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# A Systematic Review of Recall Regimen and Maintenance Regimen of Patients with Dental Restorations. Part 2: Implant-Borne Restorations

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# A Systematic Review of Recall Regimen and Maintenance Regimen of Patients with Dental Restorations. Part 2: Implant-Borne Restorations

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**Abstract**

**Purpose:** To evaluate the current scientific evidence on patient recall and maintenance of implant-supported restorations, to standardize patient care regimens and improve maintenance of oral health. An additional purpose was to examine areas of deficiency in the current scientific literature and provide recommendations for future studies.

**Materials and Methods:** An electronic search for articles in the English language literature from the past 10 years was performed independently by multiple investigators using a systematic search process. After application of predetermined inclusion and exclusion criteria, the final list of articles was reviewed to meet the objectives of this review.

**Results:** The initial electronic search resulted in 2816 titles. The systematic application of inclusion and exclusion criteria resulted in 14 articles that satisfied the study objectives. An additional 6 articles were added through a supplemental search process for a total of 20 studies. Of these, 11 were randomized controlled clinical trials, and 9 were observational studies. The majority of the studies (15 out of 20) were conducted in the past 5 years and most studies were conducted in Europe (15), followed by Asia (2), South America (1), the United States (1), and the Middle East (1). Results from the qualitative data on a combined 1088 patients indicated that outcome improvements in recall and maintenance regimen were related to (1) patient/treatment characteristic (type of prosthesis, type of prosthetic components, and type of restorative materials); (2) specific oral topical agents or oral hygiene aids (electric toothbrush, interdental brush, chlorhexidine, triclosan, water flossers) and (3) professional intervention (oral hygiene maintenance, and maintenance of the prosthesis).

**Conclusions:** There is minimal evidence related to recall regimens in patients with implant-borne removable and fixed restorations; however, a considerable body of evidence indicates that patients with implant-borne removable and fixed restorations require lifelong professional recall regimens to provide biological and mechanical maintenance, customized for each patient. Current evidence also demonstrates that the use of specific oral topical agents and oral hygiene aids can improve professional and at-home maintenance of implant-borne restorations. There is evidence to demonstrate differences in mechanical and biological maintenance needs due to differences in prosthetic materials and designs. Deficiencies in existing evidence compel the forethought of creating clinical practice guidelines for recall and maintenance of patients with implant-borne dental restorations.

Implant-supported restorations often represent a favorable alternative to conventional dental prostheses due to improved support, comfort, and function. Treatment plans to address patient needs using implant-borne restorations range from implant-supported single crowns, implant-supported partial fixed dental prostheses (FDP), implant-supported complete arch FDPs, implant-supported partial removable dental prostheses (RDP) to implant-supported complete RDPs (overdentures). Each type of restoration/prosthesis requires

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careful planning, meticulous coordination of care, and a long-term partnership with the patient to maintain an enduring result. This includes an appropriate patient recall regimen and professional as well as at-home maintenance.[1-20] The fabrication of implant restorations also represents a considerable investment of time and resources, with the anticipation of an enduring result by patients and clinicians. Current guidelines for the maintenance of implant restorations are poorly defined and often based on traditional protocols for patients with natural dentition rather than what is most suitable for maintenance of implant restorations and supporting tissues. Therefore, maintenance guidelines for patients with implant-borne removable and/or fixed restorations are necessary to minimize the risk for restoration failure, peri-implant disease and failure of the supporting implants themselves. Furthermore, maintenance protocols in healthy adult patients with implant-borne restorations may be significantly different when compared to patients with tooth-borne restorations, no restorations, or patients with acute or chronic oral and systemic diseases.

Maintenance programs in dentistry have often focused on younger patient cohorts and on assessing and managing chronic processes such as caries or periodontal disease.[21-24] The typical 6-month patient recall interval used by dentists worldwide was advocated by the American Academy of Dental Science as early as 1879.[24,25] Later, the American Dental Association (ADA) also advocated the 6-month recall in its first oral health patient brochure. The 6-month interval for dental visits was also promoted by a popular dentifrice commercial (Ipana; Bristol-Meyers Company, New York, NY) in the 1930s, eventually resulting in wide acceptance as a standard in the dental insurance industry.[24,25]

Traditionally, patients at both lower and higher risk for dental disease have been placed on 6-month recalls with the logic of early detection, prevention of disease, and oral cancer screening.[24,26] Recall programs based on risk assessment of potential complications such as caries or periodontal disease have become increasingly accepted in dentistry.[27-29] Despite the logic of 6-month recalls, recent systematic reviews determined that 6-month recall protocols for caries prevention were not supported by the literature, and that existing recall patterns in dentistry did not account for varying risk patterns seen in

patients.[24,30] These authors concluded that clinicians might consider assigning recall intervals based on the patients' risk of developing dental disease rather than using 6-month intervals as the standard recall interval. Basing recall schedules on patient-specific needs to avoid complications has been implemented in recall maintenance programs for diabetic patients with good success.[31]

Implant-supported single crowns and implant-supported FDPs have favorable survival rates but considerable mechanical and biologic complications in the long term.[32-37] Ten-year survival rates for implants supporting single crowns were reported as approximatively 95%,[33] and implant-supported FDPs reported as 93%.[32] Notably, 33.6% of the patients had a mechanical and/or biologic complication in the first 5 years, prompting the authors to recommend that patients be placed in a well-structured maintenance program.[32] Mechanical complications of implant-supported FDPs have been reported to include veneering material fractures (13.5%), screw loosening (5.3%), loss of retention of cemented FDPs (4.7%), and screw fracture (1.3%) over a 5-year period.[32]

Biologic complications with implant-supported prostheses include bone loss and associated midfacial soft tissue recession and inflammatory peri-implant diseases including peri-implant mucositis and "peri-implantitis," which have been difficult to quantify due to authors using differing criteria; however, peri-implantitis has been estimated to occur in approximately 8.5% of patients treated with implants evaluated over a 5-year period.[32] The primary clinical criteria to identify biologic complications include periodontal probing depths ≥ 5 mm and bleeding on probing of ≥ 30%, which may increase the risk of implant loss over a mean follow-up of 7.9 years.[32] It has also been reported that failing implants have been associated with higher plaque biofilm levels than successful implants.[37] This underscores the value of implementing an oral self-care and professional oral care regimen. The benefit for a recall program was also shown in a study of 80 patients diagnosed with peri-implant mucositis, where those not participating in a structured recall program progressed to peri-implantitis at more than twice the rate as patients participating in a recall maintenance program.[8]

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The purpose of this systematic review was to evaluate the current scientific evidence on patient recall and maintenance of implant-supported restorations, to standardize patient care regimens, and to make recommendations to improve maintenance of oral health. An additional purpose was to examine areas of deficiency in the current scientific evidence and provide recommendations for future studies. For the purposes of this systematic review, patient recall was defined as the routine follow-up of patients following insertion of implant-borne dental restorations. Professional maintenance was defined as the procedures and guidance provided by the dentist and dental auxiliaries. At-home maintenance was defined as the daily oral hygiene and maintenance routine that patients perform to maintain their implant restorations, any existing natural teeth, and restorations and supporting tissues.

