

## INVESTIGATIVE REPORT

# Accuracy of Clinical Skin Tumour Diagnosis in a Dermatological Setting

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**The aim of this study was to evaluate the accuracy of preoperative diagnosis of skin tumours in a dermatological setting. Patients undergoing skin surgery at the Department of Dermatology without preoperative biopsy were prospectively enrolled. Preoperatively, a single clinical diagnosis was registered. The histopathological diagnosis, performed after excision, was registered as the correct diagnosis. The sensitivity and positive predictive value of the clinical diagnosis were calculated. A total of 2,953 tumours were included. Altogether, 55.1% of the excised lesions were malignant. Excision margins for malignant tumours were free from tumour cells in 96.0% of cases. The sensitivity for diagnosis of malignant tumour was 98.0% and the positive predictive value was 85.3%. In line with previous studies, the sensitivity and positive predictive value were highest for basal cell carcinoma, 95.4% and 85.9%, respectively. For squamous cell carcinoma, the corresponding values were 68.0% and 67.3%, and for melanoma, 70.6% and 51.3%. *Key words: skin cancer; skin cancer diagnosis; basal cell carcinoma; squamous cell carcinoma; malignant melanoma; skin surgery.***

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Skin cancer is an increasing health problem in fair-skinned populations. The 3 most common skin cancers are basal cell carcinoma (BCC), squamous cell carcinoma (SCC) and malignant melanoma. In Sweden, malignant melanoma is one of the most rapidly increasing malignant tumours, and malignant melanoma and SCC account for approximately 14% of all invasive cancers (1). Skin cancer (BCC excluded) is the second most common cancer in both Swedish men and women. In 2010, the age-standardized incidence rate (ASIR) (per 100,000 inhabitants) of malignant melanoma was 31.9 for men and 26.6 for women; for SCC, it was 72.0 for men and 36.9 for women. Basal cell carcinoma has been reported to the Swedish Cancer Registry since 2003, and in 2010 the ASIR of BCC was 422.0 per 100,000 for men and 349.6 per 100,000 for women.

Over the last decade, the mean age-standardized yearly rate of increase for incidence of malignant melanoma in Sweden was 4.4% for men and 4.2% for women, while for SCC the rate of increase was 4.7% for men and 6.7% for women (1). The mortality rate of melanoma is increasing slightly, but remains low (3.5 per 100,000 for women and 6.6 per 100,000 for men) (2).

Since 2001 a new protocol for referral of skin tumours from general practitioners (GPs) has been implemented at Helsingborg Hospital, establishing that all referrals for suspected skin tumours are sent to the Department of Dermatology (3). The rationale for this protocol is that specialists in dermatology are the most experienced in the clinical diagnosis of malignant and premalignant skin lesions, and dermatology departments are equipped for providing tailored treatment for these patients. A register for skin tumours excised at the Department of Dermatology, Helsingborg, was started in 2001. The results from the first years (2001 to 2005) have been published elsewhere (4). The aim of this study was to evaluate the accuracy of preoperative diagnosis of skin tumours in a dermatology department. The study was approved by the Regional Ethical Review Board in Lund, Sweden.

## MATERIALS AND METHODS

The study was performed at the Department of Dermatology at Helsingborg Hospital, Helsingborg, Sweden. The hospital serves approximately 250,000 inhabitants in southern Sweden. Six consultants and 3 residents in dermatology are working at the Department.

For the majority of referred skin tumours, treatment is carried out at the Department of Dermatology. In selected cases, e.g. tumours on the eyelids, the patients are further referred to other specialist clinics. For head and neck tumours, there is collaboration with ear, nose and throat (ENT) specialists. Head and neck tumours are excised at the Department of Dermatology by either a dermatologist or an ENT specialist/resident. For selected cases of highly aggressive BCC, patients are referred for Mohs surgery, which is performed at the neighbouring Lund University Hospital in collaboration between dermatologists from Lund and one of the authors (IA).

All physicians who participated in this study use dermoscopy for diagnosis of skin cancer, in particular for diagnosing pigmented skin lesions. The department used whole-body pictures for follow-up of patients with multiple atypical naevi, but did not have computerized follow-up for pigmented lesions during the study period.

The register is integrated in the computerized patient file (Journalssystem Melior®, Siemens AB, Upplands Väsby, Sweden) as a standardized patient file with fixed answer options. Data from this file were extracted and processed using the software program QlikView® (QlikTech International AB, Lund, Sweden). Microsoft Excel® (Microsoft Corp., Seattle, USA) and PASW Statistics 18 (SPSS Inc., Chicago, IL, USA) were used for the statistical analyses.

