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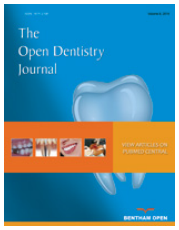

**The Open Dentistry Journal**

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REVIEW ARTICLE

# Role of Dental Implant Homecare in Mucositis and Peri-implantitis Prevention: A Literature Overview

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**Abstract:**

***Background:***

Correlation between high plaque index and inflammatory lesions around dental implants has been shown and this highlights the importance of patient plaque control. Until now, knowledge of peri-implant home care practices has been based on periodontal devices.

***Objective:***

The aim of this overview is to identify the presence of scientific evidence that peri-implant homecare plays a role in mucositis and peri-implantitis prevention.

***Methods:***

Different databases were used in order to detect publications reflecting the inclusion criteria. The search looked into peri-implant homecare studies published from 1991 to 2019 and the terms used for the identification of keywords were: Dental implants, Brush, Interproximal brushing, Interdental brushing, Power toothbrush, Cleaning, Interdental cleaning, Interspace cleaning, Flossing, Super floss, Mouth rinses, Chlorhexidine. The type of studies included in the selection for this structured review were Randomized Clinical Trials, Controlled Clinical Trials, Systematic Reviews, Reviews, Cohort Studies and Clinical cases.

***Results:***

Seven studies fulfilled all the inclusion criteria: 3 RCTs, one Consensus report, one cohort study, one systematic review and one review. Other 14 studies that partially met the inclusion criteria were analyzed and classified into 3 different levels of evidence: good evidence for RCTs, fair evidence for case control and cohort studies and poor evidence for expert opinion and case report.

***Conclusion:***

Not much research has been done regarding homecare implant maintenance. Scientific literature seems to show little evidence regarding these practices therefore most of the current knowledge comes from the periodontal literature. Manual and powered toothbrushes, dental floss and interdental brushes seem to be useful in maintaining peri-implant health. The use of antiseptic rinses or gels does not seem to have any beneficial effects.

It can be concluded that to better understand which are the most effective home care practices to prevent mucositis and peri-implantitis in implant-rehabilitated patients, new specific high evidence studies are needed.

**Keywords:** Dental implant, Home care maintenance, Mucositis, Peri-implantitis, Literature overview, Inflammatory lesions.

| Article History | Received: August 22, 2019 | Revised: October 30, 2019 | Accepted: December 05, 2019 |
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## 1. INTRODUCTION

Oral rehabilitation with dental implants is a widely used technique to substitute teeth in partially or totally edentulous patients. Since dental implants are a biocompatible prosthetic device implanted in living bone and rehabilitated to function in the oral environment, their surrounding tissue conditions can change overtime [1, 2].

After implant insertion and Osseo integration, implant

complications can be due to loss of surrounding tissues, such as oral mucosa and supporting bone, or mechanical issues affecting itself or its components. Implant fracture, due to metal fatigue, can be caused by material defects, design or by prosthetic rehabilitation unfitting [3].

Implants overload have often been related to implant failure, but the lack of studies with a high level of evidence, systematic reviews and Randomized Clinical studies (RCT), prevents understanding if this relation is realistic [4].

However, the failure of an implant can occur not only from a functional point of view, but also from an aesthetic point of view: it is important to provide prosthetic rehabilitations and peri-implant mucosa in harmony with adjacent teeth [5].

The major problem clinicians have to deal with is the loss of supporting tissues: the peri-implant disease. Peri-implant diseases are defined as inflammatory lesions that develop in tissues surrounding implant rehabilitations and are classified into two main groups: peri-implant mucositis and peri-implantitis [6]. The definition of these two conditions was purposed during the IV World Workshop of Periodontology in 2017, in which both were recognized as phlogistic, but while peri-implant mucositis was described as a reversible lesion affecting only the peri-implant mucosa, peri-implantitis was described as a not reversible condition with damage of the supporting bone [7].

