SIMSYS™ MoleMate™ North America

BY medx

# DIAGNOSING PIGMENTED SKIN LESIONS

By Symon Cotton,
September, 2011

# Contents

# Diagnosing pigmented skin lesions

## 1 Introduction

Talking with many consultant dermatologists and GPs reveals that one of the main problems of diagnosing and monitoring pigmented lesions is the issue of subjectivity. When two people look at the same, non-uniform object, the chances are that they will not describe its color and shape in exactly the same way. When two digital photographs of the same subject are taken, without complicated equipment and procedures there will be subtle differences in lighting, angle and distance to the object, all things that can make the two pictures appear non-identical. Whether based on the expertise of the dermatologist, built up over years of specialisation, or the 'gut reaction' of a GP seeing something new, it is extremely difficult to bring uniformity to diagnosis and treatment monitoring where the skin is concerned.

Up until now, getting simply a more detailed look at the surface of the skin has been the aim of skin imaging techniques. However, better magnification does not automatically lead to better classification when it is still only the eye that decides, based on color and shape alone. Health practitioners who examine or treat the skin need an objective, rigorous and repeatable way of characterising and diagnosing lesions that can be reproduced and matched or compared in other clinical settings. Such a method needs to generate images, but these images must be backed up with spectrocsopic data. It is the spectroscopic data, rather than the images, that actually determine the parameters for diagnosis.

**Photo 1:** A contact SIAscan is taken of a lesion using the SIAscope V.

Better diagnosis can mean more timely and appropriate treatment, and reduce the number of false positives. In the US numbers there are around 2.5 million 'excess' excisions annually. Given these figures, it is not hard to imagine the impact that more accurate diagnosis could have on patient throughput and waiting lists. Better diagnosis can prevent disfigurement where cancer is not confirmed and, in the case of malignant melanoma, save lives.

Many doctors are now looking beyond traditional methods and seeking modern ways to aid their diagnosis and increase consultation efficiency, and many of them are using an advanced, clinically proven, non-invasive skin imaging technique called SIAscopy, Spectrophotometric Intracutaneous

Analysis. SIAscopy allows you to examine the skin to a depth of 2mm, and shows concentrations of haemoglobin, pigment and collagen. It is proving to be not only a valuable aid to diagnosis, but also a reliable method for obtaining objective data for baseline purposes or for referral.

## 2 Pigmented skin lesions

Marks (2003) states that acne, eczema, psoriasis, warts and skin tumours are amongst the commonest of all human disorders. Thus it is hardly surprising that 'skin diseases account for about 15 per cent of a general practitioner's workload' (Marks 2003). The skin is the body's largest organ and highly complex in structure and function. Skin disorders can be general or localised in particular areas of the body. They are frequently instantly visible and can have devastating physical, emotional and psychological effects. So fast and accurate diagnosis can be key to patient wellbeing and a successful treatment outcome.

A large number of skin conditions present as pigmented skin lesions, discolorations of areas of skin due to an underlying physiological problem. Pigmented skin lesions can be confined to the stratum corneum, or penetrate deeper into the epidermis and dermis, and may also expand upwards from the skin's surface. They range from the benign to the life-threatening, and from those that are merely a nuisance to those that are completely debilitating.

The skin condition that requires the most urgent diagnosis and treatment is skin cancer. Hunter et al (2002) list 32 types of skin tumour, from the benign, such as squamous cell papilloma and haemangioma, to the malignant, such as basal cell carcinoma and Kaposi's sarcoma. The most dangerous form of skin cancer is malignant melanoma, which spreads either horizontally (superficial spreading malignant melanoma, SSMM) or vertically downwards (nodular malignant melanoma, NMM), the latter being the more immediately life-threatening. Malignant melanoma has a very high five-year survival rate if treated early, and prognosis is closely correlated with the depth to which the malignant melanoma has penetrated into the dermis.

The color of the skin is mostly due to the concentrations of pigment and haemoglobin, and it is changes in these constituents that lead to the appearance of pigmented skin lesions. Pigment is synthesised by melanocytes and darker areas of skin indicate higher pigment production (rather than greater numbers of melanocytes). Coloration due to haemoglobin relates not only to concentration but also to degree of oxygenation.

