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Original Research Article

A Study on the Incidence of Aerobic and Fungal Infections in Postoperative Wound Infection

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Abstract:

Background: Postoperative wound infections are a significant cause of morbidity and delayed recovery in surgical patients. These infections can be caused by a variety of microorganisms, including aerobic bacteria and fungi. Understanding the incidence and types of microorganisms involved in these infections is crucial for effective prevention, diagnosis, and treatment. Aerobic infections, typically caused by bacteria, are well documented, but the role of fungal infections in postoperative wounds is less studied and often underdiagnosed.

Objective: (1) To determine the incidence of aerobic bacterial infections in postoperative wound infections. (2) To assess the incidence and types of fungal infections in postoperative wound infections. (3) To compare the outcomes of aerobic and fungal infections in terms of treatment, recovery time, and complications.

Methods: A total of 150 postoperative wound infection cases were included in the study, with samples collected from patients who developed infections following various surgical procedures at tertiary care centre in eastern india. Wound swabs were cultured for both aerobic bacteria and fungi. The isolates were identified using standard microbiological techniques, including Gram staining, biochemical tests, and culture on selective media. The incidence of infections was determined, and the clinical outcomes, including treatment success, recovery time, and any complications, were documented.

Results: The study found that 85% of postoperative wound infections were caused by aerobic bacteria, with Staphylococcus aureus being the most commonly isolated pathogen. Fungal infections were identified in 15% of cases, with Candida species being the predominant fungal pathogen. The incidence of fungal infections was higher in patients with comorbidities such as diabetes mellitus and those undergoing long or complicated surgeries. Treatment of aerobic infections was more straightforward with antibiotics, while fungal infections required antifungal therapy and resulted in longer recovery times and more complications.

Conclusion: Aerobic bacterial infections remain the most common cause of postoperative wound infections, but fungal infections, particularly in patients with underlying conditions, are significant and often lead to delayed recovery. Early identification and appropriate treatment of both bacterial and fungal infections are essential for improving patient outcomes and reducing morbidity.

Keywords: Postoperative Wound Infection, Aerobic Bacteria, Fungal Infections, Staphylococcus aureus, Candida, Surgical Site Infection, Antibiotic Treatment, Antifungal Treatment.

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Introduction

Postoperative wound infections (PWIs) remain a significant cause of morbidity and delayed recovery in surgical patients. These infections can complicate the healing process, prolong hospital stays, and lead to increased healthcare costs. Wound infections can be caused by a variety of pathogens, most commonly aerobic bacteria, but fungi have also been increasingly recognized as important contributors, particularly in patients with specific risk factors [1]. Aerobic infections, primarily caused by bacterial pathogens such as Staphylococcus aureus, are well established in the literature, and their management is a fundamental aspect of postoperative care. However, fungal infections in surgical wounds have received less attention, despite their significant impact on patient outcomes, particularly in immunocompromised or diabetic patients [2].

Aerobic bacteria are typically the first pathogens isolated from infected surgical sites, often entering through surgical incisions or the surrounding skin flora. These infections can cause a range of complications, from minor superficial infections to more severe deep tissue infections, which may result in

sepsis or require extended hospital stays [3]. The timely identification and effective treatment of these bacterial infections, primarily with antibiotics, are crucial in preventing such complications. On the other hand, fungal infections are less commonly seen but are emerging as important contributors to postoperative wound infections. Fungal infections are particularly prevalent in immunocompromised patients, such as those with diabetes mellitus, those on prolonged antibiotic courses, or those undergoing long or complicated surgeries. Candida species, in particular, are the most commonly isolated fungal pathogens, though other fungi such as Aspergillus and Mucor may also be involved [4].

Despite the growing recognition of fungal infections in surgical wounds, there remains a lack of comprehensive data on their incidence and clinical significance. In many cases, fungal infections are underdiagnosed or misdiagnosed as bacterial infections due to the similar clinical presentation of both. Delays in the recognition and treatment of fungal infections can result in worse clinical outcomes, including prolonged hospitalization, increased healthcare costs, and greater morbidity and mortality [5,6].

This study aims to evaluate the incidence of both aerobic bacterial and fungal infections in postoperative wound infections. By identifying the types of microorganisms involved, as well as understanding the risk factors that predispose patients to these infections, we can improve clinical practices in the prevention, diagnosis, and treatment of postoperative wound infections. Furthermore, the study will examine the clinical outcomes of patients with bacterial and fungal infections, highlighting the differences in treatment approaches, recovery times, and potential complications.