## Materials and methods

An independent electronic search of the English language literature was performed by two investigators (AB, DC) using the PubMed search engine and Cochrane Library database. The specific search terms, search string, and limits are presented in Table 1. The specific PICO question for this systematic review was: in patients with implant-borne restorations, does one specific recall regimen and dental maintenance regimen compared to others, or no regimen, improve clinical outcomes and patient care, and optimize maintenance of oral health? The period searched was from January 1, 2004 to December 31, 2014. The only search limits applied to the electronic search were the English language, the search period, and clinical studies (Table 1). The anticipated implant-borne restorations of interest in this study were: implant-supported single crowns, implant-supported partial FDPs, implant-supported complete FDPs, implant-supported partial RDPs, and implant-supported complete RDPs. The predetermined inclusion criteria were: (1) English language article in a peer-reviewed journal; (2) any clinical study published between January 1, 2004 and December 31, 2014; and (3) any clinical study with the primary focus on patient recall regimen, professional maintenance, or at-home maintenance regimen for implant-borne restorations, in healthy patients. The predetermined exclusion criteria were: (1) articles that did not pertain to items described in the inclusion criteria; (2) articles

that did not pertain to the objectives of the systematic review; (3) articles that did not describe data on recall and maintenance of patients with implant-borne restorations; (4) articles that described data on unhealthy patients or patients with peri-implantitis; (5) articles with a focus on outcomes after implant surgery; (6) review articles or technique articles without associated clinical study and data; (7) patients or data being repeated in other included articles; and (8) article description that would not allow extraction of qualitative or quantitative data related to objectives of the study.

**Table 1.** Description of the search terms and search process used in the PubMed search engine

| Search | Query | Results |
|---|---|---|
| #1 | ((Prosthodontics[MeSH] OR prosthodontics[tiab] OR prosthodont*[tiab]) OR (Dental Abutments[MeSH] OR abutments[tiab]) OR (Dental Cements[MeSH] OR dental cement*[tiab] OR dental adhesive[tiab] OR luting agent[tiab]) OR (Dental Implantation[MeSH] OR dental implantation[tiab]) OR (Dental Implantation, Endosseous[MeSH] OR osseointegrated dental implant[tiab] OR endosseous implantation[tiab]) OR (Dental Implantation, Endosseous, Endodontic[MeSH] OR endodontic stabilization[tiab]) OR (Dental Implants[MeSH] OR dental implants[tiab]) OR (Dental Implants, Single-Tooth[MeSH] OR single tooth implant[tiab] OR single-tooth implant[tiab]) OR (Dental prosthesis[MeSH] OR dental prosthesis[tiab]) OR (Dental Prosthesis, Implant-Supported[MeSH]) OR (Dental Restoration Failure[MeSH] OR dental restoration failure[tiab]) OR (Denture Precision Attachment[MeSH] OR intracoronal attachment[tiab]) OR (Denture, Overlay[MeSH] OR denture overlay[tiab] OR overlay denture*[tiab] OR overdenture*[tiab]) OR (Denture, Partial, Fixed[MeSH] OR fixed bridge*[tiab] OR pontic*[tiab]) OR (Immediate Dental Implant Loading[MeSH] OR immediate dental implant loading[tiab] OR early dental implant loading[tiab]) OR (Tooth, Artificial[MeSH] OR artificial tooth[tiab] OR artificial teeth[tiab])) AND (((Comprehensive dental care[MeSH] OR comprehensive dental care[tiab]) OR (Dental care[MeSH] OR dental care[tiab]) OR (Dental health services[MeSH] OR dental health services[tiab]) OR (General Practice, Dental[MeSH] OR general practice dental[tiab]) OR (Oral health[MeSH] OR oral health[tiab]) OR (Oral hygiene[MeSH] OR oral hygiene[tiab] OR dental hygiene[tiab]) OR (Preventive Dentistry[MeSH] OR preventive dentistry[tiab]) OR (implant hygiene[tiab]) OR (implant care[tiab])) OR ((Appointments and schedules[MeSH]) OR (Case management[MeSH] OR case management[tiab]) OR (Office Visits[MeSH] OR office visit[tiab]) OR (Patient compliance[MeSH] OR patient compliance[tiab] OR patient adherence[tiab] OR patient non-adherence[tiab]) OR (Self report[MeSH] OR self report[tiab] OR patient recall[tiab] OR motivational interview*[tiab]) OR (Time factors[MeSH] OR time factors[tiab])) OR ((Dental prophylaxis[MeSH] OR dental prophylaxis[tiab]) OR (Dental Scaling[MeSH] OR dental scaling[tiab] OR root scaling[tiab]) OR (Diagnosis, Oral[MeSH] OR oral diagnosis[tiab] OR oral | 18,803 |

| Search | Query | Results |
|---|---|---|
| | examination[tiab]) OR (Periodontal Debridement[MeSH] OR periodontal debridement[tiab]) OR (Root planing[MeSH] OR root planing[tiab]) OR (Periodontal Index[MeSH] OR periodontal index[tiab] OR bleeding on probing[tiab] OR gingival index[tiab] OR gingival bleeding on probing[tiab])) OR ((Dental Devices, Home Care[MeSH] OR dental floss[tiab]) OR (Toothbrushing[MeSH] OR toothbrushing[tiab]) OR (Toothpastes[MeSH] OR toothpaste*[tiab]) OR (Dentifrices[MeSH] OR dentifrice[tiab]) OR (Mouthwashes[MeSH] OR mouthwash[tiab]) OR (Chewing Gum[MeSH] OR chewing gum[MeSH]) OR (Triclosan[MeSH] OR triclosan[tiab]) OR (interproximal brush[tiab]) OR (proxabrush[tiab]) OR (Mouth protectors[MeSH] OR mouth protectors[tiab] OR mouth piece[tiab] OR mouthpiece[tiab] OR mouth guard[tiab])) | |
| #2 | #1 + English | 16,574 |
| #3 | #2 + Humans | 13,783 |
| #4 | #3 + 2004-present | 7,115 |
| #5 | #4 + Limit to Clinical Trial, Comparative Study, Controlled Clinical Trial, Multicenter Study, Observational Study, Randomized Controlled Trial, or Validation Study | 2,816 |

The electronic search process was systematically conducted in three stages. A PRISMA[38] (Preferred Reporting Items for Systematic Reviews and Meta-analyses) format was used as a filter to remove duplicate articles and to ensure a systematic search process. In stage 1, the investigators independently screened all relevant titles of the electronic search, and any disagreement was resolved by discussion. In situations where the application of the exclusion criteria was not clear, the controversial article was included for consideration in the abstract stage. In stage 2, the investigators independently analyzed the abstracts of all selected titles, and disagreements were resolved by discussion. In situations of uncertainty, the abstract was included for the subsequent full-text stage. After the application of the exclusion criteria, the definitive list of articles was screened at stage 3 by the investigators to extract qualitative and quantitative data (when available). A supplemental electronic search for articles from Scopus, Google Scholar and CINAHL (Cumulative Index to Nursing and Allied Health Literature) search engines along with a hand search of references of all included articles was conducted using systematic methods. Additionally, articles that had a lag time to appear on the PubMed search engine were also screened for the three stages, as part of the supplemental search. Data from all included studies were then tabulated, analyzed, and compared to satisfy the objectives of the review.

