The Clinical Application of Spectrophotometric Intracutaneous Analysis for the Diagnosis of Cutaneous Malignant Melanoma

by

Marc Dominic Spence Moncrieff

A thesis submitted to the Faculty of Science
of the University of East Anglia
for the degree of
Doctor of Medicine

School of Medicine, Health Policy & Practice
Faculty of Science
The University of East Anglia

September 2001

Abstract

Spectrophotometric Intracutaneous Analysis (SIA) is a is a rapid, dermal scanning technique that uses remitted light in the visible and infrared spectra to derive information regarding the skin. The clinician is presented with SIAgraphs that are high-resolution images of the collagen and haemoglobin content of the papillary dermis and the melanin content of the epidermis and papillary dermis.

This clinical study was the first to use SIA in the diagnosis of cutaneous malignant melanoma. Patterns within the SIAgraphs were identified that were indicative of histopathology and pathophysiology consistent with melanoma. These included the presence of dermal melanin, blood displacement with erythematous blush, asymmetry of melanin and collagen holes. These simple features were reproducible and reliable to identify. Predictive models were generated with logistic regression using these features and the addition of clinical information enhanced the diagnostic accuracy of the model with a sensitivity of 90.38% and a specificity of 73.99%. Classification trees were produced using CART and QUEST algorithms that employed the same predictors with a sensitivity of 92.3% and a specificity of 77.7%. Simple scoring systems were derived that allow the clinician to make a rapid appraisal of a pigmented skin lesion. These results were validated using a test dataset.

When comparing receiver operating characteristic (ROC) curves, the SIAscopy-derived models were superior in predicting melanoma than clinical symptoms and signs alone. When comparing these models to dermatoscopy, the current clinical standard, the ROC curves indicated that SIAscopy is a powerful technique for diagnosing melanoma. Whereas dermatoscopy requires prolonged formal training and apprenticeship to attain proficiency and is hampered by problems of subjectivity in identification and interpretation of the visual cues, the SIAscopy features are very simple to learn and identify.

This thesis demonstrates that SIAscopy is a simple, powerful and useful tool in the diagnosis of cutaneous malignant melanoma.

Acknowledgements

During this research I have been extremely lucky to receive help and support from many people and I would like to acknowledge them here.

First and foremost I would like to thank all the patients that took part in the study. I would also like to thank my colleagues who allowed me to recruit their patients at Addenbrooke's and at the West Norwich Hospital. In particular, the Dermatologists at Addenbrooke's were extremely welcoming and provided me with operating time in the department in order to complete this study. The staff in Clinic 7 at Addenbrooke's Hospital, both nursing and clerical, were extremely supportive and went to great efforts to accommodate me and the extra operating lists. I am indebted to them. I am similarly indebted to the staff at the West Norwich Hospital. I would like to acknowledge the support from the Histopathologists – Drs Grant & Rytina at Addenbrooke's and Dr McCann at the Norfolk & Norwich Hospital who also kindly gave me tutorials in his own time.

I was lucky to be involved with the SIAscope from its early beginnings at Astron Clinica in Cambridge. Being involved in the design and establishment of a medical device is actually quite a lot of fun and I am grateful to Astron Clinica for allowing me to be a part of that. The SIAscope is a highly technical piece of equipment, and it's to Astron Clinica's credit that it was only very occasionally that there were any problems. I am extremely grateful to everyone at Astron Clinica who helped me out when I needed them, often at very short notice and always with good humour.

I cannot complain that I didn't get to see my supervisor – I have had five of them! In Norwich, Professor Scott gave me good advice and guidance and Mr O'Neill has always been extremely supportive to me. At the University of Birmingham, Dr Ela Claridge has been very encouraging and has also given me excellent advice and tuition. Without her skill and knowledge this research would not have been funded in the first place. At the University of East Anglia, Dr Lee Shepstone has been superb and I am truly indebted to him. He patiently read through all the sections of this thesis, and guided me skilfully through the challenging subject of medical statistics. Finally I am beholden to Per Hall, Consultant Plastic Surgeon at Addenbrooke's Hospital, in innumerable ways. He supported and encouraged me and acted as my advocate many times. Above all, though, I am grateful to him for giving me the chance to undertake this research and trusting me with it.

Three years ago, Dr Symon Cotton published his PhD thesis on Spectrophotometric Intracutaneous Analysis. The SIAscope is derived mainly from his intelligence, perseverance and passion. It has been a privilege to work with him and have him as a friend.

Finally, this research would have been impossible for me to do without the endless support, backing and faith in me from my wife, Julia.

This research was funded by a grant from EPSRC.