Peer reviewed article

Dermoscopy of pigmented lesions: a valuable tool in the diagnosis of melanoma

R. P. Braun, L. E. French, J.-H. Saurat

Pigmented Skin Lesion Unit, Department of Dermatology, University Hospital, Geneva, Switzerland

Summary

Although malignant melanoma is not the most frequent cancer, its incidence is increasing faster than any other. Early diagnosis of melanoma is particularly important because if the diagnosis is made at an early stage when the tumour thickness is less than 1 mm the prognosis is excellent. Dermoscopy is an in vivo method for the early diagnosis of melanoma and the differential diagnosis of pigmented lesions of the skin. It has been shown to increase diagnostic accuracy over clinical visual inspection in the hands of experienced physicians. This paper reviews the principles of dermoscopy, diagnostic strategies and recent technological developments.

Key words: dermoscopy; malignant melanoma; pigmented lesions

Introduction

Although malignant melanoma is not the most frequent cancer, its incidence is increasing faster than any other. It is considered to be the most serious of skin cancers because it has a potential for metastasis which explains why melanoma is responsible for 90% of all skin cancer-related deaths. According to the national tumour registry there are approximately 1500 new cases of melanoma per year in Switzerland.

Early diagnosis of melanoma is particularly important because if the diagnosis is made at an early stage, meaning that the tumour thickness is less than 1 mm, the prognosis is excellent and the 10-year survival rate is estimated to be between 90 and 97% [1, 2]. If the diagnosis is made at a more advanced stage the five-year survival rate drops to 10–15%. A further important point is that melanoma is a skin cancer that in almost 100% of cases is localized to the skin and is therefore detectable by simple examination. For these two reasons early diagnosis of melanoma is important.

Clinical diagnosis of malignant melanoma

In the 1960s and 1970s the clinical diagnosis of malignant melanoma was based on symptoms such as bleeding, itching or ulceration. The presence of these criteria at the time of diagnosis was associated with a poor prognosis as these symptoms only appear in advanced stages of disease. In the 1980s the clinical "ABCD rule" was introduced. This diagnostic rule was based on simple clinical morphological features of melanoma such as asymmetry, border irregularity, colour variegation and a diameter exceeding 5 mm. This clinical algorithm is now used worldwide allowing early detection of a large proportion of melanomas. Later a fifth criterion called evolution was added to describe morphologic changes in the lesion over time (ABCD***E*** rule).

Figure 1 shows the clinical presentation of a malignant melanoma. It is an asymmetric lesion with an irregular border, a multitude of different colours and a diameter of 9 mm.

This clinical algorithm has a sensitivity of 65 to 80% but has been shown to have a tendency to fail in small melanomas of <5 mm in diameter. These small, early melanomas are frequently not diagnosed with the clinical ABCDE rule, because very early melanomas can be regular in shape and homogeneous in colour. Figure 2 shows a malignant melanoma that is perfectly symmetrical with a regular border and a homogenous brown pigmentation. Clinically this lesion looks like any of several hundred pigmented lesions in this patient.

No financial support declared.