# Results

The initial electronic search using the specific search terms from the PubMed search engine resulted in a total of 2816 titles, out of which 83 abstracts were applicable to the study. Further scrutiny resulted in detailed analysis of 44 full-text articles from which 30 articles were excluded. Incorporating a supplemental and electronic hand search process and systematic exclusion eventually resulted in 20 full-text articles, all of which reported data on patient recall and maintenance of dental restorations on implants (Fig 1). These 20 studies were included for qualitative data extraction and analysis (Table 2). The authors did not identify a significant amount of quantitative data from the data extraction, which may be related to the nature of the topic and PICO question posed in this systematic review. Therefore, no statistical analysis was completed.

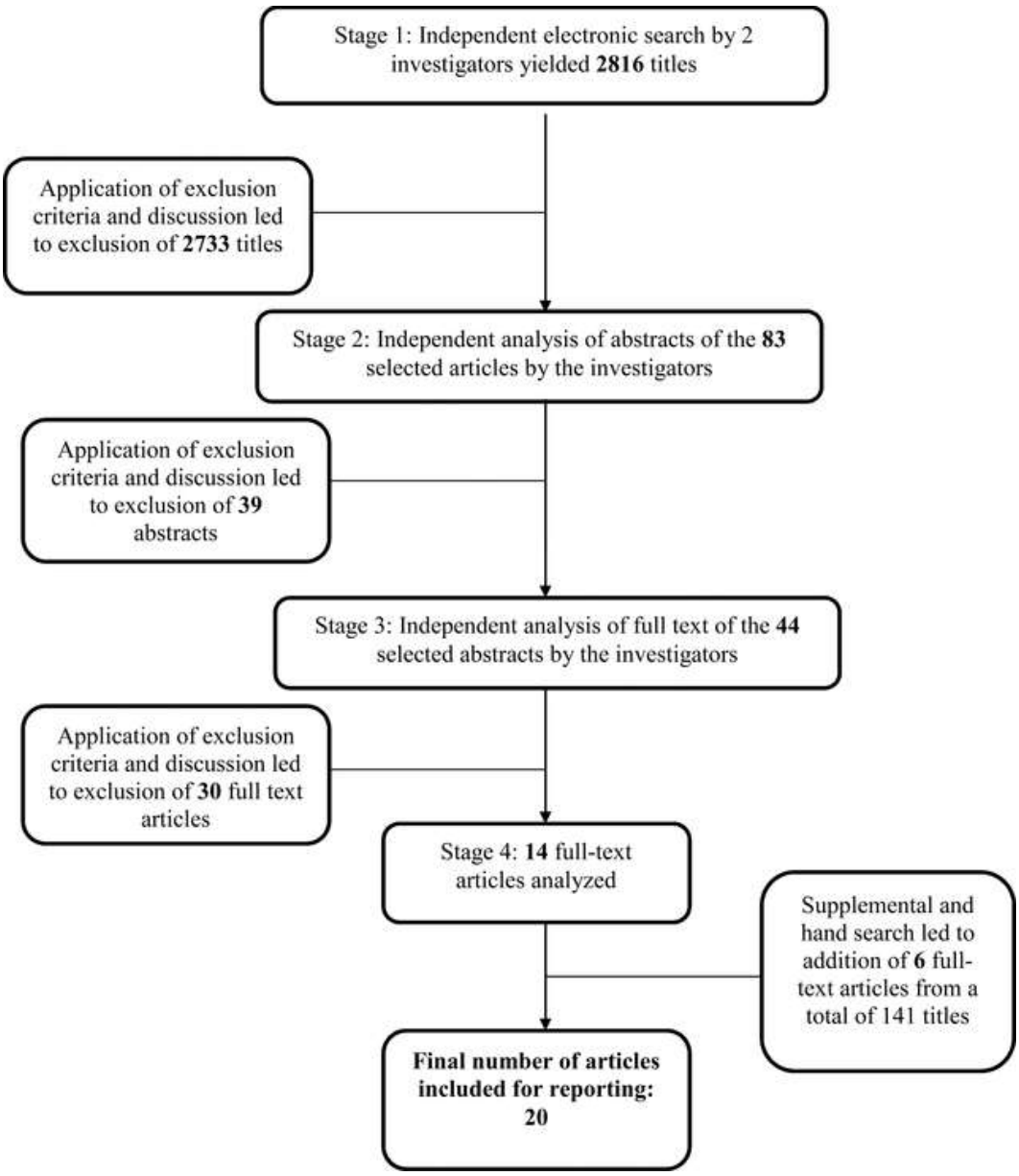


**Figure 1.** Systematic search process.

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**Table 2.** Descriptive data from the 20 included studies that reported on recall and maintenance of implant-borne restorations

| Author and year | Type of study | Study setting | Geographic region | Number of patients | Age of patients | Type of implant-borne restorations included in the study | Study sponsorship |
|---|---|---|---|---|---|---|---|
| Magnuson et al (2013)[1] | RCT | University | USA | 44 | Range: 22 to 62 years Mean age: NR | Implant-supported crowns | Corporate; Water Pik, Inc. |
| Morawiec et al (2013)[2] | RCT | University and private practice | Europe (Poland) | 16 | Range: 22 to 65 years Mean age: NR | Implant-supported crowns, FDPs, and overdentures | Product support by Nihon Natural Food Co. Ltd and university support for the study |
| Mussano et al (2013)[3] | RCT | University | Europe (Italy) | 15 | NR | Implant overdentures in the mandible | None |
| Swierkot et al (2013)[4] | RCT-single-blinded | University | Europe (Germany) | 83 | Range: 45 to 78 years Mean age: 59.8 | Implant-supported crowns | Corporate; Philips Healthcare Systems |
| Zou et al (2013)[5] | Observational | University | Asia (China) | 30 | Range: 57 to 79 years Mean age: NR | Implant overdentures in the maxilla with either telescopic crowns, bars, or locators | National government of China |
| De Siena et al (2012)[6] | RCT | University | Europe (Italy) | 30 (23 patients completed) | Range: 43 to 87 years Mean age: 62.3 ± 9.9 | Mandibular 4-implant-supported metal-resin fixed prosthesis or metal-resin fixed prosthesis in the anterior | Product support by Curaden Healthcare |

