

EVALUATION OF MARGINAL BONE LOSS IN IMPLANTS WITH VARIOUS COLLAR SURFACE DESIGNS – A SYSTEMATIC REVIEW AND META-ANALYSIS

Dr. Chirag Chauhan^{*}, Dr. Darshana Shah^{**}, Dr. Rucha Gandhi^{***}, Dr. Awa Parmar^{****}, Dr. Paras Doshi^{*****}

ABSTRACT

Aim: The purpose of the present systematic review and meta-analysis was to compare dental implants with different collar surfaces, evaluating marginal bone loss

Materials and Methods: The literature was searched electronically and 1014 studies were identified and final 18 studies were included based on the inclusion and exclusion criterias in which the marginal bone loss was evaluated in different implant collar surface designs.

Result: In the 18 studies it was concluded that marginal bone loss was seen less in laser collared and microtextured collared implant.

Conclusion: The marginal bone loss around microthreaded collared and laser microtextured collared implants were significantly lower than for machined i.e polished and rough collared implants.

Keywords: Dental implant, oral implant, collar, surface design, bone remodeling, and marginal bone loss.

INTRODUCTION:

Osseointegration is an essential requirement for allowing the survival of dental implants in the jaw bone. Maintenance of osseointegration and a steady state in marginal bone level are imperative.

Factors such as unfavorable stress distribution, surgical trauma, implant-abutment microgap, and bacterial infiltration can detrimentally affect osseointegration and accelerate bone loss.¹⁻³

Several factors such as implant surface quality, implant neck macro and micro design and crestal implant position play particularly crucial roles in osseointegration.^{4,6}

The long term result of implant-supported restoration both aesthetically and clinically depends on preservation of soft and hard tissues around implant, thus the overall amount of marginal bone loss may influence the clinical success of implants.⁴

The initial breakdown of bone surrounding the implant takes place in the most coronal portion of the bone-implant interface.⁴

Bone resorption of 1.5 to 2 mm is observed during the first year of function and is generally considered a normal physiologic process. Successive annual bone loss of 0.2 mm occurs in subsequent years.⁷⁻⁹

Implant collar surface characterization has been associated with reduced marginal bone loss which

has led to the development of implants with new collar configuration and surface modification for improving the soft and hard tissue osseointegration.

Different implant collar surface characterizations have been proposed in order to stabilize the marginal bone loss around an implant.

Various implant collar surface characterizations include polished collars which are also known as machined or turned collar; rough surfaced collar, in this type the collar surface has been roughened by various treatments such as acid etching, sandblasting; in another type of collar surface modification there was an introduction of microgrooves in the rough surface of collars¹⁰; laser microtextured surfaces¹¹ of implant collars are also used nowadays.

MATERIALS AND METHOD:

Sources used:

An electronic search was conducted for articles in English, listed with PubMed, Medline, Embase, Cochrane.

The search methodology applied was combination of MeSH terms and keywords like dental implant, oral implant, collar, surface design, bone remodeling, and marginal bone loss.

Review articles as well as references from different studies were also used to identify the relevant articles.

*Professor, **Head Of Department, ***PG Student, ****PG Student, *****Professor

DEPARTMENT OF PROSTHODONTICS AND CROWN AND BRIDGE AHMEDABAD
DENTAL COLLEGE AND HOSPITAL

ADDRESS FOR AUTHOR CORROSPONDENCE : DR. CHIRAG CHAUHAN TEL: +91 98241 65096

Selection of studies:

The review process consists of two phases. In first phase, titles and abstract of the search were initially screened by two authors for relevance and the full text of relevant abstract were obtained and assessed. Any disagreements were solved by discussion or third author suggestion, if needed. The hand search of selected journals as well as search of references 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 which were screened in second phase and relevant and suitable articles were isolated for further processing and data extraction. Duplicates and articles with insufficient necessary data were excluded by the two authors and any disagreements were resolved by the third author suggestions.

Inclusion Criteria:

- Randomized Controlled Trials (RCTs).
- Prospective studies.

