

Penile Lesions as an Initial Manifestation of Invasive Fungal Disease: Case Report and Review of the Literature

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Case Report

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Abstract

Cutaneous lesions in immunocompromised (IC) patients are a challenging diagnostic phenomenon but may provide early clues to invasive fungal disease (IFD). Genital involvement in IFD is rare and often mistaken for viral infections or malignancy. We present a comprehensive literature review of penile lesions as the initial manifestation of IFD, a topic that has not been well described in the literature. We identified 23 cases published between 1966 and 2025 and included a recent case from our institution. IFD with penile lesions typically occurred in patients with neutropenia (38%), diabetes (38%), hematologic malignancy (33%), and stem cell transplants (17%). Mucorales were the most frequent pathogens, followed by *Histoplasma* and *Fusarium* species. Diagnostic delays were common due to variations in lesion morphology and clinical symptomatology. For this reason, neutropenic patients with genital ulcers should undergo prompt biopsy and fungal culture to expedite diagnosis.

Introduction

Invasive fungal disease (IFD) is rising in prevalence due to the advent of highly immunosuppressive cancer treatments including chimeric antigen receptor T-cell therapy (CAR-T), increased stem cell and organ transplantation, emergence of fungal resistance, and climate change [1–5]. IFD is associated with mortality rates ranging from 50–80% and such infections disproportionately affect patients with hematological malignancies [5–8]. Infections by fungi usually manifest as persistent neutropenic fever, sinusitis, skin lesions or pneumonia of unknown origin [1, 9]. For this reason, a new genital rash does not immediately prompt consideration of IFD.

While less common, skin lesions can be seen particularly in IFD caused by *Candida*, *Cryptococcus*, *Fusarium*, endemic fungi, and rarely by other hyalohyphomycetes such as *Aspergillus* species, and they often serve as a nidus for dissemination [10]. Genitourinary manifestations of IFD have been described primarily in the setting of disseminated endemic mycoses or involvement of the urinary tract, prostate, epididymis, or testes [11]. Here, we describe a case of invasive fusariosis presenting with penile and scrotal ulcerations in a profoundly neutropenic patient with leukemia. Furthermore, we systematically characterized published cases of penile lesions serving as the initial manifestation or sole culture-positive site of IFD, with an emphasis on host factors, lesion morphology, diagnostic mimics, pathogens, treatment, and outcomes.

Case Report

A 72-year-old man with a past medical history of chronic lymphocytic leukemia and chronic sinusitis was hospitalized for 2 months in El Paso, Texas, USA, for a new diagnosis of high-risk myelodysplastic syndrome with excess blasts. He received two cycles of chemotherapy with decitabine and venetoclax without improvement in his cell counts. During this time, he had been receiving prophylactic oral acyclovir and fluconazole for prolonged neutropenia. He was subsequently transferred to MD Anderson Cancer Center (Houston, TX) for consideration of stem cell transplant.

On admission to MD Anderson (hospital day 0), the patient had a neutropenic fever of 100.6°F and a white blood cell count of $0.1 \times 10^9/L$. He reported painful penile lesions that had first appeared one month prior and had progressively worsened over the last two weeks. The lesions had become ulcerated and increasingly painful, causing difficulty with voiding. He also endorsed mild nasal congestion. Empiric therapy was initiated with intravenous cefepime 2 g every 8 hours, intravenous acyclovir 5 mg/kg every 8 hours, oral linezolid 600 mg every 12 hours, and oral posaconazole 300 mg every 24 hours.

Given the unusual appearance of the genital lesions and the presence of neutropenic fever, Infectious Disease was consulted. A social history was obtained, revealing that the patient was originally from Mexico but had lived in El Paso, Texas, for many years, working as a carpenter and woodworker. He enjoyed gardening and using his jacuzzi. He had recently gone camping in New Mexico, but he otherwise denied international travel, animal exposures, genital trauma, and recent sexual activity.

His physical exam was notable for multiple tender, friable ulcerations of the glans penis, foreskin, and scrotum (Fig. 1). Inguinal lymphadenopathy was absent. Otolaryngology (ENT) evaluation with nasal endoscopy demonstrated dark crusting along the nasal septum, concerning for invasive fungal sinusitis. Initial infectious workup was negative including blood cultures, urine cultures, and respiratory viral panel. Serologic testing for hepatitis viruses, HIV, HTLV, syphilis, *Coccidioides*, *Histoplasma*, and *Blastomyces* was negative. An HSV/VZV PCR swab from the penile ulcer returned negative, hence intravenous acyclovir was discontinued and prophylactic oral valacyclovir was resumed.