1. NR: not reported; RCT: randomized clinical trial; FDP: fixed dental prosthesis.

| Author and year | Type of study | Study setting | Geographic region | Number of patients | Age of patients | Type of implant-borne restorations included in the study | Study sponsorship |
|---|---|---|---|---|---|---|---|
| | | | | | | maxilla with distal cantilever extensions | |
| Chongcharoen et al (2011)[7] | RCT | University | Asia (Hong Kong, China) | 8 | Range: 26 to 65 years Mean age: NR | Implant-supported crowns | Government and Product support by Top Caredent and TePe AB |
| Costa et al (2011)[8] | Retrospective | University and private practice | South America (Brazil) | 80 | Range: NR Mean age: 50 | Implant-supported crowns and FDPs | Government |
| Fischer et al (2011)[9] | RCT | University | Europe (Sweden) | 24 | Range: NR Mean age: 64 | Maxillary implant-supported metal-resin fixed prosthesis | None |
| Katsoulis et al (2011)[10] | Observational | University | Europe (Switzerland) | 41 | Range: 52 to 78 years Mean age: NR | Implant-supported metal-resin fixed prosthesis and implant bar-supported overdentures | NR |
| Akça et al (2010)[11] | Observational | University | Europe (Turkey) | 35 | NR | Implant bar-supported overdentures | Government |
| Corbella et al (2010)[12] | Prospective cohort study | Independent dental center | Europe (Italy) | 61 | Range: NR Mean age: 54 | Implant-supported metal-resin fixed prosthesis | None |
| Rentsch-Kollar et al (2010)[13] | Retrospective | University | Europe (Switzerland) | 147 | Range: NR Mean age: 62 | Maxillary denture and mandibular overdentures; majority of patients having a | NR |

| Author and year | Type of study | Study setting | Geographic region | Number of patients | Age of patients | Type of implant-borne restorations included in the study | Study sponsorship |
|---|---|---|---|---|---|---|---|
| | | | | | | gold bar and a few having solitary ball anchors | |
| Sreenivasan et al (2010)[14] | RCT-double-blinded | Community centers in Israel | Middle East (Israel) | 120 | Range: 20 to 75 years Mean age: NR | Implant-supported crowns | Corporate; Colgate Palmolive Company |
| Thöne-Mühling et al (2010)[15] | RCT | University | Europe (Germany) | 13 | Range: 37 to 67 years Mean age: NR | Implant-supported crowns, FDPs, and double crown retained overdenture abutments | NR |
| Kleis et al (2009)[16] | RCT | University | Europe (Germany) | 60 | Range: 46 to 95 years Mean age: NR | Implant-supported overdentures in the mandible (with 3 types of attachment systems) | NR |
| Paolantonio et al (2008)[17] | Observational | University | Europe (Italy) | 30 | Range: 27.3 to 54.2 years Mean age: NR | Implant-supported crowns | None |
| Ramberg et al (2009)[18] | RCT-double-blinded | University | Europe (Sweden and Italy) | 60 | Range: 30 to 70 years Mean age: NR | Type of implant restoration was not clarified | Colgate-Palmolive Company |
| Rasperini et al (2008)[19] | Prospective | Private practice | Europe (Italy) | 100 patients out of which 98 completed | Range: NR Mean age: 56 | Implant-supported crowns and FDP in the maxillary | Product support by Braun Oral-B |

| Author and year | Type of study | Study setting | Geographic region | Number of patients | Age of patients | Type of implant-borne restorations included in the study | Study sponsorship |
|---|---|---|---|---|---|---|---|
| | | | | | | anterior region | |
| Vandekerckhove et al (2004)[20] | Prospective cohort study | University | Europe (Belgium) | 100 | Range: 18 to 80 years Mean age: 56.3 | Implant-supported partial FDP and implant-supported complete FDP | NR (however, patients received free Braun Oral-B Plaque Control Ultra [D9] electric toothbrush as part of the study) |

Out of the 20 studies, eleven were randomized controlled clinical trials (RCTs), and nine were observational studies. The majority of the studies (15/20) were conducted in the past 5 years, and most studies were conducted in Europe (15), followed by Asia (2), South America (1), the United States (1), and the Middle East (1). A total of 1088 patients were included in these 20 studies. Fifteen studies were conducted exclusively in a university setting, two involved a university as well as a private practice setting, one was exclusive to private practice, and two were conducted in a community center or independent center. Eight studies received corporate support (partial or full), four were supported by university and/or government, three reported no support, and five did not report on study sponsorship.

To segregate the qualitative data and provide a meaningful method of understanding outcomes, the analyzed data were grouped into three categories: (1) outcomes related to patient-specific restorative treatment; (2) outcomes related to maintenance using oral topical agents and hygiene aids; and (3) outcomes related to maintenance using professional intervention. Additionally, the professional intervention was dichotomized as biological maintenance and mechanical maintenance (Table 3).

**Table 3.** Professional maintenance, at-home maintenance, and patient recall data from the 20 included studies that reported on recall and maintenance of implant-borne restorations

| Author and year | Categorization of study outcome in this systematic review | Primary objective of the study | Professional maintenance regimen reported in the study | At-home maintenance regimen reported in the study | Patient recall regimen used in the study |
|---|---|---|---|---|---|
| Magnuson et al (2013)[1] | Agent-related outcome | To determine the effectiveness of water flosser in reducing the bleeding on probing index, when compared to flossing, in patients with implant crowns | NA | Participants were asked to either use a string flosser or a water flosser in conjunction with manual brushing (based on the treatment arm assigned) | Baseline, 14, and 30 days |
| Morawiec et al (2013)[2] | Agent-related outcome | To determine the effectiveness of a dentifrice-containing ethanol extract of Brazilian green *propolis* on selected oral health parameters, oral microflora, and periodontal health | NA | Patients were instructed to either use a dentifrice containing 3% ethanol extract of Brazilian *propolis* or a placebo dentifrice that did not have *propolis* | Baseline, 1 week, and 8 weeks |
| Mussano et al (2013)[3] | Professional intervention-related outcome | To compare the peri-implant outcomes on mandibular overdenture patients, when professional maintenance was performed by using PTFE curettes or a glycine powder air | Patients were either assigned to professional cleaning with hand instrumentation with PTFE curettes or a glycine powder air polishing system | Not reported | 1 hour after treatment, 1 week, and 4 weeks |

