Original Article

A meta analysis for evaluation of marginal bone level changes at dental implants

ABSTRACT

Aim: The aim of this study was to assess the marginal bone level changes at dental implants after 1 year in function.

Methods: Detailed searches from PubMed databases were made. A MEDLINE search (PubMed) published in the English language from 1980 to December 2018 was included in this study.

Results: The electronic database research (MEDLINE) produced 166 corresponding articles. One hundred and twenty studies were excluded on the basis of abstract while the 46 researches were used chosen for full-text examination after the title and abstract testing, and 41 studies were excluded that did not meet the requirements of our inclusion and exclusion criteria. A total of 5 studies for a quantitative analysis were taken into account.

Conclusion: Within the limits of the study, the mean marginal bone loss (MBL) was found to be 0.56 mm. A statistically significant difference in the MBL was found between the various studies.

Keywords: Dental implants, marginal bone loss, meta-analysis, prospective study, randomized control study

INTRODUCTION

Tooth loss can be caused by periodontal disease, abscess formation, trauma, or vertical tooth fracture. Common consequences of tooth loss include progressive alveolar bone resorption and ultimately decreased masticatory function. Hence, there are several ways for the rehabilitation of the edentulous arch, the most important being the endosseous dental implants.[1-3]

Friedman PK (2000) has established the conventional loading of implant.[1,4] Authors suggested a waiting period of 3–6 months for the proper osseointegration.[5] Loading before this healing phase will ultimately lead to hindrance in stability and implant failure.[6] This failure in the implant stability ultimately leads to marginal bone loss (MBL). The success rate of well-osseointegrated implant is evaluated by the MBL found after the implantation.[7,8]

Many factors that lead to MBL involve – microgap,[9] surgical trauma,[10] peri-implantitis,[11,12] occlusal overload,[13,14] bacterial colonization,[15] biologic width formation,[16] implant–abutment interface design,[17] and implant surface topography.[18]

According to Wieland M *et al*. (2004), a successful implant should sustain <1.5 mm of bone loss during the 1st year in function and <0.2 mm annually thereafter. Further, to

Varun Kumar, Geeta Arya, Pranshu Singh[1], Pallavi Chauhan[2]

Department of Prosthodontics and Oral Implantology, Seema Dental College and Hospital, Rishikesh, Uttarakhand, [1]Facedentiss Clinic, IIMT Lifeline Hospital, [2]Facedentiss Clinic, Meerut, Uttar Pradesh, India

Address for correspondence: Prof. Varun Kumar, Department of Prosthodontics and Oral Implantology, Seema Dental College and Hospital, Pashulok, Rishikesh, Uttarakhand, India.
E-mail: drvarun_smile@yahoo.co.in

Received: 16 August 2020, **Revised:** 25 September 2020, **Accepted:** 04 November 2020, **Published:** 16 March 2021

Access this article online

Website: www.njms.in

DOI: 10.4103/njms.NJMS_179_20

Quick Response Code

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Kumar V, Arya G, Singh P, Chauhan P. A meta analysis for evaluation of marginal bone level changes at dental implants. Natl J Maxillofac Surg 2021;12:13-6.

prevent this MBL and to attain secondary stability, various modifications in the implant topography and design and implant–abutment connection have been corporated.[19-22] The positioning of the implant in the bone plays an important role in the preservation of the crestal bone in the future.[23-27] The ectodermal tissues serve to protect against invasion from bacteria and other foreign materials. However, both teeth and dental implants must penetrate this defensive barrier.

The biologic width has consists of approximately 1 mm of connective tissue, 1 mm of epithelium, and 1 mm or more of sulcular depth, around natural teeth, so, the reformation of biologic width around dental implants contribute to early implant bone loss. This process starts immediately after Stage 2 surgery. The dimension and position of the biologic width which are related to the degree of early implant bone loss during surgical healing phase may be determined by the location of the microcap if present, or implant crest module designs such as surface textures, implant–abutment interface designs in 2 part implants, and the location of a junction between rough and polished surfaces. Therefore, it would appear that among all possible contributing factors, reformation of biologic width, occlusal overload, microgap, and implant crest module are most likely contributing causes for early implant bone loss phenomenon.

The aim of this study was to evaluate the marginal bone level changes after 1 year of function through a systematic screening of the literature.

METHODS

This review was performed according to the Preferred reporting items for Systematic Reviews and Meta-Analyses statement. The focused question serving for literature search was structured according to the:

PICO format:

- P – Patients with implants
- I – After loading
- C – Bone loss after 1 year compared to no MBL
- O – Marginal bone loss.