Urology was consulted on hospital day 2 due to concern for a primary penile malignancy, but it was felt that the patient's clinical presentation was inconsistent with penile malignancy. Biopsy by Dermatology was recommended instead of an excisional biopsy, and a shave biopsy of the penile lesion was performed. Histopathology demonstrated fungal hyphal elements on preliminary staining, prompting addition of liposomal amphotericin B to the patient's antimicrobial regimen. Tissue bacterial and AFB cultures demonstrated no growth. Tissue fungal culture subsequently grew *Fusarium* species. Histopathology analysis of the shave biopsy specimen demonstrated ulceration and necrosis with deep fungal infection. Immunohistochemical (IHC) staining with the ISCA Diagnostics *Fusarium* mouse monoclonal antibody (ED7 clone; ID2525-0100) demonstrated the presence of *Fusarium* antigens. Staining for *Rhizopus* and *Aspergillus* antigens was negative.

Following finalization of fungal culture results, liposomal amphotericin B was discontinued, and the patient's antifungal regimen was changed to oral voriconazole 300 mg twice daily and terbinafine 500 mg twice daily. ENT recommended surgical debridement of suspected invasive fungal sinusitis; however, the patient declined surgical intervention. After discussions with Palliative care, the patient ultimately elected to pursue home hospice care. All antimicrobial therapy was stopped prior to discharge. At the time of this report, the patient remains alive.

Literature Review

A qualified medical librarian (R.H.) conducted a comprehensive literature search for published cases of IFD with genital involvement, with no date or language exclusions. Medline (Ovid), Scopus, and Embase (Ovid) were queried using both natural language and controlled vocabulary terms for male genital anatomy (penis, glans, foreskin, balanitis) and fungal organisms and mycoses (*Aspergillus*, Mucorales, *Fusarium*, *Scedosporium*, *Histoplasma*, *Blastomyces*, *Coccidioides*, *Paracoccidioides*, and dermatophytes).

Thirty-five articles were identified, consisting of 59 cases published between 1966 and 2025. We included only cases in which penile lesions were the initial manifestation of IFD or served as the diagnostic site leading to recognition of IFD. Cases were excluded if penile lesions developed after an established diagnosis of IFD; if findings represented superficial fungal colonization or balanitis; or if there was insufficient clinical detail.

After applying these criteria, we analyzed 23 published cases [12–33], with the addition of the case described above for a total of 24 cases that are summarized in Table 1. Individual case-level data are provided in Online Resource 1. The median age was 56.5 years (range, 12–80 years). Hematologic malignancy was present in 8 of 24 patients (33%), including acute myeloid leukemia (n = 4), B-cell acute lymphoblastic leukemia (n = 1), chronic myeloid leukemia (n = 1), lymphoma (n = 1), and the present case of chronic lymphocytic leukemia with high-risk myelodysplastic syndrome. Neutropenia was documented or presumed in 9 patients (38%), including all patients with hematologic malignancy and one patient with severe aplastic anemia after cord blood stem cell transplantation. Diabetes mellitus was present in 9 patients (38%). Six patients had no reported diabetes or major immunocompromising condition, although several had possible occupational or environmental exposures, including farming and printing press factory work.

Clinical presentation varied substantially. Of 17 cases, only 8 patients (47%) had documented fevers that coincided with lesion onset. Pain or tenderness associated with penile lesions was reported in 13 of 21 patients (62%). Dysuria was reported in 4 of 20 cases (20%). Lesion morphology was heterogeneous, but mainly manifested as ulcers (50%), followed by necrotic patches (17%), necrotic plaques (8%), violaceous macules (8%), nodules (8%), bullae (4%), and other morphologies (4%). Initial diagnostic impressions, available in 14 cases, included bacterial infections (6/14, 43%), malignancy such as penile cancer or leukemia cutis (3/14, 21%), viral infection such as herpes simplex virus or molluscum contagiosum (3/14, 21%), and drug reactions (2/14, 14%). Other differential diagnoses included pyoderma gangrenosum, Behçet's disease, and paraphimosis.

