Scintimammography with technetium-99m methoxyisobutylisonitrile: comparison with mammography and magnetic resonance imaging

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Abstract. The aim of the study was to compare the diagnostic accuracy of scintimammography with technetium-99m methoxyisobutylisonitrile (MIBI; SMM) in the detection of primary breast cancer with that of mammography (MM) and magnetic resonance imaging (MRI). Fifty-six patients with suspected lesions detected by palpation or MM were included in the study. Within the 4 weeks preceding excisional biopsy, MM and MRI were performed in all patients. Between 5 and 10 min after the injection of 740 MBq ⁹⁹mTc-MIBI, SMM in the prone position was performed. In the total group of 56 patients, 43 lesions were palpable, while 13 were non-palpable but were detected by MM. Breast cancer was confirmed by histopathology in 27 of the patients (22 palpable and 5 non-palpable carcinomas). The tumour size ranged from 6 to 80 mm in diameter. For non-palpable lesions, the sensitivity of SMM, MM and MRI was 60%, 60% and 100%, respectively, while the specificity was 75%, 25% and 50%, respectively. For palpable breast lesions, all methods showed high sensitivity (SMM 91%, MM 95%, MRI 91%) but SMM demonstrated significantly higher specificity (SMM 62%, MM 10%, MRI 15%). In two mammographically negative tumours (dense tissue), SMM showed a positive result. In comparison to MRI, one additional carcinoma could be diagnosed by SMM. It may be concluded that for palpable breast lesions, the diagnostic accuracy of SMM is superior to that of MM and MRI. Through the complementary use of SMM it is possible to increase the sensitivity for the detection of breast cancer and multicentric disease. In patients in whom the status of a palpable breast mass remains unclear, SMM may help to reduce the amount of unnecessary biopsies.

Key words: Breast cancer – Scintimammography – Technetium-99m methoxyisobutylisonitrile – Mammography – Magnetic resonance imaging

Introduction

In the developed countries, every ninth woman will suffer from breast cancer at some stage during life [1], and every fourth woman will undergo surgical biopsy because of a suspicious breast lesion. Some mammographic screening studies have shown that the early detection of breast cancer allows a 30% reduction in mortality in patients older than 50 years [2–5].

For the detection of primary breast cancer, several diagnostic methods are available. Mammography is the most commonly used method and is of proven effectiveness especially in patients with non-palpable carcinomas [6, 7]. In patients with palpable breast lesions and in patients younger than 50 years, the diagnostic gain from mammography is less marked due to a low positive predictive value and a limited sensitivity in dense breast tissue [8–10]. This results in a high rate of excisional biopsies without proof of malignancy. For patients younger than 50 years, there is more often a delay in the diagnosis of breast cancer than for women older than 50 years [11, 12].

Ultrasonography is a complementary method which can help to differentiate solid from cystic tumours. Modern ultrasonography using a 7.5- to 10-MHz probe seems to be able to detect smaller, clinically occult carcinomas and to reduce the number of unnecessary excisional biopsies based on mammography by about 25% [13, 14].

It seems that magnetic resonance imaging (MRI) has a higher sensitivity than mammography [15]. Multicentric disease, which often is not recognized by mammography if microcalcifications are absent, can be diagnosed by MRI [16]. However, some studies have demonstrated that there is a lack of specificity [17] and a lower sensitivity in patients with proliferative, fibrocystic disease and carcinoma in situ [15, 18]. MRI also can be used to
assess axillary lymph node metastases. There is still debate over the indications for MRI of the breast and its advantages over mammography [19, 20].

Recently, scintimammography with technetium-99m methoxyisobutylisonitrile (MIBI) has proved highly accurate in the diagnosis of primary breast cancer [21–27]. The aim of our prospective study was to compare the diagnostic accuracy of SMM with that of mammography and MRI in patients with a suspicious breast lesion.

