PERI IMPLANT BONE LOSS AROUND SINGLE AND MULTILE PROSTHESIS-A SYSTEMATIC REVIEW

Review Article

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ABSTRACT

Purpose: The objective of this systematic review was to assess and compare the marginal bone loss around implants supporting single fixed prostheses and multiple-unit screw-retained prostheses. Materials and Methods: The literature was searched electronically to identify studies in which the marginal peri-implant bone loss around single-implant prostheses and multiple-implant prostheses was evaluated radiographically. The random-effects method was used to obtain estimates of marginal peri-implant bone loss (means and 95% confidence intervals [CIs].Results: Of the 188 studies identified by a preliminary search, 28 fulfilled the inclusion criteria; 12 were related to single-implant prostheses and 16 to multiple-implant screw retained fixed prostheses. The mean marginal peri-implant bone loss was 1.08 mm (95% CI, 0.253 to 0.283 mm) for multiple-implant retained prostheses and 0.88 mm (95% CI, 0.519 to 0.593 mm) for single-implant prostheses. Conclusion: The mean marginal bone loss is less in single implant supported prosthesis (0.88 mm) compare to multiple implant supported prosthesis (1.08 mm).

KEYWORDS: multiple implant–supported prosthesis, peri-implant bone loss, single implant–supported prosthesis, systematic review

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INTRODUCTION:

Peri-implant marginal bone loss is influenced by many factors, including surgical technique[1], implant positioning[2], tissue thickness[3], the presence of a microgap[4] at the implant-abutment interface[5], and implant design[6], all of which can also influence the marginal bone loss. One of the possible theories of the pathogenesis of marginal peri-implant bone loss, a common phenomenon ranging from minor marginal bone loss to implant failure, is that the stresses in the prosthesis / implant / bone system contribute to the process.[7] Any stress generated by the transmission of forces to the bone can cause problems in the prosthesis (screw loosening or fracture), the implant (implant fracture),[8,9] or the bone (marginal peri-implant bone loss or osseointegration failure).

Adequate clinical adaptation of the prosthesis with passivity is important in maintaining osseointegration, although a specific level of such passivity has not yet been established.[10] The absence of the periodontal ligament may prevent the implant from proper seating in a nonpassively fitting situation, which occurs independent of the moment of loads applied to the implants.[11] In fact, a certain biologic bone tolerance for stress caused by the misfit may be present.[12] Inaccurate adaptation of the prosthesis to the implants causes stress that can lead to biologic or mechanical failure of the implant itself, if the misfit is too extreme.[13,14] One way to avoid such failures during dental prosthesis fabrication is to achieve passive fit.[15] An absolute passive fit seems to be difficult to achieve through conventional casting procedures[16], as the fit is affected by each step of the prosthesis manufacturing process.[17] In fact, computer-aided procedures are able to produce frameworks with greater precision compared with traditional casting methods.[18,19]

Absolute passive fit between implants and prostheses has been widely discussed as a way of reducing biomechanical complications in the treatment of total or partial edentulism.[20,21] When the adaptation between the implants and the prosthesis is inaccurate, some units support the major part of the load, whereas others bear virtually no load.[22] Therefore, single fixed prostheses tend to show better passive fit than multiple screw-retained prostheses and thus induce little or none of the tension caused by a lack of passivity, leading to the hypothesis that a single fixed prosthesis will show less bone loss.[23-26]

The vast number of available publications has created a need for syntheses to facilitate access to the full data set and allow conclusions to be drawn from the comparison or combination of results from multiple sources. One way to accomplish this is through systematic reviews with or without meta-

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analysis.[27] Recently, systematic reviews in the field of implant dentistry have been performed with the objective of establishing evidence-based practices.[28-31]

Material and Methods

Sources used:

An electronic search was conducted for articles in English, translated into English listed with Science Direct till January 2015.

The search methodology applied was a combination of keywords: marginal bone loss, dental implants, single implant supported prosthesis, multiple implant supported prosthesis.