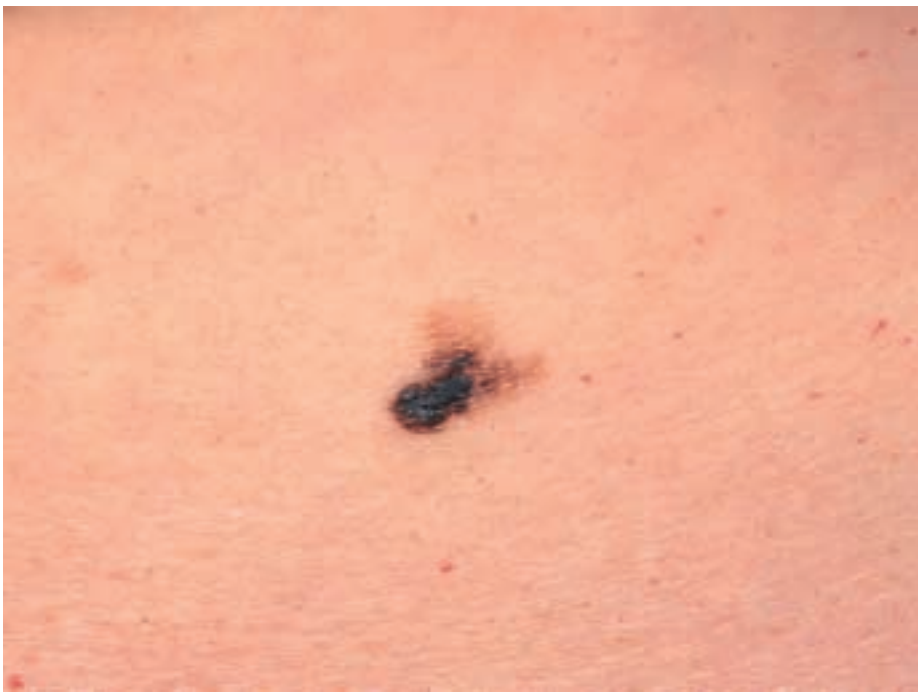


Figure 1
Clinical presentation of a malignant melanoma.

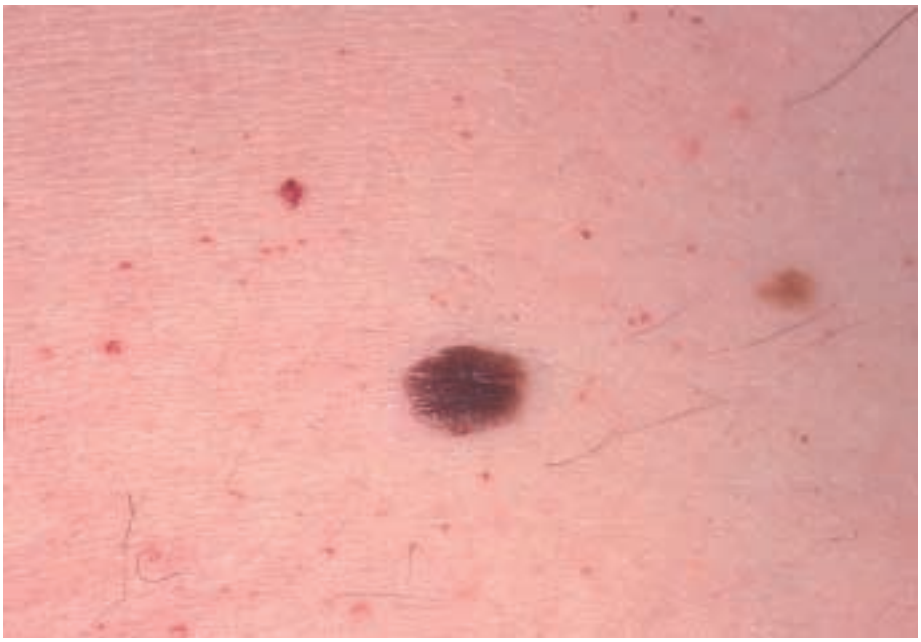


Figure 2
Perfectly symmetrical malignant melanoma with a regular border and a homogenous brown pigmentation.

Differential diagnosis of pigmented lesions

To understand the difficulties related to the diagnosis of pigmented lesions it is important to know the differential diagnosis of a pigmented skin lesion.

This comprises all other skin cancers including malignant melanoma and pigmented basal cell carcinoma, the large group of pigmented melanocytic naevi (compound naevi, junctional naevi etc) and a group of benign lesions such as pigmented seborrhoeic keratoses and benign vascular lesions.

Clinical examination alone has been shown to have a rather low specificity and sensitivity. In practice this means that many benign lesions are over diagnosed as malignant lesions leading to unnecessary surgery. On the other hand some melanomas might remain undiagnosed or be diagnosed too late.

The diagnosis of melanoma can also be difficult as they can in certain instances resemble benign lesions or vice versa.

