






# Recommendations for post-rehabilitation care of maxillofacial prostheses

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**Aim:** This study aimed to review the scientific literature to describe the main care and hygiene protocols for different types of maxillofacial prostheses (MFP). **Methods:** A bibliographic search on the PubMed / Medline database using the following keywords: ["maxillofacial prosthesis" OR "ocular prostheses" OR "palatal obturators"] AND ["Cleaning" OR "disinfection"] AND ["care"] AND ["color stability"] OR ["denture cleansers" OR "cleansing agents"]. Articles addressing materials, cleaning and disinfection protocols, and care related to MFP were included. The following exclusion criteria were applied: no adequate methodology, incompatibility with the area of interest, and unavailability for reading in full.

**Results:** The papers were grouped into the following topics: facial prostheses, ocular prostheses, maxillofacial intraoral prostheses, and retention systems. **Conclusion:** Despite the MFP changes over time, its degradation decreases upon following the recommendations and post-adaptation care. The guidelines for cleaning and disinfection must be individualized to guarantee the longevity of the prosthesis and the patient health.

**Keywords:** Maxillofacial prosthesis. Maxillofacial prosthesis implantation. Palatal obturators. Ossicular prosthesis. Disinfection.

## Introduction

Maxillofacial prosthetic treatment is aimed at the rehabilitation of acquired or congenital mutilation to restore aesthetics, protect remaining tissues, and assist in psychological therapy<sup>1-3</sup>. Studies have reported that reconstructing intraoral (mandibular, maxillary, or palate defects) or extraoral anatomical structures (eyes, nose, ear, and facial structures) is accessible, inexpensive, non-invasive, and strongly influences the patient's quality of life and self-esteem<sup>2-5</sup>.

Maxillofacial prostheses (MFP) can be manufactured using alloplastic materials such as polymethylmethacrylate (acrylic resin or PMMA), polyurethanes, latex, and silicone or vinyl plastic polymers. These prostheses can have different retention means, such as the anatomical defect itself, remaining teeth, osseointegrated implants, adhesives, and eyeglasses<sup>4</sup>.

The care involved in the methods of disinfection, placement, and removal of the prosthesis is crucial for its durability and the health of the surrounding tissues<sup>6</sup>. Thus, the post-installation recommendations of MFP should be considered during the prosthetic planning, when the material, retention system, and clinical approach most suitable for the patient will be determined<sup>7</sup>. Therefore, the guidelines on care and hygiene should be individualized and the patients must be monitored to ensure that they are cleaning their prostheses correctly, also in addition to solving their doubts<sup>2</sup>.

However, disinfection protocols may not be always effective and can change the properties of the polymers used to fabricate MFP<sup>8</sup>. In contrast, there is still no consensus in the literature regarding the best hygiene and care methods for each material, type of MFP, and retention system. Aiming to enlarge the knowledge on prosthetists concerning the guidelines for patients, this study reviewed the literature on post-installation care for MFP by systematizing the recommendations according to the variables and characteristics of the different types of prostheses.

## Methods

We conducted a literature search on the PubMed/Medline database using the following keywords: ["maxillofacial prosthesis" OR "ocular prostheses" OR "palatal obturators"] AND ["Cleaning" OR "disinfection"] AND ["care"] AND ["color stability"] OR ["denture cleansers" OR "cleansing agents"]. Articles that discussed materials, cleaning and disinfection protocols, and care related to MFP were included. The search was widened, when necessary, and references cited in the publications were also included. Neither the year of publication nor the language of articles were delimited. After reviewing the articles, we included as all papers that showed to be suitable to our central theme. Relevant concepts and the publication of well-known and trusted journals were considered as important requirements. We disregarded any articles that presented no adequate methodology or did not address the area of interest, in addition to those that were not available for reading in full.

## Literature Review

This review presents the mostly recommended hygiene and care methods for each type of MFP considering the material of manufacturing and retention system used. The recommendations were divided by a) classification of the MFP variables and the characteristics of the different types of manufacturing materials and b) retention systems. Table 1 summarizes the main care and hygiene methods.