Similarities in periodontal and peri-implant reaction after biofilm accumulation were analyzed, in both animal and human studies, using histological and immunohistochemical techniques. It was demonstrated that after 21 days of absence from oral hygiene procedures, in both natural dentition and dental implant rehabilitation, periodontium and peri-implant mucosa developed signs of inflammation with similar Plaque Index (PI) and inflammatory infiltrate amount [8].

Association between plaque accumulation and clinical inflammation on implants was also analyzed by Ferreira *et al.* in a cross-sectional study in which the authors tried to identify prevalence and risk factors of peri-implant diseases [9]. It was found that healthy implants had low PI and Bleeding on Probing (BoP) scores, and using a multivariate statistical analysis, poor oral hygiene was identified as a risk factor. Among the analyzed population, 64.6% showed peri-implant mucositis and a lower percentage of 8.9% showed peri-implantitis, though prevalence data showed that peri-implant mucositis and peri-implantitis ranged from 19% to 65% [9].

Being aware of the histological differences between the peri-implant tissue and the periodontium is fundamental to better understand the peri-implant tissue biology. Natural dentition and osteointegrated dental implants have been compared histologically. Berglundh *et al*. carried out an animal study on beagle dogs, comparing peri-implant and periodontal tissue histology through block biopsies [10]. Histological examination showed that both oral epithelium and the outward portion of peri-implant mucosa presented well-keratinized areas, but while the first one was followed by sulcular and junctional epithelium (attached to the enamel surface), the second one was not, presenting only a few cells and thick epithelium in contact with the implant abutment. Another important difference was found in collagen arrangement: peri-implant tissue fibers showed a parallel course originating from the crestal bone, while the periodontal fibers course was perpendicular to dental root, going from root cementum to alveolar bone [10]. Also, the blood supply is anatomically different between the peri-implant tissues and the periodontium: peri-implant bone vessels only consist of the periosteum source, while the gingiva supply is guaranteed by a double source, composed by supra-periosteal and periodontal ligament vessels [11].

Clinicians, implant rehabilitated patients and dental industry have based on their maintenance approaches on techniques and tools derived from a pre-implant era. Also, all the knowledge of peri-implant home care practices has been based on periodontal ones [12].

As already stated [9], the correlation between plaque accumulation and inflammatory lesions in osteointegrated implants have been shown and this is the reason to focus on plaque control, despite good oral hygiene it is difficult due to prosthetic rehabilitation [13].

Several tools are commonly used to prevent plaque accumulation in patients with dental implants rehabilitations: manual and powered toothbrushes, mouth rinses and interproximal aids, such as dental floss and proxa-brushes.

Patients have to be instructed regarding proper use during oral hygiene motivation according to the type of rehabilitation and patient skills. For example, a powered toothbrush can facilitate oral hygiene practice in elderly people or in not manual skilled ones [14]. Toothbrushes, however, are not enough for good cleansing, since interproximal spaces are not reached during the cleaning practice, and this leads to a higher risk of inflammation. There are a lot of interproximal cleaning devices available in the market, and even though they are effective, patients rarely use them constantly, because they are difficult and time-consuming [15].

Peri-implant and periodontal tissues have also similarities in microbial colonization: in both, there is a proportional growth for the bacterial frequency from a healthy to an unhealthy status, with analog presences of *Porphyromonas gingivalis, Aggregatibacter actinomycetemcomitans, Treponema denticola, Fusobacterium nucleatum, Prevotella intermedia* and *Staphylococcus aureus* [16]. Since these bacterial features, it is reasonable to take into account a chemotherapeutic approach with substances that show an antimicrobial effect (chlorhexidine) to inhibit biofilm formation around dental implants [17].

The aim of this review is to identify the presence of scientific evidence that peri-implant home care is effective in mucositis and peri-implantitis prevention.

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## 2. MATERIALS AND METHODS

The focused question for literature search "Is there a scientific evidence reported in the literature that we are using the proper hygiene tools or antimicrobials for dental implants rehabilitation homecare to prevent mucositis and peri-implantitis?" was structured according to the PICO format [18].

- Population: Patients rehabilitated with dental implants.
- Intervention: Homecare cleaning practice of implant, implant prosthesis and peri-implant tissue.
- Comparison: Different homecare practices.
- Outcome: Finding if there is any evidence and which is the best homecare strategy for mucositis/periimplantitis prevention.

