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REVIEW ARTICLE

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Immediate loading vs. early/conventional loading of immediately placed implants in partially edentulous patients from the patients' perspective: A systematic review

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Abstract

Objectives: This systematic review aimed at answering the following PICO question: In patients receiving immediate (Type 1) implant placement, how does immediate compare to early or conventional loading in terms of Patient-Reported Outcome Measures (PROMs)?

Material and Methods: Following search strategy development, the OVID, PubMed, EMBASE, and Cochrane Database of Systematic Reviews databases were search for the relevant literature. All levels of evidence including randomized controlled trials, prospective and retrospective cohort studies, and case series of at least five patients were considered for possible inclusion. An additional manual search was performed by screening the reference lists of relevant studies and systematic reviews published up to May 2017. The intervention considered was the placement of immediate implant.

Study selection and data extraction were performed independently by two reviewers.

Results: The search yielded a list of 1,102 references, of which nine were included in this systematic review. The limited number of studies included and the heterogeneity of the data identified prevented the performance of a meta-analysis. Three studies, one of which was a randomized controlled trial, allowed the extraction of comparative data specific to the aim of the present systematic review. The remaining studies allowed only data extraction for one single treatment modality and were viewed as single cohort studies. Overall, irrespective of the PROMs chosen, patients' satisfaction was overall high with little difference between the two loading protocols. Moreover, studies indicated a positive impact on oral health-related quality of life following immediate implant placement and loading.

Conclusions: Within the limitations of the present systematic review, immediate implant placement and loading in single tooth edentulous space seems to be a well-accepted treatment modality from the patients' perspective and is worthy of consideration in clinical practice. However, the paucity of comparative data limits any definitive conclusions as to which loading protocol; immediate or early/conventional, should be given preference based on PROMs.

KEYWORDS
clinical trial, immediate dental implant loading, patient-reported outcome measures, visual analog scale

1 | INTRODUCTION

Dental implants have become a well-accepted and predictable treatment modality. From the pioneer work of Brånemark and Schroeder describing osseointegration in the 70s to the more recent digital developments in implant dentistry, our understanding in implant science has evolved. Similarly, outcome assessment of dental implants has considerably evolved.

Initially, the main outcome that was documented included implant survival. The dichotomous nature of this outcome does not allow for specific discrimination between the two extremes of this assessment parameter; that is, the implant is either in the alveolar bone or it is not. Later, a set of proposed criteria for success based on the knowledge acquired on the Brånemark implant system has been described by Albrektsson, Zarb, Worthington, and Eriksson (1986) and has been widely used. Comprehensive evaluation of implant therapy outcome included further parameters taking in account not only the dental implant but also the health of the peri-implant hard and soft tissue interface, the integrity of prosthetic reconstruction and the overall aesthetic integration of the prostheses (Belser, Buser, & Higginbottom, 2004; Belser et al., 2009; Cosyn, Thoma, Hammerle, & De Bruyn, 2017; Furhauser et al., 2005; Lang et al., 2004; Papaspyridakos, Chen, Singh, Weber, & Gallucci, 2012; Salvi & Lang, 2004).

Patients' perceptions of implant therapy outcome have gained considerable attention in the last two decades (De Bruyn, Raes, Matthys, & Cosyn, 2015). The generic term used to describe the patients' view is PROMs or Patient-Reported Outcome Measures and is defined as follows: *"report of the status of a patient's health condition that comes directly from the patient, without interpretation of the patient's response by a clinician or anyone else"* (US Department of Health and Human Services, 2006). The importance of PROMs is underlined by the fact that they may improve delivery of care as illustrated by improved patient–clinician communication, clinical outcomes and patient satisfaction (Nelson et al., 2015). Therefore, PROMs represent an important tool to develop treatment guidelines in which the patients are actively engaged.

Over the last four decades, progress made in biological understanding of implant wound healing, refinement of surgical procedures combined with technological advances related to implant design and surface developments have challenged the initial treatment guidelines that were established by the pioneers in implant dentistry. While early guidelines recommended an undisturbed healing for 3–6 months prior to prosthesis loading (Brånemark et al., 1977), protocols have been developed to shorten the overall treatment duration for the patient. The most extreme development is represented by the placement of a dental implant in single tooth gap fresh extraction socket and immediately temporized with a single implant-supported provisional restoration. In 1998; Wöhrle reported on 14 consecutive patients treated successfully with immediate implants and immediate temporization. The success with this treatment protocol has been further documents in multiple case series and small cohort studies have (Ferrara, Galli, Mauro, & Macaluso, 2006; Groisman, Frossard, Ferreira, de Menezes Filho, & Touati, 2003; Kan, Rungcharassaeng, & Lozada, 2003; Palattella, Torsello, & Cordaro, 2008; Shibly, Patel, Albandar, & Kutkut, 2010). Patient selection, risk analysis, and clinical expertise seem to be key for successful outcome (Ganeles & Wismeijer, 2004; Jivraj, Reshad, & Chee, 2005). The majority of these reports have focused on the outcome of this protocol in the aesthetic zone; that is, in the anterior maxilla. From an aesthetic standpoint, successful outcome can be achieved with immediate implant placement although mucosal midfacial recession is not uncommon (Chen & Buser, 2014).

While there seem to be no difference in implant survival rate and marginal bone level between immediate and conventional loading, from an aesthetic perspective controversial outcomes preclude any definitive conclusion (Benic, Mir-Mari, & Hammerle, 2014). The proceedings of Fifth ITI Consensus Conference concluded that, irrespective of the timing of implant placement or loading protocol, successful outcomes can be achieved and reinforced the notions that highly trained clinicians were a prerequisite for success. Based on the classic clinical outcomes reported, there are still no clear guidelines as to which treatment protocol should be favored in daily practice (Gallucci et al., 2014; Morton, Chen, Martin, Levine, & Buser, 2014). The practitioner is then faced with multiple treatment options that could lead to similar results. In such a situation, the patients' perspective may be decisive in determining the preferred treatment modality.

