

SYSTEMATIC REVIEW

# Oral health-related quality of life after prosthodontic treatment for patients with partial edentulism: A systematic review and meta-analysis



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Despite declines in edentulism, particularly in developed countries, tooth loss remains prevalent globally and leads to functional and esthetic disabilities with negative psychosocial impacts.<sup>1-3</sup> Patients with fewer than 20 natural teeth have worse OHRQoL than those with 20 teeth or more.<sup>4</sup> Replacing missing teeth improves appearance and function, and it prevents undesirable tooth movements.<sup>5</sup> Variables such as number of missing teeth and position of missing teeth can influence how patients perceive treatment to replace missing teeth.<sup>6</sup> Extent of tooth loss, local factors, and systemic factors are important considerations in the planning of prosthodontic treatment.<sup>7</sup> Prosthodontic options for replacing missing teeth in patients with partial edentulism include implant-supported crowns (ISCs), implant-supported fixed dental prostheses (IFDPs), implant-supported removable dental prostheses (IRDPs), tooth-supported fixed dental prostheses (TFDPs), and removable partial dentures (RPDs).<sup>8</sup>

## ABSTRACT

**Statement of problem.** Clinicians are currently unable to quantify the psychosocial, functional, and esthetic effects of prosthetic interventions to replace teeth. Understanding the effects of treatment to replace teeth on oral health-related quality of life (OHRQoL) is important for informed consent. A systematic review of the evidence of OHRQoL improvements with prosthodontic tooth replacement and a comparison of outcomes between treatment modalities is therefore indicated.

**Purpose.** The purpose of this systematic review was to examine the OHRQoL of patients with partial edentulism after different dental prosthetic treatments.

**Material and methods.** Electronic database and manual searches were conducted to identify cohort studies and clinical trials reporting on the OHRQoL of individuals receiving implant-supported crowns (ISCs), implant-supported fixed dental prostheses (IFDPs), implant-supported removable dental prostheses (IRDPs), tooth-supported fixed dental prostheses (TFDPs), and removable partial dentures (RPDs). Two reviewers independently conducted article selection, data extraction, and quality assessment. Random-effects models were used to compare OHRQoL change scores (standardized mean change, 95% confidence intervals).

**Results.** Of the 2147 identified studies, 2 randomized controlled trials and 21 cohort studies met the inclusion criteria. Overall, studies were of low or moderate risk of bias. Pooled mean OHRQoL change  $\leq 9$  months was 15.3 for TFDP, 11.9 for RPD, and 14.9 for IFDP. Pooled standardized mean change OHRQoL change  $>9$  months was 13.2 for TFDP and 15.8 for IFDP. Direct comparisons  $\leq 9$  months between TFDP against IFDP and RPD against IFDP significantly favored IFDP in both cases.

**Conclusions.** TFDP and IFDP had short- and long-term positive effects on OHRQoL. RPDs positively affected OHRQoL in the short term. IFDP showed greater short-term improvement in OHRQoL than RPD and TFDP. (J Prosthet Dent 2019;121:59-68)

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## Clinical Implications

Clinicians may advise patients with multiple missing teeth that implant-supported fixed dental prostheses (FDPs) make greater improvements to oral health-related quality of life (OHRQoL) than tooth-supported FDPs or RPDs. They should also inform patients that although RPDs improve OHRQoL in the short term, these effects may be less noticeable in the medium term.

Outcome measures of prosthetic replacement of missing teeth include masticatory efficiency, continued prosthesis use, technical failure, and biological failure.<sup>9-13</sup> While the importance of these measures is indisputable, they fail to consider the patient's subjective perceptions. The use of patient-reported outcome measures has increased in dental research.<sup>14</sup> These allow assessment of oral health-related quality of life (OHRQoL), a multidimensional construct assessing the impact of oral problems on subjective esthetic, functional, and psychosocial well-being.<sup>15</sup> OHRQoL measures include the following: Oral Health Impact Profile (OHIP), Global Oral Health Assessment Index (GOHAI), Oral Impacts of Daily Performance (OIDP), and UK Oral Health-Related Quality of Life Measure (OHQoL-UK).<sup>16-19</sup>

OHRQoL measures are used to evaluate the effect of oral conditions on quality of life and assess the effect of dental interventions.<sup>20,21</sup> OHRQoL may be improved with prosthodontic rehabilitation in patients with partial edentulism, demonstrated by improvements in OHIP scores between baseline and follow-up.<sup>22-24</sup> Previous systematic reviews suggest that rehabilitation with dental implants in edentulous and partially edentulous patients can improve OHRQoL, but comparisons of different prostheses in patients with partial edentulism have not yet been comprehensively reviewed.<sup>25-31</sup> Given the range of different scales to measure OHRQoL, each with different scoring methods and scoring ranges, any synthesis of data is challenging; different scales may be combined for meta-analysis provided that scales measure similar constructs and that researchers are mindful of the increased risk of heterogeneity.<sup>32-35</sup>

The purpose of this systematic review was to assess the impact of treatment with ISCs, IFDPs, IRDPs, RPDs, and TFDPs on quantifiable measures of OHRQoL in patients with partial edentulism. We assessed the effect of different dental prosthetic interventions for replacing missing teeth in partially dentate patients with respect to the changes in oral health-related quality of life. The null hypothesis was that no difference between prosthodontic

treatments to replace teeth would be found in their impact on OHRQoL.

## MATERIAL AND METHODS

This systematic review was conducted in compliance with principles proposed by the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement.<sup>36</sup> For inclusion in the review, studies had to include partially edentulous adults of either sex treated with ISCs, IFDPs, IRDPs, RPDs, or TFDPs reporting OHRQoL outcomes using validated OHRQoL measures such as OHIP, GOHAI, or OIDP.<sup>16-18</sup> Only studies measuring pretreatment to posttreatment change in OHRQoL score were included. Single or multiple group prospective randomized controlled trials (RCTs), non-RCTs, and cohort studies were included. Studies reporting interventions on edentulous participants were excluded, as were descriptive studies, cross-sectional studies, case reports, reviews, and review protocols.

A comprehensive literature search was conducted. The electronic libraries, MeSH terms, and keywords used are presented in Table 1. Searches were restricted to English-language articles published from January 1979 to April 2016. Additional literature was sought from systematic reviews identified in the electronic search and from the references of the included papers. Non-peer-reviewed literature was identified from the abstracts of conference proceedings for International Association for Dental Research meetings published online.