Review articles as well as references from different studies were also used to identify the relevant articles. Further the manual search was conducted and additional articles could not be identified.

Selection of studies:

The review process consist of two phases. In first phase titles and abstract of the search were initially screened for relevance and the full text of relevant abstract were obtained and accessed. The hand search of selected journals as well as search of reference of the selected studies were also done. The articles were obtained after first step of the review process using the following inclusion and exclusion criteria were screened in second phase and relevant and suitable articles were isolated for further processing and data extraction.

Inclusion criteria:

1) Prospective study.
2) Retrospective study.
3) Studies mentioned mean marginal bone loss with standard deviation in milimeter.
4) Articles published in English up to and including January 2015.
5) Platform switched implants/External hex implants.
6) Screw and cement retained implants prosthesis.
7) Studies with minimum 1 year of follow up.

Exclusion criteria:

1) Case reports.
2) Studies in animals.
3) Studies in cadavers.
4) In vitro studies.
5) Immediate implants.
6) Immediate loading.
7) Bone Grafts.
8) Systemic diseases.
9) Removable prosthesis.
10) With cantilevers.
11) Incomplete data.

Results of the search:

The database search yielded 188 titles, Out of which 64 titles were discarded after reading the abstracts, full text was obtained for the remaining 124 articles. 30 articles were selected based on inclusion and exclusion criteria, out of the 30 articles, 2 did not provide clear information regarding the variables of interest and thus were excluded and finally 28 titles were selected for data extraction.

Data extraction:

Data of the finally included studies were tabulated and the following information were extracted. Study, no. of patients, no. of implants, implant system, type of retention, follow up, jaw and region, implant design, prosthetic connection, success/survival rate, marginal bone loss. The specified values were tabulated and subjected to statistical analysis.

Table 1 : Data collected for single implant supported prosthesis

1	Study (YEAR)	No.of patients	No.of implants	System/mfr	Retention	Follow up	Jaw and region	Implant Design	Prosthetic connection	Survival/success rate	Marginal bone loss SD(mm)
2	Henrikson and jemt (2003)	11	11	MK III, Nobel Biocare	Screwed	1 yr	Ant max	cylindric	external	100%/-	0.4±0.3
3	Drago(2003)	69	104	Osseotite, Biomet 3i	cemented	1 yr	cost max, post manc	cylindric	external	100%/-	0.45±0.16
4	Henrikson and jemt(2003)	9	13	MK III	cemented	1 yr	Ant Max	cylindric	external	100%/-	0.3±0.6
5	Glauser et al (2004)	19	36	MK II	cemented	4 yr	d,incisors, canines,p	cylindric	external	–	1.2±0.5
6	Vigolo et al(2006)	20	40	osseotit	cemented	4 yr	post max, post mand	cylindric	external	-/100%	0.4±0.3
7	Hall et al(2007)	14	14	Southern implants	screwed	1 yr	Ant max	cylindric	external	–	0.78±1.01
8	Jemt(1996)	27	32	Branmark, Nobel Biocare	cemented	15 yr	Ant max	cylindric	external	100%/-	0.66±0.78
9	vigolo and Zaccaria(2010)	44	60	Osseotite, Biomet 3i	cemented	5 yr	post max	cylindric	external	100%/-	0.8±0.2
10	Michael(2006)	54	173	Astra Tech	cemented	1 yr	max post, mand post	cylindric	Internal	99.4%/-	0.65±0.52
11	David L. Cochrane(2009)	53	139	Straumann	cemented	5 yr	max/mand	cylindric	Internal	–	2.90±1.56
12											
13											
14	Ant=anterior: Post=posterior: max=Maxilla: mand=mandible: mfr=manufacture										

