Increased Uniformity in Diagnostic Accuracy of Pigmented Lesions Using Electrical Impedance Spectroscopy Information

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ABSTRACT

BACKGROUND: Novel non-invasive technologies augment information available to a clinician to enhance diagnosis. Electrical impedance spectroscopy (EIS) is a highly sensitive technology used before biopsy to differentiate equivocal lesions through differences in electrical resistance of benign versus malignant cells. A recent study of an EIS device approved by the United States Food and Drug Administration supported this device's impact on clinical management among dermatology residents. The device provides an EIS score, which increases with greater likelihood of malignancy. **OBJECTIVE:** We investigated whether the addition of an EIS score improved uniformity and diagnostic accuracy of pigmented lesions. **METHODS:** A *post-hoc* analysis of previously collected data from a survey of 164 dermatology residents was performed. Residents were asked to determine whether they would biopsy a lesion based on clinical morphology alone versus clinical morphology with an EIS score. A total of 45 lesions were assessed (including 17 malignant and 28 benign lesions). Subjects were grouped by percent correct pre-EIS score biopsy decisions and divided into quartiles. **RESULTS:** With clinical assessment alone, the mean correct decisions to biopsy was 59.9%. With the addition of EIS score, the mean increased to 71.0%. All quartiles significantly increased their correct biopsy decisions with EIS ($P<0.001$), but the lowest scoring quartiles improved more than the highest scoring quartiles. **CONCLUSIONS:** The data from the EIS device were designed to be integrated into the biopsy decision as an additional piece of information in the diagnostic pathway. The study findings are consistent with this objective. In addition to clinical judgment, the use of the EIS score most increased the lowest-scoring residents, but all were improved after integrating the EIS score. EIS information improved homogeneity of ability and diagnostic accuracy.

KEY WORDS: Electrical impedance spectroscopy; non-invasive technology; melanoma

Melanoma is the skin cancer with the highest mortality rate, and the incidence continues to increase.[1] Early detection is key to improving outcomes and decreasing mortality seeing as treatment of early-stage lesions is mostly curative, while thicker lesions correlate with poor survival.[2] Making a clinical diagnosis of melanoma may be straightforward in lesions with marked asymmetry, varied pigmentation, or a history of change. However, for patients with numerous and possibly atypical nevi, it is difficult to clinically identify the lesion(s) most likely to represent melanoma. This can lead to a significant number of benign lesions being unnecessarily excised or, more gravely, clinically unsuspicious melanomas can be misdiagnosed as benign. In addition, lesions that are histologically equivocal can be challenging to manage. Novel non-invasive technologies can augment information available to a clinician (in addition to visual examination) and enhance an early accurate diagnosis of melanoma.

Electrical impedance spectroscopy (EIS) is a highly sensitive technology used before biopsy to differentiate equivocal lesions. Using a painless, low-voltage electrode directly applied to a suspicious skin lesion, the EIS device detects differences in the electrical resistance of benign and malignant cells.[3,4] First, the normal skin neighboring the suspicious lesion is moistened with saline for 30 seconds. Then, an electrical impedance measurement is taken of this normal skin. After repeating the saline moisturization step with the suspicious lesion, this area is also probed with the electrode.

A device (Nevisense, Scibase, Stockholm, Sweden) approved by the United States Food and Drug Administration that provides an EIS score, which increases with increasing likelihood of malignancy, has previously been shown to improve biopsy efficiency.[5] The EIS device generates a score from 0 to 10. Values from 0 to 3 are deemed to be EIS-negative (negative predictive value, 98%), while values of 4 to 10 are deemed to be EIS-positive (positive predictive value, 9%–64%). A recent study of the EIS device supported its impact on clinical management among dermatology residents, showing both fewer missed melanomas and a net decrease in benign biopsies following incorporation of EIS score versus clinical morphology alone.[6]

METHODS

A *post-hoc* analysis was performed on previously collected data from a survey of 164 dermatology residents who were asked to determine whether biopsy was indicated depending on clinical morphology alone. Dermoscopic evaluation was specifically excluded to better measure the direct effect of EIS on pigmented lesion diagnosis. They were then provided with the lesion's EIS score and asked to make a biopsy recommendation with the additional information. In total, 45 lesions were assessed (including 17 malignant and 28 benign lesions).

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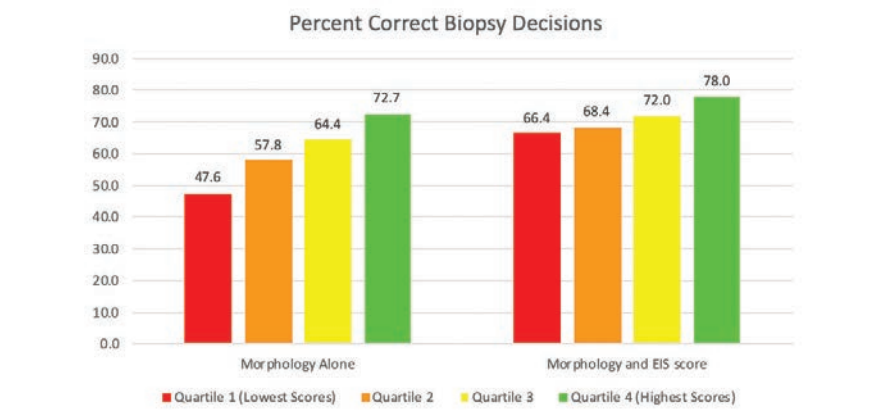

FIGURE 1. Addition of EIS score leads to improvement among all quartiles. The diagnostic accuracy of lower-scoring groups more closely approached that of the higher-scoring groups with the addition of EIS information.