Aspects of skin lesions that aid in diagnosis include not only color (shade and tone), but also shape, how well-defined the edges of the lesion are, and size. Given the vast array of different types of skin lesions, it is not surprising that it can sometimes be difficult to distinguish between them. For instance, while some skin tumours have distinctive characteristics that make them more straightforward to diagnose, in many cases alternative conditions have to be ruled out. Seborrhoeic ketoses, for example, although easy to recognise, may be confused with 'a pigmented cellular naevus, a pigmented basal cell carcinoma and, most importantly, with a malignant melanoma' (Hunter et al, 2002).

Dermatologists address this difficulty in part through their extensive experience. They build up a mental database that enables them to arrive at their diagnosis by a process of comparison and elimination against similar conditions that they have diagnosed in the past. Scoring systems have been developed based on visible characteristics to aid the diagnostic process, but many of these have a large margin of error and this leads to significant numbers of false positive results. Confirmation of this visual method of diagnosis can only be provided by microscopic analysis, which means removing some of the skin for examination (Biopsy).

Biopsy is particularly common in cases of suspected malignant melanoma, due to the recognised risks of leaving a potential malignancy untreated. Excision includes a margin of skin surrounding the suspected melanoma, typically at least 2cm of skin around a melanoma of 1cm diameter (Marks 2003). The expression, 'if in doubt, cut it out', is a familiar one, and typically one would expect the patient to prefer this option for certainty of a cure. However, melanoma is linked to exposure to the sun, therefore it is not surprising that the face, hands and feet are the most likely sites for melanomas. Large excisions may disfigure the patient, and accuracy in diagnosis can go a long way towards preventing unnecessary scarring and disfigurement. Given that the ratio of biopsies performed to malignant melanomas confirmed can be as high as 100:1, more accurate diagnosis can also have a considerable impact on the efficient use of a clinician's time and resources.

## 3 Methods of diagnosing pigmented skin lesions

The **magnifying glass** is the most basic aid to diagnosing pigmented skin lesions, giving the practitioner a better view of color distribution, shape and the margins of the lesion.
A **Wood's light** emits short wavelength ultraviolet radiation and is used for conditions where fluorescence is characteristic, such as some fungal infections, erythrasma and pseudomonas infections. Determining the underlying color of vascular lesions by blanching them with a glass slide or clear spoon is known as **Diascopy**. **Photography**, typically digital nowadays, enables the practitioner to record lesions at each visit, so that changes can be assessed over time.

**Dermatoscopy** is a specialised form of illuminated magnification, using a fluid (mineral oil, alcohol or water) to eliminate surface reflection from the skin and magnifying the lesion by a factor of 10. This method requires formal training, but the trained practitioner is then better able to assess visually pigmented structures in the epidermis and superficial dermis. Dermatoscopy is combined with digital photography to give the practitioner a record of each lesion at each visit. Automated scoring systems, such as ABCDE, compare dermatoscopic images against a large database for best fit.

The newest aid in the diagnosis of pigmented skin lesions is SIAscopy, or Spectrophotometric Intracutaneous Analysis, which provides spectroscopic data about a skin lesion without the need for laboratory analysis and so takes the subjectivity out of clinical examination. SIAscopy is unique in that it allows the practitioner to view beneath the surface of the skin. It uses white light and sophisticated software to provide independent views of pigment, dermal pigment, haemoglobin and collagen in the stratum corneum, epidermis and dermis to a depth of 2mm. The images (SIAscans) can be viewed separately or overlaid, to demonstrate how the features relate to one another, and help to make any necessary excision more precise by showing the exact size of a lesion. SIAscopy is a completely safe, non-invasive and painless technique, which makes it ideal for analyzing and monitoring many skin conditions, including skin cancers, psoriasis, acne, eczema, skin de-pigmentation, skin aging and scars. The technique is available in two methods, contact and non-contact SIAscopy. How SIAscopy works is described in more detail below.

## 4 How SIAscopy works

SIAscopy measures the amount of haemoglobin, pigment, collagen in the stratum corneum, epidermis and dermis to a depth of 2mm, and identifies whether pigment is present in the epidermis or the dermis.

