ACTA SCIENTIFIC DENTAL SCIENCES (ISSN: 2581-4893)

Volume 3 Issue 11 November 2019

Research Article

The Effect of Implant Collar Design and Development over the Years on Soft Tissue and Bone Level– A Systematic Review and Meta-Analysis

Klenise Silva Paranhos[1]*, Mashal Alrajhi[2], Simone SI de Oliveira[3] and Malvin N Janal[4]

[1]Adjunct Clinical Assistance Professor at Ashman Department of Periodontology and Implant Dentistry, New York University College of Dentistry, New York

[2]Graduated Student at Advanced Program for International Dentists in Implant Dentistry, Student at New York University - Master of Public Health, New York University College of Dentistry, New York

[3]Associate Professor at Universidade Federal Fluminense (UFF), Brazil

[4]Senior Research Scientist, Department of Epidemiology and Health Promotion, New York University College of Dentistry, New York

***Corresponding Author:** Klenise Silva Paranhos, Adjunct Clinical Assistance Professor at Ashman Department of Periodontology and Implant Dentistry, New York University College of Dentistry, New York.

Received: September 17, 2019; **Published:** October 31, 2019

DOI: 10.31080/ASDS.2019.03.0684

Abstract

Purpose: This systematic review compares the effect of rough-surfaced and machined implant collar on marginal bone loss in adult patients.

Materials and Methods: An online search was assembled with a combination of Medical Subject Headings (MeSH terms) and free-text words of the literature published up to February of 2016, to identify studies that compared modifications in the implant neck area and measured marginal alterations.

Results: The primary search yielded 1,110 significant titles. After filtering, data extraction and quality assessment, eighteen full text studies were selected and divided according to the follow-up at one year, three years and five or more years.

Conclusion: In short-term cases, defined as ≤ 1-year follow-up, rough collar implant surfaces showed better marginal bone preservation than smooth collar implant surfaces. However, there was no difference between implant designs in longer-term studies, defined as ≥ 3ys follow-up. The data do not suggest a long-term advantage to the use of either implant collar surface.

Keywords: Biofilm; Implant Surface; Implant Neck; Marginal Bone Loss; Mucositis; Periodontitis

Introduction

When Branemark first introduced the concept of osseointegration in 1952, a new era of oral reconstruction emerged [1]. For a long period of time, this machined type of implant was clinically and histologically considered successful for osseointegration. In response to clinical demand, rough surface implants were introduced in the late 80's in order to facilitate bone–implant-contact (BIC) [2,3]. However, plaque can attach up to 25 times more easily to rough surfaces than to machined surfaces [4,5], jeopardizing long-term success of the biological seal around the implant collar [6-9].

Dental implant surface roughness first started with an appetite-layer (e.g., hydroxyapatite (HA)-coated), then titanium plasma-sprayed, titanium oxide [TiO_2] blasted, acid-etched, blasted and acid-washed/etched, anodized, laser ablation) [2,310]. For decreasing the healing time and reducing the stress at the peri-implant marginal bone to prevent crestal bone alteration [11,12].

Lack of effectiveness of the machined neck, when it is placed under the crest of the bone, led to the introduction of one stage implant designed by Straumann Standard Implant, formerly known as the "ITI Implant" in 1985 and later, sandblasting large grit and acid-etched surface (SLA), applying the smooth transmucosal neck supracrestal [13,14].

The concept of having implants roughened along their entire length, without machined collar, was introduced in most implant brands [15,16] in order to accommodate the new clinical challenges of immediate loading and to improve the immediate placement method. Previous studies compared subcrestal with epicrestal implant placement with platform switching without abutment removal and showed very low bone loss in both groups of implants and delayed loading [17,18].

The transition from turned (machined) to textured surface of the implant collar started when research demonstrated that this surface modification has a beneficial effect on early osseointegration and it reduces the time of loading [16,18,19].

Starting in 2005, the incorporation of micro-threads to the collar of the implant was introduced, in order to try to shorten or even to eliminate the polished collar [20-22].

Besides the microbial issue, crestal bone loss could still happen due to the possibility of a macrogap in butt-joint connections and potential movements between the implant fixture and the abutment/prosthesis during loading [12,22,23]. In order to solve this issue, the platform-switching concept was introduced in 2006 by Lazzara and Porter [23,24]. To minimize crestal bone loss, enhance soft tissue contour, and improve home care and esthetics.

The fact that the placement of a rough surface up to the collar at the bone level reduces the amount of marginal bone loss and that is has "durable" soft-tissue cuff [25-28], started to bring attention to this configuration.

A concept of placing the implant flush with the crest of the alveolar bone or even slightly below (traditional Branemark protocol), bone level implants were introduced to be a selection procedure to maintain the implant-bone-soft tissue complex [29].

