A Comparison of Imaging Techniques for Diagnosing Drusen of the Optic Nerve Head

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Objective: To determine the best imaging procedure for diagnosing drusen of the optic nerve head.

Methods: We reviewed retrospectively the clinical records of 142 patients (261 eyes) with suspected drusen of the optic disc. The patients were referred to our hospital over a 7-year period and evaluated by B-scan echography, orbital computed tomographic (CT) scan, and/or preinjection control photography for detection of autofluorescence. The relative diagnostic yield of these imaging techniques was compared.

Results: Thirty-six of the 261 eyes were evaluated using all 3 imaging techniques, with drusen of the optic nerve head diagnosed in 21 eyes. Findings from B-scan echography were positive in all 21 eyes compared with 9 positive findings from the CT scans and 10 positive findings from the preinjection control photographs (P<.01 for B-scan echography vs both CT scan and preinjection control photography). In 82 eyes with suspected buried drusen of the optic nerve head, B-scan echography showed drusen in 39 eyes compared with 15 eyes in which drusen were shown using preinjection control photography. In the whole series, no diagnosis of drusen was made by either preinjection control photography or CT scan and was missed on B-scan echography.

Conclusions: Drusen of the optic nerve head are diagnosed most reliably using B-scan echography compared with both preinjection control photography and CT scans. Preinjection control photography should be performed mainly when confirmation of visible drusen of the optic disc is desired. Neuroimaging using CT is suitable to exclude diagnosis of an intracranial mass lesion and possibly to detect buried drusen of the optic nerve head at the same time.


DRUSEN OF the optic disc may be easily diagnosed when glowing yellow hyaline bodies are visible on ophthalmoscopy. However, diagnostic difficulties may be encountered when drusen are buried deep within the nerve tissue in the optic nerve head, as they can resemble true optic disc swelling based on the ophthalmoscopic appearance alone. Buried drusen of the optic nerve head should be included in the differential diagnosis of optic disc swelling to avoid subjecting the patient to extensive examinations for exclusion of increased intracranial pressure. Signs suggestive of buried drusen of the optic nerve head include a scalloped margin of an elevated disc without a physiologic cup, anomalous vascular patterns on the disc surface, including early branching, and an increase in the number of major retinal vessels and vascular tortuosity, absence of hyperemia and dilated capillaries on the disc surface, and absence of obscuration of the surface vessels despite disc elevation. However, these signs do not allow a definitive diagnosis. Therefore, several diagnostic methods have been proposed and include preinjection control photography for detection of autofluorescence, B-scan echography, and computed tomography (CT). In the evaluation of patients with newly detected elevated discs and suspected drusen of the optic nerve head, little is known about the relative value and sensitivity of these tests. We therefore reviewed clinical records of patients with suspected drusen of the optic disc to determine the best diagnostic procedure.

RESULTS

Between January 1991 and January 1998, 159 patients were referred to our hospital for further evaluation of suspected drusen of the optic disc. After reevaluating the color photographs of the optic nerve head, the appearance of the optic disc was found not to be consistent with drusen in 16 pa-

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**PATIENTS AND METHODS**

We reviewed retrospectively the clinical records of patients with suspected drusen of the optic nerve head seen at the Department of Ophthalmology at the University Hospital in Zürich, Switzerland, between January 1991 and January 1998. Patients identified had been referred for further evaluation by B-scan echography or preinjection control fundus photography. From the clinical records, we recorded the patient’s age, sex, and the findings from neuroimaging by CT scan or magnetic resonance imaging (MRI), if performed. These examinations were all performed at the Department of Ophthalmology, University Hospital in Zürich in a standardized fashion after obtaining informed consent from the patients. Neuroimaging was conducted mostly at the Institute for Neuroradiology at the University Hospital.

In 5 cases the CT scan and in 7 cases the MRI scan were performed elsewhere. Patients were excluded from the study if no drusen of the optic nerve head were suspected when re-evaluating the color fundus photographs and if pseudodrusen were present owing to longstanding papilledema. The color fundus photography was performed with the Topcon TRC-50VT camera (Tokyo Optical Co Ltd, Tokyo, Japan), with the excitation and barrier filter in place for the preinjection control photography. In this group, drusen of the optic nerve head, 82 eyes were evaluated by both B-scan echography and preinjection control photography. We reviewed the color photographs, all of which were taken using the same magnification factor of 2½, to differentiate visible from buried drusen of the optic disc. The preinjection control photographs were reevaluated for autofluorescence without knowledge of the findings from the color photographs. Where available, we reviewed the CT and MRI scans, paying special attention to the region of the optic nerve head to confirm the initial neuroradiological findings. Computed tomography and MRI were performed with high resolution in the region of the optic disc; in the CT scans, a 1.5-mm slice thickness and bone windows were used. B-scan echography was performed with the contact B-scan method, which is performed by applying methylcellulose to the eye and placing the probe directly onto the globe, with transverse and longitudinal probe orientation for examining the optic nerve head. Drusen of the optic nerve head were diagnosed if a highly reflective echo persisted at a very low-gain setting, between 0 and 10 dB, using both probe orientations.7,8 The B-scan echograms of the optic disc were reevaluated without knowledge of other findings.