1. PTFE: polytetrafluoroethylene; PEEK: polyetherether ketone; CHX: chlorhexidine.

| Author and year | Categorization of study outcome in this systematic review | Primary objective of the study | Professional maintenance regimen reported in the study | At-home maintenance regimen reported in the study | Patient recall regimen used in the study |
|---|---|---|---|---|---|
| | | polishing system | | | |
| Swierkot et al (2013)[4] | Agent-related outcome | To compare plaque levels following sonic-powered and manual toothbrushing in subjects with dental implants | NA | Participants were asked to either brush with manual toothbrush or sonic-powered toothbrush using the modified bass technique (based on the treatment arm assigned) | Baseline, 3, 6, 9, and 12 months |
| Zou et al (2013)[5] | Patient/treatment characteristic-related outcome | To evaluate telescopic crown, bar, and self-aligning attachments used in removable four implant-supported overdentures for patients with edentulous maxilla | Not specified, but authors stated that biologic and mechanical professional maintenance procedures were performed at baseline and annually for 3 years | Not reported | Baseline and follow-up radiographs were obtained 12, 24, and 36 months after functional loading Patient satisfaction was completed at end of 3-year evaluation |
| De Siena et al (2012)[6] | Agent-related outcome as well as professional intervention-related outcome | To compare the use of two CHX-based antimicrobial agents as an adjunct to mechanical therapy for the treatment of peri-implant mucositis | Professional cleaning was performed by a single experienced dental hygienist for all patients; patients were then prescribed CHX agent | Patients were asked not to modify their normal oral hygiene measures but asked to supplement by using either CHX 0.2% mouthwash or chlorhexidne 1% gel (based on the treatment arm assigned) | Baseline, 10 days, 1 month, and 3 months |
| Chongcharoen et al (2011)[7] | Agent-related outcome | To compare the interproximal cleaning efficacy of a specially designed interproximal brush with a 5 mm diameter (with a conventional interproximal brush with a | In this experiment, patients were asked to not brush for 3 days followed by second appointment where an assistant guided the interdental brush through the contacts three times | Not reported | Baseline, 3 days, 6 days |

| Author and year | Categorization of study outcome in this systematic review | Primary objective of the study | Professional maintenance regimen reported in the study | At-home maintenance regimen reported in the study | Patient recall regimen used in the study |
|---|---|---|---|---|---|
| | | 3 mm diameter | and process was repeated with the other brush after 3 more days of abolishing toothbrushing | | |
| Costa et al (2011)[8] | Professional intervention-related outcome | To determine among patients with peri-implant mucositis, whether a professional maintenance program resulted in a more favorable outcome compared to patients who did not receive professional maintenance | Three procedures were performed: (1) periodontal and peri-implant status assessment; (2) the application of disclosing agents and oral hygiene instructions; (3) coronal prophylaxis and mechanical debridement, when necessary | Not reported | This was a retrospective study, which evaluated the effect of patients returning for professional maintenance vs. patients who did not. Patients returning to professional maintenance had an average of 5.6 visits during the 5-year maintenance period |
| Fischer et al (2011)[9] | Patient/treatment characteristic-related outcome | To evaluate and report 10-year data on outcomes and maintenance of screw-retained implant-supported full-arch casted titanium-resin prostheses in the edentulous maxilla | Not specified, but authors stated that professional maintenance procedures were performed at baseline and at 1, 3, 5, and at 10 years | Not reported | Baseline and 1-, 3-, 5-, 10-year follow-up |
| Katsoulis et al (2011)[10] | Patient/treatment characteristic-related outcome | To analyze professional maintenance of fixed maxillary prostheses and overdentures based on | Professional cleaning, oral hygiene instructions, evaluation of prosthetic mechanical maintenance | Not reported | Twice a year |

| Author and year | Categorization of study outcome in this systematic review | Primary objective of the study | Professional maintenance regimen reported in the study | At-home maintenance regimen reported in the study | Patient recall regimen used in the study |
|---|---|---|---|---|---|
| | | conventional gold bars or titanium bars and frameworks fabricated with CAD/CAM technology | events and needs | | |
| Akça et al (2010)[11] | Patient/treatment characteristic-related outcome | To evaluate peri-implant parameters and professional mechanical maintenance outcomes of patients with bar-retained implant-supported overdentures | Not specified, but authors stated that professional maintenance procedures were performed annually | Not reported | Annual |
| Corbella et al (2010)[12] | Professional intervention-related outcome | To assess the outcomes of an implant maintenance protocol for implants supporting a full-arch rehabilitation | Professional maintenance with manual PTFE curettes, electric toothbrushes, and interdental floss for removal of plaque | A very specific protocol that included CHX 0.2% rinse, 3 days before and 7 days after surgery, the use of soft toothbrush on prosthetic surfaces with prosthetic restoration, the additional use of small or medium diameter brushes 2 weeks after surgery, and toothbrushes, interdental brushes, and interdental floss after definitive restoration | Baseline and then every 6 months for 2 years and then yearly for up to 4 years |
| Rentsch-Kollar et al (2010)[13] | Professional intervention-related outcome | To analyze patient compliance and prosthetic maintenance service, including complications with the retention | Professional mechanical maintenance included replacement of loose, broken, and lost matrices or repair and remaking the prosthesis | Not reported | Twice a year |

| Author and year | Categorization of study outcome in this systematic review | Primary objective of the study | Professional maintenance regimen reported in the study | At-home maintenance regimen reported in the study | Patient recall regimen used in the study |
|---|---|---|---|---|---|
| | | components of mandibular overdentures | | | |
| Sreenivasan et al (2010)[14] | Agent-related outcome | To determine the effect of a 0.3% triclosan/2% copolymer dentifrice on oral biofilms and gingival inflammation on dental implants and peri-implant tissues | Not reported | Participants were asked to either brush twice daily with dentifrice containing 0.3% triclosan/copolymer dentifrice or a dentrifrice without triclosan for 6 months | Baseline, 3 and 6 months |
| Thöne-Mühling et al (2010)[15] | Agent-related outcome as well as professional intervention-related outcome | To determine if an additional full mouth disinfection with CHX results in a greater clinical and microbiological improvement compared with sole mechanical debridement, within one session in patients with peri-implant mucositis and treated chronic periodontitis | Professional maintenance for implants included use of plastic scalers and PEEK-coated ultrasonic instruments. In the test group, additionally, CHX gel 1% was applied once subgingivally, and the dorsum of the tongue was brushed for 1 min with a 1% CHX gel, and each tonsil was sprayed four times with 0.2% CHX spray | In the test group, in addition to the professionally applied CHX, patients were instructed to rinse twice for 1 min with 0.2% CHX. For 14 days after the treatment, patients were instructed to rinse once daily for 30 sec with 0.2% CHX solution and also to spray the tonsils once daily with 0.2% CHX spray | Baseline, 1 month, 2, 4, 8 months |
| Kleis et al (2009)[16] | Patient/treatment characteristic-related outcome | To study the prosthodontic maintenance of 2-implant overdentures with self-aligning attachment system (Locator) attachment compared to two different | Not specified, but authors stated that professional mechanical maintenance procedures were performed as needed and at 12 months | Not reported | Baseline, as needed for maintenance, and at 12 months |

