Systematic Literature Review on Coronavirus Infectious Disease-19 and Dental Masks

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Background: Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is transmitted primarily through droplets, and dental practitioners are at risk of occupational exposure to SARS-CoV-2 infection owing to direct contact with the patient's mouth, aerosols from dental procedures, and saliva. Wearing a mask is believed to be the best method of protection against infection, and a systematic literature review was conducted on whether the dental masks used in dentistry are effective in preventing Coronavirus Infectious Disease-19 (COVID-19).

Methods: We used PubMed, Google Scholar, DBpia, NDSL, and KISS databases for this study. Of the 917 documents narrowed down by the search terms "Coronavirus, COVID-19, and dental," 83 documents were collected and studied. Ultimately, 42 of these papers were selected for analysis after considering duplication from the flow chart of the literature selection process.

Results: While dental masks are often used when treating patients with unknown COVID-19 status, the Ministry of Food and Drug Safety stated that the use of dental masks is insufficient in preventing cross-transmission of COVID-19; instead, it was recommended that N95 masks, which correspond to KF94 masks, should be worn daily. On the other hand, wearing a dental mask and following precautions such as hand hygiene may not pose a significantly higher risk of infection than wearing an N95 mask when treating COVID-19 patients.

Conclusion: There is an ongoing discussion regarding the use of dental masks when treating dental patients, and many argue that different types of masks should be selected according to the degree of infection and the individual's respiratory condition. By considering the safety and efficacy of dental masks in preventing infection, improvements can be made in the management of COVID-19 and dental-related infections.

Key Words: COVID-19, Dental mask, SARS-CoV-2

Introduction

The coronavirus infection was first reported in Wuhan, Hubei Province, China in December 2019¹⁾. On February 11, 2020, the World Health Organization (WHO) announced the official name of this new infection as Coronavirus Infectious Disease-19 (COVID-19)²⁾. The pathogen behind COVID-19 is severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which is similar to the virus that causes severe acute respiratory syndrome. Continuous monitoring of infected patients is necessary^{3,4)}.

Transmission of COVID-19 occurs directly through droplets discharged during coughing, sneezing, and vocalization, and indirectly by touching mucous membranes, such as the oral cavity, nasal cavity, and eyes, after physical contact with contaminated surfaces^{5,6)}. The incubation period may exceed 14 days, and patients may remain contagious up to three weeks after recovery⁴⁾.

Considering the possibility of COVID-19 transmission, medical professionals, particularly dental professionals working in dental clinics, are at a high risk of contracting the virus⁷⁾. There is a high biological risk of SARS-CoV-2

Received: February 22, 2021, Revised: March 10, 2021, Accepted: March 13, 2021

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eISSN 2233-7679

transmission when carrying out dental procedures due to airborne droplets, aerosols generated by dental procedures, saliva, blood particles, and secretions, among others⁸⁾. Furthermore, COVID-19 transmission through droplets can occur when the distance between two people is less than 1 m apart. Dental care workers are vulnerable to cross-transmission of COVID-19 due to long treatment durations and the short (less than 1 m) distance between the practitioner and the patient⁹⁾.

Given the mode of transmission, masks are an effective way to prevent infection⁴⁾. The types and classifications of masks vary by country. The N95, N99, N100, and R classifications are used in the United States, while European standards classify the filtering capability of masks into FFP1, FFP2, FFP3, P1, P2, and P3. The N95, N99, and N100 masks have filtration efficiencies of 95%, 99%, and 99.97% or more, respectively, while the FFP1, FFP2, and FFP3 masks have filtration efficiencies of 80%, 94%, and 99%, respectively. Since N95 and FFP2 masks are nearly identical, they should be used to prevent the transmission of infectious diseases^{10,11)}. The letters “KF” in KF masks mean “Korea Filter,” and the KF99 and KF94 masks block more than 99% and 94% of 0.4 μm -sized particles, respectively, while the KF80 blocks more than 80% of 0.6 μm -sized particles. As recommended by the Centers for Disease Control and Prevention (CDC), the Emergency Use Authorization (EUA) approved the use of face masks that cover the mouth and nose for health care personnel (HCP) in the healthcare environment and in all populations to prevent the spread and transmission of severe acute respiratory syndrome coronaviruses during SARS-COV-2. However, because regular face masks only filter approximately 24% of particles smaller than 2.0 μm , they cannot protect against viruses¹²⁾. A surgical mask, which is a mask used by medical personnel, is also called a dental mask due to its wide use in dentistry. These masks are fluid-resistant, loose, easily disposable, and function as a physical barrier and are primarily intended for surgical use. However, surgical masks do not completely block the inhalation of airborne pathogens such as viruses. The N95 mask is a medical mask that blocks pollutants from the air with a special filter and is worn by medical staff who treat COVID-19 patients. One μm means 1 millionth of a