One possible approach would be to systematically remove all pigmented lesions, but since most patients have a large number of lesions, this is virtually impossible in practice and would be very expensive. This is why there is a need for a non-invasive method that is simple to use and allows the analysis of a large number of lesions with better sensitivity and specificity than simple clinical examination.

Dermoscopy (also known as epiluminescence microscopy, dermatoscopy, or amplified surface microscopy) is an in vivo method that is a useful tool for the early recognition of malignant melanoma [3–6].

The term "dermatoscopy" was introduced in 1920 by the German dermatologist Johann Saphier who published a series of communications using a new diagnostic tool resembling a binocular microscope with a built in light source for the examination of the skin [7–10]. He used this new tool in various indications and made some interesting morphological observations on anatomical structures of the skin, thus demonstrating the high performance of his equipment. He used this technique for the observation of lupus erythematoses and lichen planus but not for pigmented lesions. The technique was then forgotten until a renaissance in 1971 when Rona MacKie et al. clearly identified the advantages of surface microscopy in the preoperative diagnosis of pigmented skin lesions and the differential diagnosis of benign versus malignant pigmented skin lesions [11]. Thereafter further investigations were continued mainly in Europe by several Austrian and German groups.

Technique

Light is reflected, dispersed or absorbed by the stratum corneum due to its refraction index and its optical density, which is different from air [12]. Thus, deeper underlying structures cannot be adequately visualised. However, when various immersion liquids are used to render the skin surface translucent and reduce the reflection, underlying structures are readily visible. The application of a

Table 1

Provides an overview of the most important dermoscopy criteria, their definition and their histopathological correlation according to Argenziano et al. [46].

Criterion	Morphological definition	Histopathological correlation	Diagnosis
Pigment network	Network of brownish lines over a diffuse tan background	Pigmented rete ridges	Melanocytic lesion
Typical network	Brown pigmented, regularly meshed and narrowly spaced network	Regular and elongated rete ridges	Benign melanocytic lesion
Atypical network	Black, brown, or grey network with irregular meshes and thick lines	Irregular and broadened rete ridges	Melanoma
Dots/globules	Black, brown, and/or grey round to oval, variously sized structures regularly or irregularly distributed within the lesion	Pigment aggregates within stratum corneum, epidermis, dermoepidermal junction, or papillary dermis	If regular, benign melanocytic; if irregular, melanoma
Streaks	Irregular, linear structures not clearly combined with pigment network lines at the margins	Confluent junctional nests of melanocytes	Melanoma
Blue-whitish veil	Irregular, confluent, grey-blue to whitish-blue diffuse pigmentation	Acanthotic epidermis with focal hypergranulosis above sheets of heavily pigmented melanocytes in the dermis	Melanoma
Blotches	Black, brown, and/or grey pigmented areas with regular or irregular shape/ distribution	Hyperpigmentation throughout the epidermis and/or upper dermis	If regular, benign melanocytic lesion; if irregular, melanoma
Regression structures	White (scar-like) areas, blue (pepper-like) areas, or combinations of both	Thickened papillary dermis with fibrosis and/or variable amounts of melanophages	Melanoma
Milia-like cysts	White-yellowish, roundish dots	Intraepidermal horn globules also called horn pseudocysts	Seborrhoeic keratosis
Comedo-like openings	Brown-yellowish, round to oval or even irregularly shaped, sharply circumscribed structures	Keratin plugs situated within dilated follicular openings	Seborrhoeic keratosis
Leaf-like areas	Brown-grey to grey-black patches revealing a leaf-like configuration	Pigmented, solid aggregations of basaloid cells in the papillary dermis	Basal-cell carcinoma
Red-blue lacunas	Sharply demarcated, roundish to oval areas with a reddish, red-bluish, or red-black colouration	Dilated vascular spaces situated in the upper dermis	Vascular lesion
Vascular structures	Comma like vessels		Benign melanocytic lesion
	Arborising vessels		Basal-cell carcinoma
	Hairpin vessels		Seborrheic keratosis
	Dotted or irregular vessels		Melanoma

Figure 3

Dermoscopy image of the melanoma seen in figure 1.