The information is presented to the practitioner as SIAscans, which show how these components vary over the skin.

SIAscopy makes use of the way light interacts with skin – the way it scatters or bounces and the amount absorbed by cells and other structures – and how this varies for different wavelengths or colors of light. Due to the multi-layered structure of the skin, and because the most prominent chromophores have slowly varying spectral properties, it is possible to generate models which can predict the method of light transport within skin. This allows us to analyse the skin using broadband spectrophotometric techniques.

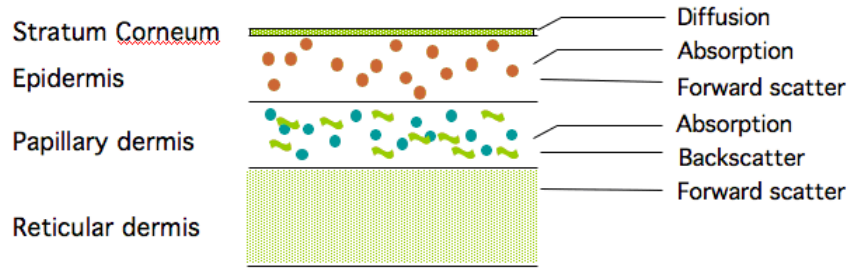



Figure 1: Optical model of the skin based on physics of image formation.

By sending light into the skin and measuring how it emerges back out, SIAscopy is able to determine the nature and position of many of the different cells and structures within the skin (see Figure 2). Four different primary wavelengths of light are shone into the skin in turn. An imaging chip records the light remitted from the skin at each pixel, giving an image representing the amount of light leaving the skin for each of the four wavelengths used. Cross polarisers are used to remove any scattering from the surface of the skin.

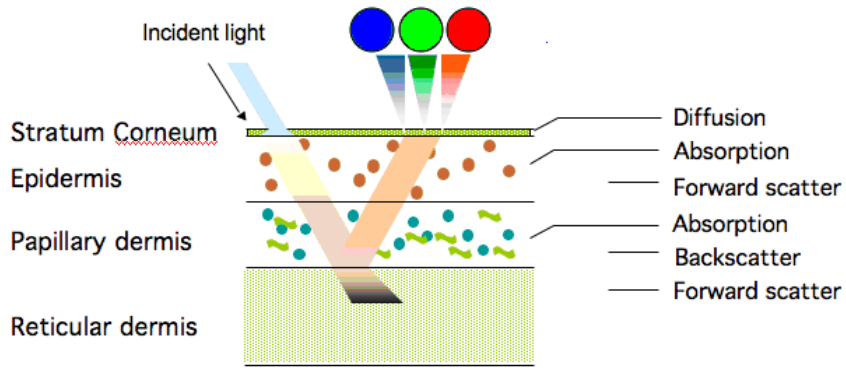



Figure 2: Optical model of the skin based on remitted light from chromophores.

In order to generate the model, simulations are run for hundreds of thousands of different combinations of haemoglobin, pigment, collagen and dermal pigment. The result of each simulation represents how the camera would respond if it was to image the corresponding combination of skin chromophores. This information is stored, and then interrogated during each scan in order to generate SIAscans. Each SIAscan is a bitmap representing the concentration of each chromophore on every pixel. Each scan is made up of more than 1.5 million measurements.

Siascopy uses a specialised camera that touches the skin and gives very high-resolution images. This method measures an area of skin approximately 11mm in diameter, and produces SIAscans for all types of cells and structures, giving the maximum amount of information about an area of skin or a lesion.

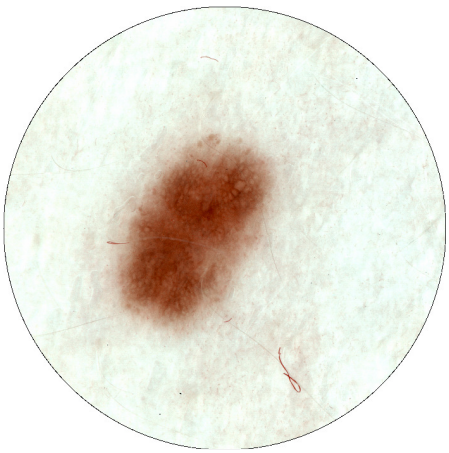

**Photo 2:** A SIAscope V, used for the acquisition of SIAscopy images.

# 5 SIAscopic Images

The following images are contact SIAscans, with the characteristic features described and histological confirmation given for each diagnosis.

