Does the Type of Implant Prosthesis Affect Outcomes in the Partially Edentulous Patient?

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Purpose: *Implant restoration of the partially edentulous patient has become highly predictable. The scientific information on the specifics of restorative designs and their influence on the long-term outcome is sparse. The main objective of this systematic review was to determine what scientific evidence exists regarding the influence of prosthodontic design features on the long-term outcomes of implant therapy (implant success and survival, prosthesis success and survival) in the partially edentulous patient.* ***Materials and Methods:*** *Four questions of primary interest regarding implant prosthodontic design options were selected by the 2 reviewers: abutment type, retention type (cemented, screw-retained), support type (implant support alone versus combined implant-tooth support), and the type of restorative material. Inclusion and exclusion criteria were formulated and applied to a total of 1,720 titles. The list of titles was primarily based on a PubMed-type search provided by the State of the Science of Implant Dentistry workshop leadership. It was supplemented by a hand search of relevant journals at the Countway Library of the Harvard Medical School and of a personal collection of relevant publications of the 2 reviewers. Information on the survival and success of implants and prostheses as defined by the respective authors was retrieved from the included articles, entered into data extraction tables, and submitted for statistical analysis.* ***Results:*** *Seventy-four articles were selected for data extraction and analysis after critical appraisal and application of the exclusion criteria. The kappa value for reviewer agreement was 100% between the 2 reviewers. The majority of studies were in the "average" range and were published between 1995 and 2003. Only 2 "best" trials, ie, randomized controlled clinical trials, were identified. For the method of retention (screw-retained versus cemented), no differences were found in implant success or survival rates between screw-retained and cemented restorations. Prosthesis success rates showed greater variations between cemented and screw-retained restorations at the various evaluation times; however, the differences never reached statistical significance. The prosthesis success rate at the last reported examination (> 72 mo) was 93.2% for cemented and 83.4% for screw-retained restorations (*P > .05*). Regarding the type of support, implant success rates at the last reported evaluation were 97.1% for implant-supported fixed partial dentures (FPDs), 94.3% for single-implant restorations, and 89.2% for implant-tooth–supported FPDs. None of the differences reached statistical significance. Implant survival at the last examination (> 72 mo) was highest for implant-supported FPDs (97.7%), followed by single-implant restorations (95.6%) and implant-tooth–supported FPDs (91.1%). Differences were not statistically significant. Prosthesis success at the last examination (> 72 mo) resulted in overall lower percentage rates than implant success or survival (89.7% for implant-supported FPDs, 87.5% for implant-tooth–supported FPDs, and 85.4% for single-implant restorations; differences not statistically significant). Insufficient extractable information was available regarding the influence of abutment type or restorative material.* ***Conclusion:*** *The scientific evidence obtained from this review is insufficient to establish unequivocal clinical guidelines for the design of implant-supported fixed prostheses in the partially edentulous patient.* Int J Oral Maxillofac Implants 2007;22(suppl):140–172

Key words: *dental implants, fixed partial dentures, fixed prostheses, implant restorations, implant success, implant survival, partial edentulism, prosthesis success, prosthesis survival, single crowns*

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The effectiveness of dental implant-supported prostheses in the replacement of missing teeth in fully and partially edentulous patients has been documented. Whereas earlier reports on the predictability of such treatment included primarily full-arch prostheses supported by dental implants,[1–3] more recent studies and reviews have focused on implant-supported restorations in the partially edentulous arch, including single crowns, and fixed partial dentures supported by implants alone or by a combination of teeth and implants.[4–9] Most studies on dental implants, particularly those involving partial edentulism and single-tooth replacement, are prospective or retrospective cohort studies. These are characterized by the fact that cohorts are followed over a certain time period; however, the follow-up time is not the same for all patients. To overcome this deficiency, life table analyses and Kaplan-Meier statistics should be applied to accurately measure implant success or survival rates after certain follow-up periods. This has, however, not been consistently done in the literature. The study design of choice is the randomized controlled clinical trial (RCT). However, publications based on the RCT methodology are sparse and not able to answer many of the open questions related to dental implant therapy. The concept of a systematic review has, therefore, justifiably gained substantial ground in recent years as a foundation for evidence-based therapy.

When implant therapy is considered for tooth replacement in the partially edentulous indication, it must be recognized that forces with different characteristics most likely affect implants and components as well as the surrounding bone compared to splinted full-arch fixed prostheses anchored by multiple implants. Also, depending on the number of missing teeth and other local factors, various design alternatives are available for single crowns or fixed partial dentures, which potentially could influence the outcome in terms of implant survival/success or prosthesis survival/success. Variables include

- Abutment type
- Retention type (cemented or screw-retained)
- Support type (implant-tooth combined support vs implant support alone; single vs multiple implant support)
- Restorative material

The scientific information in the current literature regarding these restorative concerns and their influence on long-term outcomes with implant-assisted prostheses is sparse. RCTs are particularly scarce. Thus, the main objective of this systematic review was to address the general question: "Does the type of implant prosthesis affect outcomes in the partially edentulous arch?" For this particular review, the focus was on the long-term survival and success of implants and their supported crowns and fixed partial dentures in partially edentulous patients over the longest possible observation period.

MATERIALS AND METHODS

The central PICO question (problem, intervention, comparison, and outcome) for this systematic review was to investigate whether the type of implant prosthesis affects implant success and survival and/or prosthesis success and survival in the partially edentulous arch. The reviewers/authors of this section selected 4 restorative treatment aspects to more specifically address the main PICO question:

1. Does the method of retention (screw-retained versus cemented) influence the outcome?
2. Does the method of support influence the outcome?
   (a) Implant- versus implant-tooth–supported fixed partial dentures (FPDs)
   (b) Single-implant restorations versus splinted restorations on multiple implants
3. Does the type of abutment used for retaining a restoration influence the outcome?
4. Does the restorative material influence the outcome?

Search Strategy

Titles and abstracts of a total of 1,720 publications were screened by 2 independent reviewers (CS and HPW) for possible inclusion and exclusion for this systematic review. The list of titles was based on a PubMed type search conducted on August 31, 2004, by the leadership of the Association of Osseointegration (AO) State of the Science of Implant Dentistry project. It was supplemented by a PubMed search and hand search of relevant journals at the Countway Library of the Harvard Medical School, Boston, MA and of a personal collection of relevant publications by the 2 reviewers of this section, with a publication cutoff date of March 31, 2005.* Inclusion and exclusion criteria were established by the 2 reviewers. Inclusion/exclusion disagreements in the first screening were resolved by discussion. A second screening was performed by the same 2 reviewers, in which articles in non–peer-reviewed journals, articles in journals which were difficult to get, and articles in which outdated implant systems were used were excluded. The full texts of the articles remaining on the list were retrieved. The final screening of the

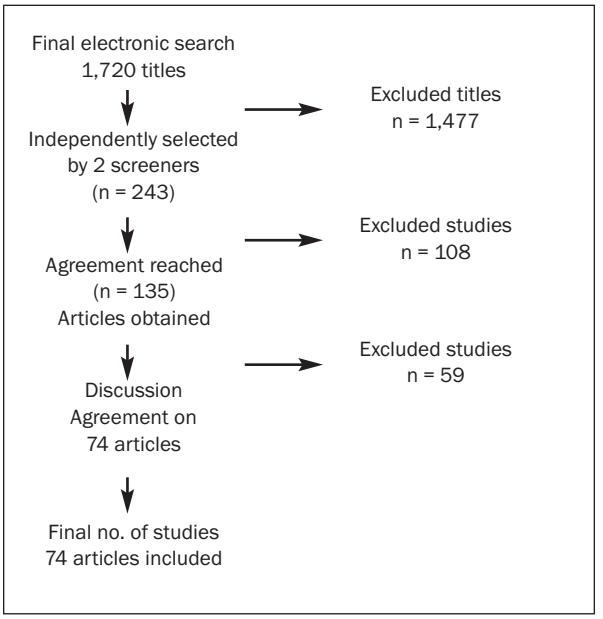


Fig 1 Screening process used to identify eligible studies.

obtained full-text articles was completed by 4 reviewers (FL and FT in addition to CS and HPW). In this round, all review articles and publications, which did not report any treatments or treatment outcomes related to the specific questions, were removed from the list. Disagreements were again discussed until agreement for inclusion or exclusion was reached. Subsequently, data were extracted from included publications and entered in the data extraction forms provided by the AO central office. The process of study selection and data extraction is schematically illustrated in Fig 1.

Inclusion Criteria

Prospective and retrospective studies of various designs and levels of evidence were included in this systematic review, provided that

- The study presented outcomes on implant restorations in partially edentulous indications.
- The study was reported in English and in the peer-reviewed dental literature.
- The study provided information on implant and/or implant prosthesis survival and/or success data.
- The study included at least 20 patients with partially edentulous indications identified.
- Details on characteristics of restorations were reported in regards to 1 or more of the questions being explored.
- The patient follow-up in the study was at least 1 year.
- The outcome (implant failure or complication) was reported in the study for the respective restorations.

Exclusion Criteria

In vitro studies, case reports, case series with ≤ 20 patients, studies performed prior to 1990, and studies with 1 year follow-up were excluded. Studies were also excluded if they evaluated an implant system no longer commercially available (IMZ, Core-Vent) or if they had been published in a non–peer-reviewed journal or manufacturer-affiliated journal. Systematic reviews were also excluded from the data extraction and analysis process but were used for comparison and discussion.

Data Extraction

Information on the survival and success of the implants and prostheses was retrieved from the selected articles. Implant survival and/or success and prosthesis success data as defined by the authors of the respective studies were entered in the provided data extraction forms and submitted for analysis. Details on data extraction, data management, and analyses are provided in a separate article by Proskin and associates elsewhere in this issue.

RESULTS

Of the 1,720 titles and abstracts selected, 243 articles survived the initial screening. After the second screening, 135 articles remained for retrieval of full-text copies. Of those, 74 articles were selected for data extraction and analysis after critical appraisal and application of the exclusion criteria stated above. The kappa test for reviewer agreement was 100% between the 2 reviewers. Table 1 contains detailed information on these 74 articles.[10–82] Details on the 59 articles excluded at this time, including the reasons for exclusion, are listed in the Web edition of this article. Table 2 presents a summary overview of the reasons for exclusion. Characteristics and quality of the included articles are presented in Table 3 and Fig 2, categorized from "best" to "unknown." Only 2 "best" quality trials (ie, RCTs) were identified. The vast majority of the studies were in the "average"' range. The distribution of the included articles in terms of year of publication is shown in Fig 3. A majority of the articles were published between 1995 and 2003.

*One study coauthored by one of the reviewers (HPW) was included because it was accepted for publication prior to the cutoff date.

Table 1 Articles Selected for Data Extraction and Analysis

Article no.	Authors	Article title	Source	Affiliation	Study aim(s) as described by author	Study design	Study quality	No. of patients	No. of implants	Treatment	Observation period (mo)
1	Bahat O, Handelsman M.	Use of wide implants and double implants in the posterior jaw: A clinical report.	Int J Oral Maxillofac Implants 1996;11:379–386.	Private practice	To report a 3-year multicenter study on 63 maxillary and 10 mandibular fixed prostheses in 71 patients.	Prospective study w/concurrent control	Better	216	133	FPD to replace single tooth	78
2	Balshi TJ, Ekfeldt A, Stenberg T, Vrielinck L.	Three-year evaluation of Brånemark implants connected to angulated abutments.	Int J Oral Maxillofac Implants 1997;12:52–58.	Center for Medical and Dental Health, Halmstad, Sweden	To review the outcome of 59 consecutive wide implants in 45 patients and doubled implants at 216 sites in 171 consecutive patients.	Prospective case study	Average	71	425	Type of abutments (angulated and standard)	36
3	Balshi TJ, Hernandez RE, Pryszlak MC, Rangert B.	A comparative study of one implant versus two replacing a single molar.	Int J Oral Maxillofac Implants 1996;11:372–378.	Private practice	To conduct a comparative study between 1 and 2 Brånemark implants replacing a single molar.	Prospective case study	Average	47	72	FPD to replace single tooth	36
4	Becker W, Becker BE.	Replacement of maxillary and mandibular molars with single endosseous implant restorations: A retrospective study.	J Prosthet Dent 1995;74:51–55.	University of Southern California, Los Angeles, CA	This retrospective report presents findings on 22 patients with 24 implants replacing single molars with implant-supported restorations.	Retrospective case study	Fair	22	24	Single-tooth replacement (screw retention)	24
5	Behneke A, Behneke N, d'Hoedt B.	The longitudinal clinical effectiveness of ITI solid-screw implants in partially edentulous patients: A 5-year follow-up report.	Int J Oral Maxillofac Implants 2000;15:633–645.	University of Mainz, Germany	To report follow-up for at least 5 years in a prospective study that focused on implant success and longitudinal reactions of the peri-implant hard and soft tissues.	Prospective case study	Average	55	114	FPDs	60
6	Behr M, Lang R, Leibrock A, Rosentritt M, Handel G.	Complication rate with prosthodontic reconstructions on ITI and IMZ dental implants.	Clin Oral Implants Res 1998;9:51–58.	University of Regensburg, Germany	To compare the complication rate of 2 implant systems with different prosthodontic concepts: rigid conical or resilient support of the suprastructure.	Prospective case study	Average	66	138	FPDs	96
7	Block MS, Gardiner D, Kent JN, Misiek DJ, Finger IM, Guerra L.	Hydroxyapatite-coated cylindrical implants in the posterior mandible: 10-year observations.	Int J Oral Maxillofac Implants 1996;11:626–633.	Louisiana University, New Orleans, LA	To report prospective follow-up on a significant sample of patients treated with HA-coated cylinders	Prospective case study	Average	174	443	Tooth and implant connected (rigid or nonrigid)	60
8	Block MS, Lirette D, Gardiner D, et al.	Prospective evaluation of implants connected to teeth.	Int J Oral Maxillofac Implants 2002;17:473–487.	Louisiana University, New Orleans, LA	To examine the effect on teeth and implants when rigidly or nonrigidly connected in a cross-arch model.	Prospective case study	Average	30	114	Implant support (rigid)	60
9	Cooper L, Felton DA, Kugelberg CF, et al.	A multicenter 12-month evaluation of single-tooth implants restored 3 weeks after 1-stage surgery.	Int J Oral Maxillofac Implants 2001;16:182–192.	University of North Carolina, Chapel Hill, NC	To evaluate the clinical survival after rapid loading of unsplinted endosseous root-form implants replacing 1 or 2 teeth in the anterior maxilla.	Prospective case study	Average	52	53	FPD to replace single tooth	36
10	Cordioli G, Castagna S, Consolati E.	Single-tooth implant rehabilitation: A restrospective study of 67 implants.	Int J Prosthodont 1994;7:525–531.	Dental School, University of Padova, Italy	To report the clinical results of 47 patients treated for single-tooth replacement.	Retrospective case study	Fair	47	67	FPD to replace single tooth	60

Table 1 continued Articles Selected for Data Extraction and Analysis

Article no.	Authors	Article title	Source	Affiliation	Study aim(s) as described by author	Study design	Study quality	No. of patients	No. of implants	Treatment	Observation period (mo)
11	Deporter DA, Todescan R, Watson PA, Pharoah M, Levy D, Nardini K.	Use of the Endopore dental implant to restore single teeth in the maxilla: Protocol and early results.	Int J Oral Maxillofac Implants 1998;13:263–272.	Faculty of Dentistry, University of Toronto, Ontario, Canada	To outline the experimental, surgical, and prosthodontic protocols for a prospective clinical trial using the Endopore dental implant to replace a single maxillary tooth.	Prospective case study	Average	20	20	FPD to replace single tooth	24
12	Drago CJ.	A clinical study of the efficacy of gold-tite square abutment screws in cement-retained implant restorations.	Int J Oral Maxillofac Implants 2003;18:273–278.	Gundersen Lutheran Medical Center, La Crosse, WI	To record the effectiveness of Gold-Tite square abutment screws, tightened to 35 Ncm with a torque indicator, in maintaining a clinically stable implant/abutment connection.	Prospective case study	Average	73	110	Cement-retained	12
13	Duncan JP, Nazarova E, Vogiatzi T, Taylor TD.	Prosthodontic complications in a prospective clinical trial of single-stage implants at 36 months.	Int J Oral Maxillofac Implants 2003;18:561–565.	University of Connecticut School of Dental Medicine, Farmington, CT	To report on prosthodontic complications in a trial of 51 patients with prostheses supported by single-stage implants over a period of 36 months.	Prospective case study	Average	51	186	Screw/cement-retained	36
14	Ekfeldt A, Carlsson GE, Borjesson G.	Clinical evaluation of single-tooth restorations supported by osseointegrated implants: A retrospective study.	Int J Oral Maxillofac Implants 1994;9:179–183.	County Hospital, Halmstad, Sweden	To present results from 93 implants for single-tooth replacements placed in 77 patients from 1987 to 1990.	Retrospective case study	Fair	77	94	FPD to replace single tooth	0
15	Naert I, Koutsikakis G, Duyck J, Quirynen M, Jacobs R, van Steenberghe D.	Biologic outcome of single-implant restorations as tooth replacements: A long-term follow-up study.	Clin Implant Dent Relat Res 2000;2:209–218.	Catholic University of Leuven, Belgium	To report on prosthodontic complications in a trial of 51 patients with prostheses supported by single-stage implants over a period of 36 months.	Prospective case study	Average	219	270	FPD to replace single tooth	54
16	Naert I, Quirynen M, van Steenberghe D, Darius P.	A six-year prosthodontic study of 509 consecutively inserted implants for the treatment of partial edentulism.	J Prosthet Dent 1992;67:236–245.	Catholic University of Leuven, Belgium	To evaluate the results of placement of a series of consecutive Brånemark implants for up to 6 years to treat partially edentulous patients from a prosthetic point of view.	Prospective case study	Average	146	509	FPD	72
17	Naert IE, Duyck JA, Hosny MM, Quirynen M, van Steenberghe D.	Freestanding and tooth-implant connected prostheses in the treatment of partially edentulous patients. Part I: An up to 15 years clinical evaluation.	Clin Oral Implants Res 2001;12: 237–244.	Catholic University of Leuven, Belgium	To report a follow-up to 15 years of FPD supported by both tooth/implant-connected prostheses as well as free-standing FPDs.	Prospective case study	Average	123	339	Tooth/implant- or implant-supported FPDs	180
18	Olsson M, Gunne J, Astrand P, Borg K.	Bridges supported by free-standing implants versus bridges supported by tooth and implant : A five-year prospective study.	Clin Oral Implants Res 1995;6: 114–121.	Department of Oral and Maxillofacial Surgery, Karnsjukhuset, Skovde, Sweden	To present the 5-year results of the study of whether it is possible to combine implants and natural teeth via fixed bridges.	Prospective case study	Average	23	89	Tooth/implant- or implant-supported FPDs	60
19	Parein AM, Eckert SE, Wollan PC, Keller EE.	Implant reconstruction in the posterior mandible: A long-term retrospective study.	J Prosthet Dent 1997;78:34–42.	Mayo Clinic, Rochester, MN	To evaluate the long-term outcome, determinants of outcome, and the type and prevalence of prosthetic complications in a series of patients treated consecutively with Brånemark implants in the partially edentulous posterior mandible.	Retrospective case study	Fair	152	392	FPD to replace single tooth	120

