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Measurement of Choroidal Melanoma Basal Diameter by Wide-Angle Digital Fundus Camera: A Comparison with Ultrasound Measurement

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Key Words
Basal diameter · Choroidal melanoma · Fundus photography · Ophthalmic ultrasound

Abstract
Purpose: To compare the measurement of the basal diameter of choroidal melanoma, an important parameter for planning treatment and as a prognostic factor, by standardized ophthalmic ultrasound versus that obtained using a wide-angle fundus camera. ***Methods:*** The longest and shortest basal diameters of 104 consecutive choroidal melanomas of patients seen at the ocular oncology service of the Hadassah University Hospital were measured by B-scan ultrasound and compared with those measured by a wide-angle fundus camera (Panoret-1000). Each diameter was measured thrice by two ophthalmic photographers, and intra-observer and interobserver reproducibility were calculated as well. ***Results:*** The measurements of both the long and short diameters of the choroidal melanomas were significantly larger when measured by Panoret-1000 as compared with the B-scan ultrasound. There was no significant difference among the three measurements of each of the photographers. The interobserver reproducibility between the two photographers was high. ***Conclusions:*** Our findings can be attributed to the larger extent of the pigmentation of the melanoma compared to its recognized elevation. Since pigmentation of choroidal melanoma is easier to recognize than its elevation, we assume that measurement by a wide-angle fundus camera is more accurate in pigmented tumors, and should be adopted for measuring the basal diameter of choroidal melanomas in planning treatment and follow-up.

Introduction

Uveal melanoma is the commonest primary malignant intraocular tumor in Caucasian adults; most of them are located in the choroid. The incidence of uveal melanoma is 4.3–8.4 new cases per million per year [1–5]. It is most often diagnosed in the sixth decade[1]. The mortality from uveal melanoma is about 20% in 5 years, and close to 50% in 15 years [6–8]. The commonest methods of treating these tumors are brachytherapy, charged-particle irradiation, and enucleation [9–12].

According to various studies, the largest tumor diameter, which is the diameter of the tumor in contact with the sclera, is the most consistent clinical prognostic parameter of posterior uveal melanoma [13–16]. The largest tumor diameter is also important in planning treatment of posterior uveal melanoma, especially using brachy-

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therapy, in order to choose the size of the radioactive applicator when using Ru-106 applicators [9], and to design the size of the applicator when using I-125 [10].

Ophthalmic ultrasound has been used by many ocular oncologists as the main tool for measuring the size of uveal melanoma [17, 18]. While the measurement of the maximal height, especially by A-scan, is accurate, it is well known that the measurement of the basal diameter by B-scan is far less accurate.

Recently, a new wide-angle digital contact camera system, the Panoret-1000 (Medibell Medical Vision Technologies, Ltd., Haifa, Israel), which enables high-resolution, wide-field imaging of the ocular fundus with minimal distortion, has become available [19]. Unlike other wide-angle fundus cameras, this camera enables one to obtain a high-quality picture of the fundus also in adults. This camera is especially useful in documenting intraocular tumors, especially choroidal melanoma, because in most cases the entire tumor can be photographed in one image. Special software enables the user to accurately measure the tumor diameter, as seen in figure 1.

The purpose of this study was to compare the measurements of the basal diameter of choroidal melanoma by conventional standardized ophthalmic ultrasound to those obtained using the new wide-angle fundus camera.

Case Reports

One hundred and four consecutive patients with choroidal melanoma, part of them before and part after treatment by brachytherapy, who were examined at the ocular oncology clinic at Hadassah University Hospital in Jerusalem, Israel, were included in the study.

The basal diameters (longest and shortest) of each recognized elevated tumor were measured using a 10-mHz B-scan ultrasound (I^3 System, Innovative Imaging, Sacramento, Calif., USA). Basal diameters of the same tumor, using its pigmentation as a landmark, were measured by a wide-angle fundus camera – Panoret-1000 (fig. 1).

Inclusion criteria were: good visualization of the entire tumor by Panoret-1000 and the availability of measurements by both Panoret-1000 and ultrasound. Exclusion criteria were: opaque media, inability to see all tumor borders, and when tumor remnants existed after brachytherapy, were scarred and with irregular borders.

The diameters of each tumor were measured thrice, using the Panoret-1000, by two ophthalmic photographers. The intra-observer and interobserver reproducibility between the two photographers were calculated as well.

For statistical analysis, we used JMP statistical software, version 5.0 (SAS Institute, Cary, N.C., USA). Paired t test and analysis of variance were used for the analysis.