Table 2 : Data collected for Multiple implant supported prosthesis

1	Study	No.of patients	No.of implants	System/mfr	Total/Partical	Relention	Follow up	Jaw and region	Implant Design	Prosthetic connection	Survival/ success rate	Marginal bone loss SD(mm)
2	Steenberghe et al (1990)	147	427	Branemark	Partial	screwed	5 yr	Ant/post max/manc	cylindric	external	–	0.4±0.65
3	Jemt and Book(1996)	7	44	Branemark	Total	screwed	1 yr	Ant max	cylindric	external	–	0.5±0.56
4	Lindquist et al(1996)	45	270	Branemark	Total	screwed	15 yr	Ant mand	cylindric	external	-/98,9%	1.2±0.74
5	Arvindson et al(1998)	91	517	Astra Tech	Total	screwed	5 yr	Ant mand	cylindric	external	98.7%/-	0.26±0.53
6	Carlsoon et al(2000)	44	237	Branemark	Total	screwed	15 yr	ncisors, canines, per	cylindric	external	98,9%/-	1.4±0.40
7	Brayat and Zarb(2003)	66	306	Branemark	Partial	screwed	11 yr	Ant/post max/mand	cylindric	external	89.1%/-	1.62±0.84
8	Ekelund et al(2003)	30	179	Branemark	Total	screwed	20 yr	ant mand	cylindric	external	98.9%/-	1.6±0.9
9	Fischer et al(2008)	7	39	SLA, Straumann	Total	screwed	5 yr	Ant max	cylindric	external	95.7%/-	0.3±1.0
10	Change and Wennstrom(201	16	43	Osseotite, Biomet 3	Partial	screwed	3 yr	post max, post manc	cylindric	external	–	0.6±1.4
11	Mertens et al(2012)	15	94	Tioblast, Astra Tech	Total	screwed	11 yr	Ant/post max	cylindric	Internal	96.8%/92.6%	0.88±0.99
12	David L Cochrane(2009)	43	117	Nobel Direct	Partial	cemented	1 yr	max/manx	cylindric	Internal	-/94.0%	2.4±1.5
13	N.Fernandez(2012)	51	114	Straumann	Partial	cemented	1 yr	max post/mand post	cylindric	Internal	–	0.68±0.88
14	David L. Cochrane(2009)	139	457	Straumann	Partial	cemented	5 yr	max/mand	cylindric	Internal	–	2.90±1.56
15	MM Goswami (2009)	20	40	io-oss, Nobel replas	Partial	cemented	1 yr	mand post	cylindric	Internal	–	1.4±0.31
16	R J Ebbetson (2007)	14	14	Southern implants	Partial	screwed	1 yr	Ant max	conical	Internal	–	0.78±1.01
17	John P Gage(2006)	54	173	Astra Tech	Total	cemented	1 yr	max post, mand post	cylindric	Internal	99.4%/-	0.65±0.52
18	Peeter F(2003)	9	13	MK III	Partial	cemented	1 yr	Ant max	cylindric	Internal	100%/-	0.3±0.6
19												
20												
21	Ant=anterior: Post=posterior: max=Maxilla: mand=mandible: mfr=manufacture											

Table 3 : Marginal bone loss in two groups

	GROUP	N	Mean (mm)	Std. Deviation	Std. Error Mean	Mean Difference	Std. Error Difference	95% Lower Diffrence	95% Upper Difference	P Value
Marginal bone loss	single implant prosthesis	12	0.88	0.72	0.207	-0.21	0.30	-0.82	0.41	0.494
	multiple implant prosthesis	16	1.08	0.82	0.211					

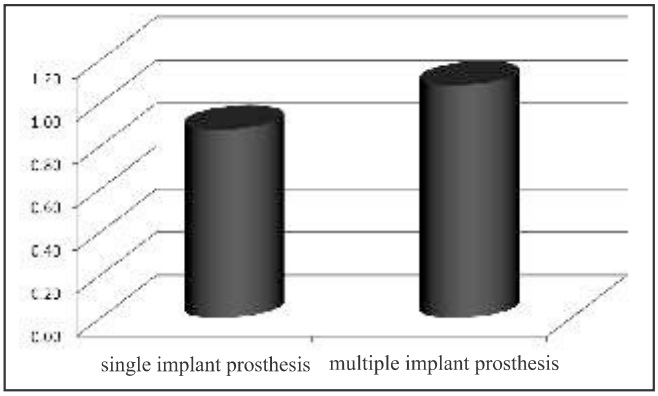

Figure 1 : Graph depicting the linear marginal bone loss in single and multiple implant supported prosthesis