Table 1 continued Articles Selected for Data Extraction and Analysis

Article no.	Authors	Article title	Source	Affiliation	Study aim(s) as described by author	Study design	Study quality	No. of patients	No. of implants	Treatment	Observation period (mo)
20	Polizzi G, Fabbro S, Furri M, Herrmann I, Squarzoni S.	Clinical application of narrow Brånemark system implants for single-tooth restorations.	Int J Oral Maxillofac Implants 1999;14:496–503.	Brånemark Study Center, Verona, Italy	To determine the predictibility of using implants with a smaller diameter for single-tooth restorations in situations when the mesiodistal dimension causes an unfavorable condition.	Prospective case study	Average	21	30	FPD to replace single tooth	96
21	Polizzi G, Rangert B, Lekholm U, Gualini F, Lindstrom H.	Brånemark system wide platform implants for single molar replacement: Clinical evaluation of prospective and retrospective materials.	Clin Implant Dent Relat Res 2000;2:61–69.	Nobel Biocare, Göteborg, Sweden	The aim of the study was to present the outcomes for wide diameter implant treatment when being used in posterior areas of the jaws.	Prospective case study	Average	51	58	FPD to replace single tooth	36
22	Preiskel HW, Tsolka P.	The DIA anatomic abutment system and telescopic prostheses: A clinical report.	Int J Oral Maxillofac Implants 1997;12:628–633.	United Medical School, Guy's Hospitals, London, United Kingdom	To investigate the effectiveness of 208 abutments designed and produced by Dental Imaging Associates and the 73 prostheses supported by them over a 2-year period.	Retrospective case study	Fair	41	238	Type of abutments—(Dental Imaging Associates (DIA)	84
23	Pylant T, Triplett RG, Key MC, Brunsvold MA.	A retrospective evaluation of endosseus titanium implants in the partially edentulous patient.	Int J Oral Maxillofac Implants 1992;7:195–202.	University of Texas Health Science Center at San Antonio, TX	To further document success rates of endosseous implants ad modum Brånemark in partially edentulous patients.	Retrospective case study	Fair	34	102	FPD	48
24	Romeo E, Lops D, Margutti E, Ghisolfi M, Chiapasco M, Vogel G.	Implant-supported fixed cantilever prostheses in partially edentulous arches. A seven-year prospective study.	Clin Oral Implants Res 2003;14: 303–311.	School of Dentistry, University of Milan, Italy	To evaluate the medium- to long-term prognosis of implant-supported cantilever fixed prostheses, and to establish to what degree this is influenced by factors such as length, type of cantilever (mesial or distal), and opposite dentition versus cantilever prostheses.	Prospective case study	Average	38	100	FPD	84
25	Romeo E, Lops D, Margutti E, Ghisolfi M, Chiapasco M, Vogel G.	Long-term survival and success of oral implants in the treatment of full and partial arches: A 7-year prospective study with the ITI dental implant system.	Int J Oral Maxillofac Implants 2004;19:247–259.	School of Dentistry, University of Milan, Italy	This study evaluated the long-term survival and success of different implant-supported prostheses supported by ITI implants.	Prospective case study	Average	250	759	FPD to replace single-tooth gaps and partial edentulous areas	84
26	Schmitt A, Zarb GA.	The longitudinal clinical effectiveness of osseointegrated dental implants for single-tooth replacement.	Int J Prosthodont 1993;6:197–202.	Faculty of Dentistry, University of Toronto, Canada	To report the efficacy of single-implant support for crowns to replace missing single teeth.	Retrospective case study	Fair	32	40	Single-tooth replacement (screw retention)	84
27	Weber HP, Kim DM, Ng MW, Hwang JW, Fiorellini JP.	Peri-implant soft-tissue health surrounding cement- and screw-retained implant crowns: A multicenter, 3-year prospective study.	Clin Oral Implants Res 2006;17: 375–379.	Harvard School of Dental Medicine, Boston, MA	To present findings in vivo, from a 3-year prospective study on peri-implant soft tissue conditions and esthetic fulfillment of cement and screw-retained implant crowns.	Prospective case study	Average	80	152	Cement-screw retained	36

Table 1 continued Articles Selected for Data Extraction and Analysis

Article no.	Authors	Article title	Source	Affiliation	Study aim(s) as described by author	Study design	Study quality	No. of patients	No. of implants	Treatment	Observation period (mo)
28	Attard NJ, Zarb GA.	Implant prosthodontic management of partially edentulous patients missing posterior teeth: The Toronto experience.	J Prosthet Dent 2003;89:352–359.	Faculty of Dentistry, University of Toronto, Ontario, Canada	This study reports on implant and prosthesis outcomes in a group of partially edentulous patients treated with Branemark implants in the posterior zones.	Prospective case study	Average	130	432	Posterior FPD	180
29	Andersson B, Glauser R, Maglione M, Taylor A.	Ceramic implant abutments for short-span FPDs: A prospective 5-year multicenter study.	Int J Prosthodont 2003;16:640–646.	Sahlgrenska univesitetssjukhuset, Molndal, Sweden.	To evaluate the long-term clinical function of CerAdapt ceramic abutments compared to titanium abutments on Brånemark implants supporting short-span fixed partial dentures (FPDs).	RCT	Best	30	103	Type of abutments	60
30	Andersson B, Odman P, Lindvall AM, Brånemark P-I.	Cemented single crowns on osseointegrated implant after 5 years: Results from a prospective study on CeraOne.	Int J Prosthodont 1998;11:212–218.	Sahlgrenska universitetssjukhuset, Molndal, Sweden.	To report on implant and prosthesis outcomes in a group of partially edentulous patients treated with Brånemark implants in the posterior zones.	Prospective case study	Average	57	65	Type of abutments	60
31	Andersson B, Taylor A, Lang BR, et al.	Alumina ceramic implant abutments used for single-tooth replacement: A prospective 1- to 3-year multicenter study.	Int J Prosthodont 2001;14:432–438.	Specialist Dental Service, Molndal, Sweden	The aim of the study was to compare results after 1 and 3 years when single crowns supported by CerAdapt (test) ceramic abutments or CeraOne (control) titanium abutments were loaded.	Prospective study w/concurrent control	Better	60	89	Type of abutments/ single-tooth replacement	36
32	Bianco J, Di Raimondo R, Luongo G, et al.	Osseointegrated implant for single-tooth replacement : A retrospective multicenter study on routine use in private practice.	Clin Implant Dent Relat Res 2000;2:152–158.	Nobel Biocare, Göteborg, Sweden	To evaluate implant survival and prosthesis stability of Brånemark implants (titanium screws) when used routinely for single-tooth replacement in all regions.	Retrospective case study	Fair	214	252	Single-tooth replacement	96
33	Astrand P, Borg K, Gunne J, Olsson M.	Combination of natural teeth and osseointegrated implants as prosthesis abutments: A 2-year longitudinal study.	Int J Oral Maxillofac Implants 1991;6:305–312.	University Hospital, Linkoping, Sweden	To perform intraindividual comparisons between prostheses supported by implants only and prostheses supported by a combination of implants and natural teeth with regard to fixture and restoration stability.	Prospective study w/concurrent control	Better	23	69	Tooth-implant/ implant-implant connected	24
34	Avivi-Arber L, Zarb GA.	Clinical effectiveness of implant supported single-tooth replacement: The Toronto study.	Int J Oral Maxillofac Implants 1996;11:311–321.	Maurice and Gabriela Goldschleger School of Dental Medicine, Tel Aviv University, Israel	To report preliminary treatment results of single-tooth implant-supported prostheses using accepted methods of osseointegration and published success criteria.	Prospective case study	Average	41	49	Single-tooth replacement	69
35	Bragger U, Aeschlimann S, Burgin W, Hammerle CH, Lang NP.	Biological and technical complications and failures with fixed partial dentures (FPD) on implants and teeth after four to five years of function.	Clin Oral Implants Res 2001;12: 26–34.	University of Berne, Switzerland	To compare the frequency of biological and technical complications with fixed partial dentures (FPDs) on implants and teeth and as mixed tooth-implant supported FPDs over 4 to 5 years of function.	Prospective study w/ concurrent control	Better	88	103	Tooth-implant/ implant-implant connected	48

Table 1 continued Articles Selected for Data Extraction and Analysis

Article no.	Authors	Article title	Source	Affiliation	Study aim(s) as described by author	Study design	Study quality	No. of patients	No. of implants	Treatment	Observation period (mo)
36	Chapman RJ, Grippo W.	The locking taper attachment for implant abutments: Use and reliability.	Implant Dent 1996;5:257–261.	Tufts University School of Dental Medicine, Boston, MA	To evaluate data from 3 dental practices to determine the reliability of the locking taper attachment.	Retrospective case study	Fair	N/A	1,253	Type of abutment	48
37	Engquist B, Nilson H, Astrand P.	Single tooth replacement by osseointegrated Brånemark implants.	Clin Oral Implants Res 1995;6: 238–245.	University Hospital, Linkoping, Sweden	To evaluate the outcome of single-tooth restorations on Branemark implants performed during the period 1984–1989.	Retrospective case study	Fair	58	82	Single-tooth replacement	36
38	Fugazzotto PA, Vlassis J, Butler B.	ITI implant use in private practice: Clinical results with 5,526 implants followed-up to 72+ months in function.	Int J Oral Maxillofac Implants 2004;19:408–412.	Private practice	To evaluate the success and failure rates over time of ITI implants placed in 3 private practices and used in a variety of clinical situations.	Retrospective case study	Fair	N/A	3,672	FPD	72
39	Glauser R, Sailer I, Wohlwend A, Arnold W, Studer S, Schibli M, Scharer P.	Experimental zirconia abutments for implant-supported single-tooth restoration in esthetically demanding regions: 4-year results of a prospective clinical study.	Int J Prosthodont 2004;17:285–290.	University of Zurich, Switzerland	To evaluate an experimental implant abutment made of densely sintered zirconia with respect to peri-implant hard and soft tissue reaction as well as fracture resistance over time.	Prospective case study	Average	27	54	Type of abutment	48
40	Gomez-Roman G, Schulte W, d'Hoedt B, Axman-Krcmar D.	The Frialit-2 implant system: Five year clinical experience in single-tooth and immediately post-extraction applications.	Int J Oral Maxillofac Implants 1997;12: 299–309.	University of Tubingen, Dental School, Germany	To access the relative success of single-tooth and immediate implants in comparison to other configurations.	Retrospective case study	Fair	376	696	Single-tooth replacement	60
41	Sethi A, Kaus T, Sochor P.	The use of angulated abutments in implant dentistry: Five-year clinical results of an ongoing prospective study.	Int J Oral Maxillofac Implants 2000;15: 801–810.	Medical School, University of Lille 2, Lille, France	To present preliminary results of the clinical long-term behavior of implants restored using a broad range of angulated abutments.	Prospective case study	Average	467	2,261	Angulated abutment	60
42	Sethi A, Kaus T, Sochor P, Axmann-Krcmar D, Chanavaz M.	Evolution of the concept of angulated abutments in implant dentistry: 14-year clinical data.	Implant Dent 2002;11:41–51.	Medical School, University of Lille 2, Cedex, France	To describe the evolution of the concept of selecting the abutment at first-stage surgery and present clinical data accumulated over 14 years on the use of this concept with angulated abutments.	Retrospective case study	Fair	N/A	3,101	Angulated abutment	120
43	Singer A, Serfaty V.	Cemented-retained implant supported fixed partial dentures: A 6-month to 3-year follow–up.	Int J Oral Maxillofac Implants 1996;11: 645–649.	Sourasky Medical Center, Tel Aviv, Israel	This study presents a follow-up of 92 implant-supported fixed partial dentures that have been cement retained for 6 months up to 3 years.	Prospetive case study	Average	70	225	Cemented restoration	36
44	Tangerud T, Gronningsaeter AG, Taylor A.	Fixed partial dentures supported by natural teeth and Brånemark system implants: A 3 year report.	Int J Oral Maxillofac Implants 2002;17: 212–219.	Faculty of Dentistry, University of Bergen, Norway	To evaluate fixed partial dentures (FPDs) supported by a combination of natural teeth and implants in a variety of clinical situations.	Prospective case study	Average	30	85	Tooth/implant-supported	36

Table 1 continued Articles Selected for Data Extraction and Analysis

Article no.	Authors	Article title	Source	Affiliation	Study aim(s) as described by author	Study design	Study quality	No. of patients	No. of implants	Treatment	Observation period (mo)
45	Tawil G, Younan R.	Clinical evaluation of short implants followed for 12 to 92 months.	Int J Oral Maxillofac Implants 2003;18:894–901.	St Joseph University, Beirut, Lebanon	To evaluate the clinical outcome of 10-mm or shorter machined-surface implants when used exclusively in the treatment of various forms of edentulism.	Prospective case study	Average	111	256	Single-tooth replacement	92
46	van Steenberghe D, Lekholm U, Bolender C, et al.	Applicability of osseointegrated oral implants in the rehabilitation of partial edentulism: A prospective multicenter study on 558 fixtures.	Int J Oral Maxillofac Implants 1990;5:272–281.	Catholic University of Leuven, Belgium	To report an interim presentation of an observation time of 1 year after prosthesis placement.	Prospective case study	Average	159	558	FPD	60
47	Vermylen K, Collaert B, Linden U, Bjorn AL, De Bruyn H.	Patient satisfaction and quality of single tooth restorations.	Clin Oral Implants Res 2003;14: 119–124.	Private practice	To describe patient opinion regarding treatment outcome and prosthetic quality and prosthetic complication encountered.	Retrospective case study	Fair	48	52	Single-tooth replacement	89
48	Vigolo P, Givani A, Majzoub Z, Cordioli G.	Cemented versus screw-retained implant-supported single-tooth crowns: A 4-year prospective clinical study.	Int J Oral Maxillofac Implants 2004;19:260–265.	University of Padova, Institute of Clinical Dentistry, Padova, Italy	To compare cemented and screw-retained implant-supported single-tooth crowns followed for 4 years following prosthetic rehabilitation with respect to peri-implant marginal bone levels, peri-implant soft tissue parameters, and prosthetic complications.	RCT	Best	12	24	Cement or screw retained, single-tooth replacement	48
49	Watson CJ, Tinsley D, Ogden AR, Russell JL, Mulay S, Davison EM.	A 3 to 4 year study of single tooth hydroxylapatite coated endosseous dental implants.	Br Dent J 1999;187:90–94.	Division of Restorative Dentistry, Leeds Dental Institute, United Kingdom	To evaluate the clinical effectiveness, common complications, and maintenance associated with hydroxylapatite (HA) coated cylindrical implants when used to support single crowns.	Prospective case study	Average	26	33	Single-tooth replacement	48
50	Wannfors K, Smedberg JI.	A prospective clinical evaluation of different single-tooth restoration designs on osseointegrated implants: A 3-year follow-up of Brånemark implants.	Clin Oral Implants Res 1999;10: 453–458.	Danderyd Hospital, Stockholm, Sweden	To evaluate the possible consequences for implant success, marginal bone loss, and any other complications related to prosthetic treatment modifications.	Prospective case study	Average	69	80	Single-tooth replacement	36
51	Wyatt CC, Zarb GA.	Treatment outcomes of patients with implant-supported fixed partial prostheses.	Int J Oral Maxillofac Implants 1998;13:204–211.	University of British Columbia, Vancouver, Canada Faculty of	To document the treatment of partially edentulous patients with implant-supported FPDs at a multidisciplinary implant prosthodontic clinic.	Prospective case study	Average	77	230	FPD	144
52	Zarb GA, Schmitt A.	The longitudinal clinical effectiveness of osseointegrated dental implants in anterior partially edentulous patients.	Int J Prosthodont 1993;6:180–188.	Dentistry, University of Toronto, Canada	To evaluate the clinical effectiveness of 2 or more implants to restore anterior partial edentulism.	Prospective case study	Average	30	94	FPD anterior	96
53	Zarb GA, Schmitt A.	The longitudinal clinical effectiveness of osseointegrated dental implants in posterior partially edentulous patients.	Int J Prosthodont 1993;6:189–196.	Faculty of Dentistry, University of Toronto, Canada	To test the effectiveness of this technique in the treatment of partially edentulous posterior areas of the maxillae and mandible.	Prospective case study	Average	35	105	FPD	108

Table 1 continued Articles Selected for Data Extraction and Analysis

Article no.	Authors	Article title	Source	Affiliation	Study aim(s) as described by author	Study design	Study quality	No. of patients	No. of implants	Treatment	Observation period (mo)
54	Mericske-Stern R, Grutter L, Rosch R, Mericske E.	Clinical evaluation and prosthetic complications of single tooth replacements by non-submerged implants.	Clin Oral Implants Res 2001;12: 309–318.	School of Dental Medicine, University of Bern, Switzerland	To evaluate single-tooth replacements by non-submerged implants.	Prospective case study	Average	72	109	Screw/cement retained	60
55	McGlumphy EA, Peterson LJ, Larsen PE, Jeffcoat MK.	Prospective study of 429 hydroxyapatite-coated cylindric omniloc implants placed in 121 patients.	Int J Oral Maxillofac Implants 2003;18: 82–92.	College of Dentistry, The Ohio State University, Columbus, OH	A 5-year prospective study of 429 HA-coated cylindric implants placed into 121 patients to determine the long-term clinical performance of the implants.	Prospective case study	Average	121	429	Screw retained only	60
56	Scholander S.	A retrospective evaluation of 259 single-tooth replacements by the use of Brånemark implants.	Int J Prosthodont 1999;12:483–491.	Public Dental Service Skane, Kristianstad, Sweden	To investigate the clinical outcome of the treatment with 259 consecutively placed Brånemark system implant-supported single crowns.	Prospective case study	Average	183	259	Screw/cement retained	108
57	Schwartz-Arad D, Samet N, Samet N.	Single tooth replacement of missing molars: A retrospective study of 78 implants.	J Periodontol 1999;70:449–454.	The Maurice and Gabriela Goldschleger School of Dental Medicine, Tel Aviv University, Israel	To present findings of 55 consecutive patients with 78 restored single osseointegrated implants in the molar area.	Retrospective case study	Fair	55	78	Screw retained	60
58	Levine RA, Clem D, Beagle J, et al.	Multicenter retrospective analysis of the solid-screw ITI implant for posterior single-tooth replacements.	Int J Oral Maxillofac Implants 2002;17: 550–556.	Albert Einstein Medical Center, Philadelphia, PA	This report involves the retrospective analysis of ITI implants placed and/or restored by a group of 7 clinicians located throughout the United States (5 periodontists and 2 prosthodontists).	Retrospective case study	Fair	471	675	Screw/cement retained	78
59	Lekholm U, Gunne J, Henry P, et al.	Survival of the Brånemark implant in partially edentulous jaws: A 10-year prospective muliticenter study.	Int J Oral Maxillofac Implants 1999;14:639–645.	Faculty of Odontology,University of Göteborg, Sweden	To report the 10 year outcome of a multicenter trial using Brånemark implants to restore partially edentulous arches	Prospective case study	Average	127	461	Fixed prosthesis	120
60	Lindh T, Back T, Nystrom E, Gunne J.	Implant versus tooth-implant supported prostheses in the posterior maxilla: A 2-year report.	Clin Oral Implants Res 2001;12: 441–449.	Faculty of Medicine and Odontology, Umea University, Umea, Sweden	To compare the biological and mechanical consequences when implants placed in the posterior maxilla were connected to teeth or when used standing free only	Prospective study w/concurrent control	Better	26	95	Implant-teeth/ implant-implant connected	24