| Author and year | Categorization of study outcome in this systematic review | Primary objective of the study | Professional maintenance regimen reported in the study | At-home maintenance regimen reported in the study | Patient recall regimen used in the study |
|---|---|---|---|---|---|
| | | ball attachment systems | | | |
| Paolantonio et al (2008)[17] | Agent-related outcome | To evaluate the effectiveness of a 1% CHX gel on the internal bacterial contamination of implants with screw-retained abutments | Not specified, but authors stated that professional biological maintenance was performed at baseline The 1% CHX gel was placed inside the implant at the 3-month recall in the test group | Not reported | Baseline, 3 and 6 months |
| Ramberg et al (2009)[18] | Agent-related outcome | To determine the effect of a dentifrice with 0.3% triclosan on peri-implant mucositis in subjects restored with dental implants | Only oral hygiene instructions were given to all patients | Participants were asked to either brush twice daily with dentifrice containing 0.3% triclosan/copolymer dentifrice or a dentrifrice 0.243% sodium fluoride in a silica base for 6 months | Baseline, 3 and 6 months |
| Rasperini et al (2008)[19] | Agent-related outcome | To evaluate the safety and the acceptability of an electric toothbrush used on the peri-implant mucosa of implants placed in the esthetic region | Not reported | Patients were instructed to use the electric toothbrush to brush twice a day over a 12-month period | Baseline, 3, 6, and 12 months |
| Vandekerckhove et al (2004)[20] | Agent-related outcome | To evaluate the safety, efficacy, and acceptability of an electric toothbrush in patients rehabilitated with fixed prostheses on implants | Not reported | Patients were instructed to use an electric toothbrush to brush twice a day. They were instructed to adhere to their normal interdental cleaning procedures, which mostly consisted of the use of | Baseline, month 3, 6, and 12 months |

| Author and year | Categorization of study outcome in this systematic review | Primary objective of the study | Professional maintenance regimen reported in the study | At-home maintenance regimen reported in the study | Patient recall regimen used in the study |
|---|---|---|---|---|---|
| | | | | interdental brushes and interdental floss | |

## *Outcomes related to patient-specific restorative treatment*

Five studies (2 RCTs, 3 observational studies) reported on a specific patient/treatment characteristic-related improvement for professional and/or homecare maintenance of implant-borne restorations. Katsoulis et al,[10] in a prospective study on 41 patients with maxillary removable or fixed rehabilitations, showed that cast bar overdentures, CAD/CAM milled bar overdentures, and fixed prostheses all resulted in professional maintenance during the 2-year study period, with the probability of a complication occurring in the first year being 60 to 70%. Fewer maintenance issues were seen in implant-supported fixed restorations than in patients with a bar overdenture over a 2-year period. Fischer et al,[9] in a prospective cohort study based on a larger RCT, collected data over a 10-year period on outcomes and maintenance of screw-retained implant-supported complete-arch cast titanium-acrylic resin prostheses in the edentulous maxilla of 24 patients. They evaluated the number of prosthetic teeth re-cemented or replaced, screw loosening, and the number of remakes of fixed prostheses, as well as cantilever length as a potential risk for fracture at baseline and 1-, 3-, 5-, and 10-year professional recall visits. They concluded that the most frequent complication was related to fractured denture teeth. The status of the opposing dentition and length of cantilever did not contribute to increased risk.

Akça et al[11] conducted a prospective study on 35 patients with maxillary and mandibular bar-supported overdentures to compare prosthetic maintenance outcomes. They recorded data obtained at annual professional recall visits over a 5-year period and concluded that mandibular bar-retained overdentures experienced a more frequent need for retightening of the retainer and occlusal adjustments than maxillary bar-retained overdentures. In an RCT of 60 patients, Kleis et al[16] compared the prosthodontic maintenance of a self-aligning

attachment system (Locator system; Zest Anchors; Escondido, CA) to two traditional ball attachment systems in mandibular implant overdenture patients. They performed all professional mechanical maintenance as needed by patients and counted the number of professional maintenance visits. They concluded at the end of the 1-year study that professional maintenance was restricted to loss of retention for all systems, but the self-aligning attachment system showed a higher rate of maintenance than the ball attachment systems. In contrast, Zou et al[5] compared peri-implant health and professional maintenance in patients with either telescopic crowns, bar, or Locator attachments used in removable four implant-supported maxillary overdentures on 30 patients. Biologic and mechanical professional maintenance procedures were performed at baseline and annually for 3 years. The authors also counted the number of professional maintenance visits for each type of prosthesis. After a 3-year period, the authors concluded that the Locator system produced superior clinical results compared to the telescopic crown and bar attachments in terms of peri-implant hygiene parameters, the frequency of prosthodontic maintenance measures, cost, and ease of denture fabrication.

## *Outcomes related to maintenance using oral topical agents and oral hygiene aids*

Eleven studies (8 RCTs, 3 observational studies) reported on a specific agent-related improvement for professional and/or homecare maintenance of implant-borne restorations. In independent studies, Swierkot et al,[4] Rasperini et al,[19] and Vandekerckhove et al[20] showed that the use of electric toothbrushes was a safe and efficient method of plaque removal around implant-borne restorations and had no adverse effects on peri-implant health; however, the superiority of electric toothbrushes over conventional toothbrushes was not proven in any of these studies. In a small-sample, double-blind RCT on eight patients, Chongcharoen et al[7] compared a specially designed interproximal brush with a 5 mm diameter (Circum Brush; Top Cardent, Zurich, Switzerland) with a conventional interproximal brush with a 3 mm diameter in patients with implant-borne restorations (and natural teeth). The authors concluded that the specially designed

interproximal brush resulted in improved removal of plaque compared to the conventional interproximal brush.

Sreenivasan et al,[14] in a double-blind RCT on 120 patients with at least one implant restoration, compared periodontal outcomes (including dental plaque, gingival index, and bleeding on probing) and bacterial outcomes in patients using a dentifrice with 0.3% triclosan/copolymer compared to patients using a dentifrice without triclosan. Assessments were performed at baseline, 3 months, and 6 months, and they showed that the dentifrice with 0.3% triclosan/copolymer was significantly more effective than a dentifrice without triclosan in improving periodontal and microbial outcomes. Similarly, a second double-blind RCT on 60 patients with various types of implant restorations by Ramberg et al[18] investigated whether the use of a dentifrice containing 0.3% triclosan in a sodium fluoride silica base was more effective than a 0.243% sodium fluoride in a silica base on peri-implant mucositis. The outcomes measured were dental plaque, bleeding on probing, and periodontal probing depth. The authors showed that the dentifrice with 0.3% triclosan/copolymer was significantly more effective than a dentifrice without triclosan in improving peri-implant outcomes in patients with peri-implant mucositis. In another RCT on 16 patients with various types of implant restorations, Morawiec et al[2] compared the use of a dentifrice containing ethanol extract of Brazilian green *propolis* with a placebo dentifrice without the *propolis* on selected oral health parameters, oral microflora, and periodontal health. The authors showed that over an 8-week period, the use of *propolis*-containing dentifrice seemed to have a beneficial effect on peri-implant tissues and plaque accumulation, resulting in improved scores in approximal plaque index, oral hygiene index-debris component, and bleeding on probing.