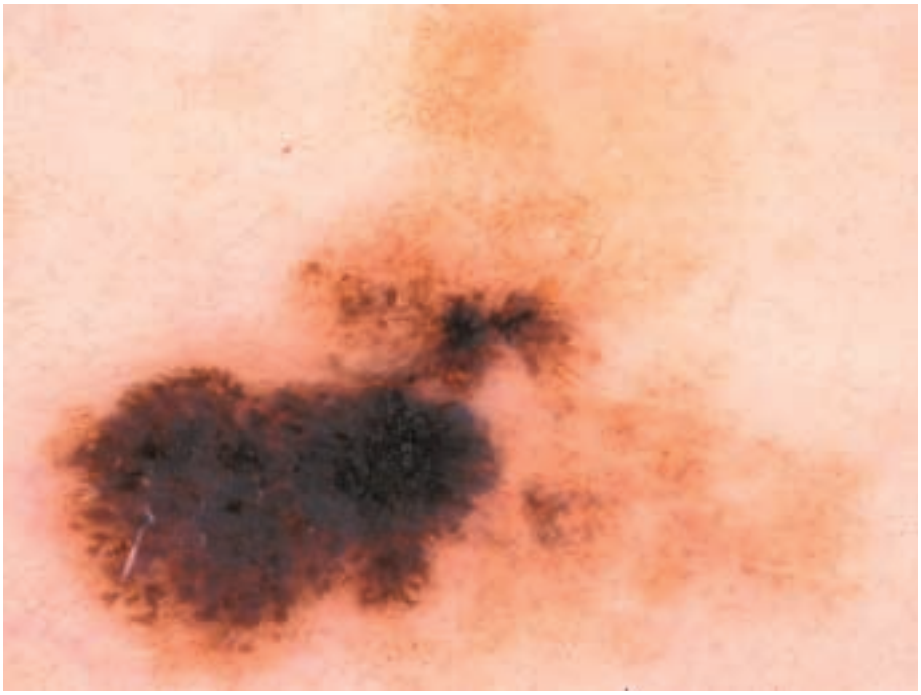
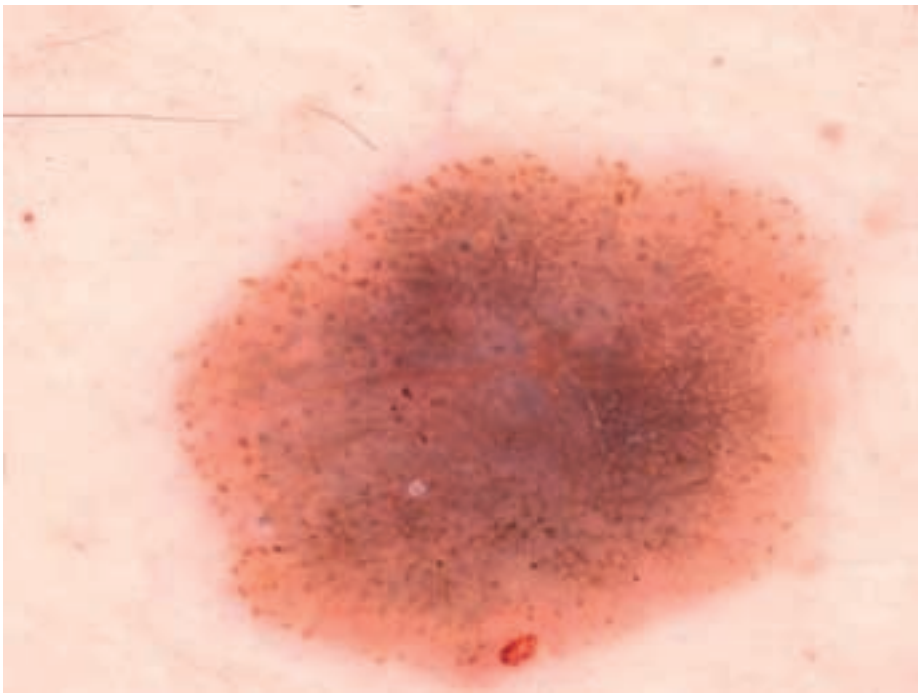