Table 1 continued Articles Selected for Data Extraction and Analysis

Article no.	Authors	Article title	Source	Affiliation	Study aim(s) as described by author	Study design	Study quality	No. of patients	No. of implants	Treatment	Observation period (mo)
61	Mangano C, Bartolucci EG.	Single tooth replacement by Morse taper connection implants: A retrospective study of 80 implants.	Int J Oral Maxillofac Implants 2001;16:675–680.	Private practice	To provide data relative to the use of a new implant system (Mac System, Cabon, Milan, Italy) with a Morse taper implant-abutment connection for single implant restorations.	Retrospective case study	Fair	69	80	Type of abutment (Morse taper)	36
62	Groisman M, Ferreira HM, Frossard WM, de Menezes Filho LM, Harari ND.	Clinical evaluation of hydroxyapatite-coated single-tooth implants: A 5-year retrospective study.	Pract Proced Aesthet Dent 2001;13:355–360.	Universidad do Gran Rio, Rio de Janeiro, Brazil	This study presents a 5-year retrospective clinical analysis of single teeth replaced with hydroxyapatite-coated implants.	Retrospective case study	Fair	129	271	Length and diameter of implants	60
63	Gothberg C, Bergendal T, Magnusson T.	Complications after treatment with implant-supported fixed prostheses: A retrospective study.	Int J Prosthodont 2003;16:201–207.	The Institute for Postgraduate Dental Education, Jonkoping, Sweden	The aim was to retrospectively evaluate the frequencies of different complications, as well as the number of visits to dentists because of such complications, after treatment with implant-supported fixed prostheses.	Retrospective study	Average	75	429	FPD	36
64	Gunne J, Jemt T, Linden B.	Implant treatment in partially edentulous patients: A report on the prostheses after 3 years.	Int J Prosthodont 1994;7:143–148.	Faculty of Odontology, University of Umea, Sweden	To describe and present an interim 3-year report on the clinical experience after placement of prostheses	Prospective case study	Average	154	521	FPD	36
65	Gunne J, Astrand P, Lindh T, Borg K, Olsson M.	Tooth-implant and implant supported fixed partial dentures: A 10-year report.	Int J Prosthodont 1999;12:216–221.	Faculty of Odontology, Umea University, Sweden	The purpose of this longitudinal study with 10 years of follow-up was to evaluate the use of short implants supporting fixed partial dentures (FPD) in the posterior part of the mandible, and to compare implant-supported FPDs to tooth-implant-supported FPDs.	Prospective study w/concurrent control	Better	23	46	Implant-implant/ implant-teeth connected	120
66	Haas R, Polak C, Furhauser R, Mailath-Pokorny G, Dortbudak O, Watzek G.	A long-term follow-up of 76 Brånemark single-tooth implants.	Clin Oral Implants Res 2002;13: 38–43.	Dental School, University of Vienna, Austria	To report on further experience with the implant-treated groups and their results after a longer observation period	Prospective case study	Average	71	76	FPD	120
67	Higuchi KW, Folmer T, Kultje C.	Implant survival rates in partially edentulous patients: A 3-year prospective multicenter study.	J Oral Maxillofac Surg 1995;53: 264–268.	University of Amsterdam, The Netherlands	To examine specific factors that might influence implant survival and some of the associated complications	Prospective case study	Average	139	460	FPD	36
68	Hosny M, Duyck J, van Steenberghe D, Naert I.	Within-subject comparison between connected and nonconnected tooth-to-implant fixed partial prostheses: Up to 14-year follow-up study.	Int J Prosthodont 2000;13:340–346.	Faculty of Medicine, Catholic University Leuven, Belgium.	To compare the outcome of fixed prostheses supported by teeth and implants and by freestanding implants only.	Prospective study w/concurrent control	Better	18	78	Implant-teeth connected	168
69	Jemt T, Lekholm U.	Oral implant treatment in posterior partially edentulous jaws: A 5-year follow-up report.	Int J Oral Maxillofac Implants 1993;8: 635–640.	Faculty of Odontology, University of Göteborg, Sweden	To report the outcome of oral implant treatment ad modum Brånemark in a group of consecutively treated partially edentulous patients followed for 5 years	Prospective case study	Average	67	259	Type of prosthesis	60

Table 1 continued Articles Selected for Data Extraction and Analysis

Article no.	Author	Article title	Source	Affiliation	Study aim(s) as described by author	Study design	Study quality	No. of patients	No. of implants	Treatment	Observation period (mo)
70	Johansson LA, Ekfeldt A.	Implant-supported fixed partial prostheses: A retrospective study.	Int J Prosthodont 2003;16:172–176.	Dental and Medical Health Centre, Halmstad, Sweden	To present treatment outcome and patient reactions to rehabilitation with implant-supported fixed partial prostheses.	Retrospective case study	Fair	83	263	FPD	84
71	Jemt T.	Customized titanium single-implant abutments: 2-year follow-up pilot study.	Int J Prosthodont 1998;11:312–316.	Private practice/Brånemark Clinic	To describe an alternative technique to fabricate single-implant restorations by using adjustable titanium abutments with porcelain applied directly to the abutment, and to follow an early group of patients treated with these crowns.	Prospective case study	Average	14	17	Type of abutments	24
72	Karlsson U, Gotfredsen K, Olsson C.	Single-tooth replacement by osseointegrated Astra Tech dental implants: A 2-year report.	Int J Prosthodont 1997;10:318–324.	Public Dental Service, Norrkoping, Sweden	This study presents the outcome of single-tooth restorations supported by Astra Tech single-tooth implants followed for 2 years. Forty-seven implants were placed in the same number of patients.	Prospective case study	Average	47	47	Cemented restorations	24
73	Krennmair G, Schmidinger S, Waldenberger O.	Single-tooth replacement with the Frialit-2 system: A retrospective clinical analysis of 146 implants.	Int J Oral Maxillofac Implants 2002;17:78–85.	Dental School University of Vienna, Austria	This study was intended to provide a report of experience and results with Frialit-2 implants used for single-tooth replacement.	Retrospective case study	Fair	112	146	Vertical screw retained	84
74	Jemt T, Henry P, Linden B, Naert I, Weber H, Wendelhag I.	Implant-supported laser-welded titanium and conventional cast frameworks in the partially edentulous jaw: A 5-year prospective multicenter study.	Int J Prosthodont 2003;16:415–421.	Public Dental Health, Göteborg, Sweden	This study evaluated and compared the clinical performance of laser-welded titanium fixed partial implant-supported prostheses with that of conventional cast frameworks in the partially edentulous jaw.	Prospective study w/concurrent control	Better	42	170	Type of framework (laser welded)	60

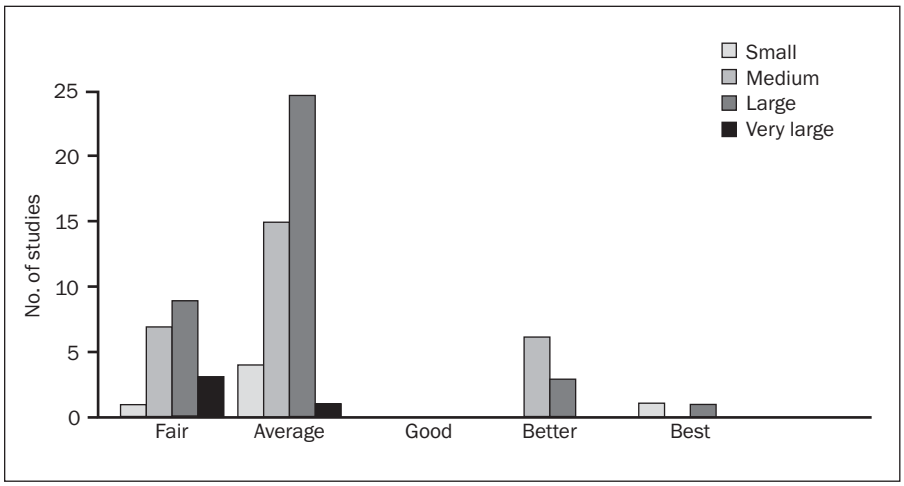


Fig 2 Included articles by size and quality of study.

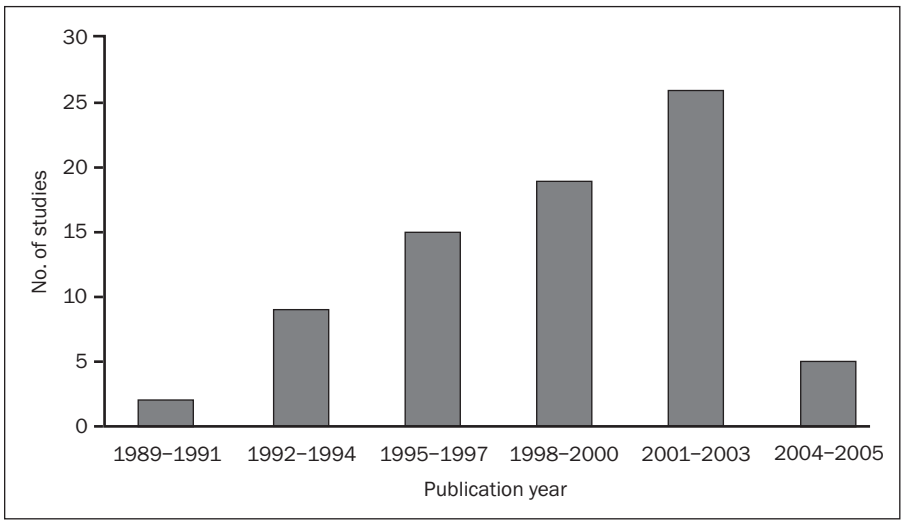


Fig 3 Articles included by date of publication.

Table 2 Analysis of Excluded Studies (n = 59)

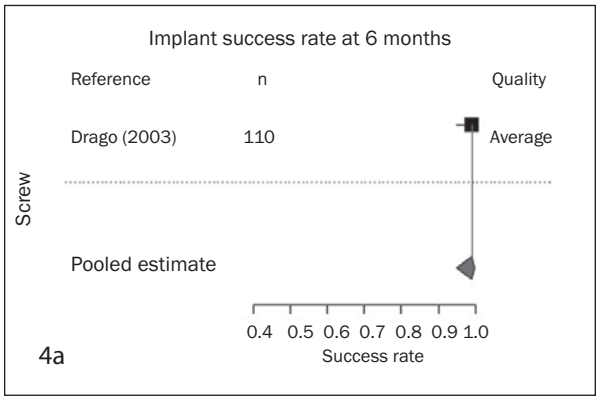
Reason for excluding study	No. of studies
Mix of partially and completely edentulous patients	15
No data regarding prosthesis could be extracted	35
In vitro/lab procedures	6
Not commonly used system	1
Clinical experience/anecdotal	2
Total	59

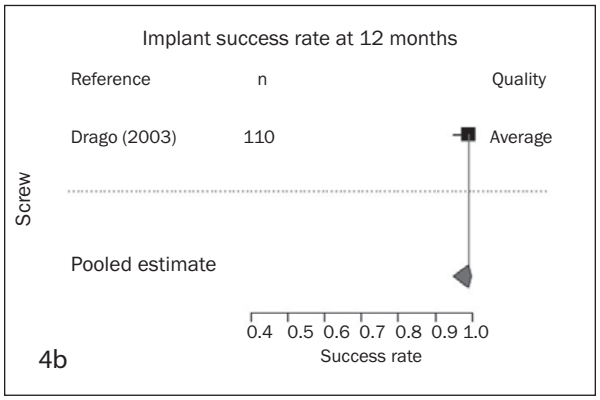
Table 3 Analysis of Included Studies (n = 74)

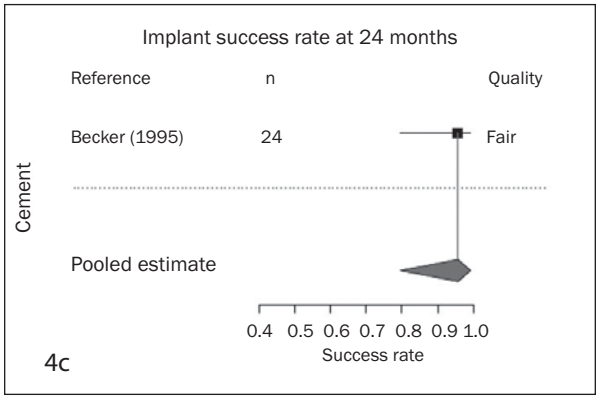
Study methodology	No. of studies
RCT	2
Prospective study with concurrent control	8
Prospective case study	43
Retrospective case study	21
Total	76

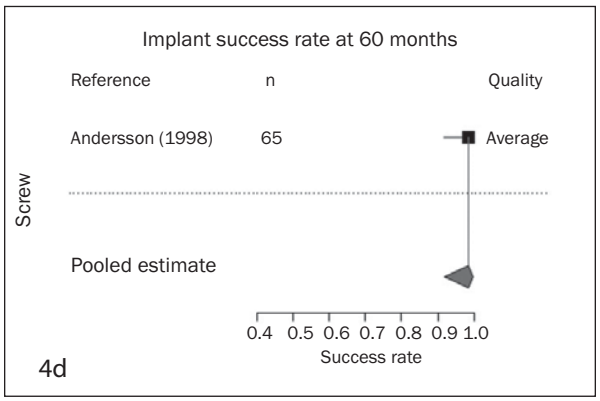
Of the 74 articles, 35% (n = 26) dealt with the treatment of partially edentulous arches, ie, spaces with more than 1 missing tooth. Thirty percent (n = 22) were on single-tooth replacement, 12% (n = 9) focused on implant-tooth–supported versus implant–supported fixed partial dentures (FPDs), and 13% of the articles (n = 10) included some information on abutments such as ceramic or angulated abutments, but the outcome information was rarely correlated to the abutment type. Finally, 9% (n = 7) of the studies evaluated cemented versus screw-retained restorations. Little to no usable information was available on restorative materials and their influence on the outcome.

Most of the studies were conducted in an institutional environment, such as university dental schools, hospitals, or specialized clinics. The operators were specialists, general dentists, and in some instances, postgraduate students. None of the studies correlated the operator background with the outcome.









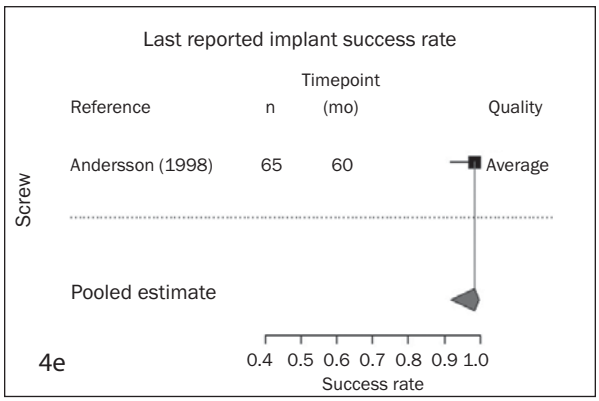


Fig 4 Implant success rate at various timepoints for cemented and screw-retained restorations.

Table 4 CIs for Proportion Estimate on Implant Success Rates for Cemented versus Screw - Retained Restorations at Various Timepoints

Treatment	Proportion estimate	95% CI
6 mo		
Cement	–	–
Screw	0.99	0.949–0.998
12 mo		
Cement	–	–
Screw	0.99	0.949–0.998
24 mo		
Cement	0.957	0.796–0.992
Screw	–	–
36 mo		
Cement	–	–
Screw	–	–
48 mo		
Cement	–	–
Screw	–	–
60 mo		
Cement	–	–
Screw	0.985	0.918–0.997
72 mo		
Cement	–	–
Screw	–	–
Last examination		
Cement	–	–
Screw	0.985	0.918–0.997

Table 5 CIs for Proportion Estimate on Implant Survival Rates for Cemented versus Screw-Retained Restorations at Various Timepoints

Treatment	Proportion estimate	95% CI
6 mo		
Cement	1	0.968–1.000
Screw	1	0.968–1.000
12 mo		
Cement	0.996	0.979–1.000
Screw	0.997	0.988–1.000
24 mo		
Cement	0.997	0.993–1.000
Screw	0.995	0.983–1.000
36 mo		
Cement	0.990	0.982–0.998
Screw	0.995	0.985–1.000
48 mo		
Cement	0.988	0.979–0.997
Screw	0.993	0.970–1.000
60 mo		
Cement	0.996	0.985–1.000
Screw	0.991	0.980–1.000
72 mo		
Cement	0.990	0.954–1.000
Screw	0.988	0.949–1.000
Last examination		
Cement	0.981	0.962–1.000
Screw	0.977	0.958–0.996

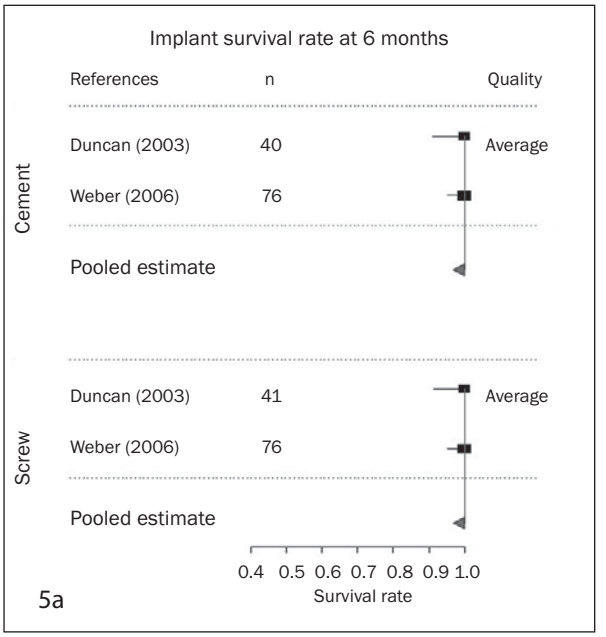


Fig 5 Implant survival rate at various timepoints for cemented and screw-retained restorations.

Only 2 publications were RCTs with the effect of the prosthetic design and its influence on the outcome being the study aim. The heterogeneity of the studies and the variable quality make it difficult to synthesize the reports into a meaningful review for clinical interpretation and documentation.

In regard to the PICO questions, results are summarized below. Details on numbers, confidence intervals, and level of statistical significance are listed in the respective figures and tables.

1. *Does the method of retention (screw-retained versus cemented) influence the outcome?*

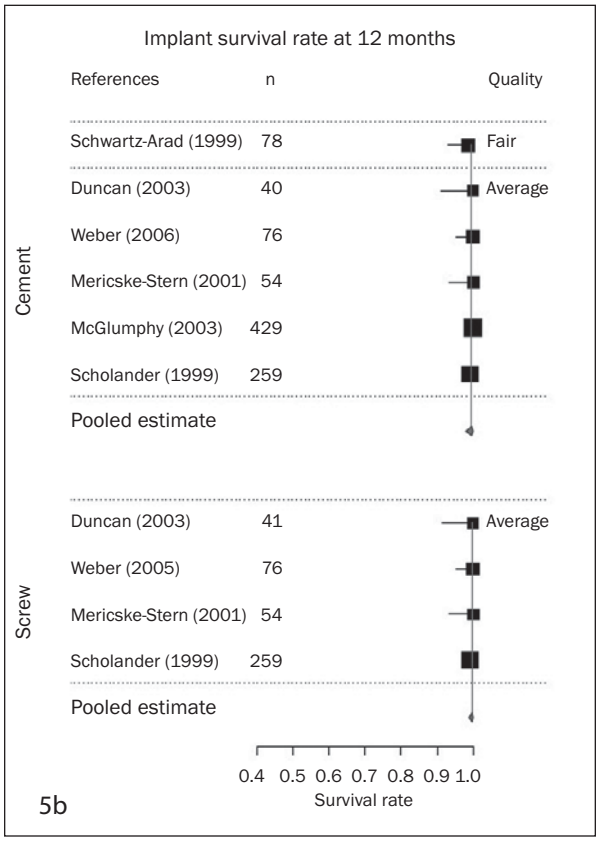
Only few studies used implant success to measure outcomes for screw-retained compared to cemented implant restorations. For any evaluation times recorded, no differences were found in implant success between screw-retained and cemented restorations (Fig 4, Table 4).

Implant survival was more frequently used. Again, no statistically significant differences were found between the 2 modes of retention at any of the evaluation timepoints recorded. The last examination (> 72 mo) revealed an implant survival rate of 98.1% for cemented and 97.7% for screw-retained restorations (Fig 5, Table 5). A pairwise test of implant survival rates between cemented and screw-retained restorations found a pooled difference of 0.0011 and a 95% CI of –0.008 to 0.0101 ($z = 0.2339$; $P = 0.8151$).

Prosthesis success rates showed greater variations between cemented and screw-retained restorations at the various evaluation times, without demonstrating statistical significance. The prosthesis success rates at the last reported examination (> 72 mo) were 93.2% for cemented restorations and 83.4% for screw-retained restorations (Fig 6, Table 6). A pairwise test of prosthetic success rates between cemented and screw-retained restorations found a pooled difference of –0.0883 and a 95% CI of –0.227 to 0.0504 ($z = -1.248$; $P = 0.212$).

