# Quantitative ABCD parameters measured by a multispectral digital skin lesion analysis device for evaluation of suspicious pigmented skin lesions strongly correlate with clinical ABCD observations

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## Abstract

Background/Study Aim: A multispectral digital skin lesion analysis (MSDSLA) device has proven to be sensitive and specific for malignant melanoma (MM) detection by dermatologists and may have other useful applications. This study aimed to develop and test objective quantitative Asymmetry, Border irregularity, Color, and Diameter (qABCD) parameters for MSDSLA and correlate them with the presence of clinical ABCD features to aid the decision to biopsy a suspicious pigmented skin lesions (PSLs). Methods: 1632 benign and malignant [175 MM/High Grade Dysplastic Nevi (HGDN)] were evaluated for their qABCD parameters. Quantitative characteristics were correlated with the presence of clinical ABCD features identified by independent dermatologists. Results: qA, qB, qC, and qD had correlations of 78%, 73%, 76%, and 86%, respectively, for non-MM/HGDN lesions. The correlations for qA, qB, qC, and qD for MM/HGDN lesions was 86.3%, 83%, 89%, and 89%, respectively. All repeatability parameters were statistically significant. Conclusions: This study demonstrates qABCD values are repeatable and strongly correlate with the clinical ABCD features. qABCD characteristics provide an additional objective and reliable means of identifying PSLs that need further evaluation to rule out MM and, in combination with the clinical ABCDs, may allow for improved assessment when evaluating the malignant potential of PSLs.

*Keywords: melanoma, ABCD, ABCDE, multispectral digital skin lesion analysis, pigmented skin lesion*

## Introduction

A multispectral digital skin lesion analysis (MSDSLA) device (STRATA Skin Sciences Inc., Horsham PA) [1] has been studied as a diagnostic tool to assist dermatologists evaluating pigmented skin lesions for biopsy. MSDSLA employs near-infrared light (430-950 nm) to image and analyze lesions at and below the skin surface. At a 20-micron resolution (~diameter of 3 melanocytes), the device uses 75 different parameters to analyze a PSL and generate a "classifier score" based on morphological disorganization. Having proven sensitive and specific for malignant melanoma detection, MSDSLA has the potential to have other useful applications [2-4].

Asymmetry (A), border irregularity (B), color variegation (C), and diameter > 6mm (D) are very important characteristics used to help diagnose early melanoma [5]. Interestingly, the 75 unique algorithms used to generate classifier scores by MSDSLA do not measure ABCD clinical features directly. The purpose of this study was to develop and test objective quantitative ABCD (qABCD) parameters for MSDSLA, develop threshold cutoff values, test reliability, and correlate with the presence of clinical ABCD features to aid the decision to biopsy a suspicious pigmented skin lesion.

## Methods

A total of 1632 lesions including 175 malignant melanoma/high grade dysplastic nevi were tested to calculate qABCD values for each pigmented lesion. A lesion was considered to have the characteristic if

the value of the quantitative parameter was equal to or greater than an established threshold. Threshold values for qABCD parameters were determined by minimizing the disagreement between human and MSDSLA assessments and testing the results on an additional set of 608 lesions (76 malignant melanoma/high grade dysplastic nevi). Repeatability of qABCD parameters was measured on a validation set of 124 lesions (25 malignant melanoma/high grade dysplastic nevi) that were imaged at least twice with the same MSDSLA system.

Quantitative asymmetry (qA) was generated by measuring the differences in normalized intensity distributions of two sides for each two principle axes of symmetry on a segmented lesion imaged with blue light (430 nm). Quantitative asymmetry is a measure of asymmetry in geometric shape of the lesion as well as the distribution of superficial melanin. Quantitative border irregularity (qB) is a measure of relative width between the actual border of a segmented lesion and the border of an ellipse approximated to fit the actual border. Color variegation (qC) measures the blotchiness of lesion images obtained with red light (700 nm). Diameter (qD) is the maximum distance between two most distant pixels on the lesion border measured in millimeters. qABCD parameters were then correlated with the presence of clinical ABCD characteristics reported by independent investigators for each pigmented lesion in the database.

Clinical assessment for the presence or absence of characteristics was defined as follows. Asymmetry: when the lesion is bisected, one half is not a mirror image of the other; Border Irregularity: the lesion has an undulating, wavy, or jagged edge as opposed to the regular, smooth line of a circle; Color Variegation: the lesion has more than one color or various shades of more than one color; Diameter > 6mm: the lesion has the diameter greater than that of a standard pencil eraser [5].

## Results

Eligible and evaluable pigmented lesions were all between 2 and 22 mm in diameter. As the ABCD paradigm is designed for the detection of early melanoma, bleeding and ulcerated lesions were excluded. Subungual, mucosal, palmar, plantar, and periorbital lesions were excluded owing to anatomic planar limitations of the device. Of the 1632 lesions, 11 (all benign) had no ABCD characteristics of malignant melanoma as assessed by human observers. Only 5 lesions (all benign) had no qABCD characteristics. Every malignant melanoma/high grade dysplastic nevi lesion had quantitative asymmetry and/or quantitative color variegation characteristics. Four malignant melanoma/high grade dysplastic nevi lesions had only one quantitative characteristic–either quantitative asymmetry or quantitative color variegation. Since all malignant melanoma/high grade dysplastic nevi lesions had at least one qABCD characteristic, the measured sensitivity was 100% (95% lower confidence bound = 98.7% (exact mid-P method)). Since almost all lesions in the original MSDSLA database were biopsied to rule out malignant melanoma, the specificity of qABCD characteristics for the general population of pigmented skin lesions could not be determined.

