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Research Article

Fungal Contamination and Disinfection of Dental Chairs Among Private Dental Clinics in Riyadh, Saudi Arabia

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Abstract

Objectives: One of the primary challenges facing dentistry today is the rapid spread of infections in clinics, which have increased due to the resistance of microorganisms. The aim of this study was to critically evaluate fungal contamination and the effectiveness of two disinfectant solutions: 70% alcohol and 1% sodium Hypochlorite on dental chairs among private dental clinics in Riyadh, Saudi Arabia.

Materials and Methods: The sample size consisted of 12 private dental clinics in Riyadh; 3 from the North, 3 South, 3 West and 3 East. The procedure consisted of rubbing sterile swabs in four dental chair areas; seat, backrest, footrest and headrest. The samples were subjected to microbiological laboratory testing. Each sample inoculated in petri dishes comprising Sabouraud Dextrose agar incubated at room temperature to allow the growth of fungal colonies. Disc diffusion technique of the samples were sub cultured was used to evaluate the effectiveness of antiseptic solutions.

Results: Fungal species were identified on dental chairs, The descriptive statistics shows that 1% Sodium hypochlorite was effective on 91.8% of samples and 70% Alcohol was less effective about 32.4% on samples.

Conclusion: It was noted that the alcohol disinfectant works more effectively with bacterial contaminants because it allows the regrowth of fungal species. On the other hand, the sodium hypochlorite kills and prevents the regrowth of fungal species showing greater efficacy in eliminating contaminants.

Keywords: *Fungi; Contamination; Dental Chair; Sodium Hypochlorite; Disinfection*

Introduction

One of the primary challenges facing dentistry today is the rapid spread of infections in clinics which have increased due to the resistance of microorganisms, the limited care of the healthcare providers as well as the high-risk of disease transmissions. Dental offices harbor various forms of contamination by microorganisms, including fungi, exposing dentists to the risk of infections transmitted in various ways, including direct contact with infectious lesions and secretions; indirect contact by means of microorganisms on instruments, equipment and rigid surfaces; aerosols, and interpersonal contact [1,2].

Dentistry is a profession described by exposure to all individuals in the clinical settings to different infectious agents that are transmitted from blood and other fluid contact. Biosafety in dental clinics is essentially important to protect the staff members as well as patients from infections. Some of these safety precautions include, the use of particular protocols, sterilization processes, ergonomic practices, effective handling of equipment, the control of chemical and physical hazards, antisepsis, disinfection, and the use of individual protective equipment (IPE) [3]. Research shows that controlling disease transmission is a challenge to dentists chiefly because the oral cavity is characterized by microorganisms which can cause numerous diseases. The aim of this study was to critically evaluate fungal contamination and the effectiveness of two disinfectant solutions: 70% alcohol and 1% sodium Hypochlorite on dental chairs among private dental clinics in Riyadh, Saudi Arabia.

Materials and Methods

A quantitative and descriptive study was performed at microbiology laboratory in Riyadh Elm University from January to April 2019 after obtaining the project approval from the university research center. The sample size consisted of 12 private dental clinics in Riyadh; 3 from the North, 3 South, 3 West and 3 East. The procedure consisted of rubbing sterile swabs in a circular motion from four dental chair areas; seat, backrest, footrest and headrest that were taken by two investigators following the same manner, specimens were stored in a refrigerator then transported to the laboratory. The samples subjected to microbiological laboratory testing. Each sample inoculated in petri dishes comprising Sabouraud Dextrose agar incubated at room temperature to allow the growth of fungal colonies. After the growth was observed, a small specimen of fungal cultures taken by sterile loop wire mounted on the microscope slides. One drop of Methylene Blue solution was dropped on the slide. The slide was covered with a glass cover slip and examined under the microscope. Disc diffusion technique of the samples were sub cultured was applied, filter paper discs were impregnated with antiseptic solution (70% Alcohol/1% sodium hypochlorite) that placed on the agar using sterile forceps to test the efficiency of disinfectant solutions.

