The role of DICOM in

Digital imaging in dermatology

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Overview

- Drivers for skin imaging
- Modalities skin imaging
  - Digital photography
  - Dermoscopy
  - Total body photography
  - Reflectance confocal microscopy
  - Optical coherence tomography

Digital imaging in dermatology

"Imaging is increasingly being used in dermatology for documentation, diagnosis and management of cutaneous disease."

Digital imaging in dermatology

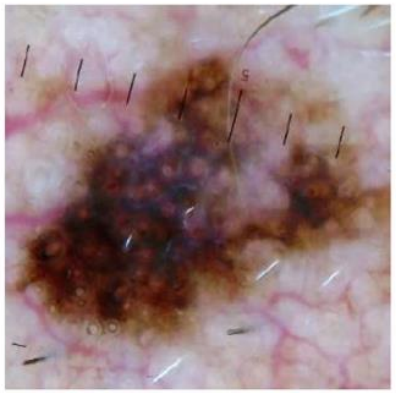
- Ubiquity of digital cameras, mobile devices and EMR
- Diagnostic imaging
  - Sequential examination for changes in mole (size, shape, colour) marker for melanoma
  - Teledermatology
  - Advance modalities e.g. dermoscopy, TBP, RCM
- Diagnostic aids
  - Consensus diagnosis
  - Technology assisted full skin examination
  - Artificial intelligence

Melanoma

- The accuracy of the clinical diagnosis of cutaneous melanoma with the unaided eye is only about 60% (Kittler et al. 2002)
  - One of every three melanomas an error in clinical diagnosis was made

Superficial spreading melanoma

Nodular melanoma



Lentigo maligna melanoma

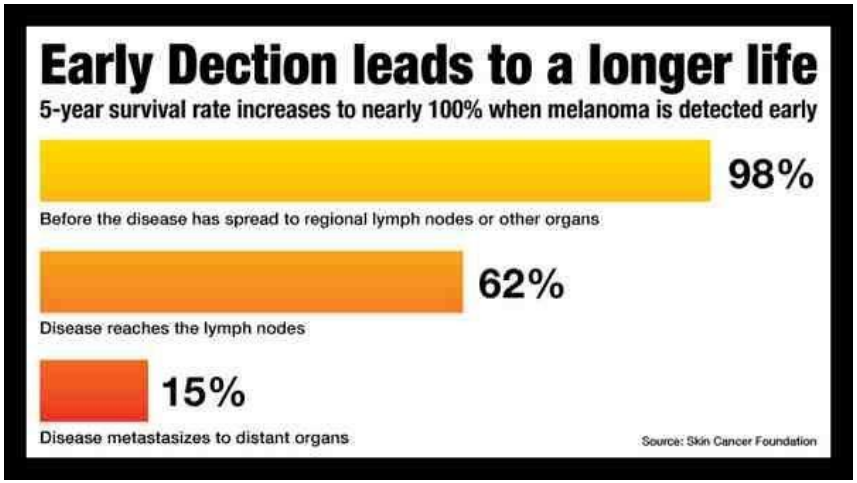
Melanoma

- Currently, 28.4 moles are biopsied or excised for every melanoma detected [1]
- In Australia, reducing unnecessary biopsy or excision can potentially save $70 million in direct health system costs [2]

1. Argenziano G, Albertini G, Castagnetti F, De Pace B, Di Lernia V, Longo C, Pellacani G, Piana S, Ricci C, Zalaudek I.Early diagnosis of melanoma: what is the impact of dermoscopy? Dermatol Ther. 2012 Sep-Oct;25(5):403-9. doi: 10.1111/j.1529-8019.2012.01482.x.
2. Elliott, T.M., Whiteman, D.C., Olsen, C.M. et al. Estimated Healthcare Costs of Melanoma in Australia Over 3 Years Post-DiagnosisAppl Health Econ Health Policy (2017) 15: 805. https://doi.org/10.1007/s40258-017-0341-y

Melanoma

- Earlier detection
  - 98% curative rate at 5 years for early melanoma
  - estimated average annual cost for an early stage versus late stage melanoma is $AUD1,681 versus $AUD115,109



Dermatologist-level classification of skin cancer with deep neural networks

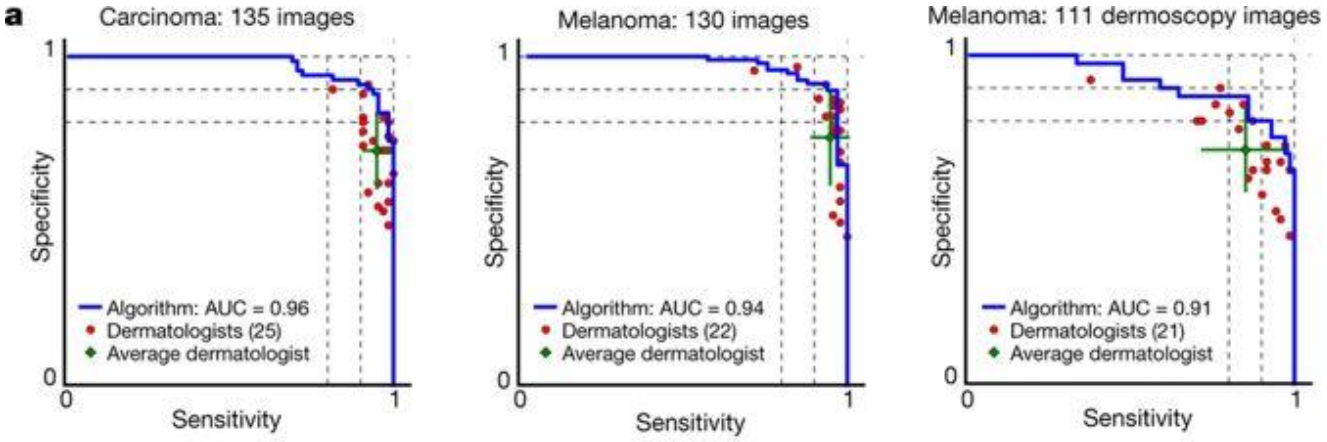
Andre Esteva[1]*, Brett Kuprel[1]*, Roberto A. Novoa[2,3], Justin Ko[2], Susan M. Swetter[2,4], Helen M. Blau[5] & Sebastian Thrun[6]

Skin cancer, the most common human malignancy[1–3], is primarily diagnosed visually, beginning with an initial clinical screening and followed potentially by dermoscopic analysis, a biopsy and histopathological examination. Automated classification of skin lesions using images is a challenging task owing to the fine-grained variability in the appearance of skin lesions. Deep convolutional neural networks (CNNs)[4,5] show potential for general and highly variable tasks across many fine-grained object categories[6–11]. Here we demonstrate classification of skin lesions using a single CNN, trained end-to-end from images directly, using only pixels and disease labels as inputs. We train a CNN using a dataset of

images (for example, smartphone images) exhibit variability in factors such as zoom, angle and lighting, making classification substantially more challenging[23,24]. We overcome this challenge by using a data-driven approach—1.41 million pre-training and training images make classification robust to photographic variability. Many previous techniques require extensive preprocessing, lesion segmentation and extraction of domain-specific visual features before classification. By contrast, our system requires no hand-crafted features; it is trained end-to-end directly from image labels and raw pixels, with a single network for both photographic and dermoscopic images. The existing body of work uses small datasets of typically less than a thousand

Summary

- Dataset of 129,450 clinical images
- Malignant melanoma *versus* benign nevi with an accuracy equivalent to 21 board-certified dermatologist



Man against machine: diagnostic performance of a deep learning convolutional neural network for dermoscopic melanoma recognition in comparison to 58 dermatologists

