Dental Implants With Immediate Loading Using Insertion Torque of 30 Ncm: A Systematic Review

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Objective: *This study aimed to perform a review of the literature regarding the survival rate of dental implants with immediate loading using insertion torque of 30 Ncm.*

Material and Methods: *A systematic review was performed based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses and the Cochrane Handbook for Systematic Reviews of Interventions (PROSPERO CRD42014015323). The search was performed in the PubMed, Web of Science, Cochrane Library electronic, OVID, and Scielo databases. Manual searches were also performed. The articles identified were assessed independently by 3 researchers. Clinical trials reporting dental implants with immediate loading and 30 Ncm torque in patients ages 18 years or older were included.*

Results: *The searches yielded 589 studies. Six studies were included in the systematic review. The survival rate of dental implants was 96.8%. Three studies showed a low potential risk of bias.*

Conclusion: *There is not strong evidence that insertion torque of 30 Ncm is enough for implant survival in cases of immediate loading. (Implant Dent 2016;25:675–683)*

Key Words: dental prostheses, torsional forces, osseointegration, immediate loading

Dental implants have become a treatment modality accepted by the scientific community for fully and partially edentulous patients.[1] Indeed, the placement of implant-retained prostheses, particularly in the lower jaw, has significantly reduced the burden of edentulism.[2]

A 2-stage surgical technique is the conventional protocol and is the most efficient way to minimize the risk of implant failure.[3–5] Traditional clinical guidelines recommend the placement of implants in healed sites, followed by 3 to 6 months of submucosal healing before functional loading.[6] However, this 2-stage protocol can be physically and psychologically challenging for patients, given the additional procedures associated with the second surgical phase, the long wait time for the restoration of function and aesthetics and inconvenience due to the multiple visits.[7] Thus, a shorter approach with immediate loading has been developed to minimize these problems.

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With immediate loading, the prosthesis is connected to the implants and is functional within 48 hours after surgery.[8,9] Studies report similar survival rates with both techniques[7] and it can be applied to all designs of prostheses, despite the most common being the full-arch mandibular rehabilitation. The immediate loading of dental implants restored by a full-arch splinted fixed prosthesis has shown excellent results. The fewer complications, the less morbidity associated interventions, and a simplified rehabilitation have contributed to the increase in the clinical use of this technique.[10]

Splinting multiple implants together with a passive fitting prosthesis limits micromovements at the bone-implant interface. Stabilizing the implants upon placement and limiting micromovements to no more than 100 μm contribute to successful osseointegration.[11] Immediate implant loading with a provisional restoration has been proposed as a simpler, more predictable, less expensive, and less time-consuming method.[12]

Primary stability is one of the most important parameters to the immediate loading of an implant and is an important requirement for the long-term success of dental implants.[4] Other important factors include bone quality, macrointerlock, and microinterlock properties of the implant, bicortical initial stabilization,

number and optimal distribution of implants and careful use of cantilevers.[13]

Different values of insertion torque are found in the literature, with 45 Ncm the most commonly used and considered the safest and most therapeutic for immediate loading.[14–18] However, lower torque values are related to primary stability and have been increasingly used for immediate loading, despite the low degree of scientific evidence regarding such insertion torque values.[19] Thus, the aim of the present study was to perform a systematic review of the literature on the survival rates of dental implants with immediate loading using insertion torque of 30 Ncm.

METHODS

Protocol

The present systematic review was performed based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement guidelines[20] and the Cochrane Handbook for Systematic Reviews of Interventions.[21] The protocol for this systematic review is registered on PROSPERO (CRD42014015323).

Focus Question

In cases of immediate loading, is insertion torque of 30 Ncm enough for the survival of dental implants?

Search Strategy

The studies included in this systematic review were obtained through electronic searches of the PubMed/MEDLINE, Web of Science, Cochrane Library electronic, OVID, and Scielo databases. The keywords used were searched in Health Sciences Descriptors (DeCs) and Medical Subject Headings (Mesh), and the following terms were used: (dental implant*) AND (immediate loading*) AND (torque*).

A general search strategy was adapted to the characteristics of each database to identify studies of interest for this review. The databases were searched for articles and abstracts with no language restriction. A manual search of dental implant-related journals was done. To identify the relevant journals to be hand searched, it was checked using the Cochrane Worldwide Handsearching Programme (http://us.cochrane.org/master-list). This hand searching included the following journals: British Journal of Oral and Maxillofacial Surgery; Clinical Implant Dentistry and Related Research; Clinical Oral Implants Research; European Journal of Oral Implantology; Implant Dentistry; International Journal of Oral and Maxillofacial Implants; International Journal of Oral and Maxillofacial Surgery; International Journal of Periodontics and Restorative Dentistry; International Journal of Prosthodontics; Journal of Clinical Periodontology; Journal of Dental Research; Journal of Oral Implantology; Journal of Oral and Maxillofacial Surgery; Journal of Periodontology; Journal of Prosthetic Dentistry.

All the corresponding authors of the included clinical trials were contacted by e-mail to identify and obtain data from any unpublished or ongoing studies. The references contained in all studies and systematic reviews included were checked for additional trials.

Screening and Selection Process

For this systematic review, clinical trials (CTs) that met the inclusion criteria and dating from the inception of the respective databases through to September 2014 were selected. Inclusion was based on an analysis of the title and abstract of studies with regard to the eligibility criteria listed below.