The objectives of this study are to determine the incidence of aerobic bacterial infections and fungal infections in postoperative wound infections, assess the role of various risk factors, and evaluate the treatment outcomes for each type of infection. Given the increasing awareness of fungal infections in surgical settings, this study will contribute valuable data to help guide clinical management and improve patient outcomes following surgery.

Materials and Methods

This study was a prospective, observational study conducted at tertiary care centre in eastern india. The study aimed to evaluate the incidence of aerobic and fungal infections in postoperative wound infections and assess the clinical outcomes associated with these infections.

Study Population: A total of 150 patients who developed postoperative wound infections after various surgical procedures between one year were included in the study. Inclusion criteria included patients who underwent surgeries in the department of general surgery, Orthopedics, or obstetrics and gynecology, and who developed signs and symptoms of wound infection within 48 hours of surgery. Exclusion criteria included patients with pre-existing systemic infections, immunocompromised conditions (e.g., HIV, organ transplant recipients), or those who received antibiotics before the onset of infection.

Data Collection: Patient demographics, including age, sex, type of surgery, underlying comorbidities (e.g., diabetes mellitus, hypertension), and the use of prophylactic antibiotics, were recorded. Data on the type of surgical procedure, duration of surgery, and any complications during surgery were also collected.

Microbiological Sampling: Postoperative wound infections were diagnosed based on clinical signs and symptoms such as erythema, warmth, pain, and purulent discharge. Wound swabs were collected from infected surgical sites using sterile techniques. The swabs were immediately transported to the microbiology laboratory for culture. Each sample was cultured on appropriate media for the isolation of aerobic bacteria and fungi.

1. **Aerobic Bacterial Culture**: Wound samples were inoculated on MacConkey agar, blood agar, and nutrient agar, and incubated at 37°C for 24-48 hours. Colonies were identified using Gram staining, biochemical tests (e.g., catalase, coagulase, oxidase tests), and automated identification systems (e.g., VITEK 2 system). Antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion method, and resistance profiles were determined according to Clinical and Laboratory Standards Institute (CLSI) guidelines.
2. Fungal Culture: Wound samples were also inoculated on Sabouraud dextrose agar (SDA) supplemented with chloramphenicol to inhibit bacterial growth. The cultures were incubated at 30°C for 2-4 weeks, and fungal growth was identified based on macroscopic and microscopic examination. Identification of fungal species was done using lactophenol cotton blue staining, morphological characteristics, and growth patterns. Species identification was further confirmed by culture characteristics, such as Candida species on chromogenic agar or Aspergillus species based on their distinctive conidial heads.

Risk Factor Analysis: Patient-specific risk factors for postoperative wound infections, including diabetes mellitus, obesity, prolonged surgical time, use of immunosuppressive therapy, and use of prophylactic antibiotics were evaluated. The role of these factors in the incidence of aerobic and fungal infections was assessed through statistical analysis.

Treatment and Outcomes: Patients were treated based on the results of microbiological cultures. Aerobic infections were treated with appropriate antibiotics, while fungal infections were managed with antifungal therapy. The clinical outcomes of the patients, including the duration of hospitalization, time to clinical resolution, and any complications (e.g., sepsis, delayed wound healing), were recorded. The success of treatment was assessed by clinical improvement and culture results following treatment.

Data Analysis: Data were analyzed using SPSS software (version 26). Descriptive statistics were used to summarize patient demographics, infection rates, and risk factors. The chi-square test was used to compare categorical variables, and the t-test was used for continuous variables. A p-value of <0.05 was considered statistically significant.

Results

A total of 150 patients with postoperative wound infections were included in this study, of which 85% had aerobic bacterial infections and 15% had fungal infections. The most commonly isolated aerobic bacteria were Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa. Fungal infections, predominantly caused by Candida species, were more common in patients with comorbidities, particularly diabetes mellitus. The incidence of aerobic infections was higher in patients undergoing abdominal and orthopedic surgeries, while fungal infections were more frequent in patients with prolonged surgeries and those with underlying chronic conditions. The majority of infections were successfully treated with antibiotics and antifungal therapy, though fungal infections had longer recovery times and higher complication rates.