Therefore, the aim of this systematic review was to answer the following PICO question: In patients receiving immediate (Type 1) implant placement, how does immediate compare to early or conventional loading in terms of patient-reported outcomes?

2 | MATERIAL AND METHODS

2.1 | Protocol registration

The systematic review was registered in the PROSPERO international database on October 2016 (Registration number #49604).

2.2 | Search methodology

A health sciences librarian (M.A.W), in collaboration with the systematic review team, developed and conducted searches

in MEDLINE (OVID, 1946-present), PubMed (1809—present), EMBASE and the Cochrane Database of Systematic Reviews (Issue 5 of 12, May 2017). Search strategies were developed for MEDLINE but revised appropriately for each database to take account of differences in controlled vocabulary and syntax rules. The main concepts identified were as follows: dental implants, immediate implant loading, and treatment outcomes. Terms searched related to the concept of treatment outcomes included, but were not limited to: quality of life, visual analog scale, and patient outcome assessment. Terms searched related to the concept of dental implantation included but were not limited to edentulous jaw or mouth, endosseous dental implants, and implant-supported dental prosthesis. Terms searched related to the concept of immediate dental implant loading included but were not limited to immediate implants or functions or temporizations, and teeth-in-a-day. Results were limited to humans. No other search restrictions were made. The PubMed (1809—present) Search Strategy is described thereafter:

"partially edentulous"[tiab] OR "partial edentulism"[tiab] OR "partially dentate"[tiab] OR "dental implant*"[tiab] OR "complete edentulous"[tiab] OR "complete edentulism"[tiab] OR "total edentulous" [tiab] OR "total edentulism"[tiab] OR "totally edentulous"[tiab] OR "endosseous implant*"[tiab] OR "implant borne"[tiab] OR "edentulous jaw"[tiab] OR "edentulous mouth"[tiab] OR "Jaw, Edentulous"[Mesh] OR "Mouth, Edentulous"[Mesh] OR "Dental implantation, endosseous" [Mesh:NoExp] OR "Dental Implants"[Mesh] OR "Dental implantation"[Mesh:NoExp] OR "Dental prosthesis, implant supported"[Mesh:NoExp]
AND
"immediate implant*"[tiab] OR "all on 4"[tiab] OR "all on four"[tiab] OR "teeth in an hour"[tiab] OR "teeth in a day"[tiab] OR "immediate loading"[tiab] OR "immediate function"[tiab] OR "immediate temporization"[tiab] OR "Immediate dental implant loading"[Mesh:NoExp]
AND
"quality of life"[tiab] OR "qol"[tiab] OR "OHRQoL"[tiab] OR "OHIP-14"[tiab] OR "HRQL"[tiab] OR "visual analog scale"[tiab] OR "visual analogue scale"[tiab] OR "VAS"[tiab] OR "patient centered"[tiab] OR "PCOR"[tiab] OR "patient preference*"[tiab] OR "patient satisfaction"[tiab] OR "patient reported"[tiab] OR "patient outcome*"[tiab] OR "treatment outcome*"[tiab] OR "restoration failure*"[tiab] OR "follow up studies"[tiab] OR "follow up study"[tiab] OR "comparative effectiveness research'"[tiab]
OR
"Quality of life"[Mesh] OR "Visual analog scale"[Mesh] OR "Patient outcome assessment"[Mesh:NoExp] OR "Patient centered research outcomes"[Mesh] OR "Patient Satisfaction"[Mesh] OR "Treatment Outcome"[Mesh] OR "Dental restoration failure"[Mesh] OR "Follow-up studies"[Mesh] OR "Patient reported outcome measures"[Mesh]
AND
Humans

Reference lists of relevant studies and systematic reviews published up to May 2017 were "hand-searched" for potential relevant literature.

2.3 | Study selection

The type of studies considered for this review included randomized controlled trials, prospective and retrospective cohort studies, and case series of at least five patients. The different components of the PICO questions served as the basis for study inclusion. The patient population comprised partially edentulous patients receiving immediate dental implants (Type 1). The tested intervention under scrutiny was immediate loading, that is, within 1 week of implant placement, while the comparison group entailed early (1 week to 2 months) or conventional loading (>2 months) as previously defined by the ITI (Gallucci et al., 2014) and others (Esposito, Grusovin, Willings, Coulthard, & Worthington, 2007). Studies reporting on PROMS as defined by the FDA were considered for inclusion (US Department of Health and Human Services, 2006). Moreover, the patient-centered outcomes had to be supported by presented data in the article.

Studies reporting on "All-on-4" protocol, as initially described by Malo and coworkers (Malo, Rangert, & Nobre, 2003, 2005), and full-arch restoration were excluded for the following reasons. First, it could not be ascertained that all the implants placed according to this protocol were immediate implants (Type 1). These treatment protocols are usually used in failing dentitions of partially edentulous patients. While the remaining failing dentition is extracted immediately prior to implant placement, some implants may have been placed in long-standing edentulous healed sites (Type 4). Second, the technique used for immediate implant placement in the all-on-4 protocol calls for the placement of tilted implants with a crossarch stabilization prosthetic reconstruction which differs drastically from the immediate load of implants placed in fresh extraction socket of partially edentulous sites. Third, the crossarch stabilization represents a different biomechanical entity compared to single or short span fixed dental prostheses. Finally, indications for full-arch restoration treatment usually include patients who have experienced a failing dentition over time, which is no longer satisfactory and a more drastic and permanent therapy is sought for. The impact of such treatment cannot be combined with that of implants placed in fresh extraction socket typically involving a limited number of teeth replaced which was the focus of this review.