Duplicated studies were removed, and 2 reviewers (S.S., Z.A.) independently screened titles and abstracts of all articles to select those suitable for full reading, which were also independently reviewed according to inclusion and exclusion criteria. Interreviewer reliability of inclusion was assessed in 10% of articles. A Cohen kappa score of 0.70 was set as the accepted standard.<sup>37</sup> Disagreements were resolved through discussion with a supervising reviewer (N.M.). Data concerning publication year, country, setting, study design, participant characteristics (age, sample size), follow-up, OHRQoL instrument, and prosthodontic interventions were extracted independently by 2 reviewers (S.S., Z.A.). Results were grouped qualitatively according to the type of prosthodontic interventions analyzed: studies investigating conventional tooth- and mucosa-supported prostheses only, studies investigating implant-supported prostheses only, and studies investigating both conventional and implant-supported prostheses.

Two reviewers (S.S., Z.A.) assessed the quality of the included studies independently. The Cochrane Collaboration's risk of bias tool was used to assess the risk of bias in RCTs.<sup>38</sup> The performance bias item was not assessed because blinding participants and clinicians to

**Table 1.** Systematic review search strategy

Electronic Databases and Libraries	MeSH Search Terms and Keywords
Medline-PubMed, Medline-Ovid, Cochrane-Central, Cochrane Database of Systematic Reviews, National Health Service Economic Evaluation Database, Health Technology Assessment Database and Web of Science.	(Jaw, Edentulous, Partially [Mesh] OR Jaw, Edentulous [Mesh] OR Mouth, Edentulous [Mesh] OR Anodontia [Mesh] OR Tooth Loss [Mesh] OR Partially Dentate OR Edentulous OR Missing Teeth OR Absent Teeth OR Edentate OR Partial Edentulous OR Hypodontia OR Tooth loss) AND (Dentures [Mesh] OR Denture, Partial [Mesh] OR Denture, Partial, Removable [Mesh] OR Denture, Partial, Fixed [Mesh] OR Dental-Prosthesis, Implant-Supported [Mesh] OR Dental Implants [Mesh] OR Denture OR Partial Denture OR Bridge OR Dental Bridge OR Implant) AND (Oral Health Impact Profile OR OHIP OR Oral Impacts on Daily Performance OR OIDP OR Global Oral Health Assessment Index OR Geriatric Oral Health Assessment Index OR GOHAI OR OHQoL-UK)

prosthodontic interventions is not possible. The quality of nonrandomized trials was evaluated with the Newcastle-Ottawa scale, consisting of 3 categories: group selection (4 items), comparability (1 item), and outcome assessment (3 items).<sup>39</sup> If an item did not apply to the study, it was labeled “not applicable.” For example, “definition of control group” is not applicable for single group studies.

Meta-analysis was carried out to estimate pooled mean changes for OHRQoL scores involving mean and SD or variance data, where available. Total scores of OHRQoL instruments were standardized from 0 to 100 in the same direction to obtain a standardized mean change (SMC) before and after each individual prosthodontic treatment. Positive differences of SMC indicated better OHRQoL after dental prosthesis intervention to replace missing teeth. The mean differences for OHRQoL between 2 or more prosthodontic interventions were calculated as the difference of SMC between groups. Subgroup analyses were performed according to follow-up periods:  $\leq 9$  months (short term) and  $>9$  months (medium/long term).

Pooled mean changes for OHRQoL scores (95% confidence interval [CI]) for each type of dental prosthesis treatment (indirect comparisons) and between dental prosthetic treatments (direct comparisons) were estimated by the inverse variance method. Indirect comparisons were considered to be valid on the basis of the following aspects: OHRQoL scores were assessed using validated instruments; OHRQoL measures were standardized from 0 to 100; only studies involving partially dentate patients were included; and unique dental prosthetic treatments (ISCs, IFDPs, IRDPs, RPDs, and TFDPs) were assessed. Meta-analyses were conducted using a random-effects model, which was appropriate because the purpose of the review was to draw general conclusions about the role of prosthesis type on OHRQoL. The random-effects model accounts for variability in study design, follow-up periods, research sites, and the variety of potential clinical confounders, including the number of teeth being replaced and the different regions of tooth replacement.<sup>40</sup>

Homogeneity was tested by the Cochran Q test, and the proportion of variance between studies due to heterogeneity was assessed by the  $I^2$  test. When heterogeneity was detected, a meta-analysis was considered

inappropriate. All statistical analyses were performed by statistical software (Stata 14; StataCorp LLC) ( $\alpha=.05$  for all analyses).

