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Effect of Loading Protocol on Crestal Bone Loss in Micro threaded Neck Dental Implants - A Systematic Review

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Abstract

This systematic review investigated the effect of implant loading protocol on crestal bone loss in micro threaded-neck dental implants. Using PICO system, the following was focused upon- Do implant loading protocol affect the crestal bone level around micro threaded neck dental implants? Along with manual search, we also searched 3 electronic databases to find articles published up to September 2021 that contained any combination of the following keywords: dental implant, loading protocol, micro thread, crestal bone level, crestal bone loss. Case reports, review articles, letters to the editor, commentaries, and articles published in a language other than English were excluded.

After eliminating duplicates and applying PICO eligibility criteria, articles that reported the results of clinical trials that compared the crestal bone loss due to loading protocol in micro threaded implant design were selected. 20 articles were left for review, which reported crestal bone loss ranging from 0.3 mm to 0.9 mm with immediate loading and of 0.4 mm to 0.9 mm with delayed loading, with a range of 12 to 60 months of follow-up.

Immediate loading showed similar outcomes concerning survival rate and stability as compared to delayed loading.

Keywords: Dental implant, loading protocol, micro thread, crestal bone level, crestal bone loss

Introduction

Dental implants are considered the standard treatment option for the replacement of missing teeth due to different pathologies and trauma.[1]

It should be noted, however, that implantprocedures may have certain complicationswhich hinder a successful outcome.

The level of crestal bone surrounding the implant is of utmost importance for Osseointegration, as preservation of marginal bone height is vital for long-term dental implant survival.[2]

Several factors influencing the crestal bone height include delayed vs. immediate implant placement, the timing of implant loading, the need for bone grafting at the implant site, the presence of infection, medical conditions that impair wound healing, oral hygiene status and its proximity to vital structures, and implant size. [3-8]

After implant placement, the recovery period according to the standard protocol is 3 to 6 months, after which the implant can be loaded. This is a significant disadvantage for patients with aesthetic concerns. As a result, there has been increasing interest in lowering the implant's healing and loading period.[9]

Recently three implant protocols have been widely accepted: immediate loading (IL), in which prosthesis is placed intraorally after implant placement; early loading (EL), in which placement of prosthesis is delayed 4 to 8 weeks to allow for healing; and delayed loading (DP), in which prosthesis is placed after 3 to 6 months. [10-12]

Various studies [13-17] have compared immediate with conventional loading and found no evidence of prosthesis or implant failure in the first year and had 95 percent overall success rates. With the growing popularity of immediate implant placement and loading, the attention shifted towards minimizing crestal bone loss.

Thereafter, numerous studies [18-20] have been conducted which describe various methods to minimize crestal bone loss.

Extensive research [21-22] on the effects of micro threads at the implant neck has now demonstrated that micro threads can be designed to maximize initial contact, provide primary stability, increase surface area, facilitate load dissipation at the bone-implant interface, and minimize micro-movement to accelerate Osseointegration.

In addition to platform switching, the incorporation of micro threads at the neck of implants is thought to be an effective way of combating marginal bone loss.

Now it is commonly agreed that the micro thread design help in reducing the crestal bone loss, the influence of various loading protocols on the crestal bone levels in such micro threaded implants is still not clear.

Materials and Methods

This review was based on the PRISMA guidelines. [23,24] The protocol was registered in PROSPERO International Prospective Register of Systematic Reviews (CRD42021241822).

The patient, intervention, comparator, outcome (PICO) question formulated for this study was: In patients with micro threaded neck dental implants (P), will the immediate loading (I) compared with delayed/conventional loading (C) change the marginal bone loss around implants (O)?

Search strategy

The results for this review have been searched into databases – PubMed/MEDLINE, Google Scholar, and Cochrane Databases. The databases were searched up to September 2021. The searches were restricted to English language only.

Hand searching was done through various journals for relevant articles related to the topic.

To be considered for inclusion, published articles were required to contain combination of the following

keywords

micro thread, micro threaded, dental implant, implant loading, crestal bone level, alveolar bone level. No limits were applied to the initial search.

This electronic search was followed by hand searching. Titles of articles were thoroughly scrutinized to exclude publications that did not clearly compare implant loading protocol in micro threaded neck implants.

Whenever the titles of the articles were not sufficiently informative to allow us to judge their relevance, abstracts were scrutinized to determine whether the articles qualified for the study.

Inclusion and Exclusion criteria

Randomized controlled trials, prospective or retrospective cohort studies, other types of clinical trials that evaluated the crestal bone loss due to implant loading protocols were included.