Table 4 : Survival rate of two groups (single implant prosthesis and multiple implant prosthesis)

	GROUP (in mm)	N	Mean (%)	Std. Deviation	Std. Error Mean	Mean Difference	Std. Error Difference	95% Lower Difference	95% Upper Difference	P Value
Survival rate	single implant prosthesis	6	99.90	0.24	0.100	3.55	1.55	0.10	7.00	0.045
	multiple implant prosthesis	6	96.35	3.79	1.546					

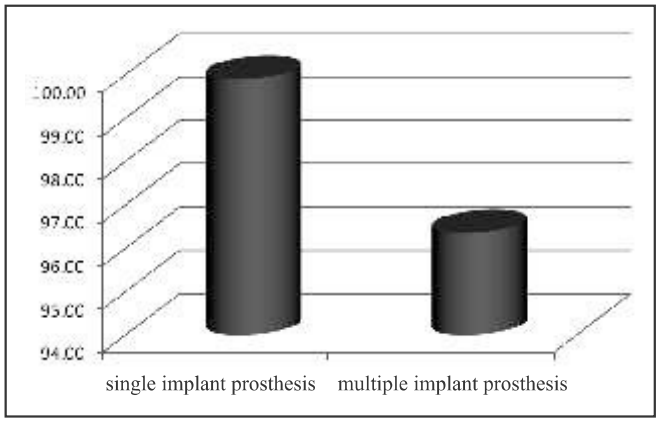

Figure 2 :Graph depicting Survival rate of two groups (single implant prosthesis and multiple implant prosthesis)

DISCUSSION

This result showed a mean marginal peri implant bone loss of 0.88 mm for single unit screw retained prostheses and 1.08 mm for multiple fixed prostheses.

Unlike conventional prostheses, under which an abutment tooth can move up to 100 µm inside its periodontal ligament and thus compensate for a certain degree of imprecision in a fixed prosthesis, implants can move only within a 10-µm range. [32,33] An in vitro study showed that the implant-prosthesis interface had a mean misfit value of 31.63 µm, which is greater than the bone compensation limit of 10 µm. This lack of flexibility at the bone-implant interface means that any traction, compression, or flexion forces imposed by superstructure misfit can lead to lack of passive fit, which can result in problems such as marginal periimplant bone loss. [34–37] Another factor that can compensate for the limited flexibility in the bone-implant interface of multiple-unit prostheses is the cementation line. Bottino et al[38] showed that the smallest values of maladaptation for cemented prostheses were greater than 36.6 µm, regardless of the type of cement used. Because these values were greater than the mean misfit in the implant-prosthesis interface, it was assumed that cement-retained multiple prostheses would easily achieve passive fit without causing tension at the bone-implant interface.

The marginal peri-implant bone loss was evaluated for single prostheses in twelve studies and for multiple-unit screw-retained prostheses in 16 studies. Therefore, two separate meta-analyses were conducted to evaluate marginal peri-implant bone loss around single and multiple-unit prostheses, which allowed indirect comparison of marginal peri-implant bone loss.