Type of study. Clinical trials (either randomized or not) of any design that evaluated the use of dental implant with immediate loading were considered.

Participants. Patients were aged 18 years or older who were having osseointegrated root-form dental implants.

Type of intervention. The interventions of interest were those involving dental implants with immediate loading. In this review, immediate loading was defined as an implant put into function within 48 hours after placement.[8,9]

Exclusion criteria. CTs not clearly meeting the inclusion criteria and those that did not report dental implants with exactly 30 Ncm insertion torque were excluded.

Outcomes. The primary outcome includes implant survival. Secondary outcomes were prosthesis failure, radiographic marginal bone level changes, and postoperative complications.

Review Method and Data Extraction

The study selection process was performed by 3 reviewers (D.W.D.d.O., F.S.L., A.M.G.) in 2 phases. In the first phase, the 3 reviewers independently identified all relevant studies through electronic and other search methods based on the inclusion criteria applied to the titles and abstracts. For studies appearing to meet the inclusion criteria or for which insufficient data were found in the title and abstract to make a clear decision, the full text was preselected. In the second phase, the preselected studies were analyzed by the same researchers to define whether the clinical trial met the inclusion criteria. When necessary, the authors of the clinical trials were contacted by e-mail to clarify issues related to the trials. Studies excluded in this or following stages were recorded along with the reasons for rejection. Clinical trials meeting the inclusion criteria were included in the final analysis and were submitted to data synthesis. Articles identified 2 or more times were considered only once.

The studies were analyzed and discussed by independent researchers who conducted the development of the systematic review. Disagreements were resolved by consensus among the 3 reviewers and a fourth reviewer (L.A.L.). This procedure was applied at all steps. The reviewers were trained for each database before the study.

Data were recorded qualitatively to allow comparisons among the studies selected. Each researcher qualitatively assessed the studies using an evaluation form. Data were collected on the following items: author; year of publication; country; study design; characteristics of participants; insertion torque; follow-up; prosthesis type; implant brand; and results regarding the dental implants. The survival rate was calculated for dental implants inserted with insertion torque of 30 Ncm and immediate loading.

Quality Assessment

A methodological quality of the studies was assessed based on the

Table 1. Variables Used to Assess Quality of Included Clinical Trials

Sample-size calculation, estimating the minimum number of participants required to detect a significant difference among compared groups	0 = did not exist/not mentioned/not clear 1 = reported but not confirmed 2 = reported and confirmed
Allocation concealment	0 = inadequate 1 = possibly adequate 2 = clearly adequate
Random Allocation	0 = inadequate 1 = possibly adequate 2 = clearly adequate
Losses (specified reasons for withdrawals and dropouts in each study group)	0 = no/not mentioned/not clear 1 = yes/no withdrawals or dropouts occurred
Blinding of assessors	0 = no 1 = unclear/not complete 2 = yes
Appropriate statistical analysis	0 = no 1 = unclear/possibly not the best method applied 2 = yes

revised recommendations of the Consolidated Standards of Reporting Trials statement.[22] The criteria used are listed in Table 1. The risk of bias was estimated for each selected clinical trial based on the Cochrane Handbook for Systematic Reviews of Interventions[21]: low risk of bias (when all criteria were met); moderate risk of bias (when ≥1 criterion was partially met); and high risk of bias (when ≥1 criterion was not met).

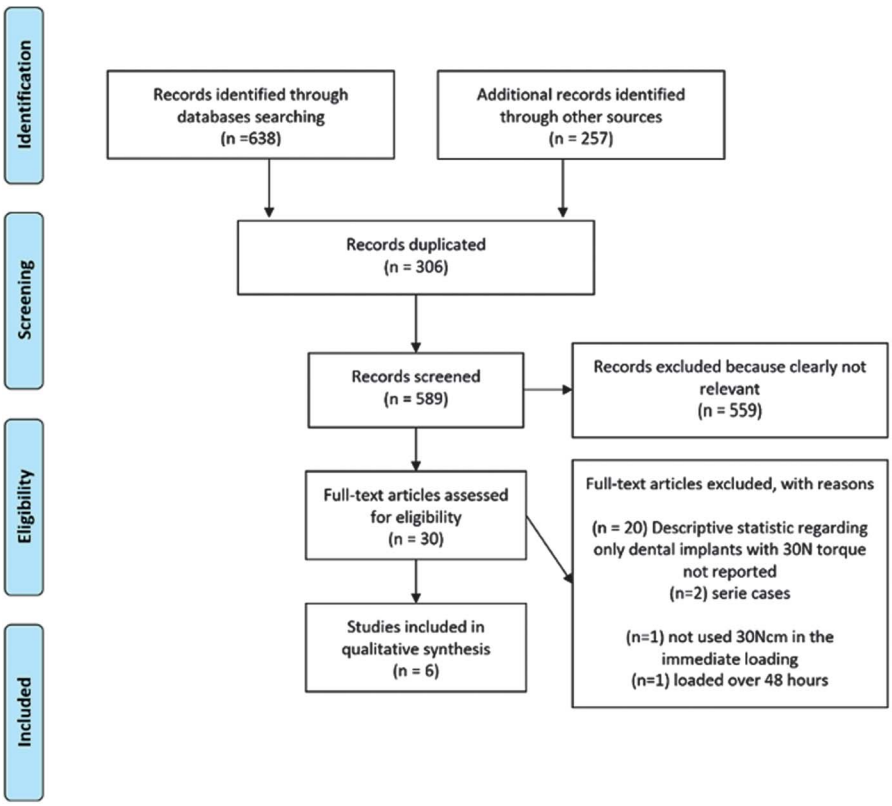

Fig. 1. Representative flow chart for the search results. Total of identified and excluded articles and the final studies is included.