Results

This study focused on investigating and analysing the fungal contamination of dental chairs in private clinics in Riyadh, Saudi Arabia. It applied the quantitative research approach and focused on examining the issue across 12 private dental clinics in Riyadh by subdividing the region into four parts and selecting 3 clinics from the Northern, Southern, Eastern and Western blocs.

The study identified *Aspergillus*, *Aspergillus parasitvcus, Aspergillus famigatus, Aspergillus flavus, Candida albicans, Rhizopus SP* and *Aspergillus niger* (Figure 1 and 2) as the most common contaminants on dental chairs in the private clinics across Riyadh. A focus on the different parts of the dental chairs highlighted *Aspergillus niger*, *Aspergillus flavus*, and *Candida albicans* as the most frequent species occurring at all sites of the dental chair. Further, the footrest part of the dental chair was found to harbor the highest level of contamination at 100% followed by the backrest at 83.5% and the headrest and seatrest both having a 66% each. These findings are shown in table 1 and 2. Further, regarding disinfection, the study found that 70% Alcohol and 1% Sodium hypochlorite were the most commonly used disinfectants. It was noted that the application of the disinfectants eliminated fungal spores and contaminants reducing contamination and the risk of fungal infections. Importantly, the study found that after the application of the alcohol disinfectant, fungal growth still occurred in samples from certain sites. Unlike the Alcohol disinfectant, after the use of the 1% Sodium hypochlorite, there was no fungal growth observed (Figure 3). The descriptive statistics shows that 1% Sodium hypochlorite was effective on 91.8% of samples and 70% Alcohol was less effective about 32.4% on samples (Figure 4).

Discussion

Fungal contaminants in dental clinics

Dental clinics and chairs are susceptible to contaminants especially microorganisms such as fungi that expose the dentists and the patients to risks of infections. Numerous studies have investigated fungal infections in dentistry and noted their influence on the health and well-being of patients and dentists [4,5]. The presence of fungi in dental clinics exposes the dentists and patients to the risk of contracting infections transmitted through direct and indirect contact with infectious lesions, secretions, or on the dental equipment, rigid surfaces, interpersonal contact, and aerosols among others. Dental chairs are likely to harbour the fungal microorganisms and increase the risk of

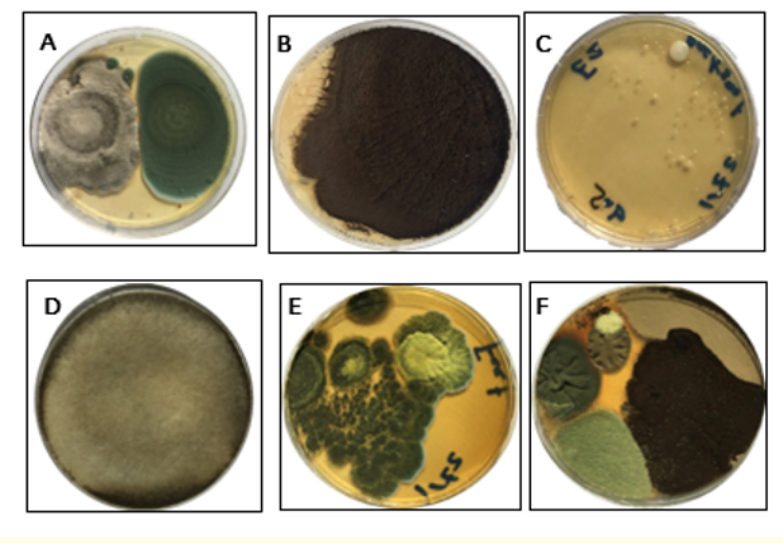

Figure 1: *Cultural Presentation of Fungal Species.*
A-A. famigatus ; B- A. niger ; C- Candida albicans; D- Rhizopus SP E- A. flavus; F- A. niger , A. parasitvcus , A. famigatus.

