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DERLEME / REVIEW

Contemporary Advancements in the Early Detection of Melanoma and the Horizon of Home- Based Diagnostic Approaches

Melanomun Erken Teşhisindeki Güncel İlerlemeler ve Ev Tabanlı Tanısal Yaklaşımların Geleceği

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ABSTRACT

Melanoma remains a significant health concern, given its escalating incidence and associated mortality rates. In recent years, there have been noteworthy advancements in early detection methods in this domain. While the literature corroborates the effectiveness of these methods in enhancing early detection potential, there exists pronounced skepticism regarding their broader implications on overall survival outcomes. In this exhaustive review, we delve into the cutting-edge diagnostic methodologies developed for melanoma detection that transcend the need for direct dermatological intervention. Our nuanced analysis highlights the existence of several home-based and non-specialized techniques offering commendable precision in melanoma detection. However, deeper investigations are warranted regarding their efficacy in clinical practice, reliability, and cost-effectiveness. The review also encompasses discussions about the transformative potential artificial intelligence-centric diagnostic methods might hold as the paramount tools for future prognosis.

Keywords: Melanoma, early-detection, self-assessment, primary healthcare, artificial intelligence, clinical application

ÖZ

Melanom, yükselen insidansı ve buna bağlı mortalite oranları nedeniyle ciddi bir sağlık endişesi olarak kalmaya devam etmektedir. Son yıllarda, bu alanda erken teşhis yöntemlerinde kayda değer gelişmeler yaşanmıştır. Literatürde, bu yöntemlerin erken teşhis potansiyelini artırmada etkili olduğu belgelense de, genel yaşam süresi sonuçları üzerindeki etkileri hakkında ciddi şüpheler bulunmaktadır. Bu detaylı incelemede, melanom teşhisi için doğrudan dermatolojik müdahalenin ötesinde geliştirilen güncel tanısal yöntemleri ele almaktayız. Yaptığımız analiz, melanoma teşhisinde yüksek hassasiyet sunan bir dizi ev tabanlı ve uzmanlık-dışı tekniklerin varlığını ortaya koymaktadır. Ancak bu tekniklerin klinik uygulamadaki etkinlikleri, güvenilirlikleri ve maliyet-etkinlikleri gibi konularda daha derinlemesine araştırmalara ihtiyaç vardır. Ayrıca, yapay zekâ odaklı teşhis yöntemlerinin geleceğin tanı araçları olarak nasıl bir dönüşüm potansiyeli taşıdığına dair tartışmaları da içermektedir.

Anahtar Sözcükler: Melanom, erken teşhis, öz-muayene, birinci basamak sağlık hizmeti, yapay zekâ, klinik uygulama

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Introduction

In recent decades, melanoma's incidence has witnessed a pronounced escalation in the U. S., with an increase of 320% since 1975 (1). This trend in melanoma is not just restricted to the U. S.; globally, there's a discernible rise in its incidence (2). Interestingly, this rise presents a stark contrast to the overall cancer rates, which have either plateaued or experienced a modest decline (3). As melanoma takes its place as the fifth most frequently diagnosed cancer in the U. S., there's a concerted push towards enhancing its diagnostic methodologies, especially targeting its nascent stages. The literature suggests that direct dermatological evaluations (in contrast to assessments by non-specialized physicians) are associated with prompt melanoma detection, which in turn aligns with improved survival outcomes (4). A comprehensive study conducted within the German populace revealed that individuals who had been screened dermatologically exhibited superior survival rates than those who hadn't (5). However, overarching analyses spanning large datasets have indicated that the recent strategic measures may not have sufficiently mitigated melanoma-associated mortality (6).

While specialized dermatological evaluations remain the cornerstone for melanoma diagnosis, an over-reliance on such specialist interventions can inadvertently become an impediment, especially for populations grappling with access challenges, culminating in potential therapeutic delays. Empirical evidence underscores the salient fact that early-stage melanoma identification, irrespective of the disease's severity,

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Table 1. Comprehensive overview of melanoma identification techniques