A MEDLINE search (PubMed) was conducted, and works published in the English language from 1980 to December 2018 were included in the review.

The following terms were used in different combinations for search: "dental implants," "prospective studies/randomized studies," "long-term or 1-year follow-up," and "marginal bone loss."

Titles and abstracts were screened, and full text analysis was performed in relevant publications [Table 1].

Table 1: Comparative investigation of various studies for marginal bone loss changes of dental implants

Authors	Type of study	Number of patients/implants	Conclusion
Nemli *et al*.	Evaluated the implant survival and the crestal bone loss with a follow-up period of 3 years	72 patients/255 implants	Survival rate of 97.6%. At 6, 12, and 24 months after prosthetic loading, mean marginal bone losses observed were 0.35±0.14 mm, 0.47±0.15 mm, and 0.58±0.16 mm[28]
Formoso *et al*.	Evaluated the alteration in the marginal bone level radiographically that was restored according to platform-switched concepts	54 patients/77 implants	Mean bone loss with standard platform implant was 0.42 mm and 0.01 mm for platform-switched implants. Statistically significant difference found in marginal bone loss[29]
Cappiello *et al*.	Evaluated the bone loss around the platform-switched implants	45 patients/131 implants positioned at crestal level	Radiographic study was performed, and after 12 months, the data collected showed vertical bone loss between 0.6 mm and 1.2 mm for the test group (mean: 0.95±0.32 mm), while for the control cases, bone loss was between 1.3 mm and 2.1 mm (mean: 1.67±0.37 mm). This data showed the role of microgap between implant and abutment in the remodeling of peri-implant crestal bone. Hence, platform switching reduces crestal bone resorption and increases long-term success of the implant[30]
Kapoor *et al*.	Evaluated the crestal bone loss around platform-switched implants	12 patients/20 implants with 5-mm diameter placed at the crestal level	Radiographs were obtained at 3, 6, and 12 months after loading that showed mean bone loss of 0.76±0.1265 mm on mesial side and 0.72±0.1481 mm on distal side after 1 year. Hence, the platform-switched implants lead to better preservation of crestal bone[31]
Beriberi *et al*.	Examined the marginal bone level in healed ridges and extraction sockets in maxilla after 5 years follow-up of implants with immediate loading protocol	36 patients/42 implants	The marginal bone loss after implant placement was 0.26±0.16 mm for 1 year and 0.26±0.171 mm for 3 years and 0.21±0.185 mm for 5 years in healed ridges. Significant marginal bone loss has been found on the mesial side of the implant[32]

Inclusion criteria

- The implant system should presently be available on the market. Duplicate systems without documentation were not accepted
- The studies should include all relevant data records: radiographic data and clinical and histologic evaluation on change in marginal bone level up to 1 year of implant placement
- Case studies or case reports with a minimum of five patients included, as well as controlled clinical trials, were accepted
- One stage as well as two stage surgeries were included
- Study design criteria included in publication search: randomized control study and follow-up of 1 year after implantation, mean MBL, and survival rate.

Exclusion criteria

- Advanced surgery, for example, sinus lift procedures and bone augmentation procedures
- Immediate implant loading.

The following variables were extracted from the identified articles: type of study, number of patients included, number of implants placed, implant sites (maxilla/mandible and anterior/posterior), type of prosthesis, healing time before loading, number of lost implants, implant survival rate, mean marginal bone level change (MBLC), and standard deviation (SD) observed for over 1 year of placement.

Data analysis

Selection of eligible studies are on the basis of inclusion and exclusion criteria.

The statistical analyses were carried out by a statistician in the form of blobbogram/forest plot. Mean and SD values from each study were used to assess pooled mean MBLCs and 95% confidence interval (CI) for each implant system. As SD data were unavailable for a number of studies, it was assumed that SDs between studies were homogeneous. Consequently, the common SD was assessed based on all available SD data.

To account for the difference in the number of subjects between the different studies, weighted mean values and 95% CI were also assessed. Differences in MBLC values between systems were tested for statistical significance using the unpaired *t*-test. $P < 0.05$ was considered statistically significant.

RESULTS

The electronic database research (MEDLINE) produced 166 corresponding articles. One hundred and twenty studies were excluded on the basis of abstract while the 46 researches were used chosen for full-text examination after the title and abstract testing, and 41 studies were excluded that did not meet the requirements of our inclusion and exclusion criteria. A total of 5 studies for a quantitative analysis were taken into account.