Patients who underwent surgical excision at the Department of Dermatology, Helsingborg Hospital, from March 2008 to September 2011, were prospectively enrolled in the study. Pre-operatively, sex, age, tumour size and site and clinical diagnosis were registered by the dermatologist who made the decision for surgery. Only one clinical diagnosis was allowed. After excision the tumour specimens were sent for histopathological diagnosis, which was registered as the correct diagnosis. Tumour cells present at surgical margins were registered.

The sensitivity and positive predictive value (PPV) for the malignant diagnoses were calculated. "Sensitivity" is defined as the chance that the histopathological diagnosis was also the clinical diagnosis (true positive/(true positive + false negative)), while PPV is the chance that a clinical diagnosis is verified histopathologically (true positive/(true positive + false positive)).

## RESULTS

A total of 4,082 excisions on 2,745 patients were performed during the period March 2008 to September 2011. Since this study aims to determine the diagnostic accuracy of the dermatologist, we excluded tumours where a histopathological diagnosis had been determined before surgery (e.g. by punch biopsy or previous excisions) ( $n=953$ ). In cases where the referral from the GP included data on exact location and size of tumour, the patients were scheduled for surgery without a preoperative visit. These cases were excluded ( $n=319$ ), as were equivocal pathology reports ( $n=7$ ). The excluded groups were partly overlapping and 2,953 tumours, in 1,415 men (47.9%) and 1,538 women (52.1%), were included in the study. The median age at excision was 65 years (range 7–93, mean 61 years). Of the tumours, 269 were excised by ENT doctors and 2,684 by dermatologists.

Altogether, 55.1% ( $n=1,626$ ) of the excised lesions were malignant and 44.9% ( $n=1,327$ ) benign.

### Benign tumours

The median age of patients with benign tumours was 44 years (mean 47, range 7–98 years).

Of the benign tumours, 964 (72.6%) were melanocytic naevi, of which 299 (31.0%) were dysplastic. Other benign diagnoses included actinic keratosis ( $n=68$ ), seborrhoeic keratosis ( $n=54$ ), epidermal cyst ( $n=45$ ) and dermatofibroma ( $n=48$ ) (Table I).

### Malignant tumours

The median age of patients with malignant tumours was 74 years (mean 72, range 19–100 years).

Table I. Diagnoses of 1,327 excised benign tumours

|                                 | Frequency, <i>n</i> | %           |
|---------------------------------|---------------------|-------------|
| Melanocytic naevus (dysplastic) | 964 (299)           | 72.6 (31.0) |
| Actinic keratosis               | 68                  | 5.1         |
| Other benign tumour             | 64                  | 4.8         |
| Seborrhoeic keratosis           | 54                  | 4.1         |
| Dermatofibroma                  | 48                  | 3.6         |
| Epidermal cyst                  | 45                  | 3.4         |
| Benign lentigo                  | 20                  | 1.6         |
| Haemangioma                     | 15                  | 1.1         |
| Chondrodermatitis nodularis     | 14                  | 1.1         |
| Neurofibroma                    | 9                   | 0.7         |
| Lichenoid keratosis             | 8                   | 0.6         |
| Scar                            | 8                   | 0.6         |
| Lipoma                          | 4                   | 0.3         |
| Cornu cutaneum                  | 3                   | 0.2         |
| Sebaceous naevus                | 3                   | 0.2         |

In this group, 49.8% of the tumours were located in the head and neck region. Excisions of malignant tumours had clear margins in 96.0% of cases. The malignant tumours were categorized into 3 different diagnoses: BCC, SCC (including invasive SCC, keratoacanthoma, and SCC *in situ*) and melanoma (including invasive malignant melanoma, melanoma *in situ* and lentigo maligna). Only 7 cases were other kinds of skin tumours (e.g. lymphoma and atypical fibroxanthoma) that did not belong to any of these categories.

The most common malignant tumour was BCC, accounting for 72.6% ( $n=1,180$ ) of the malignant tumours. The median age for patients with BCC was 73 years (range 31–97, mean 71 years); in this group, 51.6% were women and 48.4% men. Of the BCCs, 53.3% were located in the head and neck region (Table II).

SCC accounted for 18.6% ( $n=303$ ) of the malignant tumours and median age in this group of patients was 80 years (range 40–100 years, mean 78 years), and 53.1% were women and 46.9% were men. Altogether, 50.8% of the SCCs were located in the head and neck region (Table II).

