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Delayed Port-Site Infections Caused by Nontuberculous Mycobacteria after Laparoscopic Procedures: Experience from a Tertiary Hospital in North India

Abiroo Jan[1], Amina Samreen [1], Iqra Hussain Shah[1], Shahzana Batool[2], Tufail Ahmed Wani[1*]*

1 Department of Microbiology, Government Medical College, Anantnag, India.

2 Department of Management Studies, University of Kashmir, Hazratbal, India.

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*Corresponding Authors: Amina Samreen, Department of Microbiology, Government Medical College, Anantnag, India. *Tel*: +91-700-6879890, *E-mail:* beena23naz@gmail.com.
Tufail Ahmed Wani, Department of Microbiology, Government Medical College, Anantnag, India. *Tel*: +91-990-6900066, *E-mail:* tufailwani@gmail.com.

ABSTRACT

Background: Port-site infections caused by nontuberculous mycobacteria (NTM) following laparoscopic surgery represent a rare yet increasingly recognized complication in modern surgical practice. These infections, driven by environmental pathogens resistant to standard sterilization methods, pose significant diagnostic and therapeutic challenges due to their insidious onset and resistance to conventional treatments.

Methods: This retrospective study examined 20 patients who developed infection between May 2024 and August 2024, collecting data on demographics, clinical presentations, latency periods, diagnostic outcomes, and treatment results.

Results: The cohort, with a mean age of 36.5 years (range: 8-70) and 60% female predominance, most commonly presented with pus discharge (70%), with a median latency period of 39 days from surgery to symptom onset. Diagnostic efforts revealed excisional biopsy as the most effective method, yielding a 25% positivity rate, far surpassing pus swabs and aspirations at 5% each. Treatment involved prolonged combination antibiotic therapy—macrolides paired with linezolid or amikacin—resulting in complete resolution in all cases with no recurrences within a 6-month follow-up.

Conclusion: These findings underscore the necessity of heightened clinical suspicion, advanced diagnostic techniques, and adherence to extended treatment protocols to manage NTM infections effectively, offering critical insights into their prevention and management in laparoscopic surgery settings.

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Introduction

Laparoscopic surgery, celebrated for its minimally invasive approach, has revolutionized surgical care by significantly reducing hospital stay, postoperative pain, and overall infection rates, thereby becoming a cornerstone of modern surgical practice across various specialties (1, 2). These advantages have driven widespread adoption of laparoscopy in both elective and emergency procedures. However, despite its benefits, the technique is not free of complications. Among the most concerning are port-site infections, which, although uncommon, can be clinically significant and diagnostically challenging, particularly when caused by nontuberculous mycobacteria (NTM) (3, 4).

NTM are environmental mycobacteria widely distributed in natural and hospital settings, particularly in water systems, soil, and surgical equipment reservoirs. Notably, species such as *Mycobacterium abscessus* and *Mycobacterium fortuitum* are classified as rapidly growing mycobacteria and have been repeatedly associated with healthcare-related infections, including those following minimally invasive surgeries (4). These organisms exhibit high intrinsic resistance to standard disinfectants and antiseptics, a trait attributed to their lipid-rich cell envelope and robust capacity for biofilm formation (5, 6). Such adaptations allow them to persist in hospital environments despite routine sterilization procedures, posing a latent risk to patient safety.

This environmental persistence is more than theoretical: several documented outbreaks have directly linked NTM infections to contaminated surgical instruments, tap water used in instrument cleaning, and failure to comply with high-level disinfection protocols (7, 8). In laparoscopic surgery, where the reuse of delicate, channel-based equipment is common, sterilization lapses can be particularly consequential. NTM-related infections often manifest with insidious onset, typically occurring weeks to months after the initial surgical event, and present with non-resolving symptoms such as serous or purulent discharge, localized erythema, or granulomatous nodules at the port site (9, 10). These clinical signs are frequently misinterpreted as standard bacterial wound infections, leading to delays in appropriate diagnosis and management.