Well-elaborated inclusion and exclusion criteria must be established to minimize the risk of introducing bias during the selection of studies and, consequently, into the results of a review.[53] In the present study, the inclusion and exclusion criteria were rigorously elaborated, which was confirmed by the homogeneity observed among the studies. The use of the periapical radiographic technique for evaluating bone loss was used as an inclusion criterion in this study. Several studies have demonstrated the accuracy of this technique for evaluating changes in the bone crest as well as its superiority to panoramic radiographs for this purpose.[29,54,55] This led the authors to consider the panoramic technique less than ideal for the present study, as its use could introduce bias. Another important aspect in the choice of inclusion / exclusion criteria is the fact that only studies with a follow-up period of at least 1 year were selected. The classic study of Adell et al[36] showed that marginal peri-implant bone loss occurs during the first year and then tends to stabilize for the majority of implants.[36]

CONCLUSION

From the systamatic review of available literature following conclusion can be drawn:

1. The mean marginal bone loss is less in single implant supported prosthesis (0.88 mm) compare to multiple implant supported prosthesis (1.08 mm).

2. The survival rate of single implant supported prosthesis is greater than multiple implant supported prosthesis.

REFERENCES:

1. Barros RRM, Novaes AB Jr, Papalexiou V. Buccal bone remodelling after immediate implantation with a flap or flapless approach: A pilot study in dogs. Titanium 2009;1:25–51.
2. Caneva M, Salata LA, Souza SS, Baffone G, Lang NP, Botticelli D. Influence of implant positioning in extraction sockets on osseointegration: Histomorphometric analysis in dogs. Clin Oral Implants Res 2010;21:43–49.
3. Berglundh T, Lindhe J. Dimensions of the peri-implant mucosa. Biological width revisited. J Clin Periodontol 1996;23:971–973.
4. Dias ECLCM, Bisognin EDC, Harari ND, et al. Evaluation of implantabutment microgap and bacterial leakage in five external-hex implant systems: An in vitro study. Int J Oral Maxillofac Implants 2012;27:346–351.
5. Broggini N, McManus LM, Hermann JS, et al. Persistent acute inflammation at implant-abutment interface. J Dent Res 2003;82:232–237.
6. Shin YK, Han CH, Heo SJ, Kim S, Chun HJ. Radiographic evaluation of marginal bone level around implants with different neck designs after 1 year. Int J Oral Maxillofac Implants 2006;20:789–794.
7. Misch CE. Stress treatment theorem for implant dentistry. In: Misch CE. Contemporary Implant Dentistry, ed 3. St Louis, Missouri: Mosby Elsevier, 2008:68–88.
8. Gómez-Polo M, Bartens F, Sala L, Tamini F, Celemin A, Rio JD. The correlation between crown-implant ratios and marginal bone resorption: A preliminary clinical study. Int J Prosthodont 2010;23:33–37.
9. Ueda T, Kremer U, Katsoulis J, Mericske-Stern R. Long-term results of mandibular implants supporting an overdenture: Implant survival, failures, and crestal bone level changes. Int J Oral Maxillofac Implants 2011;26:365–372.
10. Abduo J, Bennani V, Waddell N. Assessing the fit of implant fixed prostheses: A critical review. Int J Oral Maxillofac Implants 2010;25: 506–515.
11. Zarone F, Apicella A, Nicolais L, Aversa R, Sorrentino R. Mandibular flexure and stress build-up in mandibular full-arch fixed prostheses supported by osseointegrated implants. Clin Oral Implants Res 2003; 14:103–114.
12. Jemt T, Book K. Prosthesis misfit and marginal bone loss in edentulous patients. Int J Oral Maxillofac Implants 1996;11:620–625.
13. Markarian RA, Ueda C, Sendyk CL, Lagana DC, Souza RM. Stress distribution after installation of fixed frameworks with marginal gaps over angled and parallel implants: A photoelastic analysis. J Prosthodont 2007;16:117–122.
14. Di Lorio D, Sinjari B, Fergalli B, Murmura G. Biomechanical aspects in late implant failures: Scanning electron microscopy analysis of four clinical cases. J Contemp Dent Pract 2011;12:356–360.
15. Guichet DL, Caputo AA, Choi H, Sorensen JA. Passivity of fit and marginal opening in screw- or cement-retained implant fixed partial denture designs. Int J Oral Maxillofac Implants 2000;15:239–246.
16. Sahin S, Çehreli MC. The significance of passive framework fit in implant prosthodontics: Current status. Implant Dent 2001;10:85–92.
17. Karl M, Rosch S, Graef F, Taylor TD, Heckmann SM. Static implant loading caused by as-cast metal and ceramic-veneered superstructures. J Prosthet Dent 2005;93:324–330.
18. Abduo J, Lyons K, Waddell N, Bennani V, Swain MA. Comparison of fit of CNC-milled titanium and zirconia frameworks to implants. Clin Implant Dent Relat Res 2012;(suppl 1):e20–29.
19. Torsello F, di Torresanto VM, Ercoli C, Cordaro L. Evaluation of the marginal precision of one-piece complete arch titanium frameworks fabricated using five different methods for implant-supported restorations. Clin Oral

