What Is the Effect on Outcomes of Time-to-Loading of a Fixed or Removable Prosthesis Placed on Implant(s)?

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Purpose: *A systematic review of the available literature to assess the effects of time to loading of implants on treatment outcomes.* ***Methods:*** *PubMed search strategies identifying clinical trials on implant prosthetics, combined with searching of a personal library and reference lists from included studies, resulted in 1,882 titles published before May 1, 2005. Two independent reviewers appraised the titles and abstracts and identified 187 papers that seemed to focus on the effects of time to loading on treatment outcomes in clinical trials. These papers were retrieved and critically appraised in full text. A set of predefined inclusion and exclusion criteria were applied. All trials (randomized and nonrandomized clinical trials, prospective and retrospective) were included in the review if both an experimental and a control group were adequately described, if the implants had been followed for at least 1 year, and if the sample contained at least 5 patients.* ***Results:*** *Twenty-two papers, published between 1990 and 2005 described the influence of time to loading on implant treatment success. Seven trials were randomized controlled trials, 13 were prospective with concurrent controls, and 2 were retrospective with concurrent controls. The general impression of the papers was that* (1) *the methodologic rigor of the trials was often not very strong,* (2) *the reported treatment outcomes were mostly surrogate rather than patient-centered, and* (3) *the follow-up times were relatively short. Statistical comparisons between subgroups were considered inappropriate because of the heterogeneity of trials. Data from 19 trials reporting different patient follow-up periods between 1 and 10 years suggest that the overall performance was not significantly different between immediate or early loaded implants versus implants using a conventional loading period.* ***Conclusion:*** *Within the limitations of the study populations in the papers appraised in this systematic review, although the average outcome was in favor of delayed loading, there are no indications that immediate or early loading cannot be a safe procedure.* Int J Oral Maxillofac Implants 2007;22(suppl):19–48

Key words: *early loading, immediate loading, oral implants, osseointegration, prosthodontics*

The Brånemark group in Gothenburg established the principles of modern implant treatment some 30 years ago.[1] Their long-term clinical studies showed that screw-type implants made from titanium could osseointegrate with bone intraorally and that abutments penetrating the mucosa could support a fixed prosthesis in a predictable manner over many years.[2,3] The investigators took precautions regarding the various operational steps of the treatment because of the many years of trial-and-error treatments that had been carried out on patients previously without proper understanding of the basic mechanism underlying implant osseointegration. The surgical procedure was a 2-stage process requiring an unloaded initial stage, since it was presumed that a load would inhibit osseous healing and thereby compromise proper osseointegration. Dental implants had until then commonly been loaded at placement, because it was believed that the stimulation of immediate loading resulted in less crestal bone loss, although at the time the results were unpredictable.[4] Brånemark and his fellow investigators emphasized not only the use of a 2-stage process but also the need to install only screw-type implants that had been turned with a particular machining process and made from grade 1 commercially pure titanium, in spite of contemporary research that demonstrated promising results using,

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for example, titanium alloys, alternative surface treatments such as titanium plasma-spray, and implants placed using a 1-stage surgical procedure.[5–7] Since then, continued research has given the profession a greater understanding of the physiology, mechanical stresses, and bone remodeling processes following insertion of dental implants into jawbones, though much remains to be learned about basic osseointegration processes. Additionally, implant treatment has been embraced by the general dental community, leading to an explosion of implant manufacturers and implant brands, a vast array of biomaterials with various types of surface treatments,[8] and a renewed interest in alternative approaches for surgical implant procedures.

Currently, one such active research area is focused on the merits and risks of immediate loading for complete or partial edentulism and for single crowns. The advantages to the patient of early loading seem logical, since the technique allows the patient to resume function quickly after surgery and avoid provisional restoration placement. Many papers with a focus on early loading can be found in the published literature. Very few of these are randomized clinical trials with immediate/early versus delayed loading defined as the principal study aim. Moreover, the variability or heterogeneity among the studies and the variable quality of the papers cause problems in synthesizing reports for clinical interpretation and application. This may explain the difficulties encountered when attempts have been made to achieve consensus for providing clinical guidelines or standard operating procedures for immediate and early loading. In this context, several reviews (systematic or otherwise) have been published.[9–24] Some of these reviews are limited in scope in that only randomized controlled trials have been included rather than all types of studies regardless of consideration of scientific merit. Other problems with published reviews include incomplete reference lists and even apparent selection bias of papers, which result in a paper that does not appropriately represent the knowledge base for the topic reviewed. Finally, a crucial element for any systematic review that is intended to be useful to clinicians is the determination of a clear researchable question which describes the problem, intervention, comparison, and outcome (PICO), as this should be used to establish what can be considered the most appropriate scientific studies to include or exclude in the review.

With an understanding of the historical context surrounding this complex issue, the purpose of this systematic review is to answer the question "What is the effect on outcomes of time-to-loading of a fixed or removable prosthesis placed on implant(s)?"

MATERIALS AND METHODS

The PICO question of this review is about comparing the effectiveness (under general clinical practice circumstances) or efficacy (what is achievable clinically under optimal circumstances) of an intervention versus another alternative. Thus, the study methodology which best answers such questions is the randomized controlled trial (RCT) with adequate sample sizes and carried out correctly and reported accordingly. Because RCTs are few and limited clinical guidance would be provided to dental clinicians if this review were based solely on RCTs, it was decided to include any clinical trial that attempted to compare early or immediate loading of implants versus a delayed procedure and which incorporated any element of time (ruling out cross-sectional studies). Other criteria for trial exclusion are detailed in Table 1. Although in the past reports of consecutive case series have provided important documentation of safety and clinical application for implant use, for this review comparison interventions or controls were required for establishing intervention effects. Studies using submerged implants as the control in consecutively treated patients were included because this is not a typical standard clinical procedure.

Literature Search

A master list consisting of 1,766 studies limited to English citations with potentially useful outcomes information was received from the Academy of Osseointegration. The list had been generated using a generic literature search strategy to identify all clinical trials on dental implants registered in MEDLINE. This database was matched with a personal database (AJ) containing over 1,900 English and non-English references on topics related to oral implants and prosthetics and with references identified in previous reviews and systematic reviews.[9–24] The cutoff date for the literature search was the May 1, 2005. Two reviewers assessed the reference lists independently and together in a nonblinded fashion with regard to the papers' authors, title, publication journal, and abstract. Papers with abstracts containing potentially relevant information were selected for further critical appraisal of the full text.

Data Extraction

Two reviewers independently and together in a nonblinded fashion assessed the relevance of each potentially applicable paper with regard to the inclusion and exclusion criteria. The agreement of the reviewers with respect to inclusion and exclusion was 100% or kappa = 1. Once agreement to include a paper was established, data that described the study

as whole, the variables that described the interventions employed in the trial, and the outcomes for each intervention appraised in the trial were extracted.

Methodologic issues such as the relevance of the hypothesis tested, the choice of outcome measures, and the interpretation of results were not evaluated, since these are difficult to quantify objectively and since great variability existed among the studies regarding these characteristics. Papers were evaluated only on the basis of the information that they included, and no additional reference or information was sought. The statistical analyses are detailed in an article by Proskin and associates elsewhere in this supplemental issue. In summary, these were survival analyses that investigated the risk difference between the treatments, which was obtained by subtracting the reported survival rate for the experimental versus the control group for separate timepoints. The pooled estimate and variance for the risk difference were based on the DerSimonian-Laird random effects model, which yielded *P* values and confidence intervals for the pooled risk difference based on a normal approximation.

RESULTS

Literature Search

From the original list of 1,882 titles that resulted from combining the master list, the personal database, and the reference lists from the review articles, 187 papers were identified as reporting clinical data on immediate or early implant loading (Fig 1). Following a critical appraisal of the papers and application of the exclusion criteria detailed in Table 1, 22 papers were included for further data extraction (Table 2).[25–46] All papers were written in English and published between 1990 and 2005. Most of these trials were categorized as being of "better" methodologic quality, according to the overall methodologic score used in this State of the Science on Implant Dentistry workshop (see Proskin and associates article) (Fig 2). One hundred sixty-five papers were excluded (see Table W1; in Web edition only). Because of the established PICO question, only studies which were designed to include a comparison or control group could be included. Consequently the most common reason for exclusion was lack of a comparative patient group (n = 112). A secondary reason was that the reporting methods were ambiguous and/or anecdotal (n = 35). The characteristics of the included papers are detailed in Table 3. Seven of these studies were RCTs, 13 were prospective trials with a concurrent control group, and 2

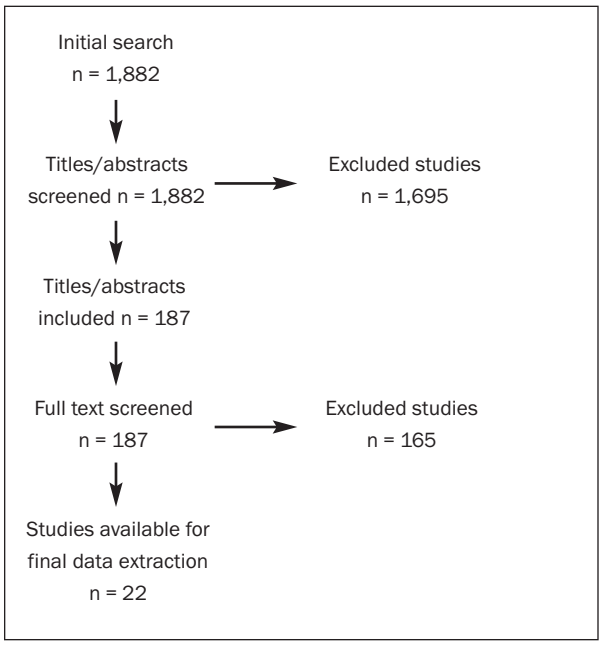


Fig 1 The screening process used to identify eligible studies.

Table 1 Criteria for Exclusion of Studies

• Anecdotal or ambiguous reporting of results
• Cross-sectional, case-control, and "failing implants" studies
• Report limited to description of techniques for fabrication of provisional prostheses
• Observation period less than 1 year
• Published in a journal produced by a manufacturer
• Less than 5 patients
• Only abstract published
• Old implant technology (ie, study published prior 1985)
• Post hoc analyses of prior publications
• Single-technique case series without a comparison group

Table 2 Summary of the Excluded (n = 165) and Included (n = 22) Studies

	No. of studies
Reason study excluded*	
Absence of comparative control group	112
Reporting methods anecdotal or ambiguous	35
Less than 5 patients	18
Old technology reported	13
Observation period of less than 1 y	11
Methodology of included studies	
RCT	6
RCT—split mouth	1
Prospective controlled trial w/ concurrent controls	7
Prospective controlled trial w/ concurrent submerged implants	6
Retrospective study w/ concurrent controls	2

*Some studies were excluded for multiple reasons.

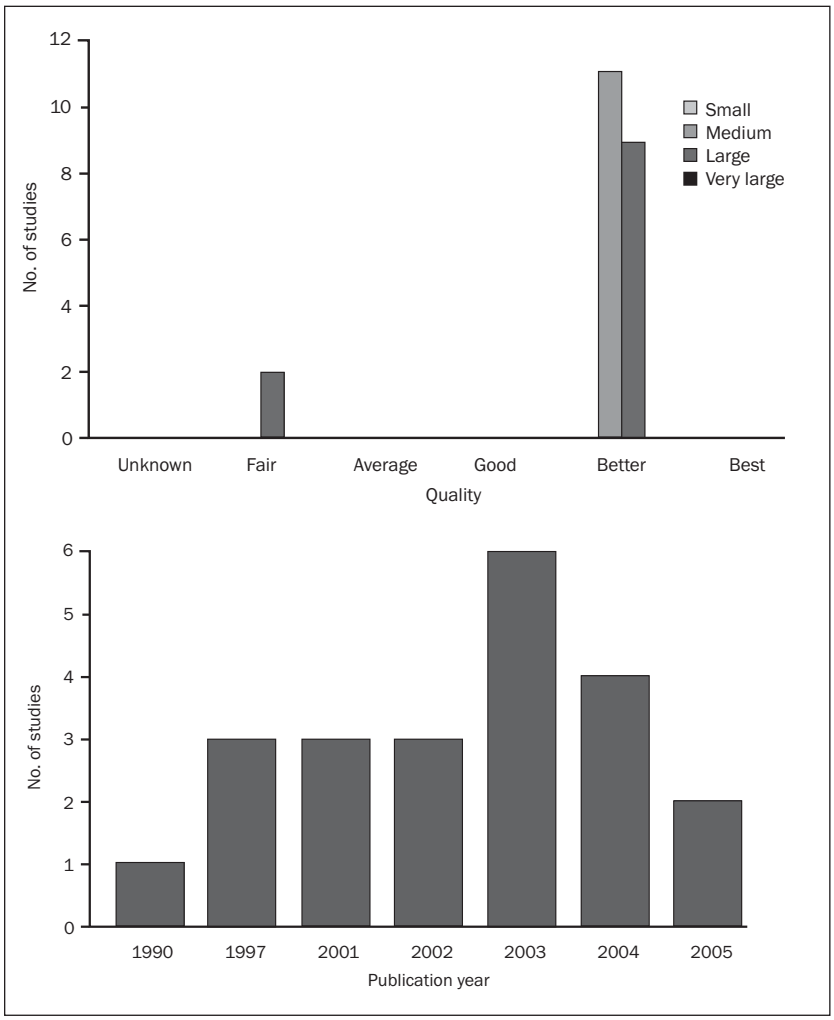


Fig 2 Included papers (n = 22) according to publication year and the methodologic quality of the study designs.

were retrospective with a concurrent control group. The 7 RCTs varied in methodological quality from poor to good. The authors were either private practitioners reporting on data from private or public clinics or university-affiliated researchers. These authors reported on a range of outcomes, including failure, according to a variety of criteria, including their own criteria, as listed in Table 4. A slight majority of the papers had applied validated and/or consensus determined failure criteria.[47–51] The clinical observation periods were in general relatively short and ranged from 1 year (the minimum for a paper being included in this review) to 10 years. Three studies appeared to include the same patient materials in 2 reports each—Bischof et al (2004)[26] and Nedir et al (2004)[34]; Balshi and Wolfinger (1997)[25] and Wolfinger et al (2003)[46]; and Schnitman et al (1990)[39] and Schnitman et al (1997).[40] The sizes of the patient samples varied between 7 and 195.

The characteristics of the treatments employed in the studies are shown in Table 5. In some studies, extensive lists of inclusion and/or exclusion criteria for patient participation were used; in others, none were stated. There were large variations in the execution of therapy ranging from immediate postextraction implant placement and immediate loading to implant placement more than 6 months after extraction and subsequent immediate function. Moreover, some papers reported on single implants, some on 2- or 4-implant ball-attachment–supported overdentures, and some on fixed dental prostheses (FDPs) supported by 4 or more implants. The most commonly reported implant systems were Brånemark (standard, Mk II, Mk III, or Mk IV), ITI (TPS or SLA), and 3i (Osseotite).

Table 3 Characteristics of Each Study as a Whole and of Each Publication

Study	Affiliation	Study design	Study aim as described by author (sic)	Clinician's clinical setting	Financial support	No. of patients at start	Observation period (y)	Reported treatment outcomes	RCT quality (only if RCT)
Balshi and Wolfinger[25]	General practice, Fort Washington, PA	Prospective controlled trial w/concurrent submerged implants	Report immediate loading of Brånemark implants in the edentulous mandibles	General practice	Nobel Biocare	10	1.5–1	Failure (own criteria)	
Bischof et al[26]	University, Geneva, Switzerland	Prospective controlled trial w/concurrent controls	Generate RFA data with implants and determine the parameters governing the ISQ values at implant placement	None stated	None stated	36	1	Failure (Buser et al, 1997 and Cochran et al, 2002) Stability (RFA)	
Cannizzaro and Leone[27]	General practice, Pavia, Italy	Prospective controlled trial w/concurrent controls	Determine the clinical effectiveness of placing dental implants with microtextured surfaces into full occlusal loading at the time of placement in partially edentulous patients	General practice	None stated	28	2	Bone (periapic-standardized) Failure (own criteria) Plaque (0–3) Pocket (mm) Stability (Periotest)	
Chiapasco et al[28]	University, Milano, Italy	RCT	Compare the results of immediate and delayed loading of implants with implant-retained mandibular overdentures	University	None stated	20	2	Bleed (0–3) Bone (OPG) Failure ('86 Albrektsson et al) Plaque (0–3) Pocket (mm) Stability (Periotest and clin)	Allocation concealment inadequate, no allocation description
De Bruyn et al[29]	General practice, Brussels, Belgium	Prospective controlled trial w/concurrent submerged implants	Evaluate (1) the 1- and 3-year success rates of implants loaded within 1 mo after one-stage surgery with a fixed 10- to 12-unit bridge on three regular platform Brånemark System implants in the mandible	General practice: 2	Nobel Biocare	20	3–1 average not stated	Bone (periapic-nonstandardized) Failure ('94 Albrekt-lsid) Patient_satisfaction (own criteria) Pain stability (clinic)	
Dhanranjani and Al-Rafee[30]	General practice, Sydney, Australia	Retrospective study w/concurrent controls	Present a 6-year audit of single-tooth implant restorations at the dental centre	Public health	None stated	101	5–1 average not stated	Failure (criteria unknown) Mechanic_complications	
Fischer and Stenberg[31]	Public health, Falun, Sweden	RCT	Investigate safety, feasibility and reliability of the early loading of implants in edentulous maxillae	Public health	Straumann	24	1	Bone (periapic-nonstandardized) Mechanic_complications mucosa-width (mm) Pain Plaque (0–3) Pocket (mm) Stability (clin) Failure (criteria unknown)	Allocation concealment inadequate, no allocation description

Table 3 continued Characteristics of Each Study and as a Whole and Each Publication

