Reliability of echographic examination for the study of optic nerve cupping

Confiabilidade do exame ecográfico como método de estudo da escavação do nervo óptico

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SUMMARY

Purpose: **To investigate the reliability and applicability of echography to detect optic nerve cupping smaller than or equal to 0.3 and greater than or equal to 0.9.**

Patients and Method: **Fifty-three eyes from 30 patients, with transparent optic media, underwent contact B-scan echography to evaluate optic disc cupping. On biomicroscopy, twenty-six eyes presented small (Group I) and 27 large (Group II) optic nerve cupping.**

Results: **B-scan images of the optic disc were evaluated by two observers and ocular echography was considered reliable with a Kappa index of 0.77 (± 0.14). Sensitivity and specificity were 71.4% (53.4 - 81.1) and 96.2% (78.4 - 99.8), respectively, with a confidence interval of 95%. The positive and negative predictive values found for the sample were 95.2% (74.1 - 99.8) and 78.1% (59.6 - 90.1), respectively.**

Conclusion: **Echography is a reliable method to evaluate optic disc cupping when ≤ 0.3 and ≥ 0.9. However, as a screening method it would be more important in the case of negative results.**

Keywords: Ophthalmic ultrasound; Optic nerve cupping; Glaucoma.

INTRODUCTION

Primary open angle glaucoma is a chronic disease whose diagnostics is based, among others, on the triad intraocular pressure, optic nerve cupping and visual field. Sometimes the evaluation of optic nerve cupping is difficult or even impossible due to the opacity of the media. In these cases, the echographic study of optic nerve head could be useful for the visual prognosis evaluation.

Cohen et al. [1] showed that, on echographic examination, cuppings greater than or equal to 0.7 usually appear as a concavity at the posterior pole of the eye, opposite the acoustically void area corresponding to the optic nerve [1]. In addition there is a discontinuity at the vitreous-retinal interface corresponding to the area of the optic disc [1], indicating presence of increase cupping.

The optic nerve is considered normal on echographic examination if there is a triangular image in the retrobulbar region which is echogenically void, without irregularity at the vitreous-retinal interface [1-3].

Darnley-Fisch et al. [4] showed that echography is a faulty method if used alone to classify the size of cupping and that great cuppings (≥ 0.7) are more easily diagnosed. In addition shallow cuppings, although great, may be also difficult to detect.

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The purpose of this study is to investigate the possibility of evaluating optic nerve cuppings smaller than or equal to 0.3 and greater than or equal to 0.9 using echography, its reliability and applicability, in the attempt to distinguish between physiological and great cuppings.

PATIENTS AND METHODS

This study was carried out at the Department of Ophthalmology of the Santa Casa de Misericórdia de São Paulo, from December 1994 to December 1995.

Fifty-three eyes from 30 patients, with transparent optical media were selected, and submitted to biomicroscopy of the optical disc with a 90-diopter Volk lens by the same examiner. Of these, 26 were eyes without a diagnosis of glaucoma, with a ratio cupping/optic disc ≤ 0.3 (Group I). The remaining 27 were from patients with ocular hypertension or glaucoma with a ratio cupping/optic disc ≥ 0.9 (Group II).

The age of the patients with small cupping (≤ 0.3) ranged from 53 to 80 years, with a mean of 67.5 ± 12.8 years. Group II presented ages ranging from 53 to 62 years, with a mean of 64.7 ± 8.5 years.

All eyes were submitted to B-scan echography in order to evaluate the cupping by the same examiner. The photographs of the echographic examination of the two groups were then randomly evaluated by two observers (A and B), and classified into positive or negative echographic images regarding glaucomatous cupping. The image was considered positive regarding advanced glaucomatous cupping when a depression limited to the papilla, anterior to the optic nerve or discontinuity at the vitreous-retinal interface was observed (Figures 1 and 2). It was considered negative regarding cupping when no irregularity anterior to the optic nerve was observed (Figure 3).

The echographic examination was performed with the patient in dorsal decubitus under ocular topic anesthesia (anesthetic tetracaine chlorhydrate, phenylephrine chlorhydrate and boric acid eyedrops). Direct transpalpebral and transscleral contact technique was used, in the horizontal transversal positions with the patient looking at the upper nasal region and the probe at a lower position, the marker turned to the upper nasal region (longitudinal at 2 hours in the right eye and at 10 hours in the left).

The echographic equipment used was Ultrascan Digital B System IV, Cooper Vision®, with a 10 MHz probe.