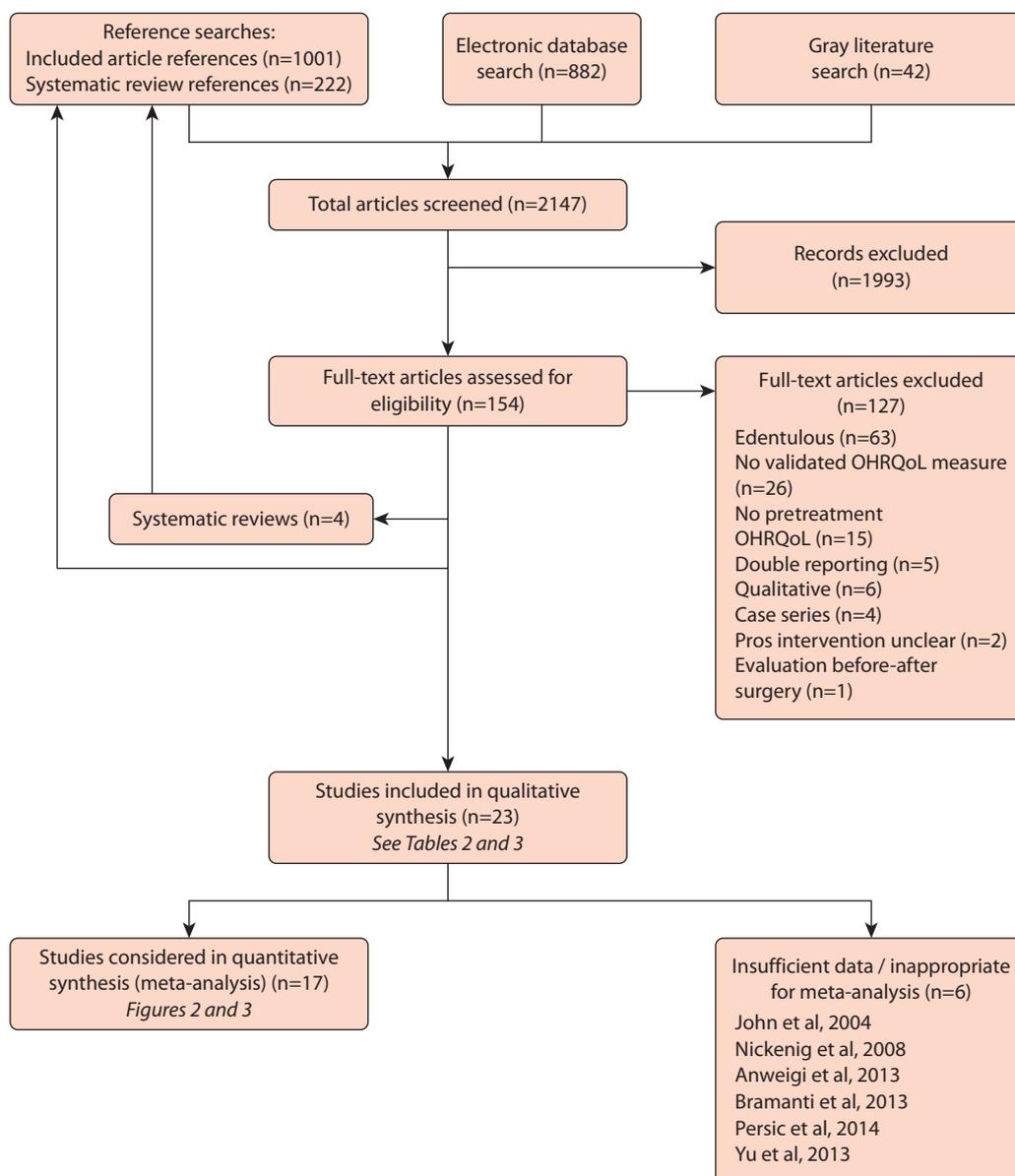
## RESULTS

Initially 882 studies were identified from the electronic database and 42 studies from the gray literature. A further 1223 articles were included from the reference lists of included papers. Of the 2147 articles initially screened, 1993 studies were excluded on the basis of an assessment of study titles and abstracts (interreviewer agreement,  $\kappa=0.80$ ). The full text of the remaining 154 studies was analyzed, and a further 131 articles were excluded ( $\kappa=0.77$ ). Of the 23 articles included for quality assessment, 17 were selected for meta-analysis (Fig. 1).

Supplemental Tables 1 to 3 summarize the characteristics of the 2 clinical RCTs and 21 nonrandomized clinical studies and the effects on OHRQoL, grouped according to the type of prosthodontic treatment being investigated.<sup>23,24,41-61</sup> Of the 21 nonrandomized clinical studies, 20 were prospective studies with 1 or more groups of dental prosthetic treatments, and 1 study was a crossover controlled clinical study. The sample sizes varied considerably among the studies. Twelve studies had 9 months or less of follow-up, whereas 11 studies had more than 9 months of follow-up. OHRQoL was assessed using OHIP-14 in 11 studies and OHIP-49 in 9 studies. Two studies used OHIP-20 and 1 study used GOHAI. Eight studies investigated ISCs, 10 studies IFDPs, 9 studies TFDPs, 10 studies RPDs, and 2 studies IRDPs.

The 2 RCTs were considered to be at low risk of bias except with regard to the blinding of participants and assessors (Table 2). Both studies presented details about random sequence generation and showed no risk of selective reporting bias. Risk of assessment or measurement bias was considered low because validated OHRQoL instruments were used.

The results of quality assessment of the 21 nonrandomized studies with the Newcastle-Ottawa scale are presented in Table 3. Thirteen reported on only a single intervention; therefore, the item “selection of the nonexposed cohort” was not applicable. All studies used representative samples of the partially dentate



**Figure 1.** PRISMA flow of search strategy and outcomes. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-analyses.

**Table 2.** Risk of bias: findings for included randomized studies

Study	Random Sequence Generation	Allocation Concealment	Selective Reporting	Attrition Bias	Other Bias
McKenna et al, 2015 <sup>24</sup>	+	?	+	+	+
Wolfart et al, 2014 <sup>49</sup>	+	+	+	+	+

+, low risk of bias; ?, unclear risk of bias

participants, reported clearly on the type of dental prosthesis used, and explained the outcome used and the scoring method. Variability was found in the level of accounting of confounders such as age, tooth position, and number of teeth being replaced.

Two studies investigated IRDPs and represented only 32 participants, 17 of whom were involved in a

crossover study. Data for this group were insufficient to conduct a meta-analysis.<sup>44,46</sup> Two studies combined the effect of ISCs and IFDPs into one “implant-supported” intervention and were also excluded.<sup>50,60</sup> Two studies were excluded from meta-analysis because mean data were unavailable or were not supplied on request.<sup>23,61</sup> Two studies reporting on unrepresentative samples or uncommon treatments deemed heterogeneous compared with conventional practice were excluded. These were Yu et al,<sup>55</sup> who reported on participants treated in a military hospital, and Persic et al,<sup>43</sup> who reported on the use of mini implants ranging from 1.9 to 2.5 mm in diameter.

Seventeen papers provided quantitative data for meta-analysis. The pooled SMC scores of the OHRQoL

