RESEARCH PAPER

Influence of chemical disinfectants on the colour stability of maxillofacial prostheses - A Systematic Review

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ABSTRACT

Background: MSP has established the necessity of regular washing and disinfection of it to maintain a hygienic condition and prevent the development of bacteria on the surface of a prosthesis. Nevertheless, prolonged exposure to chemical disinfectants may affect the silicone elastomer material properties especially colour stability. Even the slightest alterations to colour could interfere with the aesthetic connection of the prosthesis and the tissues that surround it, reducing the satisfaction levels of the patients. Even though cleaning chemicals are often recommended as part of daily prosthesis maintenance, it is not known about its impact on the colour stability of maxillofacial silicone materials. The aim of this systematic study was to determine the effect of different disinfectants on the stability of colour of maxillofacial silicone prosthesis.

Materials and Methods: There was an electronic search conducted on the PubMed/MEDLINE, EBSCO, and Ovid databases without any restrictions to language. in-vitro experiments on the effect of disinfecting agents on stability of maxillofacial silicone materials were found satisfactory. Study data were extracted in a systematic way by employing a typical extraction template. Quality Assessment of In Vitro Studies (QUIN) methodology was used to assess the methodological quality of the included studies. Due to the dissimilarity among the silicone materials, disinfection agents, and experiment methods of the studies included, the summary of the data were conducted through qualitative instead of meta-analysis method.

Results: The first search resulted in 105 results. Following the removal of duplicates and filtering titles and abstracts, 10 in vitro studies were eligible and included in the qualitative information. The selected study compared different silicone, disinfectants, immersion method, and observation. There was observable colour alteration in all experiments that have been subjected to disinfectants. The severity of such changes however differed and seemed to depend on the type of disinfectant used, silicone material construction, colouring process and exposure period. Within a majority of the cases, the resulting colour change was within the range of clinically acceptable bounds.

Conclusions: The available in vitro studies indicate that frequently used disinfectants have the potential of impacting the colour stability of MSP. However, the colour change measures which are observed across the majority of studies are ones which seem to be within the clinical limit. Better thought-out research and systematic methods of disinfection are needed to reach good prosthesis hygiene without compromising long-lasting aesthetic resolutions.

Keywords: Maxillofacial prostheses; Maxillofacial silicone; Color stability; Chemical disinfectants; Silicone elastomers; In-vitro studies.

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INTRODUCTION

Elasticity and the surface characteristics that are close to natural facial tissue characterize silicone elastomers and make them a significant choice in the manufacturing of maxillofacial prosthesis. Such materials may be copies of fragile anatomical forms and still be soft enough to ensure successful recovery of prostheses. Face prostheses have to be present in the majority of day-to-day activities due to which it is essential to maintain their appearance during a lifetime to achieve aesthetic success and patient confidence in the prosthesis.

One of the most crucial properties of maxillofacial silicone materials is colour stability. Even minor discolouration may affect the natural appearance of the prosthesis, and this will need replacement sooner than desired. These changes of colour can be influenced by intrinsic and external factors. Some intrinsic factors that will be required are the chemical composition of the silicone, the colours employed when producing it, and other fillers and additions. Progressive discolouration can be caused by external factors such as environmental exposure, UV radiation, cosmetic products as well as routine hygiene routines.

Maxillofacial Silicone Prosthetics (MSP) is made using a wide range of silicone elastomers, such as RTV (room-temperature vulcanised) and HTV silicones. In order to enhance aesthetic performances, these materials are often impregnated with natural or added colours, opacifiers, and recently with nanoparticles. Even though these modifications are likely to enhance the visual realism of the prosthesis, it is possible that they will alter the behaviour of the material with environmental agents and chemicals which will increase or decrease its propensity to change colour.

To ensure that the health of a patient is safeguarded, appropriate hygiene of the maxillofacial prosthesis is essential in prevention of microbial colonisation. This has led to a situation whereby patients are usually advised to wash their prosthetics regularly using disinfectants. The most widely proposed cleaning processes include neutral soaps, chlorhexidine solution, sodium hypochlorite, effervescent cleaning pills, herbal medicines and disinfectants based on ozone. Although these variants are effective in microbial growth

prevention, an extended exposure to disinfectants can react with the silicone base or colourants, leading to subtle gradual fading of the colour.