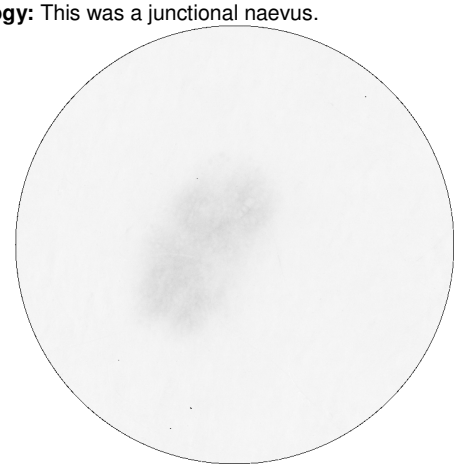
### Junctional Naevus

**Summary:** A regular lesion with no suspicious features.

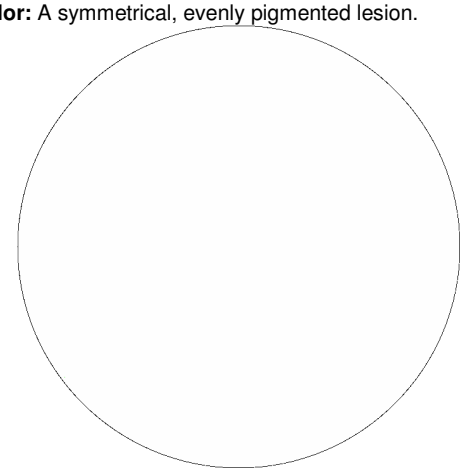


**Histology:** This was a junctional naevus.

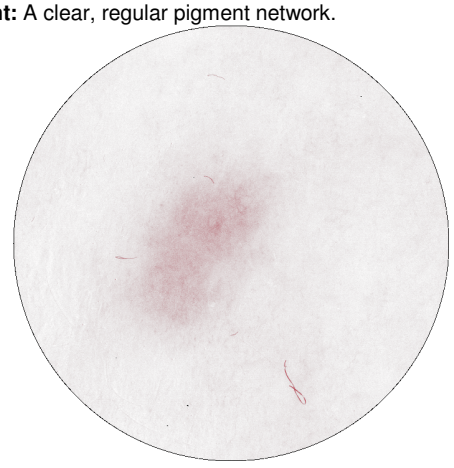
**Color:** A symmetrical, evenly pigmented lesion.



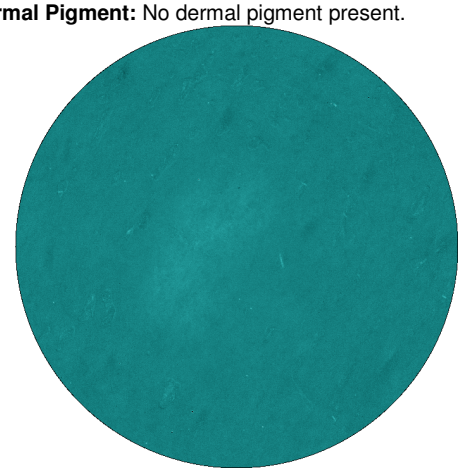
**Pigment:** A clear, regular pigment network.



**Dermal Pigment:** No dermal pigment present.



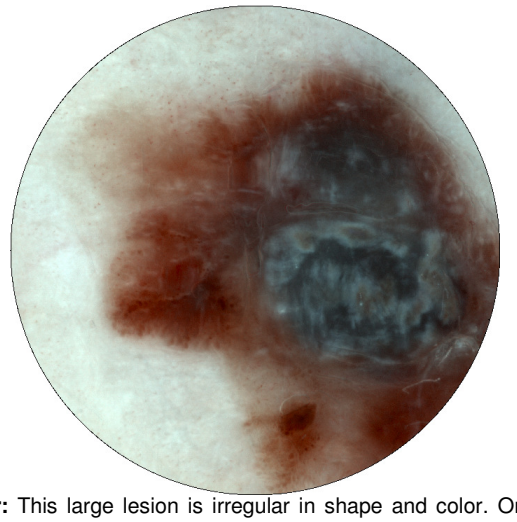
**Blood:** A homogenous vascular pattern throughout the lesion.