meter, and these masks can block 95% of small viruses 0.02 to 0.2 μm in size, thereby providing a level of protection against viruses and bacteria that is 8 to 12 times higher than other masks¹¹⁾.

The continued community spread of COVID-19 can lead to unintended aerosol exposure from infected patients in dental practices¹³⁾. Due to the recent epidemic COVID-19, dental clinics are at a higher risk of infection than other medical settings. Various preventive measures, such as disinfection, hand washing, and the use of masks, are being implemented to suppress the rapid spread of the virus; however, unlike other preventive measures, different experts have different opinions regarding what type of masks should be worn. Therefore, we would like to study the relationship between dental masks, the personal protective equipment (PPE) worn by dental personnel, and COVID-19 prevention.

Research Methods

1. Literature and database search

A literature search was performed using PubMed and Google Scholar for foreign papers, and the Academic Database Service Database Periodical Information Academic (DBpia), Research Information Sharing Service (RISS), National Digital Science Leaders (NDSL), and Korean Studies Information Sharing System (KISS) for domestic papers. From January 2020 to December 2020, we searched for articles published in domestic and foreign journals using the search terms “Coronavirus, COVID-19, and dental.”

2. Literature selection criteria and exclusion criteria

Among the 917 papers narrowed down using the search terms, 241 articles remained after the first screening stage, which was conducted by reviewing the titles and abstracts of the documents according to the inclusion and exclusion criteria. In the second screening stage, we examined the full-text in detail and assessed for the degree of conformity with our criteria, duplication along with the flow chart of the literature selection process, and valid associations between the use of dental masks and COVID-19 prevention.

This left 83 articles (39 overseas and 3 domestic 42 total) for further analysis. The final papers were selected after two researchers independently reviewed both the accepted and rejected articles; experts were consulted in cases of disagreement. Non-original articles, gray literature, research reports, dissertations, studies published in conference presentations, studies in which the original text could not be verified, and studies published in languages other than Korean or English were excluded (Fig. 1).

Results

1. Characteristics of studies included in the review

Table 1 shows the general characteristics of the 42 studies included in the final analysis. The proportion of studies published by country is as follows: Italy=14.2% (6/42); USA=9.5% (4/42); Korea=9.5% (4/42); Iran, Saudi Arabia, Poland, and Singapore=7.1% each (3/42); Nigeria, UK, Pakistan, Peru, and Egypt=4.8% each (2/42); and Canada, Brazil, Serbia, Romania, Germany, and Netherlands=2.4% each (1/42). The most common type of research included in the final analysis were theoretical review articles (45.2%, 19/42) related to the research topic.

2. Personal protective equipment masks suitable for COVID-19

On February 5, 2020, the Central Disease Control Headquarters (CDCH) recommended that healthcare

personnel use KF94 and KF99 masks to protect the respiratory system from infection¹⁴⁾. Based on the European FFP-class system, the KF80, KF94, and KF99 masks perform almost the same functions as the FFP1, FFP2, and FFP3 masks, respectively. According to the National Institute for Occupational Safety and Health (NIOSH) criteria, N95 masks correspond to KF94 masks by the Ministry of Food and Drug Safety¹⁵⁾.

The use of PPE is recommended when performing both aerosol-generating and -non- generating procedures in all dental practices. The use of PPE, such as N95, FFP2, or FFP3 masks, gloves, gowns, and protective glasses is the most important aspect of all dental procedures¹⁶⁾. In addition to the use of PPE, hand hygiene and disinfection of all surfaces in the clinic are also recommended as infection control measures in dentistry¹⁷⁾.

