Evaluation of Ocular Tumors with Technetium-99m-MIBI: Planar Pinhole Technique or SPECT?

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Objective: This study compares 2 imaging protocols, planar pinhole technique (PPHT) and SPECT , for evaluating ocular masses with ^{99m}Tc-MIBI.

Methods: Sixteen patients with ocular lesions were studied. Planar images were acquired 10 min after the injection of 740 MBq ^{99m}Tc-MIBI with an LFOV camera fitted with a pinhole collimator (5.0 mm). A SPECT study was performed immediately after the planar study, using a 360° orbit, 64 steps, 20 s/stop, a 128 × 128 matrix, and a low-energy high-resolution (LEHR) collimator. Twelve lesions (9.5–18.0 mm) proved to be malignant: 8 primary tumors (ocular melanoma); 3 local relapses of different tumors of the conjunctiva; and 1 ocular metastasis from breast cancer. The remaining 4 lesions (10.0–16.0 mm) were benign: 1 inflammatory lesion; 1 benign intraocular calcification; and 2 naevi.

Results: SPECT images showed 11 of 12 malignant lesions (91.6%), whereas the planar technique demonstrated only 4 of the 12 lesions (33.3%). One false-positive result, the inflammatory lesion, was visualized by both techniques. The remaining benign lesions were not detected with either method.

Conclusion: Technetium-99m-MIBI SPECT is a sensitive technique for detecting malignant ocular tumors. SPECT imaging is a better alternative to planar imaging for ocular tumors.

Key Words: technetium-99m-MIBI; ocular tumors; pinhole collimator; SPECT

J Nucl Med Technol 2000; 28:85–87

Intraocular malignant tumors of any type are relatively uncommon. Recent therapeutic strategies have become more conservative with eye preservation and plaque or proton beam radiotherapy (*1*). Since these tumors are not easily accessible for biopsy without loss of vision, noninvasive imaging techniques are of great relevancy for patient management.

Several imaging modalities have been used in diagnosing ocular masses, such as ultrasonography, angiography, CT and MRI (*2*,*3*). The nature of the lesion, however, very often remains unclear after using these techniques (*4*). Orbital CT and MRI are best adapted to document extraocular extension (*5*). The differentiation of viable tumor cells from post-treatment fibrosis is always difficult with anatomical imaging methods.

Technetium-99m-MIBI is a radiopharmaceutical with well-known tumor-seeking properties (*6*–*9*). To our knowledge, the evaluation of ocular tumors with this tracer and the establishment of a suitable imaging protocol have not been reported. In this study we compared the abilities of 2 nuclear medicine imaging techniques, planar pinhole technique (PPHT) and SPECT, for evaluating ocular masses with ^{99m}Tc-MIBI.

MATERIALS AND METHODS

Patient Population

Sixteen patients (10 women and 6 men; age range 14–85 y, mean 58 y) with ocular lesions were included in this study (Table 1). In 12 patients malignant lesions were suspected on the basis of clinical examination, ultrasonography, and CT and/or MRI. In 10 of these patients the diagnosis was confirmed by pathology: histology tests after enucleation in 7 cases and fine-needle biopsy in 3. Six patients proved to have choroidal (n = 5) and iris (n = 1) melanomas. Three patients had local relapse of different conjunctiva tumors: epidermoid carcinoma (n = 2) and non-Hogkins lymphoma (n = 1). One patient presented an ocular metastasis from a breast carcinoma. In the remaining 2 cases the diagnosis of choroidal melanoma was made by clinical and ultrasonography follow-up for at least 12 mo. Two patients had ocular naevi, 1 patient had an ocular calcification without showing progression on serial clinical and ultrasound examinations, and 1 patient had a histologically proven inflammatory uveal lesion. Lesion size was obtained in 12 patients by pathology examination (n = 7), CT/MRI (n = 3), and ultrasound (n = 2).

Imaging Protocol

Planar images started 10 min after the intravenous injection of 740–1110 MBq ^{99m}Tc-MIBI. The equipment consisted of a large field-of-view gamma camera fitted with a pinhole collimator (5.0 mm). The image acquisition time was 10 min using a 256 × 256 matrix and a zoom factor of 1.66.