**Collagen:** A homogenous collagen pattern.

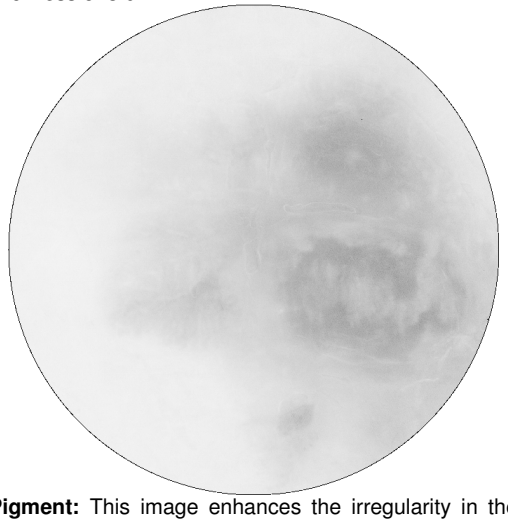
## Malignant Melanoma, invasive

**Summary:** This large lesion has many irregular SIAscopic features with consistant features suggesting invasive activity. The presence of the collagen holes is significant in a rough perception of lesion depth, indicating vertical invasion into the deeper reticular dermis.

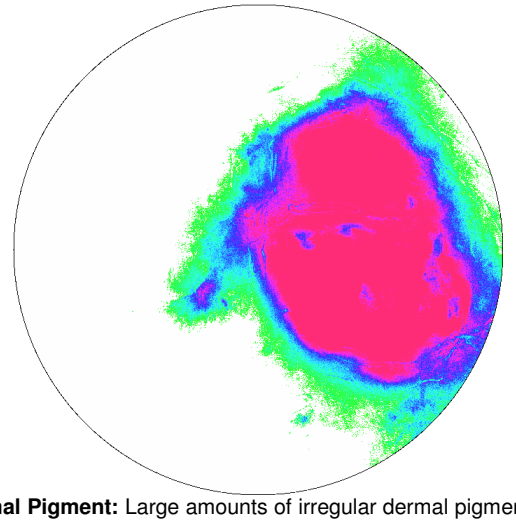


**Color:** This large lesion is irregular in shape and color. On the right there is a large area of blue-grey veil.

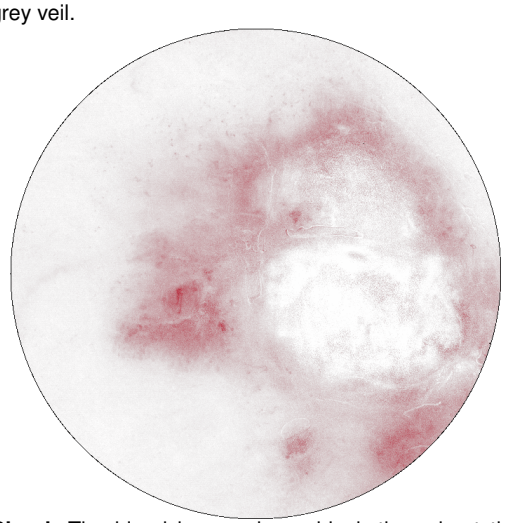
**Histology:** This lesion was on the knee of an 89yr old man and was a malignant melanoma with a Breslow thickness of 3.0mm.