Study	Affiliation	Study design	Study aim as described by author (sic)	Clinician's clinical setting	Financial support	No. of patients at start	Observation period (y)	Reported treatment outcomes	RCT quality (only if RCT)
Ibanez et al[32]	General practice, Cordoba, Spain	Prospective controlled trial w/concurrent controls	Compare the success rates that can be obtained from two-stage surgeries and one-stage surgeries when double acid-etched surface external hex titanium implants are used	General practice	None stated	195	3	Bone (periapic-standardized) Failure ('86 Albrektsson et al)	
Malo et al[33]	General practice, Lisbon, Portugal	Retrospective study w/concurrent controls	Document a protocol for immediate function of four implants supporting fixed prostheses in completely edentulous mandibles : the All-on-Four concept	General practice	Nobel Biocare	44	3–0.5 average not stated	Bone (periapic-nonstandardized and/or OPG) Failure (criteria unknown) Mechanic_complications	
Nedir et al[34]	University, Geneva, Switzerland	Prospective controlled trial w/concurrent controls	Evaluate the Ostell as a diagnostic tool capable of discriminating between stable and mobile implants	None stated	None stated	36	1	Failure ('97Buser et al & '02Cochran et al) Stability (RFA)	
Payne et al[35]	University, Otago, New Zealand	RCT	Compare the success rates after 1 and 2 years of conventionally and early loaded pairs of unsplinted ITI implants supporting mandibular overdentures in edentulous patients	University	Colgate, ITI Research Foundation, Ivoclar	24	2	Bleed (0-3) Bone (periapic-standardized) Failure ('98 Albrekt-Zarb) mucosa-width (mm) Plaque (0-3) Pocket (mm) Stability (Periotest & RFA)	Good allocation concealment and allocation description
Romeo et al[36]	University, Milan, Italy	RCT	Compare the results of immediate and delayed loading of implant-retained mandibular overdentures	University	None stated	20	2	Bleed (0-3) Bone (OPG) Failure ('86 Albrekt et al) Plaque (0-3) Pocket (mm) Stability (Periotest)	
Røynesdal et al[37]	University, Oslo, Norway	Prospective controlled trial w/concurrent controls	Evaluate the efficacy of early loading of implants and to provide evidence to support simplified treatment of mandibular edentulism by using an implant designed for 1-stage surgery, combined with ball abutments	University	None stated	21	2	Bleed (y&n) Bone (OPG) Patient_satisfaction (1-3) Stability (Periotest) Failure ('86 Albrekt et al)	Allocation concealment adequate, no allocation description
Salvi et al[38]	University, Bern, Switzerland	RCT	Evaluate the effect of early loading of ITI solid screw titanium implants with a sand-blasted and acid-etched (SLA) surface on clinical and radiographic parameters.	None stated	None stated	27	1	Bleed (0-3) Bone (periapicstandardized) mucosa-width (mm) Pocket (mm) Stability (Periotest) Failure (criteria unknown)	Allocation concealment inadequate, no allocation description
Schnitman et al[39]	University, Boston, MA	Prospective controlled trial w/concurrent submerged implants	Develop an approach that can overcome the need for a period of several months when complete dentures must be worn to allow for a stress-free healing period of the implants	University	None stated	7	3. 5–0. 5 average 1	Failure ('90 Albrekt-Senner)	

Table 3 continued Characteristics of Each Study and as a Whole and Each Publication

Study	Affiliation	Study design	Study aim as described by author (sic)	Clinician's clinical setting	Financial support	No. of patients at start	Observation period (y)	Reported treatment outcomes	RCT quality (only if RCT)
Schnitman et al[40]	University, Boston, MA	Prospective controlled trial w/concurrent submerged implants	Develop a method to provide patients with a fixed provisional prosthesis placed at the time of implant placement	General practice	None stated	10	7–10 Average 9 years	Failure (criteria unknown)	
Tarnow et al[41]	University, New York	Prospective controlled trial w/concurrent submerged implants	Evaluate immediate loading of threaded implants with a fixed provisional restoration at stage 1 surgery	University	None stated	10	1–5 average not stated	Failure (criteria unknown)	
Tawse-Smith et al[42]	University, Otago, New Zealand	RCT	Compare the success rates of two different dental implant systems following conventional or early loading protocols in patients being rehabilitated with mandibular overdentures	University	Colgate, Southern, Nobel Biocare	48	1	Bleed (0-3) Bone (perapic-standardized) Failure ('98 Albrekt-Zarb) mucosa-width (mm) Plaque (0-3) Pocket (mm) Stability (Periotest)	
Testori et al[43]	University, Milan, Italy	RCT	Report the preliminary experiences with partially loaded provisonal restorations within 24 hours after surgery as opposed to patients treated according to an early loading protocol	University	None stated	32	0.5–2 Average not stated	Bone (periapic-digital corrected) Failure ('86 Albrekt et al) Stability (RFA)	Allocation concealment inadequate, no allocation description
Testori et al[44]	University, Milan, Italy	Prospective controlled trial w/concurrent controls	Report preliminary data from a clinical study of immediately loaded, full-arch, screw-retained prosthesis with distal extensions supported by Osseotite implants in the edentulous mandible	University	None stated	15	4-2 average 3	Bone (periapic-digital corrected) Failure ('86 Albrekt et al)	Allocation concealment inadequate, no allocation description
Vanden Bogaerde et al[45]	General practice, Concorezzo, Italy	Prospective controlled trial w/concurrent controls	Develop a strict protocol for and to evaluate the feasibility of immediate/early function on implants placed in fresh extraction sockets located in maxillae and posterior mandibles	General practice	None stated	19	1.5	Bone (perapic-standardized) Stability (RFA) Failure (own criteria)	
Wolfinger et al[46]	General practice, Fort Washington, PA	Prospective controlled trial w/concurrent submerged implants	Evaluate the 5-year results of 9 of 10 patients in a clinical investigation of immediate functional loading of Brånemark System implants in edentulous mandibles	General practice	None stated	34	5	Bone (periapic-nonstandardized and/or OPG) Failure (own criteria)	

Table 4 Treatment Outcomes Described in Papers on Immediate Loading (n = 22)

Treatment outcomes	No. of papers	Papers
Failure		
Criteria used		
Albrektsson et al[47] (1986)	6	Chiapasco et al[28] Ibanez et al[32] Romeo et al[36] Røynesdal et al[37] Testori et al[43] Testori et al[44]
Albrektsson and Sennerby[48] (1990)	1	Schnitman et al[39]
Albrektsson and Isidor[49] (1994)	1	De Bruyn et al[29]
Buser et al[50] (1997)	2	Bischof et al[26] Nedir et al[34]
Albrektsson and Zarb[51] (1998)	2	Payne et al[35] Tawse-Smith et al[42]
Self-defined criteria	4	Balshi and Wolfinger[25] Cannizzaro and Leone[27] Vanden Bogaerde et al[45] Wolfinger et al[46]
Criteria not described in paper	6	Dhanrajani and Al-Rafee[30] Fischer and Stenberg[31] Malo et al[33] Salvi et al[38] Schnitman et al[40] Tarnow et al[41]
Mechanical complications	1	Fischer and Stenberg[31]
Pain	1	Fischer and Stenberg[31]
Bone levels		
According to standardized periapical radiographs	6	Cannizzaro and Leone[27] Ibanez et al[32] Payne et al[35] Salvi et al[38] Tawse-Smith et al[42] Vanden Bogaerde et al[45]
According to nonstandardized but digitally corrected periapical radiographs	2	Testori et al[43] Testori et al[44]
According to nonstandardized periapical radiographs	2	De Bruyn et al[29] Fischer and Stenberg[31]
According to orthopantomograms (OPGs)	3	Chiapasco et al[28] Romeo et al[36] Røynesdal et al[37]
According to nonstandardized periapical radiographs and/or OPGs	2	Malo et al[33] Wolfinger et al[46]
Not reported	7	Balshi and Wolfinger[25] Bischof et al[26] Dhanrajani and Al-Rafee[30] Nedir et al[34] Schnitman et al[39] Schnitman et al[40] Tarnow et al[41]

Table 5 Variables That Describe Each Treatment Employed in the Study

Study	Patient status/ situation	Inclusion criteria	Exclusion criteria	Presurgical period (time from extraction to implant placement)	Postsurgical procedure (2 or more alternative procedures)	No. of implants retaining the superstructure and type of prosthesis (crown/FDP/ overdenture)	Implant brand
Balshi and Wolfinger[25]	Edentulous mandible	1. Healthy patients in need of full-arch mandibular implant-supported prostheses 2. Adequate bone for implants of at least 7 mm in posterior mandible	None stated	2 protocols: 1. Immediately postextraction (n = 58) 2. Healed tissue (n = 72)	Groups (2): E: 4 implants immediately connected to abutments and loaded with acrylic resin fused to metal provisional prostheses, impression made at 10 d, new definitive FDP 6 wk later, new impression made at 3 mo (both C and E groups) C: Submerged healing for 3 mo (n = 90), definitive prostheses delivered 6 wk later Arms (2):	Provisional prosthesis supported by 4 implants; definitive FDPs supported by additional implants	Brånemark (standard)
Bischof et al[26]	Partially edentulous (either jaw; anterior or posterior)	None stated	1. Type 4 bone 2. No augmentation or grafting 3. Lack of primary stability	Not stated	E: Impression immediately, nonoccluding provisional prosthesis within 2 d, definitive prosthesis after 3 to 4 mo (n = 63) C: Abutments connected after 3 mo (at 35 Ncm torque), followed by impression making and delivery of definitive prosthesis (n = 43) Arms (2):	E: Impression made immediately, occluding provisional prostheses delivered within 3 h, replaced after 6 wk (n = 46) C: Submerged healing 3.5 to 4.5 mo, impression after additional 14 d (n = 46), delivery of definitive prosthesis within 6 wk of impression Arms (2):	Crown or an FDP supported by 2-3, 2-4, or 5-6 implants	ITI (SLA)
Cannizzaro and Leone[27]	Partially edentulous (either jaw; anterior or posterior)	1. Excellent oral hygiene 2. Commitment to follow-up	None stated	2 protocols: 1. Immediately postextraction (no. of patients not stated) 2. Healed tissue (no. of patients not stated)	E: Standard abutment connected immediately; impression made and denture connected by Dolder bar delivered within 3 d (n = 40) C: Healing cap placed immediately, abutment connection at 4 to 8 mo (n = 40)	Crown + FDP supported by 2 to 7 implants	SplineTwist MTX
Chiapasco et al[28]	Edentulous mandible	1. Healthy 2. Difficulties with existing denture 3. Adequate oral hygiene 4. Absence of local inflammation 5. Intraforaminal bone height sufficient to harbor 4 implants 3.75 mm wide and at least 13 mm in length 6. Bone quality types 1, 2, or 3	1. Skeletal discrepancy 2. Radiation therapy of head and neck 3. Severe bruxism 4. > 10 cigarettes/day 5. Var. systemic diseases 6. General surgical contraindications	Healed (> 3 mo)	Overdentures supported by 4 implants with Dolder bars	Brånemark (MkII)	

Table 5 continued Variables That Describe Each Treatment Employed in the Study

Study	Patient status/ situation	Inclusion criteria	Exclusion criteria	Presurgical period (time from extraction to implant placement)	Postsurgical procedure (2 or more alternative procedures)	No. of implants retaining the superstructure and type of prosthesis (crown/FDP/ overdenture)	Implant brand
De Bruyn et al[29]	Edentulous mandible	1. Edentulous mandible > 6 mo 2. Intraforaminal bone height sufficient to harbor 5 implants of 13 to 15 mm 3. At least 10 teeth in the opposing jaw 4. Agreement to participate in recalls	None stated	Healed (> 6 mo)	Groups (3): E: Standard abutment immediately + softline in denture C1: Standard abutment immediately, unloaded C2: Submerged healing, definitive prosthesis delivery in 4 to 53 days	Provisional prosthesis supported by 3 implants; FDP supported by 3 to 5 implants	Brånemark (standard)
Dhanrajani and Al-Rafee[30]	In need of single tooth replacement (either jaw; anterior or posterior)	1. Single tooth space* 2. Good patient compliance *NOTE: Inconsistent with immediate postextraction placements	1. Insufficient bone precluding implant of ø3. 25 > 8.5m 2. Insufficient vertical space 3. Active growth 4. "Vital anatomical structures" 5. No augmentation or grafting	2 protocols: 1. Immediately postextraction (8 patients) 2. Healed tissue (93 patients)	Cohorts (3): E1: Temporary crown immediately (n = 16) E2: Temporary crown immediately on implant placed in postextraction site (n = 8) C: Submerged healing 3 and 6 mo (n = 123)	Crown	Brånemark (MkII) (115), Omniloc (8), Osseotite (19), Replace (5)
Fischer and Stenberg[31]	Edentulous maxilla	1. Completely edentulous maxilla 2. Expectation of good occlusion 3. Adequate bone quality and sufficient height and width to permit placement of 5 or 6 implants	1. Var. systemic diseases 2. > 10 cigarettes/day 3. Unhealed extraction sites 4. No augmentation or grafting	Not stated	Arms (2): E: Octa-abutment factory-attached at the time of implant surgery, impression made immediately, healing caps, definitive prosthesis loaded after 9 to 18 d (n = 16) C: Healing caps and relining, EstheticPlus abutments connected after 3 to 5 mo, followed by impression making and definitive prosthesis delivery (n = 8)	FDP supported by 5 to 6 implants	ITI (SLA)
Ibanez et al[32]	Partially edentulous (either jaw; anterior or posterior)	For experimental group: 1. Implants with good fixation 2. At least 2 mm interocclusal space	For experimental group: 1. Signs of bruxism 2. Augmentation or grafting	Not stated	Arms (2): E: Abutment connected immediately (n = 133) and loaded with nonoccluded (n = 24) and occluded (n = 68) provisional and definitive (n = 91) prostheses (n = 316) C: Submerged healing 3 to 6 mo (n = 338)	Not stated	Osseotite
Malo et al[33]	Edentulous mandible	1. Edentulous mandible or mandible with hopeless teeth	None stated	2 protocols: 1. Postextraction (n = 45) 2. Healed (n = 131)	Cohorts (2): E: Nonsubmerged impression, acrylic resin FDP within 2 h C: Submerged healing 4 to 6 mo; definitive prosthesis delivered after 12 mo	4-implant-supported FDP	Brånemark (MkII, III, or IV)

Table 5 continued Variables That Describe Each Treatment Employed in the Study

Study	Patient status/ situation	Inclusion criteria	Exclusion criteria	Presurgical period (time from extraction to implant placement)	Postsurgical procedure (2 or more alternative procedures)	No. of implants retaining the superstructure and type of prosthesis (crown/FDP/ overdenture)	Implant brand
Nedir et al[34]	Partially edentulous (either jaw; anterior or posterior)	None stated	1. Type 4 bone 2. Augmentation or grafting 3. Lack of primary stability	Not stated	Arms (2): E: Impression immediately, nonoccluding provisional within 2 d, definitive after 3 to 4 mo (n = 63) C: Abutment connection (at 35 Ncm torque), impression making, and definitive prosthesis delivery after 3 mo (n = 43)	Crown + FDP supported by 2-6 implants	ITI (SLA)
Payne et al[35]	Edentulous mandible	1. Edentulousness 2. Age between 55 and 80 y 3. 13 to 15 mm residual anterior mandibular bone	1. Previous or current smoking 2. Systemic diseases likely to compromise implant surgery 3. Previous bone grafting 4. Previous radiation therapy of the head and neck 5. History of bruxism 6. Type 4 bone	Not stated	Arms (2): 3-mm healing caps immediately, no use of dentures for 2 wk, soft relined denture (reline contact situation vs with healing cap not described) C: Replace with ball abutment + matrices at 12 wk (n = 24) E: Replace with ball abutment + matrices at 6 wk (n = 24)	E1: Overdenture supported by 2 implants, ball attachments	ITI (SLA)
Romeo et al[36]	Edentulous mandible	1. Adequate oral hygiene 2. Edentulous mandible > 3 mo 3. Absence of local inflammation and mucosal diseases 4. No previous radiation therapy 5. Intraforaminal bone volume to receive four 3.3-mm implants > 10 mm bone height 6. Bone quality types 1, 2, or 3	1. Skeletal discrepancies 2. Radiation therapy of the head and neck 3. Augmentation or grafting 4. > 20 cigarettes/d 5. Various systemic diseases or drug abuse or influence 6. Type 4 bone 7. Width of keratinized mucosa < 2 mm 8. Signs of bruxism 9. Poor oral hygiene	Healed (> 3 mo)	Arms (2): E: Octa-abutment immediately + impression, Dolder bar attached 2 d later C: Octa-abutment attachment, impression making and Dolder bar at 3 to 4 mo	Overdenture supported by 4 implants, Dolder bar	ITI (SLA)
Røynesdal et al[37]	Edentulous mandible	1. Patient age > 60 2. Edentulous mandible 3. Attached keratinized mucosa present on the alveolar crest	1. Systemic diseases likely to compromise implant surgery 2. Serious mental illness 3. History of drug/alcohol abuse 4. Heart operation within last 6 mo 5. Primary stability not achieved	Not stated	Arms (2): Healing caps placed and soft-lined denture delivered immediately E: Ball attachment at 2 to 3 wk (n = 11) C: Submerged healing 3 mo (n = 10)	Ovedenture supported by 2 implants	ITI (TPS)

Table 5 continued Variables That Describe Each Treatment Employed in the Study

Study	Patient status/ situation	Inclusion criteria	Exclusion criteria	Presurgical period (time from extraction to implant placement)	Postsurgical procedure (2 or more alternative procedures)	No. of implants retaining the superstructure and type of prosthesis (crown/FDP/ overdenture)	Implant brand
Salvi et al[38]	Partial edentulous (posterior mandible)	1. Age > 18 y and good general health 2. Good patient compliance 3. Need for bilateral implants in comparable posterior mandible 4. Low plaque and bleeding scores 5. Sufficient bone volume, ie, > 6 mm width >10 mm height 6. Bone quality types 1, 2, or 3	1. Various systemic diseases 2. Radiation therapy of the head and neck 3. Augmentation or grafting 4. > 20 cigarettes/d 5. Drug abuse or influence 6. Residual roots 7. Type 4 bone 8. Width of keratinized mucosa < 2 mm 9. Signs of bruxism	Not stated	Arms (2–split-mouth): Healing caps immediately E: Abutment connected at 1 wk (n = 31) C: Abutment connected at 5 wk (n = 36) and impression making and delivery of permanent crown 1 wk later If a torque of 35 Ncm was not reached, an additional 12-wk waiting period was applied	Cemented crowns	ITI (SLA)
Schnitman et al[39]	Edentulous mandible	1. Healthy patients in need of full-arch mandibular implant-supported prostheses 2. Refusal to wear interim dentures 3. Willingness to risk early implant failure	None stated	2 protocols: 1. Immediately postextraction (no. of patients not stated) 2. Healed tissue (no. of patients not stated)	Groups (2): E: Abutment immediately on 3 implants, temporary cylinder within 3 d, acrylic fused to provisional FDP and screw-retained FDP, new impression at 3 mo (n = 20) C: Submerged healing for 3 mo (n = 26), impression making at 3 mo, delivery of definitive prosthesis 1 mo later	Provisional prostheses supported by 3 implants; FDPs supported by 5 to 8 implants	Brånemark (standard)
Schnitman et al[40]	Edentulous mandible	None stated	None stated	2 protocols: 1. Immediately postextraction (no. of patients not stated) 2. Healed tissue (no. of patients not stated)	Groups (2): E: Abutment immediately on 3 implants, temporary cylinder within 3 d, acrylic fused to provisional FDP and screw-retained FDP, new impression at 3 mo (n = 28) C: Submerged healing for 3 mo (n = 35), impression making at 3 mo, delivery of definitive prosthesis 1 mo later	Provisional prostheses supported by 3 implants; FDPs supported by 5 to 8 implants	Brånemark (standard)