PubMed, Embase, MEDLINE, Web of Science and Cochrane databases were used in order to detect publications reflecting the inclusion criteria. The search looked into peri-implant homecare studies published from 1991 to 2019. The terms used for the identification of keywords were: Dental implants, Brush, Interproximal brushing, Interdental brushing, Power toothbrush, Cleaning, Interdental cleaning, Interspace cleaning, Flossing, Super floss, Mouth rinses, Chlorhexidine.

The inclusion criteria used for screening were papers written in the English language, with available abstract, conducted in humans having at least one dental implant, reporting on homecare dental implant practices.

The exclusion criteria were: papers in a language other than English, works with abstract that was not available, non clinical studies, absence of dental implants, studies not reporting on homecare implant practices.

The type of studies included in the selection for this structured review was Randomized Clinical Trials (RCTs), Controlled Clinical Trials (CCTs), Systematic Reviews, Reviews, Consensus papers, Cohort Studies and Clinical cases.

Studies were first screened by titles and abstracts and examined by two reviewers (F.R. and L.L.B.); studies that fulfilled the inclusion criteria were selected, the full text of the selected papers was found and data was analyzed.

Full text studies admitted for final selection were divided into two groups: high and low evidence groups.

The studies that fulfilled the following criteria where classified as high evidence: RCT and COHORT studies with 6 months follow up, 20 patients, analyzing Probing Pocket Depth (PPD), Plaque Index (PI) or Bleeding Index (BI) or Bleeding on Probing (BoP); Consensus papers; systematic reviews/ reviews and case control studies that analyze Plaque Index (PI) and Probing Pocket Depth (PPD).

## 3. RESULTS

Seven studies fulfilled all the inclusion criteria, respectively three RCTs [19 - 21], one Consensus report [22], one cohort study [23], one systematic review [24] and one Chochrane review [25].

The seven selected studies were grouped according to their keyword and referring Mesh in Table. **1**.

Among these, one single blind parallel arm RCT study compared manual versus sonic toothbrush, concluding that there was a significant reduction for both toothbrushes ($p$<0.005) in BI, PI, GI, PPD [19]. One cohort study on 100 patients revealed that there was the absence of tissue desquamation and/or ulceration, a significant reduction of PPD ($p$<0.001) and REC ($p$<0.001) using a powered toothbrush [23]. One multicenter CCT analyzed the effect of powered toothbrushes on 2966 implant-supported restorations, showing that this device has a statistically significant higher plaque removal effect than the manual method ($p$<0.001) [20]. A single blind RCT conduct on 83 patients and 290 implants instead reported no statistically significant differences between groups in BOP, GI, PPD and PI [21]. Also, Grusovin *et al.* found no statistically significant differences between manual and powered toothbrushes [25]. A consensus report in 2019 concerning homecare maintenance stated that manual and powered toothbrushes are both equally useful in peri-implant health maintenance and that interdental brushes and dental floss are effective differently from the use of antiseptic mouthwashes [22]. Louropoulou *et al.* ended their systematic review concluding that there was still a lack of evidence for the best homecare maintenance practice [24].

The 14 studies that partially met the inclusion criteria (Table. **2**) were analyzed and classified into 3 different levels of evidence: good evidence for RCTs, fair evidence for case control and cohort studies and poor evidence for expert opinion and case report [26].

Six articles analyzed the peri-implant maintenance describing the efficacy of Chlorhexidine (CHX) [27 - 32]. CHX gel seemed to decrease BI, BoP, PI and PPD values [27, 29 - 32], and showed ability in reducing edema in anti-phlogistic activity [28]. Other mouth rinse agents seemed to be effective in reducing Bi and GI [33] and in inhibiting biofilm formation [34].

One cohort study with 100 patients and 12 months of follow up showed that powered toothbrushes are able to significantly reduce PPD, REC and bleeding score, more than manual toothbrushes [35]. A single blind RCT performed on 40 patients instead concluded that there was no statistically significant PI and BI reduction, nor any differences between brushing methods [15].