**Table 1.** Main Recommendations for Post-adaptation Care of Maxillofacial Prostheses

Facial Prostheses (FP)	<ul style="list-style-type: none"> <li>• Whenever possible, remove the prosthesis before sleeping<sup>25</sup>.</li> <li>• Cleaning can be done through mechanical removal with water and neutral soap, without rubbing<sup>8</sup>.</li> <li>• Daily immersion in 0.2% CHX for 5 min is also indicated<sup>2,25</sup>.</li> </ul>
Ocular Prostheses (OP)	<ul style="list-style-type: none"> <li>• Regular replacement of the artificial eye is indicated<sup>28</sup>.</li> <li>• For adult individuals, the prosthesis must be changed every two or six years, depending on age, care with the prosthesis, and constituent materials<sup>27,29</sup>. In the age group from 10 to 12 years old, it must be renewed every six months<sup>28,30,70</sup>. For younger children, replacement should be quarterly<sup>31</sup>.</li> <li>• Control consultations should be annual for adults and semiannual or quarterly for children<sup>31</sup>.</li> <li>• Daily use of lubricant eye drops is recommended<sup>31,32</sup>.</li> <li>• Morning irrigation of the eyelids with saline solution to remove crusts, secretions, or debris from the anophthalmic socket<sup>34</sup>.</li> <li>• The prosthesis must be professionally polished once a year to remove irregularities and maintain its surface gloss<sup>28,32</sup>.</li> <li>• The acrylic resin OP must not be cleaned with alcohol, abrasives, or aggressive chemicals<sup>27,35</sup>. The use of common soap or products containing colorings should also be avoided<sup>26</sup>.</li> <li>• Daily cleaning of the prosthesis can be performed with 0.5% CHX or Efferdent.</li> <li>• For periodical cleaning (every three days), an alkaline peroxide tablet or 4% CHX can be used<sup>38</sup>.</li> <li>• Do not clean less than monthly or more than semiannually<sup>28</sup>.</li> <li>• Do not remove the prosthesis before sleeping<sup>9,30,36</sup>.</li> </ul>
Maxillofacial Intraoral Prostheses	<p>Pre-installation care:</p> <ul style="list-style-type: none"> <li>• The dentist must immerse the acrylic in an anionic detergent solution (without flavoring) for 20 min; wash in filtered water; then immerse it in hydrogen peroxide for 10 min and finally wash with sterile distilled water or saline solution. Disinfection before installation can also be performed by immersing the prosthesis into a 0.5% povidone-iodine solution, followed by immersion in saline solution for 20 s.<sup>47</sup></li> </ul> <p>Daily care:</p> <ul style="list-style-type: none"> <li>• The patient should be instructed to brush the denture with water, neutral soap, and a toothbrush with soft bristles after each meal when waking up, and before bedtime<sup>2</sup>.</li> <li>• Tubes of toothpaste containing abrasive agents and mouthwashes are not indicated for cleaning the prosthesis<sup>48</sup>.</li> <li>• The prosthesis should never be boiled<sup>2</sup>.</li> <li>• For tissues, CHX is the most recommended antiseptic.</li> <li>• For maxillectomized patients, irrigation with saline solution (or salt and sodium bicarbonate) through the nasal cavity is indicated, as well as oral washing several times a day<sup>43</sup>.</li> </ul>

Continue

## Continuation

Chemical retention by adhesives	<ul style="list-style-type: none"> <li>• It is essential to remove the prosthesis to sanitize it and the remaining tissues for purposes of preservation<sup>57</sup>.</li> <li>• Consider using adhesive removers during the prosthesis removal process<sup>71</sup>.</li> <li>• Mineral oil or Vaseline can also be used in situations where the adhesive will not be reapplied in the same area within a short period<sup>66</sup>.</li> <li>• The surface of the prosthesis and the skin must always be clean and dry before using the adhesive<sup>71</sup>.</li> <li>• It is advised to use an alcohol-free skin barrier for skin protection before applying the adhesive<sup>71</sup>, which should only be applied on dry skin<sup>66</sup>.</li> <li>• Reapplying the adhesive layer is indicated every 4 or 8 h.<sup>62</sup></li> <li>• Using more than one layer of adhesive increases bond strength<sup>47,49</sup>.</li> <li>• In cases of allergy and/or irritation caused by the use of adhesives, the wound must be cleaned with a non-toxic solution. For contact dermatitis, apply cold compresses over the region and use lipid-containing moisturizers. Topical steroids are also indicated to control inflammation. If the lesion does not regress within 7 days, a dermatologist should be consulted<sup>66</sup>.</li> </ul>
Implant retention system	<ul style="list-style-type: none"> <li>• Remove the prosthesis before bedtime<sup>25</sup>.</li> <li>• Isopropyl alcohol can be used to remove oily residue from the restorative material and skin<sup>2</sup>.</li> <li>• Cleaning the areas around the abutments daily and preferably at night<sup>58</sup>.</li> <li>• Cleaning the abutments: moisten the area and any dry residue present with a mixture of water and hydrogen peroxide (50:50) or water and neutral soap. Then, use a cotton swab or soft brush to carefully clean the area around the skin, the abutment, and/or the bar, avoiding traumatizing the tissues<sup>26</sup>.</li> </ul>