Table 5 continued Variables That Describe Each Treatment Employed in the Study

Study	Patient status/ situation	Inclusion criteria	Exclusion criteria	Presurgical period (time from extraction to implant placement)	Postsurgical procedure (2 or more alternative procedures)	No. of implants retaining the superstructure and type of prosthesis (crown/FDP/ overdenture)	Implant brand
Tarnow et al[41]	Edentulous mandible and maxilla	1. Complete edentulousness 2. Refusal to wear a removable denture 3. Adequate bone distal to the mental foramen to allow implants of at least 10 mm 4. Patient consent 5. Medical history revealed no contraindications to surgery	None stated	2 protocols: Incompatible information in inclusion criteria ". . . completely edentulous. . . " and in results ". . . implants placed in immediate extraction sockets. . . "	Groups (2): E: Abutment immediately on 5 to 10 implants, temporary cylinder fused with acrylic to laboratory-prefabricated FDP, permanent at 2 to 4 mo (n = 69) C: Submerged healing 4 to 6 mo, abutment + impression (n = 38)	Cement-retained provisional prostheses supported by 4 to 6 implants or screw-retained provisional prostheses supported by 6 to 10 implants; screw-retained FDPs supported by 8 to 13 implants	3i (10), Astra (21), Brånemark (65), ITI (SLA) Bonefit (11)
Tawse-Smith et al[42]	Edentulous mandible	1. Edentulousness 2. Age between 55 and 80 y 3. Presence of 13 to 15 mm of residual anterior mandibular bone	1. Type 4 bone quality 2. Previous bone grafting 3. Previous radiation therapy of the head and neck 4. History of bruxism 5. Previous or current smoking 6. Systemic diseases likely to compromise implant surgery	Not stated	Arms (2): Healing caps immediately and soft-relined denture C: 12 wk (n = 41) E2: 6 wk ball attachment + matrices (n = 41)	Overdentures supported by 2 implants with ball attachments	Southern (48) and SteriOss (HL) (48)
Testori et al[43]	Partially edentulous (either jaw; anterior or posterior)	1. Health adequate to physically tolerate surgery 2. Age greater than 18 y 3. Elective consideration of short-span FDPs 4. Use of at least 2 splinted implants 5. Implants seated with torque > 30 Ncm	1. Systemic diseases 2. Radiation therapy of head or neck within the previous 12 mo 3. Severe bruxism or clenching 4. > 10 cigarettes/d 5. Active infection and inflammation 6. Lack of augmentation or grafting 7. Unresorbed allograft 8. Postextraction sites	Healed	Arms (2): E: Healing caps immediately + impression, provisional FDP within 24 h (n = 52) C: Impression after 6 wk; definitive prosthesis after 6 to 9 mo (n = 49)	FDPs supported by 2 or more implants	Osseotite (65) Osseotite (NT) (36)

Table 5 continued Variables Which Describe Each Treatment Employed in the Study

Study	Patient status/ situation	Inclusion criteria	Exclusion criteria	Presurgical period (time from extraction to implant placement)	Postsurgical procedure (2 or more alternative procedures)	No. of implants retaining the superstructure and type of prosthesis (crown/FDP/ overdenture)	Implant brand
Testori et al[44]	Edentulous mandible	1. Completely edentulous mandible 2. Elective treatment decision 3. Health adequate to physically tolerate surgery 4. Normal/good bone quality 5. Implants seated with torque > 30 Ncm	1. Active infection and inflammation 2. > 10 cigarettes/d 3. Various systemic diseases 4. Radiation therapy of the head and neck 5. Lack of augmentation or grafting 6. Unresorbed allograft 7. Severe bruxism	Not stated	Arms (3): C: 5 or 6 implants submerged; screw-retained provisional FDP supported by 5 implants; impression at 6 months including all implants (22) E1: Impression immediately, provisional within 4 h, definitive prosthesis delivered after 6 mo (41) E2: Impression immediately, definitive FDP delivered within 36 h (40)	Screw-retained FDPs supported by 5 to 6 implants	Osseotite
Vanden Bogaerde et al[45]	Posterior mandible or maxilla	None stated	1. Various systemic diseases 2. Severe bruxism 3. Deep bite at maxillary central incisors	Postextraction	Arms (2): E: Immediate abutment connection, impressions, and delivery of a provisional FDP (n = 11) C: Immediate abutment connection, impressions, and healing caps; delivery of a temporary FDP (n = 11) 4 to 7 d later. Definitive FDP after 6 mo	FDPs	Brånemark MkIV, TiUnite
Wolfinger et al[46]	Edentulous mandible	1. Healthy 2. Need for full-arch mandibular restoration (edentulous mandible) 3. Adequate bone for the placement of implants at least 7 mm long in the posterior mandible	None stated	2 protocols: 1. Immediately postextraction (n = 82) 2. Healed tissue (n = 62)	Groups (4): E (developmental protocol): Abutment immediately on 4 implants + acrylic resin FDP, replaced after 6 wk with a metal-reinforced acrylic resin FDP, impression making at 3 mo, delivery of definitive prosthesis 2 wk later (40) C (developmental protocol): Submerged healing 3 mo, incorporated into existing provisional and subsequently definitive FDP (n = 90) E (simplified protocol): Abutment immediately on 4 implants + acrylic resin FDP, impression making at 3 mo followed by delivery of definitive prosthesis 2 wk later (144) C (simplified protocol): Submerged healing 3 mo, incorporated into existing provisional and subsequently definitive FDP (n = 18)	Screw-retained FDPs supported by 3 to 9 implants	Brånemark (standard)

SLA = sand-blasted, large-grit, acid-etched; TPS = titanium plasma-sprayed; FDP = fixed dental prosthesis; E = experimental; C = control.

Table 6 Outcomes for Each Treatment Employed

Study	Characteristics of intervention	No. of, or severity of, adverse biological outcomes/ complications	Mean bone loss from implant placement to 1 y	Mean bone loss from implant placement to 3 y	No. of, or severity of, adverse mechanical outcomes/ complications	Time to retreatment	Reported survival
Balshi and Wolfinger[25]							
Experimental	4 implants immediately connected to abutments and loaded with acrylic resin fused to metal provisional prostheses, impression made at 10 d, definitive FDP 6 wk later, new impression made at 3 mo (both C and E groups) (n = 40)	8	Not reported	Not reported	Not reported	Not reported	Not reported
Control	Submerged healing for 3 mo (n = 90), definitive prostheses delivered 6 wk later	2 preload and 2 postload	Not reported	Not reported	Not reported	Not reported	Not reported
Bischof et al[26]							
Experimental	Impression immediately, non-occluding provisional prosthesis within 2 d, definitive prosthesis after 3 to 4 mo (n = 63)	1	Not reported	Not reported	Not reported	Not reported	Not reported
Control	Abutments connected after 3 mo (at 35 Ncm torque), followed by impression making and delivery of definitive prosthesis (n = 43)	1	Not reported	Not reported	Not reported	Not reported	Not reported
Cannizzaro and Leone[27]							
Experimental	Impression made immediately, occluding provisional prostheses delivered within 3 h, replaced after 6 wk (n = 46)	0	Not reported	Not reported	Not reported	Not reported	Not reported
Control	Submerged healing 3.5 to 4.5 mo, impression after additional 14 d (n = 46), delivery of definitive prosthesis within 6 wk of impression	1	Not reported	Not reported	Not reported	Not reported	Not reported
Chiapasco et al[28]							
Experimental	Standard abutment connected immediately; impression made and denture connected by Dolder bar delivered within 3 d (n = 40)	1	Not reported	Not reported	Not reported	Not reported	Not reported
Control	Healing cap placed immediately, abutment connection at 4 to 8 mo (n = 40)	1	Not reported	Not reported	Not reported	Not reported	Not reported
De Bruyn et al[29]							
Experimental	Standard abutment immediately + softline in denture	6	0.9	1.4	Not reported	Not reported	Not reported
Control 1	Standard abutment immediately, unloaded	0	0.7	1.6	Not reported	Not reported	Not reported
Control 2	Submerged healing, definitive prosthesis delivery in 4 to 53 days	0	0.4	0.3	Not reported	Not reported	Not reported
Dhanrajani and Al-Rafee[30]							
Experimental 1	Temporary crown immediately (n = 16)	2	Not reported	Not reported	Not reported	Not reported	Not reported
Experimental 2	Temporary crown immediately on implant placed in postextraction site (n = 8)	2	Not reported	Not reported	Not reported	Not reported	Not reported
Control	Submerged healing 3 and 6 mo (n = 123)	5	Not reported	Not reported	Not reported	Not reported	Not reported
Fischer and Stenberg[31]							
Experimental	Octa-abutment factory-attached at the time of implant surgery, impression made immediately, healing caps, definitive prosthesis loaded after 9 to 18 d (n = 16)	1 preload	0.4	Not reported	Not reported	Not reported	Not reported
Control	Healing caps and relining, EstheticPlus abutments connected after 3 to 5 mo, followed by impression making and definitive prosthesis delivery (n = 8)	0	0	Not reported	Not reported	Not reported	Not reported

Table 6 continued Outcomes for Each Treatment Employed

Study	Characteristics of intervention	No. of, or severity of, adverse biological outcomes/ complications	Mean bone loss from implant placement to 1 y	Mean bone loss from implant placement to 3 y	No. of, or severity of, adverse mechanical outcomes/ complications	Time to retreatment	Reported survival
Ibanez et al[32]							
Experimental	Abutment connected immediately (n = 133) and loaded with nonoccluded (n = 24) and occluded (n = 68) provisional and definitive (n = 91) prostheses (n = 316)	3 preload	0.6	0.9	Not reported	Not reported	3 y: 99%
Control	Submerged healing 3 to 6 mo (n = 338)	2 preload	0.5	0.8	Not reported	Not reported	3 y: 99%
Malo et al[33]							
Experimental	Nonsubmerged impression, acrylic resin FDP within 2 h	4	Not reported	Not reported	Not reported	Not reported	3 y: 97%
Control	Submerged healing 4 to 6 mo; definitive prosthesis delivered after 12 mo	3(?) preload +3 postload	Not reported	Not reported	Not reported	Not reported	3 y: 95%
Nedir et al[34]							
Experimental	Impression immediately, nonoccluding provisional within 2 d, definitive after 3 to 4 mo (n = 63)	1	Not reported	Not reported	Not reported	Not reported	Not reported
Control	Abutment connection (at 35 Ncm torque), impression making, and definitive prosthesis delivery after 3 mo (n = 43)	1	Not reported	Not reported	Not reported	Not reported	Not reported
Payne et al[35]							
Experimental	3-mm healing caps immediately, no use of dentures for 2 wk, soft relined denture (reline contact situation vs healing cap not described) . Replace with ball abutment + matrices at 6 wk (n = 24)	0	0.3	Not reported	Not reported	Not reported	Not reported
Control	3-mm healing caps immediately, no use of dentures for 2 wk, soft relined denture (reline contact situation vs healing cap not described). Replace with ball abutment + matrices at 12 wk (n = 24)	0	0.3	Not reported	Not reported	Not reported	Not reported
Romeo et al[36]							
Experimental	Octa-abutment immediately + impression, Dolder bar attached 2 d later	0	0.2	Not reported	Not reported	Not reported	Not reported
Control	Octa-abutment attachment, impression making and Dolder bar at 3 to 4 mo	1	0.2	Not reported	Not reported	Not reported	Not reported
Røynesdal et al[37]							
Experimental	Healing caps placed and soft-lined denture delivered immediately. Ball attachment at 2 to 3 wk (n = 11)	0	0	Not reported	Not reported	Not reported	Not reported
Control	Healing caps placed and soft-lined denture delivered immediately. Submerged healing 3 mo (n = 10)	0	0	Not reported	Not reported	Not reported	Not reported
Salvi et al[38]							
Experimental	Healing caps immediately. Abutment connected at 1 wk (n = 31)	0	0.6	Not reported	Not reported	Not reported	Not reported
Control	Healing caps immediately. Abutment connected at 5 wk (n = 36) and impression making and delivery of definitive crown 1 wk later. If a torque of 35 Ncm wasn't reached, an additional 12-wk waiting period was applied	0	0.7	Not reported	Not reported	Not reported	Not reported

Table 6 continued Outcomes for Each Treatment Employed

Study	Characteristics of intervention	No. of, or severity of, adverse biological outcomes/ complications	Mean bone loss from implant placement to 1 y	Mean bone loss from implant placement to 3 y	No. of, or severity of, adverse mechanical outcomes/ complications	Time to retreatment	Reported survival
Schnitman et al[39]							
Experimental	Abutment immediately on 3 implants, temporary cylinder within 3 d, acrylic fused to provisional FDP and screw-retained FDP, new impression at 3 mo (n = 20)	3	Not reported	Not reported	Not reported	Not reported	Not reported
Control	Submerged healing for 3 mo (n = 26), impression making at 3 mo, delivery of definitive prosthesis 1 mo later	0	Not reported	Not reported	Not reported	Not reported	Not reported
Schnitman et al[40]							
Experimental	Abutment immediately on 3 implants, temporary cylinder within 3 d, acrylic fused to provisional FDP and screw-retained FDP, new impression at 3 mo (n = 28)	4	Not reported	Not reported	Not reported	Not reported	10 y: 85%
Control	Submerged healing for 3 mo (n = 35), impression making at 3 mo, delivery of definitive prosthesis 1 mo later	0	Not reported	Not reported	Not reported	Not reported	10 y: 100%
Tarnow et al[41]							
Experimental	Abutment immediately on 5 to 10 implants, temporary cylinder fused with acrylic to laboratory-prefabricated FDP, definitive at 2 to 4 mo (n = 69)	2	Not reported	Not reported	Not reported	Not reported	Not reported
Control	Submerged healing 4 to 6 mo, abutment + impression (n = 38)	1 preload	Not reported	Not reported	Not reported	Not reported	Not reported
Tawse-Smith et al[42]							
Experimental	Healing caps immediately and soft-relined denture. Ball attachment + matrices placed after 6 wk (n = 41)	7	0.1	Not reported	Not reported	Not reported	Not reported
Control	Healing caps immediately and soft-relined denture. Ball attachment + matrices placed after 12 wk (n = 41)	1	0.1	Not reported	Not reported	Not reported	Not reported
Testori et al[43]							
Experimental	Healing caps immediately + impression, provisional FDP within 24 h (n = 52)	2	0.9	Not reported	Not reported	Not reported	Not reported
Control	impression after 6 wk, definitive prosthesis after 6 to 9 mo (n = 49)	1 preload	0.7	Not reported	Not reported	Not reported	Not reported
Testori et al[44]							
Experimental 1	Impression immediately, provisional within 4 h, definitive prosthesis delivered after 6 mo (n = 41)	1	0.9	1	Not reported	Not reported	3 y: 99%
Experimental 2	Impression immediately, definitive FDP delivered within 36 h (n = 40)	0	0.9	1	Not reported	Not reported	3 y: 99%
Control	5 or 6 implants submerged; screw-retained provisional FDP supported by 5 implants; impression at 6 mo including all implants (n = 22)	0	0.8	0.9	Not reported	Not reported	3 y: 99%

Table 6 continued Outcomes for Each Treatment Employed

Study	Characteristics of intervention	No. of, or severity of, adverse biological outcomes/ complications	Mean bone loss from implant installation to 1 y	Mean bone loss from implant installation to 3 y	No. of, or severity of, adverse mechanical outcomes/ complications	Time to retreatment	Reported survival
Vanden Bogaerde et al[45]							
Experimental	Immediate abutment connection, impressions, and delivery of a provisional FDP (n = 11)	0	Not reported	Not reported	Not reported	Not reported	Not reported
Control	Immediate abutment connection, impressions, and healing caps; delivery of a temporary FDP (n = 11) 4 to 7 d later; definitive FDP after 6 mo	0	Not reported	Not reported	Not reported	Not reported	Not reported
Wolfinger et al[46]							
Experimental	E(dev): Abutment immediately on 4 implants + acrylic resin FDP, replaced after 6 wk with a metal-reinforced acrylic resin FDP, impression making at 3 mo, delivery of definitive prosthesis 2 wk later (40) E(sim): Abutment immediately on 4 implants + acrylic resin FDP, impression making at 3 mo followed by delivery of definitive prosthesis 2 wk later (144)	13	0.2	0.5	Not reported	Not reported	5 y: 80% (develop phase) 97% (improved phase)
Control	C(dev): Submerged healing 3 mo, incorporated into existing provisional and subsequently definitive FDP (n = 90) C(sim): Submerged healing 3 mo, incorporated into existing provisional and subsequently definitive FDP (n = 18)	2 preload + 2 postload	0.1	0.5	Not reported	Not reported	5 y: 96%

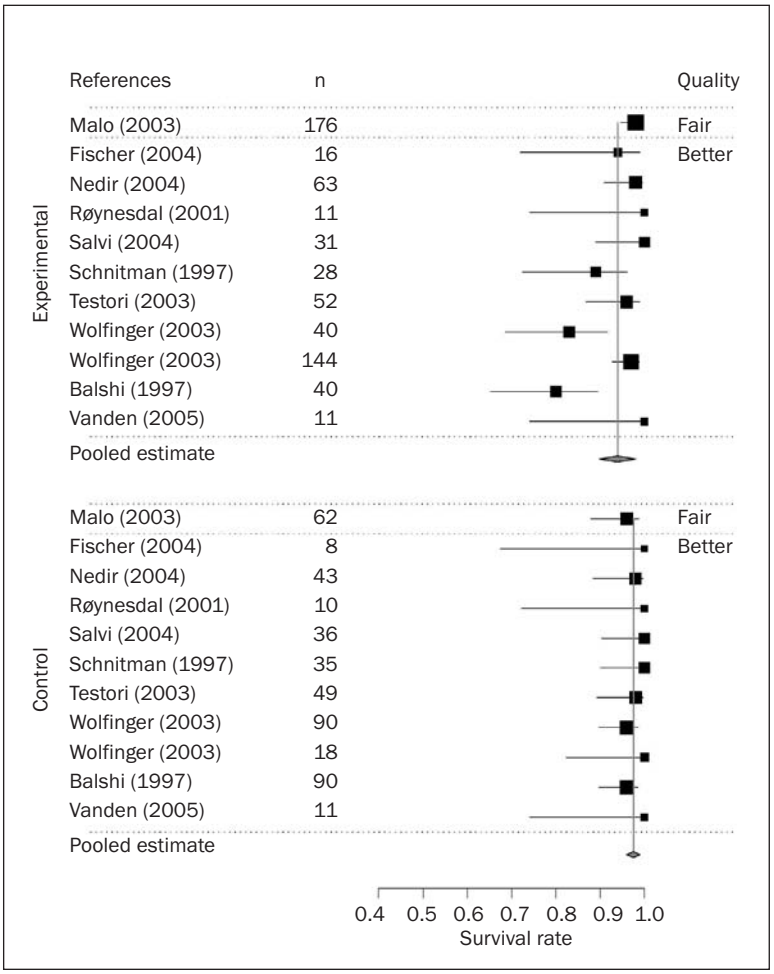


Fig 3a Implant survival rates for the experimental (immediate/early loading) and the control groups at 12-month examination.