Diagnosis was most often established by tissue-based evaluation. Histopathology was performed in 20 cases (83%), while culture was positive for fungi in 14 cases (58%). Direct microscopy was used in 3 cases (13%), and molecular identification was performed in 3 cases (13%). In our institution's case, diagnosis was established by histopathology, immunohistochemistry, and tissue culture. Time from lesion onset to diagnosis was reported in 11 cases, with a median of 13 days (range, 5–46 days). Mucorales and *Histoplasma* were the most frequently identified fungi in our data set, with full pathogen

distribution shown in Table 1. Blood cultures were positive in 3 cases, including 2 cases of *Fusarium solani* fungemia that occurred over 30 days after onset of penile lesions.

Breakthrough infections occurred frequently. Ten patients (42%) had recent antifungal exposure before diagnosis: seven received prophylaxis and three received empiric antifungal therapy for a febrile syndrome. Six of these patients had received mold-active agents. Treatment varied by pathogen and disease extent. Commonly used regimens included amphotericin B monotherapy, mold-active azole monotherapy, and amphotericin B followed by an azole. Surgical intervention was performed in 15 cases (63%), including debridement, circumcision, resection, or penectomy. Penectomy was required in 5 cases (21%).

Disseminated disease occurred in 8 of 24 patients (33%), including 6 patients with neutropenia. Overall, 21 patients (88%) survived at last follow-up and 3 died (13%). All deaths occurred among patients with disseminated disease, and 2 of 3 patients who died had *Fusarium solani* identified as the causative pathogen with widespread dissemination to the lungs, heart, spleen, and kidneys.

Table 1

Summary of 24 cases of penile lesions as the initial manifestation or diagnostic site of invasive fungal disease

Demographics	
Age, median years (range)	56.5 (12–80)
Sex, male	24 (100%)
Underlying conditions	
Hematologic malignancy	8 (33%)
Neutropenia ^a	9 (38%)
Diabetes mellitus ^b	9 (38%)
Stem cell transplant ^c	4 (17%)
Solid organ transplant	1 (4%)
Presenting symptoms	
Fever	8/17 (47%)
Pain of penile lesion	13/21 (62%)
Dysuria	4/20 (20%)
Lesion morphology at presentation	
Ulcers	12 (50%)
Necrosis present	14/23 (61%)
Initial diagnostic impression	
Bacterial	6/14 (43%)
Malignancy	3/14 (21%)
Viral	3/14 (21%)

Denominators less than 24 are due to cases that did not report certain variables. Percentages may not sum up to 100% due to rounding and/or overlapping categories. ^a One patient with neutropenia did not have hematologic malignancy but had severe aplastic anemia. Two of the patients had strongly presumed neutropenia based on their chemotherapy regimens, although this was not explicitly documented. ^b One patient had hematologic malignancy and diabetes. ^c Three patients had both hematologic malignancy and stem cell transplant. ^d Included cases with recent empiric antifungal therapy that was not given as prophylaxis. ^e Included cases with *Rhizopus arrhizus* (n = 1), *Rhizopus oryzae* (n = 1), *Rhizopus microsporus* (n = 2), *Absidia corymbifera* (n = 1), and 4 with unidentified species. ^f One patient had *Candida*, *Mucor*, and *Cryptococcus* identified; one had *Rhizopus* and *Fusarium*; one had *Rhizopus* and Vancomycin-resistant *Enterococcus*. ^g All-cause mortality reflects deaths reported during available follow-up (range, 14 days – 4 years)