We evaluated the diagnostic yield of the different imaging techniques employed for the studied eyes as a whole and after stratification for visible vs buried drusen of the optic disc according to our judgment of the color fundus photographs.

The diagnostic yield of the different imaging techniques was compared with the $\chi^2$ test. $P$ values <.05 were considered significant.

Patients, who were therefore excluded from the study along with 1 patient who had chronic papilledema and pseudodrusen. A total of 142 patients (261 eyes) consequently remained in the study. Their mean age ±SD was $34.2 \pm 18.2$ years (age range, 3-82 years). There were 74 women and 68 men.

Of the 142 patients in the study, drusen of the optic disc were diagnosed in 80 patients by at least one of the methods described. Fifty-four (68%) of the 80 patients had bilateral drusen of the optic disc. Twenty-two patients (36 eyes) were examined using all 3 imaging techniques: preinjection control photography, B-scan echography, and CT. In 15 eyes, drusen could not be demonstrated with any of the methods employed.

In the remaining 21 eyes, a diagnosis of drusen of the optic nerve head was possible by B-scan echography in all of the eyes. Preinjection control photography showed drusen in 10 eyes, and CT scans showed drusen in 9 eyes ($P<.01$ for B-scan echography vs both CT scan and preinjection control photography). In 7 eyes (33%), drusen of the optic nerve head were detected by all 3 imaging techniques. In 3 eyes (14%), findings from preinjection control photographs and B-scan echography were positive, but the CT scan did not show drusen of the optic nerve head. In 2 eyes (10%), findings from CT scan and B-scan echography were positive, but preinjection control photographs did not show any autofluorescence. In 9 eyes (43%), findings from B-scan echography were positive, but preinjection control photographs did not show any detectable autofluorescence, and CT scans did not show visible calcification.

In the Figure, a patient is depicted with drusen of the optic disc in both eyes. In the right eye, all 3 imaging techniques showed the drusen, whereas in the left eye, drusen were demonstrated by B-scan echography only and missed using preinjection control photography and CT.

In diagnostic workup, 51 patients (94 eyes) underwent B-scan echography as well as preinjection control photography. Drusen of the optic nerve head were detected on B-scan echography in 51 eyes (54%) compared with the detection of autofluorescence in 26 eyes (32%) in preinjection control photographs. Ninety-one patients (167 eyes) were evaluated only by preinjection control photography. In this group, drusen of the optic nerve head were seen in 90 eyes (54%).

Of all the eyes included in the study, 52 showed visible drusen of the optic disc, demonstrating autofluorescence in preinjection control photography in all but 2 eyes. In 9 eyes, B-scan echography was performed and showed drusen of the optic nerve head in every eye (1 eye, however, did not demonstrate autofluorescence in preinjection control photography).

Of the 206 eyes suspected of having buried drusen of the optic nerve head, 82 eyes were evaluated by both B-scan echography and preinjection control photography. B-scan echography showed drusen in 39 eyes (32%) while preinjection control photographs revealed autofluorescence in only 15 eyes (12%) ($P<.001$ for B-scan echography vs preinjection control photography). In addition, 41 eyes showed autofluorescence when only preinjection control photography was performed. In 3 eyes evaluated using only B-scan echography, the echograms of which showed drusen, no preinjection control photography was performed. In 126 eyes, no drusen could be demonstrated by any method.

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Neuroimaging by CT scan with good resolution in the region of the optic nerve head was performed on 30 patients (60 eyes), detecting superficial calcification consistent with the diagnosis of drusen of the optic nerve head in 6 patients (9 eyes). In all of these 9 eyes, drusen of the optic disc were also identified by the highly reflective echo in B-scan echography, and in all but 1 patient (2 eyes), drusen were identified by autofluorescence in preinjection control photography. In 12 eyes with no calcification seen on the CT scans, drusen of the optic disc could be identified by B-scan echography. In these 12 eyes, positive by B-scan echography and negative by CT, autofluorescence in preinjection control photography was detected in only 3 eyes.

Magnetic resonance imaging performed on 20 patients did not show any abnormalities in the region of the optic nerve head, although in 12 eyes, drusen of the optic nerve head could be identified either by autofluorescence in preinjection control photography or by B-scan echography.

To verify the original interpretation concerning the presence of drusen of the optic nerve head, we reviewed the available CT and MRI scans (37 patients) independently and could confirm the findings in all cases.

COMMENT

Superficial drusen of the optic nerve head are usually easily identified on ophthalmoscopy by the characteristic glowing yellow light they reflect. However, deeply situated buried drusen of the optic nerve head may be difficult to differentiate from true disc edema by ophthalmoscopic appearance alone. Although several diagnostic methods, such as...
as preinjection control photography, B-scan echography, and CT, have been reported.\cite{22,23} There is no accepted criterion standard for imaging of drusen of the optic nerve head since none of those reports conclusively compared the methods described with any others.

