DENTAL MATERIALS XXX (2018) XXX.E1–XXX.E8

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.intl.elsevierhealth.com/journals/dema

Does the size matter? Evaluation of effect of incorporation of silver nanoparticles of varying particle size on the antimicrobial activity and properties of irreversible hydrocolloid impression material

Kishore Ginjupalli[a,*], *Tushar Shaw*[b], *Chaitanya Tellapragada*[c], *Ramakrishna Alla*[d], *Lokendra Gupta*[e], *Nagaraja Upadhya Perampalli*[f]

[a] *Department of Dental Materials, Manipal College of Dental Sciences, Manipal Academy of Higher Education, Manipal, 576104, Karnataka, India*

[b] *Department of Microbiology, Kasturba Medical College, Manipal Academy of Higher Education, Manipal, 576104, Karnataka, India*

[c] *Manipal Center for Virus Research, Manipal Academy of Higher Education, Manipal, 576104, Karnataka, India*

[d] *Department of Dental Materials, Vishnu Dental College, Bhimavaram, 534202, Andhra Pradesh, India*

[e] *Department of Prosthodontics and Crown and Bridge, Manipal College of Dental Sciences, Manipal Academy of Higher Education, Manipal, 576104, Karnataka, India*

[f] *Department of Dental Materials, Manipal College of Dental Sciences, Manipal Academy of Higher Education, Manipal, 576104, Karnataka, India*

ARTICLE INFO

Article history:
Received 3 August 2017
Received in revised form
19 January 2018
Accepted 23 March 2018
Available online xxx

Keywords:
Alginate
Antimicrobial activity
Disinfection
Infection control
Irreversible hydrocolloid
Silver nanoparticles

ABSTRACT

Objectives. The main objective of the present in vitro study is to evaluate the antimicrobial activity and properties of irreversible hydrocolloid impression material incorporated with silver nanoparticles of varying size at different concentrations.

Methods. Silver nanoparticles of 80–100, 50–80, 30–50 and 10–20 nm size were added to irreversible hydrocolloid impression material at 0.5, 1.0, 2.0 and 5.0 wt%. Antimicrobial activity of the silver nanoparticle incorporated irreversible hydrocolloid was measured using disk diffusion method. The gel strength, flow, gelation time and permanent deformation were measured according to American Dental Association specification #18. Data were analyzed using analysis of variation at a confidence interval of 95% ($\alpha = 0.05$).

Results. Silver nanoparticles of 80–100 nm size have imparted superior antimicrobial activity to the irreversible hydrocolloid in a dose-dependent manner whereas finer nanoparticle size did not exhibit any antimicrobial activity. The addition of silver nanoparticles did not alter the properties of irreversible hydrocolloid at 0.5 and 1.0 wt% whereas at higher concentrations significant differences in flow, gelation time and strength were observed.

* *Corresponding author.*
E-mail address: kishore.gp@manipal.edu (K. Ginjupalli).

https://doi.org/10.1016/j.dental.2018.03.016

Please cite this article in press as: Ginjupalli K, et al. Does the size matter? Evaluation of effect of incorporation of silver nanoparticles of varying particle size on the antimicrobial activity and properties of irreversible hydrocolloid impression material. Dent Mater (2018), https://doi.org/10.1016/j.dental.2018.03.016

Significance. The results of the present study indicate that silver nanoparticles of size range 80–100 nm are superior in imparting antimicrobial activity to irreversible hydrocolloid compared to finer particle size range.

1. Introduction

Irreversible hydrocolloid impression materials are widely used in dentistry to record preliminary impressions of dentulous and partially dentulous mouths. Traditionally, it is supplied as a powder comprising soluble alginate, calcium sulfate and sodium phosphate as primary reactive ingredients along with diatomaceous earth as filler. Upon mixing with water, gelation reaction occurs between soluble alginate and calcium sulfate leading to the formation of calcium alginate gel [1–3].

Dental impression materials invariably come in contact with patient's oral fluids populated with a myriad of microorganisms and can be a potential source of disease transmission among the dental staff and the laboratory personnel [4–6]. Attributes such as hydrophilic nature, soft surface, and texture of irreversible hydrocolloid impressions predispose them for carriage of large amounts of microbes not only on their surface but also within the material [5–7]. Considering these aspects, irreversible hydrocolloid impressions should be thoroughly disinfected. However, conventional disinfection by either spray or immersion technique leads to only surface disinfection and is reported to be associated with dimensional changes [8,9]. In addition, there have been reports of noncompliance to disinfection of impressions [10–13].