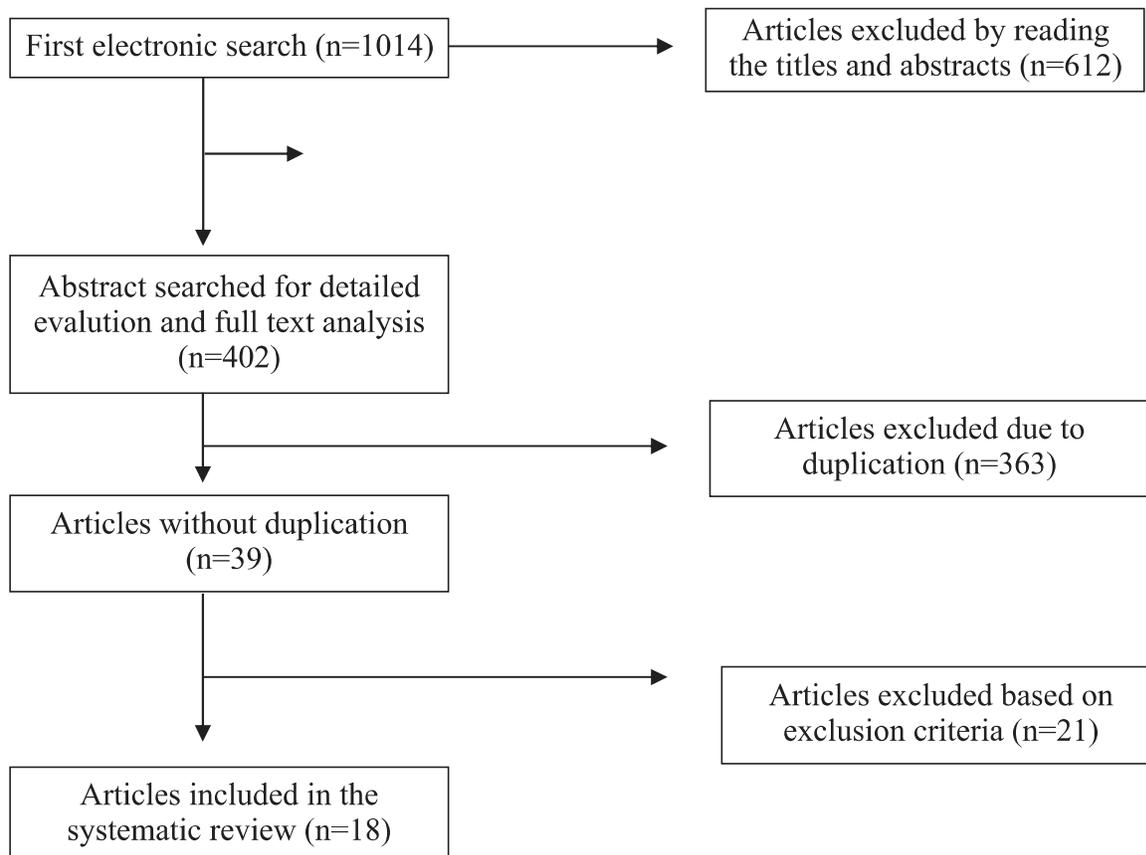
- Case reports.
- Studies showing use of implants with various collar surface characterizations.
- Published in English.
- Follow up period > 12 months.
- Age > 18 years.

Exclusion Criteria:

- In vitro studies.
- Finite element analyses.
- Animal studies.

Results of the Search:

The search from the electronic databases identified 1014 publications out of which 612 references were excluded after reviewing the title and abstracts. From the remaining 402 studies, after excluding the duplicate manuscripts, 39 studies were eligible for analysis. Upon reading the full texts, 21 studies were excluded based on the exclusion criteria. This resulted in a final number of 18 publications for the current systematic review.