RESULTS

After eliminating duplications, the electronic and hand searches yielded 589 potentially relevant references. In the first stage of study selection, 559 publications were excluded after the examination of the title and abstract. The full texts of the remaining 30 articles were read. Twenty articles were excluded in this second stage due to a lack of reporting the number of implants and descriptive statistics for dental implants with a insertion torque of 30 Ncm.[15,17,18,23–39] Two manuscripts were case series and were excluded.[40,41] One article did not use 30 Ncm with immediate loading and was excluded.[42] One manuscript was excluded because it reported implants with insertion torque of 30 Ncm loaded within 72 hours.[43] Thus, a total of 6 studies[44–49] met the selection criteria and were submitted to the qualitative analysis (Fig. 1). Only one corresponding author replied to the email with no unpublished data.

All CTs included in this review were conducted in Italy.[44–49] Four studies were conducted with a parallel group design.[44,45,48,49] One was conducted with split-mouth design[47] and one was noncontrolled, nonrandomized clinical trial.[46] Two days was the most common loading time for implants with 30 Ncm of insertion torque.[44,45,49] In 3 clinical trials, the dental implants were placed only in the mandible.[46–48] In the other clinical trials, implants were inserted in upper and lower jaws.[44,45,49] The main characteristics of the 6 studies are summarized in Table 2.

Insertion torque was measured during the setting of the dental implant using an electronic device (OsseoCare, Nobel Biocare, Switzerland).[44–49] Among all clinical trials, 31 dental implants were inserted with insertion torque of 30 Ncm and loaded immediately and only one implant had failed in the follow-up,[47] which constitutes a 96.8% survival rate for this type of dental implant.

One clinical trial did not mention the sample size.[46] Five studies presented appropriate statistical analysis.[44,45,47–49]

Table 2. Characteristics of Studies Included in Present Systematic Review

Study	Study Design	Country	Participants	Loading Time (d) for 30N Immediate Implants	Occlusal Contact for 30N Immediate Implants	Total No. of Implants	No. of 30N Implants	No. of Drop-Outs
Capelli et al[44]	Randomized Clinical Trial, parallel group	Italy	23 males, 29 females; 27–74 y	2	No	104	6	1
Galli et al[45]	Randomized Clinical Trial, parallel group	Italy	23 males, 29 females; 27–74 y	2	No	104	6	0
Marzola et al[46]	Clinical trial not controlled not randomized	Italy	6 males, 11 females; 36–91 y	0	Yes	34	8	0
Schincaglia et al[47]	Randomized Clinical Trial, split-mouth	Italy	6 males, 4 females; 37–74 y	1	Yes	42	4	0
Schincaglia et al[48]	Randomized Clinical Trial, parallel group	Italy	9 males, 21 females; 31–75 y	1	Yes	30	1	0
Testori et al[49]	Randomized Clinical Trial, parallel group	Italy	23 males, 29 females; 27–74 y	2	No	104	6	0

Study	Follow-Up, mo	Jaw	Prothesis Type	Implant Brand	Graft Bone	Outcomes	No. of Failures of Immediate Implants (30N)	Survival Rates for 30N Dental Implant, %
Capelli et al[44]	60	Mixed	Unitary and fixed dental prothesis	Biomet 3i	In some cases	Loss of marginal periimplant bone; recession of vestibular soft tissue; prosthesis failure	0	100
Galli et al[45]	14	Mixed	Unitary and fixed dental prothesis	Biomet 3i	In some cases	Loss of marginal periimplant bone; No recession of vestibular soft tissue; prosthesis failure	0	100
Marzola et al[46]	12	Mandible	Denture	Nobel Biocare	NR	Loss of marginal periimplant bone; prosthesis failure	0	100
Schincaglia et al[47]	12	Mandible	Multiple	Nobel Biocare	NR	Loss of marginal periimplant bone; prosthesis failure	1	75
Schincaglia et al[48]	12	Mandible	Unitary	Nobel Biocare	NR	Loss of marginal periimplant bone	0	100
Testori et al[49]	14	Mixed	Unitary and fixed dental prothesis	Biomet 3i	In some cases	Loss of marginal periimplant bone; No recession of vestibular soft tissue; prosthesis failure	0	100

Table 3. Risk of Bias in Studies Analyzed

Study	Sample Size	Allocation Concealment	Random Allocation	Losses	Assessors Blinding	Statistical Analysis	Judged Bias Risk
Capelli et al[44]	2	2	2	1	2	2	Low
Galli et al[45]	2	2	2	1	2	2	Low
Marzola et al[46]	0	0	0	1	0	1	High
Schincaglia et al[47]	2	0	2	1	2	2	High
Schincaglia et al[48]	2	0	2	1	2	2	High
Testori et al[49]	2	2	2	1	2	2	Low

