The Promising Role of Artificial Intelligence in Nail Diseases

Sezgi Sarıkaya Solak[1], Fatih Göktay[2]

Department of Dermatology, Trakya University Faculty of Medicine, Edirne, Türkiye
Private Dermatology Practice, İstanbul, Türkiye

Nails, the essential appendages of the skin, are not only important for their functional and aesthetic value, but also provide valuable clues about a patient's overall health. Nail diseases are associated with a wide range of pathologies, including dermatological and infectious diseases and systemic and tumoral conditions. However, interpreting nail findings and making the correct diagnosis or treatment decision can be a challenge for physicians, as some nail diseases present with similar clinical findings and require further laboratory investigations or nail biopsy for accurate diagnosis. These studies may be experience-dependent, time-consuming, costly, or inaccessible, making them unsuitable for routine clinical practice.

Dermatology is an area of medicine that has experienced a recent surge in artificial intelligence (AI) research. This is due to dermatology's visual nature and the relatively easy access to large visual datasets of clinical or dermoscopic images. These characteristics make dermatology suitable for AI.[1] The same holds for nail diseases. Moreover, because of the localization, size, and number of nails, collecting clinical and/or dermoscopic images of the nail diseases required by AI is relatively more accessible than other skin parts. While research on AI in nail diseases has gradually increased over the last 5 years, the number of studies on this subject is still limited. However, we believe that the visibility and accessibility of nails, as well as the ease of obtaining images, will increase research in this field.

Onychomycosis is now the most researched topic in the use of AI in nail diseases, which is a promising development because detecting onychomycosis, one of the most common nail diseases, can be challenging in daily practice. Physicians must make an accurate diagnosis as onychomycosis requires long-term treatment and the use of systemic antifungals, which may have adverse effects. Additionally, a diagnosis of onychomycosis has a negative psychosocial effect on patients. However, present diagnostic approaches have some pitfalls. Direct microscopic examination is experience-dependent, and fungal culture and histopathological examination are time-consuming and costly.[2,3] Therefore, adopting AI into onychomycosis diagnosis appears to be a significant and beneficial development for daily practice, as it can speed up, improve accuracy, and reduce costs compared with conventional approaches.

In this context, Aishwarya et al.[4] used a convolutional neural network (CNN) model, a type of AI, to distinguish onychomycosis from normal nails with a notable accuracy of 98.6%. Han et al. took the research one step further by investigating whether AI can distinguish onychomycosis from other nail diseases. They compared AI performance with that of dermatologists, training their dataset with 49,567 images. Interestingly, the study found that AI outperformed dermatologists in diagnosing onychomycosis, which is remarkable.[5] In addition to comparing AI with physician-performed visual examinations, researchers have compared AI with other diagnostic tools, such as dermoscopic examination. Kim et al.[6] found that AI-based onychomycosis diagnosis was similar to dermoscopic examination by experienced dermatologists, showing the potential of AI as a reliable diagnostic tool.

AI systems in onychomycosis are used in clinical image settings and diagnostic laboratory procedures. Recent research has used histopathological or microscopic images of nails to identify onychomycosis using AI.[2,3,7] Yilmaz et al.[3] used microscopic images of normal nails and nails with onychomycosis that had positive potassium hydroxide test results to develop a CNN-based deep learning method for fungal detection. Their study found that CNN models could detect fungus using microscopic images and were more accurate than dermatologists. Similarly, there have been studies evaluating the role of AI models in diagnosing onychomycosis using scanned whole-slide images of histopathological examination of nail clippings.[2,7] These studies found that AI models detected fungi equally well as dermatopathologists. AI in histopathological or microscopic images of nail specimens can be used as a diagnostic

Corresponding author: Sezgi Sarıkaya Solak, Department of Dermatology, Trakya University Faculty of Medicine, Edirne, Türkiye
e-mail: sezgisarikaya@gmail.com

Received: xxxxxx **Accepted:** xxxxxx **Available Online Date:** xxxxxx • **DOI:** 10.4274/balkanmedj.galenos.2024.010424
Available at www.balkanmedicaljournal.org

ORCID iDs of the authors: S.S.S. 0000-0002-8572-8249; F.G. 0000-0002-2380-7697..

