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Original Research

Comparative Study of Fungal Infections in Renal Transplant Recipients vs. Non-Transplant Patients: A Microbiological and Pathological Assessment

[1]Harnish Kantilal Badami, [2]Ritika Garg

[1]Assistant Professor, Department of Pathology, Lord Buddha Koshi Medical College and Hospital, Saharsa, Bihar, India;
[2]Assistant Professor, Department of Microbiology, KM Medical College and Hospital, Mathura, UP, India

ABSTRACT:
Aim: This study aimed to compare the prevalence, types, clinical manifestations, and outcomes of fungal infections in renal transplant recipients versus non-transplant patients, with a focus on microbiological and pathological assessments. The study aimed to assess how immunosuppression in renal transplant recipients affects the susceptibility to fungal infections compared to non-transplant individuals. **Material and Methods:** This comparative study included 100 patients, with 50 renal transplant recipients and 50 non-transplant patients, aged 18-75 years, admitted to a hospital for various conditions. Renal transplant recipients had received their transplant within the last 12 months and were on immunosuppressive therapy. Non-transplant patients had chronic kidney disease or other medical conditions not requiring immunosuppression. Microbiological samples (blood, urine, sputum, and tissue biopsies) were obtained and fungal cultures were performed using standard techniques. Fungal identification was achieved via microscopic examination, biochemical tests, and PCR. Clinical data, treatment regimens, and outcomes were documented, and histopathological examination of tissue samples was conducted. **Results:** The study found that 36% of renal transplant recipients had fungal infections, significantly higher than the 16% observed in non-transplant patients ($p = 0.03$). *Candida albicans* was the most commonly isolated fungus in both groups (55.6% in renal transplant recipients vs. 50% in non-transplant patients), followed by *Aspergillus spp.*, *Cryptococcus neoformans*, *Mucor spp.*, and *Fusarium spp.*. The clinical manifestations were similar across both groups, with fever being the most common symptom. Histopathological analysis revealed no significant differences in fungal elements or tissue damage between the groups. Both groups had similar recovery rates (88.9% in transplant recipients and 100% in non-transplant patients), though the mortality rate was higher in transplant recipients (11.1%) compared to none in the non-transplant group, though this difference was not statistically significant ($p = 0.25$). **Conclusion:** Renal transplant recipients exhibited a significantly higher prevalence of fungal infections compared to non-transplant patients, likely due to their immunosuppressive therapy. While the types of fungal species and clinical manifestations were similar between the groups, renal transplant recipients had a slightly higher mortality rate. These findings underscore the increased risk of fungal infections in immunosuppressed populations and emphasize the need for effective prevention and management strategies in transplant recipients.
Keywords: Fungal infections, renal transplant recipients, non-transplant patients, immunosuppression,

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Corresponding Author: Ritika Garg, Assistant Professor, Department of Microbiology, KM Medical College and Hospital, Mathura, UP, India

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INTRODUCTION

Fungal infections represent a significant concern in both immunocompromised and immunocompetent individuals, with an increasing prevalence in specific patient populations, including renal transplant recipients. The management of fungal infections in renal transplant recipients presents unique challenges, as the use of immunosuppressive therapy to prevent graft rejection compromises the host's immune response. This immunosuppression predisposes transplant recipients to a higher risk of opportunistic infections, including fungal pathogens, which can lead to severe complications and graft dysfunction.[1]

In contrast, non-transplant patients typically maintain a more robust immune system capable of handling fungal infections more effectively, although certain

underlying conditions such as diabetes, malignancies, and chronic kidney disease (CKD) can still predispose individuals to fungal infections. This study aims to explore the microbiological and pathological aspects of fungal infections in renal transplant recipients compared to non-transplant patients, focusing on the differences in incidence, species diversity, clinical manifestations, and outcomes.[2]

Immunosuppressive therapy plays a critical role in ensuring the success of renal transplantation by preventing organ rejection. However, this suppression of the immune system also leads to an increased susceptibility to a wide range of infections, including fungal pathogens. Drugs such as calcineurin inhibitors, corticosteroids, and antimetabolites, commonly used in transplant recipients, interfere with both innate and adaptive immune responses, making the host more vulnerable to infections by fungi such as *Candida*, *Aspergillus*, *Cryptococcus*, and *Mucor* species. These pathogens, typically harmless in healthy individuals, can become highly pathogenic under conditions of immune suppression.[3]

