High-resolution Magnetic Resonance Imaging for Determination of Thickness and Depth of Invasion of Skin Tumours

Sir,

Confirmation of a diagnosis of skin tumour is based on histological examination after tumour excision. The initial assessment of the tumour is performed by inspection and palpation by an experienced clinician. However, tumour thickness and depth of invasion cannot always be adequately evaluated by epiluminescence microscopy. On account of the importance of these prognostic parameters for further treatment planning, high-frequency ultrasound (20 MHz, 50 MHz) has been used for a number of years. The results obtained by this procedure show a good correlation between histometry and ultrasound, but skin layer differentiation and measurement of vertical tumour height are subject to method-related limitations (1). The aim of the present study, therefore, was to assess the usefulness of high-resolution magnetic resonance imaging (MRI) for determining depth of invasion and thickness of skin tumours.

MATERIALS AND METHODS

Magnetic resonance scans performed for preoperative tumour evaluation in 30 patients (20 females, 10 males, age range 20–65 years, median 45 years) were evaluated retrospectively. The study included were 16 naevi, 4 basalioma, 4 melanoma, 3 seborrhoeic warts, 2 fibroma and 1 lipoma. The images were obtained with a whole body scanner (Magnetom 63 SP, Siemens, Erlangen) with a field strength of 1.5 Tesla using a polarized ring coil (prototype, Siemens, Erlangen). The in-plane resolution of the coil (diameter 35 mm) was 100 μm.

For the scans the coil was fixed to the skin in the region of the tumour and the patient positioned with the coil at the centre of the magnet. First a scout film with a field of view of 80×80 mm^2 was performed in the sagittal plane (TR 500 ms, TE 25 ms, number of acquisitions 1, matrix 128×256, measuring time 1 min 6 s). If the tumour was visualized in one of the 6 slices obtained, measurements with T1-weighted (TR 500 ms, TE 25 ms, slice thickness 2 mm, number of acquisitions 3, matrix 128×256, measuring time 3 min 14 s), T2-weighted and water suppression (TR 500 ms, TE 28 ms, slice thickness 3 mm, number of acquisitions 3, matrix 128×256, measuring time 3 min 15 s) sequences were examined. A total of 5–6 slices were acquired.

In order to minimize wraparound artefacts, a saturation slice was placed perpendicular to the imaging slices (2).

The depth of invasion of the skin tumours was measured on the basis of the MRI scans using a specially designed computer program for morphometric evaluation and the area of deepest penetration of the tumour related to the surrounding skin layer. The results were later compared with the histologically determined levels of penetration.

Statistical analysis was performed using the coefficient of contingency C. This attains a maximum value of 0.816 in a 3×3 table. The tumour thicknesses measured in the MRI scans were compared with the histologically measured tumour thicknesses (in mm) determined histometrically by the method of Breslow using an ocular micrometer (3, 4).

RESULTS

Determination of tumour thickness

The tumour thicknesses of 30 skin tumours and tumour-like changes determined by the method of Breslow (3) differed

from the thicknesses measured by MRI. A comparison of the measurements obtained by histometry and by MRI showed marked differences for the majority of tumour thicknesses. In most cases the tumour thickness determined by MRI was too great. In agreement with the results of the individual measurements, the statistical tests performed showed no significant correlations.

Determination of depth of invasion

The depths of invasion determined by the method made by Clark et al. (4) showed good correlations between MRI and histology in our patient sample for the images obtained with T1-weighted, T2-weighted and fat suppression sequences. Only the water suppression sequence failed to show a good correlation.

On the basis of the T1- and T2-weighted sequences an approximately 80% agreement between the MRI and histological results was calculated. For the fat suppression sequence the percentage was about 77%. Seventy percent of the depths of invasion determined in the water suppression sequence agreed with the histologically determined results.

The coefficient of contingency was 0.69 for the T2-weighted images and 0.68 for the T1-weighted images. It must be taken into account here that the maximum possible value for this coefficient in a 3×3 table is 0.816. The value of the coefficient for the fat suppression sequence was only just below the above values (0.67). Thus, for these 3 sequences, the results correlated well. The coefficient of 0.51 for the water suppression sequence was well below the others, thus indicating a poor correlation (Table II). Examples of the MRI of skin tumours and tumour-like lesions are shown in Figs. 1 and 2.