In our study we found that B-scan echography was clearly superior to orbital CT scan. The value of the orbital CT scan has been debated since the first report of verification of drusen of the optic nerve head was published.\cite{24,25,26} Of the 21 eyes in our study diagnosed as having drusen of the optic nerve head after evaluation by all 3 imaging techniques, almost half of the cases were detected only by B-scan echography and by no other diagnostic method. There was no case in which the diagnosis was made either by preinjection control photography or by CT scan and missed by B-scan echography. Statistical comparison of the diagnostic yield results in a highly significant P value in favor of B-scan echography vs both CT and preinjection control photography. Orbital CT scan, however, proved to be more reliable than preinjection control photography in detecting buried drusen of the optic nerve head.

B-scan echography is a reliable method for verifying the presence of drusen of the optic disc because of its ability to detect calcium deposits. Drusen are thought to form because of abnormal axonal metabolism, causing intracellular mitochondrial calcification and extra-cytoplasmatic calcium deposits acting as nidi for further deposits after rupture of these axons.\cite{12} B-scan echography is able to detect deeply situated calcium deposits in the optic nerve head. The advantage of this diagnostic technique is that the entire area of the optic disc is scanned by performing a sweeping movement of the ultrasound probe, thus accounting for the reliable results when diagnosing drusen of the optic nerve head.

Although the CT scan also images calcium deposits, evaluation by this method missed a substantial number of cases of drusen of the optic nerve head. This is because the slice viewed in the region of the optic nerve head and bone windows is routinely 1.5 mm thick, which might not be fine enough for detecting smaller drusen.

To the best of our knowledge, no cases with false-positive results in B-scan echography were included in our study. However, when performing B-scan echography, be aware that pseudodrusen in chronic papilledema can be misinterpreted as true drusen of the optic nerve head. As a consequence of chronic disc swelling, small refractile bodies can accumulate and simulate drusen.\cite{13,14,15,16} Moreover, rare lesions, such as a calcified granuloma of the optic disc, a vascular lesion, or an astrocytoma, can mimic drusen of the optic nerve head on a B-scan echogram.\cite{17} However, the danger of misinterpretation is small if B-scan echography is performed properly, with the ophthalmoscopic appearance and the clinical presentation taken into account.

In comparing the results of B-scan echography with CT scanning, our study corroborates the results of a previous comparative study that included 4 patients in whom B-scan echography was found to be more sensitive than CT in the diagnosis of drusen of the optic nerve head.\cite{18} If the clinical presentation does necessitate further investigation for exclusion of an intracranial lesion, neuroimaging by CT scan and not by MRI should be considered, since in our experience the latter is not helpful in the diagnosis of drusen of the optic nerve head because of its inability to image calcium. Although the CT scan may detect drusen of the optic nerve head and at the same time rule out increased intracranial pressure owing to a mass lesion, MRI is clearly more sensitive for diagnosing intracranial abnormalities. In our study, MRI was not valuable in diagnosing drusen of the optic nerve head since no case revealed any changes in the region of the optic nerve head consistent with the diagnosis of drusen. We know of only one report describing an eye with drusen demonstrated by detection of optic disc transparency in the MRI.\cite{19}

Concerning the diagnostic value of preinjection control photography, we conclude from our results, corroborating the study of Mustonen and Nieminen,\cite{20} that this method is suitable for confirming visible drusen of the optic disc but not reliable in detecting drusen that are buried in the depth of the disc tissue. Preinjection control photography detected superficial drusen of the optic disc in over 96% of the eyes diagnosed with detecting buried drusen of the optic nerve head in 27% of the eyes diagnosed. It is possible that the autofluorescence emitted by deeply situated drusen of the optic nerve head might be too weak to be detected by preinjection control photography owing to attenuation from the overlying tissue.

Recently, imaging of drusen of the optic nerve head with a scanning laser ophthalmoscope was suggested.\cite{21} All 10 eyes with positive autofluorescence in the scanning laser ophthalmoscope also showed abnormalities consistent with drusen on B-scan echography. Imaging with the scanning laser ophthalmoscope was found to be valuable since the associated anomalous disc features could be demonstrated. However, the scanning laser ophthalmoscope does not seem to be superior to B-scan echography since this additional information is only of limited value once drusen of the optic nerve head have been detected.

In summary, buried drusen of the optic nerve head can be diagnosed most reliably by B-scan echography. It demonstrates a highly reflective echo persisting at a very low-gain setting in the region of the optic nerve head in both the transverse and longitudinal probe orientations, with little danger of false-positive results. Based on our study, B-scan echography is the most sensitive method when compared with orbital CT and preinjection control photography. Although we are aware of the shortcomings involved in a retrospective study, we strongly suggest that B-scan echography be the examination of first choice for suspected drusen of the optic nerve head as a noninvasive, inexpensive, and—with this point in question—easy to learn imaging technique. Preinjection control photography of the fundus seems to reliably detect autofluorescence mainly in cases with superficial drusen of the optic disc, while neuroimaging with orbital CT scan...
fails to reveal the calcification consistent with the
diagnosis of drusen of the optic nerve head in a sub-
stantial number of cases.

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