Cite this article as: Sarıkaya Solak S, Göktay F. The Promising Role of Artificial Intelligence in Nail Diseases.. Balkan Med J.;

tool and a time-saving method for physicians and pathologists in their daily practice. The first identification of areas suspicious of fungus initially by an AI system, followed by confirmation or rejection of the diagnosis by examination of the suspicious areas, saves considerable time.[2,7]

While most AI research has focused on identifying onychomycosis, recent studies have begun to examine nail psoriasis using AI algorithms. However, the number of research on this topic is still limited.[8-10] The Nail Psoriasis Severity Index (NAPSI) or modified Nail Psoriasis Severity Index (mNAPSI) are methods for evaluating the severity of nail psoriasis by measuring nail changes.[11,12] These scoring systems help make treatment decisions and analyze treatment outcomes. However, because of the time-consuming manual scoring process, they are not widely used in clinical practice. To address this issue, researchers developed AI systems that automatically calculate the NAPSI or mNAPSI score based on clinical images of psoriatic nails.[8-10] Folle et al.[8] have developed an AI system that uses a photo box to standardize nail photograph capture and a mobile application. The AI system automatically recognized nail changes associated with psoriasis and predicted the mNAPSI score in 1,154 nail images. Moreover, the study showed a high positive correlation between mNAPSI scores predicted by the AI system and those assessed by experts on nail psoriasis.[8] These advances in AI-based nail psoriasis assessment will help clinicians accurately classify nail psoriasis severity in daily practice and determine the most appropriate treatment options.

One possible future use of AI in nail diseases is the evaluation of melanonychia, a condition characterized by dark pigmentation in the nail. Melanonychia may be a significant indicator of nail unit melanoma, which has a poor prognosis if misdiagnosed. Currently, some clinical and dermoscopic findings can be used to evaluate the presence of nail melanoma. However, in cases with a high suspicion of nail melanoma, the gold standard for distinguishing between benign and malignant melanonychia in the early stages remains histopathological examination via nail matrix biopsy. As far as we know, no research has been conducted using AI in melanonychia to predict nail unit melanoma. In the future, AI may help identify between benign and malignant types of melanonychia, which would be a huge advancement in the field. Using AI, we may be able to identify patterns and characteristics of melanonychia that indicate malignancy, allowing for earlier and more accurate diagnosis. Even if AI cannot conclusively differentiate between the two, it may determine the necessity of a biopsy, reducing the need for invasive procedures and assisting clinicians in making decisions, thus improving patient outcomes.

Although there have been promising developments in the use of AI for nail diseases, it is important to note that this technology is still in its early stages, with much more to learn and develop. We must address the limitations associated with AI and ensure that it is used safely and effectively in clinical practice.

One of the most significant challenges, like in other fields of medicine, is obtaining a large number of standardized, high-quality, and robust data for the training dataset. Providing these data are essential to ensuring that AI is used to its full potential and improves patient outcomes. In addition, there are medico-legal issues to consider, such as patient consent, data privacy, bias, and liability in the event of AI-related medical errors.[1,13,14] By studying and resolving these issues, we can ensure that AI is used ethically and safely in clinical practice.

Despite these challenges, AI has potential benefits for the management of nail diseases and other medical concerns. By addressing limitations and working to improve the technology, we may continue to push the boundaries of medical innovation while improving patient outcomes.

In conclusion, AI can change how we diagnose, manage, and treat nail diseases such as onychomycosis, nail psoriasis, and melanonychia. By using AI in clinical practice, we can provide more accurate, efficient, inexpensive, or faster diagnoses of nail diseases, prevent unnecessary invasive or expensive procedures and reduce the workload on clinicians.

