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Original Research Article

Normative macular thickness measurements in healthy Saudi paediatric population using optical coherence tomography

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ABSTRACT

Background: The purpose of the study was to establish normative data for macular thickness in a healthy Saudi pediatric population using Cirrus HD- optical coherence tomography (OCT) and to analyze the effects of age and gender on macular thickness.
Methods: A cross-sectional study was conducted on 350 eyes of 175 Saudi children aged 6–18 years. Participants underwent a comprehensive ophthalmic examination, including vision assessment, refraction, fundus examination, intraocular pressure measurement, and macular thickness measurement using Cirrus HD-OCT. Macular thickness was measured in different quadrants following the early treatment diabetic retinopathy study (ETDRS) map and analyzed by age and gender.
Results: The mean macular thickness was 281.3±12 µm, and the mean spherical equivalent refraction was -0.31±1.75 diopters (D) (range: -2.50 to +2.25 D). The parafoveal area was the thickest, followed by the perifoveal area and the central subfield (CSF) thickness ($p<0.001$). The nasal quadrant of the macula was the thickest, followed by the superior, inferior, and temporal quadrants in both the parafoveal and perifoveal regions. No statistically significant differences were observed between genders or age groups.
Conclusions: This study provides normative data for macular thickness in Saudi children, which will aid in the early diagnosis and monitoring of macular disorders in this population. The findings suggest that gender and age have no significant impact on macular thickness measurements in pediatric patients.

Keywords: Macular thickness, Optical coherence tomography, Pediatric age, Saudi population

INTRODUCTION

Normal macular thickness values in different populations are essential for evaluating, treating, and monitoring patients with various retinal pathologies.[1] Optical coherence tomography (OCT) is a non-invasive imaging technique that provides high-resolution measurements of macular thickness, enabling clinicians to detect and monitor subtle changes in retinal morphology.[2,3] Despite challenges in pediatric OCT use (e.g., head positioning, machine size, motion artifacts), numerous studies have reported successful OCT evaluations in children with optic nerve swelling, glaucoma, retinal dystrophies, and other conditions, demonstrating high repeatability and reproducibility.[2-8]

While normative macular thickness data exist for adults in Saudi Arabia, such data for the pediatric population are lacking.[9] Several studies have provided normative pediatric macular thickness data using SD-OCT technology.[4-8] However, macular thickness varies significantly among different ethnic groups, necessitating population-specific reference values.[2,3] The aim of this study is to establish normative data for macular thickness in a healthy Saudi pediatric population using Cirrus HD-OCT and to analyze the effects of age and gender.

METHODS

This cross-sectional study was conducted at King Abdulaziz Specialist Hospital in Taif, Kingdom of Saudi Arabia, between August and December 2024. Ethical approval was obtained from the local institutional review board, and written informed consent was secured from the legal guardians of all participating pediatric subjects prior to any study-related procedures. Participants were recruited from among outpatient clinic staff and relatives of patients.

The inclusion criteria were age between 6 and 18 years; best-corrected visual acuity (BCVA) of better than 20/40 using the Snellen chart; spherical refractive error within ±3.00 diopters (D) and astigmatism within ±1.50 D; intraocular pressure (IOP) of ≤21 mm Hg; and a cup-to-disc ratio of ≤0.4. Exclusion criteria included refractive errors exceeding ±3.00 D, the presence of ocular conditions such as retinitis pigmentosa, strabismus, or amblyopia, a family history of glaucoma, or any history of ocular surgery or trauma.

All participants underwent a comprehensive ophthalmic evaluation, which included assessment of Snellen BCVA, IOP measurement using a non-contact tonometer, and macular thickness evaluation via spectral-domain optical coherence tomography (SD-OCT) using the Cirrus HD-OCT 5000 system (software version 11.0; Carl Zeiss Meditec, Inc.). Additional examinations included slit-lamp biomicroscopy and stereo biomicroscopic evaluation of the fundus.

OCT scans were performed by a single experienced operator through undilated pupils. An internal fixation target was used to center each scan on the fovea. High-speed volumetric raster scans covered a 20°×20° area. Macular mapping was based on the Early Treatment Diabetic Retinopathy Study (ETDRS) grid, which was overlaid on the OCT map. The macula was divided into three concentric zones centered on the fovea: the central fovea (<1 mm), parafoveal area (1–3 mm), and perifoveal area (3–6 mm). The parafoveal and perifoveal zones were further subdivided into superior, inferior, nasal, and temporal quadrants.

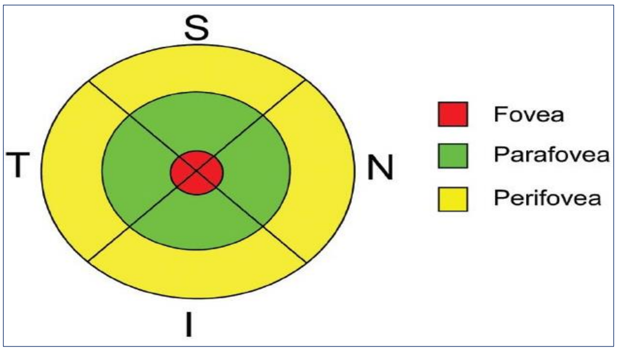

Figure 1: Central foveal, parafoveal, and perifoveal regions.

Figure 1 illustrates an example of macular thickness measurements acquired using the cirrus SD-OCT system.