In their guidelines for COVID-19, the WHO recommended the use of NIOSH-certified N95, European Union-certified FFP2, or other equivalent masks when performing procedures in dentistry¹⁸⁾. The types of masks recommended by the WHO and their filtration effects are

Table 1. Characteristics of Studies Included in the Review (n=42)

	Characteristic	Number of studies	Percentage
Nation of publication	Italy	6	14.2
	USA	4	9.5
	Korea	4	9.5
	Saudi Arabia	3	7.1
	Iran	3	7.1
	Poland	3	7.1
	Singapore	3	7.1
	Nigeria	2	4.8
	UK	2	4.8
	Pakistan	2	4.8
	Peru	2	4.8
	Egypt	2	4.8
	Canada	1	2.4
	Brazil	1	2.4
	Serbia	1	2.4
	Romania	1	2.4
	Germany	1	2.4
	Netherlands	1	2.4
Study type	Quantitative (survey)	14	33.3
	Policy research	8	19.1
	Review article	19	45.2
	Others	1	2.4

Fig. 1. Flow chart of the study selection process.

listed in Table 2¹⁹⁾.

The National Health Service (NHS) recommends the use of FFP3 masks in aerosol-generating processes²⁰⁾. Regardless of the patient's condition, eyewear protection and an N95 mask should be used for all aerosol-generating procedures⁴⁾. Some authors suggested wearing FFP2, FFP3, N95, or higher tier masks for aerosol-generating procedures, and the FFP1/dental mask for non-aerosol-generating procedures²¹⁾.

In Germany, most dental personnel recommend the use of FFP2, FFP3, or N95 masks when treating patients regardless of the type of procedure and whether the presence or risk of infection is unknown or very high⁴⁾. When treating patients suspected to have COVID-19, dentists should wear full PPE consisting of an N95 mask, gown, gloves, and protective glasses²²⁾. If treating a patient positive for COVID-19, an N95 (or higher) mask was recommended for all dental procedures¹⁶⁾. The FFP2, FFP3, and N95 masks provide dental practitioners with greater protection from viral respiratory infections than dental masks¹⁰⁾; in fact, FFP2 masks were found to be 100 times more effective than dental masks²³⁾. A survey of dental professionals in 26 countries on the use of masks found that most (91.7%) used N95/FFP2 masks¹⁷⁾. However, only 12% were found to wear N95 masks²⁴⁾. Although all dentists were mindful of the risk of COVID-19, they did not use N95 masks in the dental clinic²⁵⁾.

With the advent of SARS-CoV-2, countries have 1) encouraged the general public to perform thorough hand hygiene; 2) banned public meetings in confined spaces; 3) advised avoidance of social contact; and 4) advocated the prevention of infection through the use of PPEs such as face masks and gloves²⁶⁾. In dental clinics, dental staff

should wear PPEs, such as a face mask, during patient examination and education²⁷⁾. Long-term use or reuse of face masks is not recommended as contaminated masks increase the risk of infection²⁸⁾. If contaminated with blood or other contaminants, the mask should be replaced and a new mask should be worn for up to 6 hours according to the CDC guidelines¹⁸⁾.

A study by Umeizudike et al.²⁹⁾ emphasized that wearing face masks, gloves, and face shields during dental procedures could prevent COVID-19 transmission. Wearing a face mask alone reduces the risk of airborne infections in healthy people but provides insufficient protection from airborne viruses³⁰⁾. Therefore, face mask recommendations are based on pragmatism, including availability and priority areas within the local healthcare system, rather than maximum protection³¹⁾.

The CDC and WHO recommended the use of dental masks when treating patients who have not been diagnosed with COVID-19³⁰⁾. Wearing a dental mask protects against fluids splashing into the respiratory tract from the nasal and oral cavities²⁰⁾. The most frequently used PPEs in dental clinics in Italy were protective glasses (90.55%), disposable gloves (90.10%), and dental masks (82.80%)²⁶⁾. In dental clinics, dental personnel should wear dental masks, face shields, and protective eyewear during dental procedures²²⁾. However, it is not appropriate to use dental masks when performing dental procedures that generate aerosols¹⁸⁾. Dentists have reported that dental masks are insufficient in preventing cross-infection of COVID-19 and that N95 masks should be worn routinely³⁰⁾. It has been reported that, while dental masks are recommended for office staff who do not directly handle patients, N95 masks should be used for staff who work in clinics with a unit chair²⁰⁾.