## Facial Prostheses (FP)

Nasal, lip, oculopalpebral, and auricular<sup>4,7</sup> prostheses are made for large facial defects. Polydimethylsiloxane (silicone) and PMMA are the most commonly used materials for manufacturing FP<sup>9</sup>. Acrylic resin is occasionally used when there is small tissue movement during function<sup>10</sup> and it can also be composed of an infrastructure coated by silicone<sup>7</sup>. Silicone is the material of choice for manufacturing since its flexibility provides patient comfort and a texture like the human skin<sup>8</sup>.

The mean useful life of the silicone-based FP ranges from 1.5 and three years, but only 4.8% of them last more than 2 years<sup>7,11-13</sup> since it is difficult to repair and its aesthetic and physical properties are compromised when exposed to solar radiation, changes in temperature, humidity, body secretions, and disinfecting agents. Such a scenario results in discoloration, misfits, and degradation, thus requiring continuous maintenance appointments<sup>2,7,14,15</sup>.

Prostheses are exposed to environmental conditions and the user's skin. In general, acidic and alkaline perspirations are absorbed by silicone affecting its elasticity and hardness and contributing to polymer degradation. Contact with the skin allows microorganisms to grow, such as fungi and bacteria from the skin's natural microbiota. The porosity and roughness of silicone also allow biofilms to form, which are resistant to removal and can cause irritation and infection on the patient's skin, in addition to the presence of black spots and unpleasant odor<sup>7,8,16</sup>. Sebum can also interact with the silicone surface, causing some change in color<sup>17-19</sup>.

In this context, care with the prostheses before its installation is also necessary. They must be sterilized in humid heat at 120°C for 1 hour<sup>2</sup>. The frequent cleanness of the FP is essential for its longevity and preserving the patient's health. However, cleaning products and disinfectants can also degrade silicone. Disinfection by immersion in solutions containing chemical agents, such as effervescent tablets, 1% sodium hypochlorite, and solution of 2% to 4% chlorhexidine gluconate (CHX) may also be indicated<sup>8,20-23</sup>. The negative effects of these disinfection methods on prosthetic silicones include the presence or absence of additives, such as pigments and opacifiers<sup>6,8,23</sup>. A 4%-CHX solution showed to produce a greater color change in silicone than effervescent tablets based on alkaline peroxide<sup>20</sup>. In addition, hand-washing the silicone with mild soap and water for 30 s has been reported to be significantly more effective in reducing biofilm (*C Albicans* and *S aureus*)<sup>8</sup>.

Chamaria et al.<sup>23</sup> reported that sanitizing maxillofacial silicones by brushing with antibacterial soap caused clinically unacceptable color changes; however, when cleaned with a 2%-CHX solution, there was a noticeable but acceptable color change. Additionally, sodium hypochlorite discolors this material, which may be maximized by effervescent tablets. Thus, 0.2% CHX can be considered the most suitable agent for the disinfection of FP<sup>24</sup>.

Despite the lack of an established protocol for cleaning FP, the methods of washing the maxillofacial silicone with water and neutral soap (without brushing)<sup>8</sup> or immersing it in 0.2% CHX<sup>24</sup> are considered efficient for causing less changes in the silicone properties. The immersion in CHX solutions is efficient for disinfection of both acrylic and silicone resin prostheses<sup>24,25</sup> and should range from 2 to 5 minutes (min) daily since it starts acting in 15 seconds (s), maintaining a residual effect of 6 hours (h)<sup>2</sup>.

Patients should also be instructed not to sleep using the prosthesis. Removing the FP for sleeping prevents the occurrence of trauma and the growth of microorganisms by the accumulation of humidity, in addition to the irritation and inflammation of surrounding tissues<sup>2,26</sup>.

## Ocular Prostheses

Ocular prostheses (OP) provide patients with aesthetic and functional benefits by protecting the anophthalmic socket from ulcers, infections, tissue retraction, and severe orbital defects<sup>27</sup>. To maintain its functions, the artificial eye must be correctly fitted to the socket and kept in an excellent state of preservation<sup>28</sup>. Over time, the anophthalmic socket and the surrounding tissues may undergo changes, resulting in the misfits of the OP, leading to the development of tissue hyperplasia or chronic conjunctivitis. Thus, replacement of the artificial eye should be indicated<sup>29</sup>. Among adult individuals, the OP longevity ranges from 2 to 6 years, according to patient's age, prosthesis care, and constituent materials<sup>28</sup>. In the age group of 10 to 12 years, the OP must be replaced every six months<sup>30</sup>. For younger children, replacement should be quarterly. Thus, follow-up visits should be at least annually for adults and semiannual or quarterly for children<sup>31</sup>.