H. A. Haenssle[1*,†], C. Fink[1†], R. Schneiderbauer[1], F. Toberer[1], T. Buhl[2], A. Blum[3], A. Kalloo[4], A. Ben Hadj Hassen[5], L. Thomas[6], A. Enk[1] & L. Uhlmann[7]

Summary

- Dataset 100 images
- 58 dermatologists
- Algorithm outperformed most dermatologists irrespective of experience

Digital photography

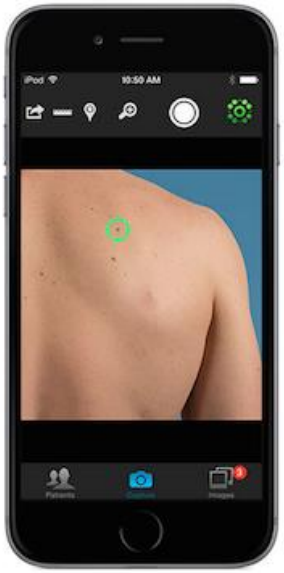
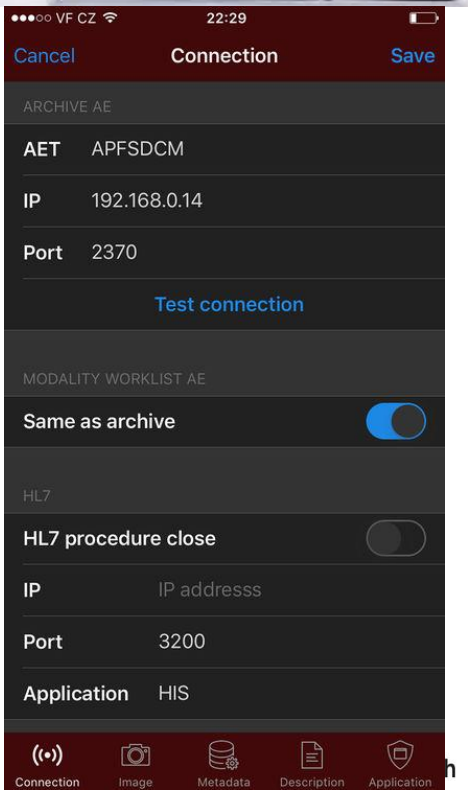


Image source
https://www.dermnetnz.org/cme/dermatoscopy-photography/dermatoscopes-and-cameras/
https://vector.childrenshospital.org/2012/10/rash-conclusions-teledermatology-as-a-shared-care-model/

Image source
https://www.meso.biz/products/dicom-camera/
http://www.dicompass.cz/dicom-camera/