The initial adhesion of bacteria in the implant surface collar mainly starts at locations with high wettability (a typical characteristic of titanium), for example: rough surface, grooves and pits [7,30], provisional restoration with inadequate contour and deficient soft tissue manipulation during healing [31], poor oral hygiene (OH) maintenance; no preservation of the biologic width by micro movement of 0.5-1mm away from the base of the sulcus; inadequate implant placement relative to the bone crest – vestibular bone lamella width; absence of micro gaps between implant and abutment that lead to bacterial colonization; presence of keratinized tissue (attached gingiva of 2mm); periodontal biotype [32,33], and periodontal conditions [34,35].

A primary concern around rough implant collar surfaces lies in the potential for accelerated loss of osseointegration, if this roughened surface becomes uncovered by recession and exposed to the oral environment [36-38]. A roughness thickness of 0.5 to 1.0 mm up to the collar of the implant may help maintain oral hygiene and provide an appropriate peri-gingival complex as well the maintenance of the biological seal [30].

Recently, laser micro texturing technology was introduced in forming the texture of the implant neck [39,40]. This kind of surface creates an attachment that differs significantly from previous reports because the collagen fibers oriented in a parallel and circumferential direction to the implant collar surface [39,40]. However, none of these technologies have been shown to prevent peri-implantitis [41-49].

The purpose of this systematic review was to determine whether the use of rough surfaced neck implants leads to a clinical advantage, defined by less marginal bone loss than machined neck implants.

Methods and Materials

The literature search was structured according to the PICO format that include: Population (P) - healthy subjects with stable implants loading for at least 6 months. Intervention (I) was implants exhibiting any kind of rough collar design (i.e. rough surfaces with or without micro threads implant collar, machined collar, Laser-lock). Comparator/Control (C) was implant with a smooth collar surface design. Outcome (O) was bone level changes assessed from radiographical images in adult patients treated with dental implants.

The search strategy used a combination of Medical Subject Headings (MeSH terms) and free-text words with the guidance of a research librarian at New York University Health Sciences Library.

This systematic review searched the following electronic databases up to February of 2016: the Cochrane Oral Health Group's Trials Register; the Cochrane Central Register of Controlled Trials (CENTRAL); MEDLINE via OVID; DOSS via EBSCO; SCOPUS; CINAHL; and EMBASE via OVID, including all of the Web of Science searches available today [50,51].

Online and academic searches of the clinical dental literature were included with no restrictions on the language or date of publication, as long as the title and abstract were provided in English. Articles available online in electronic form were considered eligible. The reference lists of all accepted articles related to the topic were evaluated and included as a manual search.

The inclusion criteria are as follows: randomized controlled trials (RCT), cohort studies, non-randomized but controlled clinical trials, and prospective and retrospective clinical studies that compare smooth and rough collar osseointegrated dental implants on marginal bone alteration with a follow–up of at least 12 months. In addition, sufficient bone height and a ridge width that allowed for at least 1.5 mm of surrounding bone after implant placement (Table 1).