**Table 3.** Newcastle-Ottawa quality assessment scale: findings for included nonrandomized studies

Study	Selection				Comparability	Outcome			Total
	Item 1	Item 2	Item 3	Item 4	Item 1 (2 Stars Available)	Item 1	Item 2	Item 3	
Swelem et al, 2014	*	*	*	*	*	*	*	*	8/9 stars
Van Eekeren et al, 2016	*	NA	*	*	**	*	*	*	8/8 stars
Persic & Celebic 2015	*	*	*	*	*	*	*	...	7/9 stars
Fueki et al, 2015	*	*	*	*	**	*	*	...	8/9 stars
Yunus et al, 2016	*	NA	*	*	*	*	*	...	6/8 stars
Gates et al, 2014	*	*	*	*	**	*	*	*	9/9 stars
Persic et al, 2014	*	NA	*	*	*	*	*	*	7/8 stars
Wickert et al, 2014	*	*	*	*	*	*	*	...	7/9 stars
Anweigi et al, 2013	*	NA	*	*	**	*	*	...	7/8 stars
Bramanti et al, 2013	*	NA	*	*	*	*	*	...	6/8 stars
Hosseini et al, 2013	*	NA	*	*	*	*	*	*	7/8 stars
Fillion et al, 2013	*	NA	*	*	*	*	*	...	6/8 stars
Raes et al, 2013	*	NA	*	*	**	*	*	*	8/8 stars
Montero et al, 2013	*	*	*	*	*	*	*	*	8/9 stars
Yu et al, 2013	*	NA	*	*	**	*	*	*	8/8 stars
Petrecievic et al, 2012	*	*	*	*	**	*	*	...	8/9 stars
Ponsi et al, 2011	*	NA	*	*	*	*	*	...	6/8 stars
Goshima et al, 2010	*	NA	*	*	**	*	*	...	7/8 stars
Allen et al, 2009	*	NA	*	*	*	*	*	...	6/8 stars
Nickenig et al, 2008	*	NA	*	*	...	*	*	...	5/8 stars
John et al, 2004	*	*	*	*	...	*	*	*	7/9 stars

\*, one point received for item; ..., \*\*, two points received for item, no point received for item; NA, item not relevant for this study.

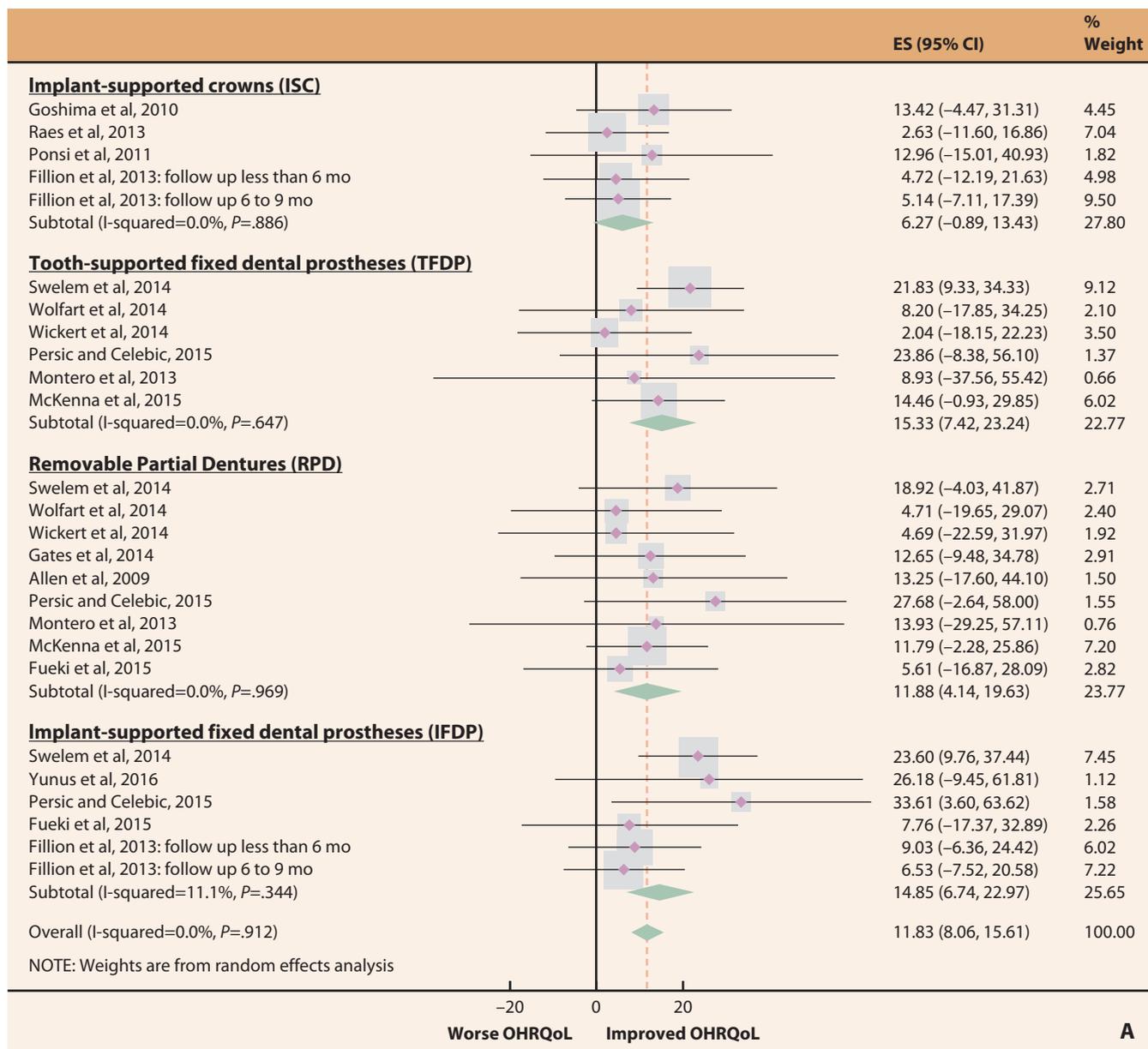
measure for each prosthodontic treatment are presented in Figure 2. The pooled SMC scores of OHRQoL at  $\leq 9$  months' follow-up were statistically significant for TFDPs (322 participants; SMC=15.3 points, 95% CI 7.4 to 22.3,  $P<.001$ ), IFDPs (196 participants; SMC=14.9 points, 95% CI 6.7 to 19.6;  $P<.001$ ), and RPDs (503 participants; SMC=11.9 points, 95% CI 4.1 to 19.6;  $P=.003$ ). These changes represented improvements in OHRQoL (Fig. 2A). The pooled SMC scores of OHRQoL at  $>9$  months' follow-up were statistically significant for the TFDPs (176 participants; SMC=13.2 points, 95% CI 3.0 to 23.4;  $P=.011$ ) and IFDPs (158 participants SMC=15.8 points, 95% CI 6.6 to 25.0;  $P=.001$ ). These changes represented improvements in OHRQoL (Fig. 2B). The Cochran Q test suggested no heterogeneity in the meta-analyses of indirect comparisons. Only 3 studies provided data for meta-analysis of direct comparisons of the OHRQoL scores between 2 different dental prosthetic treatments. The standardized mean difference in OHRQoL change was assessed between TFDPs and IFDPs (standardized mean difference=0.42 in favor of IFDPs, 95% CI, -0.75 to -0.10,  $P=.018$ ) (Fig. 3A) and between RPDs and IFDPs (standardized mean difference=0.40 in favor of IFDPs, 95% CI, -0.40 to -0.15,  $P=.002$ ) (Fig. 3B) at  $\leq 9$  months' follow-up. Evidence of heterogeneity was detected in the direct comparisons of OHRQoL scores between TFDPs and RPDs at  $\leq 9$  months' follow-up (Cochran Q test=12.20,  $P=.032$ ,  $I^2=59.0\%$ ), and  $>9$  months' follow-up (Cochran Q test=4.46,  $P=.035$ ,

$I^2=77.6\%$ ); therefore, these meta-analyses were not performed.