The risk of bias was considered low in 3 studies[44,45,49] and high in the other clinical trials analyzed (Table 3).[46–48]

A reduction in marginal peri-implant bone was reported in all studies reviewed.[44–49] No postoperative complications were reported in any study. One study reported the occurrence of peri-implantitis[44] and one clinical trial described gingival recession after implant placement.[44] Five studies reported prosthesis failures.[44–47,49]

The data extracted from the studies evaluated in the present review reveal heterogeneity in relation to the follow-up period, clinical parameters assessed, implant dimensions, and study design; in other words, the studies seem to have methodological heterogeneity. Thus, it was not possible to establish a quantitative synthesis of the data, thereby rendering meta-analysis impossible.

DISCUSSION

Previous systematic reviews report the use of dental implants (loaded immediately or not) for the treatment of partially and completely edentulous jaws with excellent clinical outcomes, patient satisfaction, and high survival rates.[50–54] However, a gap remains in current knowledge on the minimum insertion torque necessary for implants submitted to immediate loading. As shorter treatment time is a major desire of patients, such research is essential. This is the first study to focus on this issue based on clinical trials addressing dental implants immediately loaded with insertion torque of 30 Ncm.

None of the clinical trials in the present review reported adverse effects from the surgical procedures performed. These findings provide evidence of the clinical safety of dental implants for replacing missing teeth even in older adults, for whom the prevalence rates of systemic disorders, diseases, and edentulism are high. Edentulism associated with adverse health conditions, such as cardiovascular disease, diabetes mellitus, kidney disease, and coronary disease, has been investigated in several studies.[55–58]

The high success rate of dental implants has led to safe treatment and an improvement in quality of life.[59] Despite the advantages of dental implants, patients complained about long healing time and hence immediate loading was developed to decrease the treatment time and increase patient comfort and satisfaction. Immediate loading can be used in edentulous areas with good clinical and radiographic short-term outcomes.[60] Indeed, immediate loading is currently fully accepted as a treatment option for the replacement of single or multiple missing teeth in both jaws,[61,62] as confirmed by the clinical trials analyzed herein.

The period of complete osseointegration ranges from 3 to 6 months.[51,63] The follow-up period in the studies reviewed ranged from 12 to 60 months (median: 13 months). The long-term effect of osseointegration could be observed, as the evaluations were performed in a period surpassing 6 months. The results described by Capelli et al[44] are from a longitudinal follow-up (60 months) of patients whose data were published in a previous study.[49] The importance of longitudinal studies resides in the demonstration of the long-term results achieved with dental implants. Moreover, only the longitudinal clinical trial[44] reported the occurrence of peri-implantitis and soft-tissue recessions, which demonstrates the chronic aspect of these conditions[54,64] and the importance of regular maintenance visits after dental implant placement to prevent or to manage peri-implantitis.[65]

Primary stability is an important prerequisite for the success of immediate implant loading.[66] Thus, the immediate loading of dental implants may achieve predictable treatment outcomes if clinical precautions are taken. Such precautions may include under-preparation of the implant sites, particularly in the presence of soft type III and IV bones according to Lekholm and Zarb[67] the use of implants that favor stronger, faster bone integration, and accurate loading control.[49] Two major factors that influence primary stability of an implant during placement are the amount of bone–implant contact and the role of compressive stresses at the implant–tissue interface. Such stresses may be beneficial for enhancing the primary stability of an implant, but, when too high, can result in necrosis and local ischemia of the bone at the implant–tissue interface.[68] As primary implant stability is dependent on the physical connection between the implant and surrounding bone, implant design, bone quality and quantity, and surgical technique all exert an influence.[52,69]

An electronic device was used for the determination of insertion torque in all studies reviewed.[44–49] This methodological consistency in the assessment of insertion torque reflects the ease and standardized protocol in this objective method of evaluating primary stability. Insertion torque can be understood as the insertion force of an implant in an undersized receptor bed. This measure is directly related to primary stability, which suggests that osseointegration can be faster and/or improved using a surgical protocol with a high insertion torque.

In type III and IV bones,[67] the macrostructure of the implant plays a crucial

role in achieving primary stability. Some studies suggest that the implant design may influence the survival rate in different ways.[70,71] Unfortunately, the clinical trials analyzed herein did not report on the macrostructure of the implant, which may be considered a source of bias.

In the present systematic review, "immediate loading" was considered as the treatment protocol in which a prosthetic reconstruction is attached to the dental implant within 48 hours following surgery. Although "immediate" normally implies "directly after,"[50] this 48-hours' time frame is the time necessary for the dental technician to process the provisional or definitive restoration and is currently generally accepted in implant dentistry.[8,9]

There are some advantages to immediate loading that may explain the popularity of this technique and is preference over mediate loading (implant put into function over 48 hours after placement),[8,9] such as the reduction in treatment time, greater patient comfort as well as esthetic and economic benefits, especially for professionally and/or socially active patients.[50] The CTs in this review used immediate loading with[46–48] or without[44–49] occlusal contact of the restoration with the opposing arch. However, the lack of occlusion does not impede a restoration from being functional during mastication. The influence of occlusal contact on implant survival could not be verified, since all studies reported a high survival rate and a low failure rate of the dental implants and prosthesis. According to Misch et al,[72] immediate nonocclusal loading consists of modifying the immediate temporary restoration to avoid occlusal contacts in centric and lateral excursions and reduce the risk of early mechanical overload caused by functional or parafunctional forces. The findings of a previous systematic review demonstrate that differences in occlusal loading between implants with immediate functional loading and immediate nonfunctional loading do not affect the survival rate.[51]

Four CTs[44,45,48,49] also investigated dental implants with mediate loading and report a dental implant survival rate similar to that achieved with immediate loading. However, the clinical trials did not show the direct impact of the loading protocol on implant survival, since the variation in survival was visibly smaller with delayed loading (100%) in comparison to immediate loading (93.3%–100%).