Fungal infections in transplant recipients often result in serious morbidity and mortality, as the severity of the infection is exacerbated by the inability of the immune system to mount an adequate defense. The prevalence of fungal infections in renal transplant recipients is higher than in the general population, and these infections are often linked with delayed graft function, graft loss, and increased mortality rates. The types of fungi causing infections in transplant patients may also differ from those found in non-transplant patients, with a greater frequency of deep or systemic fungal infections.[4]

In non-transplant patients, the immune system is typically able to control fungal infections, especially when individuals are otherwise healthy. However, certain conditions such as chronic kidney disease, diabetes mellitus, HIV/AIDS, and cancer can compromise the immune system, making these individuals more susceptible to fungal infections. Non-transplant patients may develop fungal infections as a result of prolonged antibiotic therapy, surgery, or mechanical ventilation, all of which can alter the microbiome and disrupt the body's natural defense mechanisms.[5]

The most common fungal infections in non-transplant patients include superficial infections such as *Candida* skin infections, vaginal candidiasis, and oropharyngeal candidiasis, as well as more serious systemic infections, such as those caused by *Aspergillus* species, which are more common in immunocompromised individuals. The presentation of fungal infections in non-transplant patients can vary based on the underlying condition and the type of fungus involved. While superficial infections may be easier to diagnose and treat, systemic infections, especially those involving the lungs, central nervous system, or other organs, may be more challenging to identify and manage.[6]

This comparative study focuses on understanding the microbiological and pathological differences in fungal infections between renal transplant recipients and non-transplant patients. The microbiological aspect includes identifying the types of fungi responsible for infections in both groups, as well as assessing the frequency of different fungal species and the factors that contribute to their pathogenicity in immunosuppressed individuals. Fungal species such as *Candida albicans*, *Aspergillus fumigatus*, and *Mucor* spp. are commonly implicated in infections in transplant recipients. In contrast, non-transplant patients may experience a broader spectrum of fungal infections, depending on their comorbidities and risk factors.[7]

Pathologically, the tissue responses to fungal infections in renal transplant recipients may differ from those in non-transplant patients. In transplant recipients, fungal infections often result in more aggressive tissue invasion, with a higher risk of disseminated disease. This can lead to severe tissue necrosis and multi-organ failure, especially in cases of invasive aspergillosis or mucormycosis, which are notorious for their rapid progression and high mortality rates. In contrast, fungal infections in non-transplant patients tend to be less invasive and more localized, though they can still result in significant morbidity, particularly in those with underlying risk factors.[8]

MATERIAL AND METHODS

This comparative study was conducted to assess the prevalence and types of fungal infections in renal transplant recipients versus non-transplant patients. A total of 100 patients were included in the study, with 50 renal transplant recipients and 50 non-transplant patients, aged 18-75 years, who were admitted to the hospital for various conditions. The renal transplant recipients had received their transplant within the last 12 months, and all were on immunosuppressive therapy. The non-transplant group included patients with chronic kidney disease, undergoing dialysis, or those with other medical conditions not requiring immunosuppression.

Microbiological samples including blood, urine, sputum, and tissue biopsies were obtained from all patients presenting with signs of infection. Fungal cultures were performed using standard microbiological techniques. Isolated fungal strains were identified using microscopic examination, biochemical tests, and molecular methods, including PCR for specific fungal DNA. Additionally, the clinical manifestations, antifungal treatment regimen, and outcomes were documented. Pathological assessment was done through histopathological examination of tissue samples to detect fungal elements and associated tissue damage. Statistical analysis was performed to compare the incidence of fungal infections between the two groups using chi-square and t-tests, with a significance level set at $p <$

0.05. Ethical approval was obtained from the institutional review board, and informed consent was gathered from all participants.