Method	Target audience	Advantages	Challenges
Personal skin checks (ABCDE/Seven-point Glasgow/ Ugly duckling criteria)	General populace	– Free of charge – Immediate – Doesn't need expert equipment or guidance – Can be done frequently	– Variable efficiency findings – Public may misinterpret skin variations – Potential for unwarranted medical visits
Dermatoscope review	Healthcare providers in primary settings	– Established benefit compared to unaided inspection – Limited training for efficient use by non-experts	– Equipment costs – Necessitates skill acquisition
Mobile applications	General populace & primary healthcare providers	– User-friendly – Universally accessible with a smartphone	– Potentially high cost – Infrequent software enhancements
AI-driven image assessment	General populace & primary healthcare providers	– Continuously advancing technology identifies at risk areas – Updates can integrate newer evaluation criteria	– AI's operations are often not transparent – Potential cultural biases in software algorithms
Periodic digital skin analysis	General populace & primary healthcare providers	– User-friendly tracking of concerning skin areas – Facilitates specialist contact if necessary	-
Remote dermatology services	General populace	– Direct feedback system for prompt expert advice – Gains from expert evaluation without clinic visits – Elevates early detection chances	– Extensive use may burden specialists – Not universally insurance-supported

invariably correlates with enhanced survival trajectories (7). Such critical insights have galvanized the development of alternative, non-specialist-dependent diagnostic paradigms for melanoma's early detection. There's a prevailing emphasis on promoting self-examinatory practices; however, a subset of studies articulates potential challenges in aptly disseminating the nuances of melanoma recognition to the layperson (8,9). Notably, these self-assessment initiatives are pivotal in intercepting the initial manifestations of melanoma (10). From an economic vantage point, the early detection of melanoma doesn't just portend survival advantages but also translates to substantial fiscal efficiencies (11,12). A recent study highlighted the significant cost differential in treating T1a and T4b tumors, pointing to an expenditure that's 1000–2000% higher in contrast to the management of early-stage melanomas (13). While there have been reservations suggesting that the financial outlay linked to evaluating additional suspicious lesions might surpass the savings derived from bypassing the treatment of advanced-stage diseases, prevailing research establishes the cost-effectiveness of early detection interventions, notably screening initiatives and direct dermatological evaluations (14–16).

Notably, efforts geared towards amplifying melanoma screenings spearheaded by dermatologists have predominantly culminated in enhanced screening prevalence among younger females (17,18). Despite the increased susceptibility of this demographic to melanoma (19,20), it stands in juxtaposition to the demographic data pointing towards elderly males as the primary risk cohort for melanoma (21,22). Such paradoxes underline the imperativeness of an exhaustive deliberation of these melanoma detection modalities.

In this comprehensive review, we delve into an assortment of early melanoma detection techniques, transcending just self-assessment modalities (Table 1). Noticing the lacuna in literary discussions, our analysis pivots towards methodologies accessible to patients beyond traditional dermatological setups. This encompasses the embrace of avant-garde technological instruments and the integration of profound learning artificial intelligence algorithms. Given their pivotal roles in melanoma detection at nascent stages, we further elucidate the instrumental roles general practitioners and primary care physicians can play in channeling melanoma diagnostics.

Methodology

For this review, our objective was to explore melanoma detection techniques that eliminate the need for direct dermatologist interaction. We selected articles based on their relevance to self-testing and primary care melanoma detection procedures. Directly pertinent articles then guided our search for additional resources and enriched our understanding of specific techniques. Preference was given to articles from the past 5–7 years to ensure contemporary insights. Some exceptions were made for especially pertinent older articles when no recent alternatives were available.

Home-Based Early Detection

Advancing strategies to address the gaps left by previous efforts is pivotal to ameliorating melanoma prognoses. Studies indicate that men face a graver prognosis for melanoma (23), are at higher risk (22), but often postpone medical consultations for symptoms (24). This reluctance presents a challenge to timely detection in healthcare systems. Given this hurdle and the significance of early intervention, strategies targeting these high-risk groups should prioritize home-based accessibility.

Recognizing the observable nature of most melanomas, self-examination remains a cornerstone of numerous early detection initiatives. Entities like the Melanoma Research Alliance (25), AIM Foundation (26), Melanoma Research Foundation (27),

and the American Melanoma Foundation (28) offer resources guiding the public in self-assessing their skin.