De Siena et al,[6] in an RCT on 30 patients, compared periodontal probing depth, plaque index, and bleeding index at 10 days, 1 month, and 3 months with patients using either a 0.2% chlorhexidine mouthrinse or a 1% chlorhexidine gel. Twenty-three patients completed the study, and patients had a complete arch reconstruction supported by four implants placed either in the intraforaminal region in the mandible or in the anterior maxilla with distal cantilever extensions. All prostheses were made of acrylic resin with a titanium structure and were screw-retained to implant abutments. Professional

oral hygiene intervention was performed on all patients by a single experienced dental hygienist. The authors reported no difference in the peri-implant health of patients managed by 0.2% chlorhexidine mouthrinse or 1% chlorhexidine gel, but stated that the 1% gel may be advantageous because it could be applied selectively to affected sites.[6] Thöne-Mühling et al,[15] in an RCT on 30 patients with implant crowns and FDPs, investigated whether the addition of chlorhexidine disinfectant (in-office and at-home) provided clinical and microbiological improvement compared to professional oral hygiene maintenance alone (mechanical debridement) in patients with peri-implant mucositis and treated chronic periodontitis. Standard periodontal outcomes were recorded at baseline, 1 month, 2 months, 4 months, and at 8 months. Microbial specimens were taken 24 hours and 8 months after application. The authors reported that both treatment modalities resulted in improvement of the clinical parameters and a temporary reduction of the microflora at implants with mucositis, but there were no significant inter-group differences after 8 months.

Paolantonio et al[17] in an RCT compared the effectiveness of a 1% chlorhexidine gel on the internal bacterial contamination of implants with screw-retained abutments. The control group had conventional cement-retained crowns over the implant abutments. In the experimental group, the internal aspect (cavity) of the implant itself was filled with a 1% chlorhexidine gel before placement of the abutment and restoration. Microbiologic and clinical data were collected at baseline and at 6 months for both groups. The results showed that there was a significant reduction in the total bacterial counts and that periopathogens were detected less frequently in the experimental group. The authors concluded that application of a 1% chlorhexidine gel inside the implant itself was an effective method to reduce bacterial colonization of the implant cavity over a 6-month period. Magnuson et al,[1] in an RCT on 28 patients with implant-supported crowns, compared manual brushing and flossing with a conventional string floss to manual brushing and flossing with a water flosser. Bleeding on probing index was used as a primary outcome and was recorded at six sites on each implant at baseline, 14 days, and 30 days. The authors concluded that patients using the water flosser had a statistically significant reduction in bleeding on probing compared to patients using conventional string floss.

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## *Outcomes related to maintenance using professional intervention*

Six studies (3 RCTs, 3 observational studies) reported on professional intervention related to maintenance of implant-borne restorations. Of these six studies, two RCTs (De Siena et al[6] and Thöne-Mühling et al[15]) also reported on agent-related outcomes (chlorhexidine) as discussed previously. De Siena et al[6] concluded that peri-implant mucositis could be successfully treated with professional oral hygiene intervention in conjunction with either 0.2% chlorhexidine mouth rinse or 1% chlorhexidine gel topical antimicrobial agent; however, Thöne-Mühling et al[15] reported that professional oral hygiene intervention, with or without chlorhexidine, led to an improvement of the clinical parameters of peri-implant health and a temporary reduction of the microflora at implants with mucositis; however, there were no differences after 8 months, indicating that repeated professional intervention is necessary for long-term maintenance of peri-implant health.

In a split-mouth RCT on 15 patients, Mussano et al[3] compared the peri-implant biological outcomes when professional oral hygiene maintenance was performed using polytetrafluoroethylene (PTFE; Teflon) curettes as hand instrumentation or a glycine powder air polishing system. In this trial, all patients were restored with mandibular two-implant overdentures. Periodontal probing depth, bleeding on probing, and bacterial content within the gingival sulcus were evaluated at baseline, 1 week, and 4 weeks. The authors concluded that glycine powder air polishing was more effective than PTFE curettes for the maintenance of peri-implant soft tissues. Costa et al[8] conducted a retrospective study on 80 patients with implant-borne crowns and FDPs who had been diagnosed with peri-implant mucositis. In this study, patients were retrospectively divided into two groups: the maintenance group had an average of 5.6 visits during the 5-year maintenance period, while the nonmaintenance group had no professional recall visits. Using standard peri-implant health outcomes, the authors concluded that for patients with peri-implant mucositis, preventive professional maintenance resulted in significantly improved periodontal outcomes compared to patients with no professional maintenance.

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Corbella et al[12] conducted a prospective cohort study on 60 patients to assess the outcomes of a professional maintenance protocol on patients with immediately loaded implant-supported complete FDPs. In this study, a rigorous professional and at-home maintenance regimen was implemented for all patients. The professional maintenance comprised electric and manual devices for debridement of plaque and calculus from the implant neck and prosthetic surfaces, and the use of interdental floss for removal of plaque and calculus on mesial and distal surfaces of tilted implant necks. For the at-home maintenance regimen, patients were asked to use a 0.2% chlorhexidine rinse, a soft toothbrush on prosthesis surfaces, a small diameter plastic-coated soft-bristle interdental brush, a medium diameter plastic-coated soft-bristle interdental brush, and a spongy interdental floss. All these oral hygiene aids were to be used at different time points from commencement of surgery to postinsertion of final prosthesis for a lifelong regimen. The mean observation time was 18.3 months (ranging from 6 months to 5 years). During this time, the researchers found that frequency of plaque and bleeding indexes decreased over time. Probing depth remained stable (2.46 ± 0.5 mm at 4 years), and the authors concluded that the adoption of a systematic hygiene protocol was effective in controlling plaque accumulation and clinical attachment loss and in reducing the incidence of peri-implant mucositis. Rentsch-Kollar et al[13] conducted a long-term retrospective study on 101 patients with maxillary and mandibular overdentures where all patients had a follow-up period of more than 10 years. Patients in this study had high compliance rates when seen for professional recall visits conducted at 6-month intervals, when biological and mechanical maintenance of the implant overdentures were performed. This included cleaning of the implants, abutments, and overdentures (biological maintenance); replacement of loose, broken, and lost components and/or repair and remaking of the prosthesis (mechanical maintenance). Based on favorable results, the authors concluded that regular professional care could be provided for aging populations with implant overdentures, where implant and prosthetic survival is high, but regular professional maintenance must be provided, which may result in a considerable number of visits.

# Discussion

The aim of this systematic review was to examine the current scientific evidence on patient recall and maintenance of implant-borne fixed and removable restorations, and to identify and compare existing patient care regimens with the goal of improving oral health. An additional purpose was to examine areas of deficiency in the current scientific evidence and provide recommendations for future studies. It is important to note that the focus of this systematic review was on articles that provided data on patient recall and maintenance regimens on periodontally stable/healthy patients. Management of patients with peri-implant disease (such as "peri-implantitis") or other diseases is outside the scope of this systematic review. Similarly, management of patients with complicating medical issues, such as diabetes or being an active smoker, is outside the scope of this review. Although implant-borne restorations are increasingly accepted and recommended throughout the world, there is little guidance for the clinician or patient on how to maintain implant-borne restorations. Numerous articles in the literature have previously addressed prosthetic and biologic complications associated with implant restorations; however, few articles have suggested recall and professional and at-home maintenance regimens to prevent and manage these complications.