Studies including zygomatic implants were excluded and publications in other languages than English, German, or French were not considered.

Two investigators (G.H-B. and T.W.O.) independently screened the literature search results for possible inclusion in the systematic review. The screening was performed at the title and abstract level. Any disagreement was resolved by discussion. The same two investigators independently read the full-text articles and consensus was reached by discussion in case of disagreement. Kappa statistics was used to determine interrater agreement (Cohen, 1960).

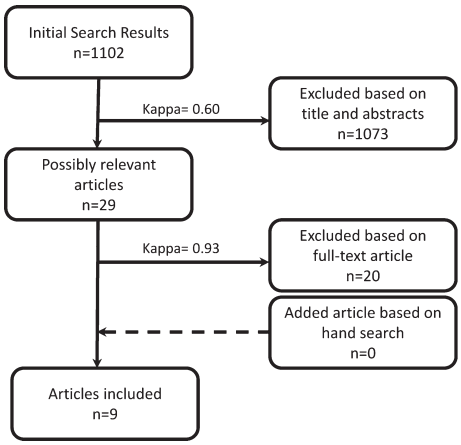

FIGURE 1 Search flow diagram

Data extraction table for included study was created and populated independently by the two investigators. Any disagreement was resolved by discussion.

3 | RESULTS

Final searches were run on 5/9/17 and resulted in 1,102 results following de-duplication. The screening of the abstracts led to the inclusion of 28 articles (k = 0.60 or "good agreement"). After evaluation of the full texts, 19 studies were excluded and a total of nine studies were included in the present systematic review (k = 0.93 or "very good agreement"). The hand search did not add any additional references (Figure 1). The reasons for exclusion of the full-text articles can be found in Table 1.

TABLE 1 Studies excluded based on full-text evaluation and reason for exclusion. *Reference list of systematic reviews were screened for other possible study inclusion

Study	Journal	Reason for exclusion
Abboud, Wahl, Guirado, and Orentlicher (2012)	The International Journal of Oral Maxillofacial Implants	No immediate implant placement
Andersen, Haanaes, and Knutsen (2002)	Clinical Oral Implants Research	No immediate implant placement
Atieh, Atieh, Payne, and Duncan (2009)*	The International Journal of Prosthodontics	Systematic review
Atieh, Payne, Duncan, de Silva, and Cullinan (2010)*	The International Journal of Oral Maxillofacial Implants	Systematic review
Barone et al. (2016)	The International Journal of Oral Maxillofacial Implants	No immediate loading
Benic et al. (2014)*	The International Journal of Oral Maxillofacial Implants	Systematic review
Bianchi and Sanfilippo (2004)	Clinical Oral Implants Research	No immediate loading
Boedeker, Dyer, and Kraut (2011)	Journal of Oral Maxillofacial Surgery	No immediate implant placement
Cosyn et al. (2011)	Journal of Clinical Periodontology	No patient-reported outcome measure
De Rouck et al. (2008a,2008b)	The International Journal of Oral Maxillofacial Implants	Review
Di Alberti et al. (2012)	The International Journal of Oral Maxillofacial Implants	No data presented to support patient satisfaction claims
Dolz, Silvestre and Montero (2014)	The International Journal of Oral Maxillofacial Implants	No immediate implant placement
Hui et al. (2001)	Clinical Implant Dentistry and Related Research	No data presented to support patient satisfaction claims
Grandi, Guazzi, Samarani, and Grandi (2013)	European Journal of Oral Implantology	No patient-reported outcome measure
Lang et al. (2007)	Clinical Oral Implants Research	No immediate loading
Malchiodi et al. (2010)	Journal of Oral Implantology	No patient-reported outcome measure
McAllister et al. (2012)	The International Journal of Oral Maxillofacial Implants	Same patient study population as Kolinski et al. (2014; which was included)
Rosa, Rosa, Francischone, and Sotto-Maior (2014)	The International Journal Prosthetic and Reconstructive Dentistry	No patient-reported outcome measure
Spies, Balmer, Patzelt, Vach, and Kohal (2015)	Journal of Dental Research	Less than 5 cases of Immediate implant placement

3.1 | Study characteristics

The data extracted from the included studies are detailed in Table 2. Of the nine included articles, three studies were randomized controlled trials (De Rouck, Collys, Wyn, & Cosyn, 2009; Felice, Pistilli, Barausse, Trullenque-Eriksson, & Esposito, 2015; Felice et al., 2011). However, only the study by De Rouck et al. (2009) included test and control groups similar to those defined in our PICO question. In the two publications by Felice et al. (2011, 2015), the test group received immediate implants (Type 1) following extraction while the control group was treated with a ridge preservation and a staged approach for implant placement (Type 4). Provided that the implant insertion torque was >35 Ncm, provisional implant restorations were placed in both treatment groups. Conversely, if the insertion torque was ≤35 Ncm, the implants were left to heal for 4 months before loading. For these two studies, only one treatment arm, that is, immediate implant placement (Type 1) with two subgroups based on nonrandomized loading protocol was considered for data extraction pertaining PROMS.

The remainder of the included studies (six studies) did not provide an adequate comparison group comprising of Type1 implant placement and conventional loading. Four of those were single-arm studies with Type 1 implant placement and immediate temporization (De Rouck, Collys, & Cosyn, 2008a, 2008b; Ferrara et al., 2006; Kolinski et al., 2014; Takeshita et al., 2015). Two studies by Raes, Cooper, Tarrida, Vandromme, and De Bruyn (2012), Raes, Cosyn, and De Bruyn (2013) were multiarms studies and only data from one arm consisting Type 1 implant placement and immediate temporization was extracted for the purpose of the present systematic review.