Demographics	
Drug reaction	2/14 (14%)
Recent antifungal exposure ^d	10 (42%)
Fluconazole	3 (13%)
Posaconazole	2 (8%)
Amphotericin B	2 (8%)
Voriconazole	1 (4%)
Itraconazole	1 (4%)
Micafungin	1 (4%)
Disseminated disease	8 (33%)
Diagnostic methods	
Histopathology	20 (83%)
Culture	14 (58%)
Direct microscopy	3 (13%)
Molecular methods	3 (13%)
Immunohistochemistry	1 (4%)
Pathogens	
Mucorales ^e	9 (38%)
<i>Histoplasma</i>	5 (21%)
<i>Fusarium</i>	4 (17%)
Polymicrobial ^f	3 (13%)
<i>Aspergillus flavus</i>	1 (4%)
Denominators less than 24 are due to cases that did not report certain variables. Percentages may not sum up to 100% due to rounding and/or overlapping categories. ^a One patient with neutropenia did not have hematologic malignancy but had severe aplastic anemia. Two of the patients had strongly presumed neutropenia based on their chemotherapy regimens, although this was not explicitly documented. ^b One patient had hematologic malignancy and diabetes. ^c Three patients had both hematologic malignancy and stem cell transplant. ^d Included cases with recent empiric antifungal therapy that was not given as prophylaxis. ^e Included cases with <i>Rhizopus arrhizus</i> (n = 1), <i>Rhizopus oryzae</i> (n = 1), <i>Rhizopus microsporus</i> (n = 2), <i>Absidia corymbifera</i> (n = 1), and 4 with unidentified species. ^f One patient had <i>Candida</i>, <i>Mucor</i>, and <i>Cryptococcus</i> identified; one had <i>Rhizopus</i> and <i>Fusarium</i>; one had <i>Rhizopus</i> and Vancomycin-resistant <i>Enterococcus</i>. ^g All-cause mortality reflects deaths reported during available follow-up (range, 14 days – 4 years)	

Demographics	
<i>Cryptococcus</i>	1 (4%)
<i>Paracoccidioides</i>	1 (4%)
Treatment	
Amphotericin B monotherapy	4/23 (17%)
Amphotericin B followed by azole monotherapy	5/23 (22%)
Azole monotherapy	6/23 (26%)
Other regimens	8/23 (35%)
Surgery	15 (63%)
All-cause mortality ^g	3 (13%)
Denominators less than 24 are due to cases that did not report certain variables. Percentages may not sum up to 100% due to rounding and/or overlapping categories. ^a One patient with neutropenia did not have hematologic malignancy but had severe aplastic anemia. Two of the patients had strongly presumed neutropenia based on their chemotherapy regimens, although this was not explicitly documented. ^b One patient had hematologic malignancy and diabetes. ^c Three patients had both hematologic malignancy and stem cell transplant. ^d Included cases with recent empiric antifungal therapy that was not given as prophylaxis. ^e Included cases with <i>Rhizopus arrhizus</i> (n = 1), <i>Rhizopus oryzae</i> (n = 1), <i>Rhizopus microsporus</i> (n = 2), <i>Absidia corymbifera</i> (n = 1), and 4 with unidentified species. ^f One patient had <i>Candida</i>, <i>Mucor</i>, and <i>Cryptococcus</i> identified; one had <i>Rhizopus</i> and <i>Fusarium</i>; one had <i>Rhizopus</i> and Vancomycin-resistant <i>Enterococcus</i>. ^g All-cause mortality reflects deaths reported during available follow-up (range, 14 days – 4 years)	

Discussion

To our knowledge, this is the first structured review on penile lesions as the initial manifestation or diagnostic site of IFD. Although dermatologic findings are recognized in several invasive mycoses, genital involvement is uncommon. As a result, clinicians may utilize a mental heuristic that favors more familiar causes of penile lesions, such as sexually transmitted infections or primary penile malignancies. Moreover, genital examination may not be routinely performed in patients without urologic complaints, even those with neutropenic fever, leading to additional delays in diagnosis. The present case of penile fusariosis illustrates many of these challenges and underscores the importance of early tissue sampling of atypical genital lesions in high-risk hosts.

Most patients in our review had established risk factors for IFD, including hematologic malignancy, neutropenia, stem cell transplantation, and diabetes mellitus. However, 25% of patients had no reported diabetes or major immunocompromising condition, suggesting that penile IFD should not be dismissed solely because classic host factors are absent. In such cases, traumatic inoculation, occupational or environmental exposure, or endemic fungal disease may be relevant. This distinction is important

because cutaneous IFD may reflect either primary inoculation or secondary hematogenous dissemination, and clinical morphology alone may not reliably distinguish between these entities.