Figure 4

Dermoscopy image of the melanoma of figure 2.



glass plate flattens the skin surface and provides an even surface. Optical magnification is used for examination. Taken together, these optical means allow the visualisation of many new structures, which were named by morphologists more then 15 years ago. These dermoscopy criteria are referred to as pigment network, globules, points, dots, streaks, branched streaks, leaf-like areas, pseudopods, radial streaming, blue white veil, pseudo horns cysts, milia like cysts or structureless areas.

Figure 3 shows the dermoscopy image of the melanoma seen in figure 1. We see an asymmetric lesion with a peripheral hyperpigmentation showing an irregular pigment network and multiple irregular dots and globules. In the periphery one can also find some pseudopods and in the centre of the hyperpigmentation a blue white veil.

Figure 4 shows the dermoscopy image of the melanoma of figure 2. The lesion is clinically symmetric and homogenous in colour, shape and structure. Dermoscopically one can perceive an irregular pigment network and multiple irregular dots and globules. In the periphery a rim of peripheral irregular globules can be seen which indicate the horizontal growth of this melanoma.

Colours also play an important role in dermoscopy because it tells us which chromophore we are dealing with and where it is localized in the skin. As an example, melanin, which is the most important chromophore in the skin, appears to be black in the stratum corneum and in the upper epi-

dermis, light brown to dark brown in the lower epidermis, grey to grey blue in the papular dermis and steel blue in the reticular dermis. It appears to be blue when it is localized within the deeper parts of the skin because visible light with shorter wavelengths (blue) is better dispersed than light with a longer wavelength (red), therefore less blue light is absorbed and more is reflected.

Correlation with histopathology

The next step after the identification of these criteria is their correlation with the histopathology. This turned out to be rather difficult because of some methodological limitations. Dermoscopy provides a horizontal overview of the whole lesion whereas the pathologist only has a focal vertical view of different sections of the lesion. In order to improve the correlation we recently described a micro punch technique [13] that allows the direct correlation of a precise area of a dermoscopical image with the histopathological slide. Following surgery a superficial incision using a 1 mm punch (as used for hair transplantation) is made. Contrary to the standard punch biopsy the punched tissue is left in place and the sections are chosen in a manner so as to pass through the site of the punch biopsy. The incisions can thus be easily visualised in the histopathological slide and a direct visual correlation with the dermoscopical image is possible.

Diagnostic approaches

Pattern recognition has historically been used by clinicians and histopathologists to differentiate benign lesions from malignant neoplasms. A similar process has been found to be useful in dermoscopy and is termed "pattern analysis". In 1987 the Austrian group of Pehamberger, Steiner and Wolff published a landmark article on pattern analysis in the Journal of the American Academy of Dermatology [14]. On the basis of 3000-pigmented lesions, the Viennese group demonstrated that pattern analysis of specific dermoscopic features permitted a distinction between the various types of pigmented skin lesions, specifically between benign and malignant melanocytic lesions. Since then, the concept of classic pattern analysis has been confirmed and redefined continuously by experts all over the world.

There are two steps in the process of pattern analysis. The first step is to decide whether the lesion is melanocytic or non-melanocytic. A special algorithm is used for this first step and the presence of aggregated globules, a pigment network, or branched streaks is determined. If present, the lesion should be considered a melanocytic lesion. If not, one should evaluate the lesion for the presence of homogeneous steel-blue areas. If so, the lesion should be considered a blue naevus (unusual exceptions are a pigmented basal cell carcinoma or a metastatic melanoma). The lesion should then be evaluated for the presence of moth-eaten borders, fingerprinting, comedolike openings, milialike cysts, and fissures. If present, the lesion is suggestive of either a solar lentigo or a seborrhoeic keratosis. One then looks for red or red-blue to black lagoons and if these structures are present, the lesion should be considered a haemangioma or an angiokeratoma.

