

RESEARCH LETTER

Utilizing Data from Electrical Impedance Spectroscopy Significantly Improves the Decision to Biopsy Pigmented Skin Lesions Beyond Clinical Evaluation and Dermoscopy

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ABSTRACT

Background: Even the most experienced dermatologists may forego a biopsy on as many as one-third of malignant melanomas (MMs). Electrical impedance spectroscopy (EIS) is a noninvasive technology that send a painless, very low voltage electrical current through a pigmented lesion to determine if it is benign or malignant. This study aimed to determine if EIS data can improve the decision to biopsy a pigmented lesion even beyond dermoscopy.

Methods: A survey with 49 images of MMs, severe dysplastic nevi (SDNs), and benign pigmented skin lesions (PSLs) was shown to dermatologists at a national conference. They were asked if they would biopsy the lesion after first seeing the clinical image, then again after seeing the dermoscopic image, and again after receiving the EIS score.

Results: 151 dermatologists completed the survey. Respondents significantly increased correct biopsy decisions (biopsy MMs and SDNs and forego biopsy of benign PSLs) with the addition of dermoscopy versus clinical image alone for MM (78.5% vs. 56.2%, $p < 0.01$) and SDN (62.7% vs. 43.8%, $p < 0.01$). Participants also demonstrated a statistically significant increase in correct biopsy decisions beyond the dermoscopic evaluation when integrating the EIS score for MM (86.2% vs. 78.9%, $p < 0.01$), SDN (68.1% vs. 62.7%, $p < 0.05$) and benign lesions (58.7% vs. 48.0% vs, $p < 0.01$).

Conclusion: EIS was able to further improve the rate of correct biopsy choice for MMs and SDNs even beyond dermoscopic evaluation. While dermoscopy worsened diagnostic accuracy for benign PSLs, EIS results were able to significantly improve decision making for these lesions as well. This study demonstrates the clinical utility of EIS technology for improving melanoma diagnosis.

INTRODUCTION

Electrical impedance spectroscopy (EIS) is a noninvasive technology that sends a

painless, very low voltage electrical current through tissue to identify the likelihood that it is malignant.¹ Benign and malignant tissue have different electrophysical properties, and EIS can detect how the electrical current's

path is affected by these properties. The EIS device generates a score from 0-10, with 0-3 indicating the lesion is not melanoma (with a 99% negative predictive value) and 4-10 corresponding to increasing positive predictive values for the lesion being a melanoma. In a prospective, multicenter, blinded clinical trial with 1,951 patients EIS was validated for the use of pre-biopsy assessment of high risk pigmented skin lesions (PSLs).² EIS and dermoscopy have been independently shown to increase correct biopsy choice of PSLs.^{3,4,5} Furthermore, a study of dermatologists in the United States (US) found that incorporating EIS data significantly increased the correct decision to biopsy melanomas (MMs), severe dysplastic nevi (SDNs), and benign PSLs beyond the combination of naked eye and dermoscopic evaluation.⁶ The aim of this study was to determine how dermoscopy and EIS impact clinical decisions in a group of German dermatologists.

METHODS

Ethical committee review was performed. 49 images of MMs (n=17), SDNs (n=6), and benign PSLs (n=26) were shown to dermatologists at the DERM[®] conference in Frankenthal, Germany from July 1-3, 2022, and the Fortbildungswoche conference in Germany on July 12-16, 2022. These images had been randomly chosen from a separate study that had final dermatopathology results available.⁴ These images were then shown to the conference dermatologists to evaluate for biopsy. After receiving a review of the technology and its clinical usage, 151 dermatologists completed the survey (73% response rate). Each lesion featured a set of three images consisting of a clinical picture, a dermoscopic image, and the corresponding EIS score. Participants then answered if they would biopsy the lesion after first viewing the

clinical image, then after seeing the dermoscopic image, and again after receiving the EIS score for each lesion. 22,197 biopsy decisions were analyzed using Microsoft Excel and correct biopsy decision rates were compared using the difference of two proportions test.

RESULTS

The results of the study are summarized in **Table 1** and **Figure 1**. Respondents significantly increased correct biopsy decisions (biopsy MMs and SDNs and forego biopsy of benign PSLs) with the addition of dermoscopy versus clinical image alone for MM (78.5% vs. 56.2%, $p < 0.01$) and SDN (62.7% vs. 43.8%, $p < 0.01$). Participants also demonstrated a statistically significant increase in correct biopsy decisions beyond the dermoscopic evaluation when integrating the EIS score for MM (86.2% vs. 78.9%, $p < 0.01$), SDN (68.1% vs. 62.7%, $p < 0.05$) and benign lesions (58.7% vs. 48.0% vs. $p < 0.01$). When evaluating benign lesions only, the addition of dermoscopy versus clinical image alone decreased the rate of correct biopsy choice (48.0% vs 59.7%, $p < 0.01$). However, when EIS data was provided, the correct biopsy rate then significantly increased to 58.7% ($p < 0.01$).