Statistical analysis was based on reliability and validity of the examination. In order to test reliability, the Kappa (K) test was used. For the validity test, sensitivity and specificity of ocular echography in detecting advanced cupping was calculated in addition to calculation of positive and negative

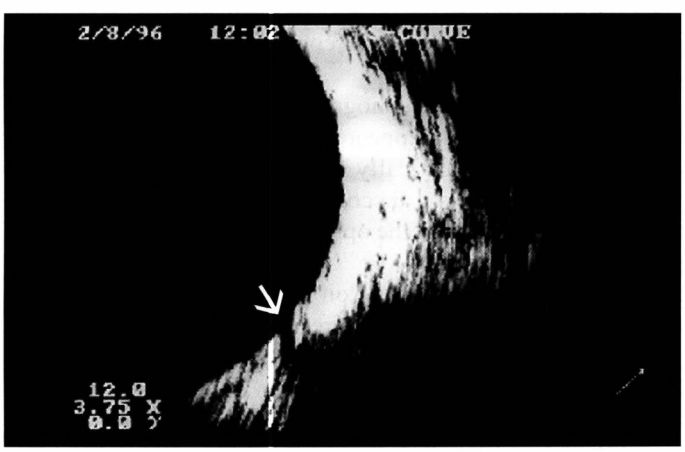


Fig. 1 - Ocular B-scan echography of advanced optic disc cupping (0.9), by the transcleral contact technique showing depression limited to the optic disc anterior to the optic nerve.

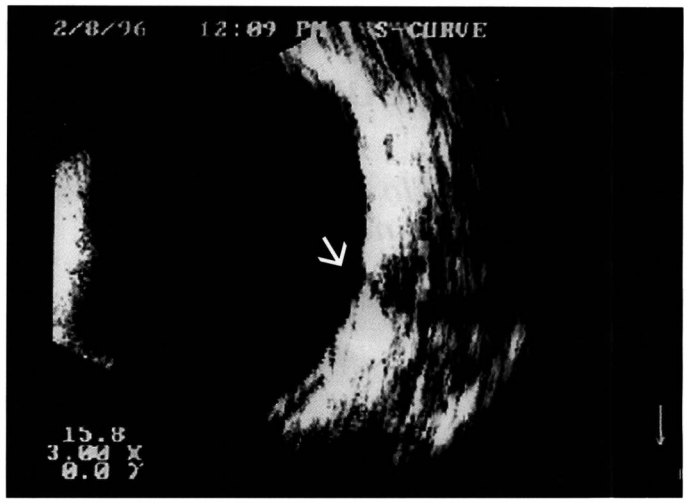


Fig. 2 - Ocular B-scan echography of advanced cupping by the transpalpebral contact technique, evidencing irregularity at the vitreous-retinal interface, limited to the papilla anterior to the optic nerve.

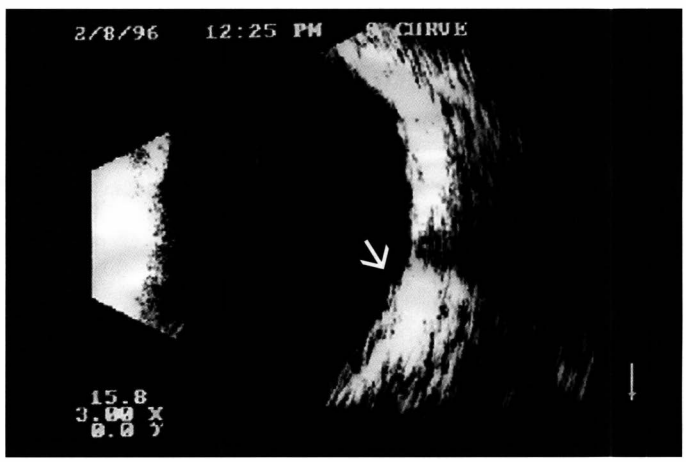


Fig. 3 - Ocular B-scan echography of small optic disc cupping by the transcleral and transpalpebral contact technique, anterior to the optic nerve, without evidence of irregularity at the vitreous-retinal interface or depression limited to the optic disc.

predictive values according to different prevalences, considering a confidence interval of 95% [5,6].

RESULTS

Table 1 shows the results of echographic examination of the eyes of Groups I and II according to the analysis by examiners A and B. It can be seen that with respect to the positive echographic image regarding cupping there was agreement in 19 eyes and in 28 eyes in the case of negative image. Therefore there was a 88.7% concordance. Kappa index was 0.77 ± 0.14; Z = 5.60 and p = 0.0000.

