

## Onychomycosis Coinfected with *Pseudomonas aeruginosa*: Report of Four Cases

Ye Ji Jang, Ji Ha Yoon, Eun Joo Park, Kwang Joong Kim and Kwang Ho Kim<sup>†</sup>

Department of Dermatology, Hallym University Sacred Heart Hospital, Anyang, Korea

Patients presenting with green nail syndrome often show coinfection with fungus. A delay in the accurate diagnosis of coinfection may warrant longer treatment duration. Four patients with green nail syndrome coinfecting with fungus were reviewed retrospectively. Fungal culture, cultivating *Candida parapsilosis* and *Candida albicans*, was performed in two patients' samples. The mean time of the initiation of treatment for onychomycosis after the first visit was 5.75 weeks. If green nail syndrome is suspected, screening for fungal coinfections and precise management are necessary.

**Key Words:** Coinfection, Green nail syndrome, Onychomycosis, *Pseudomonas aeruginosa*

### INTRODUCTION

The most common bacterial nail infection is green nail syndrome (GNS) caused by *Pseudomonas aeruginosa*. Recent studies suggest that fungal infections may promote colonization or growth of *P. aeruginosa* in the nail<sup>1</sup>. In addition, such coinfection of onychomycosis with *P. aeruginosa* can prevent the growth of fungi in fungal culture, owing to an excessive growth of bacteria in the culture<sup>2</sup>. We report four cases of onychomycosis coinfecting with *P. aeruginosa*.

### CASE REPORT

Patient 1, a 54-year-old woman, showed greenish nail color change on the right thumb fingernail approximately 2 months prior to the first visit (Fig. 1A). *Candida parapsilosis* was isolated from the fungal culture with positive potassium hydroxide (KOH) test. *P. aeruginosa* was identified with sensitivity to

ciprofloxacin in the bacterial culture. The patient was treated with ciprofloxacin 250 mg twice daily for 4 weeks following 3 cycles of itraconazole pulse therapy. Itraconazole pulse therapy was initiated 4 weeks after the first visit of the patient.

Patient 2, a 60-year-old woman, presented with bluish green melanonychia on her left thumb fingernail (Fig. 1B). Periodic acid-Schiff (PAS) staining of 3 mm punch biopsy was positive (Fig. 2). *P. aeruginosa* was identified with sensitivity to third generation cephalosporin in the bacterial culture. The patient was treated with cefpodoxime proxetil 100 mg twice daily for 2 weeks and terbinafine 250 mg daily 16 weeks. Terbinafine was initiated 1 week after the first visit. After 2 weeks of treatment, the green color change disappeared from the infected nail, and a new nail growth was observed.

Patient 3, a 45-year-old woman, presented with greenish nail color change on the left great toe nail (Fig. 1C). KOH test, that was performed before the nail extraction, showed a positive result. *P. aeruginosa* was identified with sensitivity to ciprofloxacin in the bacterial culture. After nail extraction,

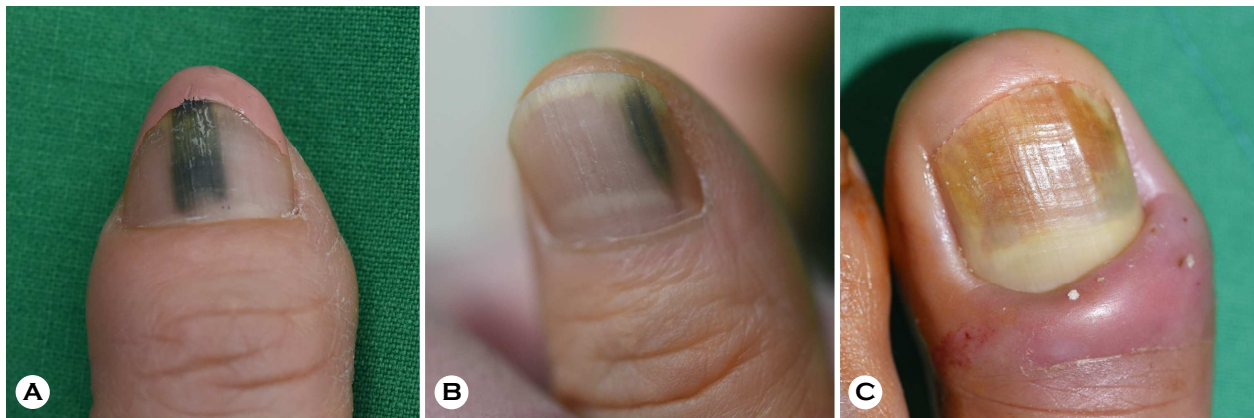
Received: September 6, 2019 Revised: September 25, 2019 Accepted: November 12, 2019

<sup>†</sup>Corresponding: Kwang Ho Kim, Department of Dermatology, Hallym University Sacred Heart Hospital, 22, Gwanpyeong-ro, 170beon-gil, Dongan-gu, Anyang, Gyeonggi-do, 14068, Korea.