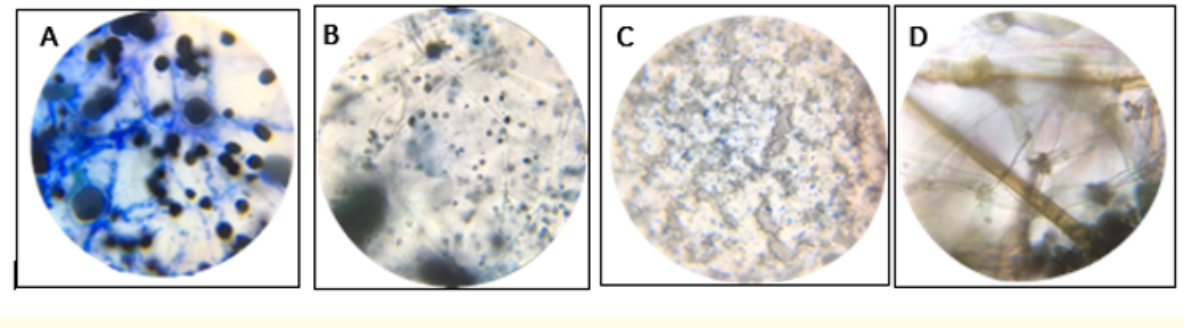

Figure 2: *Microscopic Presentation of Fungal Species.*
A- A. famigatus ; B- A. niger ; C- Candida albicans; D- Rhizopus SP.

Fungal Species	Regions			
	Headrest	Backrest	Seat	Footrest
Aspergillus niger	*	*	*	*
Rhizopas SP	*	*		*
Candida albicus	*	*	*	*
Aspergillus flavus	*	*	*	*
Aspergillus famigatus		*	*	*
Aspergillus parasitvcus				*

Table 1: *Sites, Fungal Species and Level of Occurrence.*

Dental chair sites	Number of fungal species	%
Headrest	4	66
Backrest	5	83
Seat	4	66
Footrest	6	100
Total	6	100

Table 2: *Presence of fungal species per dental chair site.*

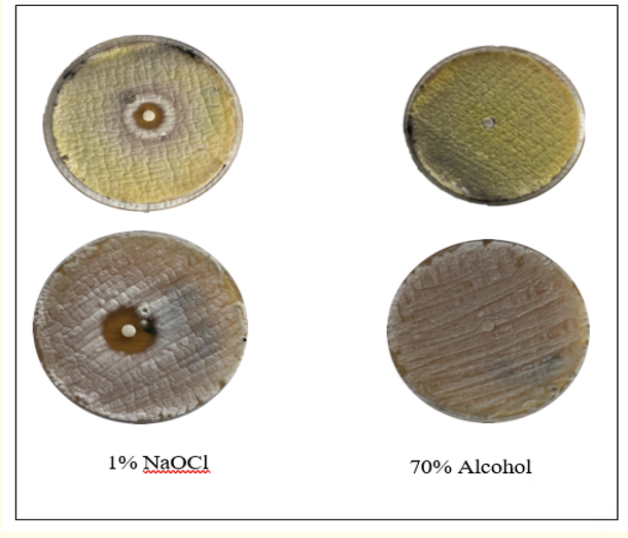

Figure 3: *Cultural Presentation of Fungal Species after Applying Disinfecting Agent.*