Consequently, there is an important clinical issue of finding the balance between good practice of cleaning the prosthesis and long-term aesthetic appearance. To come up with acceptable maintenance of these materials, a greater understanding of the effect of various disinfectants on the colour stability of maxillofacial silicone materials should be adopted. Owing to this, the present systematic review was carried out on the basis of examining and integrating the existing literature of the effect of disinfectants on the colour stability of MSV.

MATERIALS AND METHODS

Protocol Registration and Reporting Guidelines

The methodology for this systematic review was predefined and registered in the International Prospective Register of Systematic Reviews (PROSPERO) with the registration number CRD420261294514. The review approach adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria to guarantee transparency and reproducibility in study discovery, selection, and reporting.

Focused Research Question

This systematic review was designed to address the following research questions:

What impact do disinfectants have on the color stability of maxillofacial silicone prostheses?

Eligibility Criteria

The identified studies were screened and selected based on predetermined inclusion and exclusion criteria.

Inclusion Criteria

Studies were considered eligible for inclusion if they met the following criteria:

- In-vitro experimental investigations
- Studies evaluating maxillofacial silicone materials used for prosthetic rehabilitation

• Studies examining the effect of disinfectants or cleansing agents on silicone materials
• Studies reporting color stability outcomes, typically expressed as color change (ΔE)
• Articles published between January 1998 and December 2024
• Publications in any language

Exclusion Criteria

Any study meeting the following exclusion criteria was not considered for inclusion:
• Clinical studies, case reports, case series, narrative reviews, or systematic reviews
• Studies investigating materials other than maxillofacial silicone elastomers
• Studies that did not assess color stability as an outcome variable
• Conference abstracts, letters to the editor, or publications lacking sufficient extractable data

Information Sources and Search Strategy

A comprehensive electronic search was performed in the following databases:
• PubMed/MEDLINE
• EBSCO
• Ovid
The initial database search was carried out on December 9, 2025, and was later updated on January 29, 2026.
The search technique included controlled vocabulary and free-text phrases for maxillofacial prosthesis, silicone materials, disinfectants, and colour stability. Boolean operators were employed to combine relevant terms. The search terms included variations of the following concepts.
• maxillofacial prostheses and facial prosthetics
• silicone materials and silicone elastomers
• disinfectants and cleansing agents
• color stability and color change
The search string in details was as shown below:
((Maxillofacial prostheses or Maxillofacial silicone or Facial prosthesis or Facial prostheses or Silicone or Silicones or Silicone material or Silicone rubber or Medical-grade silicone or Prosthetic silicone or Silicone-based material or Polydimethylsiloxane or PDMS) and (Color stability or Color change or Delta E or Color differences) and (Disinfectant or Cleaning or Chlorhexidine or CHX or Sodium hypochlorite or Neutral soap or Ant
Besides the electronic search, the reference lists of each of the studies included in the study were also inspected manually to determine the possibility of discovering unidentified articles with possible relevance in the study that might not have been searched in the database.

Study Selection

All of the reviewed records were examined in terms of their inclusion criteria as listed on their title and abstract by Dr. Raghavendran Sathyanarayanan, Dr. Narayana Reddy D. and Dr. Bharathi Prasad.
A search of the database provided 105 documents (PubMed, 56; EBSCOhost, 31; and Ovid, 18). Having considered the titles, 27 articles were considered potentially relevant. This has decreased the number of duplicate records by 16 and now 11 studies are being reviewed in terms of their title and abstract. It eventually eliminated one article as it was a systematic review and meta-analysis. Lastly, a total of ten studies that were in vitro studies were qualified to enter into the qualitative synthesis.
Conflicts between reviewers during the process of selection were solved by talking with each other until an agreement was reached.

Data Management

All the references found in the database search were copied to the Zotero reference management software, where the duplicate records were recognized and eliminated before being subject to the screening process.

