Major Article

Correlation of echographic and photographic assessment of optic nerve head cupping in children

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PURPOSE To determine the diagnostic value of B-scan echography in optic nerve head (ONH) cupping estimation in children.

METHODS The medical records of pediatric patients who had previously undergone examination under anesthesia and for whom both adequate B-scan echography images and optic nerve head (ONH) photographs and were available were reviewed retrospectively. The cup:disk ratio was estimated with a grading scale of 0-1.0 and rounded to the nearest tenth; degree of cupping was estimated from B-scan echography (small, medium, or large) by 5 masked graders (3 glaucoma specialists and 2 ophthalmic sonographers) on 2 separate occasions. Inter- and intraobserver agreement in echographic and photographic cupping assessment by the masked graders as well as correlation of echographic and photographic cup size estimation was evaluated.

RESULTS A total of 36 children were included. Glaucoma specialists reliably assessed cup:disk ratio with moderately good consistency across specialists (average intraclass correlation coefficient [ICC] for intraobserver agreement, 0.86; average ICC for interobserver agreement, 0.71). Sonographers were extremely reliable in assessment of cup size when examining echographic images (ICC for both inter- and intrarater variability, 1.0). Echographic estimate of cup size correlated poorly with cup:disk ratio (ICC, 0.34).

CONCLUSIONS B-scan echography is a reliable and consistent diagnostic tool in estimating the degree of ONH cupping in children and can be very useful in patients in whom direct visualization is not feasible. Failure to account for disk size may have contributed to the poor correlation between echographic cup size and photographic cup:disk ratio. (J AAPOS 2017;■:1-4)

Assessment of optic nerve head (ONH) cup:disk ratio is an important component of the evaluation of glaucoma patients and glaucoma suspects. In childhood glaucoma, ONH cupping can occur secondary to pressure-induced distention of the scleral canal and lamina cribrosa, and may be reversed upon timely intraocular pressure (IOP) reduction in the early stages of the disease.[1-4] Evaluation of ONH cupping in childhood glaucoma patients is therefore important for diagnosis as well as for monitoring response to treatment.

Several methods have been developed to evaluate the ONH in children while under sedation or general anesthesia. These include direct visualization with ONH drawing, digital fundus photography, confocal scanning laser ophthalmoscopy, and optical coherence tomography (OCT).[5-7] However, fundus photography was found to be less reliable in detecting cupping changes in children,[5] and the validity of direct visualization with documentation or drawing of ONH cupping may be limited by inter- and intraobserver variability.[8,9] Additionally, a significant number of patients may present with media opacities, such as corneal clouding due to high IOP-induced corneal edema or secondary to anterior segment dysgenesis, cataracts, and/or vitreous opacities. These media opacities may preclude adequate ONH evaluation by direct visualization as well as by optical imaging modalities.

Diagnostic B-scan ultrasonography allows evaluation of the posterior segment in the presence of opaque optical media. Moreover, high-resolution B-scan echography in these cases is useful in excluding associated posterior

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Financial support: Bascom Palmer Eye Institute is supported by NIH Center Grant P30-EY014801 and an unrestricted grant from Research to Prevent Blindness.

Presented at the Annual Meeting of the American Academy of Ophthalmology, Chicago, Illinois, October 15-16, 2016.

Submitted March 25, 2017.

Revision accepted June 18, 2017.

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1091-8531/$36.00

http://dx.doi.org/10.1016/j.jaapos.2017.06.021

segment pathology such as choroidal hemangioma.[10] Its use has been previously described for evaluation of ONH cupping in adult patients with reasonable precision and reproducibility.[11-13] However, to our knowledge, no validation of this mode of evaluation of ONH cupping in the children has been published. The current study aimed to evaluate the diagnostic utility, accuracy, and reproducibility of B-scan ocular echography in estimating the degree of ONH cupping in pediatric patients and to evaluates inter- and intraobserver variability in grading ONH cupping using B-scan echography compared to digital ONH photography. We hypothesized that B-scan echography is a reliable and reproducible method for evaluation of ONH cupping in pediatric patients.