The appearance of penile lesions was heterogeneous. Although ulceration and necrosis were common, lesions were also described as plaques, macules, nodules, bullae, or vesicles. This variability likely contributed to diagnostic mimicry, including bacterial soft tissue infection, herpes simplex virus infection, molluscum contagiosum, drug reactions, pyoderma gangrenosum, leukemia cutis, neutrophilic dermatoses, and penile malignancy. Importantly, the absence of fever or tenderness should not be reassuring in immunocompromised hosts, who may not mount typical inflammatory responses [34]. In a study of leukemia patients undergoing biopsy for new skin lesions, ulcerated or necrotic lesions and the presence of bacteremia or fungemia were independent predictors of an infectious etiology, whereas fever and neutropenia were not. Additionally, the study found that invasive mold infections were diagnosed by skin biopsy alone in 71% of patients [35]. In our cohort, fever was only documented in 47% of cases, while ulceration (50%) and necrosis (61%) were more frequent findings. These observations support a low threshold for biopsy of necrotic or ulcerated lesions, even when blood cultures are negative or initial clinical suspicion is low.

When IFD manifests as cutaneous genital lesions, biopsy may not merely confirm a suspected diagnosis but may be the decisive diagnostic event. However, clinicians may be hesitant to pursue biopsy in patients with hematologic malignancy and severe thrombocytopenia or neutropenia. Available data suggest that skin biopsy can often be performed safely in this population with appropriate supportive measures. In a retrospective study of acute myelogenous leukemia (AML) patients undergoing intensive chemotherapy, most biopsies were performed during severe neutropenia and moderate-to-severe thrombocytopenia, yet biopsy-related complications (e.g. bleeding) were uncommon [36].

Timely biopsy of penile lesions may provide an early window for diagnosis before widespread dissemination of IFD. Cutaneous IFD can herald occult or evolving multiorgan involvement, particularly in profoundly immunocompromised hosts. In our review, all deaths occurred among patients with disseminated disease. In particular, two of the fatal cases were neutropenic patients in whom *Fusarium solani* was identified as the causative pathogen. Both were found to have subsequent fungemia and multiorgan involvement despite appropriate antifungal therapy. This is consistent with prior literature showing that outcomes in fusariosis are strongly influenced by host immune status, neutrophil recovery, and fungemia [8, 37, 38].

This review also highlights that antifungal exposure does not exclude IFD. Of 24 patients, 10 had prior antifungal exposure, of which 6 had exposure to mold-active agents. Of note, all patients with *Fusarium* identified as the causative pathogen had recent antifungal prophylaxis or empiric antifungal treatment. This aligns with a large body of literature that shows that breakthrough invasive fusariosis is common despite mold-active triazoles, as well as breakthrough aspergillosis and mucormycosis [39–41].

This study has several important limitations. Published cases are subject to reporting bias, and unusual, severe, or diagnostically challenging presentations may be overrepresented. Case reports varied in the

granularity of clinical detail, including antifungal exposure, duration of neutropenia, immune recovery, susceptibility data, follow-up, and outcomes. Under-reporting of cases from low- and middle-income countries may contribute to underestimation of cases in these regions, particularly where certain geographically restricted mycoses may be more prevalent. Additionally, older cases may have involved pathogen misidentification when diagnosis relied primarily on histopathology. Because of small numbers of cases and incomplete denominators, associations between host factors, treatment, surgery, and outcomes cannot be inferred.

Finally, our review demonstrates the importance of pursuing prompt biopsy for atypical penile lesions in high-risk patients to facilitate timely recognition of IFD before irreversible dissemination. Further research is needed to elucidate outcomes in IFD with penile involvement and optimal management strategies.

Declarations

Ethics approval:

Ethical review and approval were not required for this single patient case report in accordance with the institutional policy of The University of Texas MD Anderson Cancer Center. Informed consent for publication was obtained from the patient.

Competing Interests

Competing Interests: D.P.K. received research support from Astellas Pharma and Basilea, and received consultant fees from Biosegren, Matinas, Basilea, Knight, Gilead Sciences, Pulmocide, and AVIR pharma. He was a member of the data review committee for MundiPharma Therapeutics. He is the president of the Mycoses Study Group.

Consent to publish:

Informed consent for publication was obtained from the patient whose clinical course is described in the section titled 'Case Report.'