In a subset analysis based on years in practice, dermatologists in practice for less than 5 years, 6-14 years, 15-25 years, and at least 26 years all significantly increased their correct biopsy rate for MM when EIS data was added to the clinical and dermoscopic image. Each of these groups also significantly improved their correct biopsy decisions for benign lesions with the addition of EIS data. For SDNs, each subgroup increased their correct biopsy rate with EIS data ($p = NS$).

Table 1. Percentage of correct biopsy choice with sub-analysis by years in practice (YIP).

Category	Percent Overall N=151	Percent < 5 YIP N=40	Percent 6-14 YIP N=58	Percent 15-25 YIP N=33	Percent 26+ YIP N=20
Melanoma (n=17)					
Clinical Image Correct	56.2%	53.2%	45.7%	67.2%	74.1%
Clinical Image + Dermoscopy Correct Biopsy Choice	78.9%*	74.9%*	79.5%*	80.4%*	82.4%*
Clinical Image + Dermoscopy + EIS Score Correct Biopsy Choice	86.2%*	82.2%*	86.3%*	88.6%*	90.0%*
Severe Dysplastic Nevi (n=6)					
Clinical Image Correct	43.8%	40.4%	33.0%	55.6%	62.5%
Clinical Image + Dermoscopy Correct Biopsy Choice	62.7%*	60.8%*	61.5%*	61.1%	72.5%
Clinical Image + Dermoscopy + EIS Score Correct Biopsy Choice	68.1% ⁺	64.1%	63.5%	73.2% ⁺	80.8%
Benign Melanocytic and Mild-Moderate Dysplastic Nevi (n=26)					
Clinical Image Correct	59.7%	60.0%	70.1%	51.7%	41.7%
Clinical Image + Dermoscopy Correct Biopsy Choice	48.0%*	44.9%*	57.7%*	42.9%*	34.2% ⁺
Clinical Image + Dermoscopy + EIS Score Correct Biopsy Choice	58.7%*	61.6%*	64.5%*	52.6%*	46.0%*

* $p < 0.01$, $+p < 0.05$ (EIS score with dermoscopy and clinical image was compared to dermoscopy with clinical image while dermoscopy with clinical image was compared to clinical image alone for determination of significance)