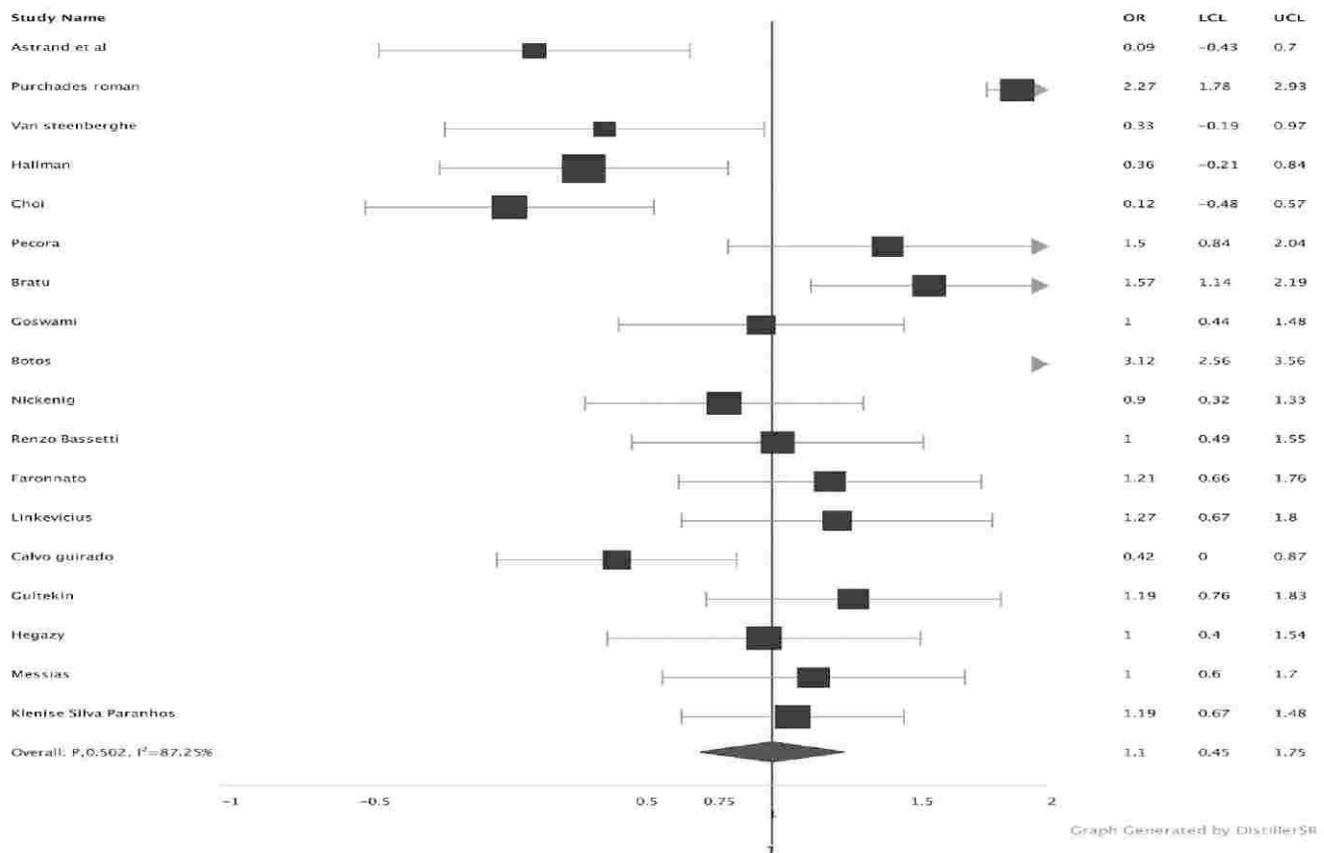
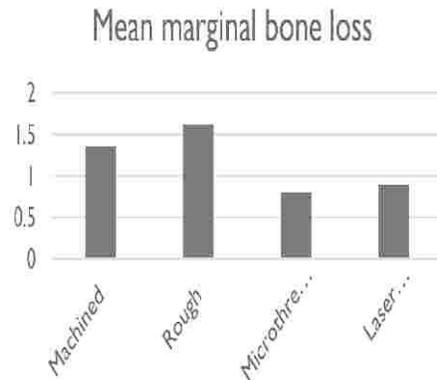
SUMMARY OF THE CHARACTERISTICS OF THE INCLUDED STUDIES.