## DISCUSSION

The present study reviewed the evidence on the impact of prosthodontic treatments to replace missing teeth on the OHRQoL in patients with partial edentulism. Improvements in OHRQoL were observed after IFDPs, TFDPs, and RPDs at short-term follow-up ( $\leq 9$  months). In addition, TFDPs and IFDPs resulted in positive changes of OHRQoL at longer follow-up ( $>9$  months). The largest effect sizes were observed for IFDPs  $>9$  months' follow-up and TFDPs  $\leq 9$  months' follow-up, resulting in 15.8% and 15.3% improvement in the OHRQoL score after treatment. However, ISCs in both follow-up periods and RPDs at  $>9$  months did not improve OHRQoL. Direct comparisons suggested that the influence of IFDPs on OHRQoL was significantly higher than TFDPs or RPDs. IFDPs improved OHRQoL score 42% more than TFDPs and 40% more than RPDs at  $\leq 9$  months' follow-up.

This review reveals a significant increase in the number of studies on the influence of dental prosthesis treatments on OHRQoL in patients with partial edentulism. Eighteen of the 23 studies included were published during the last 5 years. However, the quality of evidence of individual studies is a limitation because only 2 RCTs were identified (level of evidence 1b), and the

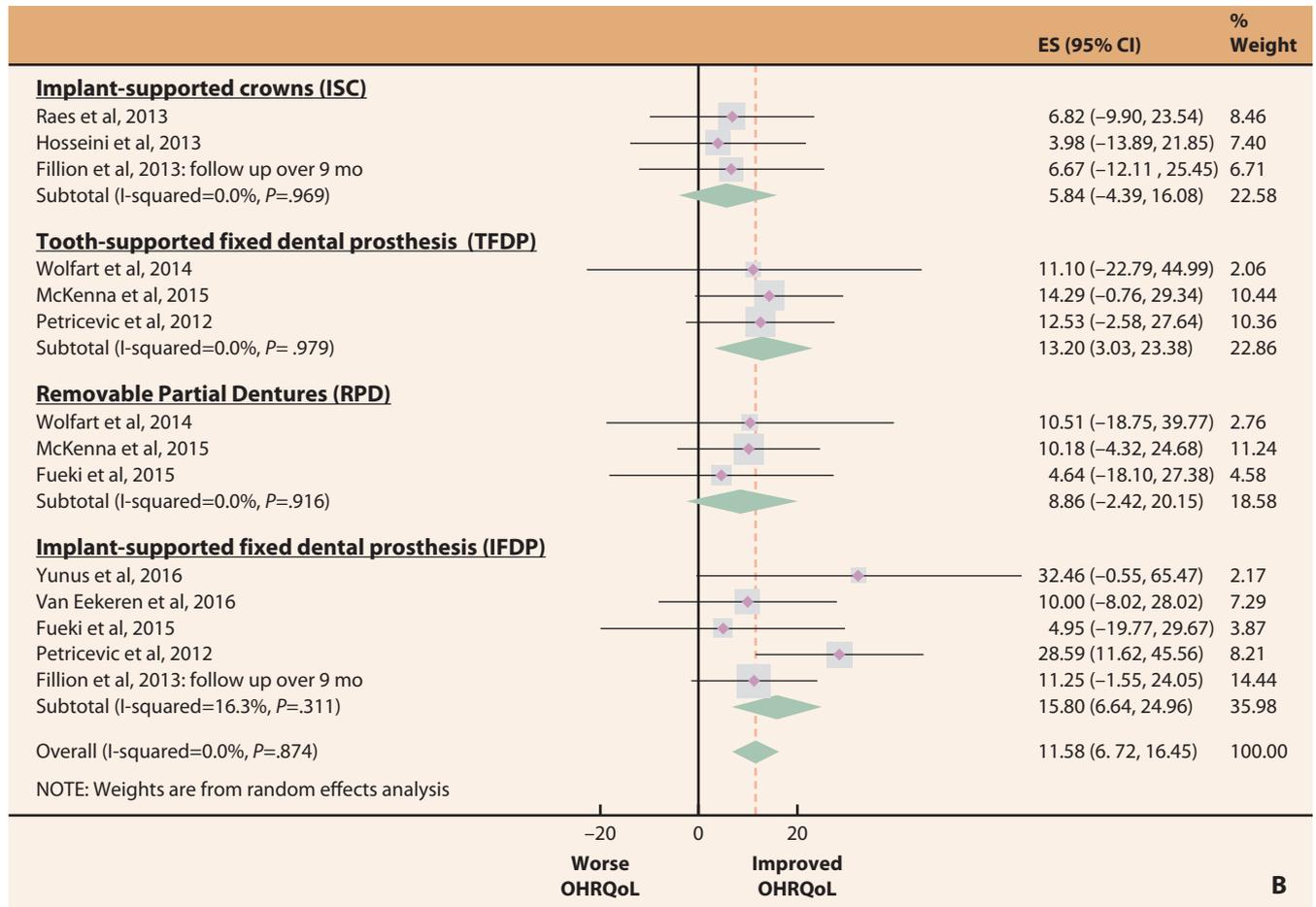


**Figure 2.** Effect of prosthodontic intervention on OHRQoL in partially dentate patients. A, Indirect meta-analysis at  $\leq 9$  month follow-up.

remaining 21 studies were clinical follow-up studies (level of evidence 2b).<sup>62</sup>