The outcomes for each treatment employed in the study are shown in Table 6. In general, minor differences between the control and the experimental groups were noted for the different treatment outcome variables. A relatively low number of implants failed in both groups.

The estimated implant survival rates for the experimental and the control groups are shown for the different reported timepoints in Fig 3 (12, 24, and 36 months) and Fig 4 (48, 60, and 72 months). It should be recognized that the 48- to 72-month estimates are to a large extent based on trials comparing traditional machined-surfaced titanium implants and may not be representative for modern implant surfaces.

The estimates of the last reported timepoints, ie, the longest reported follow-up times in the individual reports, are shown summarized in Fig 5. The relative differences of the estimated implant survival

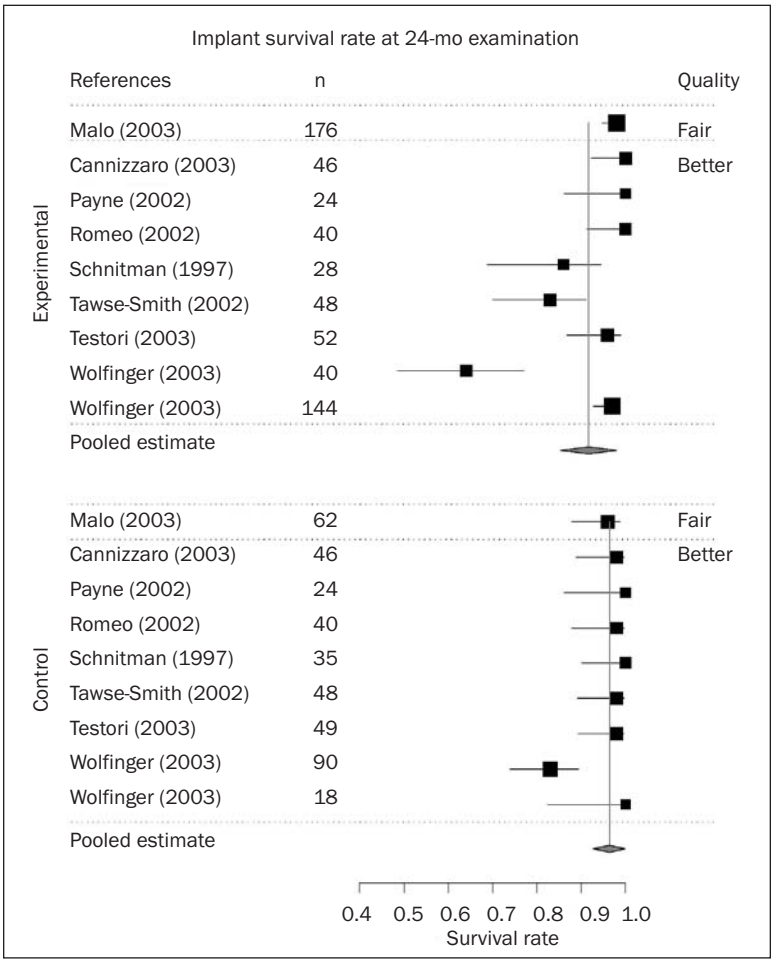


Fig 3b Implant survival rates for the experimental (immediate/early loading) and the control groups at the 24-month examination.

between the experimental and control groups for the last reported timepoints are shown in Fig 6. As can be seen from this graph, there was a slight tendency toward better results in the control group. The pairwise test indicated a pooled difference of 2% (CI: 0% to 4%, z = 1.91, *P* = .06).

Survival estimates for the control and experimental groups evaluated at different timepoints are shown in Fig 7. The survival estimates for the 2 groups did not differ significantly at any of the timepoints, as indicated by the overlapping and rather large confidence intervals.

Finally, in an effort to identify any potential indications of publication bias, a funnel plot was constructed with the difference in survival plotted against the sample sizes (Fig 8). No such bias could be identified. However, all the trials suggesting higher survival of the control group[25,29,30,39,40,46] > 10% compare traditional machined-surfaced titanium implants and may not be representative of modern implant surfaces.

Fig 3c Implant survival rates for the experimental (immediate/early loading) and the control groups at the 36-month examination.

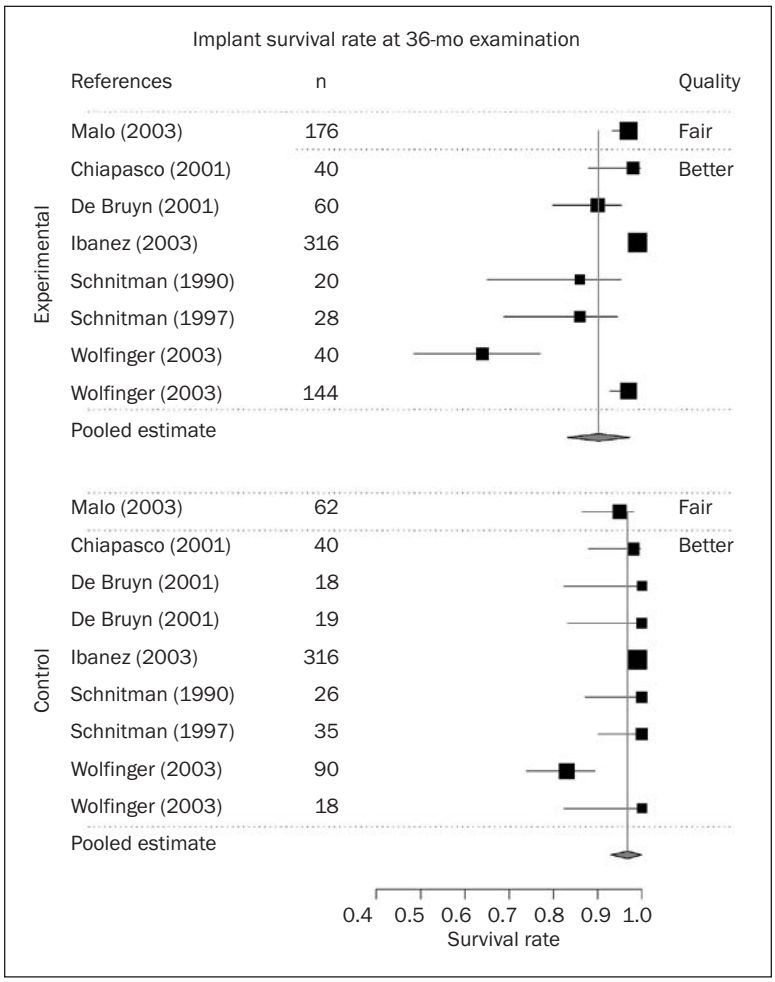
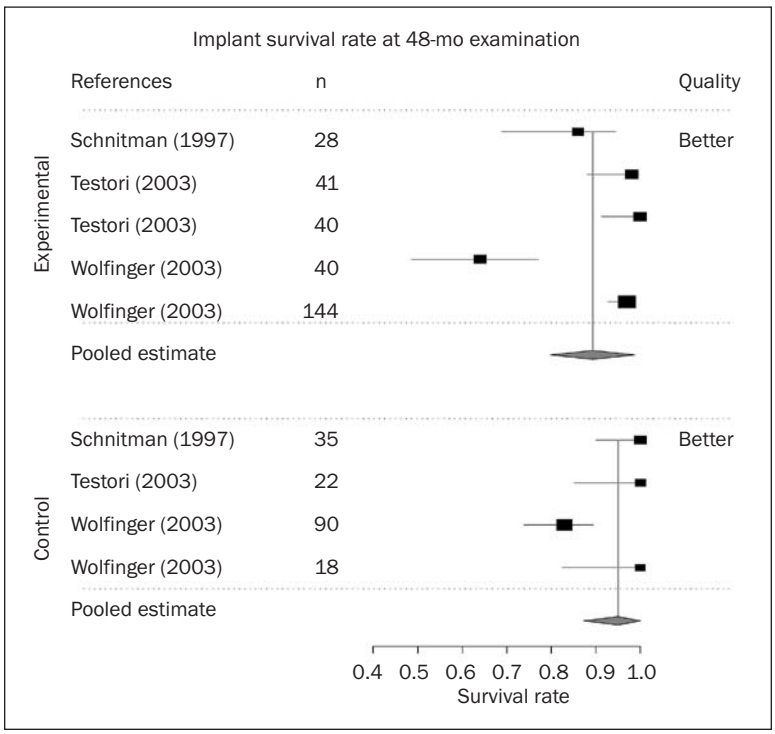


Fig 4a Implant survival rates for the experimental (immediate/early loading) and the control groups at the 48-month examination.



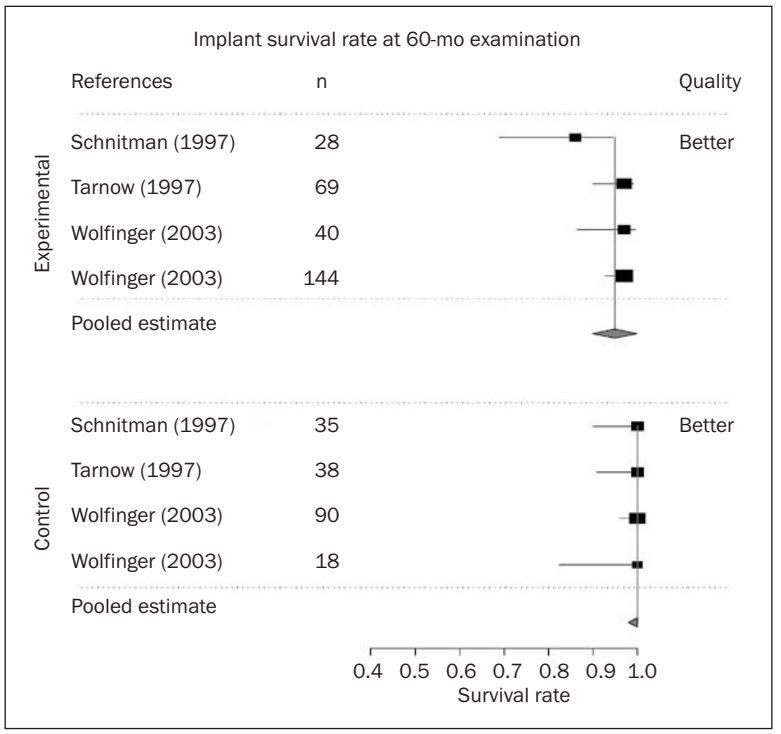


Fig 4b Implant survival rates for the experimental (immediate/early loading) and the control groups at the 60-month examination.

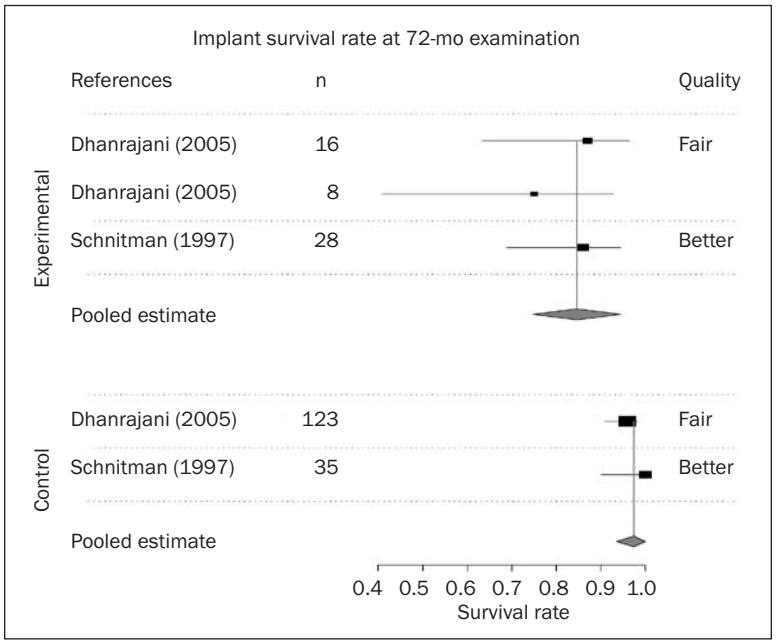


Fig 4c Implant survival rates for the experimental (immediate/early loading) and the control groups at the 72-month examination.

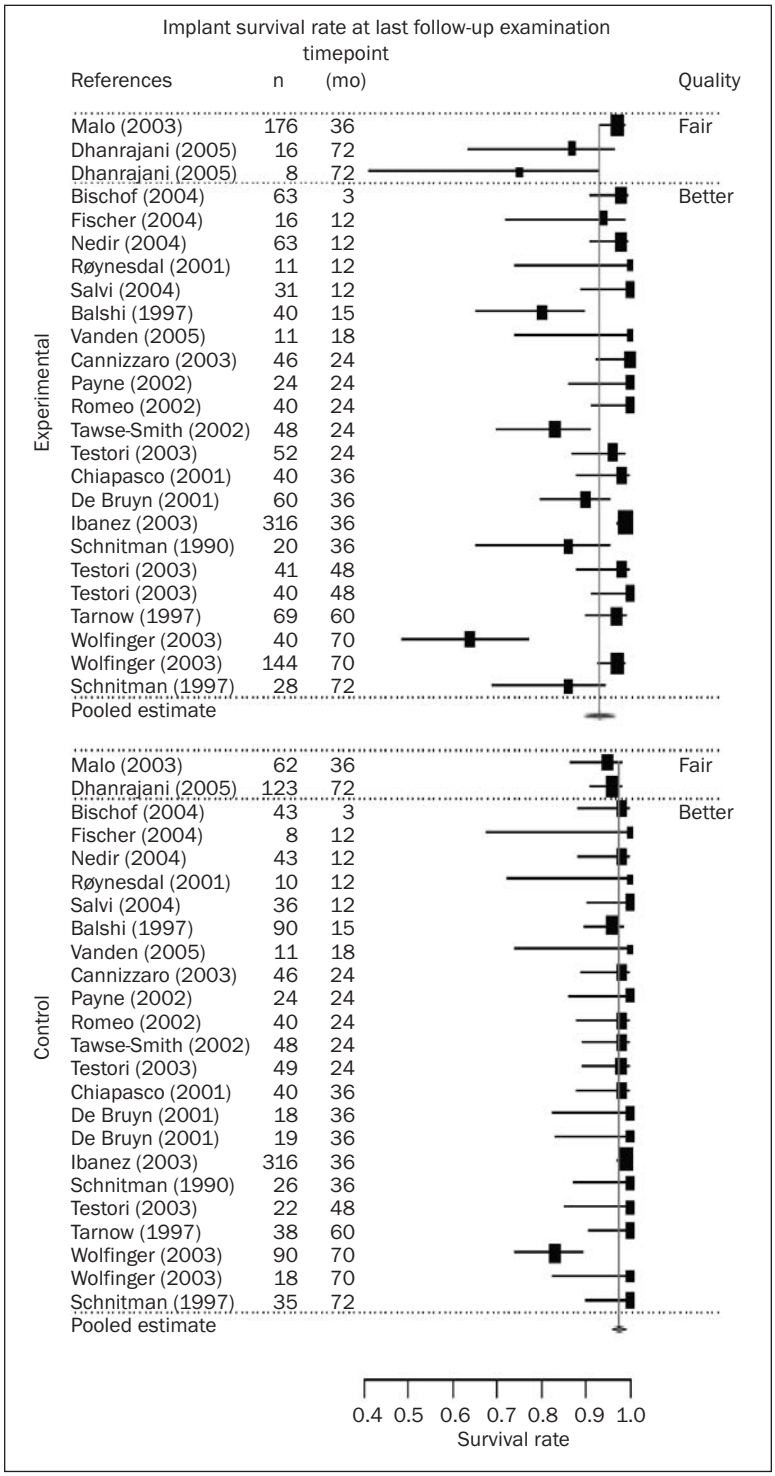


Fig 5 Implant survival rates for the experimental (immediate/early loading) and the control groups in the last reported timepoints.

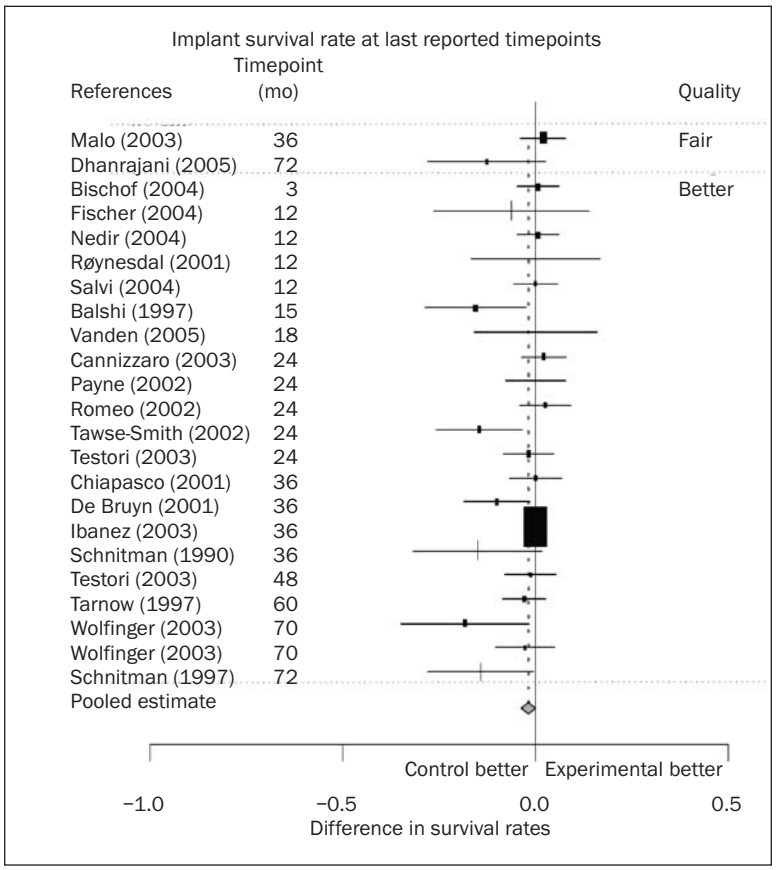


Fig 6 Relative differences in implant survival rates between the experimental (immediate/early loading) and the control groups in last reported timepoints.