RESULTS

Table 1: Demographic Characteristics of the Study Population

The demographic characteristics of the study population, which included both renal transplant recipients and non-transplant patients, were largely comparable. The mean age of the renal transplant recipients was 52.4 ± 13.1 years, while the mean age of the non-transplant patients was 51.8 ± 14.3 years, with no significant difference (p=0.84). Gender distribution was also similar, with 60% of renal transplant recipients being male compared to 64% of non-transplant patients (p=0.68). The mean duration of kidney-related disease was slightly longer in the non-transplant group (9.1 ± 5.3 years) compared to the renal transplant group (7.2 ± 4.8 years), but this difference was not statistically significant (p=0.12). Notably, all renal transplant recipients were on immunosuppressive therapy, which was not the case for any of the non-transplant patients (p<0.001). This distinction is important as immunosuppressive therapy is known to increase the risk of infections, including fungal infections, in transplant recipients.

Table 2: Prevalence of Fungal Infections

The prevalence of fungal infections was significantly higher in renal transplant recipients (36%) compared to non-transplant patients (16%), with a p-value of 0.03. This indicates that renal transplant recipients, who are immunosuppressed, are more vulnerable to fungal infections than non-transplant patients. In contrast, 64% of renal transplant recipients and 84% of non-transplant patients did not show signs of fungal infection, highlighting the overall lower prevalence of fungal infections in the non-transplant group.

Table 3: Types of Fungal Infections Identified

Among the fungal species identified, *Candida albicans* was the most commonly isolated in both groups, affecting 55.6% of renal transplant recipients and 50% of non-transplant patients. The difference between the two groups was not statistically significant (p=0.74). Other fungal species included *Aspergillus spp.* (22.2% in renal transplant recipients vs. 25% in non-transplant patients), *Cryptococcus neoformans* (11.1% in renal transplant recipients vs. 12.5% in non-transplant patients), *Mucor spp.* (5.6% in renal transplant recipients vs. 0% in non-transplant patients), and *Fusarium spp.* (5.6% in renal transplant recipients vs. 12.5% in non-transplant patients). Although there was a slight difference in the presence of *Mucor spp.* and *Fusarium spp.*, the p-values for all fungal species were above 0.05, indicating no statistically significant differences in the types of fungal infections between the two groups.

Table 4: Clinical Manifestations of Fungal Infections

The clinical manifestations of fungal infections were also similar between the two groups. Fever was the most common symptom, affecting 66.7% of renal transplant recipients and 50% of non-transplant patients, although this difference was not statistically significant (p=0.44). Other symptoms such as cough, skin lesions, abdominal pain, and respiratory distress were seen with comparable frequencies in both groups. For example, cough was observed in 33.3% of renal transplant recipients and 37.5% of non-transplant patients (p=0.82), while abdominal pain was reported in 11.1% of renal transplant recipients and none of the non-transplant patients (p=0.29). Overall, the clinical symptoms did not differ significantly between the two groups, suggesting that fungal infections may present similarly, regardless of the patient's transplant status.

Table 5: Pathological Findings in Tissue Samples from Fungal Infections

Histopathological examination of tissue samples revealed fungal hyphae in 77.8% of renal transplant recipients and 75% of non-transplant patients, showing no significant difference between the two groups (p=0.88). Granulomatous inflammation was observed in 44.4% of renal transplant recipients and 37.5% of non-transplant patients (p=0.67), while necrosis was seen in 33.3% of renal transplant recipients and 25% of non-transplant patients (p=0.56). Epithelial damage occurred in 50% of renal transplant recipients and 50% of non-transplant patients (p=1.00), and angioinvasion was found in 22.2% of renal transplant recipients versus 12.5% of non-transplant patients (p=0.44). These pathological findings suggest that both groups exhibited similar tissue damage patterns, with no significant differences between renal transplant recipients and non-transplant patients.

Table 6: Treatment and Outcome of Fungal Infections

Treatment for fungal infections was administered to all patients in both groups, with 100% of renal transplant recipients and 100% of non-transplant patients receiving antifungal therapy. The mean duration of therapy was 14.2 ± 6.4 days for renal transplant recipients and 12.7 ± 5.3 days for non-transplant patients, with no statistically significant difference (p=0.32). The recovery rate was high in both groups, with 88.9% of renal transplant recipients recovering compared to 100% of non-transplant patients. This difference was not statistically significant (p=0.32). The mortality rate was higher among renal transplant recipients, with 11.1% of them dying due to fungal infections, while there were no deaths in the non-transplant group (p=0.25). Although the higher mortality rate in renal transplant recipients was not statistically significant, it suggests that these

patients may be at a higher risk of poor outcomes from fungal infections due to their immunocompromised status.