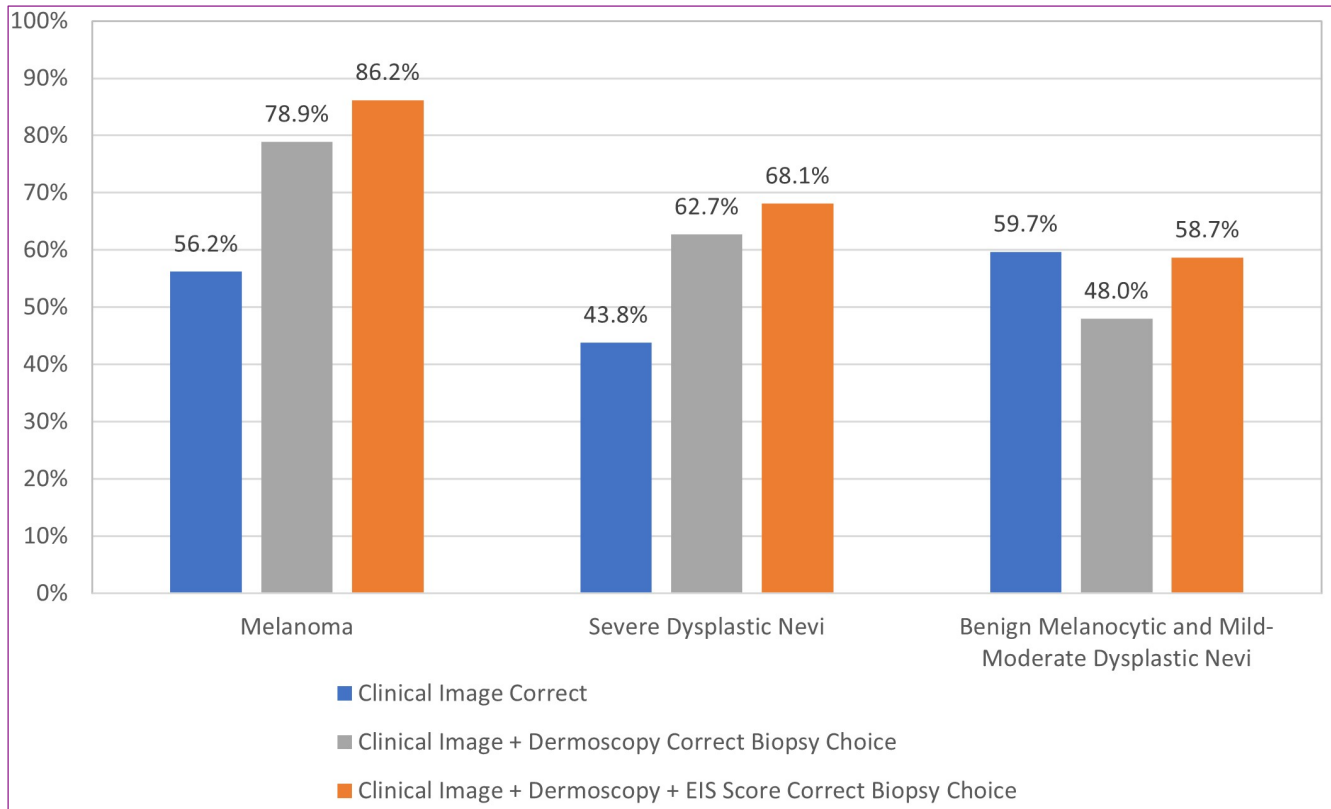


Figure 1. Correct Biopsy Choice.

DISCUSSION

Even dermatologists with experience in managing PSLs may forego a biopsy on as many as one-third of lesions that turn out to be MMs.⁷ Dermoscopy has the potential to mitigate, but not completely overcome, the known limitations of visual assessment alone.⁵ Thus, additional technology that can accurately and noninvasively detect MMs has the potential to significantly improve PSL biopsy decision making.

This study demonstrated that dermoscopy significantly improves the rate of correct biopsy choice for MMs and SDNs beyond naked eye evaluation alone. However, for benign PSLs, dermoscopy actually significantly lowered the rate of correct biopsy choice, underscoring one of its potential limitations. On the other hand, for MMs, SDNs, and benign PSLs, EIS was able to further improve the rate of correct biopsy choice even beyond the dermoscopic evaluation. For MMs, clinicians that have been in practice for at least 26 years performed the best, but they were still able to significantly improve their decision making with EIS results, making the correct decision in over 90% of cases. This improvement shows the value of EIS technology at all levels of practice.

Prior EIS studies have demonstrated that while this technology improves correct biopsy choice, clinicians do not follow the device blindly and still exercise clinical judgment when deciding to perform a biopsy.^{6,7} In this study, the EIS output in the majority of the lesions either supported the biopsy decision after clinical image and dermoscopy evaluation or helped the clinician take a better biopsy decision. However, in 16% of the biopsy decisions, the clinicians chose to ignore the EIS output, supporting the

integration of the EIS data as an adjunct rather than an absolute when making a biopsy decision.

Limitations of this study include inability to evaluate the lesions *in vivo* and the possibility that biopsy decision-making might vary in the clinical setting. Additionally, the small sample size in some of the subset groups might have resulted in a lack of statistical power. However, the results of this study confirm the findings of prior trials that the integration of EIS data into the evaluation of PSLs can significantly enhance the rate of correct biopsy choices beyond both clinical and dermoscopic evaluation alone.

Conflict of Interest Disclosures: DZ, NB, KF and CS have no disclosures. Dr. Rigel is a consultant for SciBase.

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References:

1. Cheng Z, Xiuzhen D, Feng F, Zhenyu J, Canhua X. Breast cancer detection based on multi-frequency EIS measurement. *Annu Int Conf IEEE Eng Med Biol Soc.* 2007;2007:4158-4160.
2. Malvey J, Hauschild A, Curriel-Lewandrowski C, et al. Clinical performance of the Nevisense system in cutaneous melanoma detection: an international, multicentre, prospective and blinded clinical trial on efficacy and safety. *Br J Dermatol.* 2014;171(5):1099-1107.
3. Litchman GH, Marson JW, Svoboda RM, Rigel DS. Integrating Electrical Impedance Spectroscopy into Clinical Decisions for Pigmented Skin Lesions Improves Diagnostic Accuracy: A Multitiered Study. *SKIN.* 2020;4(5):424-430.
4. Svoboda RM, Prado G, Mirsky RS, Rigel DS. Assessment of clinician accuracy for diagnosing melanoma on the basis of electrical impedance

- spectroscopy score plus morphology versus lesion morphology alone. *J Am Acad Dermatol*. 2019;80(1):285-287.
5. van der Rhee JI, Bergman W, Kukutsch NA. The impact of dermoscopy on the management of pigmented lesions in everyday clinical practice of general dermatologists: a prospective study. *Br J Dermatol*. 2010;162(3):563-567.
 6. Zakria D, Brownstone N, Han J, Owji S, Dirr M, Rigel D. Electrical impedance spectroscopy significantly enhances correct biopsy choice for pigmented skin lesions beyond clinical evaluation and dermoscopy [published online ahead of print, 2022 Oct 13]. *Melanoma Res*. 2022;10.1097/CMR.0000000000000859.
 7. Monheit G, Cagnetta AB, Ferris L, et al. The performance of MelaFind: a prospective multicenter study. *Arch Dermatol*. 2011;147(2):188-194.