The PROMs reported included the use of visual analogue scale to determine patient satisfaction with regards to aesthetics (De Rouck et al., 2008a, 2008b, 2009; Kolinski et al., 2014), function, speech, sense of implant feeling like one's own and self-esteem (Kolinski et al., 2014). Other PROMs included the use of a 5-point categorical scale to evaluate function and aesthetic (Felice et al., 2011, 2015), a 10-point categorical scale to evaluate patient satisfaction (Ferrara et al., 2006), the use of close-ended questions (Felice et al., 2011,2015) and the use of Oral Health Impact Profile (OHIP) questionnaires consisting of 14 questions (Raes et al., 2012, 2013) or 54 questions specific for a Japanese population (Takeshita et al., 2015).

Three studies evaluated PROMs prior to and after treatment (Kolinski et al., 2014; Raes et al., 2012, 2013) while the remainder of the included studies only evaluated PROMs after treatment (De Rouck et al., 2008a,2008b, 2009; Felice et al., 2011, 2015; Ferrara et al., 2006; Takeshita et al., 2015). When evaluated after treatment, the timeline to report the PROMs varied between 4 months after implant placement (Felice et al., 2011) to 4 years after final crown delivery (Ferrara et al., 2006).

Given the heterogeneity in study design, in PROMs reported and time frame of reporting PROMS a qualitative review was undertaken.

3.2 | Patient-centered outcomes in studies with an available comparison group consisting of Type 1 implant placement with conventional loading

In the study by De Rouck et al. (2009), the test group received immediate implants and was restored with immediate screw-retained provisional crowns, whereas the implants in the control group were allowed to heal for 3 months before provisionalization. In both groups, final restorations were placed after 3 months of temporary loading. At the end of the study period, that is, 12 months after implant provisionalization, patients' satisfaction of the aesthetics based on a visual analog scale (from zero to ten) was recorded by asking the following question: "How would you rate your satisfaction with respect to the aesthetic outcome of your treatment?". Patients' satisfaction averaged 93% (range 82%–100%) in the test group and 91% (range 80%–96%) in the control group. Midfacial soft tissue level was stable in both groups over the study period. However, the conventionally loaded restoration group showed on average 2.5–3 times more recession as compared to the test group with a mean difference of 0.75 mm favoring immediate restoration.

Two randomized controlled trials by Felice et al. (2011, 2015) with similar methodology aimed at comparing the outcomes of immediate postextractive implants (Type 1) and implants placed in healed ridge preserved sites (Type 4). Only one arm of each study, that is, Type 1 implant placement, was within the scope of our review. In this arm, implants that were placed with an insertion torque >35 Ncm were immediately restored with a cemented provisional crown following an abutment level impression. If the torque was inferior to 35 Ncm implants were placed and left to heal for 4 months. Final cemented metal-ceramic crowns were fabricated on customized abutments 4 months after implant placement. In both studies, patients' satisfaction was recorded using a 5-point scale with regards to aesthetics and function. The questions asked were as follows: "Are you satisfied with your function of your implant-supported tooth?" and "Are you satisfied with the aesthetic outcome of the gums surrounding this implant?". For these questions, the possible answers were as follows: (a) Yes absolutely, (b) Yes partly, (c) Not sure, (d) Not really, and (e) Absolutely not. A third, close-ended question inquired if the patient would undergo the same therapy again. Felice et al. (2011, 2015) did not separate patients' responses within the immediate placement group between the implants with immediate restorations with those receiving conventionally loaded restorations. Felice et al. (2011) reported two failures in the immediate implant placement group but did not mention if they occurred in the immediately restored subgroup or the conventional loading subgroup. Nonetheless, data pertaining to patients' satisfaction were extrapolated based on the information provided in the respective studies. With regard to function, 88.2%–100% of the patients in the immediately restored subgroup answered that they were absolutely satisfied. The corresponding value for the conventional loading subgroup was 93.9%–100%. In the immediately and conventionally loaded subgroups, 0%–5.9% and 0%–3.0% of patients, respectively, were "partially satisfied" or

"unsure." For aesthetics, 100% of patients who received immediate implants answered that they were absolutely satisfied irrespective of the loading protocol. Similarly, 100% of patients stated that they would undergo the same therapy again.

3.3 | Patient-centered outcomes of studies reporting on Immediate implant placement (Type 1) and immediate loading

De Rouck et al. (2008a,2008b) followed thirty patients who received immediate implant placement and an immediate single crown screw-retained temporary restoration over a 1-year period. At the end of the study period (12 months after implant placement), patients were asked "How would you rate your satisfaction with respect to the aesthetic outcome of your treatment?" using a visual analogue scale (VAS) of 10 cm. The average satisfaction pertaining aesthetics average 93% with a range from 82% to 100%.

Ferrara et al. (2006) in a case series of 33 patients with a follow-up time up to 50 months (average 28 months) after immediate implant placement and restoration recorded patients' satisfaction using a 10-point categorical scale with the zero value corresponding to "completely unsatisfactory result" and 10 to "complete satisfaction." Patients were followed up every 3 months and satisfaction was recorded at each follow-up. No details pertaining the question asked were given in the study. The results reported an average patient satisfaction pertaining to aesthetics at the 4-year recall timeline of 9.3 ± 0.65, which included seven patients.

A 3-year multicenter case series by Kolinski et al. (2014), evaluated the following PROMs based on VAS: (a) Function, (b) Aesthetics, (c) Speech, (d) Sense of implant feeling like one's own tooth, and (e) Self-esteem.