Authorship Contributions: Concept- S.S.S., F.G.; Design- S.S.S., F.G.; Data Collection or Processing- S.S.S., F.G.; Analysis or Interpretation- S.S.S., F.G.; Literature Search- S.S.S., F.G.; Writing- S.S.S., F.G.

Conflict of Interest: No conflict of interest was declared by the authors.

REFERENCES

1. Omiye JA, Gui H, Daneshjou R, Cai ZR, Muralidharan V. Principles, applications, and future of artificial intelligence in dermatology. *Front Med (Lausanne).* 2023;10:1278232. [CrossRef]
2. Decroos F, Springenberg S, Lang T, et al. A Deep Learning Approach for Histopathological Diagnosis of Onychomycosis: Not Inferior to Analogue Diagnosis by Histopathologists. *Acta Derm Venereol.* 2021;101:adv00532. [CrossRef]
3. Yilmaz A, Göktay F, Varol R, Gencoglan G, Uvet H. Deep convolutional neural networks for onychomycosis detection using microscopic images with KOH examination. *Mycoses.* 2022;65:1119-1126. [CrossRef]
4. Aishwarya, Goel A, Nijhawan R, (editors). A deep learning approach for classification of onychomycosis nail disease. In book: Proceedings of ICETIT 2019, Emerging Trends in Information Technology; Springer; 2019; p. 1112-1118. [CrossRef]
5. Han SS, Park GH, Lim W, et al. Deep neural networks show an equivalent and often superior performance to dermatologists in onychomycosis diagnosis: Automatic construction of onychomycosis datasets by region-based convolutional deep neural network. *PLoS One.* 2018;13:e0191493. [CrossRef]
6. Kim YJ, Han SS, Yang HJ, Chang SE. Prospective, comparative evaluation of a deep neural network and dermoscopy in the diagnosis of onychomycosis. *PLoS One.* 2020;15:e0234334. [CrossRef]
7. Jansen P, Creosteanu A, Matyas V, et al. Deep Learning Assisted Diagnosis of Onychomycosis on Whole-Slide Images. *J Fungi (Basel).* 2022;8:912. [CrossRef]
8. Folle L, Fenzl P, Fagni F, et al. DeepNAPSI multi-reader nail psoriasis prediction using deep learning. *Sci Rep.* 2023;13:5329. [CrossRef]
9. Hsieh KY, Chen HY, Kim SC, Tsai YJ, Chiu HY, Chen GY. A mask R-CNN based automatic assessment system for nail psoriasis severity. *Comput Biol Med.* 2022;143:105300. [CrossRef]
10. Ji B, Wang Y, Zuo D, editors. Automatic detection and evaluation of nail psoriasis based on deep learning: A preliminary application and exploration. International Conference on Computer Application and Information Security (ICCAIS 2021): SPIE; 2022. [CrossRef]
11. Cassell SE, Bieber JD, Rich P, et al. The modified Nail Psoriasis Severity Index: validation of an instrument to assess psoriatic nail involvement in patients with psoriatic arthritis. *J Rheumatol.* 2007;34:123-129. [CrossRef]
12. Rich P, Scher RK. Nail Psoriasis Severity Index: a useful tool for evaluation of nail psoriasis. *J Am Acad Dermatol.* 2003;49:206-212. [CrossRef]
13. Koçak B, Cuocolo R, dos Santos DP, Stanzione A, Ugga L. Must-have Qualities of Clinical Research on Artificial Intelligence and Machine Learning. *Balkan Med J.* 2023;40:3-12. [CrossRef]
14. Hayıroğlu Mİ, Altay S. The Role of Artificial Intelligence in Coronary Artery Disease and Atrial Fibrillation. *Balkan Med J.* 2023;40:151-152. [CrossRef]