The SPECT study was performed immediately after the

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TABLE 1
Patient Characteristics

Patient no.	Sex	Age (y)	Localization	Size (mm)	PPHT	SPECT	P/N ratios (PPHT/SPECT)	Diagnosis
1	F	28	Choroidal melanoma	17.0	+	+	1.5/2.4	Histology
2	F	66	Choroidal melanoma	11.0	−	−	1.0/1.0	Histology
3	M	43	Choroidal melanoma	9.5	−	+	1.0/1.5	Histology
4	F	39	Iris melanoma	10.5	−	+	1.0/1.7	Histology
5	F	72	Epidermoid carc. relapse	ND	−	+	1.0/1.6	FNAB
6	M	59	Epidermoid carc. relapse	ND	−	+	1.0/1.8	FNAB
7	F	75	NH Lymphoma relapse	ND	−	+	1.0/1.4	FNAB
8	F	14	Breast ca. metastasis	18.0	+	+	1.8/2.3	Histology
9	M	64	Choroidal melanoma	16.0	+	+	1.6/2.5	Histology
10	F	75	Choroidal melanoma	12.0	−	+	1.0/1.8	Histology
11	M	58	Choroidal melanoma	12.0	−	+	1.0/1.9	Follow-up
12	F	85	Choroidal melanoma	15.0	+	+	1.3/2.7	Follow-up
13	F	53	Ocular calcification	10.0	−	−	1.0/1.0	Follow-up
14	F	58	Naevi	15.0	−	−	1.0/1.0	Follow-up
15	M	69	Naevi	16.0	−	−	1.0/1.0	Follow-up
16	M	72	Uveal inflammation	ND	+	+	2.1/2.3	Histology

ND = not determined.

FNAB = fine-needle aspiration biopsy.

pinhole image, acquiring data over 360° in 64 angular steps for 20 s/step, using a 128 × 128 matrix and a low-energy high-resolution (LEHR) collimator. Reconstruction of cross-sectional images was done by filtered backprojection using a fourth-order Butterworth filter with a cutoff at 0.35 of the Nyquist frequency. Transaxial, coronal and sagittal images of the orbits were generated and displayed with appropriate postprocessing zoom. Reorientation also was used when necessary.

Image Analysis

Visual analysis of planar images and SPECT tomograms was done on a high-resolution computer monitor using a linear gray scale and documented on hard-copy films. Circular regions of interest were generated on planar images and on transverse SPECT slices for the calculation of pathological-to-normal eye count ratios (P/N).

Statistical Analysis

The association between sensitivity in tumor detection and the scintigraphic techniques, PPHT and SPECT, was analyzed using the Fisher exact 1-tailed test. The P/N ratios from patients with malignant tumors (both PPHT and SPECT) were compared using the paired 1-tailed Student's *t* test.

RESULTS

Data Analysis

Eleven of 12 malignant ocular tumors (diameters ranging from 9.5–18.0 mm) were clearly visible by SPECT, especially on transverse slices (sensitivity = 91.6%). One patient's small choroidal melanoma (11.0 × 3 mm height) was not visible by SPECT. Only 4 malignant lesions were demonstrated with PPHT (sensitivity = 33.3%). This difference proved to be highly significant ($P = 0.0047$). Figures 1 and 2 show scintigraphic images from 2 representative cases. An uveal inflammatory lesion was visualized by both techniques. This was the only false positive case we had. The remaining patients with benign lesions, ocular naevi (n = 2) and benign intraocular calcification (n = 1), showed symmetrical tracer uptake in the orbitae, which is considered a true negative for diagnosing malignant lesions.

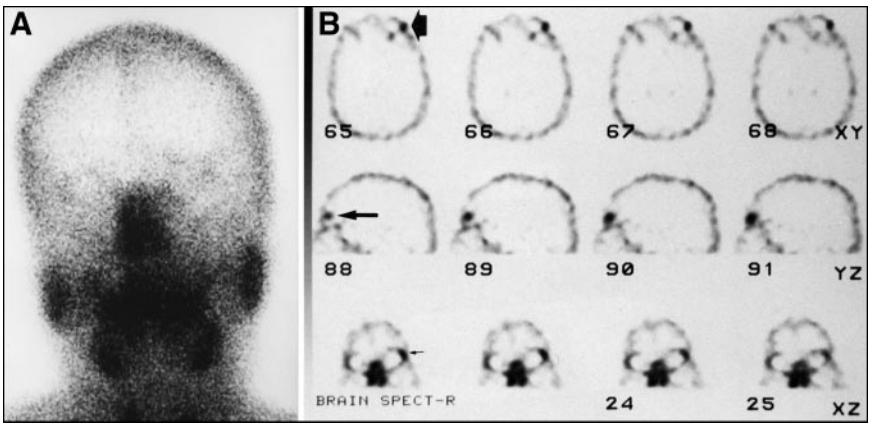

FIGURE 1. (A) Pinhole image of a patient with a left choroidal melanoma showing no abnormality. (B) SPECT study performed on the same patient clearly demonstrates increased focal uptake on transverse (thick arrow), sagittal (long arrow) and frontal (short arrow) tomograms.