Previous well-conducted systematic reviews of the OHRQoL impacts of prosthetic replacement of missing teeth have found insufficient data to determine which treatment is better or worse than another, and they tended to focus on the management of the edentulous patient.<sup>28-30</sup> More recent reviews have investigated partially dentate patients, although the focus of these reviews has either been on the narrow area of the shortened dental arch versus RPDs or has restricted analysis only to implant-supported prostheses.<sup>26,27</sup> Hultin et al<sup>25</sup> reviewed this topic covering articles up to 2010 and demonstrated that oral rehabilitation to replace

missing teeth in edentulous and partially edentulous patients can improve OHRQoL. However, this review included only 5 studies and grouped together edentulous and partially dentate patients.<sup>25</sup> Thomason et al<sup>31</sup> provided a thorough qualitative review of the existing literature on the role of implants in the management of the edentulous patient, although they found sparse information on the impact on the OHRQoL in partially dentate patients. Recent review articles focused on the impact of dental implants on OHRQoL in edentulous or partially dentate patients<sup>27</sup> and on the comparison of OHRQoL between 2 modalities of tooth replacement in patients with a shortened dental arch.<sup>26</sup> Having broader inclusion criteria has allowed this review to focus on a



**Figure 2.** (continued). Effect of prosthodontic intervention on OHRQoL in partially dentate patients. B, Indirect meta-analysis at >9 month follow-up. OHRQoL, oral health-related quality of life.

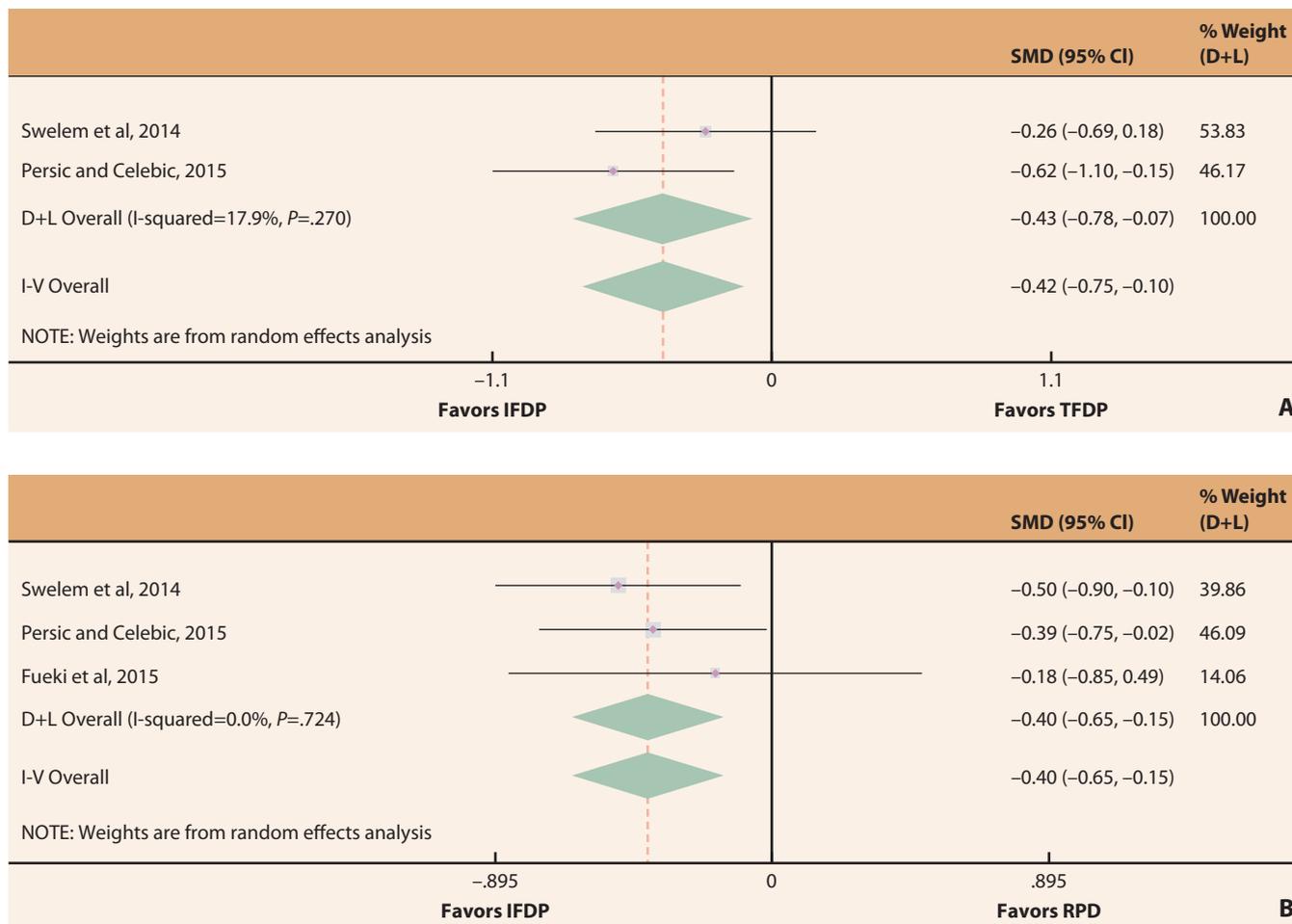
wider range of interventions to manage the partially dentate patient.

Although this approach allows for general conclusions to be drawn, it has its limitations. The review found that particular clinical confounders such as number of missing teeth and position of missing teeth were rarely controlled for or adequately described. These confounders in patients with partial edentulism can affect prosthodontic treatment. Therefore, a limitation of this review is a lack of RCTs controlling for significant confounders. Future studies should consider both the use of validated OHRQoL measures and appropriate research designs to reduce confounding by stratifying for tooth position, occlusal stability, and number of missing teeth. This approach will both reduce the risks of bias and allow meaningful conclusions to be drawn.<sup>21</sup>

Direct comparison between IFDPs and RPDs provides insight into the benefits of fixed implant support in edentulous spans where TFDPs may have been inappropriate. The impact of IRDPs on OHRQoL could not be similarly evaluated because of the small numbers of participants. However, data from both studies

investigating IRDPs and OHRQoL are encouraging, with a suggested 41-point improvement in OHIP-49 and 29-point improvement in OHIP-14 at 3 months' follow-up.<sup>44,46</sup> The findings that RPDs had no significant effect on OHRQoL at follow-up of >9 months was interesting. Whether this was due to issues concerning maintenance, distortions in fit over time, negative effects on periodontal health, or changes in outcome expectation is uncertain from this review. Previous studies have demonstrated that success with RPDs is greater where they replace anterior teeth and that effective maintenance is crucial to longer-term success.<sup>10</sup> Patient outcome expectations and response shift may account for some changes in OHRQoL outcome with RPDs. Clinicians should make patients aware that their expectations of treatment may change with time. While some may be happy just to restore a space initially for esthetic concerns, over time the importance of functional performance and ease of maintenance may become more of a priority.