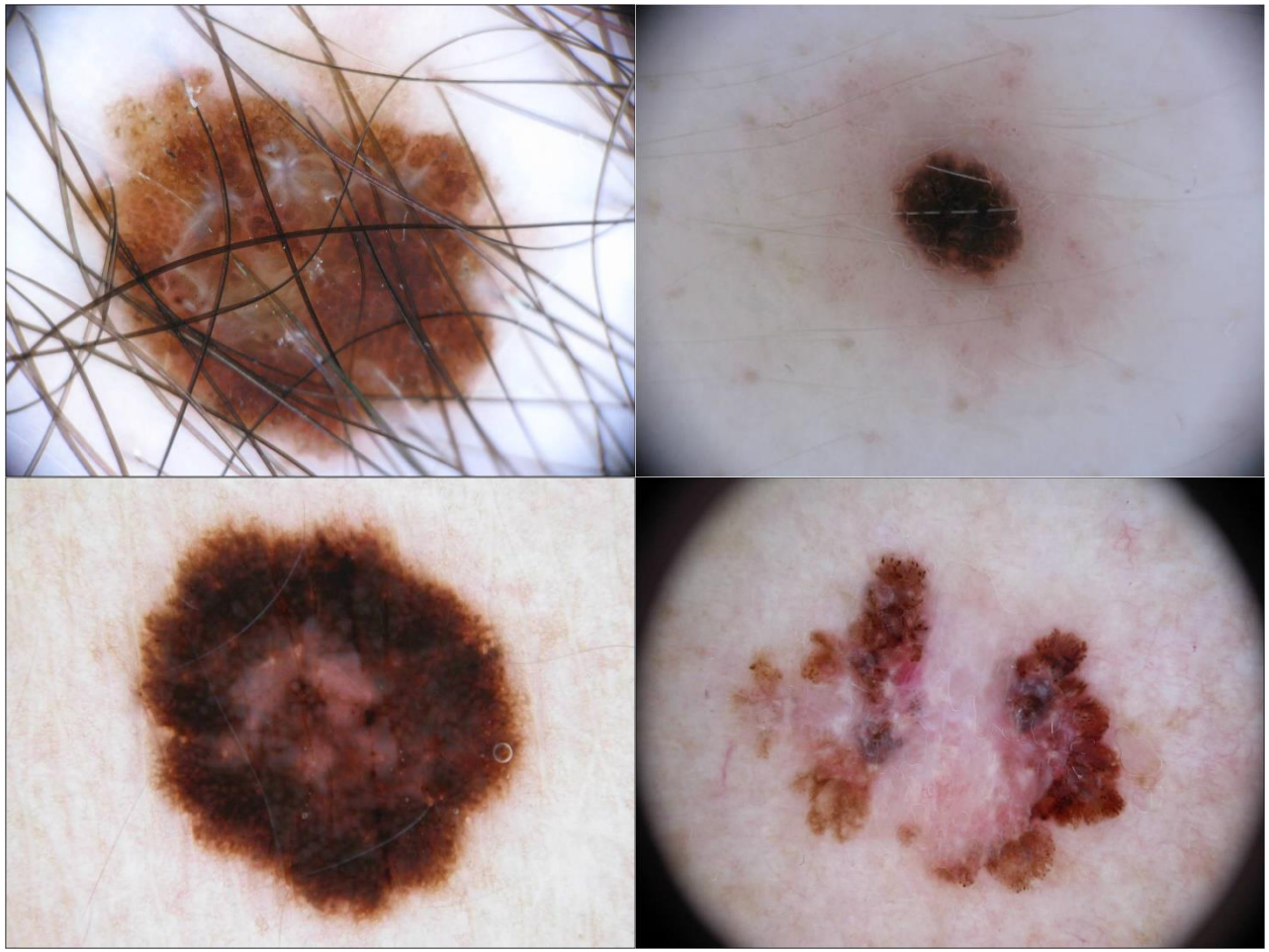
DICOM cameras



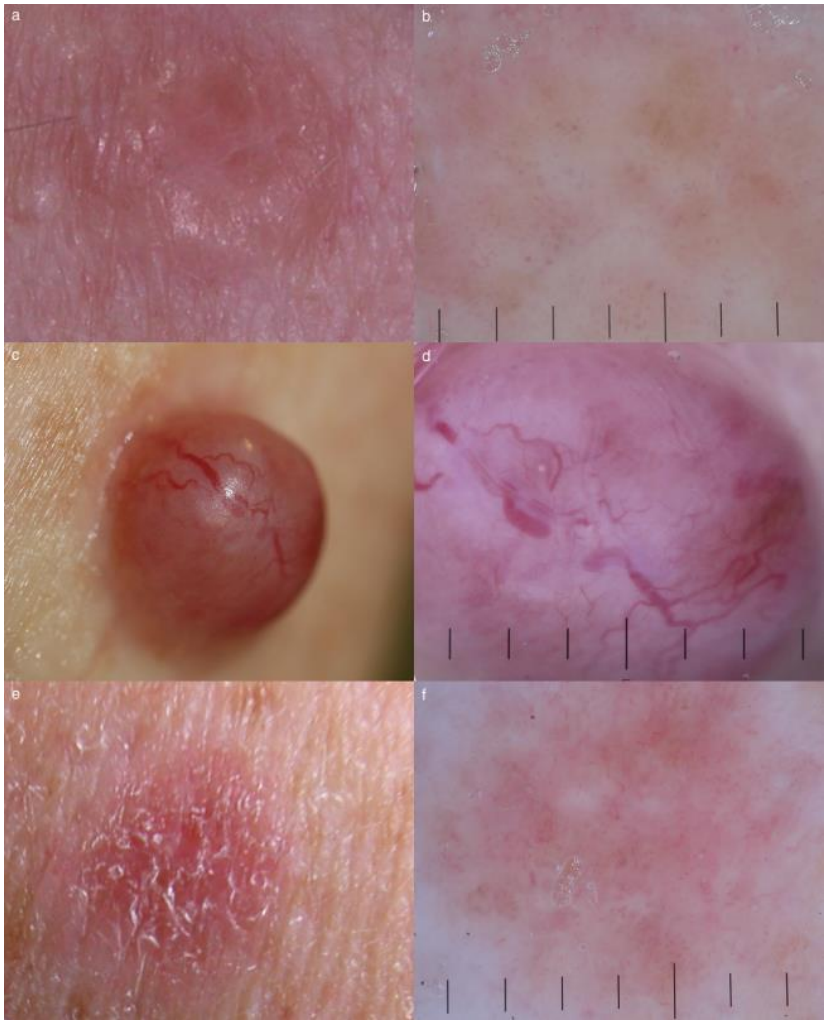
Dermoscopy

- Dermoscopy is a non-invasive diagnostic technique that enable the visualisation of sub-surface morphological (structural) features not seen by the naked eye.

Argenziano G1, Soyer HP.Dermoscopy of pigmented skin lesions--a valuable tool for early diagnosis of melanoma.Lancet Oncol. 2001 Jul;2(7):443-9.



International Skin Imaging Collaborative Archive https://www.isic-archive.com/



https://onlinelibrary.wiley.com/doi/abs/10.1111/ajd.12121

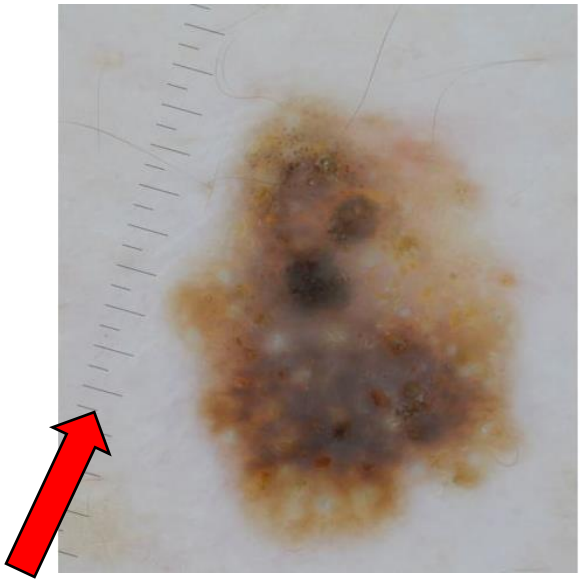
Dermoscopy – diagnostic accuracy

- Improve diagnostic accuracy for melanoma in comparison with inspection by the unaided eye
- Dermoscopy by untrained or less experienced examiners was no better than clinical inspection without dermoscopy.
- A consensus diagnosis involving two or more experts is recommended to yield the highest possible diagnostic accuracy.

Kittler, H Pehamberger, K Wolff, M Binder, Diagnostic accuracy of dermoscopy, In The Lancet Oncology, Volume 3, Issue 3, 2002, Pages 159-165

Dermoscope - equipment

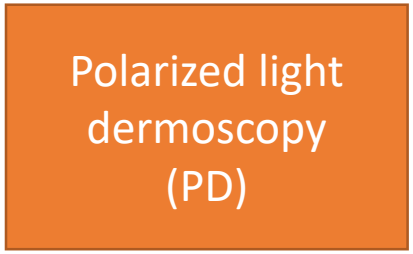
- Magnifying lens
- Light source (LED +/- polarized filters)
- Can switch between non-polarized and polarized light source
- Glass plate + scale



International Skin Imaging Collaborative Archive https://www.isic-archive.com/

Clinical examination

Light: LED + polarized filters to achieve **cross-polarization**



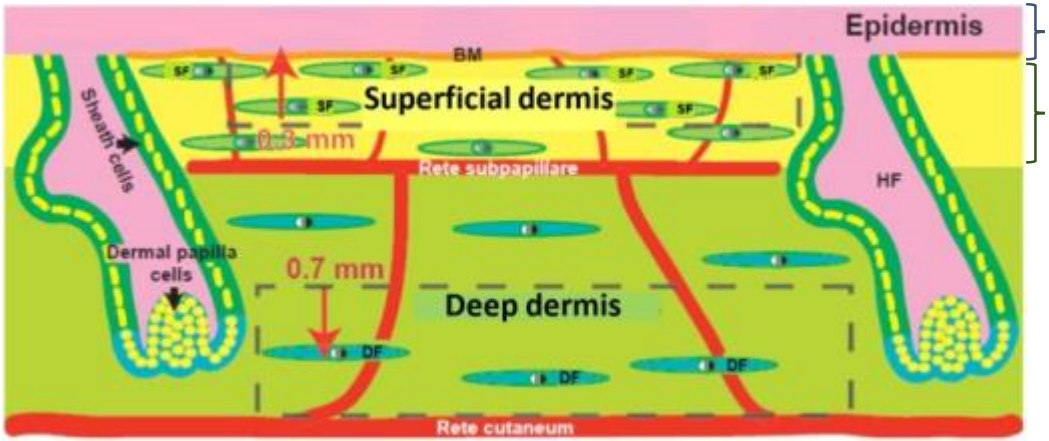
Light: LED

Technique

Non-contact does not require direct contact with the skin

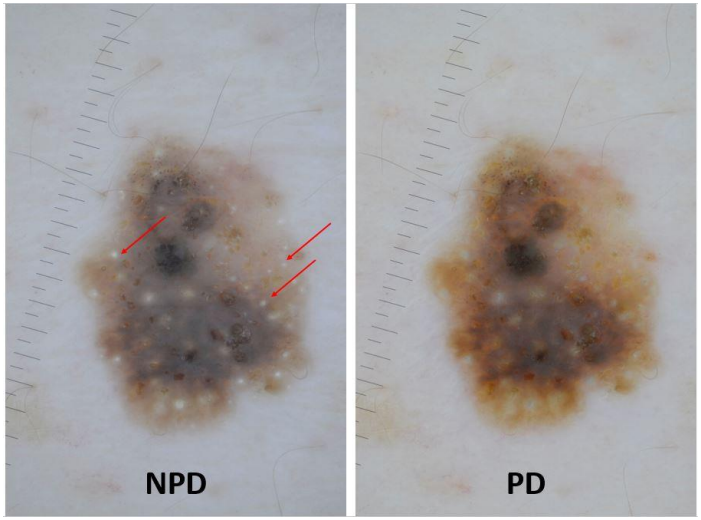
Direct contact of the glass plate with the skin surface
+ **liquid interface**