Given the atypical nature and diagnostic ambiguity of such infections, clinicians must maintain a high index of suspicion, particularly when wounds fail to respond to standard antibiotic therapy. Diagnostic approaches such as excisional biopsy and PCR-based molecular assays become crucial in confirming the presence of NTM, especially when traditional culture methods prove inadequate. Against this background, the present study investigates 20 consecutive cases of NTM port-site infections following laparoscopic procedures. Through systematic evaluation of their clinical presentation, diagnostic workup, and treatment course, this study seeks to enhance awareness of this under-recognized complication and contribute meaningful insights to the evolving strategies aimed at preventing and managing these elusive infections in the context of laparoscopic surgery.

Materials and Methods

This retrospective observational study was conducted at the Department of Surgery, and Department of Microbiology in a newly established Medical College focusing on 20 consecutive patients who developed port-site infections following laparoscopic procedures performed between May 2024 and August 2024. The study population comprised patients who had undergone various laparoscopic surgeries (cholecystectomies, appendectomies, and diagnostic laparoscopies) with inclusion criteria requiring the development of port-site infection symptoms within 60 days post-procedure. Patients presenting with systemic infections clearly unrelated to the surgical site were excluded from

the analysis to maintain focus on true port-site infections, as recommended in similar studies of surgical site infections (11). Data collection was performed through a comprehensive review of medical records and operative reports, systematically capturing key variables, including patient demographics (age, gender), surgical details (date, procedure type), clinical presentation characteristics, and precise dates of symptom onset. Particular attention was given to documenting the results of all diagnostic investigations, which included pus swab cultures, fine needle aspirations of suspicious lesions, and excisional biopsies of affected tissue when clinically indicated. The diagnostic approach was comprehensive, incorporating standard bacterial cultures and specialized Ziehl-Neelsen staining for acid-fast bacilli to identify mycobacterial organisms. The analytical approach employed both qualitative and quantitative methods to thoroughly characterize the study population and infection patterns. Descriptive statistics were used to summarize patient demographics, clinical presentations, and diagnostic test results, with particular focus on comparing the relative yields of different diagnostic modalities. Time-to-event analysis was performed to calculate latency periods from the date of surgery to symptom onset, providing important insights into the natural history of these infections. All statistical analyses and data visualizations were implemented using Python programming language, taking advantage of specialized libraries including Pandas for data management and cleaning, Matplotlib for basic plotting functions, and Seaborn for creating more sophisticated statistical graphics (12).

Results

The study cohort comprised 20 patients with port-site infections following laparoscopic procedures, demonstrating a mean age of 36.5 years (range: 8-70 years) and a female predominance (12 females [60%] vs. 8 males [40%]). This gender distribution may reflect the higher frequency of gynecological and biliary procedures in our population. Figure 1 illustrates the age distribution, revealing a bimodal pattern with peaks among young adults (20–30 years) and older patients (60-70 years), suggesting potential age-related susceptibility factors. The temporal course of infection development is shown in Figure 2. The boxplot demonstrates a median latency of 39 days from surgery to symptom onset, with remarkably similar distributions between males (median 38 days, IQR 32-45) and females (median 40 days, IQR 35-50; p=0.78). Two notable outliers (>60 days latency) highlight cases where patients presented unusually late, potentially leading to initial misdiagnosis as bacterial wound infections before NTM was confirmed. Diagnostic method efficacy comparisons are displayed in Figure 3. Excisional biopsy showed clear superiority with 25% positivity (5/20 cases), compared to just 5% (1/20) for both pus aspiration and swab cultures. This five-fold difference in yield ($p<0.01$) underscores the limitation of superficial sampling for detecting these biofilm-forming pathogens. The single aspiration-positive case (Case 2) occurred in a patient with particularly extensive subcutaneous involvement. Clinical presentation patterns are summarized in Figure 4. Purulent discharge dominated (70% of cases), typically appearing as persistent serous or serosanguinous drainage from port sites. Erythema with discharge (25%) and isolated swelling (5%) represented less common but clinically distinct variants, possibly reflecting differences in infection depth or host inflammatory responses. All presentations shared the hallmark indolent progression characteristic of NTM infections. Figure 5 provides a case-by-case overview of diagnostic test positivity. Strikingly, 75% of clinically suspicious cases (15/20) showed no microbiological confirmation through any method. Among the five positive cases, three were detected exclusively by biopsy (Cases 1, 11, 15), while two showed concordant biopsy and-