Table 1: Demographic Characteristics of the Study Population

Characteristic	Renal Transplant Recipients (n=50)	Non-Transplant Patients (n=50)	p-value
Age (mean ± SD)	52.4 ± 13.1 years	51.8 ± 14.3 years	0.84
Gender (Male) (%)	30 (60%)	32 (64%)	0.68
Duration of Disease (mean ± SD)	7.2 ± 4.8 years	9.1 ± 5.3 years	0.12
Immunosuppressive Therapy (%)	50 (100%)	0 (0%)	-

Table 2: Prevalence of Fungal Infections

Fungal Infection Group	Renal Transplant Recipients (n=50)	Non-Transplant Patients (n=50)	p-value
Positive Fungal Infection (%)	18 (36%)	8 (16%)	0.03
No Fungal Infection (%)	32 (64%)	42 (84%)	0.03

Table 3: Types of Fungal Infections Identified

Fungal Species	Renal Transplant Recipients (n=18)	Non-Transplant Patients (n=8)	p-value
Candida albicans	10 (55.6%)	4 (50%)	0.74
Aspergillus spp.	4 (22.2%)	2 (25%)	0.89
Cryptococcus neoformans	2 (11.1%)	1 (12.5%)	0.99
Mucor spp.	1 (5.6%)	0 (0%)	0.45
Fusarium spp.	1 (5.6%)	1 (12.5%)	0.61

Table 4: Clinical Manifestations of Fungal Infections

Clinical Manifestation	Renal Transplant Recipients (n=18)	Non-Transplant Patients (n=8)	p-value
Fever (%)	12 (66.7%)	4 (50%)	0.44
Cough (%)	6 (33.3%)	3 (37.5%)	0.82
Skin Lesions (%)	3 (16.7%)	1 (12.5%)	0.74
Abdominal Pain (%)	2 (11.1%)	0 (0%)	0.29
Respiratory Distress (%)	5 (27.8%)	2 (25%)	0.88

Table 5: Pathological Findings in Tissue Samples from Fungal Infections

Pathological Finding	Renal Transplant Recipients (n=18)	Non-Transplant Patients (n=8)	p-value
Fungal Hyphae Present (%)	14 (77.8%)	6 (75%)	0.88
Granulomatous Inflammation (%)	8 (44.4%)	3 (37.5%)	0.67
Necrosis (%)	6 (33.3%)	2 (25%)	0.56
Epithelial Damage (%)	9 (50%)	4 (50%)	1.00
Angioinvasion (%)	4 (22.2%)	1 (12.5%)	0.44

Table 6: Treatment and Outcome of Fungal Infections

Treatment Type	Renal Transplant Recipients (n=18)	Non-Transplant Patients (n=8)	p-value
Antifungal Therapy (%)	18 (100%)	8 (100%)	-
Length of Therapy (mean ± SD)	14.2 ± 6.4 days	12.7 ± 5.3 days	0.32
Recovery Rate (%)	16 (88.9%)	8 (100%)	0.32
Mortality Rate (%)	2 (11.1%)	0 (0%)	0.25

DISCUSSION

The demographic characteristics of this study showed no significant differences between renal transplant recipients and non-transplant patients in terms of age and gender, with similar mean ages and gender distributions in both groups (p=0.84 and p=0.68, respectively). These results align with those of previous studies, such as one by Akbari et al. (2017), who found no significant difference in age and gender between their groups of renal transplant recipients and non-transplant patients.[6] However, an important distinction was the presence of immunosuppressive therapy in all renal transplant recipients, which is a known risk factor for increased susceptibility to fungal infections (Chavez et al., 2019).[7] The duration of kidney-related disease was slightly longer in the

non-transplant group, but the difference was not statistically significant, consistent with findings by Huang et al. (2018), who noted no significant variation in disease duration between transplant and non-transplant groups in a similar study. These findings suggest that the increased risk for fungal infections in transplant recipients is more likely due to immunosuppressive therapy rather than other demographic variables.[8]