Difference PD and NPD



NPD – superficial epidermis to dermo-epidermal junction

PD – dermo-epidermal junction to superficial dermis



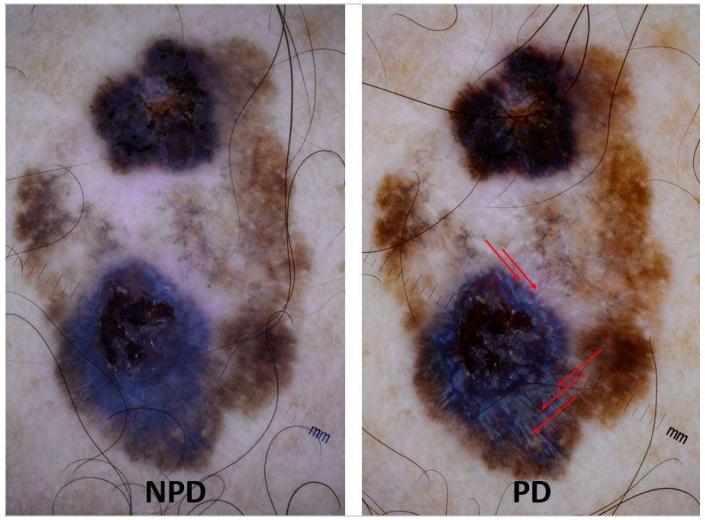


Image source Dermoscopedia https://dermoscopedia.org/Main_Page

Video dermoscopes

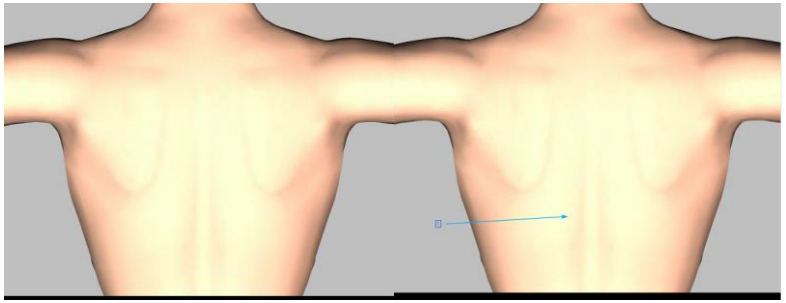
- Camera attached
- Smart-phone attached
- Handheld
- System

DICOM support

Vendor	Type	IOD	Service class
3Gen	CA, SPA	*	*
Canfield / Visiomed	CA,SPA,S	US, SC	Storage SCU
Derma	H,S	SC	
Fotofinder	SPA, H, S	Multi-frame True Color SC	
Heine	CA	*	*
Pixience	S	SC	

CA = camera attached; SPA=smart phone attached, H=handheld, S=System

* DICOM support if coupled with a DICOM camera software



Total Body Photography

3D

Canfield Scientific
https://www.canfieldsci.com/imaging-systems/vectra-wb360-imaging-system

2D

Fotofinder
https://www.fotofinder.de/en/

Total body photography?

Advantages

- Unimaged melanoma
- “Ugly duckling”

Disadvantages

- Genital, acral, scalp and body folds
- Maturity
- Cost
- Resolution +/- dermoscopy

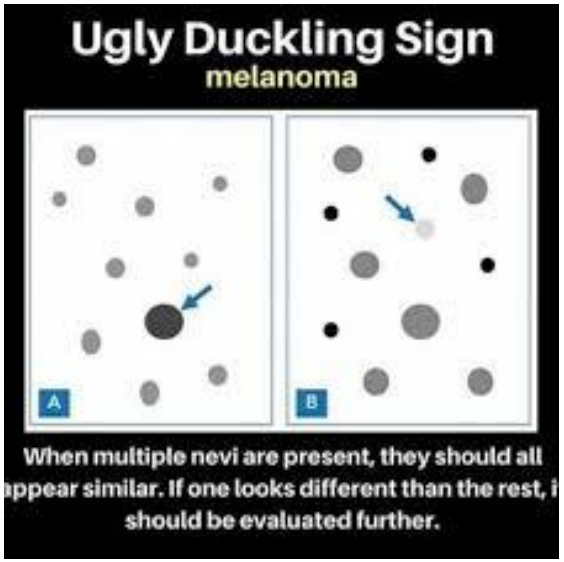


Image source
https://www.skincancer.org/skin-cancer-information/melanoma/melanoma-warning-signs-and-images/the-ugly-duckling-sign

2D versus 3D

- Examination time
  - 25 exposures 2D *versus* 1 (simultaneous) exposure 3D
- Orthogonal imaging
  - Skin lesions on curved surfaces

2D Total Body Photography

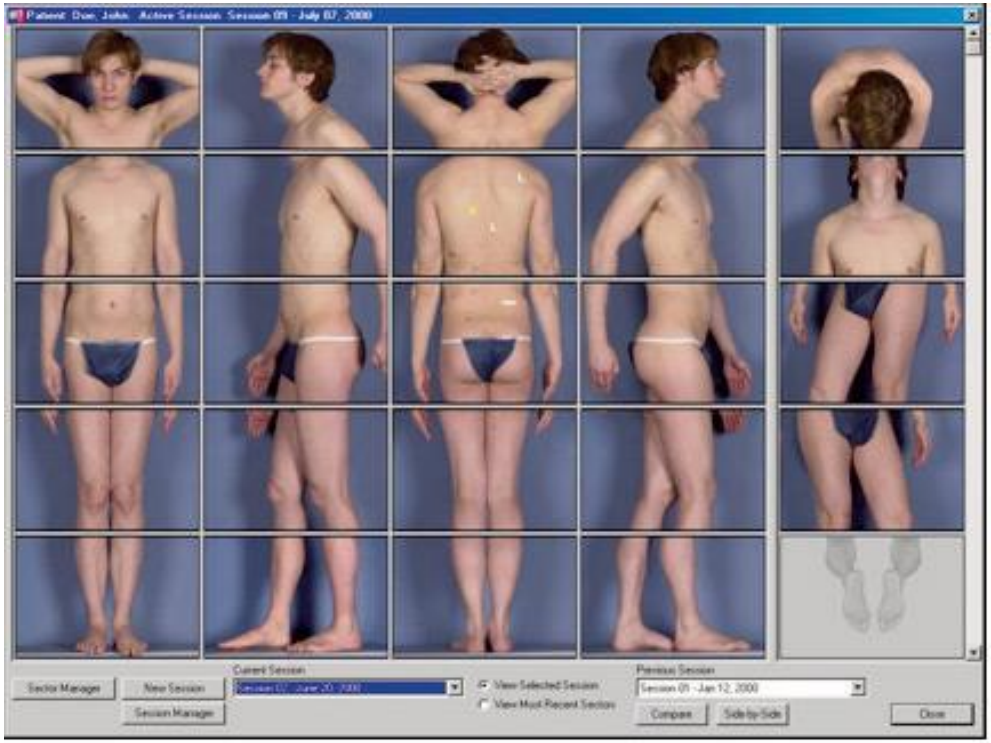
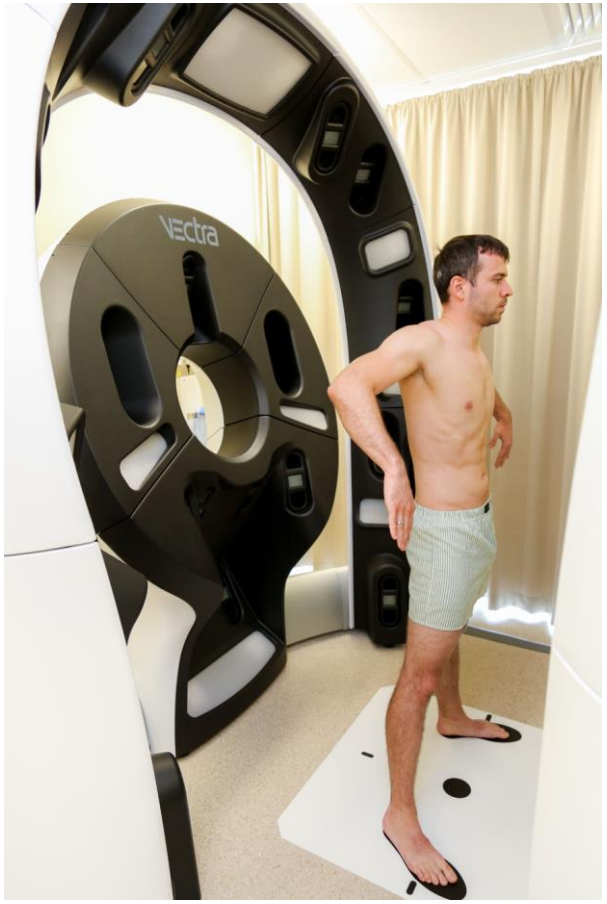
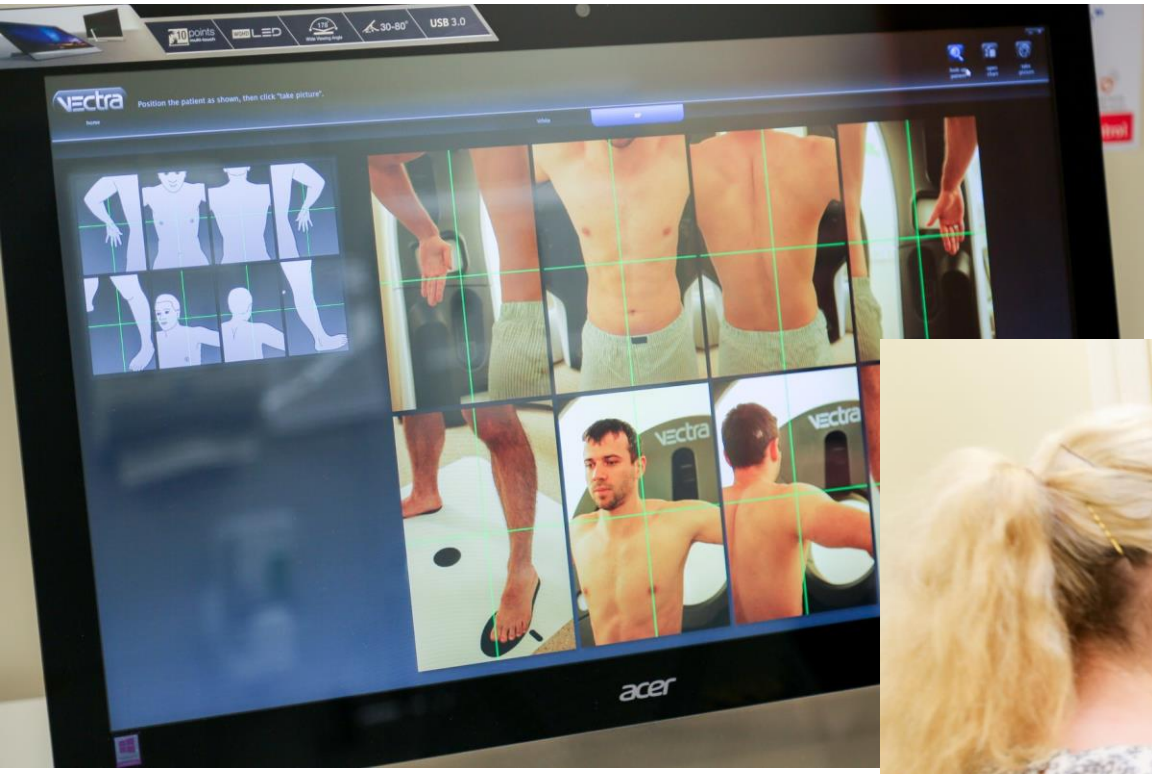