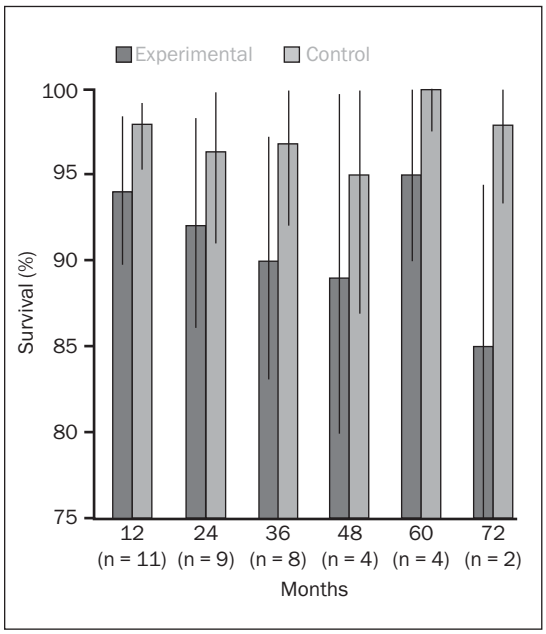


Fig 7 Estimates of survival functions for the experimental groups and control groups at different time points. Shaded boxes are experimental groups (immediate and early loading), the light shaded boxes are the control groups. The numbers in brackets represent the number of trials whereupon the survival estimates are calculated.

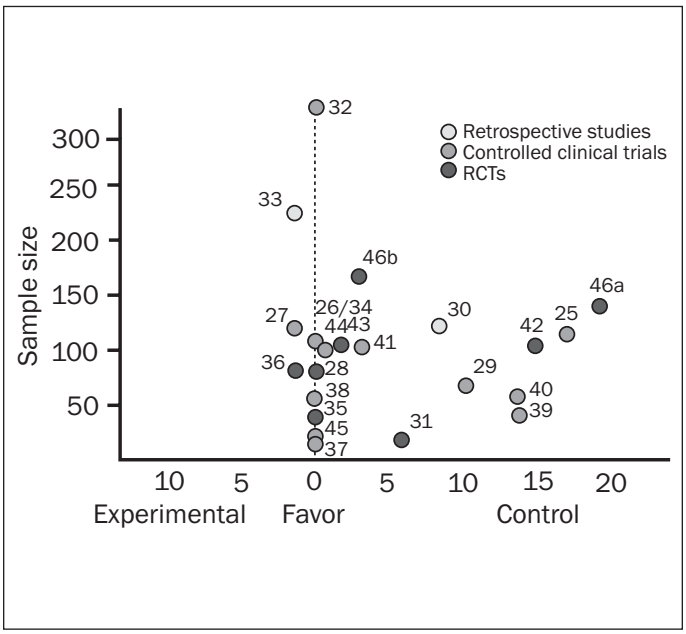


Fig 8 Estimates of the difference in estimated survival of implants in the experimental and control groups as a function of the population sample size of the trials. Light shade circles represent retrospective studies (n=2), shaded circles are controlled clinical trials (n=13), and dark shade circles represent RCTs (n=7). The numbers refer to the studies as listed in the reference list.

DISCUSSION

This systematic review sought to summarize the literature relative to clinical outcomes for fixed or removable implant-supported prostheses based on time to loading. Attempts to use standard systematic review procedures (application of scientific strategies in ways that limit bias to the assembly, critical appraisal, and synthesis of all relevant studies that address a specific clinical question) were challenged because of report variability, and this limits the ability to draw conclusive comments from the work. An important feature of systematic reviews is that they can improve power by increasing sample size through pooling multiple smaller studies. This requires pooled studies to be homogenous. Of note, only 2 of the studies in this review had a sample size greater than 50 patients per implant group. None of the studies were similar enough in terms of methodology to be considered homogenous.

Heterogeneity

It is common for studies brought together for systematic review to differ. The difference between studies constitutes variability, referred to as heterogeneity, and poses a significant challenge to meaningful quantitative synthesis of findings. Heterogeneity can relate to: *(1)* the participants, interventions, and outcomes, where it is called clinical heterogeneity; *(2)* trial design and quality, where it is called methodologic heterogeneity; or *(3)* treatment effects in the different trials, where it is called statistical heterogeneity. Quantitative synthesis of results among studies in a systematic review is most meaningful when a group of trials is sufficiently homogenous in terms of participants, interventions, and outcomes.

The results of these clinical trials are difficult to compare and synthesize because of significant heterogeneity of study designs, study aims, choice of treatment outcomes, follow-up observation periods, and size and selection of patient samples. In addition to these basic methodologic issues are variations in cofactors with regard to implant, patient, and operational criteria which may have influenced outcomes independent of the interventions.

Variable Clinical Applications

Although all the included studies involved the use of dental implants restored at different times following placement, the specific clinical procedures performed were quite variable. This makes the application of the review findings to a specific clinical situation inappropriate.

The timing of implant placement following tooth extraction was quite variable. In 9 studies no timing was reported; 7 papers had groups labeled "healed" and "postextraction." Two studies allowed greater than 3 months of healing while one allowed greater than 6 months, and in 2 studies the implants were simply described as "healed"[43] or "postextraction"[45] without description of specific times (Table 5). Such diversity makes it difficult to know how best to apply the collective findings to a specific patient situation.

Not only did postextraction healing time vary, but the site and size of the restoration/prosthesis was quite variable, compounding concerns regarding the applicability of the findings. Twelve studies utilized implants in edentulous mandibles for full-arch prostheses, while 7 studies involved partially edentulous maxillae and mandibles. One study each involved implants for single-tooth crowns, edentulous maxillae, and edentulous maxillae and mandibles (Table 6).

Variable Outcomes

Both the type and number of treatment outcomes described in the papers varied (Table 6). The range and selection of the specific variables can give an indication of the methodologic quality of the paper. For example, while 10 of the papers lacked a description of the failure criteria or used self-defined criteria, in the studies described in the other 12 papers, well-described and validated sets of criteria were applied.

"Implant survival" was a common outcome, but the criteria used to assess it (ie, the failure criteria) were not consistent across studies. Figure 6 summarizes the difference in implant survival for the groups in each study. It shows that in general, implant survival was greater in the control group, although the difference was not significant. As stated, because of the heterogeneity between the studies and the different meaning each individual study outcome represents, it is inappropriate to represent the pooled outcome as informative to any general clinical application.

Quality of Evidence

It is appropriate to consider how confidently the results of this systematic review can be used. This relates to the strength of the evidence. For confident inference, at least 1 high-quality RCT following 50 patients for 5 years is desirable. For the largest group of studies addressing the same clinical application (ie, edentulous mandible), there were no high-quality RCTs of sufficient size or studies similar enough to be appropriately synthesized to provide strong evidence. At best, the evidence is limited for most clinical applications of early/immediate loading.

CONCLUSIONS

From the literature, 187 papers were identified reporting clinical data on immediate or early implant loading. Twenty-two papers published between 1990 and 2005 described the influence of time to loading on implant treatment success. Seven trials were RCTs, 13 were prospective with concurrent controls, and 2 were retrospective with concurrent controls.

The general impression of the papers was that *(1)* the methodologic rigor of the trials was often not very strong, *(2)* the reported treatment outcomes were mostly surrogate and less patient-centered, and *(3)* the follow-up times were relatively short.

Statistical comparisons between subgroups were considered inappropriate because of the heterogeneity of trials (ie, variation in the clinical settings, patient inclusion and exclusion criteria, implant sites, clinical procedures, implant morphology, number of implants used to support a superstructure, nature of implant-supported superstructure, treatment outcomes, and observation periods).

Data from 19 trials reporting different patient follow-up periods between 1 and 10 years suggest that the overall performance was not significantly different between implants loaded early and immediately and implants loaded using a conventional healing period.

Within the limitations of the study populations in the papers appraised in this systematic review, although the average outcome was in favor of delayed loading, there are no indications that immediate or early loading cannot be a safe procedure.

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SECTION 1
CONSENSUS REPORT

What is the effect on outcomes of time-to-loading of a fixed or removable prosthesis placed on implant(s)?

Members of Section 1 evaluated the systematic review on immediate/early loading of implant prostheses. The focused PICO question addressed by the authors, Asbjørn Jokstad and Alan B. Carr, of the evidence-based systematic review is: What is the effect on outcomes of time-to-loading of a fixed or removable prosthesis placed on implant(s)?

1. Does the section agree that the systematic review is complete and accurate?
The nature of the PICO question makes it appropriate to limit the review to comparative studies. The section agrees that the review is complete and accurate.

2. Has any new information been generated or discovered since the review cutoff date?
There have been 4 additional articles published since the cutoff date of May 1, 2005, that would have met the criteria to be included in the authors' review. They include:

- Hall JAG, Payne AGT, Purton DG, Torr B. A randomized controlled clinical trial of conventional and immediately loaded tapered implants with screw-retained crowns. Int J Prosthodont 2006;19:17–19.
- Ottoni JMP, Oliviera ZFL, Mansini R, Cabral AM. Correlation between placement torque and survival of single-tooth implants. Int J Oral Maxillofac Implants 2005;20:769–776.
- Fischer K, Stenberg T. Three-year data from a randomized, controlled study of early loading of single-stage dental implants supporting maxillary full-arch prostheses. Int J Oral Maxillofacial Implants 2006;21:245–252.
- Turkyilmaz I. Clinical and radiological results of patients treated with two loading protocols for mandibular overdentures on Brånemark implants. J Clin Periodontol 2006;33:233–238.

Although not included in the statistical analysis of the review paper, the data from these articles appear consistent with that presented in the 22 articles that were included in the systematic review.

3. Does the section agree with the interpretation and conclusion of the reviewers?
The section agrees with the interpretation and conclusions of the reviewers. There were 187 studies reporting clinical data on immediate/early loading. Twenty-two papers, published in the period between 1990 and 2005, described the influence of time-to-loading on implant treatment outcomes. Seven trials were randomized control trials, 13 were prospective with concurrent controls, and 2 were retrospective with concurrent controls.

The general impression of these papers was that *(1)* the methodological rigor of trials was often not very strong, *(2)* the reported treatment outcomes were mostly surrogate and less patient-centered, and *(3)* the follow-up times were relatively short.

Statistical comparisons between subgroups were considered inappropriate due to the heterogeneity of trials (eg, clinical setting, patient inclusion and exclusion criteria, intraoral implant site, clinical procedures, implant morphology, number of implants to support a superstructure, treatment outcomes, and observation periods).

Data from 19 trials (3 represented follow-up reports on the same patient data) reported patient follow-up periods between 1 and 10 years. Analysis of these data suggested that the overall performance did not differ between immediate/early loaded implants versus implants using a delayed loading period ($P = .06$). However, increased variability of results was noted in the immediate/early loading groups as compared to the control groups.

Within the limitations of the study populations in the papers evaluated in the systematic review, there are no indications that early or immediate loading is an unsound procedure.

The statistical technique employed made pairwise comparisons of survival estimates at different timepoints. It would be inappropriate to make longitudinal inferences between the treatment protocols. The heterogeneity of treatment groups (eg, full or partial edentulism, implant technologies) and diminishing number of trials would make conclusions biasing one treatment over the other inaccurate.

4. What further research needs to be done relative to the PICO question?

Since a large fraction of the evaluated implants were placed in the interforaminal area, it appears that further verification is necessary for other intraoral locations.

Other variables warranting consideration include but may not be limited to bone type, host factors (eg, diabetes), environmental factors (eg, smoking, parafunction), number of implants, implant geometry, types of prostheses, local factors (eg, stage of healing following extraction), stability of outcome assessments, treatment efficiency, and patient satisfaction.

Priority should be given to research on implant surface characteristics, partial edentulism, and the maxillary arch. Furthermore, efforts should be made toward standardizing the methodology of comparative studies focusing on a broader range of outcomes. A multivariate analysis of the factors associated with success and failure from the current data might provide meaningful information for the clinician.

5. How can the information from the systematic review be applied for patient management?

Despite a tendency favoring the longest time-to-loading protocols, no generalized clinical recommendations can be made because potential influencing factors on outcomes were underrepresented.

Nearly half of the implants that were evaluated in the systematic review were located in the interforaminal area. The existing limited data suggest that the immediate/early loading of implants placed in the interforaminal area can be considered as a reasonable treatment alternative to delayed loading. The remaining implants were too widely dispersed amongst other anatomic regions and applications to draw any clinical conclusions.

The applicability of immediate/early loading protocols to a given clinical situation must be considered in the context of the unique anatomic, biomechanical, and host factors. The competency of the clinician should also be considered.

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Table W1 Excluded Studies and Reasons for Exclusion

Authors/Title/Source	Study aim (sic)	Reason for exclusion
1. Aalam AA, Nowzari H, Krivitsky A. Functional restoration of implants on the day of surgical placement in the fully edentulous mandible: A case series. Clin Implant Dent Relat Res 2005;7:10–16.	Report the clinical experience and outcome of a study of the functional rehabilitation of 16 completely edentulous mandibles with immediately loaded cross-arch screw-retained hybrid prostheses at the University of Southern California	Single-technique case series
2. Abboud M, Koeck B, Stark H, Wahl G, Paillon R. Immediate loading of single-tooth implants in the posterior region. Int J Oral Maxillofac Implants 2005;20:61–68.	Evaluate the clinical response and safety of immediately loaded single-tooth implants placed in the posterior region of the maxilla and mandible	Single-technique case series
3. Ahn MR, An KM, Choi JH, Sohn DS. Immediate loading with mini dental implants in the fully edentulous mandible. Implant Dent 2004;13:367–372.	Evaluate the efficacy of 27 provisional dental implants	Insufficient observation period (< 1 year) and single-technique case series
4. Aires I, Berger J. Immediate placement in extraction sites followed by immediate loading: A pilot study and case presentation. Implant Dent 2002;11:87–94.	Compare the results of implants immediately loaded in edentulous sites with implants loaded immediately in extraction sites	Anecdotal
5. Andersen E, Haanæs HR, Knutsen BM. Immediate loading of single-tooth ITI implants in the anterior maxilla: A prospective 5-year pilot study. Clin Oral Implants Res 2002;13:281–287.	Evaluate the success rate of immediately loaded single-tooth ITI solid plasma-sprayed (TPS) implants in the maxilla	Single-technique case series
6. Arvidson K, Bystedt H, Frykholm A, von Konow L, Lothigius E. Five-year prospective follow-up report of the Astra Tech dental implant system in the treatment of edentulous mandibles. Clin Oral Implants Res 1998;9:225–234.	Present the 5-years' results from the 1st and 2nd generations of the Astra Tech implant System to support fixed detachable bridges in the treatment of edentulous mandibles	Single-technique case series
7. Attard NJ, David LA, Zarb GA. Immediate loading of implants with mandibular overdentures: One-year clinical results of a prospective study. Int J Prosthodont 2005;18:463–470.	Present the implant and clinical outcomes of an immediate-loading protocol of TiUnite implants with mandibular overdentures in edentulous patients	Single-technique case series compared with historical data
8. Austin BW, Stevenson AR, Hogan PF, Walton TR. Same day teeth-Sydney style: Immediate functional loading of Brånemark dental implants in the anterior mandible. Ann R Australas Coll Dent Surg 2000;15: 340–342.	Present preliminary results from an ongoing study	Anecdotal
9. Babbush CA, Kent JN, Misiek DJ. Titanium plasma-sprayed TPS screw implants for the reconstruction of the edentulous mandible. J Oral Maxillofac Surg 1986;44:274–282.	Describe the TPS Swiss screw implant system, implantation and prosthetic techniques, clinical applications and a four- to eight-year follow-up study of cases from the US, Switzerland, Germany and Sweden	Old technology
10. Balshi SF, Allen FD, Wolfinger GJ, Balshi TJ. A resonance frequency analysis assessment of maxillary and mandibular immediately loaded implants. Int J Oral Maxillofac Implants 2005;20:584–594.	Gain insight into the dynamic pattern of implant stability under immediately loaded conditions	Single-technique case series
11. Balshi SF, Wolfinger GJ, Balshi TJ. Analysis of 164 titanium oxide-surface implants in completely edentulous arches for fixed prosthesis anchorage using the pterygomaxillary region. Int J Oral Maxillofac Implants 2005;20:946–952.	Calculate the survival rate of Brånemark implants with TiUnite surfaces in edentulous maxillary sites, including the pterygomaxillary region, restored with complete fixed maxillary prostheses	Single-technique case series compared to historical data
12. Balshi SF, Wolfinger GJ, Balshi TJ. A prospective study of immediate functional loading, following the teeth in a day protocol: A case series of 55 consecutive edentulous maxillas. Clin Implant Dent Relat Res 2005;7:24–31.	Evaluate the results of 55 patients in a clinical investigation of immediate functional loading of Brånemark System implants (Nobel Biocare USA, Yorba Linda, CA) in edentulous maxillas. Its further purpose is to suggest a reliable and evidence-based protocol for immediate implant loading of full-arch prostheses in the maxilla	Single-technique case series