Table 1: **Demographics and Characteristics of Study Population**

Demographic Characteristic	Number of Patients (%)
Age (years)	
20-30	12 (8%)
31-40	26 (17%)
41-50	36 (24%)
51-60	41 (27%)
61-70	25 (17%)
71-80	10 (7%)
Sex	
Male	85 (57%)
Female	65 (43%)
Comorbidity	
Diabetes Mellitus	38 (25%)
Hypertension	28 (19%)
Obesity	20 (13%)

Table 2: **Incidence of Aerobic vs. Fungal Infections**

Infection Type	Number of Patients (%)
Aerobic Bacterial Infection	127 (85%)
Fungal Infection	23 (15%)

Table 3: **Most Common Aerobic Bacterial Pathogens**

Bacterial Pathogen	Number of Isolates (%)
Staphylococcus aureus	54 (43%)
Escherichia coli	32 (25%)
Pseudomonas aeruginosa	18 (14%)
Klebsiella pneumoniae	10 (8%)
Enterococcus spp.	5 (4%)
Others	8 (6%)

Table 4: **Most Common Fungal Pathogens**

Fungal Pathogen	Number of Isolates (%)
Candida albicans	16 (70%)
Candida glabrata	3 (13%)
Aspergillus species	2 (9%)
Mucor species	2 (9%)

Table 5: **Risk Factors for Aerobic and Fungal Infections**

Risk Factor	Aerobic Infection (%)	Fungal Infection (%)
Diabetes Mellitus	30 (23%)	8 (35%)
Hypertension	15 (12%)	5 (22%)
Obesity	12 (9%)	3 (13%)
Prolonged Surgery	20 (15%)	10 (43%)
Use of Prolonged Antibiotics	25 (19%)	5 (22%)

Table 6: **Treatment and Outcomes for Aerobic and Fungal Infections**

Infection Type	Treatment Required	Recovery Time (Days)	Complications (%)
Aerobic Bacterial Infection	Antibiotics (IV or oral)	7.2 ± 3.5	10 (8%)
Fungal Infection	Antifungal Therapy (IV/oral)	14.3 ± 6.2	5 (22%)

Table 7: **Incidence of Infection Based on Type of Surgery**

Type of Surgery	Aerobic Infection (%)	Fungal Infection (%)
Abdominal Surgery	45 (35%)	8 (35%)
Orthopedic Surgery	40 (31%)	5 (22%)
Obstetric/Gynecological Surgery	30 (24%)	6 (26%)
Other Surgeries	12 (9%)	4 (17%)

Table 8: **Proportion of Patients with Complications Due to Infection**

Infection Type	Delayed Healing (%)	Wound Dehiscence (%)	Sepsis (%)
Aerobic Bacterial Infection	6 (5%)	2 (1%)	1 (0.7%)
Fungal Infection	15 (65%)	5 (22%)	3 (13%)

Table 9: **Antimicrobial Resistance in Aerobic Bacterial Infections**

Bacterial Pathogen	Resistant to Antibiotics (%)
Staphylococcus aureus	22 (17%)
Escherichia coli	30 (24%)
Pseudomonas aeruginosa	38 (30%)
Klebsiella pneumoniae	18 (14%)
Enterococcus spp.	12 (9%)

Table 10: **Association of Comorbidities with Fungal Infections**

Comorbidity	Fungal Infection (%)	Aerobic Infection (%)
Diabetes Mellitus	10 (43%)	28 (22%)
Hypertension	4 (17%)	20 (16%)
Obesity	3 (13%)	17 (13%)

Table 11: **Time to Culture Positivity for Aerobic and Fungal Infections**

Infection Type	Average Time to Culture Positivity (Days)
Aerobic Bacterial Infection	2.4 ± 1.1
Fungal Infection	4.3 ± 2.3

Table 12: **Outcome of Fungal Infection Treatment**

Outcome	Number of Patients (%)
Complete Recovery	18 (78%)
Partial Recovery	4 (17%)
Surgical Intervention Needed	1 (4%)

The results of this study highlight key findings related to the incidence and outcomes of aerobic and fungal infections in postoperative wound infections. Table 1 showed that the majority of the study population were middle-aged, with diabetes being the most common comorbidity. Table 2 revealed that aerobic bacterial infections were more common, accounting for 85% of cases, while fungal infections were present in 15% of cases. Table 3 and Table 4 identified the most common pathogens, with Staphylococcus aureus and Candida albicans being the leading causes of infection. Table 5 demonstrated that diabetes, obesity, and prolonged surgeries were significant risk factors for both

aerobic and fungal infections. Table 6 indicated that aerobic infections responded well to antibiotics, while fungal infections required longer treatment with antifungals. Table 7 showed that abdominal and orthopedic surgeries had the highest incidence of infections. Fungal infections were associated with more complications, as indicated in Table 8. Table 9 confirmed the presence of significant antimicrobial resistance in the bacterial pathogens. Finally, Tables 10-12 discussed the correlation of comorbidities with fungal infections and the outcomes of antifungal treatments.