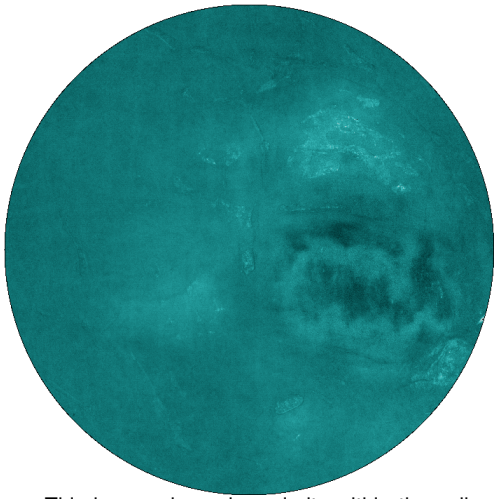
**Pigment:** This image enhances the irregularity in the distribution of the pigment within the lesion, showing higher concentrations in the area relation to the blue-grey veil.



**Dermal Pigment:** Large amounts of irregular dermal pigment are seen. It is irregular in both distribution and concentration.



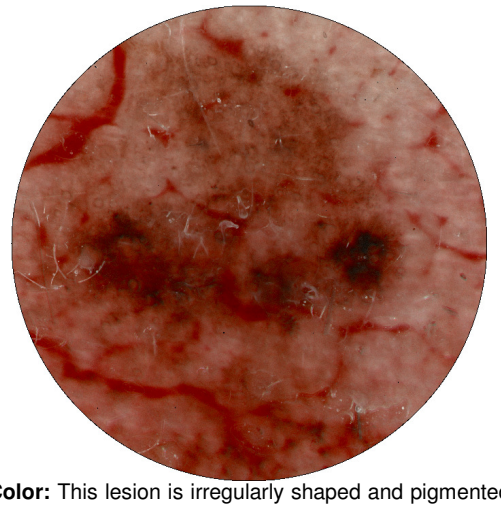
**Blood:** The blood image shows blush throughout the peripheral sections of the lesion and a large area of vascular displacement in the right of the lesion.



**Collagen:** This image shows irregularity within the collagen. On the right of the lesion the black areas are collagen holes indicating vertical growth down through the reticular dermis.

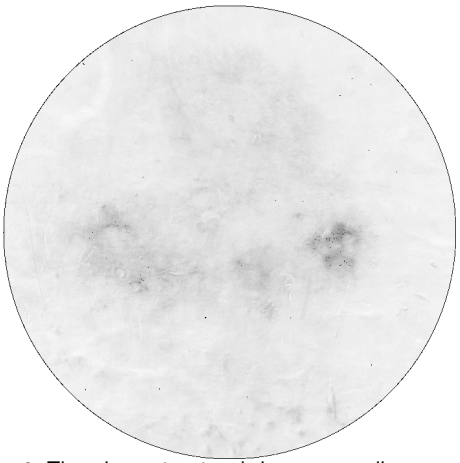
## Lentigo Maligna Melanoma:

**summary:** All the irregular activity in the independent images maps together to suggest malignant transformation. This example again shows that it is important to appreciate the 'normal skin damage' when looking for malignant change.

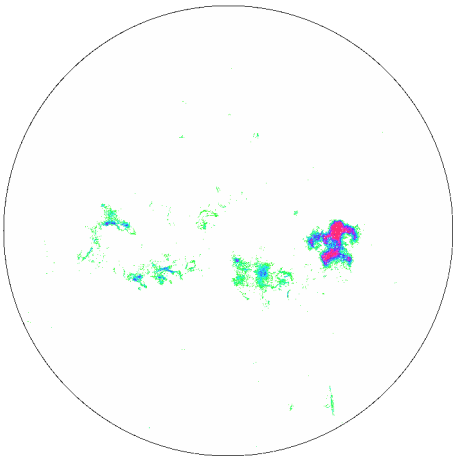


**Histology:** This was a lentigo maligna melanoma on the cheek of a 78yr old farmer.

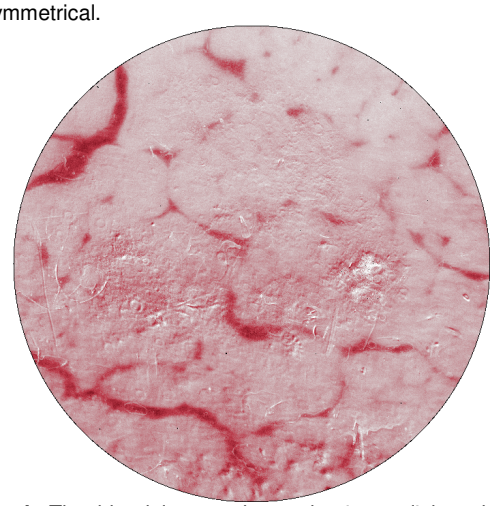
**Color:** This lesion is irregularly shaped and pigmented with no symmetry visible. The normal lentigo pigmentation broadens as you go down the lesion. It also appears on a background of a broadened vascular network, suggesting chronic solar damage.