Table W1 continued Excluded Studies and Reasons for Exclusion

Authors/Title/Source		Study aim (sic)	Reason for exclusion
13.	Balshi TJ, Wolfinger GJ. Immediate loading of dental implants in the edentulous maxilla: Case study of a unique protocol. Int J Periodontics Restorative Dent 2003; 23:37–45.	Illustrate a patient history to illustrate the teeth-in-a-day protocol	Anecdotal and less than 5 patients
14.	Balshi TJ, Wolfinger GJ. Immediate placement and implant loading for expedite patient care: A patient report. Int J Oral Maxillofac Implants 2002;17: 587–592.	Present history and treatment typical of that provided for patients using the immediate functional loading concept in the edentulous mandible	Anecdotal and less than 5 patients
15.	Balshi TJ, Wolfinger GJ. Teeth in a day for the maxilla and mandible: Case report. Clin Implant Dent Relat Res 2003;5:11–16.	Present a surgical and prosthetic protocol developed by the authors and describe the use of this protocol in treating a long-distance patient	Anecdotal and less than 5 patients
16.	Barone A, Covani U, Cornelini R, Gherlone E. Radiographic bone density around immediately loaded oral implants. Clin Oral Implants Res 2003;14:610–615.	Analyze the bone density around immediately loaded oral implants by a new volumetric CT-scan and compare it with unloaded implants	Insufficient observation period (< 1 year) and less than 5 patients
17.	Becker W, Becker BE, Huffstetlert S. Early functional loading at 5 days for Brånemark implants placed into edentulous mandibles: A prospective, open-ended, longitudinal study. J Periodontol 2003;74:695–702.	Evaluate placement of 4 to 6 implants in edentulous mandibles	Single-technique case series
18.	Bergkvist G, Sahlholm S, Karlsson U, Nilner K, Lindh C. Immediately loaded implants supporting fixed prostheses in the edentulous maxilla: A preliminary clinical and radiologic report. Int J Oral Maxillofac Implants 2005;20:399–405.	Evaluate clinically and radiologically the survival rate of ITI implants immediately loaded (ie within 24 hours) in the edentulous maxilla after 8 months.	Insufficient observation period (< 1 year)
19.	Bijlani M, Lozada JL. Immediately loaded dental implants—Influence of early functional contacts on implant stability, bone level integrity, and soft tissue quality: A retrospective 3- and 6-year clinical analysis. Int J Oral Maxillofac Implants 1996;11: 126–127.	Not stated	Less than 5 patients (and only abstract)
20.	Bornstein MM, Lussi A, Schmid B, Belser UC, Buser D. Early loading of nonsubmerged titanium implants with a sandblasted and acid-etched (SLA) surface: 3-year results of a prospective study in partially edentulous patients. Int J Oral Maxillofac Implants 2003;18:659–666.	Evaluate the success rate of ITI implants with the SLA surface that were loaded after 6 weeks of healing	Single-technique case series
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.	Assess the clinical and radiographic 3-year results for titanium implants with the SLA surface tested in posterior sites of partially edentulous patients	Single-technique case series
22.	Brånemark PI, Engstrand P, Ohrnell LO, et al. Brånemark Novum: A new treatment concept for rehabilitation of the edentulous mandible. Preliminary results from a prospective clinical follow-up study. Clin Implant Dent Relat Res 1999;1:2–16.	Report the preliminary clinical results of a new method for implant treatment of the edentulous mandible.	Single-technique case series
23.	Brånemark PI, Hansson BO, Adell R, et al. Osseointegrated implants in the treatment of the edentulous jaw. Experience from a 10-year period. Scand J Plast Reconstr Surg Suppl 1977;16:1–132.	Give a summarized review of materials, methods and results from 15 years of clinical use of osseointegrated fixtures in the treatment of the edentulous jaw	Anecdotal

Table W1 continued Excluded Studies and Reasons for Exclusion

	Authors/Title/Source	Study aim (sic)	Reason for exclusion
24.	Buchs AU, Levine L, Moy P. Preliminary report of immediately loaded Altiva Natural Tooth Replacement dental implants. Clin Implant Dent Relat Res 2001;3:97–106.	Present the initial clinical experiences when the Altiva Natural Tooth Replacement one-piece implant was used in a human clinical trial	Single-technique case series
25.	Buser D, Mericske-Stern R, Bernard JP, et al. 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.	Evaluate the cumulatively inserted ITI implants over a period of 8 years utilizing the life table analysis of Cutler & Ederer (1958)	Single-technique case series
26.	Calandriello R, Tomatis M. Simplified treatment of the atrophic posterior maxilla via immediate/early function and tilted implants: A prospective 1-year clinical study. Clin Implant Dent Relat Res 2005;7(suppl 1): S1–S12.	Develop a clinical protocol for the use of tilted posterior implants placed in immediate/early function and to evaluate its clinical efficacy	Single-technique case series
27.	Calandriello R, Tomatis M, Rangert B. Immediate functional loading of Brånemark System implants with enhanced initial stability: A prospective 1- to 2-year clinical and radiographic study. Clin Implant Dent Relat Res 2003;5(suppl 1):10–20.	Investigate the clinical outcome of the immediate loading of Brånemark System implants (Nobel Biocare AB, Gothenburg, Sweden) inserted with enhanced initial stability principally in posterior sites	Single-technique case series
28.	Calandriello R, Tomatis M, Vallone R, Rangert B, Gottlow J. Immediate occlusal loading of single lower molars using Brånemark System Wide-Platform Ti-Unite implants: An interim report of a prospective open-ended clinical multicenter study. Clin Implant Dent Relat Res 2003;5(suppl 1): 74–80.	Evaluate immediate loading of Brånemark System TiUnite Wide-Platform implants (Nobel Biocare AB, Gothenburg, Sweden) supporting single molar crowns in the lower jaw	Single-technique case series
29.	Callan DP, Hahn J, Hebel K, et al. Retrospective multicenter study of an anodized, tapered, diminishing thread implant: Success rate at exposure. Implant Dent 2000;9:329–336.	Compare the performance of the implant at exposure and its performance (ie, success rate) observed after longer periods (ie, > or = 1 year) of loaded service	Insufficient observation period (< 1 year)
30.	Calvo Guirado JL, Saez Yuguero R, Ferrer Perez V, Moreno Pelluz A. Immediate anterior implant placement and early loading by provisional acrylic crowns: A prospective study after a one-year follow-up period. J Ir Dent Assoc 2002;48:43–49.	Anecdotal	Anecdotal
31.	Castellon P, Blatz MB, Block MS, Finger IM, Rogers B. Immediate loading of dental implants in the edentulous mandible. J Am Dent Assoc 2004;135:1543–1549.	Anecdotal	Single-technique case series
32.	Chatzistavrou M, Felton DA, Cooper LF. Immediate loading of dental implants in partially edentulous patients: A clinical report. J Prosthodont 2003;12:26–29.	Present a case involving a partially edentulous patient who was successfully restored with a fixed partial denture after immediate loading of dental implants	Anecdotal and less than 5 patients
33.	Chaushu G, Chaushu S, Tzohar A, Dayan D. Immediate loading of single-tooth implants: Immediate versus non-immediate implantation: A clinical report. Int J Oral Maxillofac Implants 2001;16:267–272.	Compare the clinical success of immediately loaded single-tooth implants placed in fresh extraction sites to that of immediately loaded single-tooth implants placed in healed sites	Single-technique case series
34.	Chee W, Jivraj S. Efficiency of immediately loaded mandibular full-arch implant restorations. Clin Implant Dent Relat Res 2003;5:52–56.	Compare the number of treatment visits for patients undergoing traditional implant placement and healing with that of patients receiving immediate implant loading prior to construction of the definitive prostheses	Insufficient observation period (< 1 year)
35.	Chiapasco M, Gatti C. Implant-retained mandibular overdentures with immediate loading: A 3- to 8-year prospective study on 328 implants. Clin Implant Dent Relat Res 2003;5:29–38.	Evaluate prospectively survival and success rates of implants placed in the interforaminal area of edentulous mandibles and immediately loaded with an implant-supported overdenture	Case series (4) defined by differences of implant types
36.	Chiapasco M, Gatti C, Rossi E, Haefliger W, Markwalder TH. Implant-retained mandibular overdentures with immediate loading: A retrospective multicenter study on 226 consecutive cases. Clin Oral Implants Res 1997;8:48–57.	Evaluate long-term results of immediate-loaded implant-retained overdentures supported by 4 implants rigidly connected by a U-shaped curved bar	Case series (4) defined by differences in provisional fabrication techniques used over 11 years

Table W1 continued Excluded Studies and Reasons for Exclusion

Authors/Title/Source		Study aim (sic)	Reason for exclusion
37.	Chow J, Hui E, Liu J, et al. The Hong Kong Bridge Protocol. Immediate loading of mandibular Brånemark fixtures using a fixed provisional prosthesis: Preliminary results. Clin Implant Dent Relat Res 2001; 3:166–174.	Present the Hong Kong Bridge protocol and report the short-term evaluation of this protocol in a group of patients who had undergone dental implant treatment for their edentulous mandibles	Single-technique case series
38.	Cochran DL, Buser D, ten Bruggenkate CM, et al. The use of reduced healing times on ITI implants with a sandblasted and acid-etched (SLA) surface: Early results from clinical trials on ITI SLA implants. Clin Oral Implants Res 2002;13:144–153.	Determine whether the 4.1 mm diameter SLA ITI solid screw implants could be predictably and safely restored as early as six weeks after implant placement surgery	Single-technique case series
39.	Collaert B, De Bruyn H. Early loading of four or five Astra Tech fixtures with a fixed cross-arch restoration in the mandible. Clin Implant Dent Relat Res 2002;4:133–135.	Verify whether four or five fixtures installed in edentulous mandible were suitable for early loading with a cross-arch fixed restoration	Single-technique case series
40.	Colomina LE. Immediate loading of implant-fixed mandibular prostheses: A prospective 18-month follow-up clinical study-Preliminary report. Implant Dent 2001; 10:23–29.	Conduct a prospective study of patients receiving immediately loaded mandibular fixed-implant prostheses	Case series (2) defined by provisional fabrication after 24 h vs after 10 days
41.	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.	Evaluate the clinical survival rate after rapid loading of unsplinted endosseous root-form implants replacing the loss of 1 or 2 teeth in the anterior maxilla	Single-technique case series
42.	Cooper LF, Rahman A, Moriarty J, Chaffee N, Sacco D. Immediate mandibular rehabilitation with endosseous implants: Simultaneous extraction, implant placement, and loading. Int J Oral Maxillofac Implants 2002;17:517–525.	Define the limitations for treatment, refine the prosthetic procedures for immediate loading using a simple acrylic resin fixed denture, and evaluate the relative safety and efficacy of this approach to mandibular dental rehabilitation	Single-technique case series
43.	Cooper LF, Scurria MS, Lang LA, Guckes AD, Moriarty JD, Felton DA. Treatment of edentulism using Astra Tech implants and ball abutments to retain mandibular overdentures. Int J Oral Maxillofac Implants 1999;14:646–653.	Provide evidence to support simplified treatment of mandibular edentulism using denture fabrication and implant placement to circumvent the need for second-stage surgeries or prosthodontic superstructures	Single-technique case series
44.	Cornelini R, Cangini F, Covani U, Barone A, Buser D. Immediate restoration of single-tooth implants in mandibular molar sites: A 12-month preliminary report. Int J Oral Maxillofac Implants 2004;19:855–860.	Evaluate survival and success rates	Single-technique case series
45.	da Cunha HA, Francischone CE, Filho HN, de Oliveira RC. A comparison between cutting and Ti-Unite implants regarding primary stability torque and resonance frequency in the assessment of primary stability and final torque capacity of standard and TiUnite single-tooth implants under immediate loading. Int J Oral Maxillofac Implants 2004; 19:578–585.	Evaluate standard Brånemark system implants and placement torque following placement of single implants using an immediate loading procedure	Single-technique case series
46.	De Bruyn H, Collaert B. Early loading of machined-surface Brånemark implants in completely edentulous mandibles: Healed bone versus fresh extraction sites. Clin Implant Dent Relat Res 2002;4:136–142.	Evaluate the success of implants loaded early or immediately with a fixed 12-unit bridge	Case series (2) defined by provisional fabrication after 24 h vs after < 8 days
47.	Degidi M, Piattelli A. Comparative analysis study of 702 dental implants subjected to immediate functional loading and immediate nonfunctional loading to traditional healing periods with a follow-up of up to 24 months. Int J Oral Maxillofac Implants 2005;20:99–107.	Clinically evaluate a new implant	Case series (3) defined by differences in intraoral status
48.	Degidi M, Piattelli A. Immediately loaded bar-connected implants with an anodized surface inserted in the anterior mandible in a patient treated with diphosphonates for osteoporosis: A case report with a 12-month follow-up. Clin Implant Dent Relat Res 2003;5:269–272.	A 12-month follow-up clinical and radiological study in a patient	Anecdotal and less than 5 patients

Table W1 continued Excluded Studies and Reasons for Exclusion

	Authors/Title/Source	Study aim (sic)	Reason for exclusion
49.	Degidi M, Piattelli A. Immediate functional and non-functional loading of dental implants: A 2- to 60-month follow-up study of 646 titanium implants. J Periodontol 2003;74:225–241.	Evaluate clinically implants subjected to immediate functional loading (IFL) and to immediate non-functional loading (INFL) in various anatomical configurations	Case series (2) defined by a difference of functional or nonfunctional provisional placement
50.	Degidi M, Piattelli A, Felice P, Carinci F. Immediate functional loading of edentulous maxilla: A 5-year retrospective study of 388 titanium implants. J Periodontol 2005;75: 1016–1024.	Evaluate the outcome of implants immediately loaded with a cross-arch fixed temporary restoration in the edentulous upper jaw in a consecutive study population	Single-technique case series
51.	Calvo MP, Muller E, Garg AK. Immediate loading of titanium hexed screw-type implants in the edentulous patient: Case report. Implant Dent 2000;9:351–357.	Present case reports that indicate that immediate loading of hexed titanium screw-type implants in the anterior mandible can lead to successful osseointegration and clinical outcomes	Anecdotal and less than 5 patients
52.	d'Hoedt B, Schulte W. A comparative study of results with various endosseous implant systems. Int J Oral Maxillofac Implants 1989;4:95–105.	Present the results of regular follow-up examinations of inserted dental implants	Old technology
53.	Drago CJ, Lazzara RJ. Immediate provisional restoration of Osseotite implants: A clinical report of 18-month results. Int J Oral Maxillofac Implants 2004;19:534–541.	Assess the survival rates and interproximal bone levels for implants that were restored with fixed provisional crowns without occlusion immediately after implant placement	Single-technique case series
54.	Engelke W, Decco OA, de las Mercedes Capobianco M, Schwarzwaller W, Villavicencio MM. Immediate occlusal loading of freestanding implants using cortical satellite implants: Preliminary report of a prospective study. Implant Dent 2005; 14:50–57.	Evaluate the success rate of two single-standing interforaminal implants stabilized with cortical satellite implants and loaded immediately with overdentures	Insufficient observation period (< 1 year) and single-technique case series
55.	Engquist B, Åstrand P, Anzen B, et al. Simplified methods of implant treatment in the edentulous lower jaw: A 3-year follow-up report of a controlled prospective study of one-stage versus two-stage surgery and early loading. Clin Implant Dent Relat Res 2005;7:95–104.	Compare the 3-year results of one-stage surgery versus two-stage surgery, early loading versus loading after a 3-month healing period, and the use of one-piece implants versus the use of two-piece implants	Single-technique case series compared to historical data
56.	Engquist B, Åstrand P, Anzen B, et al. Simplified methods of implant treatment in the edentulous lower jaw. Part II: Early loading. Clin Implant Dent Relat Res 2004; 6:90–100.	Evaluate the results of early loading in the edentulous mandible and to compare those results with treatment results of one-stage surgery followed by a healing period and with two-stage surgery	Single-technique case series compared to historical data
57.	Engstrand P, Grondahl K, Ohrnell LO, Nilsson P, Nannmark U, Brånemark PI. Prospective follow-up study of 95 patients with edentulous mandibles treated according to the Brånemark Novum concept. Clin Implant Dent Relat Res 2003;5:3–10.	Report clinical and radiographic outcomes in a group of patients treated according to the Brånemark Novum concept.	Case series defined by differences in loading times due to technician Results not presented separately
58.	Ericsson I, Nilson H, Lindh T, Nilner K, Randow K. Immediate functional loading of Brånemark single tooth implants. An 18 months' clinical pilot follow-up study. Clin Oral Implants Res 2000;11:26–33.	Evaluate the treatment outcome of single-tooth replacements with artificial crowns retained to implants installed according to a 1-stage surgical procedure and immediate loading in comparison to the original 2-stage concept	Single-technique case series compared to historical data
59.	Ericsson I, Randow K, Nilner K, Peterson A. Early functional loading of Brånemark dental implants: 5-year clinical follow-up study. Clin Implant Dent Relat Res 2000;2: 70–77.	Compare the outcome of oral rehabilitation of the edentulous mandible by fixed suprastructures connected to implants installed according to either (1) a one-stage surgical procedure and early loading or (2) the original two-stage concept	Single-technique case series compared to historical data
60.	Fradera AP, Roig EP, Sesma JM, et al. Multicenter retrospective study of implants loaded with functional prostheses 8 weeks after insertion. Implant Dent 2005;14: 43—49.	Evaluate whether the accomplishment of the prosthetic loading of implants at 8 weeks of insertion was acceptable clinically for decreasing the duration of treatment	Single-technique case series
61.	Friberg B, Henningsson C, Jemt T. Rehabilitation of edentulous mandibles by means of turned Brånemark System Implants after one-stage surgery: A 1-year retrospective study of 152 patients. Clin Implant Dent Relat Res 2005;7:1–9.	Retrospectively evaluate the 1-year results of one-stage surgery and early loading performed in edentulous mandibles in a large group of patients.	Single-technique case series compared with historical data
62.	Froum SJ, Simon H, Cho SC, Elian N, Rohrer MD, Tarnow DP. Histologic evaluation of bone-implant contact of immediately loaded transitional implants after 6 to 27 months. Int J Oral Maxillofac Implants 2005; 20:54–60.	Histologically evaluate the bone-to-implant contact of transitional implants in function for various time periods	Single-technique case series