The two extremities of the scale were 0 = poor and 100 = excellent. Kolinski et al. reported these PROMS prior to treatment, at time of implant placement, prosthesis delivery and then annually up to the 3-year follow-up visit. The mean pretreatment baseline value for function, aesthetics, speech, sense of implant feeling like one's own tooth and self-esteem were 62.2, 58.9, 80.0, 66.3 and 68.7, respectively. All the parameters increased gradually up to prosthesis delivery and remained stable throughout the study. The corresponding values at the 3-year follow-up were 93.7 ± 6.4, 89.2 ± 9.4, 93.5 ± 6.7, 87.0 ± 18.5 and 92.2 ± 7.2, which were statistically significantly different from baseline ($p < 0.001$).

Raes et al. (2012, 2013) conducted two multiarm clinical trials comparing the outcomes of Type 1 implant placement and immediate provisionalization to Type 4 implant placement and immediate provisionalization. The data for the single arm of interest, that is, Type 1 implant placement, were extracted. The assessment of PROMs was based on the shortened version of the original Oral Health Impact Profile (OHIP) questionnaire (Slade & Spencer, 1994). The questionnaire used included 14 questions (OHIP-14) with two questions assessing each of the seven dimensions including functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap (Slade, 1997). Raes et al. (2012) reported that over a 1-year period, the overall OHIP-14 average score increased from baseline to 6 months and remained stable thereafter. More specifically, two dimensions, psychological discomfort and disability, decreased significantly from baseline to 1 month which indicated that patients were less self-conscious, felt less tense, found it less difficult to relax, and were more relaxed with regard to their oral condition. The physical pain dimension decreased from the 1-month to the 6-month follow-up illustrating that the patient experienced less pain and could eat comfortably.

Similarly, Raes et al. (2013) showed that the overall OHIP-14 score increased from baseline (66.25 ± 3.86) to 12 months (69.67 ± 0.62) in patients receiving immediate implant and immediate provisionalization in the aesthetic anterior maxilla (teeth 15–25).

In a retrospective study, Takeshita et al. (2015) used a modified OHIP questionnaire specifically adapted to Japanese populations with 54 questions (Yamazaki, Inukai, Baba, & John, 2007) to report on patient satisfaction. The authors converted the overall OHIP-J scores recorded into percentage of satisfaction. One year and a half after immediate implant placement and provisionalization, the reported satisfaction rate amounted to 96.7% ± 2.16 (92.6%–100%).

4 | DISCUSSION

The present systematic review sought to answer the following question: In patients receiving immediate (Type 1) implant placement, how does immediate compare to early or conventional loading in terms of patient-reported outcomes? The relevance of this question is based on the fact that there is no clinical consensus as to which treatment protocol should be favored (Gallucci et al., 2014; Morton et al., 2014).

In the medical field, patient-centered outcome research is fairly new and is focusing on valuating questions and outcomes that are important to the end-user of the research, that is, the patient. The patients' views through this research are voiced and reduces the imbalance represented in more traditional research in which the views of the empowered, the physicians and researchers, are mostly expressed. This is performed with the premise that improving the relevance of clinical research by incorporating PROMs and thereby helping disseminate new evidence will ultimately improve patient care (Frank, Basch, & Selby, 2014). The growing importance of this type of research is illustrated by a federal initiative to create the Patient-Centered Outcomes Research Institute which goals are to improve the quantity and quality of research, facilitate its dissemination and implementation with a patient-centered approach as the overarching concept (Selby & Lipstein, 2014, https://www.pcori.org/about-us accessed on 9/15/17).

In the field of implant dentistry, despite the fact that multiple consensus conferences and workshops have recommended the inclusion on patient-centered outcomes to evaluate therapy (Albrektsson & Isidor, 1994; Klinge et al., 2015; Lang, Karring, & Meredith, 2002; Lang & Zitzmann, 2012), patient-centered outcomes have only rarely been reported in the literature (Pjetursson, Karoussis, Burgin, Bragger, & Lang, 2005).

TABLE 2 Data extraction table of included studies. [In PDF format, this table is best viewed in two-page mode]

Authors (year)	Journal	Study type	Duration	Patients (*n*)	Gender	Patient age (Mean (±*SD*), range)	Treatment group(s)	Implants (*n*)	Implant site(s)
De Rouck et al. (2009)	COIR	Multicenter Randomized Controlled Trial	1 year	Group 1: 24 Group 2: 25	Group 1: 13 females 11 males Group 2: 13 females 12 males	Group 1: 55 ± 13 Group 2: 52 ± 12	Group 1: Type 1 Implant placement Immediate provisionalization Group 2: Type 1 Implant placement and delayed loading	Group 1: 24 Group 2: 25	15–25
Felice et al. (2011)	Eur J Oral Impl	Single Center Randomized Controlled Trial	4 months	Group 1: 54 Group 2: 52	32 females 22 males	Mean 48 (28–70)	Group 1: Type 1 Implant placement + Immediate provisionalization (if insertion torque >35 Ncm) and Delayed loading (at 4 months if insertion torque was ≤35 Ncm) Group2: Ridge preservation + Type 4 Implant placement + Immediate provisionalization (if insertion torque >35 Ncm)	Group 1: 54 Group 2: 52	15–25
Felice et al. (2015)	Eur J Oral Impl	Randomized Controlled Trial	1 year	Group 1: 25 Group 2: 25	Group 1: 13 females 12 males Group 2: 12 females 13 males	Group 1: 51.3 (32–71) Group 2: 53.1 (39–72)	Group 1: Type 1 Implant placement + Immediate provisionalization (if insertion torque >35 Ncm) and Delayed loading (at 4 months if insertion torque was ≤35 Ncm) Group2: Ridge preservation + Type 4 Implant placement + Immediate provisionalization (if insertion torque >35 Ncm)	Group 1: 25 Group 2: 25	15–25