The exclusion criteria were: case report, review, animal studies, FEA, and in vitro studies; articles published in a language other than English and studies with a follow-up period of less than 1 year. Two reviewers (P.D. and S.D.) read the titles and abstracts of the studies independently to decide whether the studies met the inclusion criteria.

Full articles were examined if necessary. Any disagreement between the reviewers was resolved by an interviewer consensus with a third reviewer (A.K.).

Quality assessment

Quality assessment was performed independently by 2 investigators (V.D. and S.W.) by using the Cochrane Collaboration tool for assessing risk of bias.[25]

The tool contains 2 parts, addressing the 7 specific domains (namely sequence generation, allocation concealment, blinding of participants, blinding of outcome assessment, incomplete outcome data, selective outcome reporting, and other issues).

A risk of bias which was estimated (low, medium, or high) was assigned to each of the included studies by the investigators. The disagreements were resolved by discussion.

Data extraction and statistical analysis

Data were extracted by 2 reviewers (P.D. and S.D.) independently using a designed form that included the following information: year of publication, duration of follow-up, implant brand, implant surface (with micro threads at the neck, rough or machined), and data on CBL.

When data was missing or ambiguous, contact was made with the authors. The studies whose data were not clearly stated were excluded from the analysis.

Narrative synthesis was provided for the findings obtained from the studies, mainly focusing on the intervention details and outcome assessment. Mean differences (MD), a continuous outcome, were used to measure MBL.

The level of significance was a=0.1. Heterogeneity of the previously mentioned characteristics will be assessed using chi. test (significance: 0.1) and I^2 statistics.

Results

Outcome of Search - In sum, the electronic screening of PubMed and Cochrane identified 772 articles. From the initial 772 studies identified, after the removal of duplicates (55 articles), 717 articles were assessed for relevance to the objective of the research.

After the exclusion of 555 articles, 162 articles were assessed for eligibility. After excluding animal studies (32), invitro studies (71), and studies not in English (39), a total of 20 full-text articles were further assessed and included in the systematic review.

Of the 20 studies, reviewed [26—45], 12 were considered to have a low risk of bias, 7 were categorized as having a moderate risk of bias, and 1 was considered to have a high risk of bias. The studies with a low risk of bias were mostly RCTs. (Ref to Fig 1)

A summary of the studies, methods, results, and outcomes are presented (Figure 2,3). The total number of patients in the included studies ranged from 9 to 59 patients with the follow up period varying from 1 to 5 years.

The total number of micro-threaded implants placed in the included.

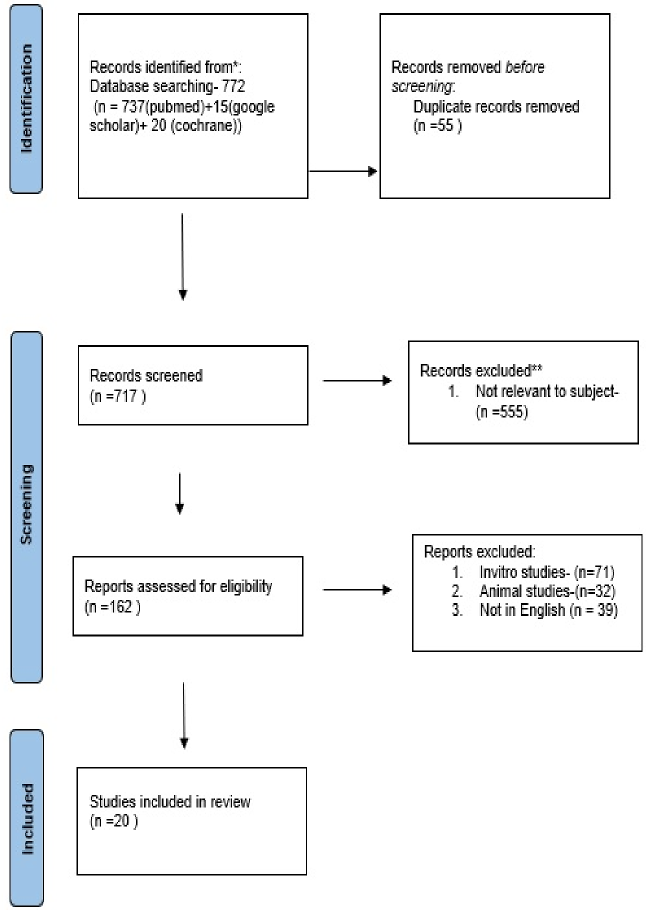

Fig 1: PRISMA Flowchart for selection of Articles in the systematic review

studies ranged from 17 to 118 implants. Five studies [27,36,42-44] followed immediate loading of prostheses, and 14 studies [26,28-31,34,35,37,38,39,40,41,45],used conventional loading. De Bruyn et al [33] used both immediate and early loading protocols. De Bruyn et al [33] and Cooper et al [30] loaded implants with removable over denture prostheses.