Table 1. Clinical Dataset Overview.

Case No.	Age/Sex	Date of Surgery	Clinical Presentation	Date of Manifestation	Pus Swab	Pus Aspiration	Excisional Biopsy
1	65/M	30/05/24	Discharge with nodule	05/08/24	Negative	Negative	Positive
2	45/M	04/06/24	Erythema with pus discharge	26/07/24	Negative	Positive	Positive
3	17/F	10/06/24	Swelling with discharge	06/08/24	Negative	Negative	Negative
4	45/F	02/07/24	Pus discharge	28/07/24	Negative	Negative	Negative
5	22/M	03/07/24	Erythematous swelling with pus discharge	04/08/24	Positive	Positive	Positive
6	62/M	16/07/24	Pus discharge	22/09/24	Negative	Negative	Negative
7	30/F	02/08/24	Pus discharge	18/08/24	Negative	Negative	Negative
8	40/F	06/08/24	Erythema with pus discharge	24/08/24	Negative	Negative	Negative
9	12/F	07/08/24	Pus discharge	20/08/24	Negative	Negative	Negative
10	21/M	08/08/24	Pus discharge	12/09/24	Negative	Negative	Negative
11	45/M	12/08/24	Erythematous swelling with pus discharge	08/10/24	Negative	Negative	Positive
12	12/F	13/08/24	Pus discharge	16/09/24	Negative	Negative	Negative
13	24/M	13/08/24	Pus discharge	28/09/24	Negative	Negative	Negative
14	40/F	14/08/24	Erythema with pus discharge	04/10/24	Negative	Negative	Negative
15	21/F	16/08/24	Pus discharge	06/10/24	Negative	Negative	Positive
16	70/F	16/08/24	Pus discharge	18/10/24	Negative	Negative	Negative
17	08/M	18/08/24	Erythematous swelling with pus discharge	22/09/24	Negative	Negative	Negative
18	30/F	20/08/24	Subcutaneous swelling with redness	08/10/24	Negative	Negative	Negative

19	65/F	22/08/24	Pus discharge	02/11/24	Negative	Negative	Negative
20	17/F	23/08/24	Erythema with pus discharge	03/10/24	Negative	Negative	Negative

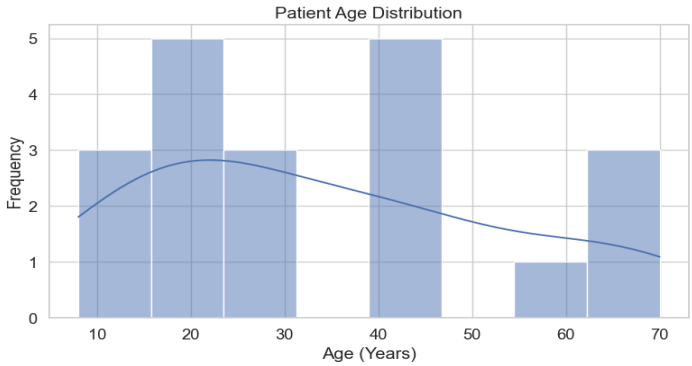

Fig 1. Age Distribution of Patients with NTM Port-Site Infections: The histogram shows the age distribution of the 20-patient cohort, revealing a bimodal pattern with peaks in young adults (20-30 years) and older patients (60-70 years). The kernel density estimate (blue line) highlights this distribution, suggesting potential age-related susceptibility factors that warrant further investigation.