Finally, 8.4% ( $n=136$ ) of the malignant tumours were melanomas. The median age for patients with melanomas was 66 years (range 19–94, mean 65 years). In this

Table II. Tumour localization of excised basal cell carcinomas (BCCs) ( $n=1,180$ ), squamous cell carcinomas (SCCs) ( $n=303$ ) and melanomas ( $n=136$ ) diagnosed by histopathology

|       | BCCs<br><i>n</i> (%) | SCCs<br><i>n</i> (%) | Melanomas<br><i>n</i> (%) |
|-------|----------------------|----------------------|---------------------------|
| Face  | 465 (39.4)           | 105 (34.7)           | 13 (9.6)                  |
| Nose  | 43 (3.6)             | 7 (2.3)              | 1 (0.7)                   |
| Ear   | 17 (1.4)             | 6 (2.0)              | 1 (0.7)                   |
| Scalp | 55 (4.7)             | 21 (6.9)             | 1 (0.7)                   |
| Neck  | 49 (4.2)             | 15 (5.0)             | 8 (5.9)                   |
| Arm   | 70 (5.9)             | 44 (14.5)            | 21 (15.4)                 |
| Leg   | 118 (10.0)           | 54 (17.8)            | 24 (17.6)                 |
| Trunk | 363 (30.8)           | 51 (16.8)            | 67 (49.3)                 |
| Total | 1,180 (100.0)        | 303 (100.0)          | 136 (100.0)               |

Table III. Sensitivity and positive predictive value (PPV) for clinical diagnosis of 1,626 excised malignant tumours

|                         | Sensitivity (%) | PPV (%) |
|-------------------------|-----------------|---------|
| Malignant tumour        | 98.0            | 85.3    |
| Basal cell carcinoma    | 95.4            | 85.9    |
| Squamous cell carcinoma | 68.0            | 67.3    |
| Melanoma                | 70.6            | 51.3    |

group, 41.9% were women and 58.1% men. Localization of melanomas is shown in Table II.

### Diagnostic accuracy

The sensitivity for diagnosis of malignant tumour was 98.0%, specificity was 82.0% (data not shown), and PPV was 85.3% (Table III).

For BCC ( $n=1,180$ ), sensitivity was 95.4% and the PPV was 85.9% (Table III). Of the misdiagnosed BCCs ( $n=54$ ), 55.5% ( $n=30$ ) were clinically diagnosed as SCC, 22.2% ( $n=12$ ) as melanoma, 14.8% ( $n=8$ ) as unspecified malignant tumour and 3.7% ( $n=2$ ) as naevus, and 3.7% ( $n=2$ ) were misdiagnosed as unspecified benign lesions (Table IV).

For SCC ( $n=303$ ), the sensitivity was 68.0% and the PPV 67.3% (Table III). Of the misdiagnosed SCCs ( $n=97$ ), 87.6% ( $n=85$ ) were clinically diagnosed as BCC and 12.4% ( $n=12$ ) as unspecified malignant tumour.

For melanoma ( $n=136$ ), the sensitivity was 70.6% and the PPV 51.3% (Table III). Of the misdiagnosed melanomas ( $n=40$ ), 70.0% ( $n=28$ ) were diagnosed as naevus, 22.5% ( $n=9$ ) as BCC, and 7.5% ( $n=3$ ) as unspecified malignant tumour.

## DISCUSSION

The present study does not cover all aspects of clinical accuracy of skin tumour diagnosis performed in a dermatology department. To achieve such data every tumour presented would have to be biopsied. Since such a study would be impossible to justify we have used a realistic alternative, namely to investigate 2,953 excised tumours without preoperative biopsy. In all cases a single preoperative diagnosis had to be chosen from a given menu as a part of the preoperative recording procedure.

Several previous studies have addressed the question of diagnostic accuracy of skin cancer (5–12); however, few had a prospective study design in a clinical setting. To our knowledge, this is the first European study with such design involving only dermatologists as diagnosticians.

We have chosen sensitivity and PPV as our major outcomes, since these 2 variables cover both the aspect of not missing a malignant diagnosis (sensitivity) and the predictability of the physician's diagnosis (PPV).

In this paper, we compare our data with 4 previous studies using the same outcome variables. Since these studies differ somewhat in design, we prefer to perform the comparison study by study. A few factors have to be taken into consideration, however: sample size in the studies varies between 835 and 28,755. Likewise, there is a wide range in the diagnosticians' training and experience, with the different studies using GPs, GPs with a special interest in skin cancer, plastic surgeons and general surgeons as well as one dermatologist. Furthermore, the level of care ranges from primary care to a tertiary referral centre. One study is retrospective. The studies involve different proportions of benign vs. malignant tumours. Different settings mean different prevalence of tumours, influencing outcomes such as PPV. Thus, the same diagnostic skill will give a higher PPV in an environment with high prevalence of disease, while not influencing sensitivity.