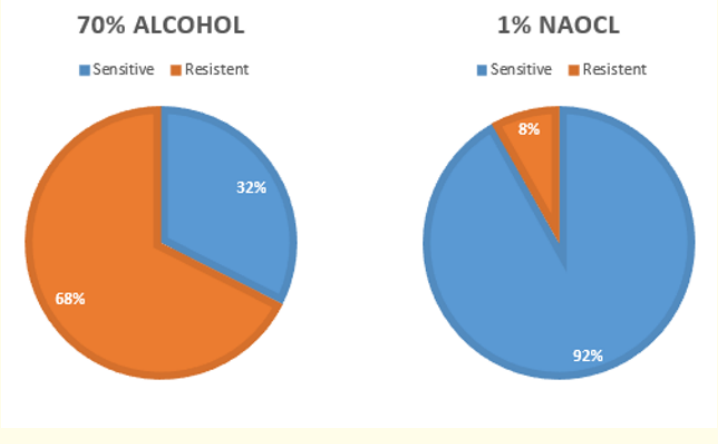

Figure 4: *Perform disinfection process with 70% Alcohol and 1% NaOCl.*

exposure to the disease-causing contaminants. The research conducted in the context of dental clinics in Riyadh, Saudi Arabia highlight the issue of fungal contamination in the settings and the need for adopting effective measures of preventing, alleviating, and addressing the health concern and its impact. Most private dental clinics in Riyadh, like others across the world, experience a major challenge in dealing with the issue of infections. Fungal contamination is common in the clinics.

The study found that dental clinics' chairs are exposed to fungi that cause contamination. Almondes., *et al.* support the findings of the research by pointing out that dental clinics take care of patients with numerous dental health issues including fungal infections among others [4]. Fungal contamination and infections are common in dental settings. The author points out that some patients have oral and maxillofacial fungal infections that can contaminate work areas, equipment/instruments, and personnel or other patients through interpersonal contact. The contamination is enhanced by other factors such as air-conditioning among others, causing serious concern. The study highlighted air-conditioning, blood and other fluid contact, self-neglect hygiene, failure following disinfection protocols, and invasive procedures performed during treatment as some of the most common ways of spreading or causing the contamination. The research finding is supported by other studies such as Azimi., *et al.* who point out air-conditioning, aerosols, inadequate sanitation, and the failure to implement set regulations effectively as some of the issues causing the contamination [6].

The investigation of the fungi contamination focused on identifying the common contaminants in the private clinics in Riyadh. The study found that the different species observed are pathogenic and may cause infections ranging from cutaneous to systemic infections. According to the study, *Aspergillus niger*, *Aspergillus flavus* and *Candida albicans* are the most common species that cause pulmonary aspergillosis, endophthalmitis, endocarditis, peritonitis and cutaneous infections [7]. (Table 3) shows the main diseases caused by the species as identified in this study. The findings indicate that clinics in Riyadh are likely to experience the mentioned diseases, which shows the need for adopting screening and monitoring approaches alongside the prevention and mitigation measures. According to Azimi., *et al.* the infectious diseases in clinics pose a major a threat not only to the dentists but also consumers who seek dental services. Patients who come into contact with contaminated areas, equipment/instruments, and fluids, and infected persons are at a higher risk of contracting infections/disease.

Fungal Species	Diseases
Aspergillus niger	Pulmonary aspergillosis, endophthalmitis, endocarditis, peritonitis, onychomycosis, cutaneous infections.
Rhizopus SP	The infection invades blood vessels in humans and other animals and can progress to other areas of the body, including the brain and lungs.
Candida albicans	mouth and throat is also called "thrush", throat or oesophagus.
Aspergillus flavus	Allergic bronchial aspergillosis, lung infections, ear infections, sinus infections and endocarditis.
Aspergillus fumigatus	Chronic pulmonary infections, allergic bronchopulmonary aspergillosis, or allergic disease in immunocompetent hosts
Aspergillus parasitic us	Delayed development in children and produce serious liver diseases and/or hepatic carcinoma in adults.