S.R. NO.	AUTHOR	YEAR	TYPE OF STUDY	NO OF IMPLANT	IMPLANT SYSTEM	ARCH	COLLAR SURFACE CHARACTERIZATION	FOLLOW UP PERIOD	MARGINAL BONE LOSS	IMPLANT ABUTMENT CONNECTION	LOADING PROTOCOL	OPPOSITE ARCH IN OCCLUSION
1.	Astrand et al ¹¹	1999	Prospective	18	Danemark Mark nobel Imcore	Maxilla	Machined	5 years	2.12	External hex	Conventional loading	Implant supported fixed prostheses
				18	Astratech TiOblast	Mandible	Roughened		1.7	Internal hex		
2.	Purchades Roman et al ¹³	2000	Prospective	15	Branemark	-	Machined	>2 years	1.6	External Hex	Conventional loading	Natural teeth
				15	Astratech SP	-	Microthreaded		0.6	Internal Hex with conical seal		
3.	Van Steenberghe et al ¹¹	2000	Prospective study	45	Nobel biocare	-	Machined	2 years	2.3	External hex	Conventional loading	Natural teeth or implant supported fixed prostheses
				30	Astratech TiOblast	-	Roughened		1.66	Internal hex		
4.	Hallman et al ¹³	2005	Prospective study	84	Nobel biocare	Maxilla	Machined	5 years	2.3	External hex	Conventional loading	Natural teeth
				77	Astratech TiOblast		Roughened		2.1	Internal hex		
5.	Lee D W Choi ¹⁶	2007	Prospective	17	Astratech,ST	Mandible	Microthreaded	3 years	0.24+0.13	Internal hex	Conventional loading	Natural teeth or implant supported prostheses
				17	Astratech TP	Maxilla	Machined		0.51+0.33	Internal hex		
6.	Pecora et al ¹⁷	2009	Prospective	20	Laserlok	Maxilla	Machined	37 months	1.94	Internal hex	Conventional loading	Natural teeth
				20	control	Mandible	Laser microgrooved		0.59	Internal hex		
7.	Bratu EA ¹⁸	2009	RCT	46	MIS S	Mandible	Microthreaded	1 year	0.69	Internal hex	Conventional loading	Natural teeth
				46	MIS I		Machined		1.47	External hex		
8.	Goswami ¹⁹	2009	Prospective	20	Oral tronics Nobel Imcore	Mandible	Machined	1 year	1.53+0.28	Internal hex	Conventional loading	Natural teeth
				20	control		Rough		1.41+0.35	Internal trichannel		
9.	Botos et al ²⁰	2011	Prospective	2	Laserlok	Mandible	Laser microgrooved	12 months	0.72	Internal hex	Immediate and conventional loading	Implant supported overdenture
				2	Nobel Select		Machined		1.13	Internal hex		
10.	Niekkeig et al ²¹	2013	RCT	63	Nobel Biocare replace select straight	Mandible	Machined	5 years	1.3	Internal trichannel	Conventional loading	Natural teeth or implant supported fixed prostheses
				70	Replace straight groovy		Rough Micro threaded		0.6	External hex		
11.	Renzo Brazetti et al ²²	2014	Retrospective	20	Nobel biocare r select tapered	Mandible	Machined	1 year	1.1+0.92	Internal trichannel	Conventional loading	Natural teeth
				20	Nobel replace tapered groovy		Rough grooved		1.25+1.33	Internal trichannel		
12.	Farronato et al ²³	2014	RCT	38	RBT biohorizon	Maxilla	Machined	3 years	1.24 + 0.28	Internal hex	Immediate functionally loaded	Implant supported fixed prostheses
				38	Laserlok biohorizon	Mandible	Laser microtextured		0.65 + 0.22	Internal hex		
13.	Linkavicius et al ¹⁴	2014	Cohort	30	Biomet	Mandible	Rough	1 year	1.43+0.23	Internal hex Platform switching	Conventional	Natural teeth
				30	Laserlok biohorizon		Laser microtextured		1.41+0.42	Internal hex		
14.	Calvo guirado et al ²⁴	2016	Prospective	71	MIS implants	-	Microthreaded	60 months	0.90+0.26	Internal hex with platform switching	Immediate nonfunctional loading	Natural teeth
15.	Gultekin et al ²⁵	2016	Cohort	56	RBT tapered biohorizon	Maxilla mandible	Machined	36 months	1.34 + 0.25	Internal hex	Conventional loading	Natural teeth
				47	Laserlok tapered biohorizon		Laser microtextured		0.53+0.28	Internal hex		
16.	Hegazy et al ²⁶	2016	RCT	18	Nanotite	Mandible	Rough	12 months	1.51+0.34	Internal hex	Early loading(2 weeks)	Conventional at complete denture
				18	Laserlok biohorizon		Laser microtextured		1.45+0.31	Internal hex		
17.	Messana et al ¹⁷	2019	Prospective	60	Titanium one piece or two piece implants	Mandible	Machined	1 year	0.19+0.27	-	Conventional loading	Natural teeth
				60	-		Rough		0.76+0.21			
				60	-		Rough microthreaded		0.18+0.16			
18.	Klenise Silva Paranhos et al ²⁸	2019	Prospective	24	Nobel biocare	Mandible	Rough	10 years	2.39+0.33	External hex	Conventional loading	Natural teeth
				24	Astratech		Rough microthreaded		1.98+0.34	Internal hex		