Data Extraction

The three reviewers independently extruded data based on data collection form that was standardized. Each study contained information on the following:

Risk of Bias Assessment

Quality Assessment of In Vitro Studies (QUIN) method was applied in assessing the methodological quality of the included studies. The rating gave each study a rating in different dimensions such as study design, methodological rigour, outcome measurement and quality of reporting. Critiques were also done on the sufficientity of reporting and research categorised accordingly. There was no additional percentage-based grading system as it was considered that the QUIN tool by its own was sufficient in in vitro experiments.

Outcome Measures

Color stability of maxillofacial silicone materials was the main outcome that was considered in this review. Accounted as color change (DE), color change is a stability color metric which is measured by objective color analysis systems and most usually varieties of the CIE Lab+ color space. Other results were noted such as

the changes in the hardness of the material and other surface features where possible.

Data Synthesis

The used studies had a great variation in terms of the silicone materials being tested, the disinfectants under test, the disinfection procedure under test, and the way outcomes were to be evaluated. It is because of this heterogeneity that quantitative pooling of the data was not possible. Rather, a qualitative synthesis was used to summarize the findings. The findings were narrated and listed based on the kind of disinfectant and properties of the silicone materials that were tested.

RESULTS

Study Selection

This search in the electronic database returned 105 entries found (PubMed, 56; EBSCOhost, 31; and Ovid, 18). After the screening of titles, 27 articles were found as possibly relevant articles. The filtering of the 16 records delivered on the basis of the duplicate records resulted in an 11-study to be reviewed per title and abstract. All these 11 papers were therefore still reviewed to establish that they were eligible. This excluded one of the articles because it was a systematic review and meta-analysis article but not an original in vitro experiment and the other article was excluded simply because the abstract only of the article was given out. Finally, 9 studies meeting the inclusion criteria were involved in the qualitative synthesis.

The PRISMA flow diagram shows how identification and selection of the studies were done.

No participant-level data were available because the study included a review of existing literature.

The nature of the Included Studies Characteristics Characteristics of the Included Studies There was no participant-level data in the study as this involved a review of available literature.

This review consisted of all the studies which were in vitro experiments that investigated the influence of the disinfectants on the colour stability of MSP materials. The studies were also published in the years 1998 to 2024 and had different geographical origins. There were no clinical studies that met the qualifying criteria to be included. The paramount performance studied in every research was the colour stability expressed in terms of colour difference values (ΔE). Objective spectrophotometric methods based on CIE Lab* colour system were used to make these observations.

Materials and Techniques of Silicone and pigmentation.

The reviewed study has considered multiple maxillofacial silicone products, but the most significant one is room-temperature vulcanised (RTV) and heat-temperature vulcanised (HTV) silicones. Some researchers worked on the aspect of enhancing the aesthetic properties of silicone materials with the help of colours, opacifiers or nanoparticles.

Silicone compositions of both types were tested: pre-colored and hand-colored. Other studies have also examined other pigments colour range (red, tan or brown) to determine whether there is any difference in colour stability with respect to pigment types.

Control Solutions and Disinfectants

The research incorporated researched a massive spectrum of disinfectants. Agents used consisted of different proportions of chlorhexidine, sodium hypochlorite, neutral soap, antibacterial soap, effervescent washing tablets, herbal disinfectants, and ozone water.

Experiments had control conditions that were different. Some studies have used pure water or saline as control solution, but others did not. This difference in disinfection agents and control factors resulted in the methodological difference in the included studies.

Disinfection and Aging Advisories

Procedures of disinfection that were used in experiments differed greatly. Other studies treated silicone samples with disinfectants through constant immersion and others through repeated disinfection procedures with differing disinfection time and frequency on a day-by-day basis.

The total duration of disinfection was also highly diverse, as the term disinfection lasted from a few seconds to several weeks or months. Moreover, external studies employed artificial ageing methodology (e.g., UV and accelerated weathering experimentation) to simulate clinical scenarios in the long term.

Color Stability Outcomes

The entire research involved in this review implied a level of change of colour of maxillofacial silicone materials after contact with disinfectants. In general, the changes in colour (ΔE) were observed in all the experimental groups.

Nevertheless, they had different degrees of modification depending on various factors which included the type of disinfectant used, type of silicone material used, colouring procedure, and duration of exposure.