DISCUSSION

Although it was possible to delineate the tumour from the surrounding tissue, it was not possible to distinguish between
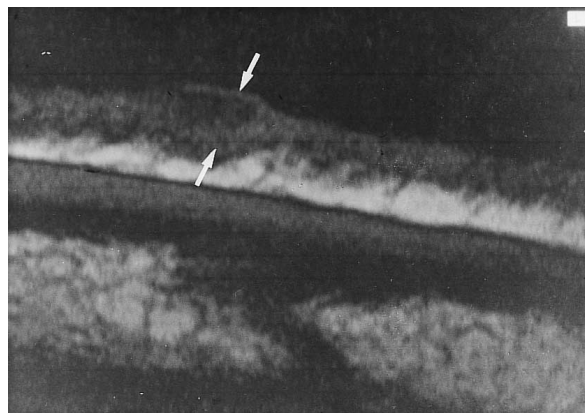

Fig. 1. Intradermal naevus-cell naevus (*arrows*) of the temple, T1-weighted image. Differentiation between dermis and epidermis is not possible. The tumour appears as roundish intradermal lesion of low signal intensity (magnification 1:1.1–2).
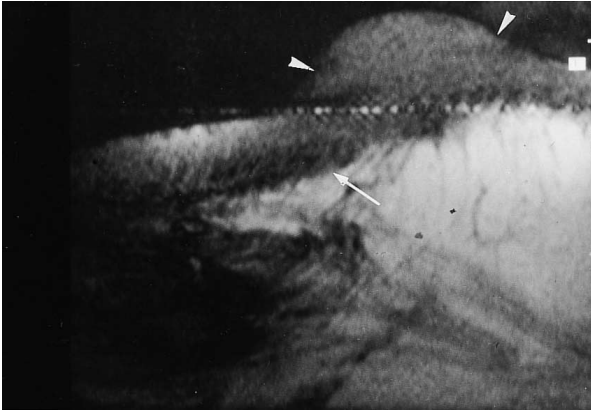
Fig. 2. Basal cell carcinoma (*arrowheads*) of the cheek, T1-weighted image. The tumour of intermediate signal intensity cannot be delineated from the dermis and epidermis and extends as far as the subcutis. There is a close anatomical relationship with the masseter muscle (*arrow*), which also gives a low signal. The vertical lines and horizontal points are hardware artefacts (magnification 1:1.1 – 2).

benign and malignant tumours. Studies designed to show the value of the examination system with regard to visual assessment of differences in infiltration, delineation and internal structure in benign and malignant tumours showed no correlations. In contrast to Zemtsov et al. (5) we did not find that the theoretical distinctions between benign and malignant tumours could be applied *in vivo*. A study by Takahashi & Kohda (6) also showed that the morphological characteristics (structure, delineation from surrounding tissue and accompanying oedema) are not absolute criteria.

One reason for the lack of agreement between the tumour thicknesses determined by MRI and by histometry may be that it was not possible to examine the histological specimens immediately after excision and that different planes of section were chosen. The fixation of the tumour is probably of subordinate relevance for the divergence of the results. We should also mention that in the MRI images the entire epidermis was used for determination of tumour thickness, as delineation of the stratum granulosum was not possible. Using our specialized coil it was also not possible to differentiate the outer dermis at the 0.75 mm level. Our system could not be helpful for the differentiation between superficial spreading and nodular melanoma. Difficulties in delineating the tumour from the surrounding tissue may explain the strikingly large differences in the measured tumour thicknesses in some cases. Also, the tumour infiltration depth was not quantitatively expressed in mm, because the reproducibility for measurement was found to be low using our computer program. The suspicion that a fat suppression sequence would permit better measurement of the invasion of the tumour, and thus of the tumour thickness in the fatty tissue, proved to be correct. This sequence might be useful for indicating Mohs surgery. However, no significant results were obtained for the measurement of tumour thickness using the fat suppression sequence. Furthermore, the intravenous application of the paramagnetic contrast medium Gd-DTPA would not be useful, because the contrast between the tumour and the dermis is diminished. This is caused by the marked contrast enhancement of the dermis.

As a conclusion it seems that MRI is not actually a reliable method for skin tumour evaluation because the method is inferior in precision and, in terms of the cost of disease management, very expensive and not generally accessible.

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