Table showing comparative mean of marginal bone loss in implants with different collar surface designs

Collar surface characterization	Mean marginal bone loss
Machined	1.36
Rough	1.62
Microthreaded	0.805
Laser microtextured	0.89167

Graph showing comparative mean of marginal bone loss in implants with different collar surface designs



Forest plot

DISCUSSION:

The present systematic review showed that implants with machined, rough surface, microthreaded and LMS collars had an influence on the rate of marginal bone loss as compared to the machined collar implants. Thus the null hypotheses of the study that there would be no difference in the marginal bone loss for different implant collar surfaces was rejected.

Irrespective of the implant system, design, or surgical approach, it has been shown that a biologic width >3 mm or equal to 3mm will be established once an implant becomes uncovered. If this soft tissue thickness is not present, peri implant bone loss will occur to accommodate the necessary soft tissue dimension.³⁰

In vivo experiments revealed that the rough surface dental implants enhanced the bone to implant interface and lowered the rate of bone loss compared with smooth surfaces.³⁰ Moreover the presence of microthread might provide an increased inter locking of the implant and the marginal bone thus reducing the marginal bone loss.¹⁶ Hansson³¹ found that the implant surface roughness at the implant collar area leads to an increased interfacial shear strength and effective in counteracting marginal bone loss. The investigations done by Hallman¹⁵ and Astrand⁷ found no clinically significant difference in marginal bone loss between a machined collar implant and a rough collared implant.

LMS collar is effective for prevention of peri implant bone loss. The reason is a firm connective tissue attachment to LMS collar can diminish apical migration of the epithelial tissue and prevent the invasion of bacterial toxin, conferring resistance to the alveolar bone against resorption.³³

Between LMS and roughened surface collars, no significant difference in marginal bone loss was detected in some studies. However in those studies the roughened surface group in one study by Hegazy²⁶ was nano surface treated. It has been reported that the nanoscale textured can augment surface energy and improve osseointegration.

This may indicate that both the LMS and the nanosurface textured collar implants have an effect on marginal bone loss. It has been reported that nanoscale textured surface can augment surface energy and improve osseointegration

compared with normal acid etched roughened surface.

Meanwhile the other study by Linkevicius¹¹ only included implant sites with soft tissue thickness less than 2mm. A minimum 2 mm of soft tissue thickness is required for the establishment of biologic width and in presence of thin tissue higher values of marginal bone loss can occur.

The result of the selected studies revealed that marginal bone loss was decreased around microthreaded and laser microtextured implants as compared to rough collared and machined collared implants.

An important issue to consider is the presence of several confounding factors in the included studies. Implant abutment connection being an important factor in marginal bone loss the most of the comparative studies included were having different implant abutment connections and with or without platform switching.

The methods of radiographic evaluation of marginal bone loss were also different in the different included studies.

In the studies rehabilitating the patients with fixed prostheses the effects of splinting were not discussed. Splinting dissipates the loads between implants and reduces the stress and hence can influence the result.

CONCLUSION:

Hence, summarizing and highlighting the findings of the included studies the marginal bone loss in implants with various collar surface characterizations are:

1. For machined surface collars 1.36 mm
2. For rough surfaced collars 1.62 mm
3. For implants with microthreads in their collars 0.805 mm
4. For implants with laser microtextured surface collars 0.89 mm
5. The comparative mean of marginal bone loss is 0.89mm

Within the limitations of this study, the present systematic review indicates that the marginal bone changes around microthreaded collared and laser microtextured collared implants were significantly lower than for machined i.e polished and rough collared implants.