Authors	Conflict of Interests?	Study Design	Jaw	No. Subjects / No. of Implants at Baseline	No. of Subjects / No. of Implants at Analysis	No. of Follow-ups (per year, range)	Implant Type and Surface	Manufacturer	Cumulative implant survival (%)	Prosthesis survival (%)	Mean Alveolar Bone Loss (mm/years of Follow-Up)	Prosthetic complications	Patient Satisfaction
Astrand et al (1999)	NR	Prospective	MAX/MN	#66 /#371	#66 /#362	1y	Smooth/Rough	Nobel Biocare Mark II machine (184) (107 MAX /80 MN) and Astra Tech TiOblast (184) (104 MAX /80MN)	NR	Nobel-4.3% Astra -0.5%	MAX Nobel: -1.971± 0.18 Astra:1.72± 0.34 MN Nobel: -1.74± 0.20 Astra: -1.24± 0.21	Yes	NR
Gotfredsen et al (2001)	NR	Prospective	MAX(48)MN(85)	#50 / #133	#44/#109	5Y	Smooth/Rough	Astra Tech Machine TiOblast	(S)95.1% (R)100%	NR	(S) 0.21 ± 0.83 MAX/ 0.22 ± 1.13 MN (R) 0.51±1.11 MAX / 0.52±1.07 MN	Yes	Yes
Engquist et al. (2002)	Yes	Prospective	MAX/MN	#66 /#371	#66 /#354	3yrs	Smooth/Rough	Nobel Biocare Mark II-machine Astra Tech - TiOblast	Nobel-95.2% Astra -98.9%	NR	Drop-outs: 3 subjects 3yrs (S) 0.08 (R) 0.28 (maxilla) (S) 0.22 (R) 0.22 (mandible) Mean: (S) 0.15 (R) 0.25	Yes (1 subject:loss of bridge at 1Y)	NR
Astrand et al (2004a)	Yes	Prospective	MAX/MN	#66 /#371	#63/NR	5 yrs	Smooth/Rough	Nobel Biocare MarkII machine (184) Astra Tech TiOblast (187)	Nobel: 94.6% Astra:98.4%	NR	Drop-outs: 3 subjects 3 and 5 yrs: (S) 0.1 (R) 0.44 (maxilla) (S) 0.2 (R) 0.13 (mandible) (S) 1.98± 0.21 MAX / 1.38 ± 0.17 MN (R)- 1.74 ± 0.45 MAX / 1.06 ± 0.19 MN	Yes (1 subject: loss of bridge at 1Y, 2 subjects: 3–5 yrs – deceased)	NR
Astrand et al (2004b)	Yes	Prospective-RCT	MAX/MN	#28 / #150	#26/#146	1/3 yrs	Smooth/Rough	Nobel Biocare -machine (73) Straumann ITI TPS (77)	Nobel: 95.5% Strauman ITI: 87.1%	NR	Drop-outs: 2 subjects (1Y); 2 subjects (3 yrs) 1 yr:(S) -0.2 ±0.09(R) -0.2 ±0.16 3 yrs: (S) 0.1±0.09 (R) 0.2± 0.25 Peri-implantitis occurred at 9.1 of the TPS-surfaced but at none of the Nobel	Yes	NR
Meijer et al (2004)	NR	Prospective-RCT	MN	# 90 / #180	#90 / #178	5ys	Smooth/Rough	#30 subjects +2 implantst per company: Nobel Biocare Machine IMZ -TPS cylinder Straumann - TPS	(S)98.3% (R)IMZ 98.3% (R)ITI- 100%	NR	Drop-outs (5 yrs): 7 subjects: (4) Nobel (3) Strauman ITI (S) 0.7 ± 0.8 (R)IMZ - 1.4 ± 1.8 (R) ITI- 0.9 ± 0.9	NR	NR
Wennstrom et al (2004)	NR	Prospective	MAX(83)MN(66)	#51/#149	#47/#137	5Ys	Smooth/Rough	Astra Tech Machine TiOblast	97.30%	NR	(S)0.33 (R)0.48	Yes	NR
Zechner et al (2004)	NR	Retrospective	MN	#51 / #144	#36 / #144	3-7Ys	Smooth/Rough	#19/ #76 Nobel Biocare MKII Machine #17#/68 Frios Sandblasted/acid-etched	NR	NR	(S) 2.4 ± 0.23	NR	NR
Shin et al (2006)	NR	Prospective	MAX/MN	#68 / #107	#68 / #107	Baseline/3/6/12 M(1Y)	Smooth/Rough	Ankylos, Lifecore and Warantec.	NR	NR	(S)1.32 ± 0.27 (R) 0.76 ± 0.21	Yes	Yes
Watzak et al (2006)	NR	Retrospective	MN	#31 / #124	#31 / #123	33 M(2,5ys)	Smooth/Rough	Nobel Biocare (MKIII) -MS and AS	NR	NR	(S)1.42 +/- 0.13 (R)1.17+/- 0.13	NR	NR
Bratu et al (2009)	Yes	Prospective	MN	#48 /#48	#48 /#46	4M/6M/1y	Smooth/Rough	MIS-Implants Inc. Sandblasted and acid-etched	NR	NR	(S) 4M: 0.76/ 6M:1.22 / 12M: 1.5 (R) 4M: 0.22/ 6M: 0.57 /12M: 0.9	NR	NR
Goswami (2009)	No	Prospective	MN	#20 /#40	# NR / # NR	6/12/18M	Smooth 2mm /Rough	(S) Innova Oraltronics (R+microthreads)Nobel Biocare Replace	NR	NR	(S) 6M: 0.62 12M: 1.09 18 M: 1.53 (R) 6M: 0.59 12M: 1.00 18 M:1.42	NR	NR
Piao et al (2009)	NR	Prospective	MAX/MN	#54 / #135	#54 / #135	Baseline/1Y	Smooth/Rough	(S)Restore, (R)Nobel Biocare (TiUnite) (R)Hexplant	NR	NR	(S) 0.89± 0.41 (R+micro) 0.42± 0.27 (R) 0.81± 0.27	Yes	Yes
Stein et al (2009)	NR	Retrospective	MX	#42 / #61	#42 / #61	Baseline/5Y	Smooth 0.5-1.5mm/Rough	Biomet 3i- acid etched Zimmer Dental-blasted	NR	NR	(S) 1.55 ± 0.10 (R)–0.61 ± 0.08	NR	NR
Meijer et al (2009)	NR	Prospective	MN	# 90 / #180	# 90 / #180	10 y	Smooth/Rough	#30 subjects +2 implantst per company: Nobel Biocare Machine IMZ -TPS cylinder Straumann - TPS	#30 subjects +2 implantst per company: Nobel Biocare Machine IMZ -TPS cylinder Straumann -TPS	NR	Drop-outs (5 yrs): 7 subjects: (4) Nobel (3) Strauman ITI (S) - 3.0 ± 0.5 (R)IMZ - 3.8 ± 1.0 (R) ITI- 3.3 ± 1.0	NR	NR
S.Y.Lee et al (2010)	No	Prospective - RCT	MAX/MN	#54 /#135	#50 / #120	Baseline/1/3 yrs	Smooth 3mm/Rough	(S)Restore Machine (R)Nobel Biocare (TiUnite) Anodized (R+ microthreds)-Hexplant	NR	NR	(S): 0.81± 0.27 / 0.95±0.27 Hybrid(3mm):0.89±0.41 / 1.05 ± 0.3 (R) 0.42±0.27 / 0.59±0.30	NR	NR
Penarrocha-Diago et al (2012)	NR	Prospective-RCT	MAX/MN	#18 / #141	#15 / #120	6/12 M(1Y)	Smooth/Rough	(S)Osseous (R)Inhex RBM-resorbable blast material	NR	NR	(S) 0.27±0.43 / 0.38 ±0.51 (R) 0.07±0.13 / 0.12±0.17	NR	NR