The issue of whether implants could be immediately loaded after their insertion was the subject in a previous study,[73] which demonstrated a low failure rate for all loading times. Moreover, the authors suggest that, under ideal conditions, surgeons can achieve a high success rate when loading implants immediately, early or conventionally.

In 14 months of follow-up, authors observed mean peri-implant bone loss of 1.1 mm with immediately loaded implants.[45,49] Five years later, the same research presented a mean bone loss of 1.2 mm.[44] These results were confirmed by Schincaglia et al,[48] who reported bone loss of 1.2 mm in the period of 12 months after implant placement with immediate loading, whereas bone loss of 0.77 mm was found with delayed loading. This difference was statistically significant. As noted in the present review, resorption is part of physiological remodeling during osseointegration and also occurs with immediate loading.[74]

Descriptive data from all studies[44–49] in the present review reveal a high rate of dental implant survival in cases of immediate loading with insertion torque of 30 Ncm. However, the studies reviewed were limited regarding the statistical analysis to determine the behavior of 30 Ncm insertion torque. In other words, no statistical evidence was presented of the effectiveness of this insertion torque value regarding the stability and survival rate of immediately loaded implants. Thus, it is not possible to rule out the occurrence of type I (false positive) or II (false negative) errors. Moreover, higher insertion torque may not always translate to greater primary stability true, as bone quantity and quality vary significantly among patients.[68]

Many factors are not distributed equally among populations worldwide and may influence the results of immediate implant loading, such as aspects related to the surgery, host, implant, and occlusion, including bone quality, dietary habits, wound healing, implant design and surface, prosthetic design, bite force, professional experience, and patient expectations.[48,63,75–77] In the present systematic review, all CTs on dental implants set at 30 Ncm with immediately loading were conducted in Italy.[45–50] This finding underscores the need for further studies, involving different populations that correlate 30 Ncm torque with immediate loading for a better comparison and reliability of the results.

The risk of bias was considered high in 3 studies.[46–49] The factor that most compromised methodological quality was the lack of allocation concealment. Without adequate allocation concealment, even randomized, unpredictable sequences can be corrupted.[78] The operator may intervene, tending to favor one group over another, which leads to selection bias. According to Schulz,[78] an inadequately concealed allocation sequence can produce greater estimated treatment effects. In future studies, this bias can be avoided by using, for example, central randomization or sequentially numbered, sealed, opaque envelopes.

It is important to note that the studies by Galli et al (2008)[44] and Testori et al[49] seem to report the same results from the same population regarding the outcomes investigated in this review, especially the total number and survival rates of implants inserted with torque of 30 Ncm. The only difference between these clinical trials is that Testori et al[49] published data on restoration success, implant success, and complications. Therefore, the results of both articles should be viewed as only one in this review.

A protocol was used to guide the search strategy, study selection, and data collection. However, the present systematic review may have some limitations, such as the absence of meta-analysis and the noninclusion of the EMBASE database due to methodological and logistical reasons. Moreover, some potentially relevant trials were excluded due to the lack of information on the number dental implants inserted with torque of 30 Ncm and such information was not obtained from the authors.

Well-conducted, randomized, controlled trials with good methodological quality and long-term postoperative follow-up are needed to corroborate or refute the findings of this systematic review. Future studies should focus on implants with insertion torque of 30 Ncm and submitted to immediate loading.

Conclusion

The results of the present systematic review must be viewed with caution, as half of the studies reviewed had a high risk of bias and 3 articles arose from the same research. On the basis of the studies included in this review, there is not strong evidence to conclude that insertion torque of 30 Ncm is enough for implant survival in cases of immediate loading, although the results demonstrated a high survival rate. Adequately powered randomized clinical trials are needed to allow clinicians to load dental implants immediately with insertion torque of 30 Ncm as safe, lasting treatment for missing teeth.

Disclosure

The authors claim to have no financial interest, either directly or indirectly, in the products or information listed in the paper.

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References

1. Wang RE, Lang NP. Ridge preservation after tooth extraction. *Clin Oral Implants Res.* 2012;23:S147–S156.

2. 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.

3. Adell R, Eriksson B, Lekholm U, et al. Long-term follow-up study of osseointegrated implants in the treatment of totally edentulous jaws. *Int J Oral Maxillofac Implants.* 1990;5:347–359.

4. Esposito M, Grusovin MG, Chew YS, et al. A Cochrane systematic review of randomized controlled clinical trials. *Eur J Oral Implantol.* 2009;2:91–99.