REFERENCES:

1. H. E. K. Bae, M.-K. Chung, I.-H. Cha, and D.-H. Han, "Marginal tissue response to different implant neck design," *The Journal of Korean Academy of Prosthodontics*, 2008 vol. 46, no. 6, pp. 602–609.
2. Qian, Jie & Wennerberg, Ann & Albrektsson, Tomas. (2012). Reasons for Marginal Bone Loss around Oral Implants. *Clinical implant dentistry and related research*. 2012; 14(6)
3. N. Brogгинi, L. M. McManus, J. S. Hermann et al., "Persistent acute inflammation at the implant-abutment interface," *Journal of Dental Research*, vol. 82, no. 3, pp. 232–237, 2003
4. T.-J. Oh, J. Yoon, C. E. Misch, and H.-L. Wang, "The causes of early implant bone loss myth or science?" *Journal of Periodontology*, 2002 vol. 73, no. 3, pp. 322–333.
5. X. Rodriguez-Ciurana, X. Vela-Nebot, M. Segala-Torres et al., "The effect of interimplant distance on the height of the interimplant bone crest when using platform-switched implants," *International Journal of Periodontics and Restorative Dentistry*, 2009 vol. 29, no. 2, pp. 141–151.
6. Ribes Lainez N, Monreal Bello A, Fuster Torres MA, Peñarrocha Oltra D, Peñarrocha Diago M. Periimplant soft-tissue and bone levels around dental implants with different neck designs and neck surface treatments: A retrospective cohort study with 3-year follow-up. *J Oral Science Rehabilitation*. 2017 3(4):16–23.
7. D. E. Smith and G. A. Zarb, "Criteria for success of osseointegrated endosseous implants", *The Journal of Prosthetic Dentistry*, 1989 vol. 62, no. 5, pp. 567–572.
8. D. Buser, H. P. Weber, and N. P. Lang, "Tissue integration of non-submerged implants. 1-year results of a prospective study with 100 ITI hollow-cylinder and hollow screw implants," *Clinical Oral Implants Research*, 1990 vol. 1, no. 1, pp. 33–40.
9. H. P. Weber, D. Buser, J. P. Fiorellini, and R. C. Williams, "Radiographic evaluation of crestal bone levels adjacent to nonsubmerged titanium implants," *Clinical oral Implants Research*, 1992 vol. 3, no. 4, pp. 181–188,
10. A.M. Al-Thobity, A. Kutkut, K. Almas, "Microthreaded implants and crestal bone loss: a systematic review," *J. Oral Implantology*. 2017 43 157–166.
11. Linkevicius T1, Puisys A, Svediene O, Linkevicius R, Linkeviciene L "Radiological comparison of laser-microtextured and platform-switched implants in thin mucosal biotype." *Clin Oral Implants Res*. 2015 May; 26(5): 599-605
12. Astrand P, Engquist B, Dahlgren S, Engquist E, Feldmann H, Grondahl K. Astra Tech and Branemark System implants: A prospective 5-year comparative study. Results after one year. *Clin Implant Dent Relat Res* 1999;1:17-26.
13. Puchades-Roman L, Palmer RM, Palmer PJ, Howe LC, Ide M, Wilson RF. A clinical, radiographic, and microbiologic comparison of Astra Tech and Branemark single tooth implants. *Clin Implant Dent Relat Res* 2000;2: 78-84.
14. Van Steenberghe D, De Mars G, Quirynen M, Jacobs R, Naert I. A prospective split-mouth comparative study of two screw-shaped self-tapping pure titanium implant systems. *Clin Oral Implants Res* 2000;11:202-209.
15. Hallman M, Mordenfeld A, Strandkvist T. A retrospective 5-year follow-up study of two different titanium implant surfaces used after interpositional bone grafting for reconstruction of the atrophic edentulous maxilla. *Clin Implant Dent Relat Res* 2005;7:121-126.
16. Lee DW, Choi YS, Park KH, Kim CS, Moon IS. Effect of microthread on the maintenance of marginal bone level: a 3-year prospective study. *Clin Oral Implants Res* 2007;18:465-70.
17. G. E. Pecora, R. Ceccarelli, M. Bonelli, H. Alexander, and J. L. Ricci, "Clinical evaluation of laser microtexturing for soft tissue and bone attachment to dental implants," *Implant Dentistry*, 2009 vol. 18, no. 1, pp. 57–66
18. E. A. Bratu, M. Tandlich, and L. Shapira, "A rough surface implant neck with microthreads reduces the amount of marginal bone loss: a prospective clinical study," *Clinical Oral Implants Research*, 2009 vol. 20, no. 8, pp.