TABLE 1. Percent change in correct biopsy decision with addition of EIS score by quartile

	% CHANGE WITH EIS SCORE
Quartile 1	+39.5%
Quartile 2	+18.3%
Quartile 3	+11.8%
Quartile 4	+7.3%

In order to compare varying levels of diagnostic accuracy, the residents were grouped by percent correct pre-EIS score biopsy decisions. This resulted in four quartiles based on natural breakpoints in the data (with 47, 40, 41, and 37 residents included in each group arranged from the lowest to highest scoring, respectively). This study was deemed exempt from institutional review board (IRB) approval by the Solutions IRB (Little Rock, Arkansas).

RESULTS

The level of training for dermatology residents was distributed as follows: first year, 15%; second year, 44%; third year, 35%; and other, 3%. No significant association was noted between the level of training and the diagnostic quartile (P=0.265). The overall number of correctly biopsied melanoma and benign lesions was previously reported.[6]

Using clinical assessment alone, the mean correct biopsy decisions was 59.9%. When integrating the EIS score information, the mean increased to 71.0% (18.5% improvement). All groups significantly increased their correct biopsy decisions with the addition of EIS score (P<0.001), but the lowest scoring groups demonstrated a greater improvement than groups who had higher a priori correct decisions (Table 1). The lowest scoring quartile improved their accuracy by almost 40%. Even the groups who scored highest at baseline were able to improve their performance by at least 7%. Of note, those who had the lowest accuracy in biopsy decision moved closer to the best diagnosticians when EIS information was available (Figure 1).

DISCUSSION

The addition of EIS score raised the less accurate physicians to levels of diagnostic accuracy more like their higher-performing peers. With use of the EIS device, the physicians were able to augment their biopsy selection ability beyond clinical judgment alone. It is important to note that EIS data are intended to be integrated into the biopsy decision-making process as an additional piece of information in the diagnostic pathway, but not followed blindly. The study findings are consistent with this objective.

In a similar manner, EIS information may also have the potential to enhance appropriate biopsy decisions of mid-level providers who may have lower diagnostic accuracy for pigmented lesions than more experienced dermatologists.[5] This study has demonstrated that EIS information improved the homogeneity of ability and has the potential to enhance accuracy among those having less clinical experience and diagnostic skills.

Limitations. A limitation of this study is that decisions were made based on clinical images alone, whereas, in actual practice, a physician would have the option to integrate clinical history and potentially dermoscopy information. In this study, we specifically chose to measure the effect of EIS independent of the effect of dermoscopy to remove any possible confounding effects on enhancing the clinical diagnosis. Additionally, only the diagnostic skills of residents were evaluated. Residents were chosen for this analysis because they were more likely to have varying levels of diagnostic skills. However, the results may not extrapolate to other clinicians with differing levels of experience and expertise.

CONCLUSION

Incorporating EIS data in the biopsy decision pathway consistently improved diagnostic accuracy among physicians with varying levels of expertise. This improvement was most marked in the lowest performing quartile. With the additional information provided by this device, the diagnostic accuracy among those with the lowest performance rose to more closely approach those of the highest performing group. For that reason, this technology has the potential to aid in the management of pigmented lesions and may be particularly useful to clinicians with less experience by enhancing the accuracy of their biopsy decisions.

REFERENCES

1. Paulson KG, Gupta D, Kim TS, et al. Age-Specific Incidence of Melanoma in the United States. *JAMA Dermatol.* 2020 Jan 1;156(1):57–64.
2. Landow SM, Gjelsvik A, Weinstock MA. Mortality burden and prognosis of thin melanomas overall and by subcategory of thickness, SEER registry data, 1992–2013. *Am Acad Dermatol.* 2017;76(2): 258–263.
3. Malvehy J, Hauschild A, Curiel-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.
4. Svoboda RM, Franco AI, Rigel DS. Electrical impedance spectroscopy versus clinical inspection approaches: melanoma efficacy detection comparison. *SKIN J Cutan Med.* 2018; 2(3):162–167.
5. Prado G, Rigel DS. Integrating electrical impedance score into decision to biopsy increases biopsy efficiency. *J Am Acad Dermatol.* 2019;81(4, Suppl. 1):AB228.
6. Svoboda RM, Prado G, Mirsky RS, Rigel DS. Assessment of clinician accuracy for diagnosing melanoma based on electrical impedance spectroscopy score plus morphology versus lesion morphology alone. *J Am Acad Dermatol.* 2019;80(1):285–287.
7. Anderson AM, Matsumoto M, Saul MI, et al. Accuracy of skin cancer diagnosis by physician assistants compared with dermatologists in a large health care system. *JAMA Dermatol.* 2018;154(5):569–573. JCAD