Visual Self-Examinations

Skin self-examinations (SSEs) are a broadly endorsed tactic that empowers individuals in melanoma prevention. Research indicates their potential in identifying preliminary melanoma manifestations (23). A popular tool for these examinations is the "ABCDE Method" (29), a mnemonic highlighting potential malignant mole indicators:

- Asymmetry: Healthy moles generally have symmetrical appearances, while malign ones may be irregular.
- Border: Healthy moles feature clear, rounded borders, whereas malignant ones may present jagged edges.
- Color: A uniform color is typical of benign moles, while malign ones may exhibit varied shades.
- Diameter: Malign moles often exceed six millimeters, roughly the diameter of a pencil.
- Evolving: Malign moles tend to evolve in dimensions, contour, and hue.

Originally conceptualized at New York University in 1985, the ABCDE method aimed at educating both medical professionals and the public in distinguishing between regular and malign moles (30). Though there are concerns regarding its consistent application by laypersons (31), it remains valuable for professionals (32,33).

A key advantage of SSE is its flexibility regarding location and time. Evidence supports its efficacy in enhancing melanoma detection with frequent annual assessments (34). The modular nature of the ABCDE framework allows future augmentations (35). Moreover, individuals are often more attuned to their skin anomalies than annual-visiting clinicians.

However, the absence of a standardized SSE procedure can lead to varied thoroughness. Statistics show that only a minority fully adhere to the recommended examination areas, with most covering just two-thirds (36). Concerningly, melanomas detected through self-examination often tend to be advanced and risk-laden (37). Such findings suggest self-examinations, without prior melanoma experience, might not be as effective in early detection.

Despite its imperfections, the ABCDE framework serves as a foundational tool for public health initiatives, warranting further refinement for more consistent public application. Parallel to this is the seven-point Glasgow checklist (7PCL), endorsed by institutions like The National Institute for Health and Care Excellence (38), and widely adopted, especially in the UK (39). The 7CPL delineates seven distinguishing mole characteristics and advises specialist consultation for scores of ≥3 (40):

- Change in lesion size: 2 points
- Lesion shape irregularity: 2 points
- Lesion color irregularity: 2 points
- Inflammation at or around the lesion: 1 point
- Alteration in lesion sensation: 1 point
- Large lesion size (>7 mm in diameter): 1 point
- Oozing or crusting at or around the lesion: 1 point

The weighted 7PCL, another SSE tool for the general public, has demonstrated greater sensitivity than the ABCDE method when used by physicians (41). It has been the focal point of several awareness and self-screening campaigns, especially in the UK (42,43). However, there's a need to assess its efficacy as a self-screening tool.

The Ugly Duckling Method

Individuals can identify "ugly duckling signs" –moles differing from others on their body (44). Typically, benign nevi share similar visual traits (45), and comparing all nevi can decrease biopsies by a factor of seven (46). This straightforward tool is easily communicated to patients, but its simplicity might cause some to overlook cancer symptoms. It should be used in conjunction with other tools, like modifying the ABCDE method into the ABCDEF approach, where F represents "funny looking moles" (47-50).

Naked-eye SSEs have yet to consistently prove their effectiveness in improving outcomes. Elements like skin awareness after melanoma diagnosis, family history, and interest in SSE are pivotal (51). While some argue that SSEs lead to more overdiagnosis than improved outcomes (52), others believe that overdiagnosis isn't the sole metric for early-detection (53). Studies indicate that women at melanoma risk, when trained online and given telehealth dermatologist access, schedule fewer benign mole checks (54-58).

The inconsistency in SSE performance and quality poses challenges in establishing its usefulness for early detection. Research has shown that educational aids can enhance SSE quality and performance. Online tools, like game-based training on ABCD or UDS methods, have boosted accurate melanoma identification (59).

Primary Care Physician and General Practitioner Methods

While self-examination aids melanoma early detection, primary care physicians (PCPs) and general practitioners play a pivotal role. Given melanoma's swift referral time after initial observation (60,61), these professionals must adeptly recognize melanoma symptoms. Thus, the tools and their referral success rate warrant analysis.

A dermatoscope, introduced in 1989 (59), magnifies skin areas, enabling detailed observation. Its use significantly improved

melanoma identification among dermatologists and generalists alike (62-65). Studies highlight its importance, suggesting brief training can make PCPs proficient dermatoscope users (66,67).

Electronic tools, like Sequential Digital Dermoscopy Imaging (SDDI), assist in tracking lesion changes. Coupling SDDI with dermatoscopes achieved >97% accuracy in managing pigmented lesions and melanoma by general practitioners (68).

Other tools like Spectrophotometric Intracutaneous Analysis (SIAscopy) provide non-invasive image assessments of pigmented skin lesions (69), proving effective in primary care settings (70).