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Author Contribution

Author Contributions: D.P.K. and A.D. contributed to conceptualization. Methodology, data curation, and formal analysis were performed by A.D., R.H., J.A. The first draft of the manuscript was written by A.D. D.P.K. was responsible for review and editing. All authors have read and agreed to the published version of the manuscript.

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Data Availability

Data Availability: All data are accessible in this manuscript and supplementary materials.

References

1. Akova U, Hicklen R, Lewis RE, Walsh TJ, Kontoyiannis DP. Fungal infections in patients with haematological malignancies in the pre-triazole era: the dawn of a new era in medical mycology. *Clin Microbiol Infect*. 2025;31:1647–54. <https://doi.org/10.1016/j.cmi.2025.06.003>
2. Little JS, Kampouri E, Friedman DZ, McCarty T, Thompson GR, Kontoyiannis DP, et al. The burden of invasive fungal disease following chimeric antigen receptor T-Cell therapy and strategies for prevention. *Open Forum Infect Dis*. 2024;11:ofae133. <https://doi.org/10.1093/ofid/ofae133>
3. Seidel D, Wurster S, Jenks JD, Sati H, Gangneux J-P, Egger M, et al. Impact of climate change and natural disasters on fungal infections. *Lancet Microbe*. 2024;5:e594–605. [https://doi.org/10.1016/S2666-5247\(24\)00039-9](https://doi.org/10.1016/S2666-5247(24)00039-9)
4. Shields BE, Rosenbach M, Brown-Joel Z, Berger AP, Ford BA, Wanat KA. Angioinvasive fungal infections impacting the skin. *J Am Acad Dermatol*. 2019;80:869–880.e5. <https://doi.org/10.1016/j.jaad.2018.04.059>
5. Colombo AL, De Almeida Júnior JN, Slavin MA, Chen SC-A, Sorrell TC. *Candida* and invasive mould diseases in non-neutropenic critically ill patients and patients with haematological cancer. *Lancet Infect Dis*. 2017;17:e344–56. [https://doi.org/10.1016/S1473-3099\(17\)30304-3](https://doi.org/10.1016/S1473-3099(17)30304-3)
6. Monzo-Gallo P, Teijon-Lumbreras C, Aiello TF, Gallardo-Pizarro A, Martinez-Urrea A, Chumbita M, et al. Epidemiological shifts of invasive fungal infections in the current era of haematology. *Med Mycol*. 2025;63:myaf070. <https://doi.org/10.1093/mmy/myaf070>
7. Denning DW. Global incidence and mortality of severe fungal disease. *Lancet Infect Dis*. 2024;24:e428–38. [https://doi.org/10.1016/S1473-3099\(23\)00692-8](https://doi.org/10.1016/S1473-3099(23)00692-8)
8. Campo M, Lewis RE, Kontoyiannis DP. Invasive fusariosis in patients with hematologic malignancies at a cancer center: 1998–2009. *J Infect*. 2010;60:331–7. <https://doi.org/10.1016/j.jinf.2010.01.010>