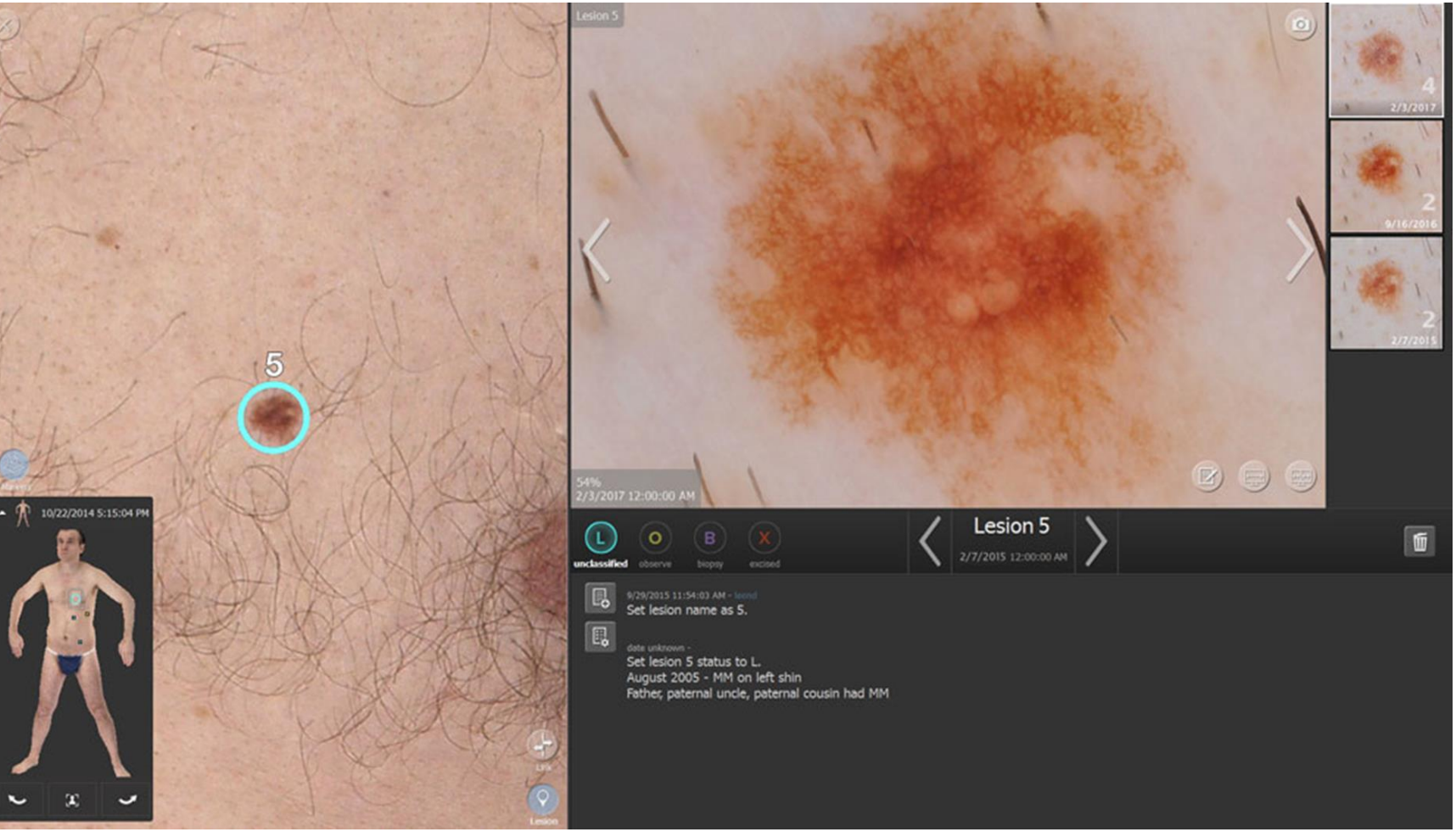
Image source
https://datfl.com/whole-body-photography/


VECTRA

Canfield Scientific
https://www.canfieldsci.com/imaging-systems/vectra-wb360-imaging-system