In order to evaluate the validity of the examination, the result of biomicroscopic evaluation by observer A was used: of the 37 eyes with cupping ≥ 0.9, 20 presented positive and 7 negative echography. Of the 26 eyes with small cupping, 01 presented positive and 25 negative echography (Table 2).

The sensitivity of echography to detect papillary cupping ≥ 0.9 with a confidence interval of 95% was 74.1% (53.4 to 81.1%) and specificity was 96.2% (78.4 to 99.8%). The positive predictive value (PPV) for the sample was 95.2% (confidence interval 74.1 to 99.8). The negative predictive value (NPV) was 78.1% (59.6 to 90.1).

PPV and NPV were calculated on the basis of sensitivity and specificity of 74.1% and 96.2%, respectively, according to prevalence estimate for advanced glaucomatous cupping, as shown in Table 3 and Graph 1.

DISCUSSION

B-scan echography with a 10 MHz probe which has a high frequency and presents sufficient penetrability to evaluate the optic nerve and its intraocular portion[2] was used in this study.

A Kappa index of 0.77 ± 0.14 and p = 0.0000 show that the test has a significance of 1% and therefore echography was considered to be reliable in the evaluation of optic disc cupping. Thus echography may be used as an auxiliary method in the evaluation of optic nerve cupping in cases of patients with cataract associated with galucoma. This association is not uncommon, since both disorders are more frequent in the elderly (usually individuals above 50 years of age) and glaucoma, as well as cataract, is a silent and chronic disease.

Table 1. Comparison of the echographic evaluation (positive or negative regarding cupping) by observers A and B of eyes with optic disc cupping ≤ 0.3 (Group I) and of eyes with cupping ≥ 0.9 (Group II), Department of Ophthalmology, Santa Casa de Misericórdia de São Paulo, 1994-1995.

Echography	Cupping		
	echo (+)	echo(-)	TOTAL
eco (+)	19	01	21
eco (-)	04	28	32
TOTAL	23	30	53

K = 0.77 ± 0.14; Z = 5.60 and p = 0.0000

Table 2. Distribution of the eyes with physiological or negative (Group I) and with great or positive (Group II) optical disc cupping observed by examiner A on ocular echography compared with cupping observed on biomicroscopy of the papilla, Department of Ophthalmology, Santa Casa de Misericórdia de São Paulo, 1994-1995.

Echography	Cupping		
	≥ 0.9	≤ 0.3	TOTAL
+	20	01	21
-	07	25	32
TOTAL	27	26	53

K = 0.77 ± 0.14; Z = 5.60 and p = 0.0000

In addition, echography is also useful in cases in which glaucoma diagnosis in patients with cataract can not be firmly established, as for instance in glaucoma cases with normal pressure where the diagnosis can only be established after cataract surgery.

Regarding validity we could observe that the sensitivity of ocular B-scan echography in the evaluation of advanced glaucomatous cupping was 74.1%, that is, echography was able to diagnose 74.1% of the advanced glaucomatous cuppings, an index considered to be reasonable, since it presents 25.9% of false negatives. Specificity was 96.2%, that is, it detects 96.2% of the patients with small cuppings, with only 3.8% of false positives.

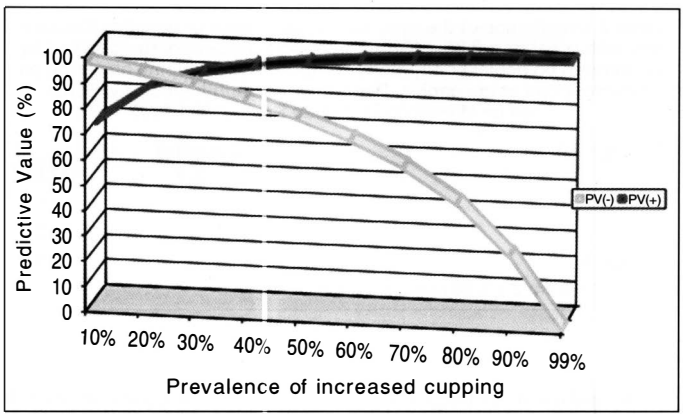
Thus echography is a method presenting a considerable percentage of false negatives and almost no false positives (3.8%) in the detection of papillary cupping. If we would use it as a predictive method for vision diagnosis of patients with opacity of visual media, it would be an acceptable method since it would not diagnose 25.9% of the advanced cuppings.