Finally, the lesion is evaluated for leaf-like-structures, arborizing telangiectasias, spoke-wheel-like areas, and blue-blue ovoid nests. If present, the lesion is likely to be a basal cell carcinoma. If all the preceding questions were answered with "no", the lesion should be considered a melanocytic lesion.

Step 2 of the pattern analysis process is the differentiation of benign melanocytic lesions from melanomas. The overall general appearance of ***C***olour, ***A***rchitectural order, ***S***ymmetry of pattern, and ***H***omogeneity (CASH) are important components in distinguishing these two groups. Benign melanocytic lesions tend to have few colours, an architectural order, symmetry of pattern and are homogeneous. Malignant melanoma often has many colours, architectural disorder, asymmetry of pattern and is heterogeneous.

The reticular pattern, globular pattern, cobblestone pattern, homogeneous pattern, starburst pattern and parallel pattern are the patterns commonly found in benign pigmented lesions.

The combination of three or more distinctive dermoscopic structures (i.e. network, dots and globules as well as diffuse areas of hyper- and hypo-pigmentation) within a given lesion is called multicomponent pattern.

This pattern is highly suggestive of melanoma but might be observed in some cases in acquired melanocytic naevi and congenital naevi. The term lesions with indeterminate patterns is retained for a non-specific pattern that can be seen in both benign and malignant pigmented lesions. Clinically and dermoscopically, one cannot distinguish between melanomas and atypical naevi.

Besides the global features mentioned above, there are important local features such as the pigment network, dots and globules, streaks, blue-whitish veil, blotch, regression structures and the vascular architecture or vascular structures, that can be used to evaluate melanocytic lesions.

Integration of clinical and dermoscopic examinations

Dermoscopy has been shown to increase diagnostic accuracy for pigmented skin lesions, especially melanoma. The efficiency of dermoscopy has been investigated by many authors. Its use increases diagnostic accuracy by 5–30% compared to clinical visual inspection, depending on the type of skin lesion and the experience of the physician [15–19]. This was confirmed by recent evidence based publications and a meta-analysis of the literature [20, 21].

Nevertheless, none of the methods enables the correct diagnosis of melanoma in all cases.

Digital dermoscopy

Digital dermoscopy uses digital or digitised dermoscopy images. Since computer hardware has become user-friendly and more affordable, digital dermoscopy has become more integrated into the clinical setting. The currently available systems for digital dermoscopy have an acceptable picture quality that comes close to that of a photograph [22]. Digital images offer the possibility of computer storage and retrieval of dermoscopic images and patient data for follow up examination [23–27]. In addition some systems offer the possibility of "computer-assisted diagnosis" [28–43] or teledermoscopy. Since diagnostic accuracy with dermoscopy has been shown do depend on the experience of the physician, such objective systems might help less-experienced physicians in the future.

Dermoscopic follow-up of pigmented skin lesions

There are two reasons necessitating regular examination of patients over time. Firstly, patients with a high risk of developing melanoma (e.g. patients with a personal or family history of melanoma, a large number of naevi or fair skin) should be monitored periodically. Secondly, morphological changes can occur in melanocytic naevi, and objective, long-term observation is necessary to monitor these modifications. This approach is even more important when monitoring patients who have many clinically atypical naevi that are difficult to remove simultaneously.

Compared with traditional methods of photographic documentation this digital approach is simple to use.

Teledermoscopy

At the beginning of the digital dermoscopic era, teledermoscopy was used between experts to exchange difficult or interesting images. The development of new electronic media and the evolution of the internet will have an important impact as the infrastructure is becoming universally available and exchange of information is now easy to perform. Telemedicine is already a well-integrated part of everyday medical practice, particularly in specialties such as radiology and pathology, where digital images are important diagnostic and therapeutic tools.