Out of the included articles, the smallest CBL measurements (0.10 ± 0.30 mm) were found around Astra tech implants fabricated and conventionally loaded with FPD prostheses [40] while the largest CBL measurements (0.9 ± 0.26 mm) were found around non-occlusal MIS Implants immediately loaded with fixed prostheses after 60 months of follow-up [44].

Discussion

The systematic review evaluated the effect of loading protocols in micro threaded-neck implant on CBL as described in the published reports of various clinical trials. In this review, the included trials did not reveal significant differences in between immediate [27,36,42-44] andconventional [26,28-31,34,35,37,38,39,40,41,45] loading protocols regarding marginal bone loss at 1 or 3 years.

These results are in accordance with some studies that agree to that immediate loading stimulates the bone implant interface that causes a functional remodeling of bone structures, resulting in a differentiation of cells, which may increase bone loss initially around implants. [46,47] Marginal bone loss in immediately loaded implants occurs with a high intensity during the first 30 days [47]. However, the presence of loading of prosthesis result in functional remodeling which arrests the CB. As this is not the case with conventional loading protocol, the range of CBL for both loading protocol is similar.

In this review, the CBL measurements varied across these reports because of differences in implant systems, loading protocols, types of prostheses used, and differences in the imaging systems used. For example, the Astra tech implants resulted in the lowest measurements of CBL (0.10 mm) when they were loaded conventionally with FPD (Fixed Partial Denture) [40] but resulted in the high measurements when they were immediately loaded with overdenture prostheses.[33] Such variation may be explained by the differences in the loading protocol between the two studies. Studies which followed conventional protocol resulted in a CBL level around 0.3-0.9 mm, while CBL measurements in studies following immediate protocol ranged from 0.4 to 0.9 mm around implants during 2 to 5 years of follow-up. [27,36,42-44]

While the different loading protocols have resulted in different CBL levels, several studies have also compared the effect of micro threads on crestal bone loss. One study [36] compared the amount of CBL associated with machined-surface implants and with micro threaded rough-surface implants; and 3 studies compared the amount of CBL associated with machined-neck implants and with micro threaded-neck implants. [35,36,41]

In conclusion, the difference between these techniques (immediate and early loading) did not affect the survival rate of implants for 1 year and 3 years, or even the marginal bone loss at 1 or 3 years. Thus, the immediate or early loading of the implants should be considered as a viable option.

Conclusion

This systematic review compares the effect of various implant loading protocols on crestal bone levels around micro threaded neck dental implants. Based on the findings of the systematic review the following conclusion was drawn- There was no significant difference in the amount of crestal bone loss in implants with either immediate loading or delayed/conventional loading. The CBL measurements vary across these reports because of differences in implant systems, loading protocols, types of prostheses used, and differences in the imaging systems used.