5. Esposito M, Grusovin MG, Achille H, et al. Interventions for replacing missing teeth: Different times for loading dental implants. *Cochrane Database Syst Rev.* 2009:CD003878.

6. Brånemark P, Zarb GA, Albrektsson T. *Tissue-Integrated Prostheses: Osseointegration in Clinical Dentistry*. Berlin, Germany: Quintessence; 1985:11–53.

7. Avila G, Galindo P, Rios H, et al. Immediate implant loading: Current status from available literature. *Implant Dent.* 2007;16:235–245.

8. Misch CE, Wang HL, Misch CM, et al. Rationale for the application of immediate load in implant dentistry: Part I. *Implant Dent.* 2004;13:207–217.

9. Misch CE, Wang HL, Misch CM, et al. Rationale for the application of immediate load in implant dentistry: Part II. *Implant Dent.* 2004;13:310–321.

10. Meloni SM, De Riu G, Pisano M, et al. Immediate versus delayed loading of single mandibular molars. One-year results from a randomized controlled trial. *Eur J Oral Implantol.* 2012;5:345–353.

11. Thomé E, Lee HJ, Sartori IA, et al. A randomized controlled trial comparing interim acrylic prostheses with and without cast metal base for immediate loading of dental implants in the edentulous mandible. *Clin Oral Implants Res.* 2014;26:1414–1420.

12. Crespi R, Vinci R, Capparé P, et al. A clinical study of edentulous patients rehabilitated according to the "all on four" immediate function protocol. *Int J Oral Maxillofac Implants.* 2012;27:428–434.

13. Degidi M, Piattelli A. 7-year follow-up of 93 immediately loaded titanium dental implants. *J Oral Implantol.* 2005;31:25–31.

14. Wöhrle PS. Single-tooth replacement in the aesthetic zone with immediate provisionalization: Fourteen consecutive case reports. *Pract Periodontics Aesthet Dent.* 1998;10:1107–1114.

15. Ottoni JM, Oliveira ZF, Mansini R, et al. Correlation between placement torque and survival of single-tooth implants. *Int J Oral Maxillofac Implants.* 2005;20:769–776.

16. Pozzi A, Sannino G, Barlattani A. Minimally invasive treatment of the atrophic posterior maxilla: A proof-of-concept prospective study with a follow-up of between 36 and 54 months. *J Prosthet Dent.* 2012;108:286–297.

17. Pieri F, Aldini NN, Fini M, et al. Immediate fixed implant rehabilitation of the atrophic edentulous maxilla after bilateral sinus floor augmentation: A 12-month pilot study. *Clin Implant Dent Relat Res.* 2012;14:e67–e82.

18. Simunek A, Strnad J, Kopecka D, et al. Changes in stability after healing of immediately loaded dental implants. *Int J Oral Maxillofac Implants.* 2010;25:1085–1092.

19. Papaspyridakos P, Chen CJ, Chuang SK, et al. Implant loading protocols for edentulous patients with fixed prostheses: A systematic review and meta-analysis. *Int J Oral Maxillofac Implants.* 2014;29:S256–S270.

20. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Med*. 2009;6:e1000097.

21. Higgins JPT, Green S, eds. *Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0*. The Cochrane Collaboration; 2011. Available at: www.cochrane-handbook.org. Accessed July 29, 2014.

22. Moher D, Hopewell S, Schulz KF, et al. Consort 2010 explanation and elaboration: Updated guidelines for reporting parallel group randomized trials. *Int J Surg.* 2012;10:28–55.

23. Degidi M, Nardi D, Piattelli A. Immediate versus one-stage restoration of small-diameter implants for a single missing maxillary lateral incisor: A 3-year randomized clinical trial. *J Periodontol.* 2009;80:1393–1398.

24. Degidi M, Nardi D, Piattelli A. A comparison between immediate loading and immediate restoration in cases of partial posterior mandibular edentulism: A 3-year randomized clinical trial. *Clin Oral Implants Res.* 2010;21:682–687.

25. Degidi M, Daprile G, Piattelli A. Implants inserted with low insertion torque values for intraoral welded full-arch prosthesis: 1-year follow-up. *Clin Implant Dent Relat Res.* 2012;14:e39–e45.

26. Grandi T, Garuti G, Guazzi P, et al. Survival and success rates of immediately and early loaded implants: 12-month results from a multicentric randomized clinical study. *J Oral Implantol.* 2012;38:239–249.

27. Grandi T, Guazzi P, Samarani R, et al. Immediate loading of two unsplinted implants retaining the existing complete mandibular denture in elderly edentulous patients: 1-year results from a multicentre prospective cohort study. *Eur J Oral Implantol.* 2012;5:61–68.

28. Romanos GE, May S, May D. Treatment concept of the edentulous mandible with prefabricated telescopic abutments and immediate functional loading. *Int J Oral Maxillofac Implants.* 2011;26:593–597.

29. Malchiodi L, Ghensi P, Cucchi A, et al. A comparative retrospective study of immediately loaded implants in postextraction

sites versus healed sites: Results after 6 to 7 years in the maxilla. *Int J Oral Maxillofac Implants.* 2011;26:373–384.