Phone: +82-31-380-3765, Fax: +82-31-386-3761, e-mail: [dermakkh@naver.com](mailto:dermakkh@naver.com)

Copyright©2019 by The Korean Society for Medical Mycology. All right reserved.

©This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>), which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited. <http://www.ksmm.org>



**Fig. 1.** (A) Longitudinal greenish melanonychia on the right thumb nail of the patient 1 (B) Slightly bluish greenish melanonychia on the left thumb nail of the patient 2 (C) Greenish melanonychia with paronychia on the left great toenail of the patient 3

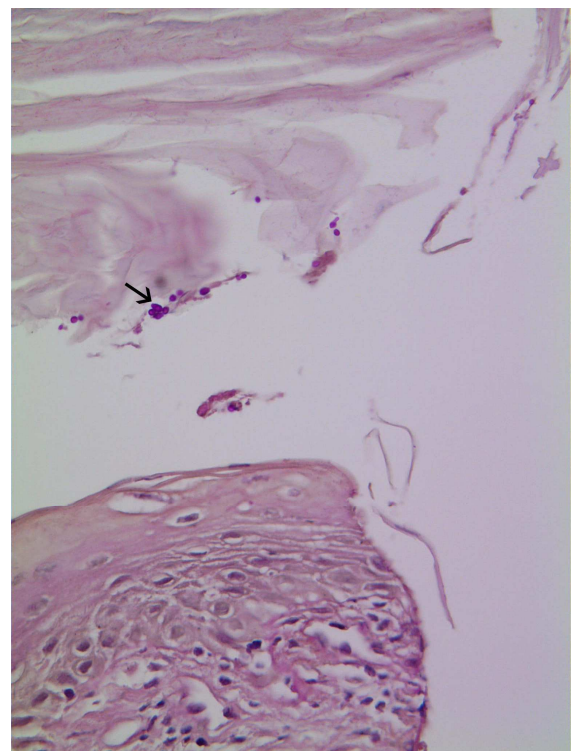
the patient was treated with ciprofloxacin 250 mg twice daily for 3 weeks. After the 3-month observation period, the patient showed inadequate nail growth with suspected residual fungal infection in the affected nail. The patient was treated with topical flutrimazole and terbinafine 250 mg daily.

Patient 4, a 51-year-old woman, underwent nail extraction of the right thumb fingernail that was infected with *Pseudomonas*. *C. albicans* was isolated in the fungal culture with a positive KOH test. *P. aeruginosa* was identified with sensitivity to ciprofloxacin in the bacterial culture. After nail extraction, the patient was administered ciprofloxacin 250 mg twice daily for 3 weeks, and 2 cycles of itraconazole pulse therapy with topical eficonazole. Itraconazole was initiated 3 weeks after the first visit of the patient. Table 1 summarizes the patients' demographics and clinical characteristics.

## DISCUSSION

GNS is characterized by the colonization of *P. aeruginosa* on the dorsal or ventral nail plate. Chronic paronychia, onycholysis, onychotillomania, microtrauma to the nail fold, chronic exposure to water, soaps or detergents are known predisposing factors for the development of GNS. In green nails, a bacterial biofilm can be seen as a basophilic layer on the undersurface of the nail. In very faintly stained sections, a greenish tinge may be detectable<sup>3</sup>.

*P. aeruginosa* produces antifungal activity by the production of pyocyanin and 1-hydroxyphenazine<sup>2</sup>. *P. aeruginosa* kills mold by forming a dense biofilm on *C. albicans* filaments<sup>4</sup>. *P. aeruginosa* also inhibits the growths of *Trichophyton rubrum*



**Fig. 2.** Biopsy slide of patient number 2. Fungal spores are seen in epidermis and nail plate. (Periodic acid-Schiff stain, original magnification x400, black arrow)

and *Trichophyton mentagrophytes*<sup>5</sup>.