9. Kontoyiannis DP, Walsh TJ. Mucormycosis. *N Engl J Med*. 2026;394:684–98.
<https://doi.org/10.1056/NEJMra2412565>
10. Mays SR, Bogle MA, Bodey GP. Cutaneous fungal infections in the oncology patient: recognition and management. *Am J Clin Dermatol*. 2006;7:31–43. <https://doi.org/10.2165/00128071-200607010-00004>
11. Wise GJ, Talluri GS, Marella VK. Fungal infections of the genitourinary system: manifestations, diagnosis, and treatment. *Urol Clin North Am*. 1999;26:701–18. [https://doi.org/10.1016/S0094-0143\(05\)70212-3](https://doi.org/10.1016/S0094-0143(05)70212-3)
12. Bezzant M, Lago K, Calvano T. Case report of penile *Rhizopus arrhizus* infection in an unexpected patient. *Med Mycol Case Rep*. 2019;26:16–8. <https://doi.org/10.1016/j.mmcr.2019.09.008>
13. Chaurasia D, Agrawal R, Misra V, Bhargava A. Penoscrotal histoplasmosis following bladder carcinoma. *Int J Urol*. 2007;14:571–2. <https://doi.org/10.1111/j.1442-2042.2007.01766.x>
14. Choudhary A, Jangid NC, Shah B. Penile histoplasmosis in an immunocompetent host: A rare intruder in genital ulcer. *J Eur Acad Dermatol Venereol*. 2023;37:e221–2.
<https://doi.org/10.1111/jdv.18675>
15. Cohen-Ludmann C, Kerob D, Feuilhade M, Chaine B, Guermazi A, Janier M, et al. Zygomycosis of the penis due to *Rhizopus oryzae* successfully treated with surgical debridement and a combination of high-dose liposomal and topical amphotericin B. *Arch Dermatol*. 2006;142:1657–8.
<https://doi.org/10.1001/archderm.142.12.1657>
16. Darré T, Kpatcha M, Djiwa T, Sewa E, Dorkenoo AM, Kouyaté M, et al. African histoplasmosis of the penis. *Oxf Med Case Rep*. 2020;2020:omaa043. <https://doi.org/10.1093/omcr/omaa043>
17. Durand CM, Alonso CD, Subhawong AP, Kwiatkowski NP, Showel M, Carroll KC, et al. Rapidly progressive cutaneous *Rhizopus microsporus* infection presenting as Fournier’s gangrene in a patient with acute myelogenous leukemia. *Transpl Infect Dis*. 2011;13:392–6.
<https://doi.org/10.1111/j.1399-3062.2011.00601.x>
18. Grossklaus DJ, Dutta SC, Shappel SB, Kirchner FK. Cutaneous mucormycosis presenting as a penile lesion in a patient with acute myeloblastic leukemia. *J Urol*. 1999;161:1906–7
19. Hombalkar NN, Vaze D, Guha P, Dhandore PD, Gurav PD. Devastating penile mycosis leading to penile gangrene. *Urology*. 2013;82:704–6. <https://doi.org/10.1016/j.urology.2013.03.073>
20. Hosangadi C, Baranikumar. Isolated penile gangrene due to mucormycosis. *Indian J Urol*. 2023;39:S145.
21. Jain P, Rudramurthy S, Patil N, Dethe G, Patil A, Jessani L. *Fusarium* infection on the penile prepuce in an allogeneic transplant recipient. *Indian J Hematol Blood Transfus*. 2024;40:547–8.
<https://doi.org/10.1007/s12288-023-01729-z>
22. Karam A, Ianotto J-C, Metges J-P, Eveillard J-R, Leroy J-P, Le Flohic A-M, et al. Ulceration of the penis due to *Absidia corymbifera*. *Br J Dermatol*. 2003;148:1286–7. <https://doi.org/10.1046/j.1365-2133.2003.05371.x>