Implants Res 2008;19:772–779.

20. Abduo J, Lyons K, Bennani V, Waddell N, Swan M. Fit of screw-retained fixed implant frameworks fabricated by different methods:A systematic review. Int J Prosthodont 2001;24:207–220.
21. Akça K, Kokat AM, Sahin S, Iplikcioglu H, Çehreli MC. Effects of prosthesis design and impression techniques on human cortical bone strain around oral implants under load. Med Eng Phys 2009;31: 758–763.
22. Yokoyama S, Wakabayashi N, Shiota M, Ohyama T. Stress analysis in edentulous mandibular bone supporting implant-retained 1-piece or multiple superstructures. Int J Oral Maxillofac Implants 2005;20: 578–583.
23. Watanabe F, Uno I, Hata Y, Neuendorff G, Kirsch A. Analysis of stress distribution in screw-retained implant prosthesis. Int J Oral Maxillofac Implants 2000;15:209–218.
24. Baggi L, Cappelloni I, Maceri F, Vairo G. Stress-based performance evaluation of osseointegrated dental implants by finite-element simulation. Simul Modeling Pract Theory 2008;16:971–987.
25. Jung RE, Pjetursson BE, Glauser R, Zembic A, Zwahlen M, Lang NP. A systematic review of the 5-year survival and complication rates of implant-supported single crowns. Clin Oral Implants Res 2008;19:119–130.
26. Karl M, Graef F, Heckmann S, Taylor T. A methodology to study the effects of prosthesis misfit over time: An in vivo model. Int J Oral Maxillofac Implants 2009;24:689–694.
27. Faggion CM Jr, Schmitter M. Using the best available evidence to support clinical decisions in implant dentistry. Int J Oral Maxillofac Implants 2010;25:960–969.
28. Zurdo J, Romão C, Wennström JL. Survival and complication rates of implant-supported fixed partial dentures with cantilevers: A systematic review. Clin Oral Implants Res 2009;20(suppl):59–66.
29. Sunyoung MA, Payne AGT. Marginal bone loss with mandibular twoimplant overdentures using different loading protocols: A systematic literature review. Int J Prosthodont 2010;23:117–126.
30. Çehreli MC, Karasoy D, Kökat AM, Akça K, Eckert S. A systematic review of marginal bone loss around implants retaining or supporting overdentures. Int J Oral Maxillofac Implants 2010;25: 266–277.
31. Brandão ML, Vettore MV, Vidigal GM Jr. Peri-implant bone loss in cement- and screw-retained prostheses: Systematic review and meta-analysis. J Clin Periodontol 2013;40:287–295.
32. Assif D, Marshak B, Schmidt A. Accuracy of implant impression techniques. Int J Oral Maxillofac Implants 1996;11:216-222.
33. Del'Acqua MA, Chávez AM, Amaral ALC, Compagnoni MA, Molo FA Jr. Comparison of impression techniques and materials for an implantsupported prosthesis. Int J Oral Maxillofac Implants 2010;25:771–776.
34. Adell R, Lekholm U, Rockler B, Brånemark PI. A 15-year study of osseointegrated implants in the treatment of edentulous jaws. Int J Oral Surg 1981;10:387–416.