Clinical ABCD and qABCD concordance results are summarized in **Table 1**. Quantitative asymmetry had a 78% correlation with asymmetry for non-malignant melanoma/high grade dysplastic nevi and 86.3%

**Table 1.** *Correlation of qABCD to presence of ABCD clinical characteristics.*

| | | qA | | qB | | qC | | qD | |
|---|---|---|---|---|---|---|---|---|---|
| | n | Θ (%) | 95% CI | Θ (%) | 95% CI | Θ (%) | 95% CI | Θ (%) | 95% CI |
| Non-MM/HGDN | 1457 | 78 | 76-80 | 73 | 71-75 | 76 | 74-78 | 86 | 84-88 |
| MM/HGDN | 175 | 86 | 81-91 | 83 | 77-89 | 89 | 83-93 | 89 | 84-93 |
| All E&E Lesions | 1632 | 78 | 77-81 | 74 | 72-76 | 78 | 76-80 | 87 | 85-89 |

*Θ= % agreement CI= Confidence Interval MM- Malignant Melanoma HGDN- High Grade Dysplastic Nevi E&E- Eligible and Evaluable*

**Table 2.** *Repeatability of qABCD parameters.*

| | 25 MM/HGDN | | | 99 non MM/HGDN | | |
|---|---|---|---|---|---|---|
| Parameter | Pearson | p-value | ARE (%) | Pearson | p-value | ARE (%) |
| qA | 0.95 | $7 \times 10^{-20}$ | 4 | 0.95 | $<10^{-38}$ | 6 |
| qB | 0.96 | $3 \times 10^{-21}$ | 7 | 0.80 | $1 \times 10^{-27}$ | 10 |
| qC | 0.97 | $4 \times 10^{-26}$ | 2 | 0.93 | $<10^{-38}$ | 3 |
| qD | 0.99 | $3 \times 10^{-38}$ | 3 | 0.98 | $<10^{-38}$ | 3 |

*ARE- Average Relative Error*

for malignant melanoma/high grade dysplastic nevi lesions (95% CI: 81-91%). There was a 73% correlation of quantitative border irregularity to border irregularity for non-malignant melanoma/high grade dysplastic nevi lesions and 83% for malignant melanoma/high grade dysplastic nevi lesions (95% CI: 77-89%). Quantitative color variegation correlated to clinical color variegation 76% for non-malignant melanoma/high grade dysplastic nevi lesions and 89% for malignant melanoma/high grade dysplastic nevi lesions (95% CI: 83-93%). Measurement of quantitative diameter correlated with diameter 86% for non- malignant melanoma/high grade dysplastic nevi lesions and 89% for malignant melanoma/high grade dysplastic nevi lesions (95% CI: 84-93%).

**Table 2** summarizes the repeatability of qABCD parameters. Pearson correlation coefficient between qA measurements was 0.95 for both malignant melanoma/high grade dysplastic nevi and non-malignant melanoma/high grade dysplastic nevi lesions. Quantitative border irregularity repeatability was 0.96 for malignant melanoma/high grade dysplastic nevi and 0.80 for non-malignant melanoma/high grade dysplastic nevi lesions. Repeatability of quantitative color variegation was 0.97 for malignant melanoma/high grade dysplastic nevi and 0.93 for non-malignant melanoma/high grade dysplastic nevi lesions. Quantitative diameter correlated the most with 0.99 correlation between separate readings for malignant melanoma/high grade dysplastic nevi and 0.98 for non-malignant melanoma/high grade dysplastic nevi lesions. qABCD parameters were found to be highly repeatable, with average errors ranging from 2% for quantitative color variegation to 10% for quantitative border irregularity. All repeatability parameter correlation coefficients were statistically significant (p=7x10-20).

## Discussion

This study demonstrated qABCD values at a calculated threshold are repeatable and correlate well with the presence of clinical ABCD features. Results suggest MSDSLA can be used reliably to assess lesions for the presence or absence of clinical ABCD characteristics. The highest level of agreement (89%, 95% CI: 84-93%) was found between quantitative diameter and diameter. Interestingly, the threshold calculated for quantitative diameter in malignant melanoma/high grade dysplastic nevi lesions was 6.3 mm, extremely close to the 6 mm nominal threshold used by clinicians. The excellent repeatability of MSDSLA supports findings of an earlier study in a smaller number of patients [1].

## Conclusion

qABCD characteristics provide an objective and reliable means of identifying pigmented skin lesions that may need further evaluation to rule out malignant melanoma. In addition to aiding pigmented lesion evaluation by dermatologists, use of qABCD data could be used for dermatology resident, family physician, physician assistant, and nurse practitioner training. Non-dermatologist practitioners could also use qABCD threshold values to learn at what point ABCD characteristics are observed clinically by dermatologists. In combination with the clinical ABCDs, the qABCDs may allow for improved assessment when evaluating the malignant potential of pigmented skin lesions [6].

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