10 points
LED
30-80°
USB 3.0
VECTRA
Position the patient as shown, then click "take picture".
VECTRA
VECTRA
acer


acer



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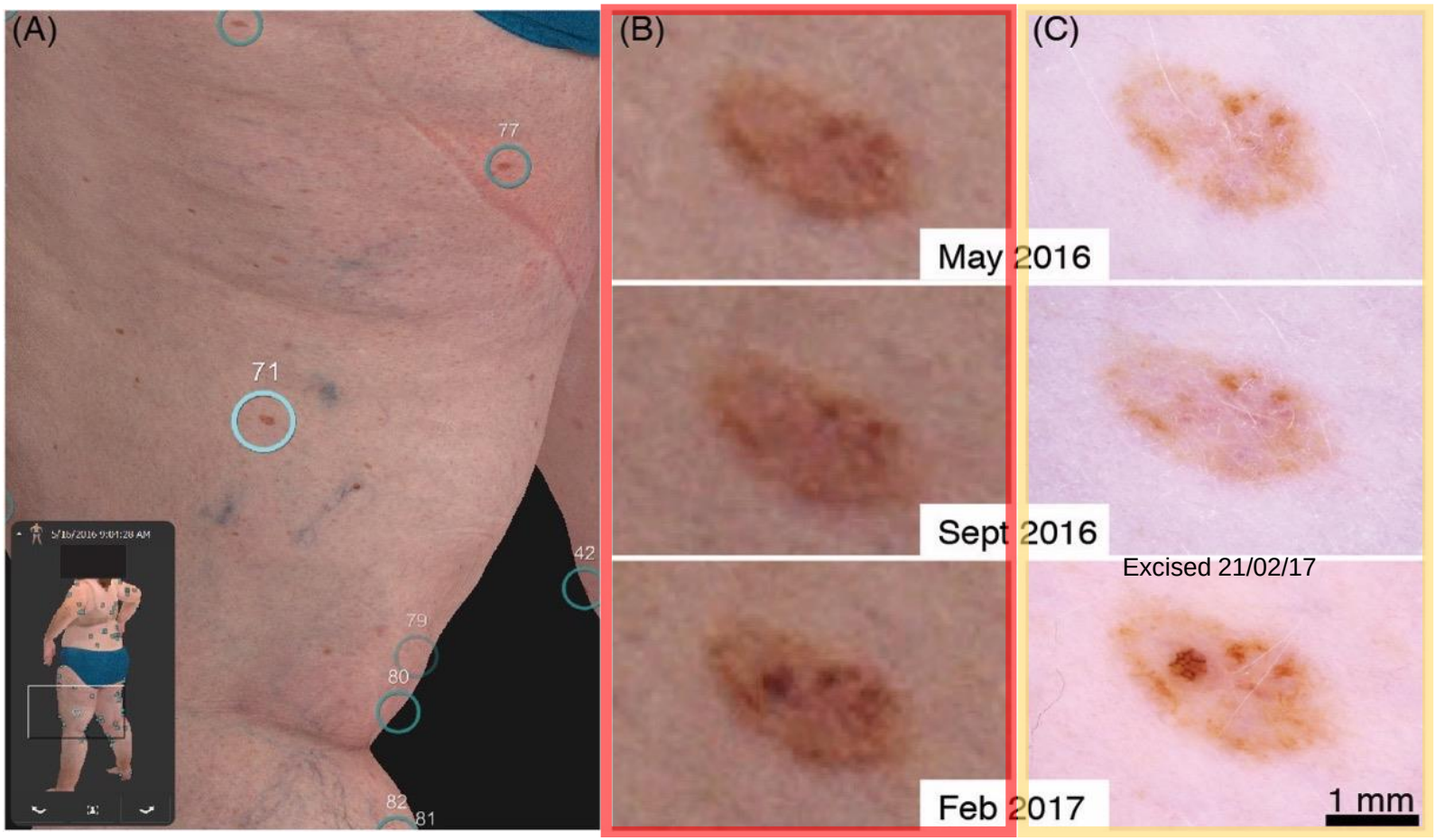


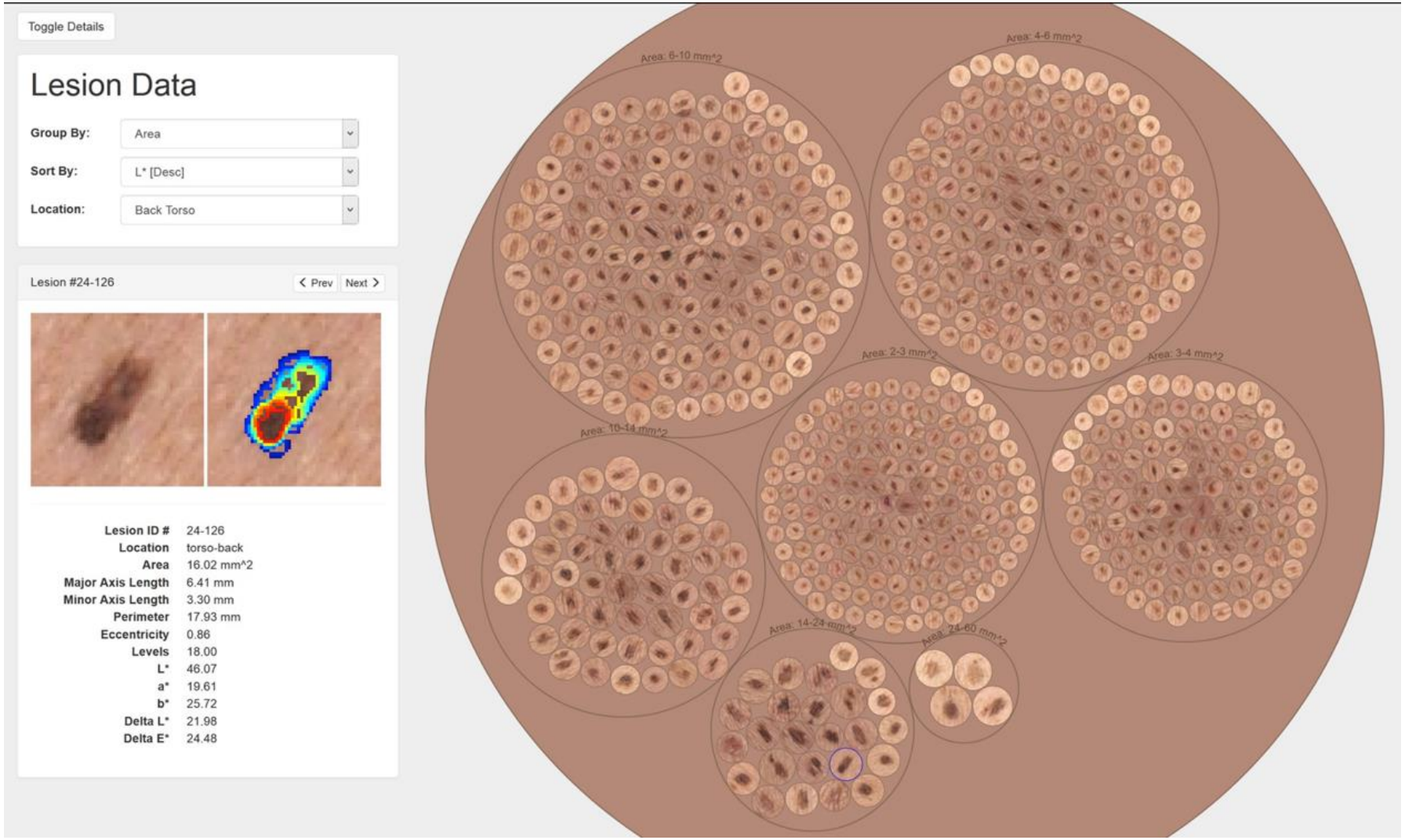
TBP

Dermoscopy

Rayner JE, Laino AM, Nufer KL, Adams L, Raphael AP, Menzies SW, Soyer HP. Clinical Perspective of 3D Total Body Photography for Early Detection and Screening of Melanoma. Front Med (Lausanne). 2018 May 23;5:152. doi: 10.3389/fmed.2018.00152. eCollection 2018.