To address these problems, disinfectant agents have been incorporated into the irreversible hydrocolloids. Irreversible hydrocolloids with disinfectants, often termed as "self-disinfectant materials", are disinfected throughout the structure rather than on the surface alone and permits immediate cast pouring without significant dimensional changes [2,6,14]. The disinfectant agents are either incorporated in the powder or dissolved in the mixing liquid. Various antimicrobial agents such as chlorhexidine, sodium hypochlorite, hypochlorous acid electrolyzed water with a pH ranging between 2.2 to 7, *Morinda citrofolia* L. juice, etc. were used as mixing liquids for the manipulation of irreversible hydrocolloids [14–18]. Alternatively, antimicrobial agents can be added to irreversible hydrocolloid powders which upon mixing with water are dissolved and distributed uniformly throughout the impression material. Quaternary ammonium compounds, 0.05% diacetate chlorhexidine, magnesium oxide, etc. have been investigated [6,19,20]

Silver nanoparticles (AgNPs) have been successfully added to devices used in alveolar bone surgery, as a coating on dental implants to minimize peri-implantitis and to prevent the biofilm formation [21,22]. They are also used in bone cements, intravenous catheters, endotracheal tubes, wound dressings, etc. [23]. Their incorporation in dental luting cements was found to impart antimicrobial action [24,25]. Similarly, addition of AgNPs conferred self-disinfection ability to reversible and irreversible hydrocolloids [26–28].

The antimicrobial activity of AgNPs was found to be size dependent. AgNPs of about 9 and 14 nm exhibited superior antimicrobial activity against gram-positive and gram-negative bacteria compared to AgNPs of size 30 nm [29]. An increase in the antibacterial activity of AgNPs with decreasing size against *Escherichia coli, Vibrio cholera, Pseudomonas aeruginosa* and *Salmonella typhi* was observed [30]. AgNPs of 5–20 nm also showed inhibition of HIV-1 virus replication [31]. These investigations suggest that use of finer size AgNPs can significantly enhance their antimicrobial activity due to the availability of increased surface area for the antimicrobial action [32–34]. With this background, the present study aims to investigate the effect of varying particle size of AgNPs on the antimicrobial activity and properties of irreversible hydrocolloid impression material. The hypothesis of the present study is that the incorporation of AgNPs with reduced particle size enhances antimicrobial activity without altering the properties of irreversible hydrocolloid impression material.

2. Materials and methods

2.1. Materials

Silver nanoparticles (Nanolabs, India) with four different particle size ranges (80–100 nm, 50–80 nm, 30–50 nm, 10–20 nm) were incorporated at various concentrations (0.5, 1.0, 2.0 and 5.0 wt%) into a commercially available irreversible hydrocolloid impression material (Zelgan Plus, Dentsply India Pvt. Ltd, India).

2.2. Methods

2.2.1. Sample preparation

Initially, the powders of irreversible hydrocolloid impression material with varying concentration of silver nanoparticles were prepared by accurately weighing the required quantities of both irreversible hydrocolloid powder and silver nanoparticles into a container. The container was attached to a drum hoop mixer and tumbled for a period of 5 min at 60 rpm to disperse the silver nanoparticles throughout the impression material. Irreversible hydrocolloid powder without any silver nanoparticles was considered as control group.

Preparation and testing of irreversible hydrocolloid specimens with or without silver nanoparticles was as per the procedures described earlier [27]. Specimens of irreversible hydrocolloid were prepared by adding accurately weighed powder into the pre-measured amount of water in a flexible rubber bowl. A water:powder ratio of 33.7 ml for 15 g as recommended by the manufacturer was followed. The contents were hand mixed using alginate mixing spatula for 45 s by stropping the mix between walls of the bowl and the blade of the spatula

Please cite this article in press as: Ginjupalli K, et al. Does the size matter? Evaluation of effect of incorporation of silver nanoparticles of varying particle size on the antimicrobial activity and properties of irreversible hydrocolloid impression material. Dent Mater (2018), https://doi.org/10.1016/j.dental.2018.03.016