Interdental devices have been suggested for implant-supported prosthesis homecare since they are able to reduce PI and BoP [36, 37], whereas superfloss could be a risk factor for peri-implantitis development in case of implant threads exposure [38].

In a systematic review by the Chochrane group of Grusovin *et al*., 9 studies were included in order to identify the best practice for peri-implant homecare. The authors concluded that there was little evidence of what the best practices were [39].

## 4. DISCUSSION

In a recent review, Mombelli stated that preventive home-care measures taken by the patient are the first component of

**Table 1. High evidence studies grouped according to referring Mesh.**

| Mesh | Reference | Study Design | Study Aim | Sample Size | Conclusions |
|---|---|---|---|---|---|
| *Manual vs Powered toothbrush* | Wolff *et al*. 98 | RCT single blind with parallel arms (6 months f.u.) | Manual *vs*. sonic toothbrush in reducing plaque and gingivitis around implants | 31 patients, 96 implants | Significant reduction for both manual and sonic toothbrushes ($p$<0.005) in BI, PI, GI, PPD |
| *Manual vs Powered toothbrush* | Truhlar *et al*. 00 | Multicenter CCT (24 months f.u.) | Analysis of the effectiveness of a counter-rotational powered toothbrush *vs*. manual method | 2966 implants | Powered toothbrush has a statistically significant higher plaque removal effect than the manual methods ($p$<0.001) |
| *Manual vs Powered toothbrush* | Swierkot *et al.* 13 | RCT single blind (12 months f.u.) | Analysis of the effectiveness of a sonic powered toothbrush *vs*. manual method | 83 patients, 290 implants | No statistical significant differences between groups in BOP, GI, PPD and PI |
| *Powered toothbrush* | Vandekerckhove *et al.* 04 | Cohort study (12 months f.u.) | Analysis of the acceptability of an oscillating/rotating powered toothbrush and its efficacy on peri-implant health | 100 patients | Absence of tissue desquamation/ulceration, significant reduction of PPD ($p$<0.001) and REC ($p$<0.001) |
| *Homecare Maintenance* | Grusovin *et al.* 10 | Chochrane review | Analysis of the efficacy of self-administered and professional interventions for manintaining peri-implant tissue | 11 included studies | No statistically significant differences between manual and powered toothbrush. CHX gel has more antiflogistic effect than CHX mouthwash |
| *Homecare Maintenance* | Louropoulou *et al.* 14 | Systematic review | Analysis of the best homecare maintenance procedures for dental implants | 699 identified studies, 5 included | Lack of evidence for the best homecare maintenance practice |
| *Homecare Maintenance* | Renvert *et al.* 19 | Consensus report | Evidence that periimplant maintenance therapy is effective in preventing periimplant disease | 1 included study | Manual and powered toothbrushes are useful maintaining peri-implant health. Interdental brushes and dental floss are effective in maintaining peri-implant health. 0.3% triclosan-containing toothpaste is effective in the maintenance of dental implants. The use of antiseptic mouthwashes has not been shown to have additional beneficial effects |