	Benign		Malignant	
Symmetrical		A **Asymmetry**		Assymetrical (the two sides do no match)
Borders are even		B **Border**		Borders are uneven
One color		C **Color**		Two or more colors
Smaller than 6 mm (1/4 inch)		D **Diameter**		Larger than 6 mm (1/4 inch)
Ordinary mole		E **Evolution**		Changing in size, shape, color, or another trait

Image source
http://www.clovisdermatology.com/melanoma



Canfield Scientific
https://www.canfieldsci.com/imaging-systems/vectra-wb360-imaging-system

Reflectance Confocal Microscopy

- Non-invasive, in vivo imaging of the cellular and tissue architecture (resolution equivalent to histology)
- Images up to 200 µm (papillary dermis)

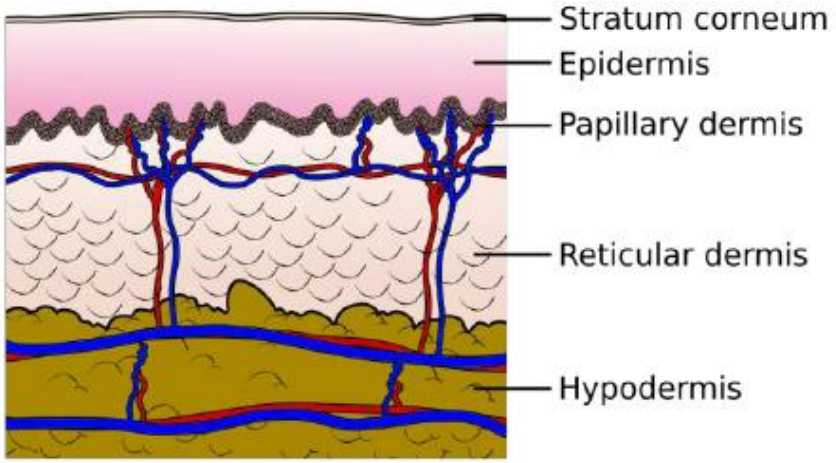
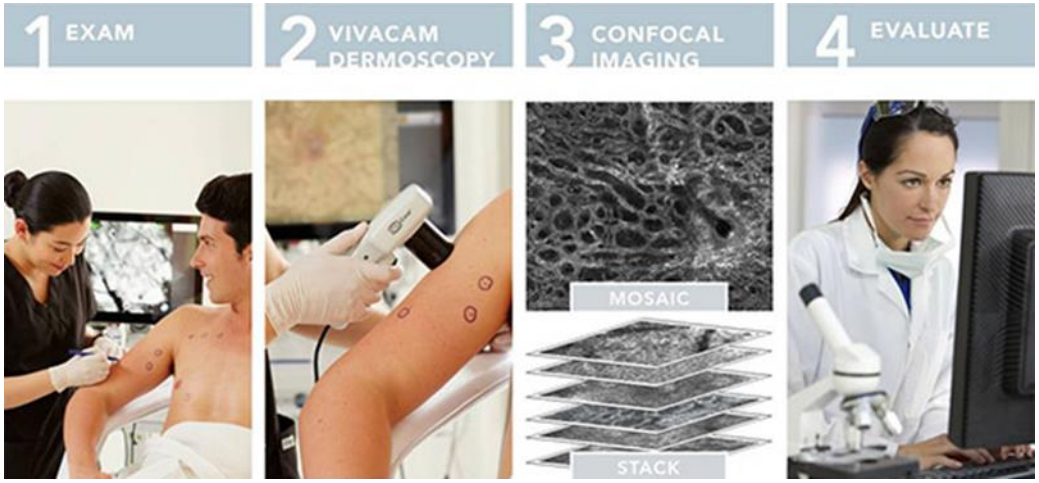
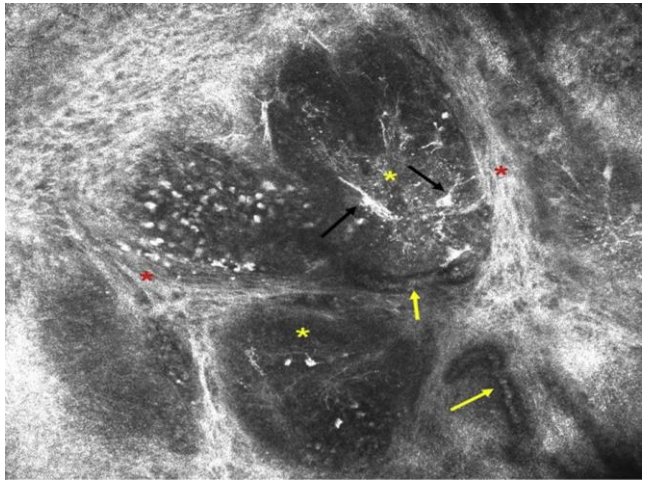