Table 1: Summary of the inclusion studies

Randomized controlled trials (RCT), cohort studies, non-randomized but controlled clinical trials, and prospective and retrospective clinical studies that compare smooth and rough collar osseointegrated dental implants and their summaries. *Randomized Clinical Trial (RCT).

All literature reviews and systematic reviews that involve studies without indications of bone measurements, animal studies, in vitro studies, case reports or case studies, studies of implants associated with bone grafting procedures, immediate implant placement, and immediate loading implants (loading within 24 hours following implant placement and early loading after 24 hours).

ii) Presence of any local or systemic disease that might contraindicate treatment, such as periodontal disease, severe smoking habit, uncontrolled diabetes, bone diseases, drugs or conditions that decrease blood supply, and radiotherapy [52].

Matching assessments

- Data: obtained from patient records (record sheets, radiographs, medical history, and clinical records).
- Implant location: mandible or maxilla with sufficient bone; one or two-stage surgery were allowed; radiographic peri-implant to measure the marginal bone height,
- Characteristics of the implant: neck length from 0.5 to 2.8 mm; implant of any diameter (3.3 - 3.5, 3.75-4.3, or 5 - 6 mm) or length; cantilevers (none).
- Technique for implant placement: delayed implants placement, not in grafted bone or in post-extraction sockets; not in periodontally compromised sites; phasing of implant restoration (two-stage: insertion of the implant in the first surgical procedure, followed by a healing period of 4 - 6 months, and abutment connection in the second surgical procedure; one-stage: implant and healing abutment insertion;
- Type of prosthetic restoration: single tooth, fixed restoration or overdenture; type of material used in the restoration (ceramic, metal-ceramic, metal-acrylic, or acrylic); screw or cemented restoration.

Identification of the studies

Two independent reviewers evaluated initial candidates for inclusion. The titles were scanned from all studies identified through the electronic search to meet the inclusion criteria or identify those without sufficient data in the title and abstract to make a clear decision to consider the full report (Figure 1). Subsequently, abstracts of all titles were downloaded and evaluated individually. If the abstract met the inclusion criteria, the full text was obtained, and evaluated. At this phase, the manual search from references of the full texts selected were individually searched and agreed to be included in the systematic review. The reviewers agreed on the final selection of the articles. All disagreement was successfully resolved.