Table 3: *Disease occurrence caused by fungi isolated from dental chairs [7].*

The different species identified in the Riyadh dental clinics show the potential impact of fungal contamination/infection on dentistry and, importantly, on the dentists and the patients. The six species identified (*Aspergillus parasitvcus, Aspergillus famigatus, Aspergillus flavus, Candida albicans, Rhizopus SP and Aspergillus niger*) contaminate dental chairs and other elements within the clinics posing significant health risks to personnel and patients. Numerous studies have termed the species identified in this study as common in dental clinics across the world. Research by Almondes., *et al.* outlines *Aspergillus niger, Aspergillus flavus, Penicillium oxalicum, Fusarium aff. Incarnatum, Drechslera biseptata, Aspergillus carnus, Curvularia clavata, Cladosporium cladosporioides, Curvularia brachyspora, Penicillium piceum, Penicillium decumbens,* and *Cladosporium oxysporum* as some of the infectious fungi in dental clinics [4]. While the study is set in

Teresina, Brazil, its findings align with the study conducted in Riyadh. Fungal contamination in private clinics' dental chairs in Riyadh are similar to most of those identified in dental chairs in Brazil.

The numerous fungal species pose numerous health and occupational risks for the patients and staff. The fungal species are associated with different diseases. Fungal contamination increases the risks of infections thus exposing the patients and the dental staff to the specific diseases caused by the fungal species they are exposed to. The following table shows the potential infectious fungal species patients who seek dental care from Riyadh private clinics and the staff are likely to be exposed to. The table highlights the possible diseases associated with each of the fungal species.

Disinfection

The disinfection of dental clinics is fundamental in preventing contamination, minimizing risks of infection, and creating a safe and effective work environment. The study found that most dental clinics without lower contamination rates implement measures such as the recirculation of air, airing the room, and using alcohol disinfectants. As pointed out, air-conditioning contributes significantly to the distribution of fungi and the contamination of dental chairs and others parts and equipment within dental clinics. Azimi., *et al.* assert that air-conditioning proliferates and spreads fungi in the dental clinic rooms prompting fungal contamination. Almondes., *et al.* support Azimi., *et al.* by stating that poor air-conditioning and improperly maintained air-conditioners facilitate fungal contamination[6]. There is a need for ensuring effective air-conditioning to ensure the microbiological cleanness in hospital operating theatre. Healthcare settings with properly maintained and efficient air-conditioning systems record lower fungal contamination as compared to ones with improperly installed/maintained systems. Using the case of *Aspergillus*, Gniadek and Macura point out that neglecting the room decontamination procedures in dental offices with poor air-conditioning contaminates the indoor air and increases the number of fungi moulds resulting in contamination [8]. The investigation of fungal infections in Riyadh private dental clinics in the context of air conditioning outlined the importance of efficient internal air-conditioning in recirculating air and airing the dental offices thus preventing the accumulation of fungal spores in dental chairs and others areas therein.

Azimi., *et al.* (2013) discuss fungal air quality in hospital rooms and identify the same fungal contaminants identified in this study. According to Azimi., *et al.* 70% of fungal genus isolated in hospital rooms were *Penicillium*, 14% *Aspergillus*, 12% *Cladosporium*, and 2% *Alternaria*. These findings align with the findings in Almondes., *et al.* and Gniadek and Macura who identified *Penicillium, Aspergillus,* and Cladosporium as the common fungal genus that contaminate hospital and surgical rooms. Studying the Riyadh private dental clinics identified similar fungal contaminants. Further, as pointed out by Almondes., *et al.* the indoor air quality is fundamental in preventing infections. Poor or low quality of the indoor air results in hospital-acquired infections and occupational risks in the context of hospital settings. This compares to the case of dental clinics, low indoor air quality causes the contamination of the dental chairs and equipment exposing the dentists to occupational risks and the patients to risks of contracting fungal infections. There is a need for adopting measures that promote the internal air quality in the dental clinics to prevent the accumulation of fungal spores and the contamination of dental chairs. An effective way of doing so is through the installation of an efficient air-conditioning system.