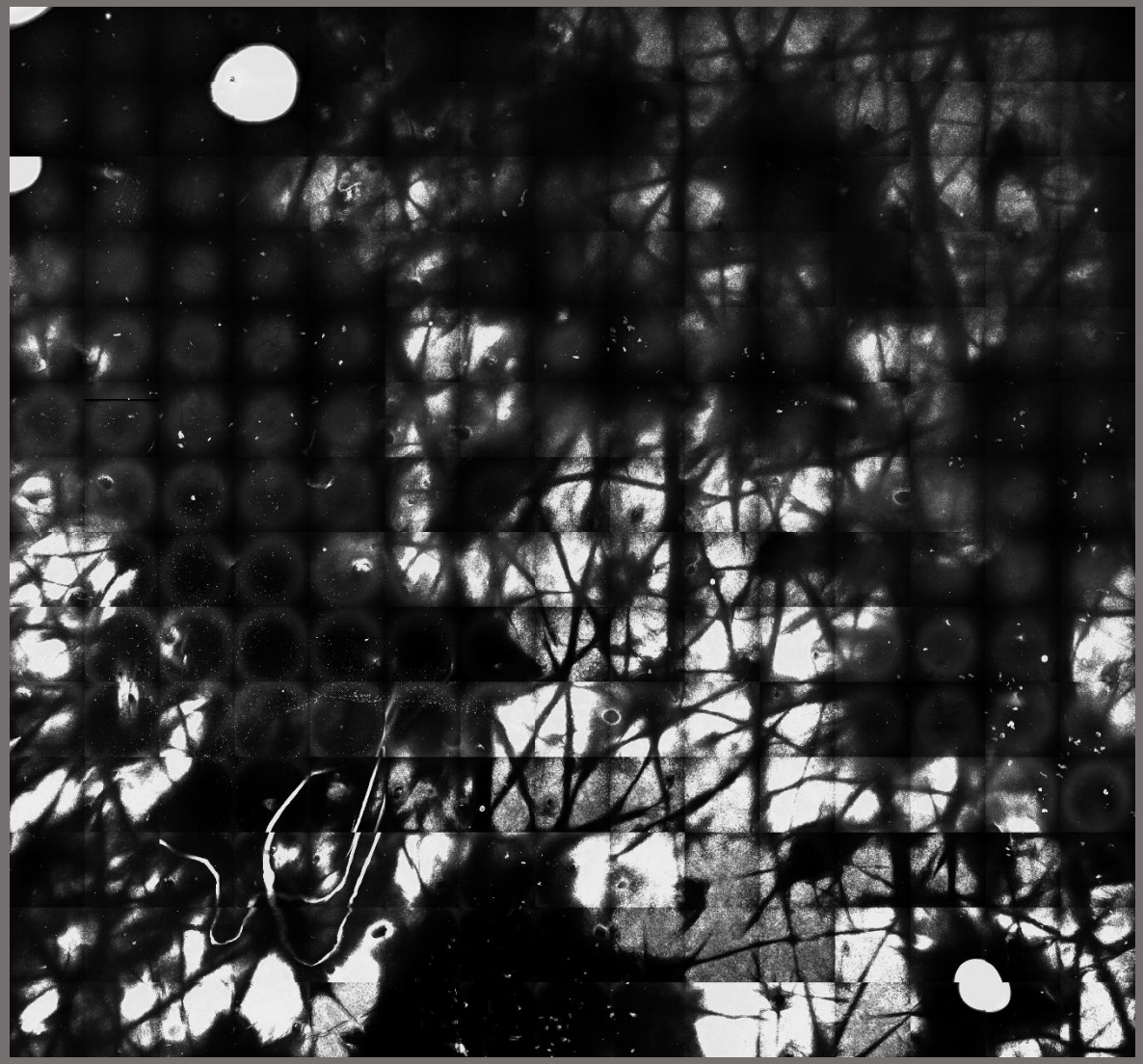
Image source http://www.caliberid.com/

Reflectance Confocal Microscopy





http://www.caliberid.com/vivascope1500-Overview.html



Reflectance Confocal Microscopy

- Dramatically increase the accuracy of skin cancer diagnosis [9]
- “Virtual biopsy”
  - Reduce the number of biopsy
- Delineation of surgical margins

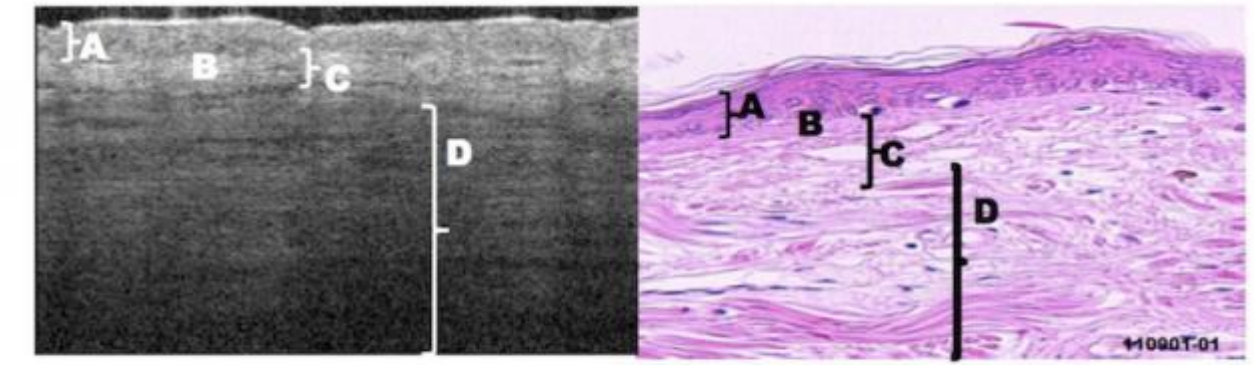
Vivanet ™ and Vivastore ™

- DICOM cloud storage + scheduling system
- Facilitates teledermatology
  - Imaging expertise
  - Second opinion
- Facilitates international community of practice

Optical Coherence Tomography

- Mainly used in ophthalmology
- Non-invasive, in vivo imaging skin architecture
- Depth up 1.5mm
  - Greater depth but lower resolution then RCM
- Inflammatory disease + sometimes skin cancer

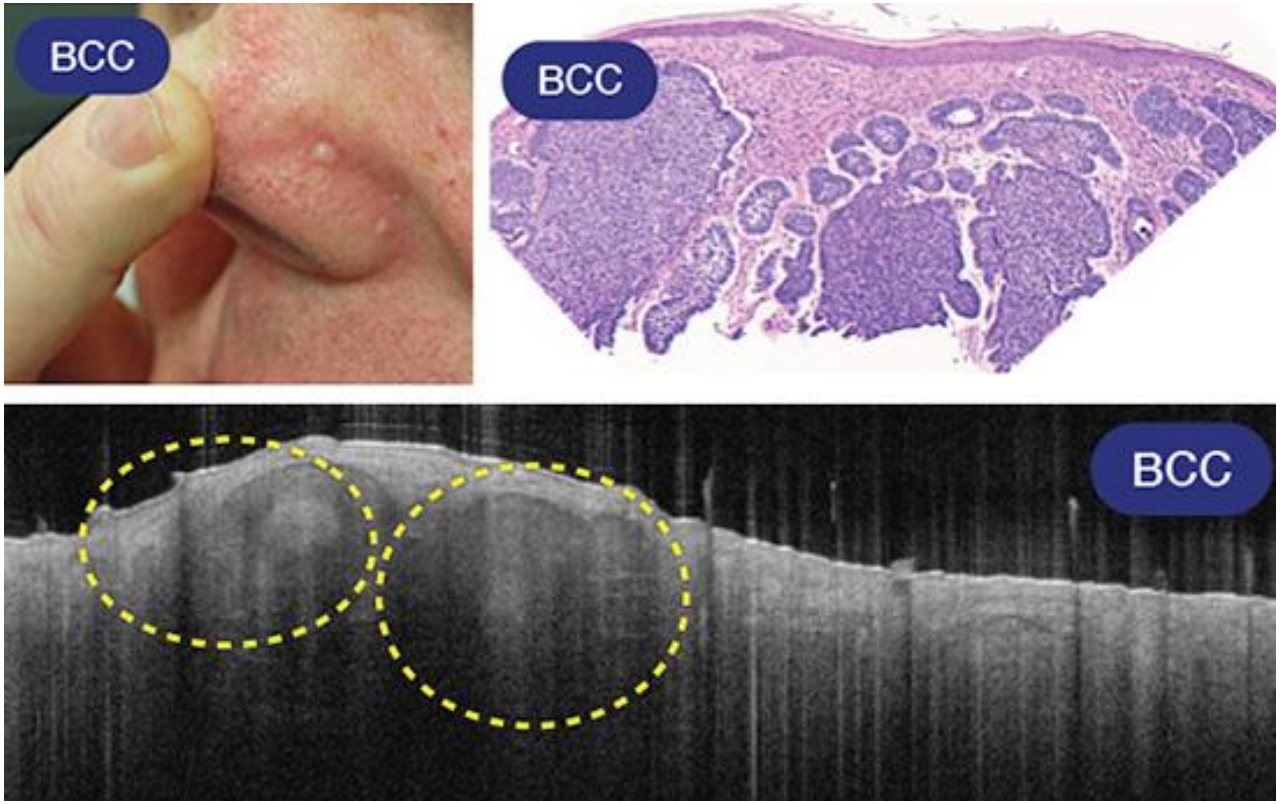
Optical Coherence Tomography



- A: Epidermis
- B: Dermal Epidermal Junction (DEJ)
- C: Papillary Dermis
- D: Reticular Dermis

DermNetNZ.org

Image source
https://www.dermnetnz.org/



The resolution enables the visualization of architectural changes, but not of single cells.

Image source
http://www.downstate.edu/dermatology/research-clinical.html

Summary

- Increasing evidentiary skin imaging
- Increasing diagnostic skin imaging
- DICOM WG 19 dormant
- No dermatology specific DICOM IODs
  - Visible Light, Ultrasound, OCT
- Many vendors have some level of DICOM (inconsistent)
- Majority of dermatologists do not use DICOM

Thank you

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