**Table 2. Low evidence studies which partially met the inclusion criteria.**

| Mesh | Reference | Study Design | Study Aim | Sample Size | Conclusions |
|---|---|---|---|---|---|
| *Powered toothbrush* | Tawse-Simth *et al.* 02 | RCT Single Blind Cross Over (18 weeks f.u.) | Comparison of clinical effectiveness of powered toothbrush and manual toothbrush in reducing inflammation around implants | 40 patients, 80 implants | No statistically significant PI and BI reduction, nor differences between brushing methods |
| *Powered toothbrush* | Rasperini *et al.* 08 | Cohort study (12 months f.u.) | Analysis of safety and acceptability of electronic toothbrush in esthetic areas of peri-implant tissues | 100 patients | Statistically significant PPD, REC and bleeding score reduction with no signs of ulceration nor desquamation |
| *Interproximal Brush* | Chongcharoen *et al.* 12 | RCT cross over single blind (2 weeks f.u.) | Analysis of the efficacy of Circum brush *vs* a straight soft interdental brush on implants and teeth | 8 patients | Statistically significant reduction of PI for both interdental brushes ($p$<0.0001) |
| *Interproximal Brush* | Magnuson *et al.* 13 | RCT single center (1 month f.u.) | Efficacy of water flosser and waxed floss reducing BoP around implants | 30 patients | Statistically significant greater bleeding reduction in the water flosser group |
| *Superfloss* | Van Venzel *et al.* 15 | Observational study (2 years f.u.) | Analysis of the correlation between use of dental floss/superfloss and peri-implantitis development | 10 patients | In case of implant exposure, there could be floss remnants that could initiate peri-implantitis development process |
| *Mouthrinse* | Ciancio *et al.* 95 | RCT blind double parallel arms (3 months f.u.) | Analysis of the efficacy of mouthrinses in peri-implant tissue maintenance | 20 patients | Antiseptic mouthrinses showed a statistically significant reduction in PI, BI, GI; no differences in REC and PPD |

*(Table 2) contd.....*

| Mesh | Reference | Study Design | Study Aim | Sample Size | Conclusions |
|---|---|---|---|---|---|
| *Mouthrinse* | Pedrazzi *et al.* 14 | Review | Analysis of the efficacy of antimicrobial mouthrinses in peri-implant tissue plaque control | Absent | 0.12& CHX and Essential oils show to be effective in inhibiting biofilm formation. |
| *Chlorhexidine* | Keltjens *et al.* 91 | 24 months f.u. | Analysis of the efficacy of CHX gel in overdenture rehabilitated patients | 19 patients | BI and PPD were lower in the CHX group than in the placebo group |
| *Chlorhexidine* | Felo *et al.* 97 | RCT single blind parallel arms (3 months f.u.) | Comparison of efficacy between 0.06%CHX using a powered irrigator with subgingival tip and 0.12% CHX mouthwash | 24 patients | Significantly greater reductions were showed in PI, MGI and SI through sub-gingival irrigation rather than mouthrinse. |
| *Chlorhexidine* | Heitz-Mayfield 11 | RCT Double blind (3 months f.u.) | Implant homecare brushing and 0.5% CHX *vs* brushing and palcebo | 29 patients | Statistically significant BoP and PPD reduction but no statistically significant differences between test and control group. |
| *Chlorhexidine* | De Siena *et al.* 12 | RCT parallel arms (3 months f.u.) | Analysis of the efficacy of 1% CHX gel and 0.2% CHX mouthwash as adjunctive therapy to mechanical treatment in peri-implantitis | 30 patients | Both solutions showed a PI, BI and PPD reduction but no statistically significant differences were found between the two solutions. |
| *Chlorhexidine* | Hallstrom *et al.* 15 | RCT double blind parallele arms (24 months f.u.) | Analysis of CHX gel-containing brush in mucositis treatment | 38 patients | CHX use showed a statistically significant decrease ($p$<0.005) in PPD and BoP, higher than in the control group |
| *Chlorhexidine* | Genovesi *et al.* 15 | RCT double blind parallel arms (2 weeks f.u.) | Analysis of anti-plaque, anti-gingivitis and anti-staining properties of 0.12% CHX and 0.12% CHX + Hyaluronic acid mouthwashes in implant rehabilitated patients after surgery | 40 patients | CHX+Hyaluronic Acid show a higher statistically difference in reducing edema but no differences between the two mouthwashes were found concerning the anti-flogistic activity |
| *Homecare Maintenance* | Grusovin *et al.* 08 | Systematic Review | Identification of the best practice for peri-implant homecare | 9 included studies | Little evidence of what the best practices for peri-implant tissue care are |

maintenance after dental implant therapy. These include personal oral hygiene, avoidance of environmental risks (such as tobacco smoke) and management of systemic diseases (such as diabetes) [40].

Since the presence of biofilm around implant-supported prosthesis has been proven to develop inflammation and peri-implant disease, the aim of professional maintenance and homecare should be pointed towards biofilm elimination. Oral hygiene instructions have to be delivered appropriately, and the patient must understand the importance of adequate hygiene around implants [41, 42].