2. *Does the method of support influence the outcome?*
   (a) Implant- versus implant-tooth–supported FPDs
   (b) Single-implant restorations versus splinted restorations on multiple implants

When comparing implant success rates for implant- versus implant-tooth–supported FPDs, the success rate was higher for implant support alone at the last reported evaluation (97.1% for implant supported, 89.2% for implant-tooth–supported FPDs), although statistical significance was not reached. This was also the case for most of the earlier observation times. Single-implant restorations showed an implant success rate of 94.3%, compared to 97.1% for FPDs supported by multiple implants. Again, this small difference was not statistically significant (Fig 7, Table 7). A pairwise test of implant success rates for



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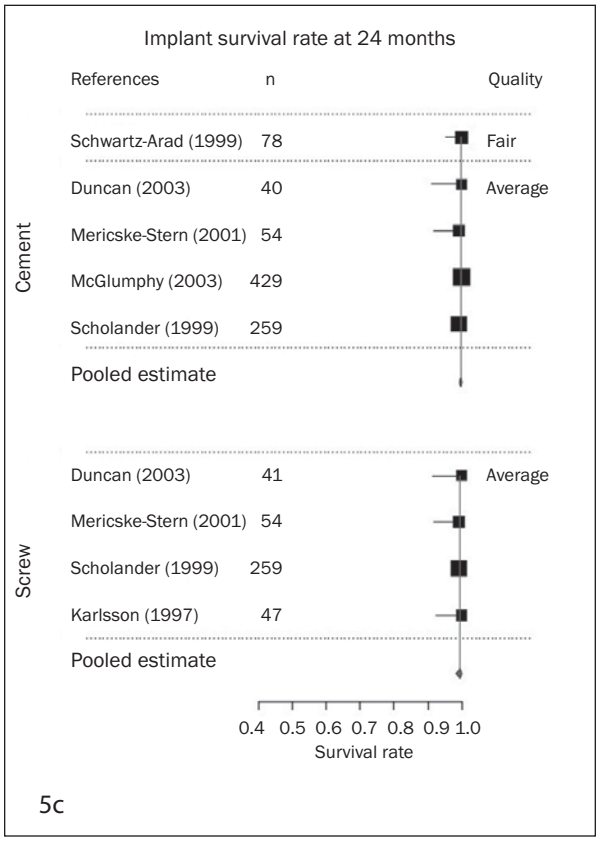

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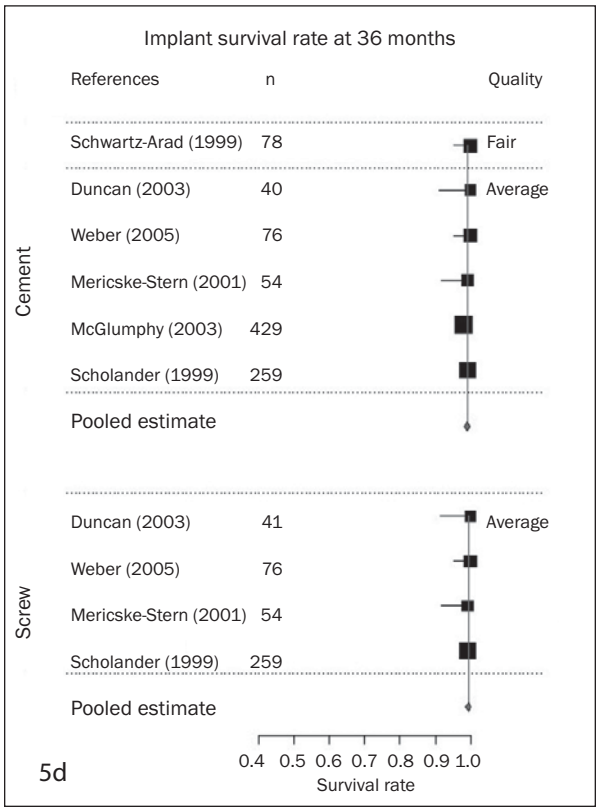

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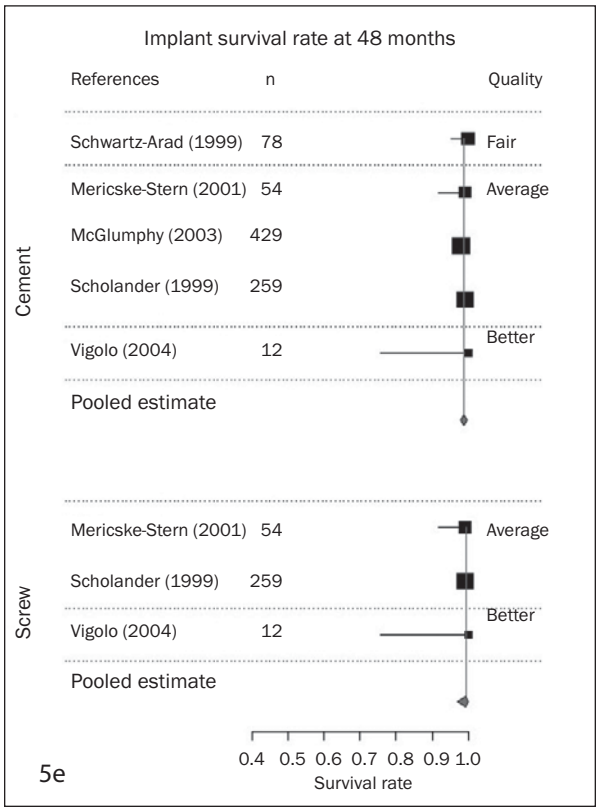

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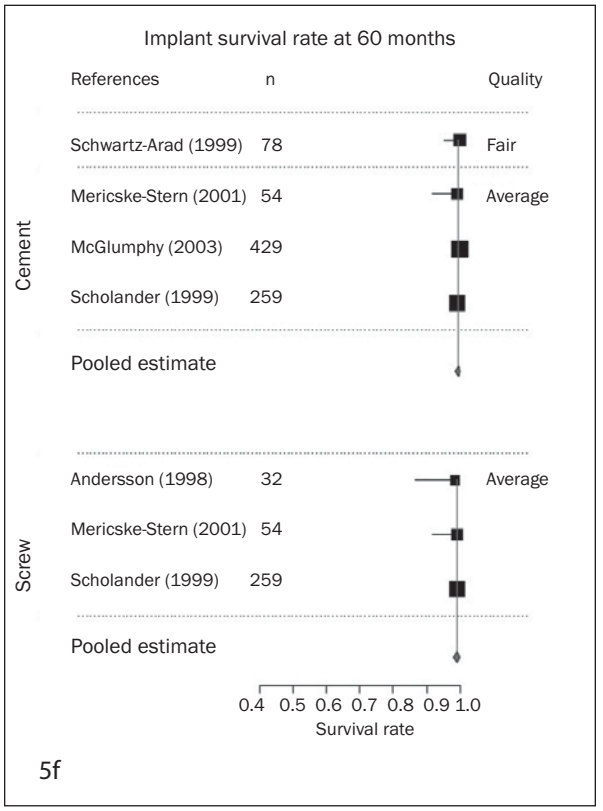
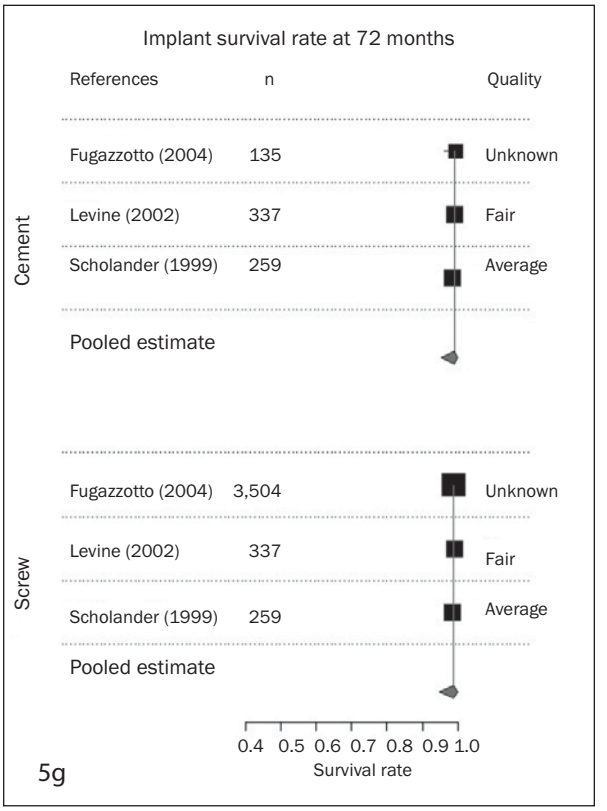
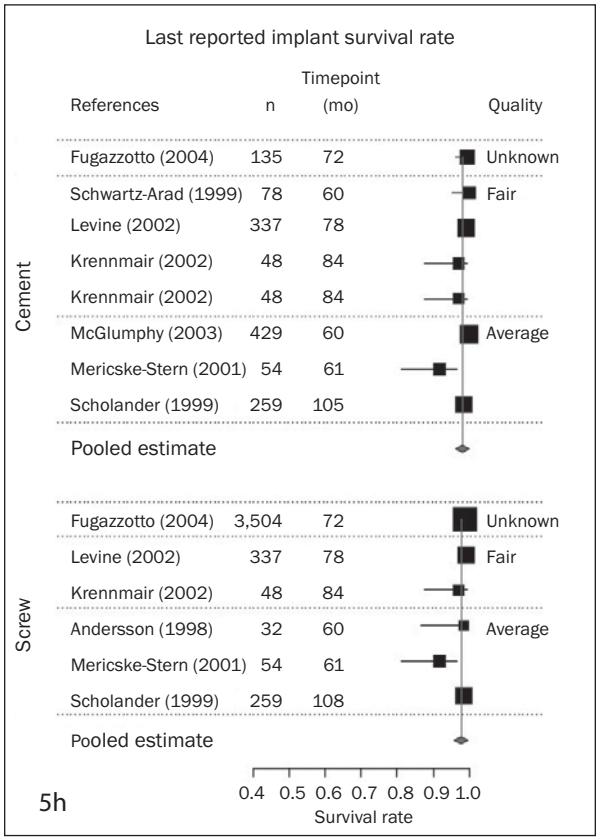






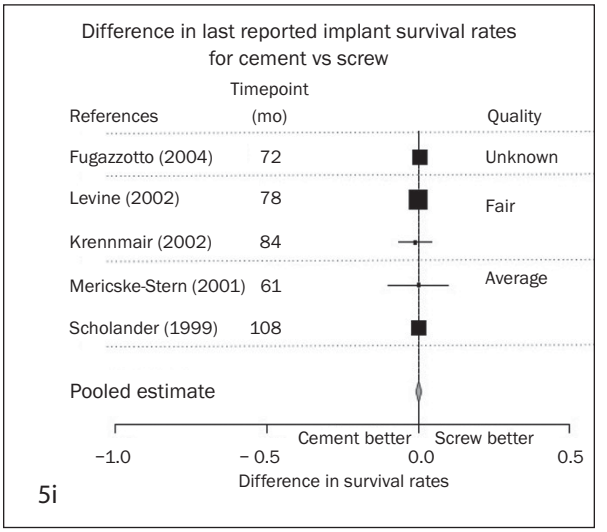
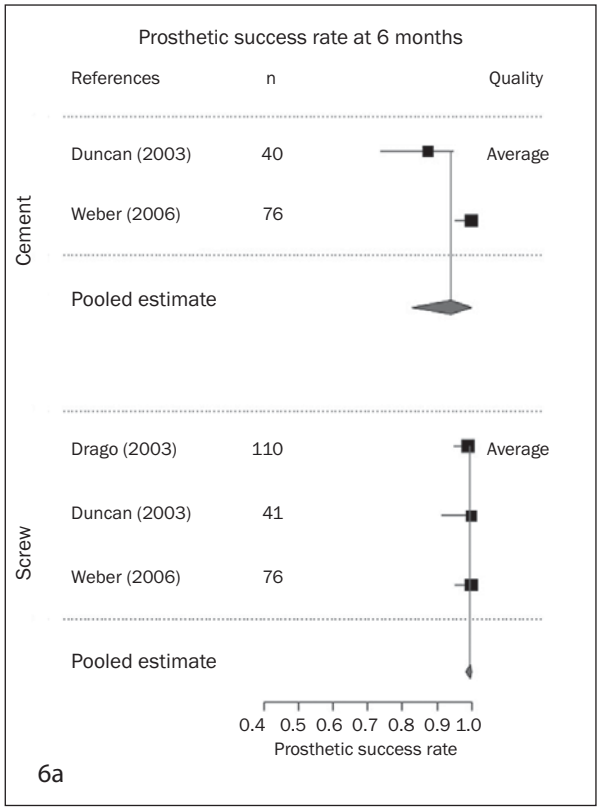
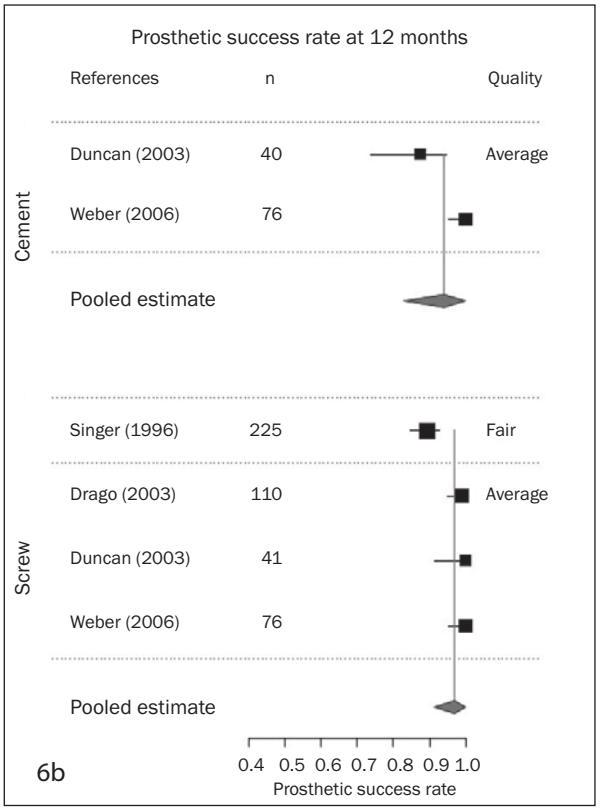
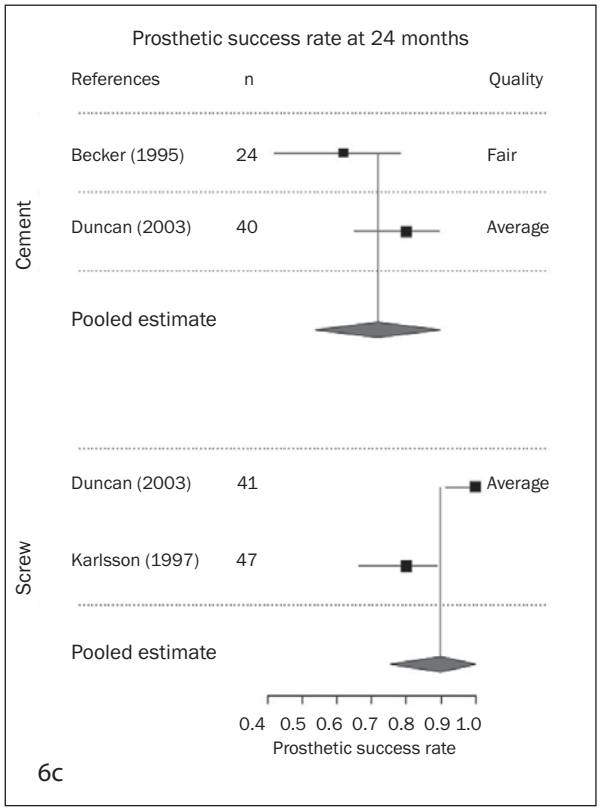
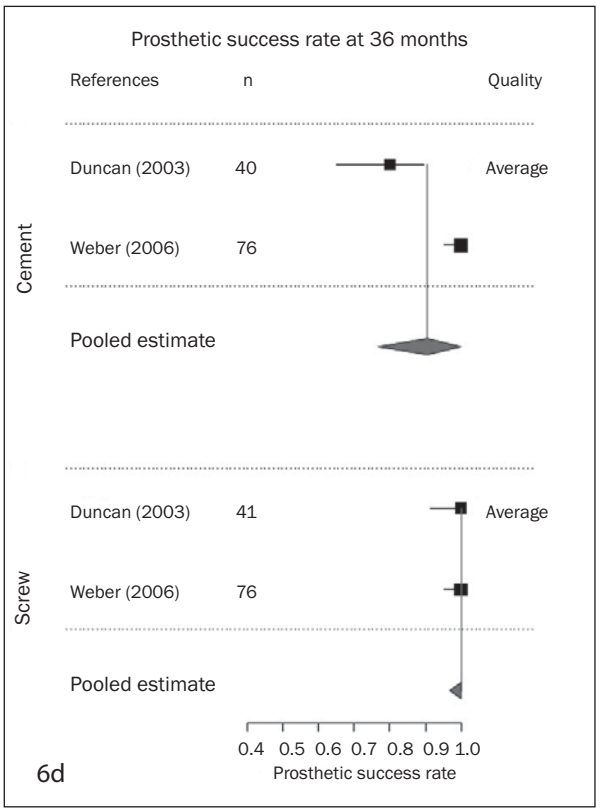


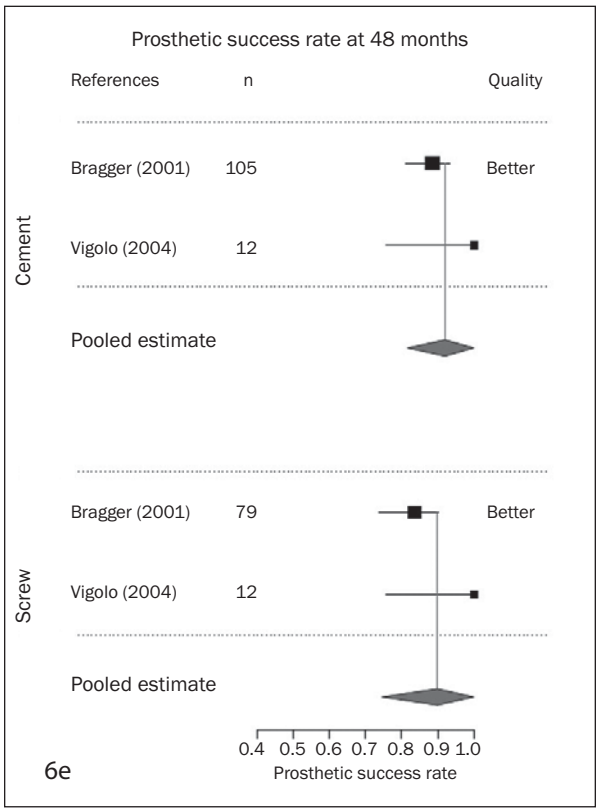
Fig 6 Prosthetic success rate at various timepoints for cemented and screw-retained restorations.