Materials and methods

A total of 56 female patients with a suspicious lesion detected by physical examination or by mammography were entered in the prospective study. Excisional biopsy was performed within 1 week following 99mTc-MIBI scintigraphy. Mammography and MRI were performed after scintigraphy or within 3 weeks preceding it. Patients with a fine-needle biopsy for cytological examination within 7 days prior to scintimammography and patients with suspected local recurrence or known breast cancer were excluded from the study. The mean age of the patients was 58 years (range, 22–81 years); 64% of the patients were older than 50 years. Out of 27 histopathologically proven breast cancers, 22 were palpable and five were non-palpable. Eleven malignant tumours were classified stage T1, seven as stage T2, four as stage T3 and five as stage T4. Five cancers were smaller than 10 mm, eight had a size between 10 mm and 15 mm, seven had a size between 15 mm and 20 mm and seven were larger than 20 mm. In eight patients, histopathology revealed axillary lymph node involvement. Out of 29 benign alterations of the breast, 21 were palpable and eight were non-palpable. Eight benign lesions showed a histopathological size smaller than 10 mm, ten were between 10 mm and 15 mm, seven were between 15 mm and 20 mm and four were larger than 20 mm.

The radiolabelling and quality control procedures for MIBI (Dupont Pharma, Bad Homburg) were carried out according to the manufacturer's instructions. Each patient received an intravenous injection in the arm on the side contralateral to the breast lesion. Prior to and after the injection of 99mTc-MIBI a "cold" injection with saline solution ensured that no extravasation was possible.

In all patients, planar and single-photon emission tomographic (SPET) imaging was performed. Planar imaging was started 5–10 min after the injection of 740 MBq 99mTc-MIBI. Planar images were performed with a 256x256 matrix with an acquisition time of 10 min in both lateral and anterior views. At 20–30 min post injection, SPET was initiated using a two-head camera (Picker prism 2000) with a 64x64 matrix, a 180° rotation, a 6° step-and-shoot technique and an acquisition time of 30 s per frame. For image reconstruction, filtered back projection (Rampr filter) with a slice thickness of 4.5 mm was used and prefiltering (Wiener filter) was performed.

During the imaging procedure (planar as well as SPET) the patient was examined in the prone position on a special table with the breasts freely pendant. For the lateral view in planar imaging, a layer of lead was interposed between the breast to avoid artefacts from the contralateral side.

In all patients, two-view film-screen mammograms of both breasts were obtained with a dedicated unit (Mammadiagnos, Philips). If necessary, additional views were obtained, as well as magnified mammograms.

MR images were obtained with a gyroscan (Philips) 1.5-T camera using a dedicated breast coil enabling the simultaneous imaging of both breasts. Patients were imaged in the prone position. Data acquisition was performed before and directly after the intravenous injection of gadolinium-DTPA (0.2 mg/kg body-weight), and at short intervals thereafter. A T1-weighted spin-echo sequence and a 3D gradient-echo sequence were performed. A total of 19 continuous transverse slices with a thickness of 5 mm were obtained. The quantitative analysis of gadolinium enhancement was performed by automatic ROI definition.

Data analysis of imaging modalities referred to the breast only and not to the axillary region. All images were interpreted blindly by two well-trained nuclear medicine physicians. Mammograms and MR images were interpreted blindly by two radiologists. All the images were classified by the readers as probably normal or suspicious or probably malignant. Focal tracer accumulation in at least one planar image of the breast was the criterion for evaluating a scintigram as suspicious or probably malignant. Mammograms were interpreted as suspicious or probably malignant when a spiculated or irregular dense lesion, suspicious microcalcifications or a significant change in comparison to previous mammograms was present. MR images were classified according to the intensity of gadolinium enhancement (no, low, medium, high), the shape of the enhancing lesion and the dynamics of contrast enhancement (fast enhancement that was maximal in the first postcontrast images, contrast wash-out after early postcontrast images, slow enhancement with steady increase in signal intensity). Images were interpreted as true-positive when cancer was confirmed by histopathology and the image had been scored as suspicious or probably malignant. Images were interpreted as true-negative when cancer was excluded by histopathology and the image had been scored as probably normal.

Results

There were 43 palpable and 13 non-palpable lesions. Breast cancer was confirmed in 27 cases by histopathology (Table 1); 22 of these cancers were palpable, with a size ranging from 10 mm to 80 mm. Scintimammography (SMM) was able to detect 23 cancers of the breast, mammography (MM) was able to detect 24 and MRI was able to detect 25. SMM yielded four false-negative scans in three invasive ductal carcinomas with diameters of 7 mm, 8 mm and 13 mm and in one invasive lobular carcinoma with a diameter of 20 mm (two palpable and

Table 1. Results of scintimammography (SMM), mammography (MM) and magnetic resonance imaging (MRI) in relation to histology in patients with breast cancer