This study found that fungal infections were significantly more prevalent in renal transplant recipients (36%) than in non-transplant patients (16%), with a p-value of 0.03. This is in agreement with findings by Delacruz et al. (2016), who reported a higher prevalence of fungal infections (38%) in renal transplant recipients compared to non-transplant patients (18%).[9] The increased susceptibility of transplant recipients to fungal infections is primarily attributed to the immunosuppressive drugs used to prevent graft rejection, which suppress both innate and adaptive immune responses (Gauthier et al., 2017). In contrast, non-transplant patients, who are generally not on immunosuppressive therapy, have a lower incidence of such infections. These results confirm that renal transplant recipients are at higher risk for fungal infections compared to non-transplant patients.[10]

Candida albicans was the most commonly isolated pathogen in both groups, affecting 55.6% of renal transplant recipients and 50% of non-transplant patients. This finding aligns with the study by Yekani et al. (2019), which reported *Candida albicans* as the predominant fungal pathogen in both transplant and non-transplant groups.[11] The identification of *Candida albicans* as the most common pathogen is consistent with previous studies, as *Candida* species are known to be opportunistic pathogens in immunocompromised individuals (Sharma et al., 2017). However, there were no significant differences in the types of fungal infections between the groups (p-values > 0.05), suggesting that while the prevalence of fungal infections is higher in transplant recipients, the types of fungi causing the infections remain similar to those in non-transplant patients.[12] This is supported by research by Mullen et al. (2018), which found no significant variation in the spectrum of fungal species between the two patient groups, further emphasizing the commonality of *Candida* as the leading pathogen in both populations.[13]

The clinical manifestations of fungal infections were similar between the two groups. Fever was the most common symptom, reported in 66.7% of renal transplant recipients and 50% of non-transplant patients. These results align with the study by Chen et al. (2015), which found fever to be the most common clinical sign of fungal infections in both transplant and non-transplant patients.[14]Other symptoms such as cough, skin lesions, abdominal pain, and respiratory distress were also observed with comparable frequencies in both groups, similar to findings by Sharma et al. (2017), where cough and respiratory distress were common across both renal transplant recipients and non-transplant patients. The lack of significant differences in clinical manifestations between the two groups further supports the notion that fungal infections may present similarly in both populations, regardless of transplant status. However, abdominal pain was more commonly reported in renal transplant recipients (11.1%) compared to non-transplant patients (0%), which may suggest a more systemic involvement in transplant recipients due to their immunosuppressed condition.[12]

Histopathological analysis of tissue samples showed fungal hyphae in 77.8% of renal transplant recipients and 75% of non-transplant patients, with no significant difference (p=0.88). Granulomatous inflammation, necrosis, epithelial damage, and angioinvasion were observed in both groups, with no significant differences between the two. These results are consistent with studies like that of Zhang et al. (2017), who found no major differences in pathological findings between transplant and non-transplant groups. The presence of fungal hyphae, granulomatous inflammation, and epithelial damage is indicative of a typical host response to fungal infections. However, the absence of significant differences between the two groups suggests that fungal infections may have similar tissue involvement regardless of transplant status, supporting the concept that the increased vulnerability in transplant recipients is largely due to their impaired immune system rather than more aggressive tissue damage caused by fungi.[15]

In terms of treatment, all patients in both groups received antifungal therapy, and the mean duration of therapy was similar between the two groups (14.2 ± 6.4 days for renal transplant recipients vs. 12.7 ± 5.3 days for non-transplant patients). The recovery rate was high in both groups, with 88.9% of renal transplant recipients recovering compared to 100% of non-transplant patients. These findings are consistent with those of Gauthier et al. (2017), who reported similar recovery rates in renal transplant recipients and non-transplant patients after antifungal treatment.10 However, renal transplant recipients had a higher mortality rate (11.1%) compared to non-transplant patients (0%), which, although not statistically significant, suggests that immunosuppressed individuals may face a greater risk of mortality due to fungal infections. This is in line with the findings of Sharma et al. (2015), who found a higher mortality rate among renal transplant recipients due to fungal infections, emphasizing the increased risk faced by this vulnerable population.[16]

CONCLUSION

In conclusion, this study highlights the significantly higher prevalence of fungal infections in renal transplant recipients (36%) compared to non-transplant patients (16%), primarily due to the

immunosuppressive therapy that these patients receive. While *Candida albicans* was the most common fungal pathogen identified in both groups, the clinical manifestations and pathological findings were similar across both populations. Treatment outcomes showed a high recovery rate in both groups, although renal transplant recipients exhibited a slightly higher mortality rate.

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