Subjects and Methods

This study was approved by the University of Miami Institutional Review Board. The medical records of pediatric patients (<18 years of age) who underwent examination under anesthesia at the Bascom Palmer Eye Institute to evaluate the ONH with both digital fundus photography (RetCam, Clarity Medical Systems, Pleasanton, CA) and ocular B-scan echography (I^3 ABD-V2 Innovative Imaging, Sacramento, CA) between 2012 and 2015 were reviewed retrospectively using Current Procedure Terminology codes. We included only fundus photographs with clarity and focus to show third-order peripapillary vessels. Exclusion criteria included unavailability of photographic and/or echographic ONH images and/or if the quality of images was inadequate for accurate evaluation of ONH cupping.

A single, nonstereoscopic digital ONH photograph and a single B-scan cross-section of ONH were included for each eye. ONH photographs were evaluated for cup:disk ratio estimation with a grading scale of 0-1.0 rounded to the nearest tenth. B-scan echography images were evaluated for ONH cupping estimation, with a grading scale for grading of small, medium, or large. Masked grading of digital ONH photographs and B-scan echography images was performed by 3 fellowship-trained glaucoma specialists, and intraclass correlation coefficients (ICC) for interobserver agreement were calculated to assess agreement between masked graders. Additionally, masked grading of B-scan echography images was also performed by 2 experienced certified diagnostic ophthalmic sonographers and ICCs for interobserver agreement were calculated. All images were graded on two separate occasions by all graders, and ICCs for intraobserver variability were calculated to assess reliability of each masked grader. All ICCs were obtained by variance component analysis with type II analysis of variance using IBM SPSS Statistics for Windows, version 22.0. (IBM Corp, Armonk, NY). Statistical analysis was performed by the Biostatistics Department at the Bascom Palmer Eye Institute.

Results

A total of 36 eyes of 36 pediatric patients were available in the electronic chart and were included in the analysis. Table 1 summarizes the demographic data of the subjects.

Table 1. Demographic data (36 eyes)

Characteristic	No.
Mean age, weeks (range)	69 (7-117)
Sex	
Female	22
Male	14
Diagnosis	
Glaucoma	20
Glaucoma suspect	9
Other	7
Laterality	
Right eye	20
Left eye	16

The interobserver agreement for cup:disk ratio estimation from ONH photographs among the 3 glaucoma specialists was high (ICC, 0.71; Table 2). Agreement among these same glaucoma specialists in evaluation of the degree of cupping based on B-scan images was, however, low (ICC, 0.44; Table 2). Nevertheless, agreement across sonographers who evaluated the same B-scan images was excellent (ICC, 1.0; Table 2).

The intraobserver agreement for each of the 3 glaucoma specialists assessing ONH photographs was excellent (average ICC, 0.86; Table 3), indicating that they were all highly consistent in their estimation of cup:disk ratio. Glaucoma specialists also showed good intra-observer agreement in assessment of B-scan images for the degree of cupping (average ICC, 0.63; Table 4), although their consistency was relatively lower than in photographic assessment. The two sonographers were highly consistent in sonographic assessment of cupping, with excellent intraobserver agreement for both sonographers (ICC, 1.0; Table 4).

B-scan images were separated into three groups: small, medium, or large cupping. The average cup:disk ratio based on respective photographic image assessment was then calculated for each of the three sonographic groups. The average cup:disk ratio was similar in all three echographic groups, demonstrating that sonographic estimation of cupping correlates poorly with photographic cup:disk ratio (ICC, 0.34; Table 5).

Discussion

In 2013 the Ninth World Glaucoma Association Consensus in conjunction with the Childhood Glaucoma Research Network (CGRN) defined childhood glaucoma as IOP-related damage to the eye.[14] Childhood glaucoma accounts for 2%-6% of blindness in children worldwide. However, prompt diagnosis and appropriate timely management of this disease can minimize the degree of visual impairment.[15] Examination under anesthesia is typically performed periodically on all children that are suspected to have or are diagnosed with glaucoma in whom clinical examination and ancillary testing is not otherwise feasible; examination typically includes a combination of IOP measurement, retinoscopy/refraction, portable slit-lamp biomicroscopy,