All the studies were prospective with a follow-up period of not <1 year. All the studies had included the patients between 25 and 75 years. Total 525 implants were evaluated to find the mean bone loss at 1-year interval.

For quantitative data evaluation, a meta-analysis was conducted. The 5 studies were included for comparison of data. The mean peri-implant bone loss was around 0.56 mm with $Z = 7.48$ and $P = 0.01$. Data were only submitted for postimplant bone loss, which had been analyzed in the meta-analysis. There was only significant heterogeneity for bone loss (tau value = 0.03, $P = 0.041$, $I^2 = 99.8\%$), which resulted in the use of the model of random effects.

DISCUSSION

The most important success criteria for the prosthetic rehabilitation of the implant are the prevention of the MBL. The loss of the marginal bone leads to hindrance to the stabilization of the implant, ultimately leading to implant failure. This systematic review aims toward the MBL after 1 year in function. This meta analysis was made to find out from the prospective 1 year studies follow ups that for conclude that how much extent of the MBL takes place. The systematic review identified 5 relevant studies published till 2018.

This study concluded with a point estimate that 0.56 mm of mean MBL is seen at 1 year of function. The major part of the MBL occurred during the 1st year after prosthetic loading, whereafter it gets stabilized. Hence, it becomes evident that MBL around dental implants under favorable conditions is comparable with that of natural teeth.

The number of studies done in this context is also very few. Many of the I^2 estimates calculated in this meta-analysis are considered high and that is the reason behind the considerable heterogeneity between the studies.

Hence, we recommend that further studies should be done regarding this context as the studies are very less regarding MBL at 1 year.