During the process of eyeball enucleation, the lacrimal glands are often preserved and can provide natural lubrication for the OP<sup>32</sup>. However, many patients experi-

ence discomfort from dryness and irritation. Therefore, regular use of lubricant eye drops is recommended<sup>31,32</sup>. There is a variety of lubricants available, including silicone oil-based drops, artificial tears, hard contact lens wetting drops, and lubricants made specifically for OP<sup>32</sup>. Each patient suits best to a type of lubricant, from the morning rinsing of the eyelids to cleaning crusts and secretions to improve artificial eye tolerance, thus reducing complications<sup>28,31,33</sup>. Saline solution is the most commonly used eyewash solution to remove debris from the anophthalmic socket<sup>34</sup>.

The OP is frequently made of PMMA due to its low cost and easy handling, in addition to provide satisfactory adaptation and esthetics<sup>35</sup>. This material must be cleaned with alcohol, abrasive cleaners, or aggressive chemicals due to possible corrosion, clouding, scratching, or roughening on the prosthesis surface<sup>28,36</sup>. In addition, OP suffers mechanical injuries and, over the years, its surface becomes more porous, promoting the deposition of bacteria, increased secretions, and discomfort. Therefore, they should be polished once a year to remove irregularities and preserve surface gloss<sup>28,31</sup>.

In general, the OP should not be removed at night since less frequent manipulations reduce the mechanical stress on the conjunctival, preventing it from any inflammation and avoiding tear fluid accumulation and mucus formation<sup>29,31,37,38</sup>. The prosthesis should never remain removed for several days in a row since it may cause the anophthalmic socket to retract<sup>28</sup>. In case of necessity, the artificial eye should be removed by clean hands, and the OP must not be cleaned under tap water, since it is a potential source of contamination. Also, common soaps should not be used as they often contain oils, coloring, or perfumes that can irritate the conjunctiva. The use of products containing preservatives should also be avoided due to the risk of inducing allergic reactions in ocular tissues<sup>28</sup>.

Despite the lack of consensus on cleaning methods for OP, some cleaning agents are more often recommended, including multipurpose solutions for hard contact lenses (no peroxides or alcohol), mild soap, CHX, alkaline peroxide tablets, and baby shampoo<sup>28,32,33,36</sup>. Paranhos et al.<sup>39</sup> demonstrate that all these cleaning agents are effective in reducing aerobic microorganisms present in the prosthesis and anophthalmic socket. However, only a multiuse solution and 0.12% CHX were able to significantly reduce the number of *Staphylococcus aureus*. Another recent study assessed the effect of disinfectants on *Staphylococcus aureus* and *Staphylococcus epidermidis* biofilms formed on the OP surface and found that the alkaline peroxide tablet and 0.5%, 2%, and 4% CHX significantly reduced the number of colony-forming units for both bacteria. However, neutral soap and multiuse solution were not recommended for disinfecting the PO. Instead, the authors recommended daily disinfection of the prosthesis with 0.5% CHX or Efferdent. Alkaline peroxide tablet or 4% CHX can be used for cleaning every three days<sup>36</sup>.

Due to divergences in the literature, it is not possible to establish an ideal cleaning protocol<sup>28</sup>. Problems related to mucoid discharge and discomfort appear to be reduced when patients are encouraged to not clean the OP daily<sup>29,38</sup>. In general, irritation symptoms are not related to altered bacterial flora, but excessively frequent cleaning regimens, as the constant manipulation of these prostheses is associated with an increase in gram-negative bacteria<sup>40</sup>. Such a habit should

be avoided since the increase in pathogenic flora, especially Gram-negative bacteria, is related to the discomfort felt by users of OP<sup>41</sup>. In contrast, patients who do not clean the artificial eye daily have more pathogens and are more susceptible to infections<sup>42</sup>. Thus, Pine et al.<sup>38</sup> suggested that patients clean their prosthesis according to their own needs but advise that prosthetic eyes should not be cleaned less than monthly or more than semiannually.

To guarantee the maintenance and longevity of the OP, there must be a close collaboration between ophthalmologists and ocularists to define customized care and cleaning methods to meet the needs of each patient<sup>33</sup>.