Table W1 continued Excluded Studies and Reasons for Exclusion

Authors/Title/Source		Study aim (sic)	Reason for exclusion
63.	Fugazzotto PA. Immediate implant placement following a modified trephine and osteotome approach: Success rates of 116 implants to 4 years in function. Int J Oral Maxillofac Implants 2002;17:113–120.	Present a technique which utilizes a trephine to implode a core of maxillary posterior alveolar bone prior to immediate implant placement	Single-technique case series
64.	Gallucci GO, Bernard JP, Bertosa M, Belser UC. Immediate loading with fixed screw-retained provisional restorations in edentulous jaws: The pickup technique. Int J Oral Maxillofac Implants 2004;19: 524–533.	Determine whether the described technique is compatible with the predictable achievement of osseointegration	Single-technique case series
65.	Ganeles J, Rosenberg MM, Holt RL, Reichman LH. Immediate loading of implants with fixed restorations in the completely edentulous mandible: Report of 27 patients from a private practice. Int J Oral Maxillofac Implants 2001;16:418–426.	Document the application of immediate loading techniques to fixed mandibular restorations	Case series (2) defined by differences in provisional fabrication
66.	Gatti C, Chiapasco M. Immediate loading of Brånemark implants: A 24-month follow-up of a comparative prospective pilot study between mandibular overdentures supported by conical transmucosal and standard Mk II implants. Clin Implant Dent Relat Res 2002;4:190–199.	Compare the long-term outcome of immediately loaded implant-retained mandibular overdentures supported by four screw-type one-piece transmucosal implants with that of four screw-type two-piece implants inserted in the interforaminal area of the mandible and rigidly connected by a U-shaped curved bar	Single-technique case series (although randomized for implant abutments)
67.	Gatti C, Haefliger W, Chiapasco M. Implant-related mandibular overdentures with immediate loading: A prospective study of ITI implants. Int J Oral Maxillofac Implants 2000;15:383–388.	Prospectively evaluate long-term results of immediately loaded implant-retained overdentures supported by 4 ITI screw-type titanium plasma-sprayed implants rigidly connected by a U-shaped bar	Single-technique case series
68.	Glauser R, Lundgren A, Gottlow J, et al. Immediate occlusal loading of Brånemark Ti-Unite implants placed predominantly in soft bone: 1-year results of a prospective clinical study. Clin Implant Dent Relat Res 2003;5(suppl 1):47–56.	Present the short-term success rates of Ti-Unite-surfaced immediate occlusally loaded Brånemark System Mk IV implants placed in various regions of the jaws	Single-technique case series
69.	Glauser R, Ree A, Lundgren A, Gottlow J, Hammerle CH, Scharer P. Immediate occlusal loading of Brånemark implants applied in various jawbone regions: A prospective, 1-year clinical study. Clin Implant Dent Relat Res 2001;3:204–213.	Evaluate the short-term success rate of immediately loaded implants placed in various regions of the jaws	Case series (2) defined by differences in stability
70.	Glauser R, Ruhstaller P, Windisch S, et al. Immediate occlusal loading of Brånemark System Ti-Unite implants placed predominantly in soft bone: 4-year results of a prospective clinical study. Clin Implant Dent Relat Res 2005;7(suppl 1):S52–S59.	Document, on a long-term basis, the outcome of immediate occlusally loaded Brånemark System Mk IV TiUnite (Nobel Biocare AB, Göteborg, Sweden) implants placed to support fixed reconstructions in various regions of the jaws	Single-technique case series
71.	Glauser R, Sennerby L, Meredith N, et al. Resonance frequency analysis of implants subjected to immediate or early functional occlusal loading. Successful vs failing implants. Clin Oral Implants Res 2004;15: 428–434.	Analyze the development of implant stability by repeated RFA	Post hoc case-control analyses
72.	Gomes A, Lozada JL, Caplanis N, Kleinman A. Immediate loading of a single hydroxyapatite-coated threaded root form implant: A clinical report. J Oral Implantol 1998;24:159–166.	Describe in a case report a new surgical concept and a technique to fabricate screw-retained provisional crowns for immediate loading of free-standing single tooth implants	Anecdotal and less than 5 patients and insufficient observation period (< 1 year)
73.	Graber G, Besimo C. Hybridprotetische Suprastrukturen mit Konuskronen oder Hülsen-Stift-systemen aud Ha-Ti Implantaten Fortsch. Zahnärztl Implantol 1991;7:125–130.	Not established	Old technology
74.	Groisman M, Frossard WM, Ferreira HM, de Menezes Filho LM, Touati B. Single-tooth implants in the maxillary incisor region with immediate provisionalization: 2-year prospective study. Pract Proced Aesthet Dent 2003;15:115–122.	Present the 2-year postoperative results of patients treated with immediate, single, tapered implants in the maxillary incisor region and the simultaneous placement of provisional implant-supported crowns	Single-technique case series

Table W1 continued Excluded Studies and Reasons for Exclusion

Authors/Title/Source	Study aim (sic)	Reason for exclusion
75. Grunder U. Immediate functional loading of immediate implants in edentulous arches: Two-year results. Int J Periodontics Restorative Dent 2001;21:545–551.	Evaluate the clinical success of immediate functional loading of immediate implants in edentulous arches	Single-technique case series
76. Hatano N, Yamaguchi M, Suwa T, Watanabe K. A modified method of immediate loading using Brånemark implants in edentulous mandibles. Odontology 2003;91:37–42.	Evaluate an immediate loading treatment procedure capable of reducing the number of surgical sessions for patients	Single-technique case series
77. Henry PJ, van Steenberghe D, Blomback U, et al. Prospective multicenter study on immediate rehabilitation of edentulous lower jaws according to the Brånemark Novum protocol. Clin Implant Dent Relat Res 2003;5:137–142.	Investigate immediate rehabilitation under various settings, to determine technique, sensitivity, and to evaluate the clinical outcome after 1 year of follow-up	Single-technique case series
78. Hoexter DL. Osseous regeneration in compromised extraction sites: A ten-year case study. J Oral Implantol 2002;28:19–24.	Compare for 10 years the healing and wear of an endosseous implant that was placed in a large osseous defect and attached with an allographic material and a GTR membrane carrier	Anecdotal and less than 5 patients
79. Horiuchi K, Uchida H, Yamamoto K, Sugimura M. Immediate loading of Brånemark system implants following placement in edentulous patients: A clinical report. Int J Oral Maxillofac Implants 2000;15:824–830.	Evaluate the immediate loading of implants with a screw-retained provisional prosthesis in edentulous patients, including the maxilla and the posterior mandible	Single-technique case series
80. Hruska A, Borelli P, Bordanaro AC, Marzaduri E, Hruska KL. Immediate loading implants: A clinical report of 1301 implants. J Oral Implantol 2002;28:200–209.	Suggest 4 techniques for the immediate loading of implants, alternative, and/or complementary to the traditional submerged technique	Anecdotal and case series (4) defined by different techniques for provisionalizing
81. Hui E, Chow J, Li D, Liu J, Wat P, Law H. Immediate provisional for single-tooth implant replacement with Brånemark system: Preliminary report. Clin Implant Dent Relat Res 2001;3:79–86.	Develop a protocol to provide an immediate solution for restoring a single missing tooth in the esthetic zone	Single-technique case series
82. Ibanez JC, Jalbout ZN. Immediate loading of Osseotite implants: Two-year results. Implant Dent 2002;11:128–136.	Determine if with adequate case selection and adherence to established principles, immediate loading could be considered for routine clinical use	Case series (2) defined by provisional fabrication vs permanent solution
83. Jaffin RA, Kumar A, Berman CL. Immediate loading of implants in partially and fully edentulous jaws: A series of 27 case reports. J Periodontol 2000;71:833–838.	Demonstrate whether in partial and fully edentulous patients, titanium screw implants may be installed and loaded within 72 hours.	Anecdotal and single technique case series
84. Jaffin RA, Kumar A, Berman CL. Immediate loading of dental implants in the completely edentulous maxilla: A clinical report. Int J Oral Maxillofac Implants 2004;19:721–730.	Determine whether clinical success can be achieved with immediate loading in the completely edentulous maxilla with endosseous screw-type implants	Case series (2) defined by differences in provisional fabrication techniques
85. Jo HY, Hobo PK, Hobo S. Freestanding and multiunit immediate loading of the expandable implant: An up-to-40-month prospective survival study. J Prosthet Dent 2001;85:148–155.	Evaluate the effectiveness of an expandable implant design for immediate and delayed loading and for freestanding and multiunit situations.	Case series (2) defined by differences in stability
86. Jungner M, Lundqvist P, Lundgren S. Oxidized titanium implants (Nobel Biocare Ti-Unite) compared with turned titanium implants (Nobel Biocare Mark III) with respect to implant failure in a group of consecutive patients treated with early functional loading and two-stage protocol. Clin Oral Implants Res 2005;16:308–311.	Compare the different surfaces of dental implants with respect to implant failure both in one-stage protocols with early loading as well as two-stage protocols with traditional healing	Insufficient observation period (< 1 year)
87. Kan JY, Rungcharassaeng K, Lozada J. Immediate placement and provisionalization of maxillary anterior single implants: 1-year prospective study. Int J Oral Maxillofac Implants 2003;18:31–39.	Evaluate the implant success rate, peri-implant tissue response, and esthetic outcome of immediately placed and provisionalized maxillary anterior single implants	Single-technique case series
88. Kinsel RP, Lamb RE. Development of gingival esthetics in the edentulous patient with immediate loaded, single-stage, implant supported fixed prostheses: A clinical report. Int J Oral Maxillofac Implants 2000;15:711–721.	Present the specific pretreatment diagnostic requirements for immediate loading of single stage implants and demonstrate a new surgical technique	Single-technique case series

Table W1 continued Excluded Studies and Reasons for Exclusion

Authors/Title/Source		Study aim (sic)	Reason for exclusion
89.	Knox R, Lee K, Meffert R. Placement of hydroxyapatite-coated endosseous implants in fresh extraction sites: A case report. Int J Periodontics Restorative Dent 1993;13: 245–253.	Anecdotal	Anecdotal and less than 5 patients
90.	Krennmair G, Furhauser R, Weinlander M, Piehslinger E. Maxillary interim overdentures retained by splinted or unsplinted provisional implants. Int J Prosthodont 2005;18:195–200.	Evaluate provisional implants specifically used for the anchorage of a removable maxillary interim overdenture supported by splinted or unsplinted provisional implants	Insufficient observation period (< 1 year)
91.	Kronström M, Widbom T, Lofquist LE, Henningson C, Widbom C, Lundberg T. Early functional loading of conical Brånemark implants in the edentulous mandible: A 12-month follow-up clinical report. J Prosthet Dent 2003;89:335–340.	Describe a 12-month evaluation of implants placed between the mental foramina according to a 1-stage surgical procedure	Single-technique case series
92.	Lazzara RJ, Porter SS, Testori T, Galante J, Zetterqvist L. A prospective multicenter study evaluating loading of osseotite implants two months after placement: One-year results. J Esthet Dent 1998;10:280–289.	Evaluate the efficacy of loading Osseotite dental implants (3i-Implant Innovations Inc, Palm Beach Gardens, Florida) at 2 months and to determine the effect of early loading on implant performance and survival	One group was loaded after approximately 2 months and the other after 3 months; not considered an early versus cinventional loading trial
93.	Ledermann PD. Die plasmabeschichtete Titanschraube als enossales implantat. Methodic der Implantaten und der postoperative Versorgung. Dtsch Zahnärztl Z 1980;35:577–579.	Describe a method for intraosseous screw implantation	Anecdotal and old technology
94.	Ledermann PD. Sechsjährige klinische Erfahrung mit dem Titanplasma-beschichteten ITI-Schraubenimplantat in der Regio interforaminalis des Unterkiefers. SSO Schweiz Monatsschr Zahnheilkd 1983; 93:1080–1089.	Not established	Old technology
95.	Ledermann PD. Über 20jährige Erfahrung mit der sofortigen funktionellen Belastung von Implantatstegen in der Regio interfor-aminalis. Z Zahnärtzl Implant 1996;12:123.	Not established	Old technology
96.	Ledermann PD. Stegprothetische Versorgung des zahnlosen Unterkiefers mit Hilfe von plasmabeschichteten Titanischrauben-implanten. Dtsch Zahnärztl Z 1979;34: 907–911.	Present preliminary findings of bar prosthesis on plasma-coated titanium screws	Anecdotal and old technology
97.	Ledermann PD. Das TPS-Schraubenimplantat nach siebenjahriger Anwendung. Quintessenz 1984;35:2031–2041.	Not established	Old technology
98.	Ledermann PD. Der Sofort-implantat-steg im zahnlosen unterkiefer. Swiss Dent 1996;17:5–18.		Old technology
99.	Lefkove MD, Beals RP. Immediate loading of cylinder implants with overdentures in the mandibular symphysis: The titanium plasma-sprayed screw technique. J Oral Implantol 1990;16:265–271.	Describe a technique for the placement of titanium plasma-sprayed screw implants in the mandibular symphysis	Anecdotal, less than 5 patients, and old technology
100.	Levine RA, Rose L, Salama H. Immediate loading of root-form implants: Two case reports 3 years after loading. Int J Periodontics Restorative Dent 1998;18: 333–343.	Anecdotal	Anecdotal and less than 5 patients
101.	Lindquist LW, Carlsson GE, Jemt T. A prospective 15-year follow-up study of mandibular fixed prostheses supported by osseointegrated implants: Clinical results and marginal bone loss. Clin Oral Implants Res 1996;7:329–336.	Longitudinally examine a group of edentulous patients who were treated with mandibular fixed implant-supported prostheses and present clinical observations and analyze the relationship of various factors to long-term (10-15 years) changes in marginal bone level around the implants	Single-technique case series
102.	Locante WM. The nonfunctional immediate provisional in immediate extraction sites: A technique to maximize esthetics. Implant Dent 2001;10:254–258.	Present a new treatment option that combines the benefits of two traditional techniques and offers the esthetic replacement of a single missing tooth	Anecdotal
103.	Lorenzoni M, Pertl C, Zhang K, Wegscheider WA. In-patient comparison of immediately loaded and non-loaded implants within 6 months. Clin Oral Implants Res 2003;14:273–279.	Compare reproducible parameters of immediate loaded and non-loaded implants at second stage surgery	Insufficient observation period (< 1 year)

Table W1 continued Excluded Studies and Reasons for Exclusion

Authors/Title/Source		Study aim (sic)	Reason for exclusion
104.	Lorenzoni M, Pertl C, Zhang K, Wimmer G, Wegscheider WA. Immediate loading of single-tooth implants in the anterior maxilla. Preliminary results after one year. Clin Oral Implants Res 2003;14:180–187.	Evaluate clinical outcomes of immediately loaded implants 12 months after placement in the maxillary incisal region	Single-technique case series
105.	Luongo G, Di Raimondo R, Filippini P, Gualini F, Paoleschi C. Early loading of sandblasted, acid-etched implants in the posterior maxilla and mandible: A 1-year follow-up report from a multicenter 3-year prospective study. Int J Oral Maxillofac Implants 2005;20:84–91.	Assess the clinical results of early and immediate loading in the posterior maxilla and mandible of partially edentulous patients	Single-technique case series
106.	Malo P, Friberg B, Polizzi G, Gualini F, Vighagen T, Rangert B. Immediate and early function of Brånemark System implants placed in the esthetic zone: A 1-year prospective clinical multicenter study. Clin Implant Dent Relat Res 2003; 5(suppl 1):37–46.	Evaluate the outcome of implants placed in incisor, canine, and premolar regions in maxillae or mandibles	Single-technique case series
107.	Malo P, Rangert B, Dvarsater L. Immediate function of Brånemark implants in the esthetic zone: A retrospective clinical study with 6 months to 4 years of follow-up. Clin Implant Dent Relat Res 2000;2:138–146.	Investigate a concept for immediate function of Brånemark implants supporting fixed prosthesis in the esthetic regions of the jaws	Single-technique case series
108.	Malo P, Rangert B, Nobre M. All-on-4 immediate-function concept with Brånemark System implants for completely edentulous maxillae: A 1-year retrospective clinical study. Clin Implant Dent Relat Res 2005;7(suppl 1): S88–S94.	Evaluate a protocol for immediate function of four implants supporting a fixed prosthesis in the completely edentulous maxilla	Single-technique case series
109.	Mau J, Behneke A, Behneke N, et al. Randomized multicenter comparison of 2 IMZ and 4 TPS screw implants supporting bar-retained overdentures in 425 edentulous mandibles. Int J Oral Maxillofac Implants 2003;18:835–847.	Compare 2 treatment concepts for implant-supported, bar-retained mandibular overdentures, ie, 2 intramobile cylinder implants with a straight Dolder bar vs 4 Ti plasma-sprayed screw implants with an angulated bar	Old technology
110.	Mazor Z, Cohen DK. Preliminary 3-dimensional surface texture measurement and early loading results with a microtextured implant surface. Int J Oral Maxillofac Implants 2003;18:729–738.	Determine the ability of microtextured surfaced implants to sustain a 1-stage surgical procedure and early full occlusal loading of single-tooth restorations in humans	Single-technique case series
111.	Misch CE, Degidi M. Five-year prospective study of immediate and early loading of fixed prostheses in completely edentulous jaws with a bone quality-based implant system. Clin Implant Dent Relat Res 2003; 5:17–28.	Report 5-year interim evaluation of a "bone-quality-based" implant system	Case series (2) defined by a difference of immediate or +14 days postsurgery provisional placement
112.	Misch CE, Wang HL. Immediate occlusal loading for fixed prostheses in implant dentistry. Dent Today 2003;22:50–56.	Anecdotal	Anecdotal
113.	Nikellis I, Levi A, Nicolopoulos C. Immediate loading of 190 endosseous dental implants: A prospective observational study of 40 patient treatments with up to 2-year data. Int J Oral Maxillofac Implants 2004;19: 116–123.	Determine the feasibility of using primary stability as a predictor of implant success in patients whose implants were immediately loaded	Single-technique case series
114.	Nordin T, Nilsson R, Frykholm A, Hallman M. A 3-arm study of early loading of rough-surfaced implants in the completely edentulous maxilla and in the edentulous posterior maxilla and mandible: Results after 1 year of loading. Int J Oral Maxillofac Implants 2004;19:880–886.	Evaluate early loaded rough-surfaced implants placed in the completely edentulous maxilla and the posterior edentulous maxilla and mandible	Single-technique case series
115.	Norton MR. A short-term clinical evaluation of immediately restored maxillary TiOblast single-tooth implants. Int J Oral Maxillofac Implants 2004;19:274–281.	Evaluate the short-term clinical outcome of single-tooth implants placed in the maxilla and immediately restored using cementless friction-fit temporary crowns	Single-technique case series
116.	Olsson M, Urde G, Andersen JB, Sennerby L. Early loading of maxillary fixed cross-arch dental prostheses supported by six or eight oxidized titanium implants: Results after 1 year of loading, case series. Clin Implant Dent Relat Res 2003;5(suppl 1):81–87.	Evaluate the outcome over 1 year of oxidized titanium implants when loaded with a fixed full-arch bridge in the maxilla 1 to 9 days after implant placement	Single-technique case series