CONCLUSION

Within the limits of the study, the mean MBL was found to be 0.56 mm. A statistically significant difference in the MBL was found between various studies.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Friedman PK, Lamster IB. Tooth loss as a predictor of shortened longevity: Exploring the hypothesis. Periodontol 2000 2016;72:142-52.
2. Chen X, Clark JJ, Naorungroj S. Length of tooth survival in older adults with complex medical, functional and dental backgrounds. J Am Dent Assoc 2012;143:566-78.
3. Müller S, Eickholz P, Reitmeir P, Eger T. Long term tooth loss in periodontally compromised but treated patients according to the type of prosthodontic treatment. A retrospective study. J Oral Rehabil 2013;40:358-67.
4. Renvert S, Persson RE, Persson GR. Tooth loss and periodontitis in older individuals: Results from the Swedish national study on aging and care. J Periodontol 2013;84:1134-44.
5. Stabholz A, Babayof I, Mersel A, Mann J. The reasons for tooth loss in geriatric patients attending two surgical clinics in Jerusalem, Israel. Gerodontology 1997;14:83-8.
6. Sussex PV, Thomson WM, Fitzgerald RP. Understanding the 'epidemic' of complete tooth loss among older New Zealanders. Gerodontology 2010;27:85-95.
7. Smith DE, Zarb GA. Criteria for success of osseointegrated endosseous implants. J Prosthet Dent 1989;62:567-72.
8. Buser D, Weber HP, Lang NP. Tissue integration of non submerged implants. L year results of a prospective study with 100 ITI hollow cylinder and hollow screw implants. Clin Oral Implants Res 1990;1:33-40.
9. Hermann JS, Schoolfield JD, Schenk RK, Buser D, Cochran DL. Influence of the size of the microgap on crestal bone changes around titanium implants. A histometric evaluation of unloaded non-submerged implants in the canine mandible. J Periodontol 2001;72:1372-83.
10. Ericsson I, Persson LG, Berglundh T, Marinello CP, Lindhe J, Klinge B. Different types of inflammatory reactions in peri-implant soft tissues. J Clin Periodontol 1995;22:255-61.
11. Cochran DL, Hermann JS, Schenk RK, Higginbottom FL, Buser D. Biologic width around titanium implants. A histometric analysis of the implanto-gingival junction around unloaded and loaded nonsubmerged implants in the canine mandible. J Periodontol 1997;68:186-98.
12. Gomez-Roman G. Influence of flap design on peri-implant interproximal crestal bone loss around single-tooth implants. Int J Oral Maxillofac Implants 2001;16:61-7.
13. Lindquist LW, Rockler B, Carlsson GE. Bone resorption around fixtures in edentulous patients treated with mandibular fixed tissue-integrated prostheses. J Prosthet Dent 1988;59:59-63.
14. Becker W, Becker BE, Newman MG, Nyman S. Clinical and microbiologic findings that may contribute to dental implant failure. Int J Oral Maxillofac Implants 1990;5:31-8.
15. Quirynen M, Naert I, Van Steenberghe D. Fixture design and overload influence marginal bone loss and future success in the Brånemark® system. Clin Oral Implants Res 1992;3:104-11.
16. Tonetti MS, Schmid J. Pathogenesis of implant failures. Periodontol 2000 1994;4:127-38.
17. Hansson S. A conical implant-abutment interface at the level of the marginal bone improves the distribution of stresses in the supporting bone. An axisymmetric finite element analysis. Clin Oral Implants Res 2003;14:286-93.
18. De Bruyn H, Christiaens V, Doornewaard R, Jacobsson M, Cosyn J, Jacquet W, *et al*. Implant surface roughness and patient factors on long-term peri-implant bone loss. Periodontol 2000 2017;73:218-27.
19. Buser D, Broggini N, Wieland M, Schenk RK, Denzer AJ, Cochran DL, *et al*. Enhanced bone apposition to a chemically modified SLA titanium surface. J Dent Res 2004;83:529-33.
20. Ko CL, Chang YY, Liou CH, Chen WC. Characterization of the aspects of osteoprogenitor cell interactions with physical tetracalcium phosphate anchorage on titanium implant surfaces. Mater Sci Eng C 2015;49:7-13.
21. Le Guéhennec L, Soueidan A, Layrolle P, Amouriq Y. Surface treatments of titanium dental implants for rapid osseointegration. Dent Mater J 2007;23:844-54.
22. Pellicer-Chover H, Peñarrocha-Diago M, Peñarrocha-Oltra D, Gomar-Vercher S, Agustín-Panadero R, Peñarrocha-Diago M. Impact of crestal and subcrestal implant placement in peri-implant bone: A prospective comparative study. Med Oral Patol Oral Cir Bucal 2016;21:e103-10.
23. Pontes AE, Ribeiro FS, da Silva VC, Margonar R, Piattelli A, Cirelli JA, *et al*. Clinical and radiographic changes around dental implants inserted in different levels in relation to the crestal bone, under different restoration protocols, in the dog model. J Periodontol 2008;79:486-94.
24. Novaes AB Jr, Barros RR, Muglia VA, Borges GJ. Influence of interimplant distances and placement depth on papilla formation and crestal resorption: A clinical and radiographic study in dogs. J Oral Implantol 2009;35:18-27.
25. de Siqueira RA, Fontão FN, Sartori IA, Santos PG, Bernardes SR, Tiossi R. Effect of different implant placement depths on crestal bone levels and soft tissue behavior: A randomized clinical trial. Clin Oral Implants Res 2017;28:1227-33.
26. Wennerberg A, Sennerby L, Kultje C, Lekholm U. Some soft tissue characteristics at implant abutments with different surface topography. A study in humans. J Clin Periodontol 2003;30:88-94.
27. Todescan FF, Pustiglioni FE, Imbronito AV, Albrektsson T, Gioso M. Influence of the microgap in the peri-implant hard and soft tissues: A histomorphometric study in dogs. Int J Oral Maxillofac Implants 2002;17:467-72.
28. Nemli SK, Güngör MB, Aydın C, Yılmaz H, Bal BT, Arıcı YK. Clinical and radiographic evaluation of new dental implant system: Results of a 3-year prospective study. J Dent Sci 2016;11:29-34.
29. Fernández Formoso N, Rilo B, Mora MJ, Martínez Silva I, Díaz Afonso AM. Radiographic evaluation of marginal bone maintenance around tissue level implant and bone level implant: A randomised controlled trial. A 1 year follow up. J Oral Rehabil 2012;39:830-7.
30. Cappiello M, Luongo R, Di Iorio D, Bugea C, Cocchetto R, Celletti R. Evaluation of peri-implant bone loss around platform-switched implants. Int J Periodontics Restorative Dent 2008;28:347-55.
31. Kapoor K, Singh RG, Puri A, Sharma A, Mittal R. Evaluation of marginal bone level around platform-switched implants. Int J Prosthodont Restorative Dent 2014;4:6.
32. Berberi AN, Sabbagh JM, Aboushelib MN, Noujeim ZF, Salameh ZA. A 5-year comparison of marginal bone level following immediate loading of single-tooth implants placed in healed alveolar ridges and extraction sockets in the maxilla. Front Physiol 2014;5:29.