## Maxillofacial Intraoral Prostheses

There are several types of intraoral prostheses (IP), highlighting the palatal prostheses for cleft patients and obturators (immediate, interim, and definitive)<sup>43</sup>. Palatal prostheses isolate the nasal cavity and the maxillary sinus from the oral cavity and its fluids, food, and external environment. In addition, they contribute to the improvement of phonation and swallowing<sup>44</sup>. Immediate prostheses are used after surgical maxillectomy to separate the nasal cavity from the oral cavity, assist in healing, and allow for intelligible speech in the immediate postoperative period<sup>43,45</sup>. The interim obturator prosthesis is installed after the early healing period and is used in a decisive phase for therapeutic success until the healing is complete<sup>43</sup>.

Edentulous obturators consist of PMMA while partially edentulous obturators are supported by chrome-cobalt (CoCr) alloy frameworks<sup>43</sup>. The prostheses of the obturators must be cleaned before being installed in the patient. They can be washed with water and neutral soap and immersed in an anionic detergent solution (unscented) for 20 min. Subsequently, these prostheses should be washed under filtered water and immersed in 10 volumes of hydrogen peroxide for 10 min, and finally washed under distilled water or saline solution (both sterile)<sup>2</sup>. It is also possible to decontaminate the obturators before installing by immersing them in 0.5% povidone-iodine solution and saline solution for 20s<sup>46</sup>.

Once installed, these prostheses can become reservoirs or deposits for the development of bacteria since correct prosthetic hygiene and the remaining tissues are important for the longevity of the prosthesis and the maintenance of oral health. It is recommended to brush the denture with mild soap and soft-bristled brushes. For disinfection, the prosthesis can be sprayed with 4% CHX for 1 min and then washed under running water<sup>2</sup>. Therefore, the daily hygiene of removable dentures should include both brushing and immersion in disinfectant solutions for less than 10 min<sup>47</sup>.

Cleansing regimens must be able to remove stains and bacterial plaque without damaging the properties of the material and its surface<sup>48</sup>. Commercially available denture cleansers use various active agents to remove biofilm from dentures, including alkaline peroxide, sodium hypochlorite, and oral mouth rinses<sup>47</sup>. Felipucci et al.<sup>49</sup> showed that chemical agents such as Periogard (0.12% CHX), Cepacol (Cetylpyridinium chloride 0.500 mg), and effervescent tablets (sodium perborate-based, like Corega Tabs, and Polident) proved suitable for cleaning removable dentures. How-

ever, these chemical agents should be used carefully as they may cause significant color change and alter the roughness and hardness of the resin surface<sup>50</sup>, even in denture bases reinforced with ZrO<sub>2</sub> nanoparticles<sup>51</sup>. In contrast, effervescent tablets have demonstrated a good combination of microbial efficacy and reasonable compatibility with the material<sup>48</sup>.

Commercial toothpaste contains abrasive agents and are not suitable for cleaning dentures. Likewise, alcohol-based mouthwashes and isopropyl alcohol are not recommended for cleaning the prosthetic base made of PMMA for promoting considerable changes such as increased roughness and decreased shine. Obturator prostheses with metallic frameworks require careful selection of chemical cleaning agents as they are usually manufactured with CoCr alloys. When contacting the chloride or oxygen present in some cleaning products, these alloys can suffer corrosion or staining<sup>48,52,53</sup>. The 0.05% sodium hypochlorite and tablets citric acid-based promote no significant changes in the roughness of CoCr or on the surface of thermal polymerization resins. However, they stain and corrode the metallic components of the removable partial dentures, thus being not indicated to clean these prostheses<sup>49</sup>. In addition, 0.05% sodium hypochlorite can cause dark spots on the metallic surface of the Ni-Cr-Mo-Ti and Ni-Cr-Mo-Be alloys<sup>54</sup>.

Other substances, such as vinegar and soap, are compatible with this alloy but do not show antimicrobial efficacy. However, peroxide-based effervescent tablets can promote antimicrobial disinfection and, at the same time, cause little damage to acrylic and metal alloys<sup>48</sup>.

Edentulous patients after maxillectomy suffer from speech impairment and masticatory dysfunction. When the use of denture adhesive is necessary to improve its retention, zinc-based adhesives are contraindicated. Additionally, at each cleaning, the adhesives must be completely removed from both the prosthesis and the oral cavity<sup>47</sup>.