The study by Youl et al. (11) compared the diagnostic skill of 104 GPs and 50 skin cancer clinic doctors (SCCDs) by prospectively studying 28,755 biopsies including 9,650 excision biopsies in Australia. The outcome for malignancy concerning sensitivity and PPV was 91% and 71%, respectively, for GPs and 94% and 70% for SCCDs. The best results for specific tumour diagnoses were achieved for SCCDs concerning BCC, with an 89% sensitivity and 68% PPV. The present study achieved corresponding values of 95.4% and 85.9%, respectively. The superior result in our study regarding PPV may partly be explained by our exclusion of preoperatively biopsied tumours, leading to a higher prevalence in our remaining excisions.

The study by Heal et al. (7) was a retrospective study of pathology reports in 8,694 excised tumours in Australia involving 202 GPs and 42 specialists including one dermatologist. In 23.5% of excisions no clinical diagnosis was suggested, but the diagnosis was registered as

Table IV. Clinical diagnosis of 1,619 malignant tumours diagnosed histopathologically as 1,180 basal cell carcinomas, 303 squamous cell carcinomas and 136 melanomas

| Histopathological diagnosis | Clinical diagnosis   |                         |           |        |                              |                           |
|-----------------------------|----------------------|-------------------------|-----------|--------|------------------------------|---------------------------|
|                             | Basal cell carcinoma | Squamous cell carcinoma | Melanoma  | Naevus | Unspecified malignant tumour | Unspecified benign tumour |
| Basal cell carcinoma        | <b>1,126</b>         | 30                      | 12        | 2      | 8                            | 2                         |
| Squamous cell carcinoma     | 85                   | <b>206</b>              | 0         | 0      | 12                           | 0                         |
| Melanoma                    | 9                    | 0                       | <b>96</b> | 28     | 3                            | 0                         |

true negative. For BCC, the study achieved a sensitivity of 63.9% and a PPV of 72.7% compared with 95.4% and 85.9% in our study. For SCC, their sensitivity was 41.1% and PPV 49.4% compared with 68% and 67.3%, respectively, in the present study. For melanoma, their sensitivity was 33.8% and PPV 33.3% compared with 70.6% and 51.3% in the present study. The results for sensitivity in the study by Heal et al. (7) were influenced by the inclusion of reports with no clinical diagnosis, whereas in our study a clinical diagnosis was mandatory.

The study by Ek et al. (6) was a prospective study of 2,582 tumours excised by plastic surgeons in a tertiary referral centre in Australia. Preoperative diagnoses were restricted to BCC, SCC, melanoma and malignancy that was "impossible to exclude". The authors achieved a sensitivity of 89% and a PPV of 64.5% for BCC, compared with our 95.4% and 85.9%, respectively. For SCC, their sensitivity was 56.3% and PPV 40.3% compared with 68% and 67.3% in the present study. Finally, for melanoma, Ek et al. (6) report a sensitivity of 47.8% and a PPV of 30.6% compared with 70.6% and 51.3% in the present study.

Har-Shai et al. (12) report a prospective study of 835 tumours excised by plastic surgeons at a referral centre for GPs and dermatologists in Israel. A structured questionnaire was used for preoperative diagnosis. They report a sensitivity of 90.3% and a PPV of 66.8% for BCC, while their figures for SCC were 36.6% and 41.7%, and for melanoma, 50% and 35%, respectively. Notable is that, in their study, complete excision of the malignant tumour was achieved in 76.7% only, compared with 96% in the present study.

In previous studies, as well as our own, the sensitivity and PPV were highest for BCC, followed by SCC. Both sensitivity and PPV were lowest for melanoma. This is a natural consequence of melanoma being the more serious tumour, making a larger number of false-positive diagnoses acceptable.

In summary, although different studies are not completely comparable, dermatologists seem consistently to perform superiorly to other specialists in diagnostic accuracy of malignant skin tumours. This may be accounted for by their larger diagnostic experience and liberal use of dermoscopy. These results also imply that preoperative biopsy in most cases can be excluded to

avoid extra costs of medical care and spare the patient unnecessary procedures. In selected cases, preoperative biopsy is certainly needed, e.g. when non-surgical treatment modalities may be superior, when exact preoperative typing of BCC or SCC has an impact on the choice of adequate surgical margins, etc. These results emphasize that dermatologists should be in the first line regarding skin tumour diagnosis and treatment.

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