Table W1 continued Excluded Studies and Reasons for Exclusion

Authors/Title/Source		Study aim (sic)	Reason for exclusion
117.	Östman PO, Hellman M, Nilson H, Ericsson I. Provisional implants: A clinical prospective study in 45 patients, from implant placement to delivery of the final bridge. Clin Implant Dent Relat Res 2004;6:142–149.	Describe the use of mini-implants for fixed restorations (with a follow-up of up to 5 years) to enable the practitioner to overcome the anatomic obstacles of ridge width and narrow interdental space by immediate loading and reconstruction	Single-technique case series
118.	Östman PO, Hellman M, Sennerby L. Direct implant loading in the edentulous maxilla using a bone density-adapted surgical protocol and primary implant stability criteria for inclusion. Clin Implant Dent Relat Res 2005;7(suppl 1):S60–S69.	Evaluate the clinical outcome and stability of directly loaded oxidized titanium implants after a modified surgical protocol and inclusion by primary implant stability	Single-technique case series compared to historical data
119.	Packer ME, Watson RM, Bryant CJ. A comparison of the early postoperative care required by patients treated with single and two-stage surgical techniques for the provision of Brånemark implant supported mandibular overdentures. Eur J Prosthodont Restor Dent 2000;8:17–21.	Compare the number of postoperative follow-up visits required by patients who underwent single stage surgery to place implants and their abutments with that of patients who had this performed in two separate surgical stages	Single-technique case series compared to historical data
120.	Payne AG, Tawse-Smith A, Kumara R, Thomson WM. One-year prospective evaluation of the early loading of unsplinted conical Brånemark fixtures with mandibular overdentures immediately following surgery. Clin Implant Dent Relat Res 2001;3:9–19.	Evaluate progressive and early loading of 20 unsplinted conical Brånemark implants in edentulous mandibles with overdentures	Single-technique case series
121.	Payne AG, Tawse-Smith A, Thompson WM, Kumara R. Early functional loading of unsplinted roughened surface implants with mandibular overdentures 2 weeks after surgery. Clin Implant Dent Relat Res 2003;5:143–153.	Evaluate the success rates of two types of roughened titanium surface implants with early 2-week functional loading of paired mandibular interforaminal implants with overdentures	Single-technique case series (although randomized for implant types)
122.	Payne AG, Tawse-Smith A, Thomson WM, Duncan WD, Kumara R. One-stage surgery and early loading of three implants for maxillary overdentures: A 1-year report. Clin Implant Dent Relat Res 2004;6:61–74.	Determine implant success, after overdenture loading, of three narrow-diameter roughened-surface implants placed in edentulous maxillas, using a one-stage surgical procedure, 12 week healing period, and opposing mandibular two-implant overdentures	Single-technique case series
123.	Petersson A, Rangert B, Randow K, Ericsson I. Marginal bone resorption at different treatment concepts using Brånemark dental implants in anterior mandibles. Clin Implant Dent Relat Res 2001;3:142–147.	Compare the marginal bone level in a short- and long-term prospective study using implants placed according to either a one- or two-step surgical procedure or a one-step surgical procedure combined with early functional loading	Post-hoc subgroup analyses
124.	Petrungaro PS. Immediate restoration of multiple tooth implants for aesthetic implant restorations. Implant Dent 2002; 11:118–127.	Review the immediate restoration of implants placed into multiple extraction sockets and the use of platelet rich plasma to enhance the healing phase	Anecdotal and less than 5 patients
125.	Petrungaro PS. Immediate restoration of dental implants in the aesthetic zone. Dent Implantol Update 2001;12:89–95.	Anecdotal	Anecdotal
126.	Petrungaro PS. Immediate one-stage implant placement and CAD/CAM abutments for posterior restorations. Pract Proced Aesthet Dent 2003;15:595–599.	Anecdotal	Anecdotal and less than 5 patients
127.	Petrungaro PS. Immediate implant placement and provisionalization in edentulous, extraction, and sinus grafted sites. Compend Contin Educ Dent 2003; 24:95–100.	Present the results of more than 400 immediate restored implants placed in edentulous sites, fresh extraction sockets and sinus grafted sites	Anecdotal
128.	Piattelli A, Paolantonio M, Corigliano M, Scarano A. Immediate loading of titanium plasma-sprayed screw-shaped implants in man: A clinical and histological report of two cases. J Periodontol 1997;68:591–597.	Report on the histological findings of two immediately loaded titanium TPS implants, retrieved for a fracture of the abutment and for psychological reasons, after 8 and 9 months of loading	Anecdotal and old technology
129.	Proussaefs P, Kan J, Lozada J, Kleinman A, Farnos A. Effects of immediate loading with threaded hydroxyapatite-coated root-form implants on single premolar replacements: A preliminary report. Int J Oral Maxillofac Implants 2002;17:567–572.	Evaluate the immediate loading of single, threaded, root-form implants placed in the maxillary premolar area	Single-technique case series

Table W1 continued Excluded Studies and Reasons for Exclusion

	Authors/Title/Source	Study aim (sic)	Reason for exclusion
130.	Proussaefs P, Lozada J. Immediate loading of hydroxyapatite-coated implants in the maxillary premolar area: Three-year results of a pilot study. J Prosthet Dent 2004;91: 228–233.	Evaluate the clinical parameters of immediately loaded single-threaded hydroxyapatite-coated (HA) root form implants	Single-technique case series
131.	Raghoebar GM, Friberg B, Grunert I, Hobkirk JA, Tepper G, Wendelhag I. 3-year prospective multicenter study on one-stage implant surgery and early loading in the edentulous mandible. Clin Implant Dent Relat Res 2003;5:39–46.	Evaluate implant survival and periimplant conditions around endosseous implants placed in a one-stage surgical procedure and early loading	Case series defined by differences in loading times due to technician Results not presented separately
132.	Raghoebar GM, Schoen P, Meijer HJ, Stellingsma K, Vissink A. Early loading of endosseous implants in the augmented maxilla: A 1-year prospective study. Clin Oral Implants Res 2003;14:697–702.	Evaluate the clinical and radiographic outcomes as well as patient satisfaction after early loading of dental implants inserted in the maxilla after augmentation of the maxillary sinus floor with autogeneous bone grafts	Single-technique case series
133.	Randow K, Ericsson I, Nilner K, Petersson A, Glantz PO. Immediate functional loading of Brånemark dental implants: An 18-month clinical follow-up study. Clin Oral Implants Res 1999;10:8–15.	Compare the outcome of oral rehabilitation in the edentulous mandible by fixed supraconstructions connected to implants installed according to either a 1-stage surgical procedure and immediate loading or the original 2-stage concept	Single-technique case series compared to historical data
134.	Rebaudi A, Silvestrini P, Trisi P. Use of a resorbable hydroxyapatite-collagen chondroitin sulfate material on immediate postextraction sites: A clinical and histologic study. Int J Periodontics Restorative Dent 2003;23:371–379.	Not established	Anecdotal
135.	Rocci A, Martignoni M, Gottlow J. Immediate loading in the maxilla using flapless surgery, implants placed in predetermined positions, and prefabricated provisional restorations: A retrospective 3-year clinical study. Clin Implant Dent Relat Res 2003;5(suppl 1): 29–36.	Evaluate an immediate-loading treatment protocol, which included flapless surgery, implants placed in predetermined positions and connected to prefabricated provisional restorations, and the 3-year clinical results	Single-technique case series
136.	Rocci A, Martignoni M, Gottlow J. Immediate loading of Brånemark System Ti-Unite and machined-surface implants in the posterior mandible: A randomized open-ended clinical trial. Clin Implant Dent Relat Res 2003;5(suppl 1):57–63.	Compare Ti-Unite and machined-surfaced Brånemark System implants when applying immediate loading of partial fixed bridges in the posterior mandible	Single-technique case series (although randomized for implant surface)
137.	Roccuzzo M, Bunino M, Prioglio F, Bianchi SD. Early loading of sandblasted and acid-etched (SLA) implants: A prospective split-mouth comparative study. Clin Oral Implants Res 2001;12:572–578.	Assess the periimplant conditions around early-loaded SLA implants, and to compare the results obtained with a standard protocol using identical implants with a TPS surface	Case series (2) defined by differences of surfaces
138.	Roccuzzo M, Wilson T. A prospective study evaluating a protocol for 6 weeks' loading of SLA implants in the posterior maxilla: One year results. Clin Oral Implants Res 2002;13:502–507.	Evaluate the efficacy of a modified surgical protocol followed by loading SLA implants at 6 weeks in the posterior maxilla	Single-technique case series
139.	Romanos GE. Treatment of advanced periodontal destruction with immediately loaded implants and simultaneous bone augmentation: A case report. J Periodontol 2003;74:255–261.	Demonstrate the oral rehabilitation of a female patient, who, after losing all teeth proceeded with implant treatment	Anecdotal and less than 5 patients
140.	Rungcharassaeng K, Lozada JL, Kan JY, Kim JS, Campagni WV, Munoz CA. Peri-implant tissue response of immediately loaded, threaded, HA-coated implants: 1-year results. J Prosthet Dent 2002;87: 173–181.	Evaluate implant success and peri-implant tissue response of immediately loaded, threaded, hydroxyapatite (HA)-coated root-form implants supporting mandibular bar overdentures with opposing conventional maxillary complete dentures in humans	Single-technique case series
141.	Ryser MR, Block MS, Mercante DE. Correlation of papilla to crestal bone levels around single tooth implants in immediate or delayed crown protocols. J Oral Maxillofac Surg 2005;63:1184–1195.	Determine if there is a difference in the papilla fill between implant and tooth comparing immediate provisionalized and delayed single tooth implant restorations	Case series (2) defined by implant type and surgery stages
142.	Salama H, Rose LF, Salama M, Betts NJ. Immediate loading of bilaterally splinted titanium root-form implants in fixed prosthodontics-A technique reexamined: Two case reports. Int J Periodontics Restorative Dent 1995;15:344–361.	Anecdotal	Anecdotal and less than 5 patients

Table W1 continued Excluded Studies and Reasons for Exclusion

	Authors/Title/Source	Study aim (sic)	Reason for exclusion
143.	Schroeder A, Maeglin B, Sutter F. Das ITI-Hohlzylinderimplantat Typ F zur Prothesen-retention beim zahnlosen Kiefer. SSO Schweiz Monatsschr Zahnheilkd 1983;93: 720–733.	Not established	Old technology
144.	Scortecci G. Immediate function of cortically anchored disk-design implants without bone augmentation in moderately to severely resorbed completely edentulous maxillae. J Oral Implantol 1999;25:70–79.	Evaluate the safety and efficacy of immediately loading a fixed implant-supported prosthesis without bone augmentation in moderately to severely resorbed, completely edentulous maxillae	Single-technique case series
145.	Siddiqui AA, Ismail JY, Kukunas S. Immediate loading of dental implants in the edentulous mandible: A preliminary case report from an international prospective multicentre study. Compend Contin Educ Dent 2001;22:867–876.	Anecdotal	Anecdotal
146.	Spiekermann H, Jansen VK, Richter EJ. A 10-year follow-up study of IMZ and TPS implants in the edentulous mandible using bar-retained overdentures. Int J Oral Maxillofac Implants 1995;10:231–243.	Present data related to 136 patients who were treated with 300 implants in the edentulous mandible anterior to the mental foramina	Single-technique case series determined by initial jaw anatomy
147.	Steveling H, Roos J, Rasmusson L. Maxillary implants loaded at 3 months after insertion: Results with Astra Tech implants after up to 5 years. Clin Implant Dent Relat Res 2001; 3:120–124.	Report the outcome of maxillary implants loaded after a 3-month healing period and followed up to 5 years	Single-technique case series
148.	Stricker A, Gutwald R, Schmelzeisen R, Gellrich NG. Immediate loading of 2 inter-foraminal dental implants supporting an overdenture: Clinical and radiographic results after 24 months. Int J Oral Maxillofac Implants 2004;19:868–872.	Evaluate the clinical outcome of immediate loading of 2 bar-connected implants supporting an overdenture	Single-technique case series
149.	Stricker A, Gutwald R, Schramm A, Gellrich NC, Schmelzeisen R. Die Sofort-belastung von 2 interformain¨ren implantaten - eine prospektive Studie bis zu 2 Jahren. Dtsch Zahnärztl Z 2003;58:482–484.	Report preliminary results of immediate loading of implants supporting a bar connected overdenture inserted in the edentulous mandible	Single-technique case series
150.	Sullivan D, Vincenzi G, Feldman S. Early loading of Osseotite implants 2 months after placement in the maxilla and mandible: A 5-year report. Int J Oral Maxillofac Implants 2005;20:905–912.	Evaluate the effect of reducing the unloaded healing time on the performance of implants with a dual thermal acid-etched surface topography	One group was loaded after approximately 2 months and the other after 3 months; not considered an early versus conventional loading trial
151.	Testori T, Del Fabbro M, Feldman S, et al. A multicenter prospective evaluation of 2-months loaded Osseotite implants placed in the posterior jaws: 3-year follow-up results. Clin Oral Implants Res 2002;13:154–161.	Evaluate the clinical performance of 2-months early loaded implants positioned in the posterior regions of the mandible and the maxilla	Single-technique case series
152.	Testori T, Del Fabbro MD, Galli F, Francetti L, Taschieri S, Weinstein R. Immediate occlusal loading the same day or the day after implant placement: Comparison of 2 different time frames in totally edentulous lower jaws. J Oral Implantol 2004;30:307–313.	Rehabilitate edentulous mandible by an occlusally loaded full-arch screw-retained prosthesis with distal extensions delivered within 48h	Case series (2) defined by a difference of 24 h between provisional placement
153.	Testori T, Meltzer A, Del Fabbro M, et al. Immediate occlusal loading of Osseotite implants in the lower edentulous jaw: A multicenter prospective study. Clin Oral Implants Res 2004;15:278–284.	Report the results of a prospective multicenter clinical study on immediately fully occlusally loaded full-arch screw-retained prostheses with distal extensions (hybrid prostheses) supported by Osseotite implants inserted in edentulous lower jaws	Single-technique case series
154.	Toljanic JA, Baer RA. Immediately restored single-tooth implants: Shortening treatment time to increase patient acceptance. Dent Today 2002;21:42–45.	Anecdotal	Anecdotal
155.	van Steenberghe D, Glauser R, Blomback U, et al. A computed tomographic scan-derived customized surgical template and fixed prosthesis for flapless surgery and immediate loading of implants in fully edentulous maxillae: A prospective multicenter study. Clin Implant Dent Relat Res 2005;7(suppl 1):S111–S120.	Evaluate a concept including a treatment planning procedure based on CT scan images and a prefabricated fixed prosthetic reconstruction for immediate function in upper jaws using a flapless surgical technique and validate the universality of this concept in a prospective multicenter study	Single-technique case series

Table W1 continued Excluded Studies and Reasons for Exclusion

Authors/Title/Source		Study aim (sic)	Reason for exclusion
156.	van Steenberghe D, Molly L, Jacobs R, Vandekerckhove B, Quirynen M, Naert I. The immediate rehabilitation by means of a ready-made final fixed prosthesis in the edentulous mandible: A 1-year follow-up study on 50 consecutive patients. Clin Oral Implants Res 2004;15:360–365.	Evaluate implant stability up to 1 year after surgery	Single-technique case series
157.	van Steenberghe D, Naert I, Andersson M, Brajnovic I, Van Cleynenbreugel J, Suetens P. A custom template and definitive prostheses allowing immediate implant loading in the maxilla. A clinical report. Int J Oral Maxillofac Implants 2002;17:663–670.	Examine to what extent precision data from 3-dimensional planning software for oral implants can be transferred to the operative field by means of a drilling template, containing high-precision drilling sleeves, fitted on the jawbone	Anecdotal and single-technique case series
158.	Vanden Bogaerde L, Pedretti G, Dellacasa P, Mozzati M, Rangert B. Early function of splinted implants in maxillas and posterior mandibles using Brånemark system machined-surface implants: An 18-month prospective clinical multicenter study. Clin Implant Dent Relat Res 2003;5(suppl 1): 21–28.	Investigate the possibility of early application of implant function in oral locations where the bone density is often low, namely the maxilla and posterior mandible	Single-technique case series
159.	Vanden Bogaerde L, Pedretti G, Dellacasa P, Mozzati M, Rangert B, Wendelhag I. Early function of splinted implants in maxillas and posterior mandibles, using Brånemark System Tiunite implants: An 18-month prospective clinical multicenter study. Clin Implant Dent Relat Res 2004;6:121–129.	Investigate the possibility of early application of implant function in oral locations where the bone density is often low, namely the maxilla and posterior mandible	Single-technique case series
160.	Vassos DM. Single-stage surgery for implant placement: A retrospective study. J Oral Implantol 1997;23:181–185.	Report on the results of using a single-stage technique	Single-technique case series
161.	Villa R, Rangert B. Early loading of interforaminal implants immediately installed after extraction of teeth presenting endodontic and periodontal lesions. Clin Implant Dent Relat Res 2005;7(suppl 1): S28–S35.	Evaluate the survival rate of early-loaded implants placed immediately after extraction of teeth with endodontic and periodontal lesions in the mandible	Single-technique case series
162.	Wagenberg BD, Ginsburg TR. Immediate implant placement on removal of the natural tooth: Retrospective analysis of 1081 implants. Compend Contin Educ Dent 2001; 22:399–409.	Report a retrospective analysis of 1,081 implants placed immediately into extraction sockets	Anecdotal
163.	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.	Allow correlation of observed bone level changes with clinical parameters as measured by suppuration, plaque indices, bleeding indices, probing depth, attachment level and mobility as well as to contribute information on the value of these parameters as predictors of long-term peri-implant tissue stability	Single-technique case series
164.	Wilson TG Jr. Guided tissue regeneration around dental implants in immediate and recent extraction sites: Initial observations. Int J Periodontics Restorative Dent 1992;12: 185–193.	Anecdotal	Anecdotal and less than 5 patients
165.	Wöhrle PS. Single-tooth replacement in the aesthetic zone with immediate provisionalization: Fourteen consecutive case reports. Pract Periodontics Aesthet Dent 1998;10:1107–1114.	Demonstrate the use of an immediate placement procedure for restoring single teeth in the aesthetic zone	Anecdotal