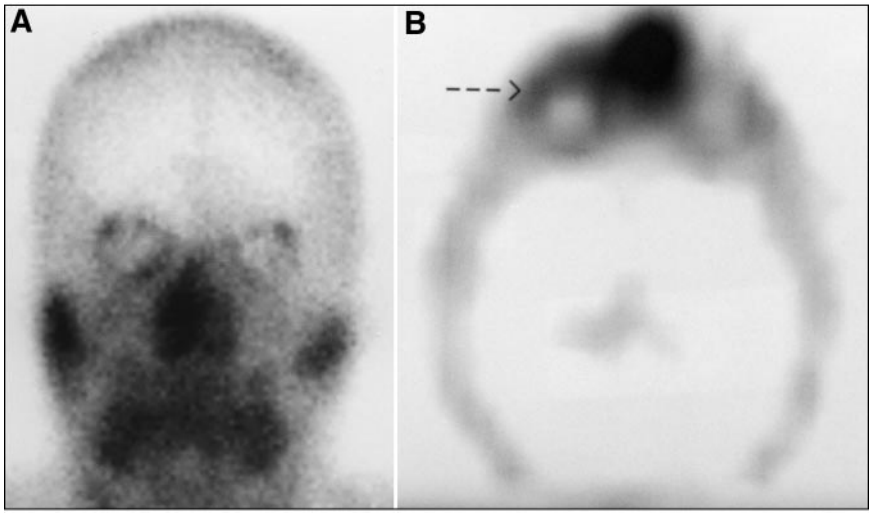

FIGURE 2. (A) Normal pinhole scan of a patient with a local relapse of a right epidermoid conjunctiva tumor. (B) SPECT transverse slice of the same patient shows diffuse increased tracer uptake on the projection of the external sector of the right eye (arrow).

Semiquantitative Analysis

In patients with malignant lesions, P/N ratios were significantly higher with the SPECT technique (mean 1.88, range 1–2.7) compared with PPHT (mean 1.18, 1–1.8) at $P < 0.0001$. In the group with benign lesions this ratio averaged 1.32 (1.0–2.3) for SPECT and 1.27 (1.0–2.1) for PPHT.

CONCLUSION

Pinhole collimators usually are used for imaging small organs that can be positioned close to the collimator. Ocular masses have been evaluated with this technique in the past using several radiotracers (*10–12*). Although the number of patients in this study was small, ^{99m}Tc-MIBI SPECT proved to be a highly sensitive technique (92%) for detecting malignant ocular tumors. SPECT is preferable to PPHT, which demonstrated a low sensitivity (33%). The malignant lesions showed higher contrast on transverse SPECT tomograms as compared with PPHT.

The only false-negative case in the SPECT study was noted in a small choroidal melanoma (11.0 × 3.0 mm). This finding could be related to the proximity of the lesion size to the spatial resolution of the gamma camera, and the normal tracer uptake of the ocular muscles that could interfere with the detection of small ''hot'' lesions. Two other lesions of similar size, however, were detected. The false-positive result was observed in an infected lesion. Technetium-99m-MIBI accumulation in tumor cells is related to high blood flow and mithochondrial retention of the tracer due to strongly negative potentials across the membrane bilayers secondary to increased cellular metabolic requirements (*13,14*). This false-positive case could be explained by the increased blood flow and high metabolic requirements of inflammatory tissues. The fact that the naevi and ocular calcification did not concentrate the tracer, supports the assumption that ^{99m}Tc-MIBI SPECT may be useful in the differential diagnosis when ocular melanoma is suspected among other possibilities.

Technetium-99m-MIBI SPECT imaging is a clinically relevant technique for evaluating ocular malignant lesions. SPECT is a better alternative to pinhole imaging.

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