30. Gillot L, Cannas B, Buti J, et al. A retrospective cohort study of 113 patients rehabilitated with immediately loaded maxillary cross-arch fixed dental prostheses in combination with immediate implant placement. *Eur J Oral Implantol.* 2012;5: 71–79.

31. Barewal RM, Stanford C, Weesner TC. A randomized controlled clinical trial comparing the effects of three loading protocols on dental implant stability. *Int J Oral Maxillofac Implants.* 2012;27:945–956.

32. Cannizzaro G, Leone M, Ferri V, et al. Immediate loading of single implants inserted flapless with medium or high insertion torque: A 6-month follow-up of a split-mouth randomized controlled trial. *Eur J Oral Implantol.* 2012;5:333–342. Erratum in: Eur J Oral Implantol. 2013;6:260.

33. Crespi R, Capparè P, Gherlone E, et al. Immediate provisionalization of dental implants placed in fresh extraction sockets using a flapless technique. *Int J Periodontics Restorative Dent.* 2012;32:29–37.

34. Fung K, Marzola R, Scotti R, et al. A 36-month randomized controlled split-mouth trial comparing immediately loaded titanium oxide-anodized and machined implants supporting fixed partial dentures in the posterior mandible. *Int J Oral Maxillofac Implants.* 2011;26:631–638.

35. Margossian P, Mariani P, Stephan G, et al. Immediate loading of mandibular dental implants in partially edentulous patients: A prospective randomized comparative study. *Int J Periodontics Restorative Dent.* 2012;32:e51–e58.

36. Peñarrocha-Oltra D, Covani U, Aparicio A, et al. Immediate versus conventional loading for the maxilla with implants placed into fresh and healed extraction sites to support a full-arch fixed prosthesis: Nonrandomized controlled clinical study. *Int J Oral Maxillofac Implants.* 2013;28:1116–1124.

37. Östman PO, Wennerberg A, Ekestubbe A, et al. Immediate occlusal loading of NanoTite tapered implants: A prospective 1-year clinical and radiographic study. *Clin Implant Dent Relat Res.* 2013;15:809–818.

38. Turkyilmaz I, Avci M, Kuran S, et al. A 4-year prospective clinical and radiological study of maxillary dental implants supporting single-tooth crowns using early and delayed loading protocols. *Clin Implant Dent Relat Res.* 2007;9:222–227.

39. 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.

40. Jensen OT, Cottam J, Ringeman J, et al. Trans-sinus dental implants, bone morphogenetic protein 2, and immediate function for all-on-4 treatment of severe maxillary atrophy. *J Oral Maxillofac Surg.* 2012;70:141–148.

41. Cricchio G, Imburgia M, Sennerby L, et al. Immediate loading of implants placed simultaneously with sinus membrane elevation in the posterior atrophic maxilla: A two-year follow-up study on 10 patients. *Clin Implant Dent Relat Res.* 2014;16:609–617.

42. Grandi T, Guazzi P, Samarani R, et al. A 3-year report from a multicenter randomized controlled trial: Immediately versus early loaded implants in partially edentulous patients. *Eur J Oral Implantol.* 2013;6:217–224.

43. Merli M, Merli A, Bernardelli F, et al. Immediate versus early non-occlusal loading of dental implants placed flapless in partially edentulous patients. One-year results from a randomized controlled trial. *Eur J Oral Implantol.* 2008;1:207–220.

44. Capelli M, Esposito M, Zuffetti F, et al. A 5-year report from a multicentre randomized clinical trial: Immediate non-occlusal versus early loading of dental implants in partially edentulous patients. *Eur J Oral Implantol.* 2010;3:209–219.

45. Galli F, Capelli M, Zuffetti F, et al. Immediate non-occlusal vs. early loading of dental implants in partially edentulous patients: A multicentre randomized clinical trial. Peri-implant bone and soft-tissue levels. *Clin Oral Implants Res.* 2008;19:546–552.

46. Marzola R, Scotti R, Fazi G, et al. Immediate loading of two implants supporting a ball attachment-retained mandibular overdenture: A prospective clinical study. *Clin Implant Dent Relat Res.* 2007;9:136–143.

47. Schincaglia GP, Marzola R, Scapoli C, et al. Immediate loading of dental implants supporting fixed partial dentures in the posterior mandible: A randomized controlled split-mouth study–machined versus titanium oxide implant surface. *Int J Oral Maxillofac Implants.* 2007;22:35–46.

48. Schincaglia GP, Marzola R, Giovanni GF, et al. Replacement of mandibular molars with single-unit restorations supported by wide-body implants: Immediate versus delayed loading. A randomized controlled study. *Int J Oral Maxillofac Implants.* 2008;23:474–480.

49. Testori T, Galli F, Capelli M, et al. Immediate nonocclusal versus early loading of dental implants in partially edentulous patients: 1-year results from a multicenter, randomized controlled clinical trial. *Int J Oral Maxillofac Implants.* 2007;22:815–822.

50. De Bruyn H, Raes S, Ostman PO, et al. Immediate loading in partially and completely edentulous jaws: A review of the literature with clinical guidelines. *Periodontol 2000.* 2014;66:153–187.

51. Chrcanovic BR, Albrektsson T, Wennerberg A. Immediate nonfunctional versus immediate functional loading and dental implant failure rates: A systematic review and meta-analysis. *J Dent.* 2014; 42:1052–1059.