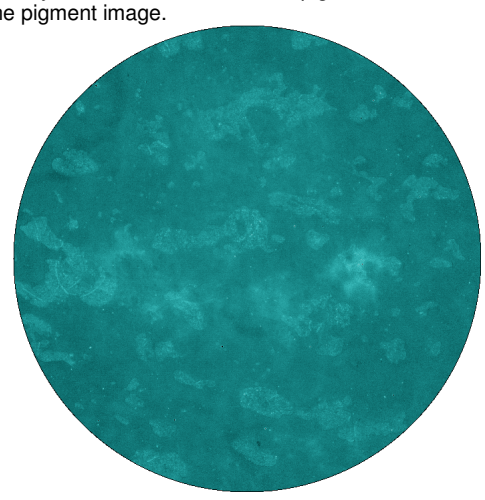
**Pigment:** The pigment network is more easily seen, as is the loss of it in the lower part of the lesion, as brown globules coalesce. The lesion is also now clearly asymmetrical.



**Dermal pigment:** There is dermal pigment present in an irregular distribution and concentration which exactly matches the increased pigmentation seen in the pigment image.



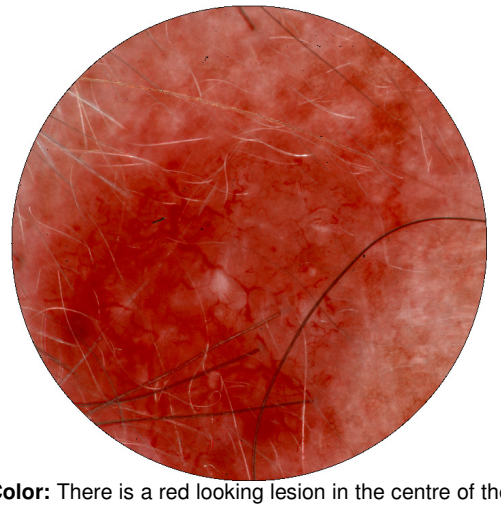
**Blood:** The blood image shows the 'normal' broadened vascular network, of chronically sun damaged skin. There is vascular blush and displacement which accurately matches the irregularities in the dermal and pigment scans.



**Collagen:** Once again there is collagen irregularity over the area of melanocytic activity. The absence of any collagen holes would suggest junctional activity only in the papillary and upper reticular dermis.

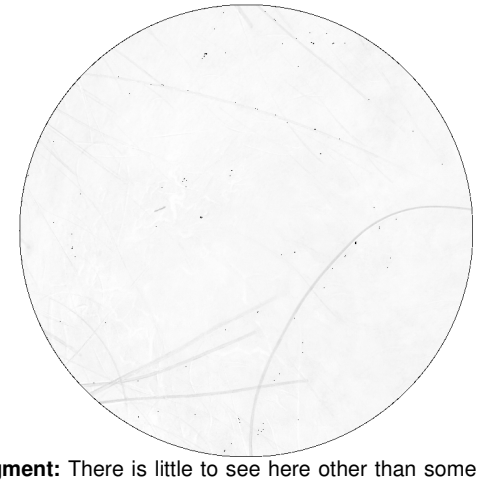
## Basal Cell Carcinoma, nodular

**Summary:** This is a nodular lesion with some clearly abnormal activity characterised by the irregular vascular and collagen disruptions.