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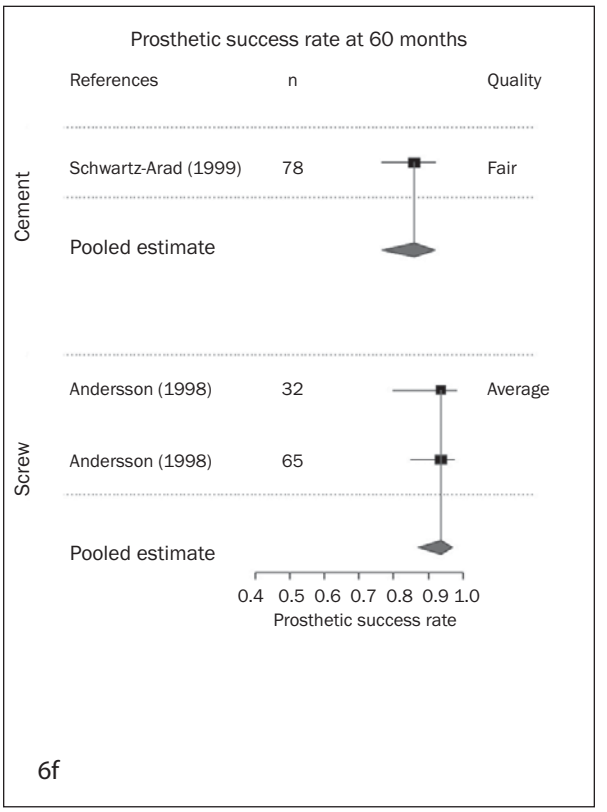

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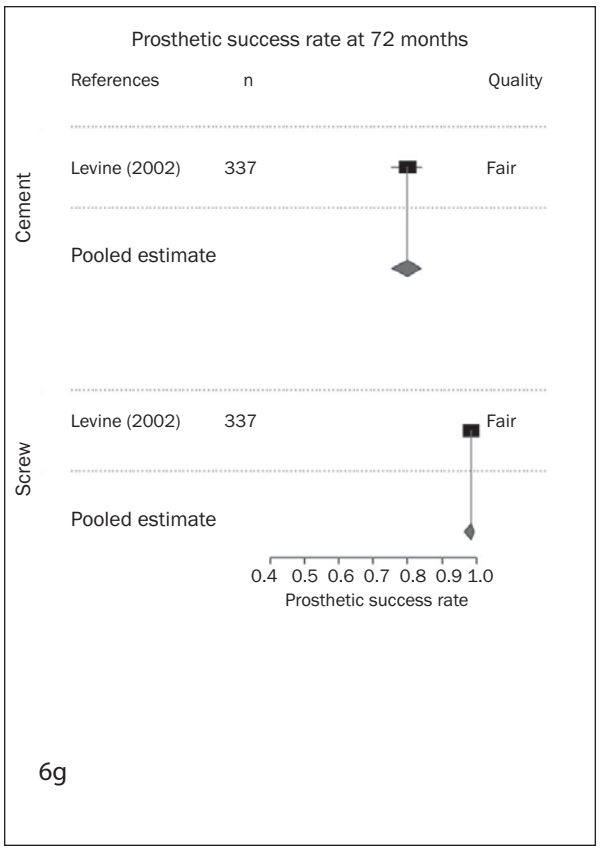

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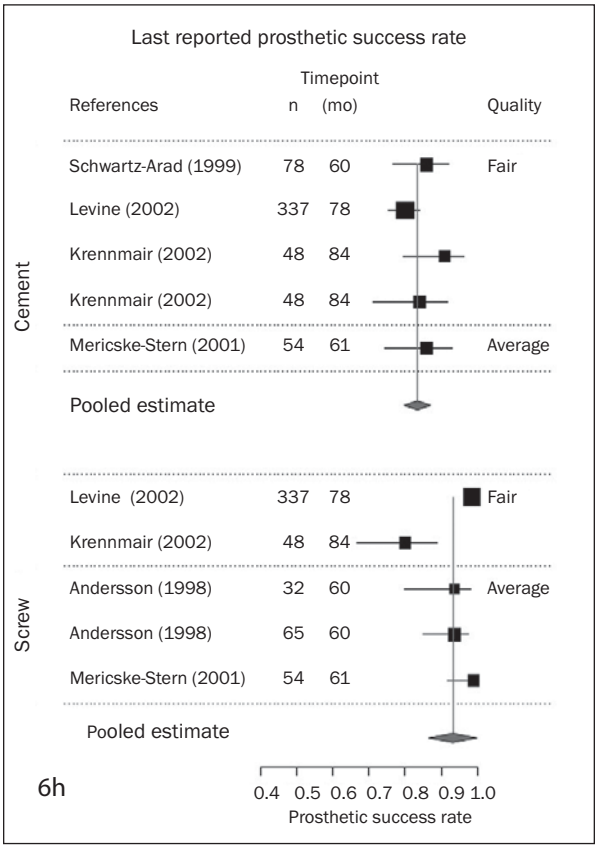

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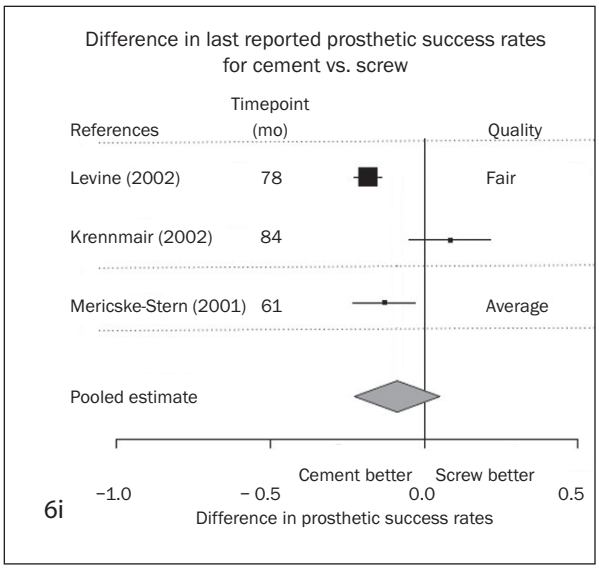


Fig 7 Implant success rate at various timepoints for implant-supported FPDs, implant-tooth–supported FPDs, and single-implant restorations.

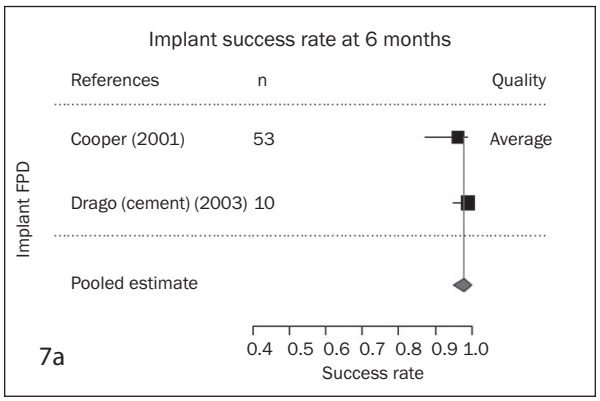
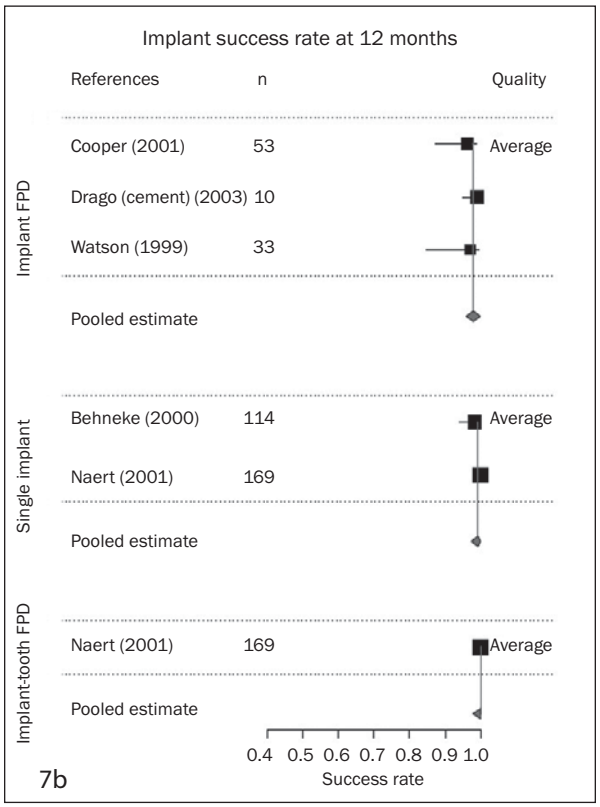
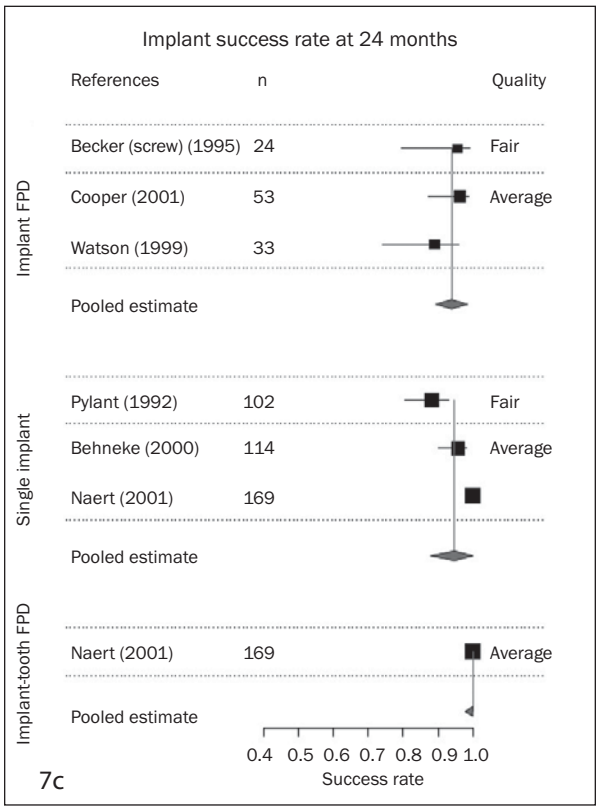
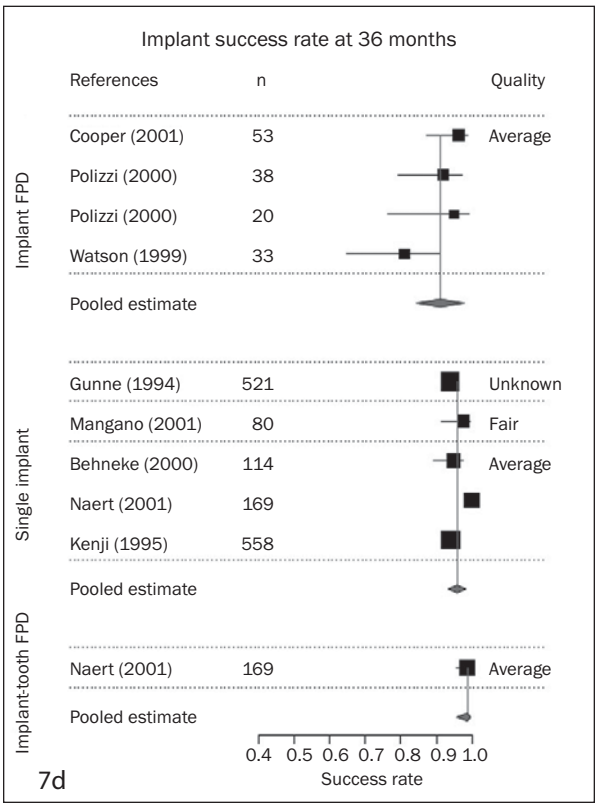


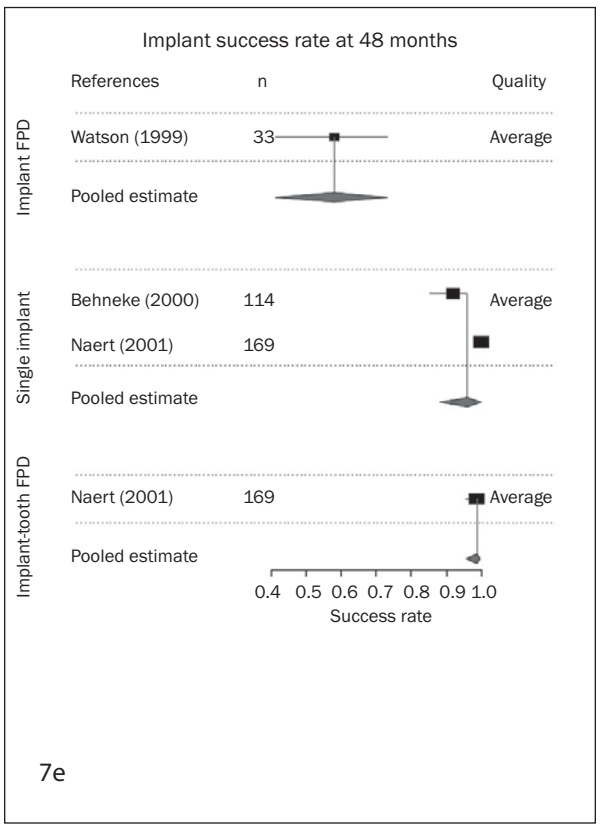
Table 6 CIs for Proportion Estimate on Prosthetic Success Rates for Cemented versus Screw-Retained Restorations at Various Timepoints

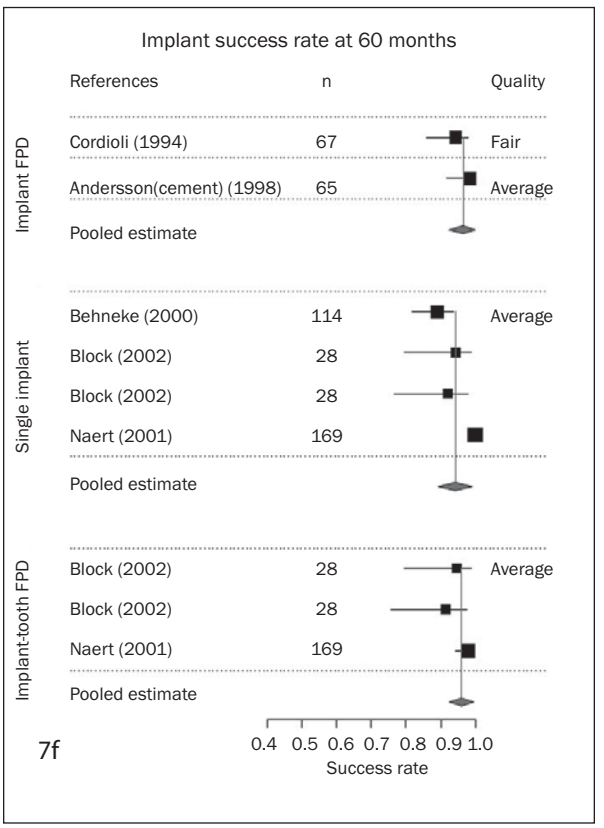
Treatment	Proportion estimate	95% CI
6 mo		
Cement	0.996	0.983–1.000
Screw	0.940	0.827–1.000
12 mo		
Cement	0.969	0.912–1.000
Screw	0.940	0.827–1.000
24 mo		
Cement	0.899	0.754–1.000
Screw	0.718	0.538–0.898
36 mo		
Cement	1.000	0.968–1.000
Screw	0.905	0.766–1.000
48 mo		
Cement	0.899	0.746–1.000
Screw	0.920	0.816–1.000
60 mo		
Cement	0.937	0.870–0.971
Screw	0.860	0.766–0.920
72 mo		
Cement	0.985	0.966–0.994
Screw	0.800	0.754–0.839
Last examination		
Cement	0.932	0.865–0.999
Screw	0.834	0.797–0.871

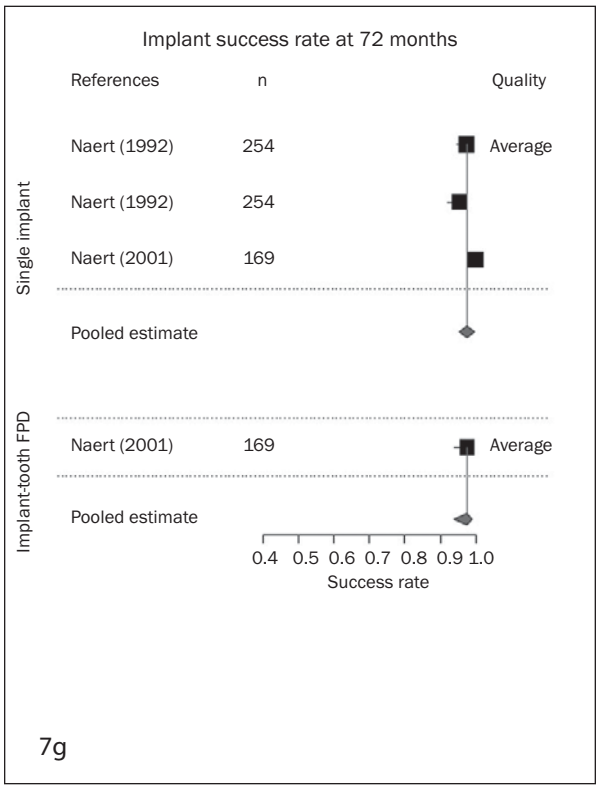












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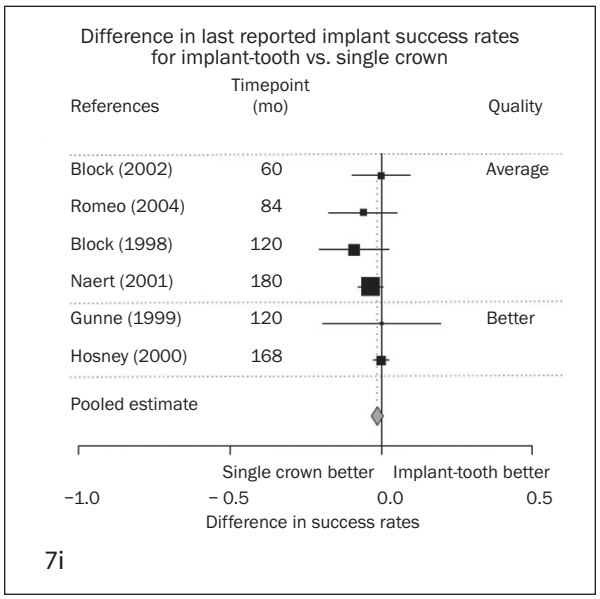

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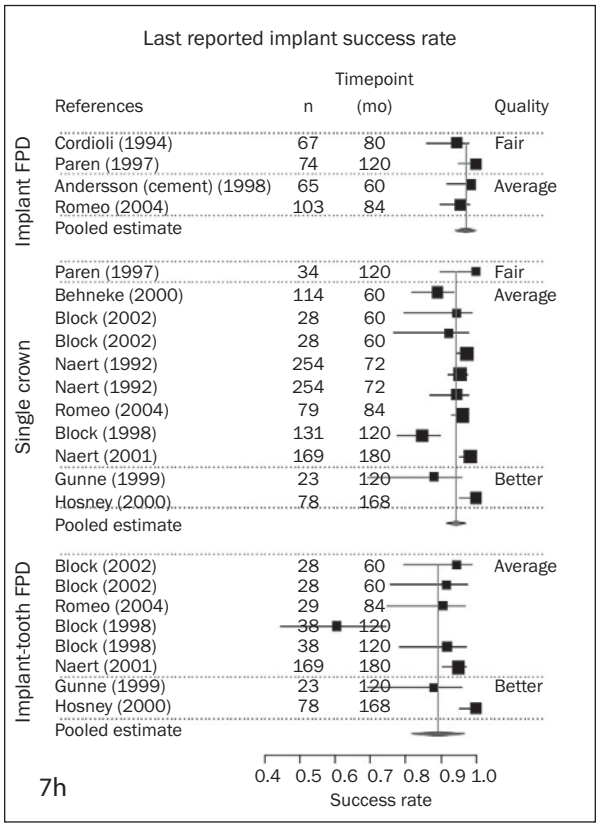