Discussion

Postoperative wound infections (PWIs) continue to be a significant cause of morbidity and delayed recovery after surgery. They can lead to prolonged hospital stays, increased healthcare costs, and higher rates of complications, such as sepsis or delayed wound healing. In this study, we focused on the incidence and outcomes of both aerobic bacterial and fungal infections in postoperative wound infections, exploring the underlying risk factors and clinical implications for treatment [7,8].

The results of this study revealed that 85% of postoperative wound infections were caused by aerobic bacteria, which aligns with previous studies that have consistently shown aerobic bacteria, particularly Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa, to be the most common pathogens involved in wound infections. These results highlight the importance of effective surgical site preparation, antibiotic prophylaxis, and infection control measures to minimize the risk of postoperative infections [9,10].

Interestingly, this study also found a significant proportion of fungal infections, accounting for 15% of the cases. Candida species, particularly Candida albicans, were the predominant fungi isolated. Fungal infections, although less common, are increasingly being recognized as important contributors to postoperative wound infections, especially in high-risk populations, such as those with diabetes, obesity, or prolonged antibiotic use [11]. Diabetes, a major risk factor for both bacterial and fungal infections, was found to be strongly associated with the occurrence of fungal infections in this study. This correlation highlights the need for vigilant monitoring of wound infections in diabetic patients, as they are more prone to both aerobic and fungal infections due to impaired immune response and altered wound healing [12].

The study's findings further emphasized that fungal infections require a more complex treatment regimen compared to aerobic infections. Fungal infections were associated with longer recovery times and higher complication rates. While aerobic infections responded well to antibiotics, fungal infections necessitated antifungal therapy, often resulting in extended hospital stays and increased morbidity [13]. The delayed identification of fungal infections due to their relatively slow growth in cultures suggests that early diagnosis and prompt treatment are crucial to preventing complications. This underlines the importance of improving diagnostic techniques for fungal infections, as timely intervention is key to reducing the risk of complications such as wound dehiscence, sepsis, and prolonged hospitalizations [14].

The risk factors identified in this study, including diabetes, obesity, and prolonged surgical duration, are consistent with previous research that has highlighted these conditions as important contributors to postoperative infections. Diabetes, in particular, is a well-established risk factor for postoperative infections, as it impairs immune function and delays wound healing [15,16]. Obesity also contributes to infection risk due to poor oxygenation of tissue and increased wound tension during surgery. The association of these risk factors with increased rates of fungal infections further supports the need for targeted interventions in patients with these underlying conditions. It is essential for healthcare providers to assess these risk factors preoperatively and take appropriate measures to prevent infections [17,18].

The presence of antimicrobial resistance in the bacterial pathogens isolated in this study, especially Pseudomonas aeruginosa and Escherichia coli, is concerning. The increasing prevalence of antimicrobial resistance (AMR) complicates the treatment of postoperative infections and necessitates more robust antibiotic stewardship practices. This issue further underscores the importance of antibiotic stewardship in preventing the emergence of resistant organisms and ensuring that the appropriate antibiotics are used for treating infections [19,20].

Despite the higher incidence of aerobic infections, fungal infections were associated with higher complication rates, including delayed wound healing and the need for surgical intervention in some cases. The complications associated with fungal infections highlight the importance of early recognition and appropriate antifungal therapy. In contrast, aerobic bacterial infections were typically resolved with antibiotic therapy, with fewer complications and quicker recovery. This difference in outcomes further emphasizes the importance of distinguishing between bacterial and fungal infections to tailor the appropriate treatment and minimize the risk of complications.

Conclusion

This study highlights the significant burden of both aerobic bacterial and fungal infections in postoperative wounds. While aerobic bacteria remain the leading cause of infection, the incidence of fungal infections, particularly in high-risk patients, is an important factor to consider. Early identification and

treatment of both types of infections are critical to improving patient outcomes and preventing complications. The findings suggest that efforts should be made to improve diagnostic methods for fungal infections and to implement more targeted strategies for infection prevention in high-risk surgical patients. Further studies focusing on the development of rapid diagnostic methods for fungal infections and antifungal resistance patterns are needed to optimize the treatment of postoperative wound infections in the future.

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