Ethanol and sodium hypochlorite disinfectants are common on dental clinics not only in Riyadh but also across the world. However, alcohol is the most used disinfectant in dental clinics and healthcare setting. Ethanol disinfectants are used across different healthcare settings to prevent septic complications, eradicate microbial contaminants thus reducing the risks of hospital-acquired infections, and to thwart fungal contaminants. Using the disinfectant has proved important in reducing the infections within the healthcare settings, improving the safety of healthcare, and enhancing the cost-effectiveness of care. The availability and cost-effectiveness of the alcohol disinfectant makes it a suitable choice for most dental clinics. The disinfectant meets the disinfection protocols. The 70% ethyl alcohol is used for the disinfection of small surfaces and medical equipment to reduce the risk of infections. In the dental clinics' setting, the use of alcohol for the disinfection of dental chairs and other equipment plays an important role in preventing fungal infections and infections.

In a study conducted by Peters., *et al.* the use of alcohol disinfectants proves effective in eradicating bacterial pathogens and fungus [9]. Using the case of *Staphylococcus aureus* and *Candida albicans*, which cause infections, the authors assert that an incubation with

30% alcohol was sufficient in killing and inhibiting the growth of *Candida albicans* while 50% was required for the complete prevention of the *Staphylococcus aureus* from re-growing. However, while the research shows that the application of the disinfectant is effective in preventing contamination, it is most effective in eradicating bacterial contaminants than it is in dealing with fungi [9]. Studying its use in the context of Riyadh dental clinics indicates that while it is commonly used and eliminates contaminants, it is not the most effective disinfectant because it leaves room for the regrowth of fungi. Regarding the action of alcohol on bacteria, several studies claim that its effect is more bacteriostatic than bactericidal. Moreover, there are studies that claim that the use of 70% alcohol is inappropriate for removing saliva layers on instruments, and it has been demonstrated that even water is more appropriate than alcohol for removing blood and organic matter [10].

Using sodium hypochlorite as a disinfectant was found more effective in eliminating fungal contamination in dental chairs. The disinfectant has broad applications in healthcare settings and provides a mix of effectiveness, low cost, safety, and ease of use. The application of the disinfectant in dental clinics helps eliminate bacterial and fungal contamination thus preventing infections, health and occupational risks associated with contamination. The disinfectant is more effective in eliminating fungal species by killing them without possibility of regrowth.

Conclusion

Dental clinics focus on ensuring the prevention of contamination and its potential impacts including the infection of patients and the personnel through disinfection. Disinfecting dental chairs, equipment, and adhering to regulatory and high sanitation standards allows the prevention of fungi contamination and infections. Dental clinics in Riyadh, Saudi Arabia implement the measures for the improvement of safety and the protection of patients and personnel from infections that affect their health and wellbeing. The study indicated that most clinics in Riyadh have acknowledged the importance of biosafety and adopted actions for protecting the patients and staff in the dental clinical setting. Clinics use specific protocols, physical and chemical hazards' control, ergonomic practices, and effective handling of dental equipment to prevent and alleviate fungal contamination. Additionally, the study found that the efficiency of the sterilization and disinfection processes, use of individual protective gear, barriers, and application of antisepsis among others are essential for preventing contamination. Using effective disinfectants is essential for eliminating fungal, bacterial and any other contaminants that cause infections. The study identified alcohol disinfectant 70% and sodium hypochlorite 1% as the most commonly used disinfectants in the private dental clinics in Riyadh. While both prove effective in addressing the problem and reducing contamination and risks of infection, it was noted that the alcohol disinfectant works more effectively with bacterial contaminants because it allows the regrowth of fungal species. On the other hand, the sodium hypochlorite kills and prevents the regrowth of fungal species showing greater efficacy in eliminating contaminants.

Recommendation

The biosafety protocol should therefore include cleaning and disinfecting chairs with 1% sodium hypochlorite after each patient in order to prevent disease transmission.

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