Dermatophytosis may be coupled with an infection of *P. aeruginosa*. Onychomycotic nails may provide a more favor-

**Table 1.** Patient demographics and clinical characteristics

Sex/Age	Infected nail	Biopsy	KOH test	Fungus culture
F/54	Right thumb	Old hemorrhage and pigmentation in nail plate	Positive	<i>Candida parapsilosis</i>
F/60	Left thumb	Some fungal spores in epidermis and nail plate PAS stain: positive	Not performed	Not performed
F/45	Left great toe	Hyperkeratotic nail with scattered fungal organisms	Positive	Not performed
F/51	Right thumb	Not performed	Positive	<i>Candida albicans</i>

KOH test: Potassium hydroxide test, F: Female, PAS: Periodic acid-Schiff

able environment as long-term carriers of *P. aeruginosa* than normal nails<sup>1</sup>. Onychomycotic nails include the nail space under the lateral folds, that are ideal for the growth of *P. aeruginosa*. Another study reported that KOH-positive nail specimens are more likely to produce *P. aeruginosa* statistically significant than KOH-negative specimens<sup>6</sup>. This suggests that fungal infections may potentiate the colonization and growth of *P. aeruginosa* in nail specimen.

Yang et al.<sup>7</sup> suggested the mechanism of coinfection in onychomycotic nail with *P. aeruginosa*. Fungal exudates containing sugars, amino acids, polyols, and organic acids aid in the positive chemotaxis of *P. aeruginosa* to the onychomycotic nail. Subsequently, *P. aeruginosa* produces an antifungal peptide toxin that inhibits fungal growth in infected nails. Thus, fungal species in the nails enhance the growth and colonization of *P. aeruginosa*, but are later replaced by *P. aeruginosa*.

For the treatment of green nail syndrome, the entire nail may be removed, or the detached nail plate may be cut off. Applying a few drops of chlorhexidine solution or diluted bleach twice or thrice daily topically removes pigmentation within a few weeks. Treatment with topical antibiotics such as nadifloxacin, gentamicin, and ciprofloxacin have also been reported as valuable therapeutic options. Topical antibiotics (polymyxin B or bacitracin) applied twice to quad times daily for one to four months have been reported to be effective in immunocompetent patients. Systemic antibiotics are not generally needed but some case reports have demonstrated successful treatment with twice or thrice weekly of oral ciprofloxacin.

All the four cases in our study support the hypothesis that onychomycosis may predispose *P. aeruginosa* infection. Although further investigations are needed to explain the interactions between these organisms, the cases in our study

emphasize the importance of recognizing this coinfection relationship for proper treatment. Furthermore, when GNS is suspected, confirmation of the presence of fungal infection by KOH, fungal culture, or PAS stain may help determine the appropriate treatment direction.

## ACKNOWLEDGEMENT

The authors declare that there is no acknowledgement.

## CONFLICT OF INTEREST

In relation to this article, we declare that there is no conflict of interest.

## ORCID

Ye Ji Jang: 0000-0002-1299-6883

Ji Ha Yoon: 0000-0003-0041-3764

Eun Joo Park: 0000-0002-9924-515X

Kwang Joong Kim: 0000-0003-4158-6100

Kwang Ho Kim: 0000-0001-5315-6031

## PATIENT CONSENT STATEMENT

The patient provided written informed consent for the publication and the use of his or her images.

## REFERENCES

1. Eckart H. Histopathology of the nail. Onychopathology. 1st ed. Florida: CRC Press, 2017:145-146
2. Kerr JR, Taylor GW, Rutman A, Hoiby N, Cole PJ, Wilson R. *Pseudomonas aeruginosa* pyocyanin and 1-hydroxyphenazine inhibit fungal growth. J Clin Pathol 1999;52: 385-387
3. Hogan DA, Kolter R. *Pseudomonas-Candida* interactions: an ecological role for virulence factors. Science 2002;296: 2229-2232
4. Treat J, James WD, Nachamkin I, Seykora JT. Growth inhibition of *Trichophyton* species by *Pseudomonas aeruginosa*. Arch Dermatol 2007;143:61-64
5. Mermel LA, McKay M, Dempsey J, Parenteau S. *Pseudomonas* surgical-site infections linked to a healthcare worker with onychomycosis. Infect Control Hosp Epidemiol 2003;24:749-752
6. Foster KW, Thomas L, Warner J, Desmond R, Elewski BE. A bipartite-interaction between *Pseudomonas aeruginosa* and fungi in onychomycosis. Arch Dermatol 2005;141: 1467-1468
7. Yang YS, Ahn JJ, Shin MK, Lee MH. *Fusarium solani* onychomycosis of the thumbnail coinfecting with *Pseudomonas aeruginosa*: report of two cases. Mycoses 2011; 54:168-171