Regular use of antiseptics, especially CHX is recommended to maintain oral tissue health<sup>55</sup>. Irrigating the nasal cavity with saline solution (or salt and sodium bicarbonate) is essential for maxillectomized patients, as well as oral rinses several times a day. The patient should be encouraged and instructed to maintain the excellent oral hygiene of the remaining dentition and attend periodic follow-up visits for assessing oral and denture conditions<sup>43,44,48</sup>. In case of injuries to the prosthesis, such as fractures, care should be sought as soon as possible<sup>2</sup>.

## Retention systems

The MPF can be retained through surgical, anatomical, chemical, and mechanical methods<sup>56</sup>. Because the longevity of these prostheses is related to these methods, for a greater acceptability of the treatment, it is essential that the retention system is carefully chosen since it provides esthetics, function, and comfort to the patient<sup>18</sup>.

### *Adhesive retention (chemical retention)*

Currently, adhesive retention is one of the most used methods for the fixation of MFP<sup>57</sup>. This system is commonly used for fixing FP considered weightless and/or smaller<sup>58</sup>.

The adhesives must not be irritating or toxic to human tissues and not interfere with blood circulation<sup>59</sup>; in addition, it must promote adequate bond strength<sup>60</sup> to prevent detaching of the FP from the skin interface. If such criteria are met, the patient accepts the prosthesis better, thus promoting a positive psychological effect and better prognosis<sup>61</sup>.

Since moisture, sweat, and skin oils can reduce the retentive capacity of adhesives, they should be reapplied every 4 or 8 h<sup>62</sup>. For a greater durability, two layers of adhesive should be applied to increase its bond strength<sup>63</sup>. Kiat-Amnuay et al.<sup>63</sup> recommended a "sandwich technic" with Secure 2 Medical Adhesive (SMA, Factor II, Lakeside, Arizona, USA) applied to the skin, and Epithane-3 adhesive (E3, Daro Products, Muskego, Wisconsin, USA) to the prosthesis. The authors found that such an application method increased the bond strength compared with the isolated use of one of these adhesives. In addition, the use of primers, such as Sofreliner T (Sofreliner Tough, Tokuyama Corp., Tokyo, Japan) and Sofreliner MS (Sofreliner MS Tokuyama Corp., Tokyo, Japan), promote a better bonding to the silicone<sup>61,64,65</sup>.

Removing the prosthesis to sanitize it and the remaining tissues is essential for maintaining health<sup>57</sup>. Adhesive residues must be removed from the prosthesis to prevent them from affecting the adhesion and durability of the new adhesive layer that will be applied to the skin. Isopropyl alcohol<sup>2</sup> and solvents such as Uni-Solve (Smith 1 Nephew, Largo, Florida, USA) can be used since they do not interfere with the adhesive properties<sup>57</sup>. It is suggested to use removers to remove residues from the skin to reduce the patient's discomfort. Alternatively, the use of mineral oil or Vaseline is recommended since they can contribute to loosening the adhesive tape; however, they should only be used in situations where the adhesive will not be reapplied within a short period of time<sup>66</sup>.

The contact of adhesives with the skin can cause dermatological problems and make it difficult to clean them. More retentive adhesives cause greater irritation to the skin as they require greater strength to remove and daily care to maintain skin integrity<sup>57</sup>. Therefore, the use of protective dressing as Skin-Prep (isopropyl alcohol, butyl ester of polyvinyl methacrylate/methyl methacrylate copolymer, acetyl tributyl citrate - Smith & Nephew, Inc, Largo, Fla.) is indicated to reduce trauma and irritation by the adhesive, in addition to improving its retention in up to 6 h<sup>57</sup>. For applying this cutaneous film, the skin and the prosthesis must be clean and dry, and the film must be dry for the adhesive to be applied. Before applying the adhesive, the protective dressing film must also be dry<sup>66</sup>.

The severity of the injury must be assessed in cases of allergy and/or irritation caused using adhesives. The wound must be cleaned with a non-toxic solution and an established therapy. For contact dermatitis, cold compresses should be applied to the region, as well as moisturizers containing lipids as a component. Topical steroids are also indicated to control inflammation. In the absence of regression of the lesion within 7 days, an evaluation by a dermatologist is recommended<sup>66</sup>.

### ***Mechanical retention***

In some situations, the prosthesis can be anchored in the anatomical defect, for example, the OP, which is retained by the orbital cavity itself<sup>68</sup>.

When other methods are not viable, mechanical retention can also be performed by fixing the prostheses in acrylic resin frames, facilitating their use and maintenance. To minimize the weight of oculo-palpebral or nasal prostheses, eyeglasses frames are frequently used, and those with greater thickness help to disguise the edges of the prosthesis<sup>12</sup>.