(Continues)

TABLE 2 (additional columns)

Implant manufaturer	Implant insertion torque	Provisional restorations	Occlusion of provisional	Final restoration	Follow-up	Patient-centered outcomes	Comments
Nobel	At least 35 Ncm	Screw-retained provsional single crown	Cleared of centric and eccentric contacts	At 6 months after implant placement with cemented restoration	3, 6, 12 months	At the end of study period (12 months after implant provisionalization), patients were asked "How would you rate your satisfaction with respect to the aesthetic outcome of your treatment?" using an Visual analogue scale of 10 cm. 0 = not at all satisfied 10 = completely satisfied Group 1: Average 93% (range 82%–100%) Group 2: Average 91% (range 80%–96%)	
MegaGen	>35 Ncm (In Group 1: 19 of 54 were immediately provisionalized and 35 of 54 received delayed loading)	Cemented provisional single crown on temporary abutment	Non-occluding	4 months after implant placement with provisionally cemented crown on customized abutment	Final crown delivery, i.e. 4 months after loading	Patient satisfaction was recorded at the time of final crown delivery with regards to: 1) Function: "Are you satisfied with your function of your implant-supported tooth?" 2) Aesthetic:"Are you satisfied with the aesthetic outcome of the gums surrounding this implant?" Possible answers were: a)yes absolutely, b) Yes partly, c)not sure, d) not really and e)absolutely not 3) Another question (closed-ended question): "Would you undergo the same therapy again?" For function: Group 1 with immediate temporization: 88.2%–100% were "absolutely satisfied", 0%–5.9% were "partially satisfied"and 0%–5.9% were "unsure" Group 1 with delayed loading: 93.9%–100% were "absolutely satisfied", 0%–3.0% were "partially satisfied" and 0%–3.0% were "unsure" 100% of patients were "absolutely satisfied" with aesthetic and 100% would undergo the same therapy again	Patient-centered outcomes extracted only for one arm (Type 1 Implant placement). Two implants failed in Group 1. Details not given if the two implants were immediate or delayed loaded implants. *Patient satisfaction range extrapolated from data available in study.
Dentsply	>35 Ncm (In Group 1: 16 of 25 were immediately provisionalized and 9 of 25 received delayed loading)	Cemented provisional single crown on temporary abutment	Absence of contact in static and dynamic occlusion	4 months after implant placement	6 months and 1 year	Patient satisfaction was recorded at time of final crown delivery and 12 months after with regards to: 1) Function: "Are you satisfied with your function of your implant-supported tooth?" 2) Aesthetic:"Are you satisfied with the aesthetic outcome of the gums surrounding this implant?" Possible answers were: a) yes absolutely, b) Yes partly, c)not sure, d) not really and e) absolutely not 3) Another question (closed-ended question): "Would you undergo the same therapy again?" 100% of patients were "absolutely satisfied" with function and aesthetic and 100% would undergo the same therapy again	Patient-centered outcomes extracted only for one arm (Type 1 Implant placement)

(Continues)

TABLE 2 (Continued) [In PDF format, this table is best viewed in two-page mode]

Authors (year)	Journal	Study type	Duration	Patients (*n*)	Gender	Patient age (Mean (±*SD*), range)	Treatment group(s)	Implants (*n*)	Implant site(s)
De Rouck et al. (2008a, 2008b)	JCP	Case series	1 year	30	16 females 14 males	Mean 54 (24–76)	Group 1: Type 1 Implant placement Immediate provisionalization	30	15–25
Ferrara et al. (2006)	IJPRD	Case series	Up to 50 months. Average: 28 months	33	17 females 16 males	24–58	Group 1: Type 1 Implant placement Immediate provisionalization	33	14–24
Kolinski et al. (2014)	J Perio	Multicenter case series	3 years	55	31 females 24 males	52.6 ± 13.3 (19–82)	Group 1: Type 1 Implant placement Immediate provisionalization	60	3 Molars 26 Premolars 31 Maxillary anterior
Raes et al. (2012)	COIR	Prospective Multicenter Case-control study	1 year	96 Group 1: 46 Group 2: 54	55 females 41 males	42 ± 14.8 (18–72)	Group1: Type 1 Implant placement Immediate-provisionalization Group 2: Type 4 Implant placement Immediate provisionalization	Group 1: 48 Group 2: 54	15–25

(Continues)

TABLE 2 (additional columns - continued)