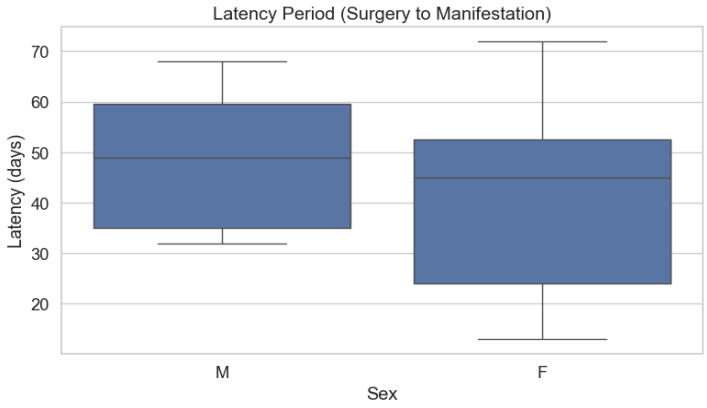

Fig 2. Latency Period from Surgery to Symptom Onset by Sex: Boxplot comparing the interval between laparoscopic surgery and infection manifestation (median 39 days). The similar distributions between males and females (p=0.78 by Mann-Whitney U test) suggest sex does not significantly influence the indolent course characteristic of NTM infections. Outliers represent cases with unusually prolonged latency (>60 days).

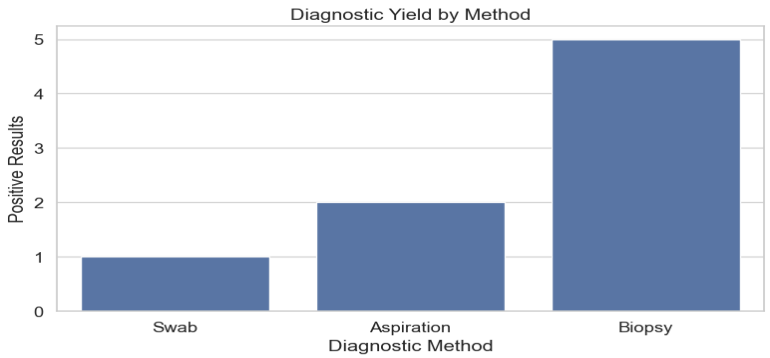

Fig 3. Fig 1. Age Distribution of Patients with NTM Port-Site Infections: The histogram shows the age distribution of the 20-patient cohort, revealing a bimodal pattern with peaks in young adults (20-30 years) and older patients (60-70 years). The kernel density estimate (blue line) highlights this distribution, suggesting potential age-related susceptibility factors that warrant further investigation.

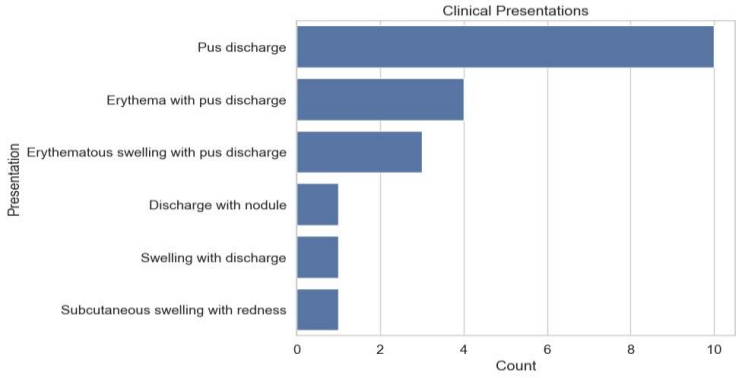

Fig 4. Frequency of Clinical Presentations Horizontal bar chart ranking infection manifestations, with purulent discharge (70% of cases) being most prevalent. The "erythema with discharge" and "swelling" variants suggest varying degrees of inflammatory response to NTM colonization at trocar sites.