For each subject, three OCT volume scans (200 × 200 axial scans) were acquired, and the scan with the highest signal strength, centered on the fovea centralis, was selected for analysis. The Cirrus OCT software automatically quantified the thickness of the central foveal area and the four quadrants (superior, inferior, nasal, and temporal) of both parafoveal and perifoveal regions.

Statistical analysis

Pearson's correlation coefficient was employed to assess the relationship between the right and left eyes in terms of mean macular thickness, central subfield (CSF) thickness, and mean total macular volume. Gender-based differences in mean macular volume were analyzed using unpaired t-tests. Participants were categorized into two age groups: 6–10 years and 11–18 years. Differences in mean macular thickness across these age groups were evaluated using one-way analysis of variance (ANOVA). A p value of less than 0.05 was considered statistically significant. All statistical analyses were conducted using IBM SPSS Statistics software, version 29 (IBM Corp., Armonk, NY, USA).

RESULTS

A total of 175 children (350 eyes) were included, with a mean age of 10.8±5.85 years. Of the 175 children, 96 (54.9%) were male and 79 (45.1%) were female, resulting in a male-to-female ratio of 1.2:1 (Figure 2). Mean spherical equivalent was -0.31±0.75 D (range: -2.75 to +2.25 D). Pearson's correlation analysis demonstrated a strong and statistically significant correlation between the right and left eyes in all measured macular parameters, including mean macular thickness, central subfield (CSF) thickness, and total macular volume (p<0.001 for all comparisons).

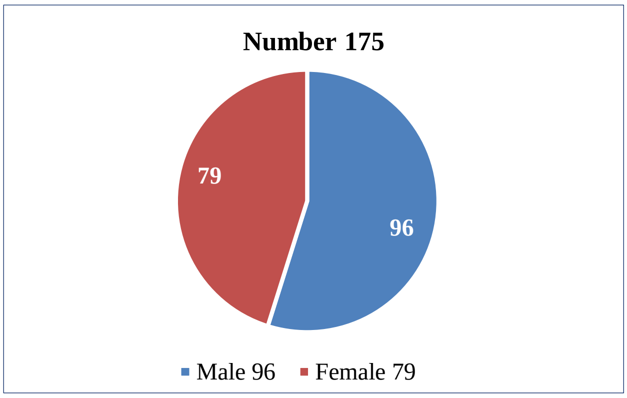

Figure 2: Gender distribution of the pediatric participants included in the study (n=175).

Mean macular thickness was 281.3±12 µm**.** Across all participants, the parafoveal region was the thickest, followed by the perifoveal, and then the central subfield (CSF) area (p<0.001). In both parafoveal and perifoveal areas, the nasal quadrant was the thickest, followed by the superior, inferior, and temporal quadrants.

Comparisons between genders revealed no statistically significant differences in total macular volume: males (9.81±0.34 mm³) versus females (9.78±0.38 mm³) (p=0.234).

Subjects were divided into two age groups: ≤10 years (n=92) and >10 years (n=83). No statistically significant differences in macular thickness were found between the two groups in any ETDRS region (all p>0.05) (Table 1).

Table 1: Mean macular thickness by ETDRS sector and age groups.

EDTRS sector	Mean thickness (µm) ±SD in pediatric ≤10 years age	Mean thickness (µm) ±SD in pediatric > 10 years age	P value
Central subfield	235.1±10	240.3±8	0.345
Parafoveal nasal	315.2±7	319.7±12	0.435
Parafoveal superior	310.1±12	313.9±7	0.576
Parafoveal temporal	302.9±6	304.5±11	0.411
Parafoveal inferior	308.2±10	311.6±10	0.654
Perifoveal nasal	298.4±11	301.4±9	0.543
Perifoveal superior	278.3±9	280.9±7	0.321
Perifoveal temporal	265.7±13	269.1±11	0.398
Perifoveal inferior	272.2±8	276.2±9	0.598

DISCUSSION

OCT is increasingly used as a diagnostic and monitoring tool of vision loss in children. OCT is increasingly used for diagnosing and monitoring pediatric retinal conditions. This study provides a normative macular thickness database for Saudi children using Cirrus SD-OCT. The parafoveal area was the thickest, followed by the perifoveal region, with the central macula being the thinnest—consistent with previous studies.[8,10]

No significant differences in macular thickness were observed between genders, consistent with previous reports.[1,2,4,11,12] Additionally, macular thickness remained stable across the studied age groups, aligning with previous findings.[10,13] However, other studies have reported a positive correlation between age and central macular thickness in Saudi adults.[5] Previous studies suggest that axial length and spherical equivalent influence OCT thickness outcomes, though these factors were not specifically analyzed in this study as we excluded children with high refractive errors.[11,14]

This study has certain limitations. First, the sample size, although sufficient for statistical analysis, may not represent the full spectrum of the Saudi pediatric population. Second, data were collected from a single hospital, which could introduce selection bias. Future multicenter studies with larger, more diverse populations are recommended.The clinical implications of this study are significant. Providing baseline normative data for Saudi children enhances diagnostic accuracy for macular disorders, facilitating early intervention and management of retinal diseases.

CONCLUSION

This study provides the first normative dataset for macular thickness in healthy Saudi children using Cirrus HD-OCT. These values serve as a reference for pediatric ophthalmic evaluations, improving diagnostic accuracy for retinal diseases.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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