Implant manufaturer	Implant insertion torque	Provisional restorations	Occlusion of provisional	Final restoration	Follow-up	Patient-centered outcomes	Comments
Nobel	At least 35 Ncm	Screw-retained provsional single crown	Cleared of centric and eccentric contacts	At 6 months after implant placement with cemented restoration	1, 3, 6, 12 months	At the end of study period (12 months after implant placement), patients were asked "How would you rate your satisfaction with respect to the aesthetic outcome of your treatment?" using an Visual analogue scale of 10 cm. 0 = not at all satisfied 10 = completely satisfied Average 93% (range 82%–100%)	
Friadent	Not reported	Cemented provisional single crown on temporary abutment	No contact in maximum intercuspation and eccentric movement	At 6 months after implant placement with cemented restoration	Once a month for the first 6 months and every 3 months thereafter up to 4 years	Patient satisfaction was recorded at each follow-up (3-month recall visit) using a 10-point scale (0 = completely unsatisfactory result; 10 = complete satisfaction) Average at 4-year recall: 9.3 ± 0.65 (ecompassing 7 patients)	
Nobel	At least 35 Ncm	58 implants with single crowns 2 implants for an FDP (lost to follow-up at 3 years examination)	Temporary restoration in light or no contact with opposing dentition	Within 6 months of implant placement	3, 6 months 1, 2, 3 years	Aesthetic and function of restoration evaluated by patients at baseline (i.e. prior to treatment), implant placement, definitive prosthesis insertion, and at 1-, 2-, 3-year follow-up. VAS was used: 0 = poor, 100 = excellent Pre-operative/Baseline: Function: 62.2 Aesthetics: 58.9 Speech: 80.0 Sense of implant feeling like one's own tooth: 66.3 Self-esteem: 68.7 3-y follow-up: Function: 93.7 ± 6.4 Aesthetics: 89.2 ± 9.4 Speech: 93.5 ± 6.7 Sense of implant feeling like one's own tooth: 87.0 ± 18.5 Self-esteem: 92.2 ± 7.2 All scores increased significantly from baseline to 3-y follow-up visit ($p < 0.001$)	
Astra	Not reported	Cemented provisional single crown on temporary abutment	Not reported	At 10 weeks	Baseline, 1, 6, 12 months	OHIP-14 questionnaire ((14 questions, Scores 1–5 for a maximum of 70) for Group 1 recorded at all time points: Overall, imited oral health-related quality of life problems were reported (because they were never toothless) by these patients. Patients described a significant decrease in3 domains: Physical pain, Psychological discomfort and Psychological disablitity. Patient-reported less pain and tension, were less occupied with their teeth, were able to eat comfortably and relax over time and were less embarrassed. These improvement were mainly seen the first six months.	-Patient centered outcomes extracted only for one arm (Type 1 Implant placement)

(Continues)

TABLE 2 (Continued) [In PDF format, this table is best viewed in two-page mode]

Authors (year)	Journal	Study type	Duration	Patients (*n*)	Gender	Patient age (Mean (±*SD*), range)	Treatment group(s)	Implants (*n*)	Implant site(s)
Raes et al. (2013)	CIDRR	Prospective 3-arm clinical trial	1 year	48 Group 1: 16 Group 2: 9 Group 3: 23	21 females 27 males Group 1: 16, 6 females, 10 males Group 2: 9, 4 females, 5 males Group 3: 23, 11 females, 12 males	Group 1: 45 ± 14 (22–68) Group 2: 35 ± 15 (20–69) Group 3: 40 ± 19 (19–75)	Group1: Type 1 Implant placement Immediate-provisionalization Group 2: GBR at time of extraction, Type 4 Implant placement Immediate provisional-ization Group 3: Type 4 Implant placement Immediate provisionalization	Group 1: 16 Group 2: 9 Group 3: 23	15–25
Takeshita et al. (2015)	IJPRD	Retrospective case series	1.5 year	18	12 females 6 males	48 ± 11 (32–77)	Group 1: Type 1 Implant placement Immediate-provisionalization	21	12–22

Given the general sense that PROMs tend to be underreported for clinical situations other than two implants supporting a mandibular overdenture (De Bruyn et al., 2015) and in an effort to capture all relevant data present in the literature, the present systematic review did not chose a specific PROM as an inclusion factor to address the PICO question. This led to the inclusion of a total of nine studies using different PROMs. Only one randomized controlled trial addressed specifically the PICO question (De Rouck et al., 2009) and two further randomized controlled trials included data for both immediate and conventional loading following type 1 implant placement within the same treatment arm (Felice et al., 2011, 2015). The loading protocol was not randomized and was based on the implant placement insertion torque. Therefore, the studies by Felice et al. (2011, 2015) had to be viewed as nonrandomized for the purpose of this review. The remaining studies only included the test intervention of interest as the sole treatment investigated (De Rouck et al., 2008a,2008b; Ferrara et al., 2006; Kolinski et al., 2014; Takeshita et al., 2015) or as part of a multiarm trial in which the other treatment arms were outside the scope of the present work (Raes et al., 2012, 2012). Therefore, the majority of the included studies (six of nine) were single cohort uncontrolled studies.

All studies included in the present review reported exclusively on single tooth implant-supported restoration except for Kolinski et al. (2014). In this study, the authors reported the outcomes of 60 implants up to 3 years. Of the 60 implants placed, 58 were placed for single tooth restorations while two were placed to support a fixed dental prosthesis (FDP). Ideally, for the purpose of the present review, data related to the two implants supporting the FDP should be excluded. Unfortunately, the report by Kolinski et al., 2014 did not discriminate the outcomes based on the restorative indication, hampering the author's ability to extract the data for single tooth restorations only. Nonetheless, the authors decided to keep the study by Kolinski et al. (2014) and to report their findings based on the following rationale:

1. At baseline, the PROMs from the one patient who received immediate implants for an FDP out of a total of 55 patients was unlikely to significantly change the reported values for the overall cohort.
2. At the 3-year follow-up examination, 37 patients with 37 implants were evaluated, indicating that the patient with the two implants supported FDP had been lost to follow-up. Therefore, the PROMs reported at the 3-year timeline only included data from implant-supported single tooth restorations.
3. As a qualitative review was undertaken, the authors felt that including the study by Kolinski et al., 2014 which had the longest follow-up of all included studies would add useful information to the review which would outweigh the fact that the baseline data included a single patient who received two implants for an FDP when the remaining data included in this review only included single tooth restorations.