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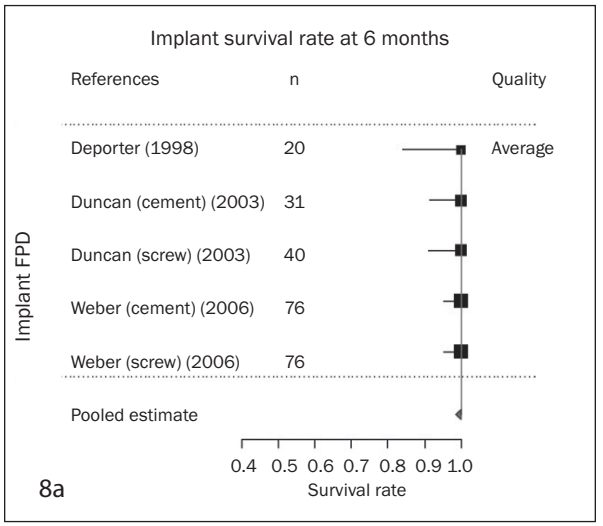
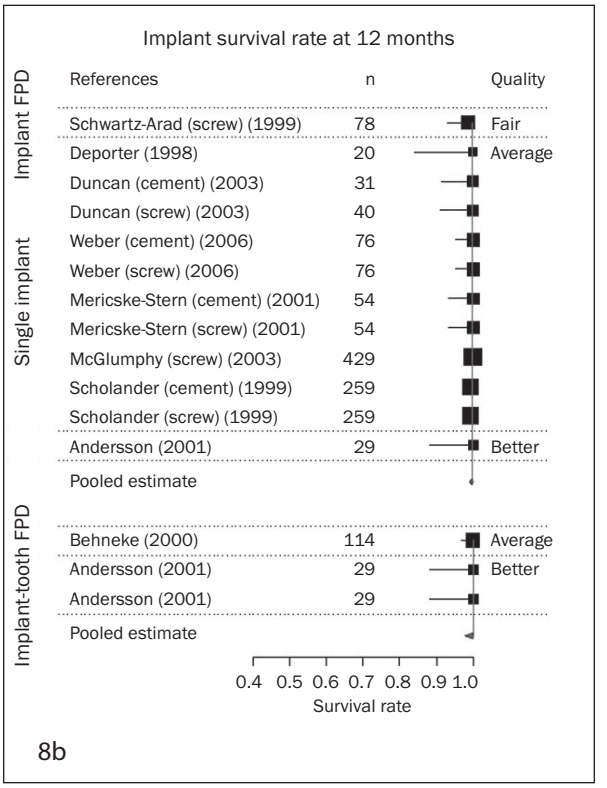
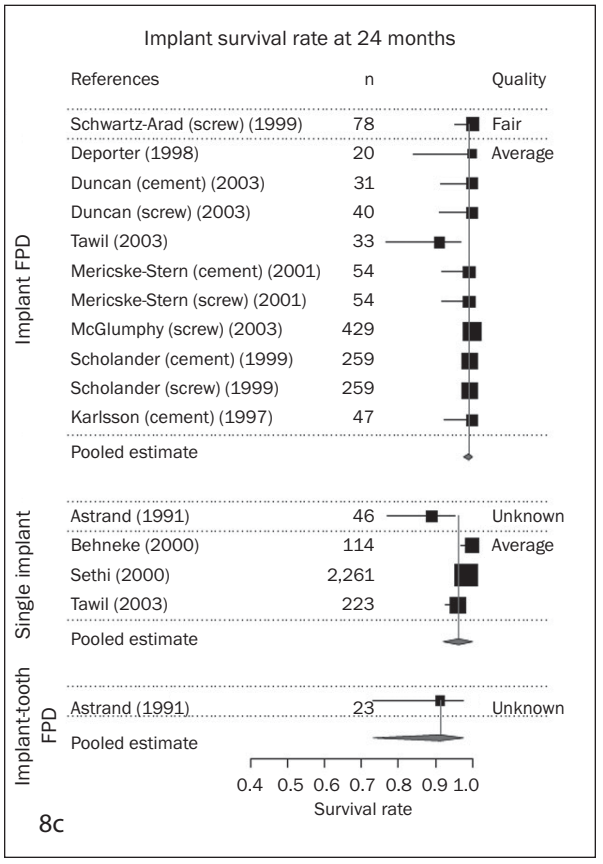
Table 7 CIs for Proportion Estimate on Implant Success Rates for Implant-Supported FPDs, Implant-Tooth–Supported FPDs and Single-Implant Restorations at Various Timepoints

Treatment	Proportion estimate	95% CI
6 mo		
Implant	0.979	0.950–1.000
Single implant	–	–
Implant-tooth	–	–
12 mo		
Implant	0.979	0.959–0.999
Single implant	0.992	0.973–1.000
Implant-tooth	1.000	0.978–1.000
24 mo		
Implant	0.939	0.893–0.985
Single implant	0.947	0.879–1.000
Implant-tooth	1.000	0.978–1.000
36 mo		
Implant	0.911	0.843–0.979
Single implant	0.958	0.933–0.983
Implant-tooth	0.987	0.956–0.996
48 mo		
Implant	0.580	0.412–0.731
Single implant	0.960	0.881–1.000
Implant-tooth	0.987	0.956–0.996
60 mo		
Implant	0.964	0.924–1.000
Single implant	0.942	0.893–0.991
Implant-tooth	0.960	0.925–0.995
72 mo		
Implant	–	–
Single implant	0.975	0.953–0.997
Implant-tooth	0.9746	0.938–0.990
Last examination		
Implant	0.971	0.939–1.000
Single implant	0.943	0.916–0.970
Implant-tooth	0.892	0.816–0.968

Fig 8 Implant survival rate at various timepoints for implant-supported FPDs, implant-tooth–supported FPDs, and single-implant restorations.



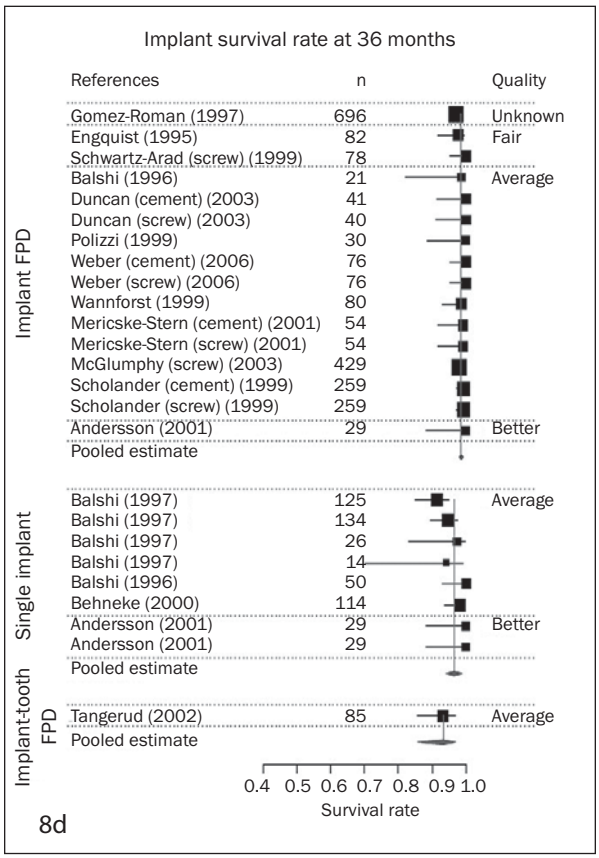


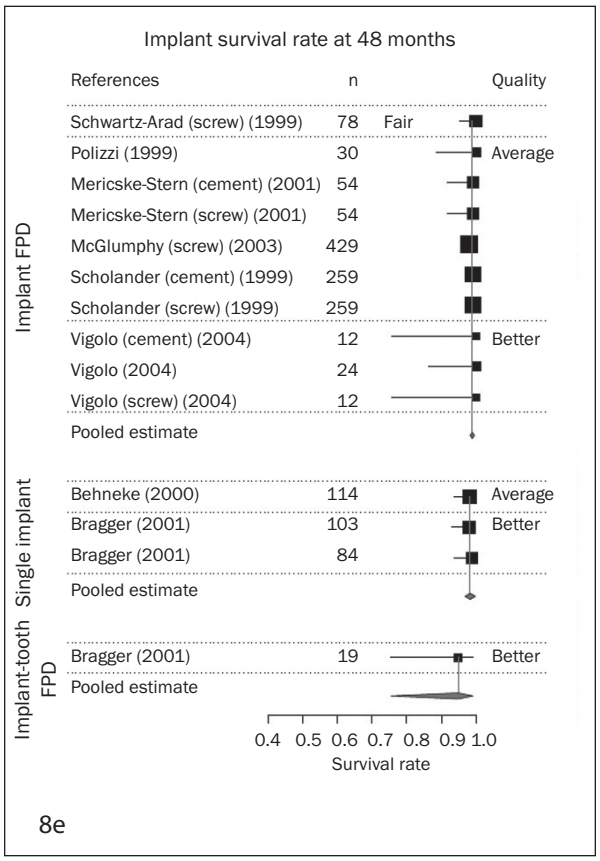


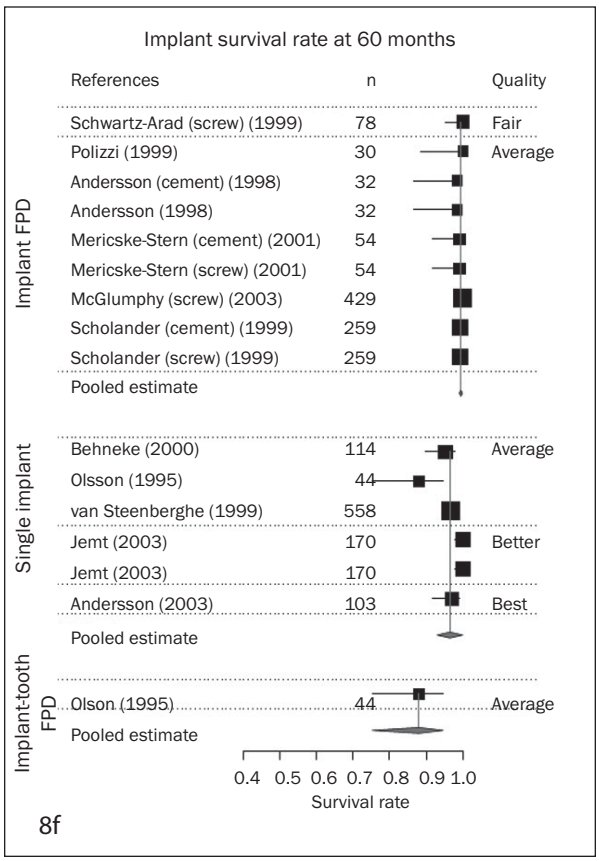
implant-tooth versus single-tooth restorations found a pooled difference of –0.0134 and a 95% CI of –0.0331 to 0.0063 (z = –1.3321, $P = 0.1828$).

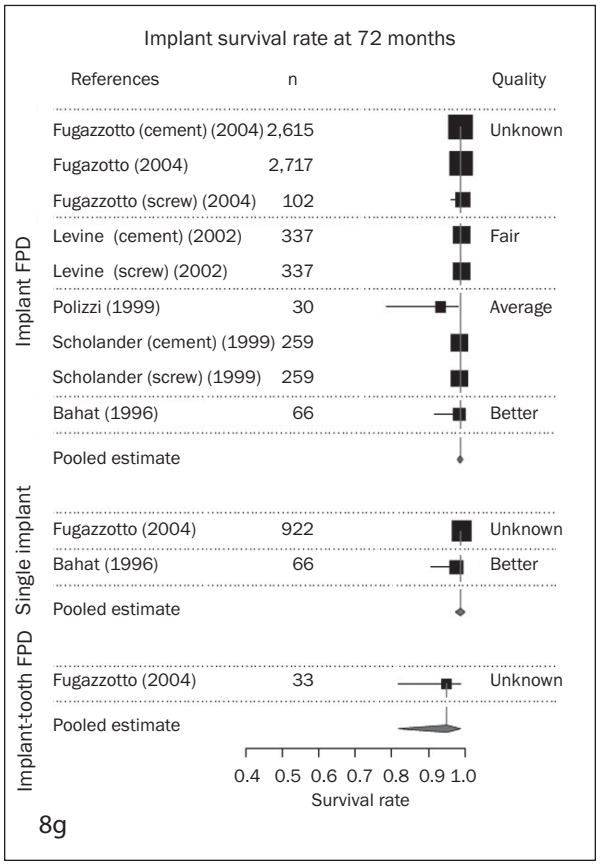
Implant survival at the last examination (> 72 mo) was highest for implant-supported FPDs (97.7%), followed by restorations supported by single implants (95.6%) and implant-tooth–supported FPDs (91.1%). None of the differences was statistically significant (Fig 8, Table 8). A pairwise test on implant survival rates comparing implant-supported FPDs and single-implant restorations found a pooled difference of –.0019 with a 95% CI of –0.0084 to 0.0046 (z = –0.5768; $P = 0.5641$). When implant-tooth–supported FPDs and single-implant restorations were compared, a pooled difference of –0.0377 with a 95% CI of –0.1072 to 0.0319 was found (z = –1.0618; $P = 0.2883$).

Prosthesis success was lower overall than implant success or implant survival. The success rate was 89.7% at the last examination (> 72 mo) for implant-supported FPDs, 87.3% for implant-tooth–supported FPDs, and 85.4% for restorations supported by single implants. Again, statistical analyses revealed that there were no significant differences (Fig 9 and Table 9). When the prosthetic success rates of implant-tooth–supported FPDs and single-implant FPDs were compared using a pairwise test, a pooled









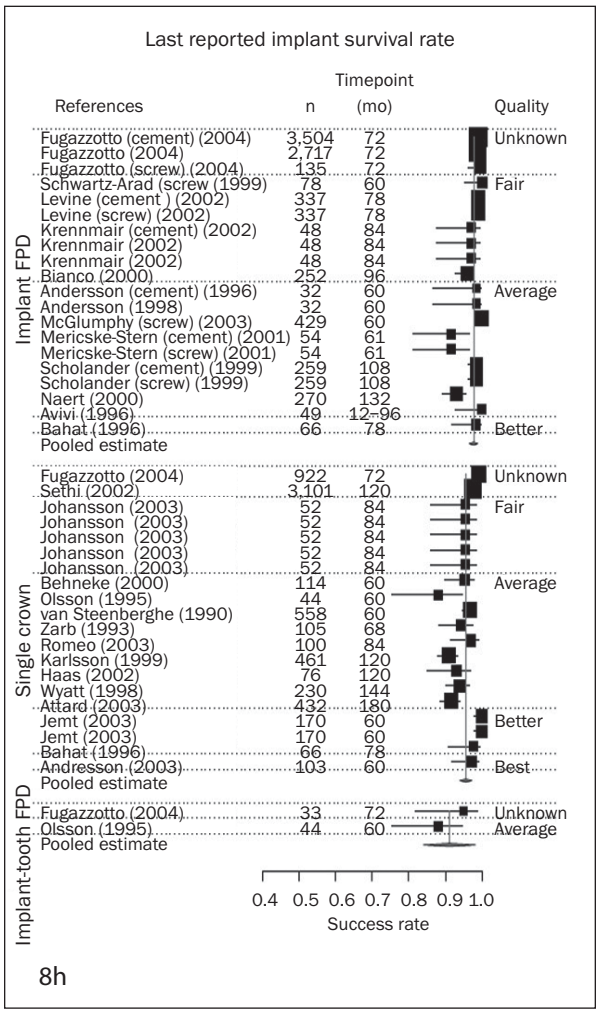


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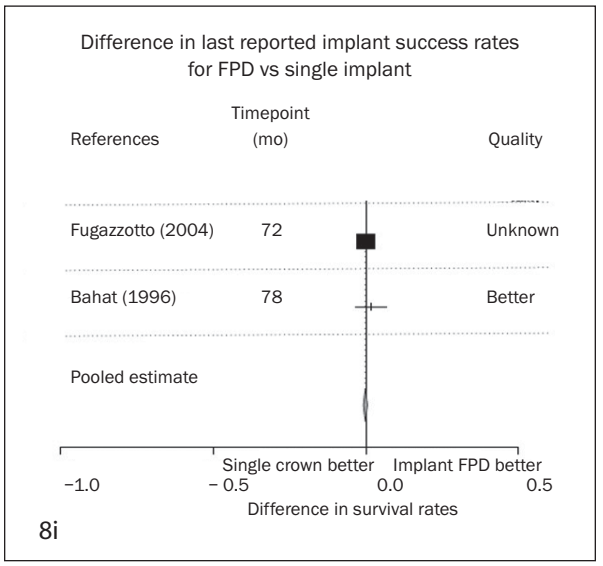
Table 8 CIs for Proportion Estimate on Implant Survival Rates for Implant-Supported FPDs, Implant-Tooth–Supported FPDs and Single-Implant Restorations at Various Timepoints

Treatment	Proportion estimate	95% CI
6 mo		
Implant	1.000	0.985–1.000
Single implant	–	–
Implant-tooth	–	–
12 mo		
Implant	0.997	0.990–1.000
Single implant	1.000	0.978–1.000
Implant-tooth	–	–
24 mo		
Implant	0.990	0.976–1.000
Single implant	0.963	0.922–1.000
Implant-tooth	0.913	0.732–0.976
36 mo		
Implant	0.986	0.980–0.992
Single implant	0.965	0.941–0.989
Implant-tooth	0.932	0.858–0.969
48 mo		
Implant	0.989	0.983–0.995
Single implant	0.983	0.968–0.998
Implant-tooth	0.948	0.754–0.991
60 mo		
Implant	0.995	0.991–0.999
Single implant	0.965	0.930–1.000
Implant-tooth	0.880	0.752–0.946
72 mo		
Implant	0.987	0.980–0.994
Single implant	0.988	0.974–1.000
Implant-tooth	0.950	0.818–0.988
Last examination		
Implant	0.977	0.965–0.989
Single implant	0.956	0.940–0.972
Implant-tooth	0.911	0.840–0.982



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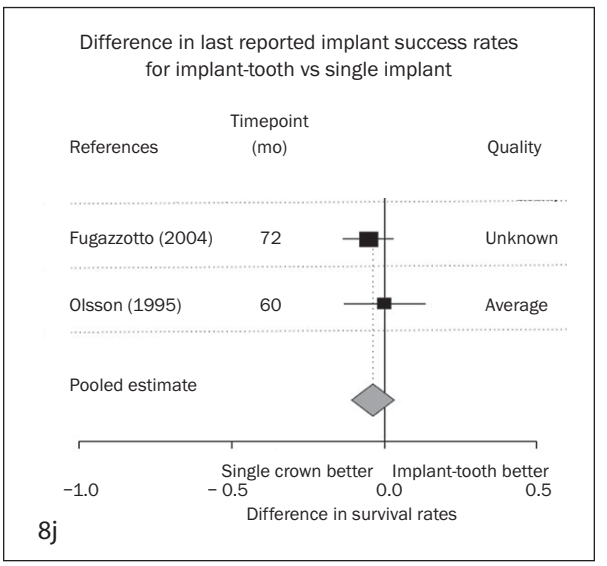