Other light cleaning agents like neutral soap, according to several studies, do not create any significant colour changes. The 01 chlorhexidine, sodium hypochlorite, and herbal/ozone-based disinfectants have higher 01 values than the rest.

Silicones that have been manually coloured are prone to change of colour comparing to pre-coloured silicone materials. In comparison experiments of different pigments hues, darker pigments tend to have more colour variations.

Methodological Quality and Risk of Bias

The quality Assessment of In Vitro Studies (QUIN) methodology was used to determine the methodological quality of the included studies. In the QUIN rating system, the methodological quality of the majority of the research was average.

All in all, the literature presented a comprehensive description of the study purpose, the experimental setup, the modes of evaluation for the study outcomes, and statistical analyses.

Synthesis of Evidence

Formal meta-analysis was not performed due to the very high heterogeneity of the investigations, which comprise variations in silicone materials, disinfectants, experiment procedures, outcome assessment strategies, and examination points. Rather, the results of this analysis were synthesised qualitatively, prioritising on establishing general patterns and trends between the included research.

Summary of Findings

In general, the existing in vitro studies reveal that disinfectants have the potential to impact the colour stability of maxillofacial silicone prosthesis. The extent of discoloration depends on the disinfectant used and the nature of silicone material. Although proper cleaning is easily required to ensure the cleanliness of the prosthesis, it is possible that long-term exposure to specific disinfectants can adversely affect the aesthetic outcome in the long term.

DISCUSSION

This empirical research aimed at examining the influence of different disinfectants on the colour stability of MSP. In vitro data available indicates that disinfection methods may have an impact on the colour of such materials. Nonetheless, the sizes and clinical importance of these changes are normally varied by a variety of factors such as the type of disinfectants used, silicone formula, colouring procedure and the duration or process of exposure.

Another requirement of the maxillofacial prosthetic materials is colour stability because any slight discolouration will spoil the aesthetic appearance of the prosthesis and prompt a premature replacement. The studies utilized in this paper were consistent as they could always find detectable changes in colour after putting it in contact with disinfection chemicals. Nonetheless, these alterations do not have to be clinically relevant. The differences in colour stability could be attributed to difference in silicone formulation, the percentages of the pigments and type of pigments, and the contact between disinfectant solutions and the polymer network of the silicone material.

The literature survey in the literature focused on some kinds of maxillofacial silicone materials such as room-temperature vulcanised (RTV) and heat-temperature vulcanised (HTV) silicone. Other studies went on further to tweak the materials with the addition of colours, opacifiers or nanoparticles in order to enhance their aesthetic properties. These materials could be sensitive to colour change depending on the amount of filler, the density of the crosslink, and the properties on their surfaces. Pigmented silicones, especially those by hand, had more variations on colour than precolored materials, which were assumed to have been caused by pigment leaching or wear and tear due to being exposed to disinfectants frequently.

The study within the frame of this review also discussed a great variety of disinfection agents. These were chlorhexidine, sodium hypochlorite, neutral and antibacterial soaps, effervescent washing pills, herbal disinfectants, and ozone-based treatment. Though they are useful in eliminating microbial containment, the chemical structure, pH and oxidizing properties can cause pigment destruction or silicone surface reactions. As reported by several studies, oxidising disinfectant powers and exposure time were found to be stronger leading to increased colour change in contrast to weaker cleaning agents.

Control solutions have also been used to measure the background colour change related to water absorption by many studies, including distilled water or saline. Silicone elastomers have been known to take in small amounts of water which can lead to swelling of the polymer network, plasticization of the material as well as alteration in the optical properties of the material. The mechanism of absorption can also permit the disinfection components

to enter into silicone matrix and increase the discolouration probability of the materials. Secondly, other studies employed ageing methodologies like UV exposure, fast weathering tests, to mimic long term clinical conditions and hypothesize its effects on colour stability.

In the experiments the disinfection and immersion techniques were considerably different. In some studies, silicone specimens were plunged into cleaning solutions, whereas others recreated the daily washing cycles (days and months long). It seemed that length of exposure and its frequency also had an effect on the magnitude of the colour change, with longer or repeated disinfection periods giving significance increase. These inconsistencies highlight why disinfection methods should be standardised in future studies in order to enable the results that differ between studies to be more comparable.