The study by Darnley-Fish et al [4] already suggested that echography alone is a faulty method for the classification of size of cupping.

The PPV found in the sample was 95.2%, with a confidence interval of 95%, that is, since the test is positive, the probability of it being actually positive is 95.2%. NPV was 78.1%, that is, when echography was negative, the chance of it being actually negative was 78.1%.

Prevalence, the number of cases in the population, modifies the indicators (predictive values) of the performance of echography. Therefore, the values of the sample do not reflect reality, since prevalence of glaucoma in the population is approximately 1%. In order to estimate the validity of the echographic examination in the actual conditions, the positive and negative predictive values were calculated for each range of prevalence (Table 3 and Graph 1). We observed that, with increase in prevalence of advanced glaucomatous cupping, PPV increases and NPV decreases and that the prevalence rate at which predictive performance would be optimal is approximately 30%, where the 2 curves cross. At the prevalence of 1%, PPV is very low and NPV quite high.

Thus, if we would use echography as a screening method to evaluate the optic disc in the population, it would be more



Graph 1 - Predictive value of optic nerve echography according to prevalence of optic nerve cupping. Santa Casa de Misericórdia de São Paulo, 1995 (Sensitivity = 74.1%; Specificity = 96.2%).

Table 3. Positive predictive value (PPV) and negative predictive value (NPV) for 74.1% sensitivity and 96.2% specificity according to the prevalence of glaucomatous cupping, Department of Ophthalmology, Santa Casa de Misericórdia, São Paulo, 1994-1995.

Prevalence (%)	PPV	NPV
01	14.9 (6.7-28.9)	99.7 (99.0-99.9)
10	68.5 (58.8-76.9)	97.1 (95.7-98.0)
20	83.1 (76.7-88.2)	93.7 (91.7-95.2)
30	89.2 (84.5-92.6)	89.6 (87.2-91.7)
40	92.8 (89.2-95.3)	84.7 (81.8-87.3)
50	95.1 (92.4-97.0)	78.9 (75.4-82.0)
60	96.7 (94.6-98.1)	71.3 (67.2-75.0)
70	97.9 (96.2-98.9)	61.5 (56.9-65.9)
80	98.7 (97.3-99.4)	48.1 (43.1-53.1)
90	99.4 (98.4-99.8)	28.3 (23.5-33.6)
99	100.0 (99.4-100)	0.41 (0.0-2.5)

significant if the examination result would be negative, since the chance that it would be actually negative would be close to 100%. However, echography is an examination that can be applied in services such as that of the Santa Casa de Misericórdia de São Paulo. Since prevalence of pathological cuppings is greater than in the population, because in is a reference service for glaucoma.

Therefore, echography was shown to be a reliable examination for the diagnosis of the presence or not of great papillary cupping, becoming an ally in the presumption of vision prognosis of patients with ocular hypertension or glaucoma who, for some reason, have a difficult observation of their optic disc, or even as a method to help in the diagnosis of the disease.

It is, however, more difficult to distinguish between medium (from 0.4 to 0.8) and advanced cuppings, but this was not the aim of this study.

RESUMO

Objetivo: *Este estudo tem o objetivo de avaliar a confiabilidade do exame ecográfico na avaliação de escavações do nervo óptico menores ou iguais a 0,3 e maiores ou iguais a 0,9.*
Material e Métodos: *Foram analisados 53 olhos, de 30 pacientes, com meios ópticos transparentes, submetidos à ecografia ocular modo B para avaliação da escavação do disco óptico. À biomicroscopia, 26 possuíam escavação pequena (grupo I) e 27 escavação grande (grupo II).*
Resultados: *Os exames impressos foram avaliados por dois observadores, e a ecografia ocular se mostrou confiável com índice Kappa de 0,77 (± 0,14). A sensibilidade e a especificidade, com intervalo de confiança de 95%, foram de 71,4% (53,4 - 81,1) e de 96,2% (78,4 - 99,8). O Valor preditivo positivo encontrado para a amostra foi de 95,2% (74,1 - 99,8) e o negativo 78,1% (59,6 - 90,1).*
Conclusão: *A ecografia é método confiável para avaliação da escavação do disco óptico permitindo a distinção entre o grupo ≤ 0,3 e o grupo ≥ 0,9. No entanto, como método de "screening" seria mais importante nos resultados negativos.*

Palavras-chave: *Ultra-som; Escavação do nervo óptico; Glaucoma.*

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