### ***Implant retention system***

Currently, osseointegrated implants have been considered one of the best retention methods for oral and maxillofacial prostheses, and can be used for retention through magnets, bar-clip systems, or O-rings<sup>67,68</sup>. Compared with other retention methods, implants have advantages such as greater stability, support, safety, comfort, and masking of the union surface. This system is recommended for sports practice, as, unlike adhesives, its retention is not influenced by perspiration<sup>67</sup>, in addition to not causing changes in the color of the silicone, contributing to the prosthesis longevity<sup>7</sup>.

However, a disadvantage of this method is the difficulty of cleaning<sup>67</sup>. It is important to clean the retainers to reduce the amount of bad waste and keep the surrounding tissue healthy, minimizing skin irritation and contributing to better adaptation and retention of the FP. It is recommended to clean the areas around the abutments since the accumulation of debris is common in these areas, and the lack of removal can cause inflammation of the tissues<sup>69</sup>. Therefore, cleaning must be executed daily and preferably at night. A cotton swab, soft brush, or tissue soaked in a mixture of water with hydrogen peroxide or water with mild soap can be used. Another option is cleaning using tufted dental floss with reciprocating movements. However, before flossing, the area should be well-moistened to facilitate the removal of debris<sup>26</sup>.

For retention of ear prostheses with the bar-clip system, the abutments are connected to a bar, which makes the cleaning process more complex than that of the prostheses retained by independent implants<sup>26</sup>. For these cases, soft bristle brushes and neutral soap should be used in the retentive areas. Isopropyl alcohol can be used to remove oily residues from cosmetic materials and the skin; however, the patient must be very careful not to dissolve the pigments<sup>2</sup>. The most critical area to clean is around the metal pillars. In this region, it is common to find accumulations of dry residues, keratin, and epithelium, which, if inadequately sanitized, can lead to inflammation of the surrounding tissues. Therefore, cleaning procedures must be performed daily and preferably before bedtime. When cleaning the abutments, the first step is to moisten the area and any dry residues present with a mixture of water and hydrogen peroxide (50:50) or water and neutral soap. Then, it is indicated to use a cotton swab or soft brush to carefully clean the area around the skin, the abutment, and/or the bar, avoiding traumatizing the tissues<sup>26</sup>.

Removal of the prosthesis during sleep is also indicated since a prolonged use can cause inadequate pressure in the retainers, in addition to irritating and skin inflammation<sup>26</sup>.

## **Discussion**

This study sought to highlight the importance of post-rehabilitation care for maxillofacial prostheses. All recommendations must be individualized considering individual

diseases and physical or cognitive limitations. More than 50% of the worldwide head and neck cancer cases annually diagnosed occur in patients older than 65. Thus, their additional chronic diseases could affect not only the available treatment options but also their quality of life and survival<sup>72</sup>.

As oral hygiene may be compromised in elderly patients with cognitive or motoric impairment, it should be considered that measures could be performed by the patients themselves. It is crucial to secure oral hygiene and aftercare, including patient's education and, in some cases, for caring staff or family members. Therefore, proper and regular instructions should be given and demonstrated not only for patients but also for caring relatives or caregivers (Nitschke et al.<sup>73</sup>). When the patients have their oral hygiene ability compromised, a relationship of trust must be established in cooperation with caregivers for them to participate in dental prevention and therapy. In cases where patients themselves are no longer capable of making decisions, a therapeutic decision without information is both legally and ethically unacceptable. Thus, caregivers and legal guardians, together with the dentist, must make decisions based on the presumed will of the patient<sup>73</sup>.

Furthermore, it is worth highlighting that maintenance practices start in the prosthetic planning stage when studying the type of material to be used in the prosthesis, its retention technique, and how both relate to the type of rehabilitation recommended for the patient<sup>7</sup>. Regardless of the type of prosthesis, hygiene protocols must be rigorously established based on the properties of the materials used for their manufacturing. Neglecting such a step can cause microorganisms to proliferate around the prostheses and adjacent tissues. Cleaning the cavity and/or adjacent tissues is as important as sanitizing the prosthesis, especially in regions with secretion. The existence of an unhealed surgical lesion also deserves special attention given the high risk of infection of the lesion<sup>2</sup>.

The choice of materials is directly related to the type of prosthesis to be made. As for the MFP, different types of materials can be used for their manufacturing, including metal, silicone, or acrylic resin. However, it is noteworthy that the hygiene protocols are specific for each material (Table 1).