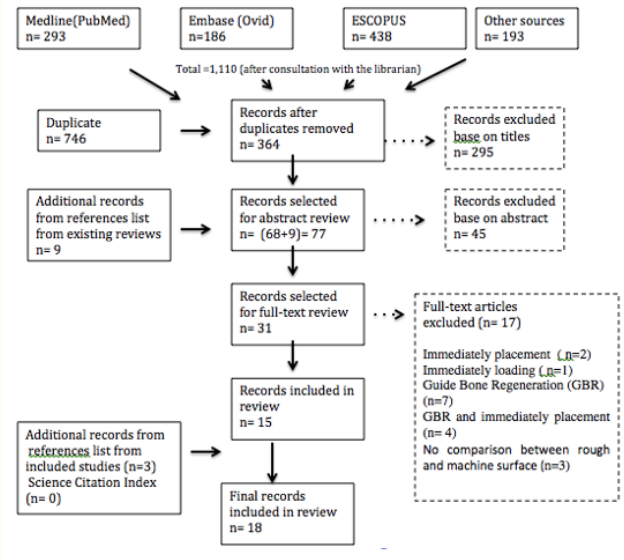


Figure 1: Search strategy studies were performed in order to include/exclude articles from the systematic review and implemented the meta-analysis on the final 18 articles.

Extraction of data

Data regarding the following parameters were extracted: type of study; setting of study; patient age, sex, systemic disease, and smoking habits; tooth replaced by the implant; reason for extraction; bone defect; probing depth (PD) or recession; tissue biotype; treatment; immediate or late implant placement; implant dimensions and brand; type of surgery (i.e., flap elevation or flapless); bone graft; restoration type; follow-up period; treatment outcome; soft tissue changes; hard tissue changes; complications; and implant survival rate.

Data collection

The following information was collected from each included study and inserted into a specifically designed electronic summary, including names of the authors, year of publication, study design, total number of subjects at baseline, total number of implants at

baseline, total number of subjects at follow-up, total number of implants at follow-up, number of implant fixtures per arch, years of mean follow-up, placement protocol (delayed implant placement); loading protocols (loading after 2 months or more following implant placement), types of surface collar (machined/rough) and manufacturer of inserted implants, cumulative implant survival, cumulative prosthesis survival, mean alveolar bone loss (mm/years of follow-up) by probing or x-rays, incidence of prosthetic complications (number of events). These study characteristics is summarized in Table 1 (Table 1).

1. Strategies to prevent, or limit, bias included: diagnosis using.
2. Several clinical and radiographic criteria and including only.
3. Implant restorations with at least 1 year of follow-up (to prevent diagnostic error); the exclusion of patients current.

Quality and risk of bias assessment and analysis study selection

Two authors independently evaluated the quality and risk for bias of the all included studies, using the criteria of Annibali., *et al* [53] (Table 2).

Author(s)	Patients collected in more than one center?	Where was the study conducted?	Aim of study described?	Inclusion & Exclusion criteria reported?	Definition of outcomes reported?	Prospective Data?	Main findings of study clearly described?	Losses to follow-up described?
Astrand., *et al*. (1999)	NR	NR	Partially	No	Yes	Yes	Partially	Partially
Gotfredsen., *et al*. (2001)	Yes	Multicenter	Yes	Yes (I)	Yes	Yes	Yes	Yes
Engquist et al. (2002)	NR	NR	Partially	No	Yes	Yes	Partially	Partially
Astrand., *et al*. et al (2004a)	NR	NR	Partially	Yes (I)	Partially	No	Partially	Partially
Astrand., *et al*. et al (2004b)	Yes	Multicenter	Partially	No	Partially	Yes	Partially	Yes
Wennstrom., *et al*.	No	University	Yes	No	Yes	Yes	Yes	Yes
Meijer., *et al*. (2004)	No	Hospital	Yes	No	Yes	Yes	Yes	Yes
Zechner., *et al*. (2004)	NR	NR	Partially	No	Partially	No	Partially	No
Shin., *et al*. (2006)	No	Hospital	Yes	Yes	Yes	Yes	Yes	Yes
Watzak., *et al*. (2006)	Yes	University	Yes	Yes	Yes	No	Partially	NR
Bratu., *et al*. (2009)	No	University	Yes	Yes	Yes	Yes	Yes	Yes
Goswami (2009)	NR	NR	Yes	Yes (I)	Yes	Yes	Partially	NR
Meijer., *et al*. (2009)	No	Hospital	Yes	No	Yes	Yes	Yes	Yes
Piao., *et al*. (2009)	No	University	Yes	Yes	Yes	Yes	Yes	Yes
Stein., *et al*. (2009)	No	University	Yes	Yes	Partially	Partially	Partially	No
S.Y.Lee et al (2010)	No	University	Yes	Yes	Yes	Yes	Yes	Yes
Arnhart., *et al*. (2013)	No	University	Yes	Yes (E)	Yes	No	Yes	Yes
Penarrocha-Diago., *et al*. (2012)	No	University	Yes	Yes	Yes	Yes	Yes	Yes

Table 2: Quality and risk of bias assessment description of the randomization process of all included 18 articles and follow up, using the criteria of Annibali., *et al* [53].