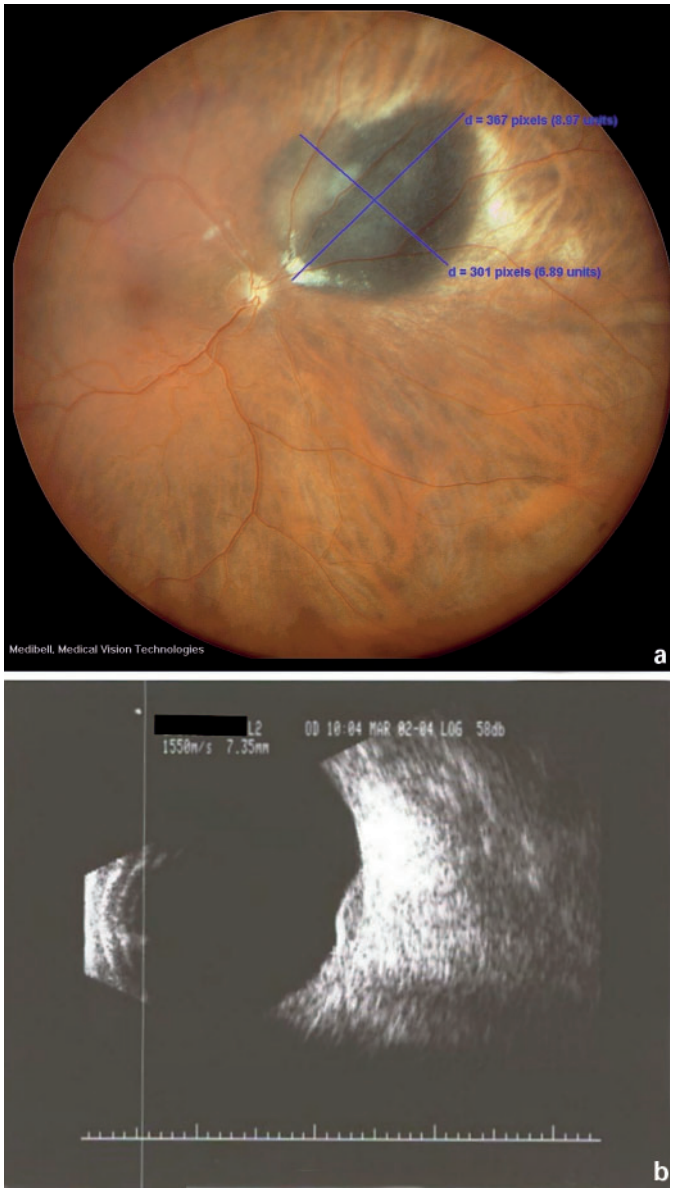

Fig. 1. a A fundus photograph of one of the patients in the study, as captured by the wide-angle fundus camera. The entire tumor is included in the picture, and its longest and shortest diameters can be measured accurately. **b** The same tumor, as taken by B-scan ultrasound. The unclear borders of the tumor's elevation do not allow for accurate measurement.

Results

The measurements of both the long and short diameters of the choroidal melanomas were larger when measured by the Panoret-1000 as compared with the B-scan ultrasound. The mean long diameter measured by Pan-

oret-1000 was 10.56 ± 3.23 mm (range 5.07–21.70) and by ultrasound it was 9.27 ± 2.36 mm (range 4.40–16.60). The difference was 1.29 ± 2.29 mm, which was statistically significant ($p < 0.0001$). The mean short diameter measured by Panoret-1000 was 8.73 ± 2.75 mm (range 4.26–15.70) and by ultrasound it was 8.13 ± 2.21 mm (range 3.00–15.60). The difference was 0.59 ± 2.39 mm, which was also statistically significant ($p < 0.0001$).

There was no significant difference between the three measurements of each of the photographers (intra-observer reproducibility): for the long diameter, for photographer 1, $p = 0.9020$, and for photographer 2, $p = 0.9240$; for the short diameter, for photographer 1, $p = 0.8776$, and for photographer 2, $p = 0.8421$. The interobserver reproducibility between the two photographers was high: for the long diameter, $r^2 = 0.8554$, and for the short diameter, $r^2 = 0.8056$.

Discussion

Measurement of the basal diameter of choroidal melanoma is important as a prognostic parameter which helps predict mortality of any given uveal melanoma patient [13–16]. Knowing the accurate measurement is even more important for practical use, when planning the size and shape of the radioactive applicator for use in brachytherapy [9–10]. The most used method of measuring the size of posterior uveal melanoma is by standardized echography [17]. While measuring the maximal thickness of the tumor by A-scan is quite accurate, the accuracy of the measurement of the basal diameter is quite problematic for two main reasons: first, only elevation of the tumor above 0.4 mm can be recognized by the ultrasound, and, second, it depends on placing the cursor on the ultrasound screen in relatively low magnifications, which can cause some inaccuracies.

The availability of a new wide-angle digital camera system, the Panoret-1000, enables us to obtain a clear panoramic image of the ocular fundus with the choroidal melanoma. Two types of wide-angle cameras that use transpupillary illumination have been used until now: the Retcam 120 (Massie Research Laboratories, Dublin, Calif., USA) can provide high-resolution images for up to 120° of the ocular fundus, and Optomat (Optos, Marlborough, Mass., USA) claims to image up to 200° of the fundus, albeit with some distortion. Both systems require wide dilation of the pupil, clear crystalline lens, and minimal media opacity, and provide the best results in young patients. In the late 1970s, Pomerantzeff et al. [20–22] and Ducrey et al. [23] designed a wide-angle camera using a fibrotic source placed on the sclera. The Panoret-1000 used in our study is based on the Pomerantzeff transscleral illumination technique.

The software used in the Panoret-1000 to measure distances, including tumor diameters in the ocular fundus, estimates the length of a line that connects the two endpoints of a line drawn by the user, assuming that the points lie on the surface of a sphere with a radius of 12.5 mm. In the calculations, the optical distortion is corrected, taking into account the optics of the camera and the optics of a model that represents an ideal eye. The particular refraction of each individual eye is not taken into account in the present program, but probably does not significantly affect the measurements, unless the refractive errors are extreme.

As we found, the assessment of the basal diameter of choroidal melanoma differs according to whether ultrasound or a wide-angle fundus camera is used, favoring larger measurements with fundus photographs. This finding can be attributed to the larger extent of the lesion's pigmentation compared to its recognized elevation. Since pigmentation of the choroidal melanoma is easy to recognize and since elevation in ultrasound can be recognized only above a certain size, we assume that measurement by a wide-angle fundus camera is more accurate and should be adopted for measuring the basal diameter of choroidal melanoma in planning treatment and follow-up.

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