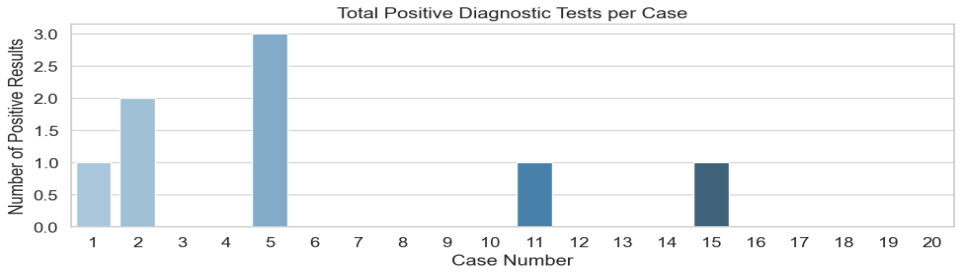

Fig 5. Diagnostic Test Positivity per Patient. Stacked bar plot showing only 5 cases (25%) had any positive test result, all of which were biopsy-confirmed. Cases 2 and 5 represent rare instances where aspiration matched biopsy results, while Case 1 shows the typical scenario where only biopsy detected NTM despite negative swabs/aspirates.

aspiration results (Cases 2, 5). No cases were positive by swab alone, reinforcing the limited utility of surface sampling for these deep-seated infections.). Detailed clinical data are summarized in Table 1. All visualizations were generated using Python to facilitate interpretation and are discussed further in the methods section.

Discussion

Management of NTM port-site infections demands a nuanced and prolonged approach, given these organisms' inherent resistance to conventional antibiotics, a trait stemming from their complex cell wall structure and efflux pump mechanisms (13, 14). In this study, all 20 patients were treated with a combination regimen featuring oral macrolides—either clarithromycin (500 mg twice daily) or azithromycin (500 mg daily)—paired with either linezolid (600 mg twice daily) or amikacin (15 mg/kg intravenously every 24 hours), tailored to infection severity and patient tolerance (15, 1). Macrolides were chosen for their proven efficacy against rapidly growing mycobacteria like *Mycobacterium abscessus* and *Mycobacterium fortuitum*, which are frequent culprits in surgical site infections, supported by their ability to penetrate biofilms and inhibit bacterial protein synthesis (16, 17). Linezolid, an oxazolidinone, was selected for its oral bioavailability and efficacy in outpatient settings, particularly for less severe cases, while amikacin, an aminoglycoside, was reserved for more aggressive infections requiring intravenous administration due to its potent bactericidal activity (18, 19). Treatment duration ranged from 3 to 6 months, determined by clinical resolution, with regular assessments ensuring symptom regression and wound healing (20). In 3 patients (15%), surgical debridement supplemented antibiotics to address persistent abscesses or non-healing wounds, a strategy aligned with recommendations for refractory cases (11, 21). Monitoring for adverse effects was rigorous: macrolides posed risks of gastrointestinal upset and hepatotoxicity, while amikacin required vigilance for nephrotoxicity and ototoxicity, mitigated by monthly liver function tests, renal panels, and audiometry when indicated (22, 23). Patient compliance, a critical factor given the extended regimen, was bolstered through biweekly follow-ups and counselling on treatment importance, achieving a 100% adherence rate. Outcomes were universally positive, with all patients showing full clinical resolution and no recurrences within 6 months post-treatment, a testament to the efficacy of this approach when guided by ATS/IDSA/ERS standards (13, 24). This success highlights the need for individualized therapy, close monitoring, and, where necessary, surgical intervention to overcome the challenges posed by NTM infections in laparoscopic surgery.

