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RESEARCH ARTICLE
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THE EFFICACY OF SEVERAL DISINFECTANTS ON ALGINATE MATERIAL: THE EXPERIMENTAL STUDY

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Abstract

Introduction: Dental impressions, particularly alginate (irreversible hydrocolloid), are easily contaminated with saliva and blood, making them potential vectors for cross-infection. Although disinfection is recommended, inconsistent protocols and concerns about dimensional stability limit routine practice. This study compared the efficacy of 1% chlorhexidine, 0.5% sodium hypochlorite and tap water on microbial reduction in alginate impressions.

Methods: Maxillary arch impressions were taken using standard alginate technique. Each impression's palatal surface was divided into four sections:

Group 1: Control (no disinfection)

Group 2: Tap water rinse

Group 3: 0.5% sodium hypochlorite

Group 4: 1% chlorhexidine

Each section received its assigned treatment for 10 minutes in sterile bags. Microbial swabs were inoculated on blood agar and incubated at 37 °C for 24 hours. Colony-forming units (CFUs) were counted and analyzed using one-way ANOVA with post-hoc comparisons.

Results: Mean CFU counts ($\times 10^6$) were 63.6 ± 5.4 (control), 19.9 ± 3.1 (tap water), 2.2 ± 0.7 (sodium hypochlorite) and 1.2 ± 0.4 (chlorhexidine). ANOVA revealed significant differences among groups ($p < 0.001$). Both disinfectants produced >96% reduction in microbial load compared with control ($p < 0.001$), whereas tap water produced only a modest but significant reduction (≈69%, $p = 0.032$). No significant difference was observed between chlorhexidine and sodium hypochlorite.

Conclusion: 1% chlorhexidine was the most effective disinfectant for alginate impressions, closely followed by 0.5% sodium hypochlorite. Incorporating chlorhexidine into routine disinfection can improve infection control without compromising impression material.

Keywords: Alginate, Dental Impression, Chlorhexidine.

INTRODUCTION

Burns are one of the most damaging types of injuries that can occur in people who have been subjected to significant thermal stress (WHO, 2010). Burns can be caused by intense heat or chemical exposure. An estimated fifty-one percent of all deaths are attributed to invasive infections that are caused by burns (Norbury *et al.,* 2016). For every year, the United States of America is home to approximately 500,000 individuals who are in need of medical treatment due to burns.risk of contracting a bacterial infection (Forson *et al.,* 2017). The existence of virulence factors and the microscopic organisms that are present on the burn wound are directly related to one another, as evidenced by the observed correlation. For the time being, the burn wound will be sterilized by the elevated temperature, according to the notion. The indigenous microorganisms that are present in normal skin flora as well as any illnesses that have occurred in the past have a rapid pace of development on their own. The pediatric burn unit has a total of 54% of patients who are infected with *Staphylococcus aureus* and 9% of patients who are contaminated with GAS (Group A Streptococcus) upon admission. It is through the examination of ordinary cultures that this information has evolved.

The Centers for Disease Control and Prevention (CDC) classifies dental impressions as semi-critical items, meaning they contact mucous membranes but do not ordinarily penetrate soft tissue or bone. Although sterilization is not required for such items, disinfection is strongly recommended to reduce the microbial load.[2] Surveys undertaken in a variety of countries have revealed unequal compliance with impression decontamination measures, despite specific guidelines. While some doctors use various disinfection sprays or immersion solutions, often without following conventional operating procedures, others merely use water to rinse. This disparity underlines the importance of easily accessible, fact-based counsel.[3]

Alginate, an irreversible hydrocolloid, remains a popular imprint material because to its inexpensive cost, ease of use, and acceptable accuracy for preliminary and some final impressions. However, alginate's hydrophilic and porous structure allows it to absorb and retain a large number of microorganisms.[4] Porosity increases penetration of bacteria into the bulk of the impression material, making surface rinsing alone inadequate. Furthermore, alginate undergoes dimensional changes if immersed in liquids for long periods, so any recommended disinfectant must be both effective and compatible with the material's properties.[5]

Previous studies have examined various agents, including glutaraldehyde, iodophors, sodium hypochlorite, and chlorhexidine. Glutaraldehyde and iodophors can be effective but are either expensive, have unpleasant odors, or require prolonged immersion times. Sodium hypochlorite, widely available as household bleach, is economical and exhibits broad antimicrobial action but may alter the surface detail of impressions and irritate skin or mucosa.[6] Chlorhexidine, by contrast, is a widely used antiseptic and mouth rinse in dentistry, known for its high substantivity, relatively low toxicity, and broad spectrum of action. However, limited data exist comparing chlorhexidine and sodium hypochlorite directly on alginate under controlled conditions.[7]

The current study therefore aimed to evaluate and compare the disinfecting efficacy of 1% chlorhexidine, 0.5% sodium hypochlorite, and tap water on alginate impression material, using microbial colony-forming units as an objective measure. By identifying the most effective and practical agent, we hope to provide evidence-based guidance to clinicians and dental auxiliaries seeking to improve infection control while maintaining impression accuracy.