Teledermatology enables PCPs to quickly consult specialists, reducing in-person appointment wait times by 78% (71,72). The store-and-forward teledermatology approach, which compiles images for future analysis, has improved detection rates and reduced in-person visits (73,74). However, concerns like image quality, potential for errors, and collaboration challenges persist (75), and insurance coverage remains limited in the US (76).

Efficacy Controversy: Contemporary Approaches to Melanoma Detection and Overdiagnosis Concerns

Contemporary advancements in melanoma detection techniques have incited debate regarding their true efficacy, especially when it comes to influencing long-term survival outcomes. Some contest that increasing melanoma detection initiatives have yet to produce a notable impact on survival rates or melanoma occurrence (77,78). Notably, incidences of less aggressive melanoma manifestations have surged, yet mortality linked to melanoma remains elevated (79,80). Questions have arisen about the effectiveness of certain imaging tools, like MoleMate – a tool developed using SIAscopy technology. Observations indicate that MoleMate led to a surge in referrals, however, these often misaligned with expert evaluations (81).

Conversely, substantial evidence suggests non-specialists can efficiently manage suspicious lesion cases, directing appropriate referrals. An insightful study contrasting rural and urban melanoma incidences revealed that rural regions, with fewer specialists, presented no amplified harm or survival risk, even when more lesions were biopsied (82). This implies that apprehensions about non-specialists may be unfounded, suggesting primary care providers' (PCPs) involvement can be beneficial. Further studies comparing melanoma detection across specialist and non-specialist clinics reveal that general practitioners effectively identify melanoma. A pivotal metric here is the number needed to biopsy (NNB), indicative of how efficiently suspicious lesions are identified. Interestingly, a 2020 study unveiled negligible differences in NNB between dermatologists and non-dermatology practitioners (83).

Horizon of Melanoma Detection: Embracing Emerging Technologies

The trajectory of melanoma detection research has been evolving at an unprecedented pace. A burgeoning approach, evident in contemporary literature, revolves around harnessing artificial intelligence (AI) and deep learning for melanoma diagnosis via dermatoscope images (84–88). Primary providers acquire these images and software subsequently analyses them against a database of healthy and afflicted skin representations (89). A particular mobile-based computer-aided diagnosis (CAD) tool, validated within PCP settings, boasts an accuracy rate exceeding 80% and nearly 90% sensitivity (90). Another investigation involving PCPs and nurse practitioners highlighted AI's potential to augment diagnostic accuracy in alignment with dermatologist panels (91). The intricacies of AI in skin cancer detection were elaborated by Dildar et al. (92).

Yet, these AI technologies remain nascent. Several shortcomings persist, including their 'black-box' characteristic, where decision-making remains opaque (93). The static nature of many diagnostic apps, not reflecting the evolving melanoma diagnostic criteria, raises concerns. Financial constraints, particularly for lower socio-economic groups, also limit technology access (94). Programs like Sklip® from Oregon Health and Science University are attempting to bridge this gap (95). Furthermore, AI's inherent biases, as evidenced by its training data predominantly originating from three states, restrict its efficacy for diverse populations (96,97).

Conclusion and Recommendations

The preceding decades witnessed pivotal strides in melanoma detection methodologies, emphasizing self-screenings, non-specialist interventions, and innovative diagnostic techniques. While these endeavors are commendable, the accuracy issues, emanating from expertise dearth and internal biases, cannot be overlooked. Some critics argue that these only lead to overdiagnoses, escalating costs without discernible survival benefits.

However, to hastily discredit such advancements may overlook the nuances of melanoma biology, yet to be fully understood. It's essential to strategize for equitable access, ensuring the inclusion of those deprived of resources. Emphasizing rural healthcare and cost-effective strategies is paramount.

The ongoing debate on overdiagnosis necessitates more studies to gauge if early detection truly offers survival advantages. It is imperative to fortify training modules for the public and PCPs, targeting high-risk, low-access groups. A paradigm shift, empowering PCPs in melanoma diagnosis, can expedite early detection and unburden the already overburdened dermatologists.

Simultaneously, AI's potential is undeniable but mandates transparency and unbiased data inputs to ensure widespread,

equitable effectiveness. Addressing AI's inherent biases can pivot the landscape of melanoma diagnosis, catalyzing a future where early, accurate detection is the norm, not the exception.

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