The suggestion that an IFDP is better than a TFDP should be treated with caution. The number of teeth



**Figure 3.** Meta-analysis. A, Direct comparison of TFDP versus IFDP at ≤9 month follow-up. B, Direct comparison of RPD versus IFDP at ≤9 month follow-up. IFDP, implant-supported fixed dental prosthesis; RPD, removable partial denture; TFDP, tooth-supported fixed dental prosthesis.

replaced by TFDPs is limited by the availability of stable abutment teeth. With IFDPs, if more support is needed, another implant can be placed. To restore an edentulous space with TFDPs, however, one must work with what remains of the dentition. In patients where a TFDP is too high a risk to the remaining teeth, this option may be discounted. In such patients, an RPD or the use of an implant-supported prosthesis would be considered more appropriate. Although the cohort of patients treated with RPDs may be similar to that treated with IFDPs, the same cannot be said for patients with TFDPs.

Intervention with ISCs did not show statistically significant improvement at either ≤9 months' and >9 months' follow-up. Subgroup analysis was not possible for the effect of ISCs placed in anterior versus posterior areas, though the esthetic importance of tooth replacement may account for variation in impact on OHRQoL.<sup>6</sup>

In the current review, 22 studies used the OHIP questionnaire and 1 used GOHAI. The similarity in construct of these scales may explain the low heterogeneity in the analysis. Although indirect

meta-analysis is not a consensus because of possible bias, no statistically significant heterogeneity was found in any of the 8 indirect meta-analyses, with 6 demonstrating null variability in point estimates because of heterogeneity ( $I^2=0$ ); this suggests reliable findings.

## CONCLUSIONS

Based on the findings of this systematic review and meta-analysis, the following conclusions were drawn:

1. Both fixed tooth-supported and implant-supported dental prostheses demonstrably improved OHR-QoL in the short (≤9 months) and medium (>9 months) term.
2. The extent of improvement was approximately 15% to 16% for IFDPs, and 13% to 15% for TFDPs.
3. RPDs improved OHRQoL at a follow-up of less than 9 months by approximately 12% of the score range but showed no measurable improvement at a follow-up of more than 9 months.

4. When directly compared, IFDPs provided an approximately 40% improvement in OHRQoL compared with both RPDs and TFDPs.

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## Noteworthy Abstracts of the Current Literature

### Reusing titanium healing abutments: Comparison of two decontamination methods

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**Purpose.** To assess the amount of contamination remaining on used healing abutments after autoclaving and to compare the effectiveness of two additional decontamination methods.

**Material and methods.** After autoclaving, a total of 120 used healing abutments were divided equally into three groups: used healing abutments after autoclaving only (group 1); used healing abutments after autoclaving and air-flow polishing (Master Piezon, EMS) using erythritol powder (AIR-FLOW PLUS, EMS) (group 2); and used healing abutments after autoclaving and sodium hypochlorite (NaOCl; 25 g/L) treatment (group 3). Residual contaminants were stained using Phloxine B (400 g/mL), and healing abutments were photographed using a light microscope with digital capture system (Nikon SMZ800). The proportion of stained (i.e., contaminated) areas on each healing abutment was then measured using imaging software (ImageJ). The healing abutments were also examined using scanning electron microscopy (SEM).

**Results.** Mean proportion of surface area affected by residual contaminants on the body, top (screwdriver-engaging), and bottom (implant-abutment interface) surfaces for group 1 was 38.2% ±28.34%, 30.0% ±19.55%, and 18.7% ±17.87%, respectively; group 2 showed 3.5% ±4.90%, 5.3% ±3.74%, and 5.4% ±8.49%, respectively; and group 3 showed 0.3% ±0.16%, 1.9% ±2.14%, and 0.7% ±1.02%, respectively. Autoclaving alone was insufficient for successful decontamination, while additional decontamination procedures significantly reduced remaining contaminants. NaOCl was significantly more effective than air polishing. SEM analysis showed no detectable differences in the surface appearance of titanium healing abutments.

**Conclusions.** The results show that decontamination of used healing abutments is achievable, thus strengthening the feasibility of reusing healing abutments.

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**Supplementary Table 1.** Characteristics of included studies comparing conventional tooth- or mucosa-supported prostheses only

Study	Study design	Country	Setting	Participants	Follow-up period (months)	OHRQoL Instrument	Dental prosthetic treatment
Allen et al, 2009	PCS	Ireland	University Teaching Hospital	Baseline sample, N= 51 Follow-up sample, N = 44 Mean age, 23.6 (SD, 14.8)	1	OHIP-20	RPD
Anweigi et al, 2013	PCS	Ireland	University Teaching Hospital	Baseline sample, N=40 Follow-up sample, N=40 Median age, 20 (IQR, 18-22)	6	OHIP-49	TFDP
John et al, 2004	PCS	Germany	University Teaching Hospital & General Dental Practice	TFDP Baseline sample, N=42 Follow-up sample, not stated Mean age, 43.8 (SD, 12.5)	1 6-12	OHIP-49	TFDP (included single crowns) RPD (included telescopic crown-retained RPDs)
McKenna et al, 2015	RCT	Ireland	University Teaching Hospital & Geriatric Day Hospital	RPD Baseline sample, N=65 (>65yrs only) Follow-up sample 1-month, N=53 Follow-up sample 6-months, N=45 Follow-up sample 12-months, N=45	1 6 12	OHIP-14	TFDP RPD
Montero et al, 2013	PCS	Spain	University Teaching Hospital	TFDP Baseline sample, N=67 (>65yrs only) Follow-up sample 1-months, N=52 Follow-up sample 6-months, N=47 Follow-up sample 12-months, N=47	1	OHIP-14	RPDs (metal) TFDP
Wickert et al, 2014	PCS	Germany	University Teaching Hospital	RPD Baseline sample, N=75 Follow-up sample, N=75 Mean age, 60.7 (SD, 12.4)	1	OHIP-49	TFDP RPD
Wolfart et al, 2014	RCT	Multi-centre: Germany, Switzerland	University Teaching Hospitals	TFDP Baseline sample, N=81 Follow-up sample, N=81 Mean age, 49.6 (SD, 17.1)	1.5 12 60	OHIP-49	RPD TFDP
				RPD Baseline sample, N=79 Follow-up sample 6-weeks, N=76 Follow-up sample 12 months, N=73 Follow-up sample 5-years, N=68 Mean age, 59.7 (SD, 10.7)			
				TFDP Baseline sample, N=66 Follow-up sample 6-weeks, N=65 Follow-up sample 12 months, N=65 Follow-up sample 5-years, N=57 Mean age, 58.9 (SD, 10.6)			

PCS, Prospective clinical study. RCT, Randomised controlled trial. RPD, Removable partial denture. TFDP, Tooth-supported fixed dental prosthesis. OHIP, Oral Health Impact Profile.