For data derived from controlled trials, combining results of randomized and nonrandomized controlled trials has been questioned as it has been shown that results of nonrandomized controlled trials tended to show greater treatment effects than randomized controlled trials (Ioannidis et al., 2001). While newer Network Meta-analysis may overcome this shortcoming (Cameron et al., 2015), two different sets of PROMs were used in the three comparative studies preventing pooling of the data and meaningful comparison between studies. Another shortcoming of these comparative trials was the fact that only one time point after treatment was considered for recording the PROMs

TABLE 2 (additional columns - continued)

Implant manufaturer	Implant insertion torque	Provisional restorations	Occlusion of provisional	Final restoration	Follow-up	Patient-centered outcomes	Comments
Astra	Not reported	Cemented provisional single crown on temporary abutment	Absence of centric and eccentric contacts	11–12 weeks after implant placement	Baseline, 1, 3, 6, 12 months	Based on OHIP-14 questionnaire (14 questions, Scores 1–5 for a maximum of 70) for group 1: There was a signifcant improvement in overall OHIP-14 score from baseline (66.25 ± 3.86) to 12 months (69.67 ± 0.62)	Patient-centered outcomes extracted only for one arm (Type 1 Implant placement)
Dentsply	At least 35 Ncm	Cemented provisional single crown on temporary abutment	Temporary restoration placed slightly of occlusal contact	14 weeks after implant placement	1.5 year	Based on OHIP-J (Japanese version of Oral Health Impact Profile = 49 + 5 = 54 questions, Scores 1–4, for a maximum of 216). Scores was converted in % satisfaction. Satisfaction based on OHIP-J: 96.7% ± 2.16 (92.6%–100%)	

which limited the prospective evaluation of the treatment benefits. These shortcomings were already mentioned in previous reviews (De Bruyn et al., 2015; McGrath, Lam, & Lang, 2012). Nonetheless, these studies indicated little to no difference in patient satisfaction following the two different loading protocols following immediate implant. This was irrespective of the PROMs reported which included a VAS for aesthetic satisfaction, a 5-point scale assessing function, aesthetics, and open-ended questions placement.

From the uncontrolled studies, overall patient satisfaction was high following immediate implant placement and loading. Three studies (Kolinski et al., 2014; Raes et al., 2012, 2013) reported PROMs with a baseline evaluation prior to treatment up to 1 year (Raes et al., 2012, 2013) or 3 years (Kolinski et al., 2014) after treatment. The impact of treatment could be objectified by the significant increase in the VAS scores pertaining to function, aesthetic, speech, sense of the implant feeling like one's own, and self-esteem (Kolinski et al., 2014) and by the improvement of oral health-related quality of life as measured by the OHIP-14 (Raes et al., 2012, 2013). While this information is valuable to demonstrate the positive impact of Type1 implant placement and immediate provisionalization, no clinical recommendation can be made pertaining the timing of loading as only one protocol was implemented. The psychometric properties of OHIP-14 have been well documented and the questionnaire has been validated to evaluate the outcome of clinical interventions (Allen, 2003; Slade, 1997). OHIP questionnaires presented the advantage to be standardized in comparison with other patient satisfaction questionnaires, for example, using VAS or categorical scales, which lacked standardization across studies and, thereby, hampered the ability to make any meaningful comparison between studies.

Given the sense of relative paucity of PROMs reported in the literature, the authors wanted to be as inclusive as possible and the scope encompassed all types of partial edentulism treated with either single or multiple tooth implant-supported restorations. However, the included studies reported almost exclusively on single tooth restorations. Therefore, the findings in the present review may not be extended to implant-supported fixed dental prostheses (FDPs) replacing multiple teeth. This maybe further supported by the fact that in clinical settings, the technical approach for immediate loading in extended tooth gaps may be more challenging as compared to single tooth restorations. Adjustment of the occlusion to limit the amount of forces in immediate loading situations, including full to the absence of contacts in centric and absence of excursive contacts have been reported (Schrott, Riggi-Heiniger, Maruo, & Gallucci, 2014). This may be more readily achievable for single tooth restorations as compared to longer span implant-supported FDPs. Finally, the clinical guidelines derived from the previous ITI consensus conference (Gallucci et al., 2014) recommended that immediate loading of single tooth restoration can be successfully implemented for all area except for maxillary molar regions which lacked solid scientific backup. For immediate loading of implant-supported FDPs the recommendations emphasized careful case selection and advanced clinical expertise, especially for anterior sites for which insufficient documentation had been identified. These clinical recommendations emphasize the fact that outcomes of immediate loading in single tooth sites and multiple tooth sites have to be reported separately.

A further limitation of the available literature resides in the multitude of factors likely to influence the assessment of subjective outcomes and the limited ability of the existing studies to control for confounders.

In conclusion, and within the limitations of the available literature, immediate implant placement and loading in single tooth edentulous space seemed to positively impact patients oral health-related quality of life as this therapeutic approach remains worthy of consideration in patient care. However, the paucity of comparative data limits any definitive conclusions as to which loading protocol; immediate or early/conventional, should be given preference based on PROMs.

5 | CONSIDERATION FOR FUTURE RESEARCH

There is little discussion that incorporating the patient in the decision making process of their treatment may positively impact the outcome of therapy. This underlines the importance of incorporating PROMs in clinical research. While the trend is encouraging with more studies including PROMs being published, limitations in the present review have been previously mentioned in other reports (De Bruyn et al., 2015; Lang & Zitzmann, 2012).

To overcome them the following suggestions are made:

- Evaluation of PROMs should be evidence-based tools that have been previously validated, for example, OHIP.
- Evaluation of PROMs should include at the very least two time points: a baseline, that is, prior to treatment, and a posttherapeutic assessment to allow the prospective evaluation of treatment benefit.
- Ideally, multiple assessments are desirable to potentially discriminate short-term vs long-term benefits of treatment.

Moreover, further well-controlled randomized trials are needed to possibly determine the standard of care with regard to loading protocols based on clinical and patient-reported outcome measures.

CONFLICTS OF INTEREST

No conflicts of interest are declared.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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