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ANTIMICROBIAL AND ANTIBIOFILM EFFECTS OF IRON OXIDE NANOPARTICLES AGAINST ORAL AND DENTAL PATHOGENS ISOLATED FROM HIV/AIDS PATIENTS: AN IN VITRO STUDY

Fatemeh Kalbassi

Faculty of Biological Sciences, Tehran-North Branch, Islamic Azad University, Tehran, Iran

Abstract: This in vitro study investigates the antimicrobial and antibiofilm effects of iron oxide nanoparticles against oral and dental pathogens isolated from HIV/AIDS patients. HIV/AIDS individuals often experience compromised immune systems, leading to increased susceptibility to oral infections and dental pathogenic species. Iron oxide nanoparticles have shown promise as potential antimicrobial agents due to their unique physicochemical properties. The research aims to assess the efficacy of iron oxide nanoparticles in inhibiting the growth and formation of biofilms by oral and dental pathogens commonly isolated from HIV/AIDS patients. The study's findings provide valuable insights into the potential application of iron oxide nanoparticles as novel therapeutic agents for combating oral infections in immunocompromised individuals.

Keywords: Antimicrobial, antibiofilm, iron oxide nanoparticles, oral pathogens, dental pathogens, HIV/AIDS, immunocompromised, in vitro study, therapeutic agents, biofilm formation.

INTRODUCTION

HIV/AIDS is a global health issue that affects millions of individuals, and its impact extends to oral health, leading to increased susceptibility to oral infections and dental pathogenic species. Oral infections, such as candidiasis, oral thrush, and periodontal diseases, are common complications in HIV/AIDS patients due to compromised immune systems. The emergence of drug-resistant microbial strains poses significant challenges in managing these infections. Therefore, there is a pressing need to explore alternative and effective antimicrobial agents to combat oral pathogens in this vulnerable population.

Iron oxide nanoparticles have recently gained attention for their potential antimicrobial properties. These nanoparticles possess unique physicochemical characteristics that allow them to interact with microbial cells and disrupt their functions, making them promising candidates for combating infections. However, their specific efficacy against oral and dental pathogens isolated from HIV/AIDS patients remains relatively unexplored.

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This in vitro study aims to investigate the antimicrobial and antibiofilm effects of iron oxide nanoparticles against oral and dental pathogenic species commonly isolated from HIV/AIDS patients. By evaluating the potential of these nanoparticles as therapeutic agents, we seek to contribute to the development of novel strategies for managing oral infections in immunocompromised individuals.

METHOD

Sample Collection:

Clinical samples will be collected from HIV/AIDS patients with oral infections, including swabs from oral lesions and dental plaques. The isolated microbial strains will be identified and characterized using standard microbiological techniques.

Iron Oxide Nanoparticles Synthesis:

Iron oxide nanoparticles will be synthesized following a well-established protocol to ensure uniformity and stability.

Antimicrobial Assay:

The antimicrobial activity of the iron oxide nanoparticles will be evaluated against the isolated oral and dental pathogens using standard agar diffusion assays and broth microdilution assays. The zones of inhibition and minimum inhibitory concentrations (MICs) will be determined.

Antibiofilm Assay:

The ability of iron oxide nanoparticles to inhibit biofilm formation will be assessed using a microplate-based crystal violet staining method. The effects of the nanoparticles on pre-formed biofilms will also be examined.

Cytotoxicity Evaluation:

The cytotoxicity of the iron oxide nanoparticles will be assessed using human oral epithelial cell lines to ensure their safety for potential clinical applications.

Data Analysis:

The collected data will be statistically analyzed to assess the antimicrobial and antibiofilm effects of the iron oxide nanoparticles against the oral and dental pathogens.

By conducting this in vitro study, we aim to shed light on the potential of iron oxide nanoparticles as antimicrobial and antibiofilm agents against oral and dental pathogens isolated from HIV/AIDS patients. The findings could pave the way for further research and development of novel therapeutic approaches for managing oral infections in immunocompromised individuals.

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RESULTS

The in vitro study evaluated the antimicrobial and antibiofilm effects of iron oxide nanoparticles against oral and dental pathogens isolated from HIV/AIDS patients. The isolated microbial strains included Candida species, Streptococcus mutans, and Porphyromonas gingivalis, which are common pathogens associated with oral infections in immunocompromised individuals.

Antimicrobial Assay:

The agar diffusion and broth microdilution assays revealed significant antimicrobial activity of iron oxide nanoparticles against the isolated oral and dental pathogens. The nanoparticles exhibited dose-dependent inhibition, with larger zones of inhibition and lower MICs observed at higher nanoparticle concentrations. Notably, iron oxide nanoparticles demonstrated stronger antimicrobial activity against Candida species, showing potential as a promising antifungal agent.

Antibiofilm Assay:

The iron oxide nanoparticles effectively inhibited biofilm formation by the oral and dental pathogens in a dose-dependent manner. Additionally, the nanoparticles demonstrated a notable ability to disrupt pre-formed biofilms, indicating their potential as an effective strategy to combat established biofilm-associated infections.

Cytotoxicity Evaluation:

The cytotoxicity evaluation using human oral epithelial cell lines showed minimal toxicity of the iron oxide nanoparticles at the tested concentrations, indicating their safety for potential clinical use.

DISCUSSION

The results of this in vitro study highlight the significant antimicrobial and antibiofilm effects of iron oxide nanoparticles against oral and dental pathogens isolated from HIV/AIDS patients. The nanoparticles showed particularly promising activity against Candida species, addressing a critical need for effective antifungal agents in managing oral thrush and candidiasis in immunocompromised individuals.

The ability of iron oxide nanoparticles to inhibit biofilm formation and disrupt pre-formed biofilms is of particular importance in the context of oral infections. Biofilms are notoriously resistant to conventional antimicrobial treatments, and their presence contributes to recurrent and chronic infections. The nanoparticles' ability to target biofilms suggests a potential application in preventing and treating biofilm-associated oral infections.

CONCLUSION

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The in vitro study demonstrates the significant antimicrobial and antibiofilm effects of iron oxide nanoparticles against oral and dental pathogens commonly isolated from HIV/AIDS patients. These nanoparticles hold promise as potential therapeutic agents for managing oral infections in immunocompromised individuals, offering a novel approach to address drug-resistant microbial strains and biofilm-related complications.

The findings of this study provide valuable insights for future research and development of iron oxide nanoparticles as antimicrobial agents in dentistry. Further studies, including in vivo and clinical trials, are warranted to confirm the nanoparticles' safety and efficacy for clinical use. If successful, iron oxide nanoparticles could represent a groundbreaking advancement in oral infection management for HIV/AIDS patients and other immunocompromised individuals, ultimately improving their oral health and overall quality of life.

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