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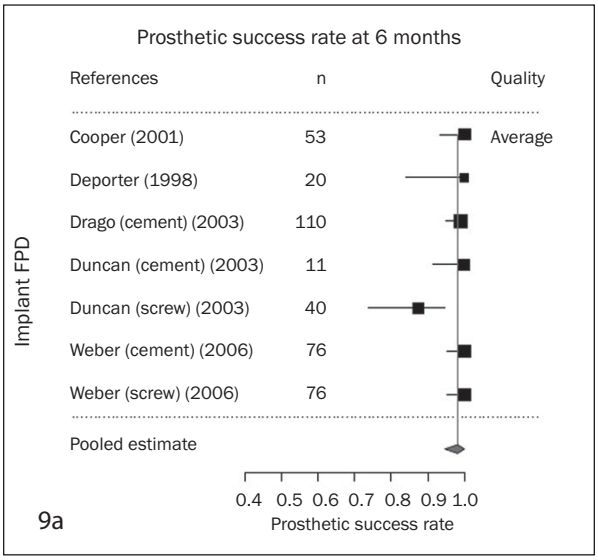
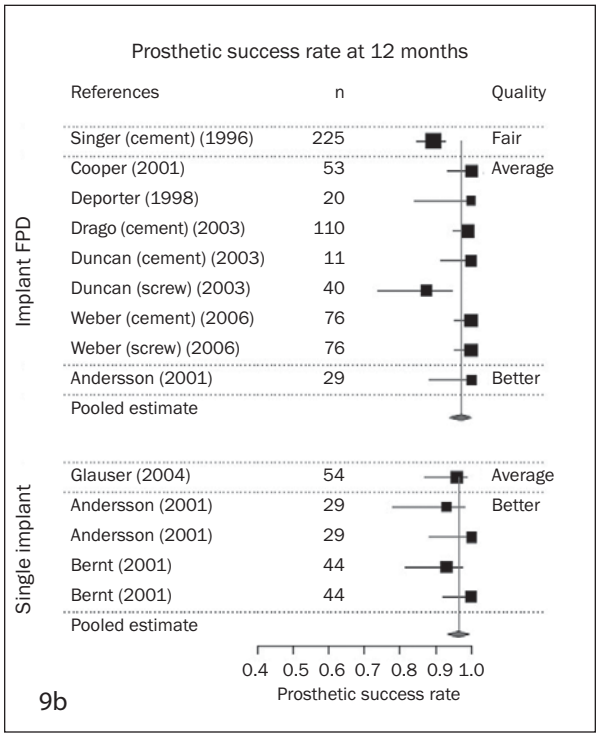
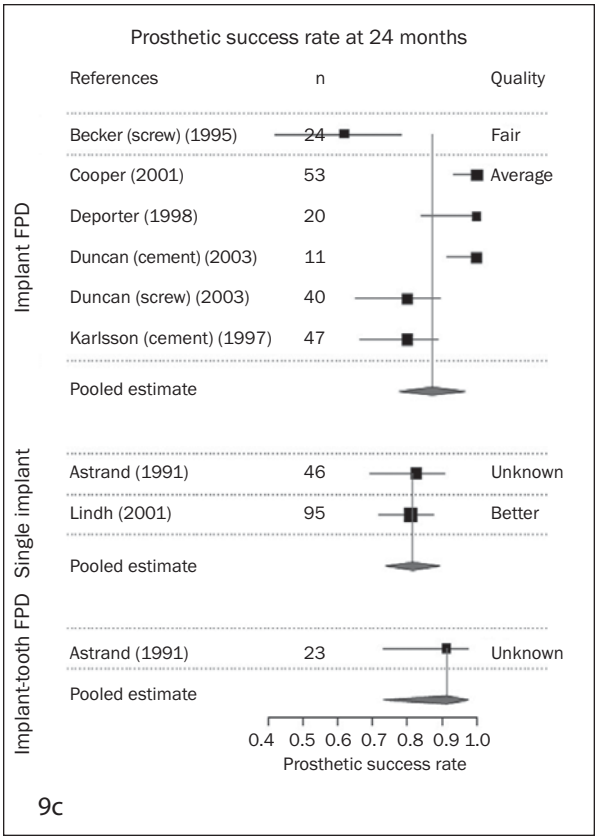
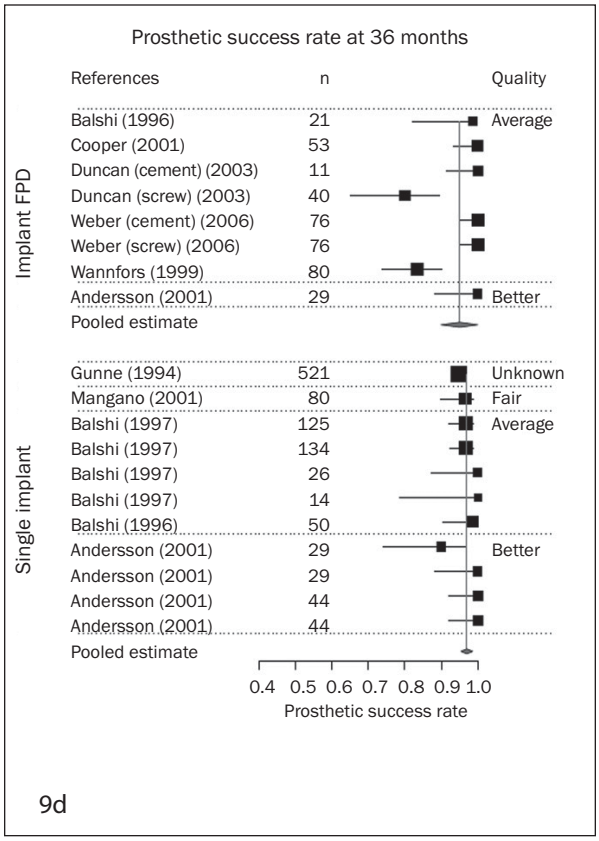
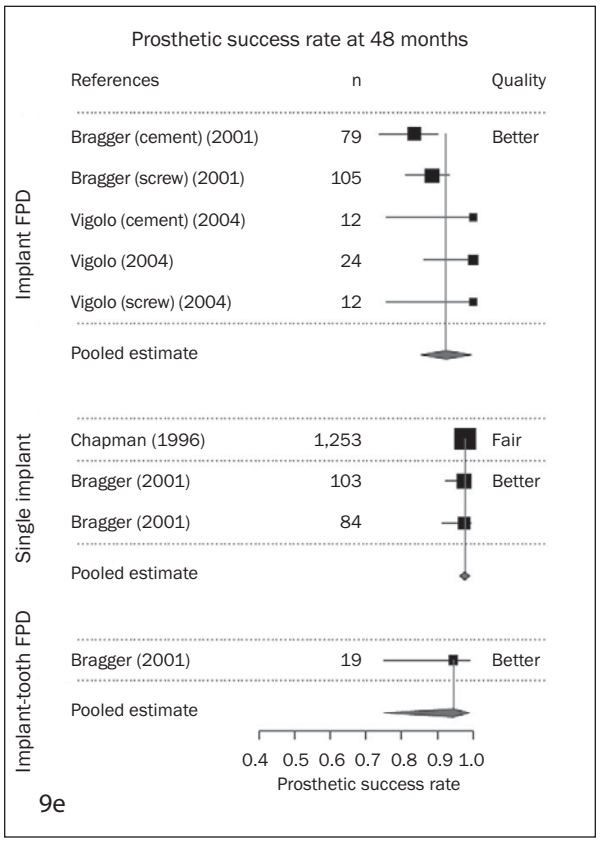
Fig 9 Prosthetic success rate at various timepoints between implant-supported FPDs, implant-tooth–supported FPDs, and single-implant restorations.











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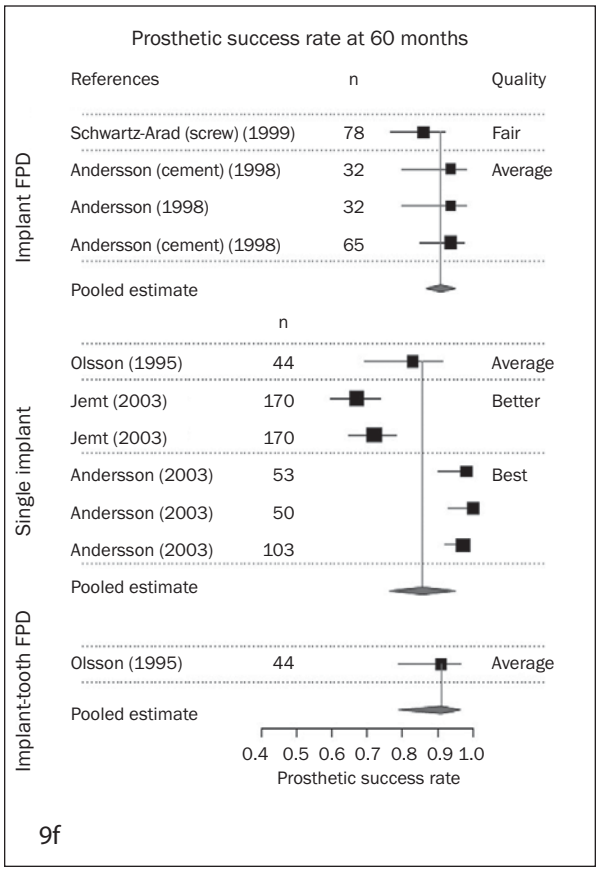

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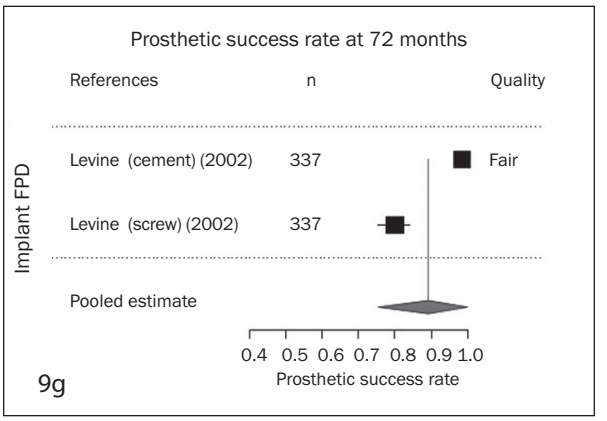

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Table 9 CIs for Proportion Estimate on Prosthetic Success Rates for Implant-Supported FPDs, Implant-Tooth–Supported FPDs and Single-Implant Restorations at Various Timepoints

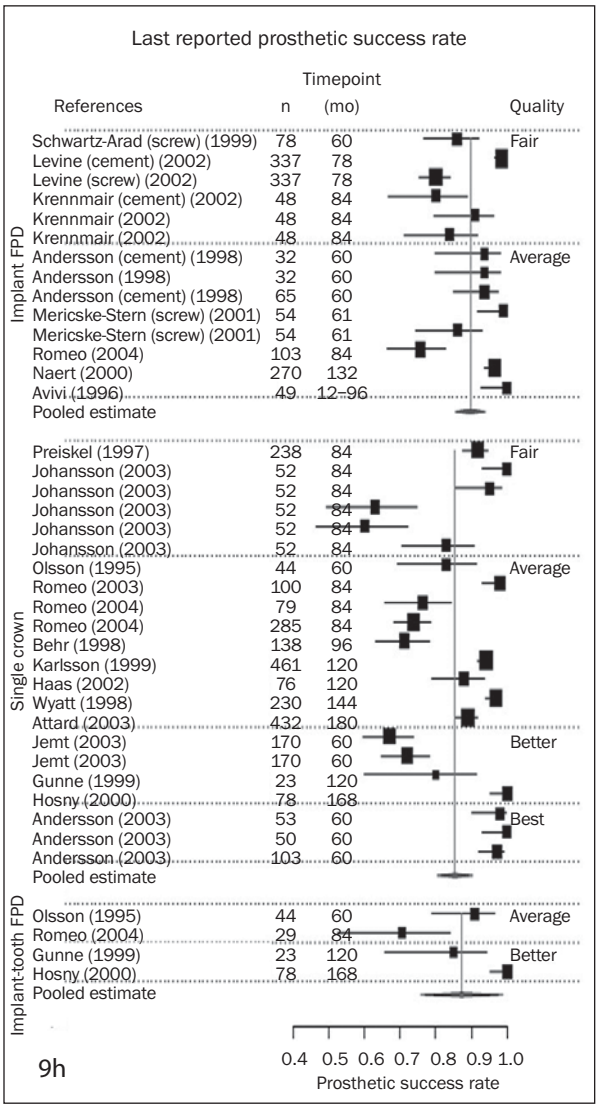
Treatment	Proportion estimate	95% CI
6 mo		
Implant	0.981	0.947–1.000
Single implant	–	–
Implant-tooth	–	–
12 mo		
Implant	0.972	0.938–1.000
Single implant	0.964	0.934–0.994
Implant-tooth	–	–
24 mo		
Implant	0.872	0.777–0.967
Single implant	0.816	0.738–0.894
Implant-tooth	0.913	0.732–0.976
36 mo		
Implant	0.951	0.899–1.000
Single implant	0.970	0.954–0.986
Implant-tooth	–	–
48 mo		
Implant	0.925	0.854–0.996
Single implant	0.977	0.963–0.991
Implant-tooth	0.945	0.750–0.990
60 mo		
Implant	0.909	0.868–0.950
Single implant	0.857	0.763–0.951
Implant-tooth	0.910	0.790–0.965
72 mo		
Implant	0.892	0.754–1.000
Single implant	–	–
Implant-tooth	–	–
Last examination		
Implant	0.897	0.855–0.939
Single implant	0.854	0.805–0.903
Implant-tooth	0.873	0.758–0.988

difference of 0.0007 was found, with a 95% CI of –0.227 to 0.024 ($z = 0.0548$; $P = .9563$).

3. Does the type of abutment used for retaining a restoration influence the outcome?

4. Does the restorative material influence the outcome?

This systematic review did not reveal sufficient data to answer questions 3 and 4, primarily due to a lack of extractable information.



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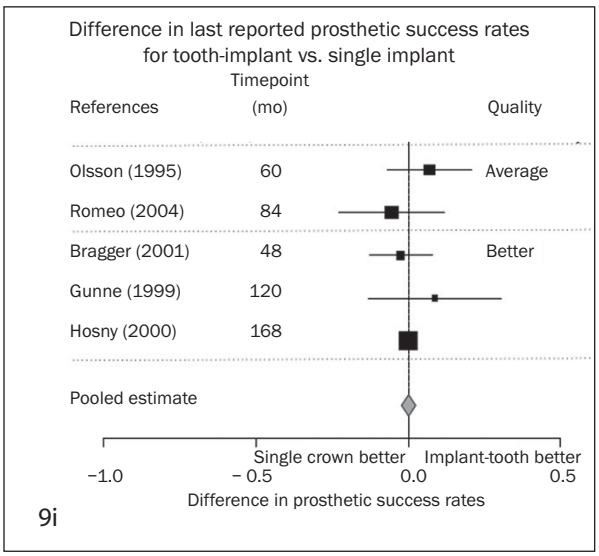

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DISCUSSION

This systematic review was intended to summarize the literature relative to clinical outcomes as measured by implant success, implant survival, and prosthesis success for fixed restorations in partially edentulous arches. The central PICO question "Does the type of implant prosthesis affect outcomes in the partially edentulous arch?" was divided into 4 subquestions which are frequently asked by clinicians who need to make evidence-based clinical decisions:

1. Does the method of retention (screw-retained versus cemented) influence the outcome?
2. Does the difference in support influence the outcome?
   (a) Implant only versus implant-tooth–supported FPD
   (b) Single-implant restorations versus splinted restorations on multiple implants
3. Does the type of abutment used for retaining a restoration influence the outcome?
4. Does the restorative material influence the outcome?

Overall, it was difficult, to say the least, to apply scientific strategies to the review process. The quality of the studies was primarily in the average range according to the criteria applied for this review (best-better-good-average-fair). Only 2 RCTs were identified. One of them included 30 subjects with 103 implants, the other only 12 subjects with 24 implants. The heterogeneity between studies was substantial in terms of study aims, designs, sample size, assessment of treatment outcomes, observation points, and duration of follow-up. None of the PICO questions was found to have been properly addressed through RCTs with adequate patient numbers. The heterogeneity was further compounded by the multiplicity of implant systems and components used in these studies, as well as by the involved clinicians' independent decisions in treatment planning and application of implant restorative techniques. An additional substantial limitation lies in the fact that implant systems and components are constantly changing, thus presenting moving targets in terms of the creation of scientific evidence. Whereas many of the implants included in this review were of the external hexagon type, the field has predominantly shifted to internal abutment connections, especially in the partially edentulous indication.

The variability in reporting outcomes (eg, implant success, implant survival, prosthesis success) was substantial as well. Whereas a few authors used success criteria as proposed in the literature, most others applied their own measures, which often were not well described, to determine an outcome. Implant survival was more likely to be the outcome measure than well-defined implant success.

Although the qualitative value of the evidence created by this review may be average at best because of the lack in quality of the reviewed literature, a few encouraging observations can be made. Overall, the type of restoration seems to have little impact on implant survival or success in the partially edentulous indication. None of the comparisons made in the attempt to answer the PICO questions revealed statistically significant differences in implant survival or implant success or prosthesis success. This may be attributed to the fine performance of the supporting implants and the long-term stability of the implant-bone interface after completion of healing. Also, the observation periods may not have been long enough to determine implant failures caused by variations in the prosthetic domain.

Screw-retained and cemented restorations performed equally well with regard to implant success or survival. Prosthetic success was better for cemented restorations (93%) in comparison to screw-retained restorations (83%) at the last examination (6 years or longer follow-up). Although the difference appears to be substantial, it was not statistically significant. The finding is not surprising, as loosening and fracture of prosthesis screws combined have an incidence of 11% among mechanical implant complications.[85]

The type of implant support used for fixed restorations in the partially edentulous arch appeared not to affect implant survival and success over observation periods of ≥ 5 years. This finding is somewhat different from that of Lindh and associates,[5] who found in their meta-analysis that implant survival was slightly better with single crowns than with FPDs. There appeared to be a trend toward lower prosthesis success rates with single-implant restorations, although it was not apparent at earlier observation times. The largest controversy in the field regarding FPD support is most probably that involving the combination of implant and tooth support. The present review did not reveal a greater risk for implant-tooth combinations. This is in contrast to a systematic review by Pjetursson and colleagues,[9] who determined a greater risk for implant failure after 10 years of function for implants used in implant-tooth combinations compared to implants supporting FPDs supported by implants alone.

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SECTION 6
CONSENSUS REPORT

Does the type of implant prosthesis affect outcomes in the partially edentulous arch?

Members of Section 6 evaluated the systematic review on the outcomes of various implant prostheses for the partially edentulous arch. The focused PICO question addressed by the authors, Hans-Peter Weber and Cortino Sukotjo, of the evidence-based systematic review is: Does the type of implant prosthesis affect outcomes in the partially edentulous arch?

1. Does the section agree that the systematic review is complete and accurate?
Yes.

2. Has any new information been generated or discovered since the review cutoff time?
An additional paper (Bragger U, Karoussis I, Persson R, Pjetursson B, Salvi G, Lang N. Technical and biological complications/failures with single crowns and fixed partial dentures on implants: A 10-year prospective cohort study. Clin Oral Implants Res 2005;16:326–334) was included because it presented data from an additional patient cohort with respect to the 5-year data from the same authors. The authors concluded that, "The implant-tooth fixed partial denture (FPD) had statistically significantly more frequent technical failures compared with the single crown and implant-implant FPD." Specifically, they did not observe technical failures in implant-implant FPDs (0 failures at 10 years) while the implant-tooth FPDs exhibited 4 failures (18.2% at 10 years).

3. Does the section agree with the interpretation and conclusion of the reviewers?
Yes. However, the section was concerned that much of the available literature was not designed to address prosthodontic parameters of success and failure.

The additional data reinforced the conclusions presented by the reviewers.

4. What further research needs to be done relative to the PICO question?
Studies need to be designed to address prosthodontic and treatment plan questions. Primary outcomes should be selected to answer these questions.

- Randomized controlled clinical trials are needed to properly assess the impact of restoration design on: *(1)* marginal hard and soft tissues and *(2)* implant and prosthodontic survival/success. Cohort and retrospective studies remain of value to assess clinical performance and prognostic factors.
- Greater detail in prosthodontic reporting is critical, including the definition(s) of success. A consensus conference is necessary to define the parameters of prosthodontic success in implant dentistry.
- Longer follow-up periods tend to better identify differences in prosthodontic function and success rates.

It is recommended that the AO Foundation create a national network (database) to track surgical and prosthodontic parameters and outcomes of implant therapy.

5. How can the information from the systematic review be applied for patient management?
There is a lack of scientific evidence regarding prosthodontic parameters for implant-supported restorations. Factors such as the clinical situation, patient/clinician preference, esthetics, retrievability, and cost influence clinical decision making and have not been examined scientifically to date.

There is a lack of scientific evidence supporting the choice of screw-retention versus cementation as it pertains to success of the implant and/or prosthesis.

There is a lack of scientific evidence supporting the choice of using multiple single-unit restorations versus splinted restorations supported by dental implants.

After review of the limited available evidence, it appears that connecting implants to teeth may lead to a higher rate of complications/failures.

Careful consideration should be given to the application of existing evidence because implant systems, components, and prosthodontic materials are constantly changing, thus presenting "moving targets" in terms of the adaptability to current treatment modalities (ie, external versus internal connection).