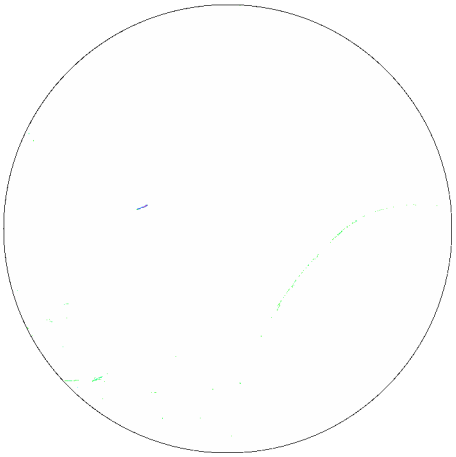


**Histology:** This was a nodular BCC on the forehead of a 61yr old man.

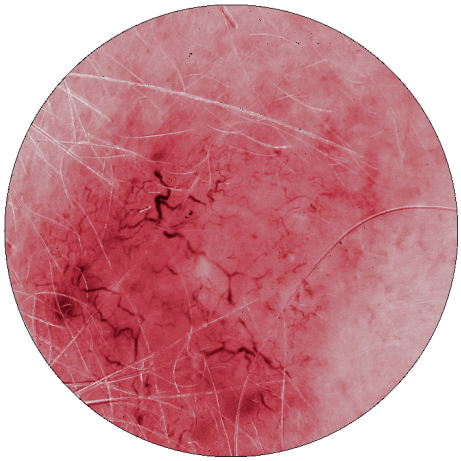
**Color:** There is a red looking lesion in the centre of the image and various caliber blood vessels are visible randomly arranged throughout it.



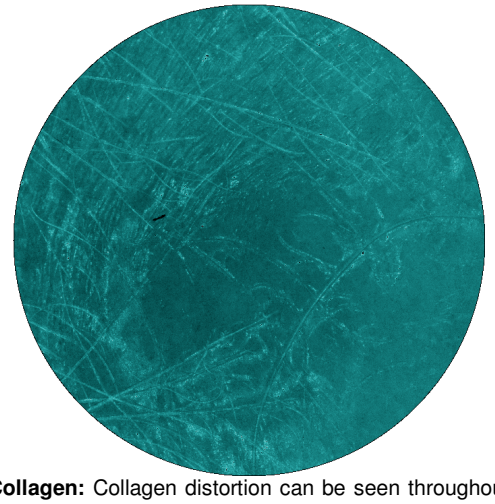
**Pigment:** There is little to see here other than some mild pigment distortion throughout the lesion.



**Dermal Pigment:** Dermal pigment is only present as an artifact from the hair.



**Blood:** A fine blush is seen throughout the lesion and its various calibre telangectasia can be seen randomly throughout the lesion, generally perpendicular to the margins of it. Normal skin vascularity can be seen at the upper and right areas of the image and help to distinguish the normal from abnormal margins.



**Collagen:** Collagen distortion can be seen throughout this lesion.

# 6 Conclusion

Diseases of the skin are extremely common and represent a huge number of different conditions. Not surprisingly therefore, pigmented skin lesions take up a large amount of clinician's time and resources. It is logical to assume that improving the accuracy and time taken for diagnosis can have a significant impact on efficiency in the clinical setting, not only in terms of patient throughput, but also in terms of making more effective treatment choices. Rapid and accurate diagnosis can also be critical In the case of malignant melanoma, where early diagnosis is frequently life-saving, as well as reducing the number of unnecessary biopsies carried out where the eventual diagnosis is negative.

Traditional methods of diagnosing skin lesions have relied on experience and comparisons against previous examples, making them subjective and allowing for a large likelihood of false positives. A new method, using SIAscopy, is objective, quick and easy to use. It provides independent views, SIAscans, of haemoglobin, pigment, dermal pigment and collagen to a depth of 2mm, and allows the practitioner to study these separately and in combination. The distributions of these four skin components show characteristic pathological changes indicative of particular skin diseases. SIAscopy has enormous potential as an accurate and cost-effective diagnostic tool for any medical practitioner who treats patients with pigmented skin lesions.

**References**

Hunter, J., Savin, J., and Dahl, M. 2002. *Clinical Dermatology*. Third edition, Blackwell Science Ltd, Oxford, UK.

Marks, R. 2003. *Roxburgh's Common Skin Diseases.* 17th edition. Arnold, London.