More recently, teledermatology was shown to be a valid diagnostic system in geographic areas where dermatologists are not available. Teledermoscopy is a development of teledermatology using digital or digitised images that are transmitted via new electronic media. This can be done as a "store and forward system" where the images of the lesions are simply sent via e-mail (secured access and encrypted transmission) and visualised by the expert when it is convenient. Another possibility is the online consultation which is much more interactive but requires the presence of both participants at the same time. In our experience this may be quiet difficult.

One of the first articles on teledermoscopy was published by Provost et al. The authors transmitted compressed digital dermoscopy images over telephone lines and concluded that diagnosis at distance based on these images is feasible [37]. More recently, Kittler et al investigated the impact of compression of digital images compared to standard photographs and concluded that compressed digital dermoscopy images (medium compression) were as informative as conventional photographs [38]. This was an important finding because the authors defined for the first time the resolution and quality (compression) requirements for digital images used for teledermoscopy.

Piccolo et al. published a paper on the evaluation of face to face diagnosis versus tele-diagnosis based on the analysis of 66 pigmented skin lesions [44]. The digital images were compressed and send

to the pigmented skin lesion clinic of the Department of Dermatology of Graz (Austria) where the remote diagnosis was made. They found a concordance in 60 cases (91%) and concluded that teledermoscopy provides a similar degree of diagnostic accuracy as face to face diagnosis. The authors postulated that this accuracy was not related to the quality of the images (which had been the main concern of early publications) but rather to the "level of diagnostic difficulty of a given pigmented skin lesion". In a second study the same authors evaluated the diagnostic accuracy (based on 43 pigmented skin lesions) in a multicentre study involving 10 centres [45]. Here the participants had greatly differing degrees of experience in dermoscopy, and diagnostic accuracy varied from 77% to 95% with a mean of 85%. The authors concluded that the diagnostic accuracy of teledermoscopy largely depends on the experience of the consultant.

Taken together it has been shown that teledermoscopy consultations are technically feasible and that the diagnostic performance depends on the "level of diagnostic difficulty" and the experience of the consultant who interprets the images. However, this remains a promising field for future research and development.

Conclusion

Dermoscopy is a useful addition to clinical examination that opens a new dimension in the clinical analysis of pigmented skin lesions and enables physicians to improve their diagnosis of malignant melanoma. Digital follow up examinations, teledermoscopy and computer-aided or computer-assisted diagnosis of pigmented skin lesions are exciting new tools that will certainly change the management of pigmented skin lesions.

Correspondence:
R. P. Braun
Department of Dermatology
University Hospital Geneva
24, rue Micheli-du-Crest
CH-1211 Geneva 14
Switzerland
E-Mail: braun@melanoma.ch

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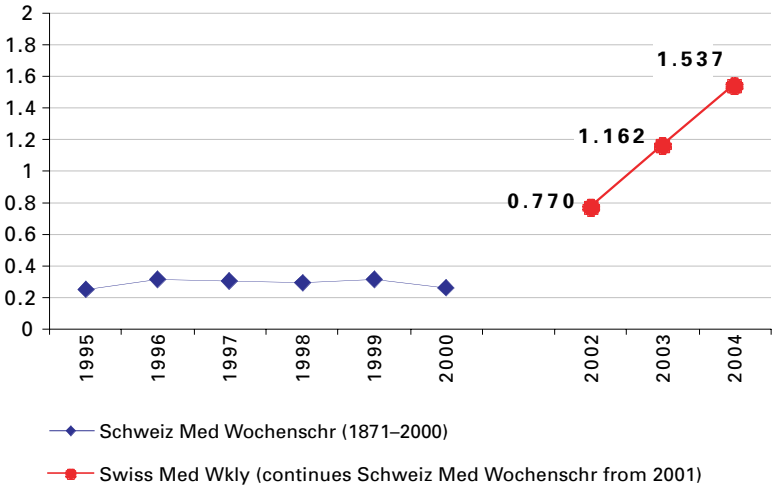

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