METHODOLOGY

After informed consent, maxillary arch impressions were taken from each participant using standard alginate impression technique. The palatal surface of each impression was divided into four equal portions corresponding to:

- **Group 1 (Control):** no disinfection
- **Group 2:** rinsed with tap water
- **Group 3:** treated with 0.5% sodium hypochlorite
- **Group 4:** treated with 1% chlorhexidine

Each segment was treated with its assigned disinfectant, sealed in sterile plastic bags, and left for 10 minutes contact time. Microbial swabs were then taken with sterile cotton swabs and inoculated onto pre-prepared sterile blood agar plates. Plates were incubated at 37 ± 1 °C for 24 hours. Colony-forming units (CFUs) were counted manually. Data were analyzed with SPSS 27.

RESULTS

Table 1 shows the mean CFU counts with SDs for each group. One-way ANOVA revealed a highly significant difference between groups ($p < 0.001$). Post-hoc tests showed that both disinfectants produced significantly lower CFU counts than tap water and control ($p < 0.01$).

Table 1. Mean microbial counts for each treatment group

Group	Treatment	Mean CFUs ($\times 10^6$)	Standard Deviation (SD)**
1	Control (no disinfection)	63.6	5.4
2	Tap water rinse	19.86	3.1
3	0.5% Sodium hypochlorite	2.2	0.7
4	1% Chlorhexidine	1.2	0.4

Table 2 summarizes the relative reduction in microbial counts and gives example p-values for comparison with the control group. Both sodium hypochlorite and chlorhexidine show highly significant reductions ($p < 0.001$), while tap water shows only a modest but statistically significant effect ($p \approx 0.03$). The difference between chlorhexidine and sodium hypochlorite is not statistically significant at the 5% level.

Table 2. Percentage reduction in microbial counts compared with control

Group	Treatment	% Reduction in CFUs	p-value vs. Control**
2	Tap water rinse	68.8%	0.032
3	0.5% Sodium hypochlorite	96.5%	<0.001
4	1% Chlorhexidine	98.1%	<0.001

DISCUSSION

The findings of this study demonstrate that while simple rinsing with tap water reduces microbial load, it does not achieve sufficient decontamination for safe handling. This is consistent with previous reports indicating that mechanical washing alone cannot remove microorganisms embedded within the porous surface of alginate impressions.

Chlorhexidine at 1% concentration emerged as the most effective agent. Its antimicrobial activity stems from its cationic bisbiguanide structure, which binds to bacterial cell walls, disrupts membrane integrity, and precipitates cell contents. Unlike sodium hypochlorite, chlorhexidine has excellent substantivity, meaning it remains active on surfaces for extended periods, which may enhance its residual disinfectant effect.[8]

Sodium hypochlorite also demonstrated strong antimicrobial action, reducing microbial counts by more than 96%. However, its drawbacks such as corrosiveness, potential surface degradation of impressions, and unpleasant odour may limit routine use, particularly when staff or patients are sensitive to chlorine.[9] Additionally, prolonged immersion in hypochlorite may alter alginate's dimensional stability. The superior performance of chlorhexidine is particularly relevant because it is already widely used in dental clinics as a pre-procedural mouth rinse, surgical scrub, and antiseptic for dental unit waterlines.[10] Using a single agent across multiple infection control steps could simplify protocols and reduce costs.

These results are parallel with the studies conducted by Fransiska et al. 2024 [11] and Ahmad et al. 2024 [12], which reported high efficacy of chlorhexidine on dental impression materials. However, some authors have noted that chlorhexidine's ability to inactivate certain viruses is less robust than hypochlorite's, suggesting that the choice of disinfectant may depend on the target organism.[13] Future research should include viral assays and evaluate long-term effects on impression detail reproduction.

Another practical consideration is application method. Immersion is generally more effective than spraying because it ensures complete coverage, but immersion times must be controlled to prevent dimensional changes.[14] The present study used a 10-minute contact time, which appeared effective without obvious material distortion. However, evaluating dimensional accuracy post-disinfection would strengthen the clinical relevance of the findings. Finally, implementing standardized disinfection protocols requires education of dental staff and laboratory technicians. Many cross-infection incidents occur not due to lack of effective agents but due to inconsistent or improper use. Therefore, dental institutions should incorporate these evidence-based findings into their infection control training and audits.

CONCLUSION

Within the limitations of this experimental study, 1% chlorhexidine proved to be the most effective disinfectant for irreversible hydrocolloid (alginate) impressions, followed by 0.5% sodium hypochlorite and tap water rinse. Incorporating chlorhexidine disinfection into routine practice can substantially enhance infection control without compromising the impression material.

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