23. Krishinger GA, Forouzandeh M, Rodríguez JA, Ashouri K, Motaparathi K, Whiles BB. Successful management of angioinvasive deep fungal infections of the penis: a multidisciplinary approach with intraoperative frozen margins. *Am J Case Rep.* 2023;24:e939971. <https://doi.org/10.12659/AJCR.939971>
24. Lai M, Zhang W, Yang Z, Zhang W, Owusu-Ansah KG, Yu S, et al. First case report of isolated penile mucormycosis in a liver transplantation recipient. *Int J Infect Dis.* 2014;29:208–10. <https://doi.org/10.1016/j.ijid.2014.09.017>
25. Li B-K, Wang X, Ding Q. A case report of severe *Aspergillus flavus* penile infection. *Asian J Androl.* 2009;11:638–40. <https://doi.org/10.1038/aja.2009.45>
26. Lobo C, Bhagavan S, Ananthamurthy A. Deadly Mucor at an unusual site: A case report of isolated genital mucormycosis. *Int J Dermatol.* 2025;64:1675–6. <https://doi.org/10.1111/ijd.17647>
27. Londero AT, Fabricio R. Genital localization of South American Blastomycosis. A new case. *Mycopathol Mycol Appl.* 1966;30:253–6. <https://doi.org/10.1007/BF02053155>
28. Miyazaki M, Miyakoshi S, Kami M, Mori M, Kishi Y, Inagawa H, et al. Systemic fusariosis after a preparative regimen including thiotepe, VP-16 and busulfan used for blood stem cell transplantation in Hodgkin's disease. *Leuk Lymphoma.* 2001;40:441–4. <https://doi.org/10.3109/10428190109057947>
29. Narváez-Moreno B, Bernabeu-Wittel J, Zulueta-Dorado T, Conejo-Mir J, Lissen E. Primary cutaneous cryptococcosis of the penis. *Sex Transm Dis.* 2012;39:792–3. <https://doi.org/10.1097/OLQ.0b013e31825f7e28>
30. Okada K, Endo T, Hashimoto D, Saga T, Ara T, Ogasawara R, et al. Disseminated fusariosis emerged from prolonged local genital infection after cord blood transplantation. *J Infect Chemother.* 2018;24:660–3. <https://doi.org/10.1016/j.jiac.2017.12.018>
31. Paixão M, Miot HA, Avancini J, Belda Júnior W. Primary cutaneous histoplasmosis developed in the penis of an immunocompetent patient. *An Bras Dermatol.* 2015;90:255–7. <https://doi.org/10.1590/abd1806-4841.20153224>
32. Castellanos Posse M, Sanz P, Sanz A, Díez M, Radonich J, Carabajal G, et al. Glans penis primary cutaneous mucormycosis. In: 24th World Congress of Dermatology Abstract Book. Milan, Italy; 2019.
33. Sazdar S, Meyer A, Braudis K, Regunath H, Rojas-Moreno C. Breakthrough penile mucormycosis in a patient with acute myelogenous leukemia on posaconazole prophylaxis. *Infect Dis Clin Pract.* 2022;30:e1131. <https://doi.org/10.1097/IPC.0000000000001131>
34. Fadlalla S, Sprute R, Koehler P, Seifert H, Cornely OA. Skin signs of invasive fungal diseases: diagnostic clues for clinicians. *Curr Opin Infect Dis.* 2026;39:90–6. <https://doi.org/10.1097/QCO.0000000000001180>
35. Farmakiotis D, Ciurea AM, Cahuayme-Zuniga L, Kontoyiannis DP. The diagnostic yield of skin biopsy in patients with leukemia and suspected infection. *J Infect.* 2013;67:265–72. <https://doi.org/10.1016/j.jinf.2013.06.004>

36. Berger T, Sherman S, Hayman L, Wolach O, Shacham-Abulafia A, Raanani P, et al. Skin biopsies in acute myeloid leukemia patients undergoing intensive chemotherapy are safe and effect patient management. *Sci Rep.* 2021;11:11940. <https://doi.org/10.1038/s41598-021-91576-7>
37. Matsuo T, Wurster S, Jiang Y, Tarrand J, Kontoyiannis DP. Adjunct terbinafine in patients with leukemia and invasive fusariosis with skin lesions: discordance between responses of skin lesions and systemic outcomes. *Open Forum Infect Dis.* 2024;11:ofae068. <https://doi.org/10.1093/ofid/ofae068>
38. Matsuo T, Wurster S, Kontoyiannis DP. Good outcomes in salvage therapy of fusariosis in patients with leukemia: is it the host or the drug? *Clin Infect Dis.* 2024;79:571–2. <https://doi.org/10.1093/cid/ciad768>
39. Marchetti C, Glampedakis E, Stemler J, Hänsel L, Kuster S, Kronig I, et al. Breakthrough invasive mould infections under posaconazole prophylaxis in patients with haematologic malignancies: a case-control study. *Mycoses.* 2025;68:e70123. <https://doi.org/10.1111/myc.70123>
40. Matsuo T, Wurster S, Jiang Y, Sasaki K, Tarrand J, Lewis RE, et al. Invasive fusariosis in patients with leukaemia in the era of mould-active azoles: increasing incidence, frequent breakthrough infections and lack of improved outcomes. *J Antimicrob Chemother.* 2024;79:297–306. <https://doi.org/10.1093/jac/dkad377>
41. Lionakis MS, Lewis RE, Kontoyiannis DP. Breakthrough invasive mold infections in the hematology patient: current concepts and future directions. *Clin Infect Dis.* 2018;67:1621–30. <https://doi.org/10.1093/cid/ciy473>

Figures



Figure 1

(a) Multiple round ulcers on the tip of the penis with surrounding erythema. (b) Small right-sided hemiscrotal ulcer with central eschar. (c, d) Ulcers on the shaft and foreskin of the penis on hospital day 5. (e) Progressive ulceration of lesions and development of necrosis and hemorrhage on hospital day 6.

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