In turn, the type of retention varies according to the location and dimension of the prosthesis<sup>57</sup>. Compared with other retention methods, implants have advantages such as greater stability, support, safety, comfort, masking off the union surface, and less chance of causing adverse effects<sup>13</sup>. Furthermore, unlike adhesives, retention is not influenced by perspiration<sup>67</sup>. However, the installation of implants must be meticulous and respect the correct handling of the adjacent soft tissues, bone availability, the occurrence of osseointegration, and correct implant inclination<sup>74</sup>, in addition to demanding rigorous hygiene to maintain its longevity<sup>13</sup>.

Different cleaning agents have been used for cleaning maxillofacial dentures, the most common being neutral soap, CHX, isopropyl alcohol, and sodium hypochlorite. Pinheiro et al.<sup>5</sup> reported that a 0.12%-CHX immersion showed the greatest antimicrobial effectiveness, with results even better than mechanical brushing. However, frequent exposure to these solutions can interfere with the silicone properties<sup>8,75,76</sup>. It is essential to choose the correct solvents for cleaning the prosthesis as inade-

quate chemical solutions can cause pigment dissolution and silicone degradation<sup>8</sup>. In a pilot study, Allen et al.<sup>77</sup> analyzed the effectiveness of a prescribed hygiene protocol for patients who received dentures retained with craniofacial implants. The authors found that damage to the silicone rubber was caused by rigorous cleaning or the use of an inappropriate cleaning agent. In general, for silicon, washing without scrubbing with water and neutral soap is recommended. Immersion in 0.2% CHX is also advised<sup>23</sup>.

A correct cleaning of the prostheses requires to use mechanical and chemical methods as applying mechanical methods alone is not enough to remove microorganisms<sup>78</sup>. The surface irregularities of the prostheses favor the adhesion of microorganisms, making cleaning difficult<sup>79</sup>. Therefore, chemical substances can be used to aid in disinfection. However, the use of abrasive products, volatile solvents, and other chemical substances that can damage prostheses must be avoided<sup>80</sup>. Regarding acrylic resin, it has been observed that CHX can be used to help remove the biofilm and clean acrylic resin dentures<sup>25</sup>. Brushing is not the most suitable cleaning method as it contributes to the discoloration of the denture by dissolving and removing pigments. In addition, when associated with abrasive products and inadequate techniques, it can lead to wear and increased roughness of the prostheses, resulting in increased accumulation of microorganisms and irritation of surrounding tissues<sup>6</sup>.

Several authors do not recommend mechanical methods for sanitizing the OP since they can increase the roughness of the prosthesis, facilitating the adhesion of microorganisms<sup>28,39,81</sup>. Moreno et al.<sup>36</sup> assessed the effectiveness of different chemical substances on the biofilm of *Staphylococcus aureus* and *Staphylococcus epidermidis* formed on the OP surface and found that 2% CHX and 0.5% CHX are clinically valid products for disinfecting these prostheses.

After installation, the hygiene of the prostheses must be maintained to ensure their longevity and the health of surrounding tissues, in addition to preventing irritation and skin infections<sup>25</sup>. Therefore, it is essential to instruct the patient regarding the methods and importance of cleaning and disinfecting the prosthesis. This review addressed relevant issues concerning post-installation care for different types of MFP highlighting individualized care for the most used materials and retention systems.

## Conclusion

Our results show that care with MFP should start in the planning phase and continue until installation and follow-up to reinforce to the patient the importance of cleaning the surrounding tissues and the prostheses for aesthetics preservation, health, and longevity. The dentist is responsible for informing and teaching the proper hygiene and care protocols. The material, type of rehabilitation, and retention system influence the care protocol to be established. However, the patients' expectations should be adjusted since the expected durability of these prostheses is not always fulfilled.

## Conflict of interests

The authors have no conflicts of interest to declare.

## Data availability

Datasets related to this article will be available upon request to the corresponding author.

## Authors contribution

**Leiliane de Oliveira Costa** - definition of intellectual content, literature search, manuscript preparation.

**Sabrina Gomes Martins Soares** - definition of intellectual content, literature search, manuscript preparation.

**Brenda Neves Barreto** - concept, literature search, manuscript preparation.

**Filipe Costa Almeida** - concept, literature search, manuscript preparation.

**Alexa Magalhães Dias** - concept, design, the definition of intellectual content, manuscript preparation and manuscript review.

**Jean Soares Miranda** - design, the definition of intellectual content, literature search, manuscript preparation, manuscript editing, and manuscript review.

The authors declare that the manuscript has been read and approved by all the authors, that the requirements for authorship as stated earlier in this document have been met, and that each author believes that the manuscript represents honest work if that information is not provided in another form.

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