The QUIN tool disclosed that most of the referred studies were of intermediate quality in terms of the methodology. A number of methodological weaknesses were identified such as insufficient reporting on calculations of sample sizes, absence of randomisation, absence of any blinding procedures and little detail on operators or the assessors of the results. The bias can be caused by these issues and must be considered in further in-vitro research to enhance the effectiveness of the findings.

There are certain limitations to evaluating the results of this review. The research all were in vitro which might not be a true account of the complex clinical environment that face prosthesis are used. The sunlight exposure, sweat, ambient contaminants, cosmetics and patient-specific hygiene routines are variables that cannot be recreated in the laboratory and can potentially affect colour stability in a clinical setting. In addition, the large variety of material, disinfectants, and measuring techniques made pooling of the quantitative data difficult.

Nevertheless, the limitations have not prevented the present study to give a comprehensive overview of the currently existing in vitro studies into the effects disinfectants have on the colour stability of maxillofacial silicone materials. These results suggest that, although cleaning has to be done regularly to ensure that the prostheses stay clean, the disinfectant agent used and the regime adopted can potentially affect the aesthetical performance in the long term. Therefore the proper choice of cleaning procedures is important to guarantee the functionality and aesthetics life of maxillofacial prosthesis.

CONCLUSION

According to the results presented in this systematic review, frequently used disinfectants caused noticeable colour changes in maxillofacial silicone prosthesis when tested under various in-vitro disinfection and immersion circumstances. However, in the majority of the examined investigations, the extent of colour change was within clinically acceptable ranges. The quantity of discolouration appears to be determined by a number of parameters, including the kind of disinfectant used, the composition of the silicone material, the pigmentation process utilised, and the period of exposure.

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Conflict of Interest

None declared.

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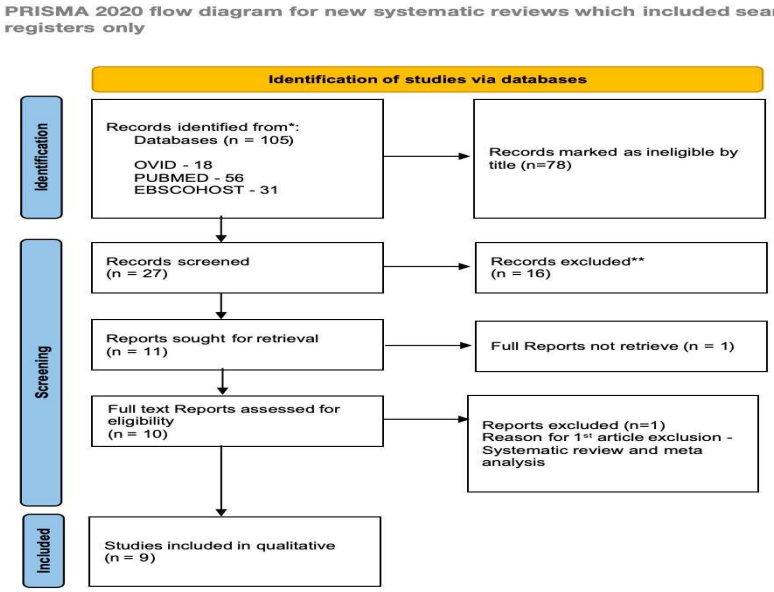

Characteristics of Included Studies

Article No.	Author & Year	Country of Study	Language of Publication	Study Design
1	Srivastava, 2025	India	English	In-vitro experimental study
2	Peter, 2023	India	English	In-vitro experimental study

3	Cevik, 2018	Turkey	English	In-vitro experimental study
4	Chamaria, 2018	India	English	In-vitro experimental study
5	Goiato, 2011	Brazil	English	In-vitro experimental study
6	Kambala, 2020	India	English	In-vitro experimental study
7	Cabral, 2018	Brazil	English	In-vitro experimental study
8	Chotprasert, 2022	Thailand	English	In-vitro experimental study
9	Daivasigamani, 2024	India	English	In-vitro experimental study