52. Duyck J, Vandamme K. The effect of loading on peri-implant bone: A critical review of the literature. *J Oral Rehabil.* 2014;41:783–794.

53. Menassa M, de Grandmont P, Audy N, et al. Patients' expectations, satisfaction, and quality of life with immediate loading protocol. *Clin Oral Implants Res.* 2016;27:83–89.

54. Glauser R, Zembic A, Hämmerle CH. A systematic review of marginal soft tissue at implants subjected to immediate loading or immediate restoration. *Clin Oral Implants Res.* 2006;17:s82–s92.

55. Osterberg T, Dey DK, Sundh V, et al. Edentulism associated with obesity: A study of four national surveys of 16 416 Swedes aged 55–84 years. *Acta Odontologica Scand.* 2010;68:360–367.

56. Medina-Solis CE, Perez-Nunez R, Maupome G, et al. Edentulism among Mexican adults aged 35 years old and associated factors. *Amer J Pub Health.* 2006;96:1578–1581.

57. de Pablo P, Dietrich T, McAlindon TE. Association of periodontal disease and tooth loss with rheumatoid arthritis in the US population. *J Rheumatol.* 2008;35:70–76.

58. Fisher MA, Taylor GW, Shelton BJ, et al. Periodontal disease and other nontraditional risk factors for CKD. *Am J Kidney Dis.* 2008;51:45–52.

59. Albrektsson T, Gottlow J, Meirelles L, et al. Survival of NobelDirect implants: An analysis of 550 consecutively placed implants at 18 different clinical centers. *Clin Implant Dent Relat Res.* 2007;9:65–70.

60. Fischer K, Stenberg T, Hedin M, et al. Five-year results from a randomized, controlled trial on early and delayed loading of implants supporting full-arch prosthesis in the edentulous maxilla. *Clin Oral Implants Res.* 2008;19:433–441.

61. Pjetursson BE, Rast C, Bragger U, et al. Maxillary sinus floor elevation using the (transalveolar) osteotome technique with or without grafting material: Part I: Implant survival and patients' perception. *Clin Oral Implants Res.* 2009;20:667–676.

62. Jung RE, Pjetursson BE, Glauser R, et al. A systematic review of the 5-year survival and complication rates of implant-supported single crowns. *Clin Oral Implants Res.* 2008;19:119–130.

63. Gapski R, Wang HL, Mascarenhas P, et al. Critical review of immediate implant loading. *Clin Oral Implants Res.* 2003;14:515–527.

64. Schwarz F, Hegewald A, John G, et al. Four-year follow-up of combined surgical therapy of advanced peri-implantitis evaluating two methods of surface decontamination. *J Clin Periodontol.* 2013;40: 962–967.

65. Patel A. Non-surgical management of peri-implant diseases. *Prim Dent J.* 2014;3:62–65.

66. Tabassum A, Meijer GJ, Walboomers XF, et al. Evaluation of primary and secondary stability of titanium implants using different surgical techniques. *Clin Oral Implants Res.* 2014;25:487–492.

67. Lekholm U, Zarb GA. Patient selection and preparation. In: Brånemark PI, Zarb GA, Albrektsson T, eds. *Tissue Integrated Prostheses: Osseointegration in Clinical Dentistry*. Chicago, IL: Quintessence Publishing Company; 1985:199–209.

68. Bayarchimeg D, Namgoong H, Kim BK, et al. Evaluation of the correlation between insertion torque and primary stability of dental implants using a block bone test. *J Periodontal Implant Sci.* 2013;43: 30–36.

69. Javed F, Romanos GE. The role of primary stability for successful immediate loading of dental implants. A literature review. *J Dent.* 2010;38:612–620.

70. Javed F, Romanos GE. Role of implant diameter on long-term survival of dental implants placed in posterior maxilla: A systematic review. *Clin Oral Investig.* 2014;19:1–10.

71. Gehrke SA, da Silva Neto UT, Del Fabro M. Does implant design affect implant primary stability? A resonance frequency analysis-based randomized split-mouth clinical trial. *J Oral Implantol.* 2015;41:e281–e286.

72. Misch CE. Nonfunctional immediate teeth. *Dent Today.* 1998;17:88–91.

73. Esposito M, Grusovin MG, Maghaireh H, et al. Interventions for replacing missing teeth: Different times for loading dental implants. *Cochrane Database Syst Rev.* 2013;28:CD003878.

74. Götz W, Gedrange T, Bourauel C, et al. Clinical, biomechanical and biological aspects of immediately loaded dental implants: A critical review of the literature. *Biomed Tech (Berl).* 2010;55: 311–315.

75. Guncu MB, Aslan Y, Tumer C, et al. In-patient comparison of immediate and conventional loaded implants in mandibular molar sites within 12 months. *Clin Oral Implants Res.* 2008;19:335–341.

76. Cornelini R, Cangini F, Covani U, et al. Immediate restoration of single-tooth implants in mandibular molar sites: A 12-month preliminary report. *Int J Oral Maxillofac Implants.* 2004;19:855–860.

77. Adell R, Lekholm U, Rockler B, et al. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. *Int J Oral Surg.* 1981;10:387–416.

78. Schulz KF. Randomized trials, human nature, and reporting guidelines. *Lancet*. 1996;348:596–598.