In this systematic review, patient recall and maintenance (professional and homecare) regimens were divided into three elements: (1) outcomes related to patient-specific restorative treatment; (2) outcomes related to maintenance using oral topical agents and hygiene aids; and (3) outcomes related to maintenance using professional intervention. The authors believe that any patient recall and maintenance (professional and homecare) regimen on implant-borne restorations should incorporate these three elements, as they are all necessary to ensure a successful long-term outcome. Furthermore, unlike tooth-borne restorations, implant-borne restorations also require professional mechanical maintenance to manage anticipated and un-anticipated consequences and complications of treatment. For outcomes related to patient-specific restorative treatment, two RCTs and three observational studies discussed professional mechanical maintenance and confirmed the fact that irrespective of the type of implant-borne restoration, professional

maintenance is necessary; however, the type of treatment and type of implant-borne restoration can affect the nature and frequency of needed professional maintenance and homecare regimens. For outcomes related to maintenance using oral topical agents and hygiene aids, eight RCTs and three observational studies successfully demonstrated that the tested agent (electric toothbrush, interdental brush, chlorhexidine, triclosan, *propolis*, water flossers) was effective in the professional and homecare maintenance protocol. Similarly, for outcomes related to maintenance using professional intervention, three RCTs and three observational studies successfully demonstrated that professional intervention for biological maintenance was effective for various types of implant-borne restorations. This knowledge is valuable for clinicians and patients when choosing the best agent(s) in conjunction with the professional intervention (biological and mechanical) and at-home maintenance for a given implant-borne restoration.

It is remarkable that 12 of 20 included studies reported on edentulous patients with implant-supported removable overdentures or fixed prostheses. Most of the patients included in these studies were older and geriatric patients. Results from these studies unequivocally showed that implant-borne removable and fixed prostheses require lifelong dental professional maintenance to provide biological and mechanical maintenance. With an increase in the use of implant therapy in aging populations across the world, the finding of lifelong need for professional maintenance may have numerous implications for geriatric dental public health policy worldwide.

The predetermined inclusion criteria for this systematic review were broad to permit the inclusion of as many articles as possible. Therefore, the search terms were expansive to maximize the selection choices from the list of articles. Scrutiny of all articles was performed by both investigators to decrease errors during the review process and minimize selection bias of included articles. Articles determined for exclusion in the full-text analysis stage were analyzed in-depth and debated with predetermined criteria before finalizing inclusion or exclusion. The search dates were restricted to the past 10 years in order to identify evidence from current best practices, as the field of implant dentistry is recognized to be rapidly evolving. Incorporating older studies with older restorative/prosthetic materials as well as

outdated oral hygiene aids and practices may not be applicable to contemporary dental practice; however, it is remarkable that 15 of 20 included studies were conducted in the past 5 years. Additionally, 16 of 20 studies were conducted in Europe and 1 study was conducted in the United States. A majority of studies included in this review were conducted in a university setting, and only three studies from a private practice setting. The impact of these disparities on the extrapolation of these research findings to the general population is unknown.

Although this systematic review satisfied most PRISMA guidelines, there are some limitations to this review. First, some aspects of the results section were not applicable or amenable to the PRISMA checklist. Second, due to the nature of the topic and PICO question posed in this systematic review, the authors did not find significant quantitative data. Therefore, no statistical analysis was performed. Third, the selection of all articles in this review was restricted to peer-reviewed journals of the English language literature. Although limiting the electronic and hand searches to English minimized problems of interpretation, there may have been a potential for bias, if a substantial number of articles in languages other than English exist; however, a recent empirical study has shown minimal consequences of exclusion or inclusion of trials published in non-English languages on combined effect estimates in meta-analyses of RCTs.[39] Fourth, given the nature of this topic and the PICO question posed, only articles with a primary focus on patient recall and maintenance were included in the electronic search process. Like most systematic reviews, despite an exhaustive search process, it is possible that the authors failed to identify some articles in the search process.[40] Gray literature was not considered in this systematic review because articles of this type are usually non-peer reviewed, with a potential for biased information or information that is restricted for use.[41] Additionally, published trials tend to be larger and show an overall greater treatment effect than gray trials.[42] However, it is unknown whether incorporation of these omitted articles would change the conclusions of this systematic review. It can be argued that including articles with a focus on implant complications may have offered additional data on professional maintenance of implant-borne restorations; however, previous systematic reviews conducted on this topic have all revealed minimal information on patient recall, professional, and at-home maintenance regimens, to prevent and

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manage these complications.[34,35] Therefore, to maintain homogeneity in the search process, the authors of this systematic review selected only articles whose primary focus was on recall and maintenance of implant-borne restorations. It is unknown whether incorporation of articles related to implant complications would change the conclusions of this systematic review.

This systematic review identified minimal evidence related to patient recall regimens for removable and fixed implant-borne restorations. Most studies had a recall regimen to satisfy the study's primary objectives and no study compared two different recall regimens for implant-borne restorations. Also, the anticipated implant-borne restorations of interest in this study were implant-supported single crowns, implant-supported partial FDPs, implant-supported complete FDPs, implant-supported partial RDPs, and implant-supported complete RDPs; however, no studies in this systematic review reported on recall and maintenance of patients with implant-supported partial RDPs. Most data were restricted to implant-supported complete fixed and removable dental prostheses. Given the small number of studies in this systematic review, the authors did not restrict the inclusion criteria to only RCTs, nor did they perform a risk of bias analysis on any of the included studies (as typically done in Cochrane systematic reviews), because this would have eliminated most selected studies and resulted in an inconclusive and ineffectual conclusion from this systematic review. This would be of little benefit to clinicians and patients. Similarly, no comparison was made for studies that reported support by the manufacturers versus studies that did not receive support. To the authors' best knowledge, this is the first systematic review on recall and maintenance of patients with implant-borne restorations and serves to provide baseline information on this topic and highlights the deficiencies of studies on this important topic as well as insights for development of future studies on this topic.

## Conclusions

There is minimal evidence related to recall regimens in patients with implant-borne removable and fixed restorations; however, there is considerable evidence demonstrating that patients with implant-

borne removable and fixed restorations require a lifelong professional recall regimen to provide biological and mechanical maintenance customized to each patient's treatment. Current evidence also demonstrates that the use of specific oral hygiene aids (electric toothbrush, interdental brush, water flossers) and oral topical agents (chlorhexidine and triclosan) can improve professional and at-home biological maintenance of implant-borne restorations. The characteristics of the treatment (type of prosthesis, type of prosthetic components, and type of restorative/prosthetic materials) can affect the professional mechanical maintenance and homecare regimens. Furthermore, due to the heterogeneity of patient populations, restorations, and treatment needs, the evidence compels forethought of creating clinical practice guidelines for recall and maintenance of patients with implant-borne dental restorations.

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