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Author	Year	Type of study	Loading Protocol	Follow-up	Implant Brand Name	Implant Design	Type of Prosthesis	CBL (mm)	Measurement Method	Implant Site
Puchades Roman et al[26]	2000	Retrospective study	Conventional	24 months	Astra Tech implants; Astra Tech AB, Mölndal, Sweden	Ti blasted with TiO2 particles with microthreads	Single Crowns	0.45	PA	Healed Bone
De Kok et al[27]	2006	Retrospective cohort study	Immediate	30 months	Astra Tech, Waltham, MA	Ti blasted with TiO2 particles with microthreads	Single Crowns	0.30 ± 0.39	PA	Fresh Socket
Shin et al[28]	2006	Prospective cohort study	Conventional	12 months	Oneplant; Waranted Seoul, South Korea	SLA treated surface and microthreads in the implant neck	Splinted Crowns	0.18 ± 0.16	PA	Healed Bone
Lee et al[29]	2007	Prospective cohort study	Conventional	36 months	TiO-blast microthread AstraTech AB, Mólndal, Sweden	Ti blasted with TiO2 particles with microthreads	Splinted Crowns	0.24 ± 0.13	PA	Healed Bone
Cooper et al[30]	2008	Prospective cohort study	Conventional	60 months	TiO-blast microthread AstraTech AS, Moindal, Sweden	Ti blasted with TiO2 particles with microthreads	Overdenture Prostheses	0.79 ± 0.09	CT	Healed Bone
Bratu et al[31]	2009	Prospective cohort study	Conventional	12 months	MIS- Implants Inc., Shiomi, Israel	Microthreads at neck present	Crowns	0.69 ± 0.25	Panoramic	Healed Bone
Kwon et al[32]	2009	Retrospective cohort study	Conventional	12 months	MicroThread Astra Tech, Mölndal, Sweden	Microthreaded neck and platform- switched design implant	Crowns	0.16 ± 0.17	PA	Healed Bone
De Bruyn et al[33]	2009	Retrospective cohort study	Early loaded	18 months	TiOblast microthread; AstraTech AB, Moindal, Sweden	Titanium blasted with TiO2 particles with microthreads	Overdenture Prostheses	0.80 ± 0.48	PA	Healed Bone
Song et al[34]	2009	Prospective cohort study	Conventional	12 months	Implantium, Dentium, Seoul, South Korea	Cp Ti with SLA surface; microthread neck present	Splinted Crowns or FPDs	0.16 ±0.19	PA	Healed Bone
Nickenig et al[35]	2009	Prospective cohort study	Conventional	24 months	Replace Straight Groovy, Nobel Biocare AB,	Rough-surfaced microthreaded implants	FPDs	0.50	Panoramic	Healed Bone
Van de Velde et al[36]	2010	Retrospective cohort study	Immediate	12 months	TiOblast microthread; AstraTech AB, Mölndal, Sweden	Titanium blasted with TiO2 particles with microthreads	Complete Fixed Prostheses with Cantilever	0.81 ± 1.11	PA	Healed Bone
Lee et al[37]	2010	RCT, Prospective	Conventional	36 months	Hexplant; Warantec Co, Seoul, South Korea	microthreads in the implant neck	Single or Splinted Crowns	0.59 ± 0.30	PA	Healed Bone
Yun et al [38]	2011	Retrospective cohort study	Conventional	12 months	Osstem GS III implants, HIOSSEN Implant Canada INC. Vancouver, BC, Canada	Tapered body with microthreads in the upper part and double threads in the lower part	Fixed Prostheses	0.16 ± 0.08	PA	Healed Bone

Table 1: Selected articles for the systematic review.

Author	Year	Type of study	Loading Protocol	Follow-up	Implant Brand Name	Implant Design	Type of Prosthesis	CBL (mm)	Measurement Method	Implant Site
Peñarrocha- Diago et al[39]	2012	RCT, Prospective	Conventional	12 months	Inhex, Mozo-Grau, S.L. Valladolid, Spain	Rough-surface, microthreaded design	Fixed Prostheses	0.12 ± 0.17	PA	Healed Bone
Chang and Wennström[40]	2012	Retrospective cohort study	Conventional	60 months	Astra Tech implants, Astra Tech AB, Mölndal, Sweden.	Titanium blasted with TiO2 particles with microthreads	Single Crowns	0.10 ± 1.30	IOPA	Healed Bone
Nickenig et al[41]	2013	Prospective cohort study	Conventional	60 months	Replace Straight Groovy, Nobel Biocare AB, Göteborg, Sweden.	Rough-surface microthreaded implants	FPDs	0.70	Panoramic	Healed Bone
Noelken et al[42]	2014	Prospective cohort study	Immediate	24 months	OsseoSpeed TM Astra Tech AB, Mölndal, Sweden,	Screw-shaped and microthreaded neck implant	Crowns or FPDs	0.70 ± 0.58	CBCT	Fresh Socket
Calvo Guirado et al[43]	2015	Prospective cohort study	Immediate non-occlusal loading	36 months	MIS Implants Inc., Shlomi, Israel	Microthreads at neck, rough surface, platform switching	Single Crowns	0.86 ± 0.29	IOPA	Fresh Socket
Calvo- Guirado et al[44]	2016	Prospective cohort study	Immediate non-occlusal loading	60 months	MIS- Implants Inc., Barlev, Israel	Microthreads at neck, rough- surface body, internal connection and platform switching	Fixed Prostheses	0.90 ± 0.26	IOPA	Fresh Socket
Khorsand et al[45]	2016	RCT, Prospective	Conventional	12 months	Implantium, Seoul, South Korea	Microthreads at neck, rough- surface body, internal connection and platform switching	Single Crowns	0.75 ± 0.32	IOPA	Fresh Socket

Table 2: Selected articles for the systematic review