**Supplementary Table 2.** Characteristics of included studies comparing implant-supported prostheses only

Study	Study design	Country	Setting	Participants	Recalls (months)	OHRQoL Instrument	Prosthetic treatment
Bramanti et al, 2013	PCS	Italy	University Teaching Hospital	Baseline sample, N=50 Follow-up sample, N=50 Mean age, 51.2 (SD: 12.6)	24	OHIP-14	IFDP ISC
Fillion et al, 2013	PCS	France	Private Practice	ISC baseline sample, N=77 ISC follow-up sample, N=77 IFDP baseline sample, N= 75 IFDP follow-up sample, N=75 Mean age 52 (SD, 9.9) (Complete cohort)	A. 6 B. 6-9 C. >9	GOHAI	IFPD ISC
Goshima et al, 2010	PCS	Denmark	University Teaching Hospital	Baseline sample, N=18 Follow-up, N=18 Mean age, 32 (SD, 10)	1	OHIP-49	ISC
Hosseini et al, 2013	PCS	Denmark	University Teaching Hospital	Baseline sample, N=59 Follow-up sample, N=59 Mean age, 27.9 (SD, 9.3)	36	OHIP-49	ISC
Nickenig et al, 2008	PCS	Germany	Armed Forces Dental Clinic	Baseline, N=219 Follow-up, N=219 Mean age, 44.7 (range, 19.2-67.6)	1-2	OHIP-21	ISC IFDP
Persic et al, 2014	PCS	Croatia	University Teaching Hospital	Baseline, N=23 Follow-up, N=23 Mean age, 66, (range 54-78)	3	OHIP-14	IFDP
Ponsi et al, 2011	PCS	Finland	Private Practice	Baseline sample, N=90 Follow-up sample, N=80 Mean age, 52 (range, 24-75)	3	OHIP-14	ISC
Raes et al, 2013	PCS	Belgium	University Teaching Hospital	Immediate loading Baseline sample, N=16 Follow-up sample, N=16 Mean age, 45 (SD, 14) Delayed loading Baseline sample, N=23 Follow-up sample, N=23 Mean age, 40 (SD, 19) Grafted sites Baseline sample, N=9 Follow-up sample, N=9 Mean age, 35 (SD, 15)	6 12	OHIP-14	ISC
Van Eekeren et al, 2016	PCS	Netherlands	University Teaching Hospital	Baseline sample, N=35 Follow-up sample, N=34 Mean age, 61 (Range, 36-85)	12	OHIP-14	IFDP
Yu et al, 2013	PCS	China	Military General Hospital	Baseline sample, N=263 Follow-up sample, N=238 Mean age, 41.5 (SD, 9.5)	6	OHIP-14	ISC and IFDP combined. Anterior teeth only
Yunus et al, 2015	PCS	Malaysia	University Teaching Hospital	Baseline sample, N=20 Follow-up, not stated Mean age, 47.0 (SD, 12.9)	3 12	OHIP-14	IFDP

PCS, Prospective clinical study. ISC, Implant-supported crown. IFDP, Implant-supported fixed dental prosthesis. OHIP, Oral Health Impact Profile. GOHAI, Global Oral Health Assessment Index.

**Supplementary Table 3.** Characteristics of included studies comparing conventional and implant-supported prostheses

Study	Study design	Country	Setting	Participants	Recalls (months)	OHRQoL Instrument	Prosthetic treatment
Fueki et al, 2015	PCS	Japan	University Teaching Hospital	RPD baseline sample, N=69 RPD follow-up samples: 3-months, N=52 6-months, N=40 12-months, N=33 RPD mean age, 63.9 (8.5) IFDP baseline sample, N=30 IFDP follow-up samples: 3-months, N=12 6-months, N=11 12-months, N=13 IFDP mean age, 56.1 (10.2)	3 6 12	OHIP-49	RPD IFDP
Gates et al, 2014	CCCT	USA	University Teaching Hospital	Baseline sample, N=17 RPD follow-up sample, N=17 IRDP follow-up sample, N=17 Mean age: 61.5, (SD not supplied)	3	OHIP-49	RPD IRDP
Persic & Celebic 2015	PCS	Croatia	University Teaching Hospital	TFDP baseline, N=25 TFDP follow-up: not stated TFDP mean age, 52.8 (SD, 16.8) IRDP baseline, N=15 IRDP follow-up: not stated IRDP mean age, 65.4 (SD, 8.2) IFDP baseline, N=59 IFDP follow-up: not stated IFDP mean age, 56.1 (SD, 11.0)	3	OHIP-14	RPD TFDP IRDP IFDP
Petrecievic et al, 2012	PCS	Croatia	Not stated	IFDP baseline sample, N=64 IFDP follow-up: not stated IFDP mean age, 46.5 (SD, 11.2) TFDP baseline sample, N=38 TFDP follow-up: not stated TFDP mean age, 57.6 (SD, 14.4)	36	OHIP-49	IFDP TFDP
Swelem et al, 2014	PCS	Russia	University Teaching Hospital	TFDP Baseline sample, N=32 Follow-up, N=32 Mean age, 44.4 (SD, 6.5) RPD Baseline sample, N=45 Follow-up, N=45 Mean age, 44.4 (SD, 6.6) IFDP Baseline sample, N=57 Follow-up, N=57 Mean age, 35.4 (SD, 5.9)	1.5 6	OHIP-14	TFDP RPD IFDP

PCS, Prospective Clinical Study. CCCT, Crossover Controlled Clinical Trial. ISC, Implant-supported crown. IFDP, Implant-supported fixed dental prosthesis. IRDP, Implant-supported removable dental prosthesis. RPD, Removable partial denture. TFDP, Tooth-supported fixed dental prosthesis. OHIP, Oral Health Impact Profile.