Patients receiving implant treatment usually have a history of poor homecare resulting in partial or complete teeth loss [43] and high plaque index has a positive correlation with peri-implant mucositis and an increase of PPD [44].

Various studies showed that powered toothbrushes have clinical effectiveness in dental implant maintenance, but because of differences in study designs, results should be interpreted with caution.

Wolff *et al*, in 1998 compared sonic versus manual toothbrushes for plaque index and gingivitis around implants [19]. In this single blind parallel arm RCT, patients were randomly selected and instructed to the use of a powered sonic toothbrush or a manual one. The duration of this study was six months and the 31 patients after baseline were recalled at 4, 8, 12 and 24 weeks to evaluate PPD, GI, BI, PI. Both techniques showed a statistically significant reduction of PI, BI and GI ($p$<0.005) and the group using the sonic device showed at every control a constantly lower, but not statistically significant, probing depth values. According to these results and to the high level of compliance, the sonic toothbrush seems to be a very effective tool for the implant homecare maintenance.

Vandekerckhove *et al*., in a prospective cohort study analyzed the efficacy of oscillating/rotating powered toothbrush on a 100 patient recording probing depth, BI, SBI and recession at baseline and at 12, 24, and 52 weeks [23].

Also, Truhlar *et al*., in a multicenter CCT compared powered counter rotational and manual toothbrush efficacy, measuring PI, GI, PPD and recession. The authors concluded that there was a statistically significant reduction of PI in the 24 months follow up ($P$<0,001) for the patients' group that used the powered device [20].

These data seem to underline the importance of a powered toothbrush in implant-supported rehabilitations homecare but two recent RCTs compared oscillating/rotating and sonic toothbrushes with the traditional manual technique and in both studies, no statistically significant differences in peri-implant inflammatory parameters were noticed [14, 21].

Study design, study length and kinds of implant restorations differed significantly among all these studies and this is probably the reason why it is so difficult to make a direct

comparison. Both manual and powered toothbrushes are effective in peri-implant soft tissue health maintenance, with no reports of adverse effects on soft tissues reported for powered toothbrushes. Today there is no clear evidence that powered toothbrushes are better than manual devices in gaining peri-implant health. Therefore, it is very important that the dental clinician is able to give detailed and personalized oral hygiene instructions based on single patient ability.

Only a few studies focused on interproximal devices and interdental plaque control.

Chongcharoen *et al*. in a cross-over 2 weeks follow up single-blind RCT, examined plaque removal efficacy of two interdental brushes both at tooth and implant sites through the comparison of two devices with different shapes [36]. Patients were randomly assigned to the different interdental brushes groups, and PI values were recorded. Results showed that plaque reduction was significantly high for both tools ($P<$ 0,0001), demonstrating that interdental brushes are effective tools for dental implant homecare maintenance.

Water floss was analyzed in one RCT in which water flossing and flossing around implants were analyzed through the reduction of BoP in one month follow up [37]. After 30 days, 81.8% of implants in the water flosser group showed a reduction in BOP compared to 33.3% in the floss group ($P$=0.0018), suggesting the water-floss could be useful in dental implant homecare maintenance. An important bias of this study could be the fact that interdental oral hygiene was carried out by a dental assistant and not directly by the patient.

Some attention should be paid to two observational studies [38, 45] regarding the alarming correlation between developing peri-implant disease and flossing. Montevecchi *et al.* described a case report of a 66 old man with two complete dentures on implants [45]. The patient showed pathological probing values, pain, edema and other signs of inflammation even after the application of CHX gel. During the following visit, an endoscopy examination revealed a large amount of filamentous foreign body around each implant. An extra-oral analysis of this residual concluded that it was part of the super-floss used by the patient during homecare practices. Ten days after the removal of the foreign body, a complete remission was observed.

Van Velzen *et al*. came to similar findings in their observational study: ten patients with progressive peri-implantitis and not responding to therapies were selected for exploratory surgery, assessing PI, BI and PPD before and after the surgical interventions [38]. After raising a mucoperiosteal flap, bone defect was cleaned and filled with autologous bone. In all patients, remnants of floss were found and eliminated.