Discussion

As COVID-19 began to spread rapidly to several countries, the WHO declared a global pandemic on March 11, 2020³²⁾. In a recently published paper, dental care during COVID-19 outbreaks was at high risk for transmission⁸⁾. Among all medical professionals, the highest risk of infection was reported by dental practitioners⁴⁾.

Table 2. Type of Mask and Filtration Effect

Mask type	Filtration efficiency (%)	Particle size (μm)
FFP1 and P1	≥ 80	≥ 0.3
FFP2 and P2	≥ 94	≥ 0.3
N95	≥ 95	≥ 0.3
N99 and FFP3	≥ 99	≥ 0.023
P3	≥ 99.95	≥ 0.3
N100	≥ 99.97	≥ 0.02

Dental personnel risk occupational exposure to SARS-COV-2 infection due to contact with the patient's mouth, body fluids, and airborne pathogens³⁰⁾. In addition, the significant amount of aerosol produced during dental procedures also contributes to the risk of COVID-19 infection⁹⁾. It is important for dental personnel to have appropriate PPE, including gowns, gloves, protective glasses, and masks; masks in particular provide a very important protective barrier³³⁾.

Most studies have shown that the N95 mask is more effective than the dental mask in protecting against COVID-19 infection³⁴⁾. The most effective masks for protection against COVID-19, if infection in the patient is confirmed or suspected, are the N95, FFP2, and FFP3 masks, while the FFP2 and FFP3 masks are recommended for all aerosol-generating procedures performed in dentistry⁹⁾.

Viral particles less than 2.0 μm in size can penetrate various types of masks thereby leading to inhalation by the wearer. However, FFP2/N95 masks can reduce the risk of virus transmission by a factor of 1.5 to 2 times. N95 masks are often functionally differentiated respirators from masks. Regular use of FFP2 masks is not recommended or implemented because, while they reduce the average risk of pathogen transmission, they can also cause breathing difficulties when worn¹²⁾. Although N95 respirators have shown several advantages over dental masks in several studies, in the clinical setting, insufficient data are available to demonstrate the superiority of N95 respirators over dental masks in protecting against infectious respiratory pathogens, including SARS-CoV-2³⁵⁾. It has been suggested that wearing a dental mask and following preventative measures such as hand hygiene may not pose a significantly higher risk of infection compared to wearing an N95 mask when treating COVID-19 patients³⁶⁾. Recent studies clearly demonstrate the effectiveness of dental masks in reducing respiratory virus excretion³⁷⁾.

There is a continuing debate about the effectiveness of dental masks against viruses and their transmission in dental patient care. Thus, biological safety rules in relevant occupations should be discussed, and possible guidance for more appropriate dental care should be provided. Preferentially, a mask should be chosen according to the degree of contamination and the

individual's respiratory condition. While the use of dental masks is important, it is only one aspect of infection control; adherence to basic quarantine guidelines, such as rules on preventive behavior and social distancing, is also important. This study is meaningful since, by reviewing the certification criteria and the proper clinical applications of different types of masks, it demonstrates that the use of masks by dental personnel is a major means of preventing COVID-19 infection. In the future, additional research based on various domestic cases is needed to determine which masks are more effective in what situations.

Notes

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Ethical approval

This study is a review-based study and does not require an IRB review.

Author contributions

Conceptualization: Min-Young Kim and Ji-Hyun Kim. Data acquisition: Min-Young Kim and Ji-Hyun Kim. Formal analysis: Min-Young Kim and Ji-Hyun Kim. Supervision: Min-Young Kim and Ji-Hyun Kim. Writing—original draft: Min-Young Kim and Ji-Hyun Kim. Writing—review & editing: Min-Young Kim.

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Acknowledgements

The authors would like to thank Dr. Jihyun Ahn for his helpful advice. This study was supported by a research fund from, Howon University.

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