Nevertheless, in some clinical situations, both classical and retrograde pathways may overlap. Strategies to prevent or limit bias include: diagnosis using clinical parameters and radiographic criteria to measure the bone height and to include only implants loaded for at least 1 year (to prevent diagnostic error).

Marginal bone loss

Marginal Bone Loss (MBL) was defined as the distance between the implant-abutment interface and the crestal bone to implant contact. The implant-abutment interface was used as a reference point because it is always present and easy to recognize. However, on ITI implants, because the border is not perceptible on radiographs, the crest was used.

Most studies sourced their images from intraoral x-rays, but panoramic radiographs were used in two articles, Watzak., *et al* 2006 [38] and Arnhart., *et al* 2012, [54] and one, Goswami 2009 [55] used computed tomography (CT). In all cases, distal and mesial measurements (as well as buccal and lingual sites, if available) were averaged prior to analysis. Dimensional distortion in all images was corrected using the ratio between the apparent implant dimension and the actual implant size. To determine the apparent dimension, a magnifying lens (x7), with a measuring scale divided into 0.1 mm graduations, was used.

Data analysis

Some studies employed multiple implants in the same subjects, but analyzed those data as if they were independent observations. To correct for the likely underestimation of residual variability in those studies, people rather than implants were used when computing standard errors. The use of a reduced sample may limit power, but it was chosen so as to be conservative in the sense of protecting against rejecting true null hypotheses. While the ideal solution would have involved the use of mixed models in the original analysis, this information could not be recovered from the published reports. Meta-analysis was performed using Review Manager (Version 5.3, Nordic Cochrane Centre, Copenhagen, DK) and employed random effects models

Results

Literature search

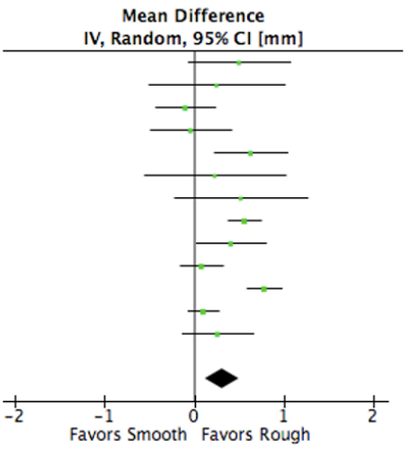
Of studies published between 1999 and February 2016, 1,110 evaluated adult patients treated with dental implants, including 293 from Medline (PubMed), 186 from Embase (OVID), 438 from SCOPUS, 193 from other sources including The Cochrane Library, and 9 articles that were found through hand searches of the cited literature. After duplicate articles were removed, 364 articles remained. Of these, seventy-seven that satisfied criteria for further evaluation and 31 of those remained after noting exclusion criteria in the abstract. After completely screening the full-text articles, another 17 studies then failed to meet the inclusion criteria. Notice that three articles were removed from those otherwise meeting selection criteria because they did not report standard deviation (SD) or standard error (SE) [Pecora., *et al* (2009) [56]; Zetterqvist., *et al* (2010) [57]; Nickening., *et al* (2013) [58].

The publication data of the selected studies ranged between 1999 - 2016, including eight articles between 1999 and 2004 and ten articles between 2009 and 2011, when modification of the neck of the implant started to receive special attention.

Follow-up times ranged from 1 to 10 years. Out of the eighteen selected articles, seven had a one-year follow-up, three with three years, six with five years and one each with seven years and ten years. Several groups followed their cohort and published at multiple follow-up intervals. Thus, Astrand [59-61] reported at 1, 3, and 5 years follow-ups, while Piao., *et al*. [62] and Lee., *et al*. [63] reported at both 1 and 3 years. Meijer., *et al* in 2009 [64] reported at 1, 3, 5 and 10 years. Analysis always stratified by follow-up time, so subjects in these studies were never 'double-counted'.

A detailed description of the study quality and risk of bias of all 18 articles are shown in Table 2. Methodological quality of the 11 randomized trials was high or moderate. However, the risk of bias was high in four studies; moderate in two studies that only partially reported the exclusion and inclusion criteria, and low in four studies that did not provide appropriate descriptions of the randomization process and description of follow-ups (Table 2).

To summarize results, 11 of the 13 studies with up to 1-year of follow-up reported less marginal bone loss when rough than machined neck surface implants were used, with more bone loss in the maxillary arch. Two of these studies found significant differences (Table 3).