Remnants of floss occurred in those implants with fixture exposure or rough surfaces; in these clinical conditions, the use of interdental brushes could be suggested instead, recommending the largest size that can fit the interdental space.

However, this recommendation is based on a report of ten patients only. All of these patients were under progressive peri-implantitis and exposed rough implant surface; therefore these results should not be generalized.

As underlined in a systematic review by Louropoulou *et al.*, there is a paucity of studies analyzing the efficacy of interdental tools. Most of the available knowledge about their plaque removal efficacy is based on natural dentition rather than on implants [12 - 45]. To date, there is very little scientific evidence on the efficacy of interdental biofilm removal by the patient in dental implant homecare.

Concerning antimicrobials, a variety of products have been tested and reported as chemotherapeutic agents for plaque control.

The use of chlorhexidine, mouthwash or gel, is considered as an effective antimicrobial device for dental implant maintenance.

Among them, it is very interesting a single blind parallel arm RCT study in which subgingival irrigation (0,06%) and mouthwash (0,12%) with chlorhexidine were compared [30]. Twenty-four patients having at least two dental implants and prosthodontically restored with complete dentures were followed for 3 months and randomly divided into two groups, one using the chlorhexidine mouthwash (0,12%) and the other using the subgingival irrigation, having their PPD, PI, GI, BI, MGI, CI, SI and calculus index evaluated at baseline and at the end of the follow up. Since there was statistical significant reduction of the MGI, PI, BI and CI scores, subgingival chlorhexidine (0,06%) irrigation seemed to be an effective tool for dental homecare maintenance.

Two different RCT compared the use of chlorhexidine gels to either mouthwash or placebo. They both reported no statistically significant differences between test and control groups [27, 32].

In a study by Pedrazzi *et al*., no differences have been found in plaque score and PPD in patients rehabilitated with fixed implant prosthesis, between hyaluronic acid and chlorhexidine gel (0,2%) application after 6 months of follow up [34]. Instead, a statistically significant difference was found by other authors in the reduction of PI, BI and GI around implants after 3 months of use of Listerine mouthwash [33]. Ciancio *et al.* analyzed the efficacy of Listerine mouthwash in reducing PI, BI and GI around implant, finding statistical significant decrease ($P$<0,01) of the indexes [33].

In this review every reported paper taking into account chlorhexidine effect shows a statistically significant decrease of PI and BI [29, 30], however, none of them meet the high evidence inclusion criteria. Moreover, many study designs include also the mechanical removal of plaque, thus masking the real antimicrobial effect. Selected studies showed that chlorhexidine, in different concentrations, has high antimicrobial effect, but it has not been demonstrated to be beneficial on clinical parameters. In conclusion, it could be considered an effective tool for dental implant homecare practices to prevent peri-implantitis [27 - 32].

## CONCLUSION

A lot of research has been carried out regarding implant dentistry, peri-implant mucositis and peri-implantitis professional treatment, however according to the above data, little has been done regarding homecare implant maintenance. Based

on this review, scientific literature seems to show little evidence in homecare implant maintenance practices, as compared to professional implant care and surgery, so that at present most of the current knowledge in homecare implant practices and tools are taken from periodontal literature.

Both manual and powered toothbrushes, dental floss and interdental brushes seem to be useful in maintaining peri-implant health. Caution is recommended on the use of dental floss when rough implant surfaces are exposed.

The use of antiseptic rinses or gels does not seem to have any beneficial effects.

The dental practitioner has the most important role to personalize oral hygiene instructions based on patient abilities.

It can be concluded that to better understand which are the most effective homecare practices to prevent mucositis and peri-implantitis in implant-rehabilitated patients, new specific high evidence studies are needed.

## CONSENT FOR PUBLICATION

Not applicable.

## FUNDING

None.

## CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

## ACKNOWLEDGEMENTS

The authors are extremely grateful to Dr. Maria Rosaria Gatto, DIBINEM, University of Bologna, for her contribution to the statistical analyses.

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