Table W1 Excluded Studies and Reasons for Exclusion

Study	Study aims	Exclusion reason
1. Bakaeen LG, Winkler S, Neff PA. The effect of implant diameter, restoration design, and occlusal table variations on screw loosening of posterior single-tooth implant restorations. J Oral Implantol 2001;27:63–72.	(1) To determine in vitro the effect of narrowing the buccolingual width of the occlusal table on the torque required to loosen gold prosthetic screws after subjecting implants and implant-supported restorations to occlusal loads and (2) to compare the incidence of screw loosening and untightening torque values of the screws among crowns supported by 1 wide-diameter as opposed to 2 standard implants after loading in vitro	In vitro study
2. Bambini F, Lo Muzio L, Procaccini M. Retrospective analysis of the influence of abutment structure design on the success of implant unit. A 3-year controlled follow-up study. Clin Oral Implants Res 2001;12:319–324.	To examine the failure of the retaining screws of 2 different antirotational systems (the Threadloc system with hexagonal polyhedral extension and the Spline system)	Not commonly used system
3. Bergendal B, Palmqvist S. Laser-welded titanium frameworks for fixed prostheses supported by osseointegrated implants: A 2-year multicenter study report. Int J Oral Maxillofac Implants 1995;10:199–206.	To evaluate the clinical performance of fixed prostheses supported by osseointegrated implants with laser-welded titanium frameworks in a prospective multicenter study	Mix of partially and completely edentulous patients
4. Davarpanah M, Martinez H, Celletti R, Alcoforado G, Tecucianu JF, Etienne D. Osseotite implant: 3-year prospective multicenter evaluation. Clin Implant Dent Relat Res 2001;3:111–118.	To evaluate the cumulative success rate of the Osseotite implant after 3 years of prosthetic loading	Mix of partially and completely edentulous patients
5. Davarpanah M, Martinez H, Etienne D, Zabalegui I, Mattout P, Chiche F, Michel JF. A prospective multicenter evaluation of 1,583 3i implants: 1- to 5-year data. Int J Oral Maxillofac Implants 2002;17:820–828.	To evaluate the efficacy of 3i threaded implants for the treatment of edentulous patients in a 1- to 5-year period	No data regarding prosthetics could be extracted
6. Davarpanah M, Martinez H, Tecucianu JF, Alcoforado G, Etienne D, Celletti R. The self-tapping and ICE 3i implants: A prospective 3-year multicenter evaluation. Int J Oral Maxillofac Implants 2001;16:52–60.	To determine the therapeutic success and marginal bone level stability of 3i's self-tapping and ICE implants after 3 years of prosthetic loading	Mix of partially and completely edentulous patients
7. Deporter D, Pilliar RM, Todescan R, Watson P, Pharoah M. Managing the posterior mandible of partially edentulous patients with short, porous-surfaced dental implants: Early data from a clinical trial. Int J Oral Maxillofac Implants 2001;16:653–658.	To determine the efficacy of sintered porous-surfaced dental implants (Endopore) in humans	No data regarding prosthetics could be extracted
8. Deporter DA, Todescan R, Watson PA, Pharoah M, Pilliar RM, Tomlinson G. A prospective human clinical trial of Endopore dental implants in restoring the partially edentulous maxilla using fixed prostheses. Int J Oral Maxillofac Implants 2001;16:527–536.	To determine the efficacy of sintered porous-surfaced dental implants (Endopore) in humans	No data regarding prosthetics could be extracted
9. Eger DE, Gunsolley JC, Feldman S. Comparison of angled and standard abutments and their effect on clinical outcomes: A preliminary report. Int J Oral Maxillofac Implants 2000;15:819–823.	To compare the success of implants restored with angled abutments to implants restored with standard abutments, 81 implants in 24 patients were evaluated for up to 36 months	No data regarding prosthetics could be extracted
10. Mordenfeld MH, Johansson A, Hedin M, Billstrom C, Fyrberg KA. A retrospective clinical study of wide-diameter implants used in posterior edentulous areas. Int J Oral Maxillofac Implants 2004;19:387–392.	To examine retrospectively the outcome of wide-diameter dental implants used to retain fixed restorations in the posterior segments of the maxilla and mandible	No data regarding prosthetics could be extracted
11. Naert I, Duyck J, Hosny M, Jacobs R, Quirynen M, van Steenberghe D. Evaluation of factors influencing the marginal bone stability around implants in the treatment of partial edentulism. Clin Implant Dent Relat Res 2001;3:30–38.	To investigate the impact of those parameters that deviate from the original protocol as defined by P-I Brånemark	No data regarding prosthetics could be extracted
12. Naert I, Koutsikakis G, Quirynen M, Duyck J, van Steenberghe D, Jacobs R. Biologic outcome of implant-supported restorations in the treatment of partial edentulism. Part 2: A longitudinal radiographic study. Clin Oral Implants Res 2002;13:390–395.	To evaluate over time the marginal bone level changes around implants placed to treat partial edentulism and to investigate the possible effects of several confounding variables	No data regarding prosthetics could be extracted

Table W1 Excluded Studies and Reasons for Exclusion

Study	Study aims	Exclusion reason
13. Naert IE, Duyck JA, Hosny MM, Quirynen M, van Steenberghe D. Freestanding and tooth-implant connected prostheses in the treatment of partially edentulous patients Part II: An up to 15-years radiographic evaluation. Clin Oral Implants Res 2001;12:245–251.	To evaluate the marginal bone stability around tooth/implant-connected prostheses as well as freestanding prostheses	No data regarding prosthetics could be extracted
14. Naert IE, Rosenberg D, van Steenberghe D, Tricio JA, Nys M.The influence of splinting procedures on the periodontal and peri-implant tissue damping characteristics. A longitudinal study with the Periotest device. J Clin Periodontol 1995;22:703–708.	To evaluate the capability of the Periotest device in detecting and monitoring functional changes in the periodontal as well as in the peri-implant tissue damping characteristics	No data regarding prosthetics could be extracted
15. Nedir R, Bischof M, Briaux JM, Beyer S, Szmukler-Moncler S, Bernard JP. A 7-year life table analysis from a prospective study on ITI implants with special emphasis on the use of short implants. Results from a private practice. Clin Oral Implants Res 2004;15:150–157.	To report on a 7-year life table analysis on the use of ITI implants in private practice environments	Mix of partially and completely edentulous patients
16. Nevins M, Langer B. The successful application of osseointegrated implants to the posterior jaw: A long-term retrospective study. Int J Oral Maxillofac Implants 1993;8:428–432.	To measure the efficacy of osseointegration when applied specifically to the maxillary and mandibular posterior regions	No data regarding prosthetics could be extracted
17. Puchades-Roman L, Palmer RM, Palmer PJ, Howe LC, Ide M, Wilson RF. A clinical, radiographic, and microbiologic comparison of Astra Tech and Brånemark single tooth implants. Clin Implant Dent Relat Res 2000;2:78–84.	To assess whether the design characteristics of dental implants, particularly the implant-abutment junction, may affect the dimensions and health of the peri-implant soft tissues and radiographic bone levels	No data regarding prosthetics could be extracted
18. Carr AB, Choi YG, Eckert SE, Desjardins RP. Retrospective cohort study of the clinical performance of 1-stage dental implants. Int J Oral Maxillofac Implants 2003;18:399–405.	To evaluate long-term clinical performance of 1-stage dental implant prostheses at a single clinic, emphasizing clinical and demographic characteristics that affect implant survival	Mix of partially and completely edentulous patients
19. Aparicio C. A new method to routinely achieve passive fit of ceramometal prostheses over Brånemark osseointegrated implants:A two-year report. Int J Periodontics Restorative Dent 1994;14:404–419.	To evaluate the clinical behavior of 214 modified gold cylinders on which ceramometal structures were cemented using the principle of adhesion of resins to metallic surfaces treated with the silicoater system and an improved cementing protocol	Laboratory procedures
20. Arlin ML. Analysis of 435 screw-vent dental implants placed in 161 patients: Software enhancement of clinical evaluation. Implant Dent 2002;11(1):58–66.	To demonstrate how a computer software program was utilized in a private practice to supplement the clinical evaluation of 1 implant system	Laboratory procedures
21. Bornstein MM, Schmid B, Belser UC, Lussi A, Buser D. Early loading of non-submerged titanium implants with a sandblasted and acid-etched surface. 5-year results of a prospective study in partially edentulous patients. Clin Oral Implants Res 2005;16: 631–638.	To evaluate the success rate of titanium screw-type implants with the sandblasted and acid-etched surface loaded early (after 6 weeks of healing)	No data regarding prosthetics could be extracted
22. Buser D, Mericske-Stern R, Bernard JP, Behneke A, Behneke N, Hirt HP, Belser UC, Lang NP. Long-term evaluation of non-submerged ITI implants. Part 1: 8-year life table analysis of a prospective multi-center study with 2359 implants. Clin Oral Implants Res 1997;8:161–172.	To evaluate the cumulative survival and success rates of 2,359 consecutively inserted ITI implants over a period of 8 years utilizing the life table analysis of Cutler and Ederer	Mix of partially and completely edentulous patients
23. Cardaropoli G, Wennstrom JL, Lekholm U. Peri-implant bone alterations in relation to inter-unit distances. A 3-year retrospective study. Clin Oral Implants Res 2003;14:430–436.	To evaluate longitudinal alterations in radiographic bone topography at proximal sites of 3-unit implant-supported fixed partial prostheses during the first 3 years after delivery in relation to vertical and horizontal interunit distances	No data regarding prosthetics could be extracted
24. Chiche GJ, Pinault A. Considerations for fabrication of implant-supported posterior restorations. Int J Prosthodont. 1991;4:37–44.	To review the principles governing fixed restorations supported by posterior dental implants	Laboratory procedures

Table W1 Excluded Studies and Reasons for Exclusion

Study	Study aims	Exclusion reason
25. el Charkawi HG, Zekry KA, el Wakad MT. Stress analysis of different osseointegrated implants supporting a distal extension prosthesis. J Prosthet Dent 1994;72:614–622.	To evaluate the new titanium plasma-sprayed implant modification system	In vitro study
26. Friberg B, Ekestubbe A, Sennerby L. Clinical outcome of Brånemark System implants of various diameters: A retrospective study. Int J Oral Maxillofac Implants 2002;17:671–677.	To evaluate the outcome of the 3 different diameters of Brånemark System implants, with special focus on the 5.0-mm-diameter implant	No data regarding prosthetics could be extracted
27. Gaggl A, Schultes G. Clinical experiences with a new maintenance-free shock absorbing element in titanium implants. Implant Dent 2001;10:246–253.	To evaluate the new implant system	Clinical experience, anecdotal
28. Garlini G, Bianchi C, Chierichetti V, Sigurta D, Maiorana C, Santoro F. Retrospective clinical study of Osseotite implants: Zero- to 5-year results. Int J Oral Maxillofac Implants 2003;18:589–593.	To evaluate a clinical trial of Osseotite implants	Mix of partially and completely edentulous patients
29. Sethi A, Sochor P. The lateral fixation screw in implant dentistry. Eur J Prosthodont Restor Dent 2000;8:39–43.	To evaluate the results of the treatment strategy	Clinical report
30. Shackleton JL, Carr L, Slabbert JC, Becker PJ. Survival of fixed implant-supported prostheses related to cantilever lengths. J Prosthet Dent 1994;71:23–26.	To examine survival of fixed implant-supported prostheses using different cantilever lengths	Edentulous patients
31. Snauwaert K, Duyck J, van Steenberghe D, Quirynen M, Naert I. Time dependent failure rate and marginal bone loss of implant supported prostheses: A 15-year follow-up study. Clin Oral Investig 2000;4:13–20.	To follow 4,971 implants (Brånemark system) installed in 1,315 patients, either fully or partially edentulous, from implant installation up to the last control	No data regarding prosthetics could be extracted
32. Sullivan DY, Sherwood RL, Porter SS. Long-term performance of Osseotite implants: A 6-year clinical follow-up. Compend Contin Educ Dent 2001;22: 326-328, 330, 332–334.	To report the clinical results of Osseotite implants initially published in 1997	No data regarding prosthetics could be extracted
33. Teixeira ER, Wadamoto M, Akagawa Y, Kimoto T. Clinical application of short hydroxylapatite-coated dental implants to the posterior mandible: A five-year survival study. J Prosthet Dent 1997;78: 166–171.	To investigate the applicability of short hydroxylapatite-coated dental implants to the posterior mandible of partially edentulous patients	No data regarding prosthetics could be extracted
34. Vehemente VA, Chuang SK, Daher S, Muftu A, Dodson TB. Risk factors affecting dental implant survival. J Oral Implantol 2002;28(2):74–81.	(1) To estimate the 1- and 5-year survival of Bicon dental implants and (2) to identify risk factors associated with implant failure in an objective, statistically valid manner	Mix of partially and completely edentulous patients
35. Walton JN, MacEntee MI. Problems with prostheses on implants: A retrospective study. J Prosthet Dent 1994;71:283–288.	To retrospectively evaluate both patient satisfaction and maintenance for 156 patients	Mix of partially and completely edentulous patients
36. Weber HP, Crohin CC, Fiorellini JP. A 5-year prospective clinical and radiographic study of non-submerged dental implants. Clin Oral Implants Res 2000;11:144–153.	To allow correlation of observed bone level changes with clinical parameters as measured by suppuration, plaque indices, bleeding indices, probing depth, attachment level and mobility	No data regarding prosthetics could be extracted
37. Weng D, Jacobson Z, Tarnow D, Hurzeler MB, Faehn O, Sanavi F, Barkvoll P, Stach RM. A prospective multicenter clinical trial of 3i machined-surface implants: Results after 6 years of follow-up. Int J Oral Maxillofac Implants 2003;18:417–423.	To evaluate the 1,179 3i standard threaded and self-tapping implants for up to 6 years and monitored according to established success criteria	No data regarding prosthetics could be extracted
38. Wheeler SL. Eight-year clinical retrospective study of titanium plasma-sprayed and hydroxyapatite-coated cylinder implants. Int J Oral Maxillofac Implants 1996;11:340–350.	To analyze the results of all implants placed in an objective manner	No data regarding prosthetics could be extracted
39. Zinsli B, Sagesser T, Mericske E, Mericske-Stern R. Clinical evaluation of small-diameter ITI implants: A prospective study. Int J Oral Maxillofac Implants 2004;19:92–99.	The clinical evaluation of 3.3-mm ITI implants that had been consecutively placed over a 10-year interval	Mix of partially and completely edentulous patient

Table W1 Excluded Studies and Reasons for Exclusion

Study	Study aims	Exclusion reason
40. McMillan AS, Allen PF, Bin Ismail I. A retrospective multicenter evaluation of single tooth implant experience at three centers in the United Kingdom. J Prosthet Dent 1998;79:410–414.	To investigate the nature, timing, and frequency of complications associated with single-tooth implant therapy in a dental hospital and 2 dental offices	No comprehensive data regarding prosthetics could be extracted
41. Moberg LE, Kondell PA, Kullman L, Heimdahl A, Gynther GW. Evaluation of single-tooth restorations on ITI dental implants. A prospective study of 29 patients. Clin Oral Implants Res 1999;10:45–53.	To present the 5-year outcome of treatment of single missing maxillary incisor teeth replaced using the ITI Dental Implant System	No comprehensive data regarding prosthetics could be extracted
42. Scurria MS, Morgan ZV 4th, Guckes AD, Li S, Koch G. Prognostic variables associated with implant failure: A retrospective effectiveness study. Int J Oral Maxillofac Implants 1998;13:400–406.	To determine implant survival rates by means of life table analyses for a cohort of patients not part of a prospective efficacy trial and treated by practitioners at varying experience levels	Mix of partially and completely edentulous patients
43. Bianco G, Di Raimondo R, Luongo G, Paoleschi C, Piccoli P, Piccoli C, Rangert B. Osseointegrated implant for single-tooth replacement: A retrospective multicenter study on routine use in private practice. Clin Implant Dent Relat Res 2000;2:152–158.	The purpose of the study was to evaluate implant survival and prosthesis stability of Brånemark implants (titanium screws) when used routinely for single-tooth replacement in all regions	No data regarding prosthetics could be extracted
44. Lazzara R, Siddiqui AA, Binon P, Feldman SA, Weiner R, Phillips R, Gonshor A Retrospective multicenter analysis of 3i endosseous dental implants placed over a five-year period. Clin Oral Implants Res 1996;7:73–83.	To review 5 years of retrospective data accumulated from 6 centers in the United States and 2 elsewhere	No data regarding prosthetics could be extracted
45. Mayer TM, Hawley CE, Gunsolley JC, Feldman S. The single-tooth implant: a viable alternative for single-tooth replacement J Periodontol 2002;73: 687–693.	To evaluate the cumulative success rate of dual acid-etched single-tooth replacement implants in 2 clinical centers	No data regarding prosthetics could be extracted
46. McDermott NE, Chuang SK, Woo VV, Dodson TB. Complications of dental implants: Identification, frequency, and associated risk factors. Int J Oral Maxillofac Implants 2003;18:848–855.	To identify the types, frequencies, and risk factors associated with complications following placement of dental implants. It was hypothesized that 1 or more factors could be identified that are associated with an increased risk for complications and may be modified by the clinician to enhance outcome	Mix of partially and completely edentulous patients
47. Arlin ML. Analysis of 435 screw-vent dental implants placed in 161 patients: Software enhancement of clinical evaluation. Implant Dent 2002;11:58–66.	To evaluate the dental implant systems used in their practices by using a computer software program	No data regarding prosthetics could be extracted
48. Gotfredsen K, Karlsson U. A prospective 5-year study of fixed partial prostheses supported by implants with machined and TiO_2-blasted surface. J Prosthodont 2001;10:2–7.	To evaluate whether there was a difference between machined and $TiO_{(2)}$-blasted implants regarding survival rate and marginal bone loss during a 5-year observation period	No comprehensive data regarding prosthetics could be extracted
49. Henry PJ, Laney WR, Jemt T, Harris D, Krogh PH, Polizzi G, Zarb GA, Herrmann I. Osseointegrated implants for single-tooth replacement: A prospective 5-year multicenter study. Int J Oral Maxillofac Implants 1996;11:450–455.	To present final treatment outcome and clinical effectiveness following 5 years of functional loading	No comprehensive data regarding prosthetics could be extracted
50. Hellden L, Ericson G, Elliot A, Fornell J, Holmgren K, Nilner K, Olsson CO. A prospective 5-year multicenter study of the Cresco implantology concept. Int J Prosthodont 2003;16:554–562.	To investigate the clinical and radiographic outcome of a prospective 5-year longitudinal multicenter test of a simplified implantology concept comprising an abutment-free implant system (Cresco) and a new method for fabrication of passively fitting superstructures, the Cresco Ti Precision method	Technique article
51. Ivanoff CJ, Grondahl K, Sennerby L, Bergstrom C, Lekholm U. Influence of variations in implant diameters: A 3- to 5-year retrospective clinical report. Int J Oral Maxillofac Implants 1999;14:173–180.	The objective of this 3-year prospective study was to evaluate a new titanium dental implant system and to identify any mechanical concerns or deficiencies in its design	Mix of partially and completely edentulous patients
52. Johnson RH, Persson GR. A 3-year prospective study of a single-tooth implant–Prosthodontic complications. Int J Prosthodont 2001;14:183–189.	The objective of this 3-year prospective study was to evaluate a new titanium dental implant system and to identify any mechanical concerns or deficiencies in its design	No comprehensive data regarding prosthetics could be extracted

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Study	Study aims	Exclusion reason
53. Jemt T, Pettersson P. A 3-year follow-up study on single implant treatment. J Dent 1993;21:203–208.	To investigate restorative and postinsertion problems in patients provided with single implant-supported restorations	No comprehensive data regarding prosthetics could be extracted
54. Jones JD, Lupori J, Van Sickels JE, Gardner W. A 5-year comparison of hydroxy-apatite coated titanium plasma-sprayed and titanium plasma-sprayed cylinder dental implants. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1999;87:649–652.	To present findings pertaining to the long-term success associated with the 2 implants system after prosthetic loading	No comprehensive data regarding prosthetics could be extracted
55. Jemt T, Henry P, Linden B, Naert I, Weber H, Wendelhag I. Implant-supported laser-welded titanium and conventional cast frameworks in the partially edentulous law: A 5-year prospective multicenter study. Int J Prosthodont 2003 Jul-Aug;16(4):415–421.	This study evaluated and compared the clinical performance of laser-welded titanium fixed partial implant-supported prostheses with that of conventional cast frameworks in the partially edentulous jaw	Study about framework; no comprehensive data regarding prosthetics could be extracted
56. Kastenbaum F, Lewis S, Naert I, Palmquist C. The EsthetiCone abutment: Three-year results of a prospective multicenter investigation. Clin Oral Implants Res 1998;9:178–184.	To report the long-term results of treatment which utilized the esthetic cone abutment	No comprehensive data regarding prosthetics could be extracted
57. Kemppainen P, Eskola S, Ylipaavalniemi P. A comparative prospective clinical study of two single-tooth implants: A preliminary report of 102 implants. J Prosthet Dent 1997;77:382–327.	To provide a preliminary comparative evaluation of 2 implants (ITI and Astra) in single-tooth restorations	No comprehensive data regarding prosthetics could be extracted
58. Khayat PG, Hallage PG, Toledo RA. An investigation of 131 consecutively placed wide screw-vent implants. Int J Oral Maxillofac Implants 2001;16:827–832.	To determine survival rates of wide Screw-Vent implants and to evaluate marginal bone loss around these implants at least 1 year after completion of the prosthetic treatment	No comprehensive data regarding prosthetics could be extracted
59. Kucey BK. Implant placement in prosthodontics practice: A five-year retrospective study. J Prosthet Dent 1997;77:171-176.	To analyze the treatment of completely and partially edentulous patients in a prosthodontics practice and the Edmonton Implant Seminar	Mix of partially and completely edentulous patients