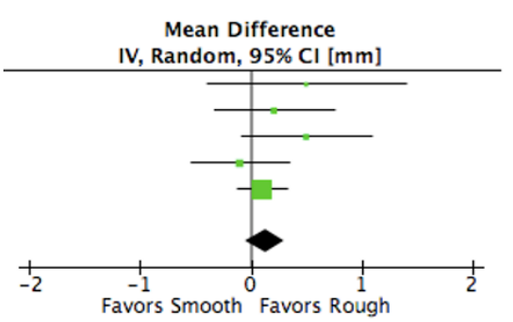
	Smooth			Rough				Mean Difference	
Study or Subgroup	Mean [mm]	SD [mm]	Total	Mean [mm]	SD [mm]	Total	Weight	IV, Random, 95% CI [mm]	Year
Astrand 1999 (Mn)	1.74	0.8	16	1.24	0.84	16	5.8%	0.50 [-0.07, 1.07]	1999
Astrand 1999 (Max)	1.97	0.74	16	1.72	1.4	17	4.1%	0.25 [-0.51, 1.01]	1999
Meijer 2004 (Mn ITI)	0.2	0.7	30	0.3	0.6	29	8.8%	-0.10 [-0.43, 0.23]	2004
Wennstrom 2004 (Both)	0.29	0.85	25	0.33	0.78	25	7.1%	-0.04 [-0.49, 0.41]	2004
Astrand 2004a (Mn)	1.9	0.48	16	1.27	0.7	17	7.7%	0.63 [0.22, 1.04]	2004
Astrand 2004a (Max)	1.97	0.72	16	1.74	1.48	17	3.9%	0.23 [-0.56, 1.02]	2004
Astrand 2004b (Max)	2.12	1.22	28	1.6	1.59	28	4.2%	0.52 [-0.22, 1.26]	2004
Shin 2006 (Both)	1.32	0.27	13	0.76	0.21	14	10.8%	0.56 [0.38, 0.74]	2006
Watzak 2006 (Mn)	1.46	1.12	64	1.05	1.08	60	8.0%	0.41 [0.02, 0.80]	2006
Piao 2009 (Both)	0.89	0.41	16	0.81	0.27	17	10.1%	0.08 [-0.16, 0.32]	2009
Bratu 2009 (Mn)	1.47	0.4	23	0.69	0.25	23	10.7%	0.78 [0.59, 0.97]	2009
Goswami 2009 (Mn)	1.13	0.25	20	1.03	0.3	20	10.9%	0.10 [-0.07, 0.27]	2009
Penarrocha-Diago 2012 (Both)	0.38	0.51	7	0.12	0.17	8	7.9%	0.26 [-0.14, 0.66]	2012
Total (95% CI)			**290**			**291**	**100.0%**	**0.32 [0.13, 0.51]**	

Heterogeneity: $Tau^2 = 0.08$; $Chi^2 = 49.90$, df = 12 ($P < 0.00001$); $I^2 = 76\%$
Test for overall effect: Z = 3.35 (P = 0.0008)

Table 3: Meta-analysis at a 1-year follow-up reported less marginal bone loss on rough neck surface than machine neck surface implants with more bone loss in the maxilla arch. Two of these studies found significant differences.

Three of the five studies with three-year follow-up favored rough implants, none significant. Five of the nine studies with five-years follow-up favored rough implants; 2 or those studies were significant in favor of the rough surface, and one study significantly favored the smooth surfaced implants (Tables 4 and 5). Two studies with 7 and 10 year follow-up showed slightly smaller loss of marginal bone with rough than machined implant neck surfaces [54,65].

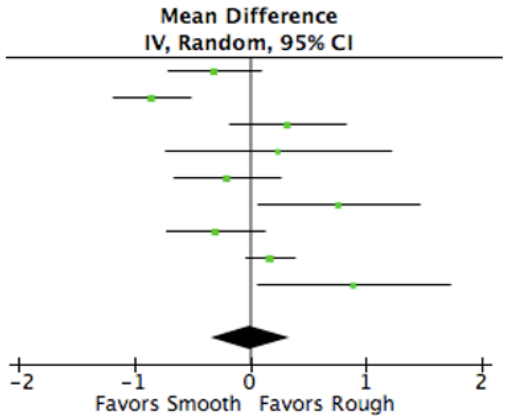
Additionally, the included studies have been evaluated for any potential publication, reporting or attrition bias.