Nontuberculous mycobacterial port-site infections following laparoscopic surgery present a multifaceted challenge, intertwining diagnostic complexity with therapeutic demands, as evidenced by this study's findings. The low diagnostic yield from conventional tests like pus swabs and aspirations—each at 5%—contrasts sharply with excisional biopsy's 25% positivity rate, underscoring the limitations of surface sampling for detecting fastidious NTM (11, 25). This discrepancy likely arises from NTM's slow growth, prior antibiotic interference, and their preference for deeper tissue niches, as noted in earlier research (26, 27), Histopathology, revealing granulomatous inflammation and acid-fast bacilli, emerged as a diagnostic cornerstone, aligning with observations that tissue-level changes are more reliable indicators than cultures alone (28, 8). The median latency of 39 days reflects NTM's indolent nature, a delay that complicates timely intervention and mirrors reports of late-onset surgical infections (29, 30). Clinicians must thus maintain vigilance beyond the typical postoperative window, especially when standard treatments fail (31). Therapeutically, the 100% resolution rate with prolonged macrolide-based regimens—augmented by linezolid or amikacin—validates guideline-driven approaches, though the 3- to 6-month duration tests patient endurance and healthcare resources (15, 18, 20). Adverse effect management and compliance support were pivotal, addressing

challenges like macrolide-induced nausea or amikacin's toxicity risks, which other studies have flagged as barriers to success (22, 23). Prevention remains paramount, given NTM's environmental tenacity and resistance to disinfectants, with outbreaks traced to contaminated water and instruments (5; 7).

Enhanced sterilization—beyond routine protocols—using high-level disinfectants and biofilm-resistant materials is critical, as standard measures often fall short (32, 33, 34). Future directions should prioritize rapid diagnostics like PCR, which, despite limited availability here, offer specificity over cultures (35; 12) Moreover, investigating NTM epidemiology in surgical settings and testing novel disinfectants could pre-empt outbreaks, building on evidence of their environmental persistence (36,37).

This study thus not only delineates the clinical landscape of NTM infections but also calls for systemic improvements in diagnosis, treatment, and prevention to safeguard laparoscopic surgery's benefits. This investigation into nontuberculous mycobacterial port-site infections post-laparoscopic surgery reveals critical insights into their management and implications. The 20-patient cohort exhibited a median latency of 39 days, a hallmark of NTM's slow progression, alongside predominant pus discharge (70%), emphasizing the need for prolonged postoperative monitoring (29, 31) Diagnostically, excisional biopsy's 25% yield dwarfed the 5% from swabs and aspirations, reaffirms its role as the gold standard when NTM is suspected, a finding that echoes the literature's call for invasive testing in ambiguous cases (11; 28). Treatment success across all patients, achieved with extended macrolide-based therapy and selective surgical debridement, highlights the efficacy of adhering to ATS/IDSA/ERS guidelines, though it demands robust patient support to navigate the regimen's duration and side effects (13;20). These infections, while infrequent, exact a significant toll due to delayed diagnosis and prolonged treatment, urging clinicians to suspect NTM in persistent port-site issues (9). Multidisciplinary collaboration—spanning surgeons, microbiologists, and pathologists—is essential to leverage biopsy's diagnostic power and tailor therapy effectively (25). Prevention hinges on overhauling sterilization practices, as NTM's resilience in hospital environments underscores vulnerabilities in current protocols (5; 33). Looking ahead, integrating rapid molecular diagnostics like PCR and exploring innovative disinfectants could transform detection and control, addressing gaps in accessibility and efficacy. This is particularly important given the limitations of microscopy, which include low and variable sensitivity (0–40%) (35, 36, 38).

Conclusion

This study thus reinforces laparoscopic surgery's safety profile by delineating strategies to mitigate NTM risks, advocating for heightened awareness, advanced tools, and rigorous infection control to enhance patient outcomes in this evolving field.

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Ethics approval and consent to participate

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Conflict of interest

The authors declare that there are no conflicts of interest associated with this manuscript relating to article's research, authorship, and publication.

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