827–832

19. M M. Goswami, “Comparison of crestal bone loss along two implant crest module designs,” *Medical Journal Armed Forces India*, 2009 vol. 65, no. 4, pp. 319–322
20. S. Botos, H. Yousef, B. Zweig, R. Flinton, and S. Weiner, “The effects of laser microtexturing of the dental implant collar on crestal bone levels and peri-implant health,” *The International Journal of Oral & Maxillofacial Implants*, 2011 vol. 26, no. 3, pp. 492–498.
21. H.-J. Nickenig, M. Wichmann, A. Happe, J. E. Zoller, and S. Eitner, “A 5-year prospective radiographic evaluation of marginal bone levels adjacent to parallel-screw cylinder machined neck implants and rough-surfaced microthread implants using digitized panoramic radiographs,” *Journal of Cranio-Maxillofacial Surgery*, 2013 vol. 41, no. 7, pp. 564–568.
22. Bassetti R, Kaufmann R, Ebinger A, Mericske-Stern R, Enkling N. Is a grooved collar implant design superior to a machined design regarding bone level alteration? An observational pilot study. *Quintessence International* 2014;45:221–9.
23. D. Farronato, F. Mangano, F. Briguglio, V. Iorio-Siciliano, F. Riccitiello, and R. Guarnieri, “Influence of Laser-Lok surface on immediate functional loading of implants in single-tooth replacement: a 2-year prospective clinical study,” *The International Journal of Periodontics & Restorative Dentistry*, 2014 vol. 34, no. 1, pp. 79–89.
24. Calvo-Guirado JL, López-López PJ, Pérez-Albacete Martínez C, et al. Periimplant bone loss clinical and radiographic evaluation around rough neck and microthread implants: a 5-year study. *Clin Oral Implants Res*. 2016 .
25. B. A. Gultekin, A. Sirali, P. Gultekin, S. Yalcin, and E. Mijiritsky, “Does the laser-microtextured short implant collar design reduce marginal bone loss in comparison with a machined collar?” *BioMed Research International*, 2016,
26. Hegazy S, Elmekawy N, Emera RM. Peri-implant outcomes with laser vs nanosurface treatment of early loaded implant-retaining mandibular overdentures. *Int J Oral Maxillofac Implants* 2016; 31:424-430.
27. Ana Messias, Ignacio Sanz-Sánchez, Ana Carrillo de Albornoz, Pedro Nicolau, Tom Taylor, Florian Beuer, Alex Schär, Robert Sader, Fernando Guerra and Mariano Sanz, Influence of implant neck and abutment characteristics on peri-implant tissue health and stability. Oral reconstruction foundation consensus report, *Clinical Oral Implants Research*, 2019; 30:6 (588-593). :
28. Klenise Silva Paranhos., et al. “The Effect of Implant Collar Design and Development over the Years on Soft Tissue and Bone Level– A Systematic Review and Meta-Analysis”. *Acta Scientific Dental Sciences* 2019 Volume 3 issue 11: 97-109.
29. Berglundh T, Lindhe J. Dimension of the peri-implant mucosa. Biologic width revisited *J Clin Periodontol* 1996; 23:971-973.
30. N. Sato, T. Kuwana, M. Yamamoto et al., “Bone response to immediate loading through titanium implants with different surface roughness,” *Odontology*, 2014 vol. 102, no. 2, pp. 249– 258.
31. S. Hansson, “The implant neck: smooth or provided with retention elements. A biomechanical approach,” *Clinical Oral Implants Research*, 1999. vol. 10, no. 5, pp. 394–405.
32. Hansson S. Implant-abutment interface: Biomechanical study of flat top versus conical. *Clin Implant Dent Relat Res* 2000; 2:33-41.
33. Nevins M, Camelo M, Nevins ML, Schupbach P, Kim DM. Connective tissue attachment to laser microgrooved abutments: A human histologic case report. *Int J Periodontics Restorative Dent* 2012;32:385-392