruments, such as the Humphrey Field Analyzer, restricts the ability to further validate the results.

Conclusion

This study yielded valuable data, which will contribute to enhancing the diagnostic interpretation of computerized perimetry, thereby facilitating the early recognition of pathologies that can alter the visual field. Additionally, it will standardize the normative values for the age group examined.

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The Authors declare that they have no relationships relevant to the contents of this paper to Disclose.

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