	Smooth			Rough				Mean Difference	
Study or Subgroup	Mean [mm]	SD [mm]	Total	Mean [mm]	SD [mm]	Total	Weight	IV, Random, 95% CI [mm]	Year
Engquist 2002 (Max)	2.06	1.12	17	1.56	1.52	17	3.8%	0.50 [-0.40, 1.40]	2002
Engquist 2002 (Mn)	1.39	0.78	15	1.18	0.78	17	10.5%	0.21 [-0.33, 0.75]	2002
Astrand 2004b (Max)	1.8	0.66	26	1.3	1.38	26	8.9%	0.50 [-0.09, 1.09]	2004
Meijer 2004 (Mn ITI)	0.4	0.9	28	0.5	0.8	29	15.7%	-0.10 [-0.54, 0.34]	2004
Lee 2010 (Both)	1.05	0.34	14	0.95	0.27	15	61.1%	0.10 [-0.12, 0.32]	2010
Total (95% CI)			**100**			**104**	**100.0%**	**0.13 [-0.04, 0.31]**	

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 3.36$, df = 4 ($P = 0.50$); $I^2 = 0\%$
Test for overall effect: Z = 1.46 (P = 0.14)

Table 4: Meta-analysis at a 3 years follow-up where three of five studies favored rough implants, none significant.



Study or Subgroup	Smooth Mean	Smooth SD	Smooth Total	Rough Mean	Rough SD	Rough Total	Weight	Mean Difference IV, Random, 95% CI	Year
Gotfredsen 2001 (Max)	0.21	0.83	46	0.52	1.11	46	12.6%	-0.31 [-0.71, 0.09]	2001
Gotfredsen 2001 (Mn)	0.22	1.13	46	1.07	0.22	46	13.3%	-0.85 [-1.18, -0.52]	2001
Astrand 2004a (Mn)	1.38	0.66	15	1.06	0.76	16	11.5%	0.32 [-0.18, 0.82]	2004
Astrand 2004a (Max)	1.98	0.84	16	1.74	1.62	13	6.8%	0.24 [-0.73, 1.21]	2004
Meijer 2004 (Mn ITI)	0.7	0.8	26	0.9	0.9	27	11.9%	-0.20 [-0.66, 0.26]	2004
Zechner 2004 (Mn)	2.4	2.01	76	1.64	2.23	68	9.3%	0.76 [0.06, 1.46]	2004
Meijer 2009	3	0.5	27	3.3	1	27	12.3%	-0.30 [-0.72, 0.12]	2009
Stein 2009 (Max)	0.36	0.31	27	0.19	0.52	34	14.3%	0.17 [-0.04, 0.38]	2009
Amhart 2012 (Mn, 7 y)	2.42	1.23	13	1.53	1.46	34	8.0%	0.89 [0.06, 1.72]	2012
Total (95% CI)			**292**			**311**	**100.0%**	**0.01 [-0.34, 0.35]**	

Heterogeneity: $Tau^2 = 0.20$; $Chi^2 = 42.28$, df = 8 ($P < 0.00001$); $I^2 = 81\%$
Test for overall effect: Z = 0.04 (P = 0.97)

Table 5: Meta-analysis at a 5-year follow-up where five of nine studies favored rough implants, two of those studies were significant in favor of the rough surface, and one study significantly favored to the smooth surfaced implants.

Discussion

The rationale behind this systematic review was to compare marginal bone loss (MBL) of implants with a rough surfaced collar, with or without micro threads, to implants with machined collar. MBL (Marginal Bone Loss), has been suggested to be the major criterion for implant success [34] and is considered a major etiologic factor for peri-implant diseases [7,30,35,66-72].

During the last three decades, many modifications on the collar of the implant have been developed to improve the long-term success of the implant procedure.

The fundamental reasons for the absence of a standard protocol on implant collar surface are the following:

a) Lack of well-conducted randomized clinical trials (RCT) with long-term follow-up;

b) There are only a few comparative studies investigating the smooth and rough implant neck designs;

c) Lack of standard protocol and criteria. Different studies use different implant neck designs and criteria, which makes comparison difficult. This affects the homogeneity of trials, when carrying out systematic reviews;

d) Different study analyses uses different measures. Often, these are not specified in the publications, making it impossible to compare results of different trials. An example is the evaluation of the measurements and the difference between the standard deviation (SD) and standard error (SE);

e) Existence of insufficient number of studies with long-term (five to ten years) follow-up.

Evaluating the implant collar surface and MBL (Marginal Bone Loss), there has not been enough attention addressed to the complications of peri-implant diseases (mucositis and peri-implantitis), especially on how to prevent it, to read the implant soft tissue, to treat it, and to repair the defect it creates. Long-term research is urgently needed to address these important areas of dentistry and implant clinical training.

The limitations of the study include

The electronic search was restricted to the most recognized dental journals, and so this systematic review may not have identified all relevant articles, particularly those conducted unpublished, by the manufacturers.

Different types of implant neck surfaces, lengths, design and manufacturers may be a factor leading to heterogeneity in the evaluation of crestal bone alteration, kinds of restorations, which could also lead to inconsistent results.

In terms of the study designs and protocols, four studies tested rough and smooth implants in the same subjects [Gotfredsen., *et al* (2001) [46], Wennstrom., *et al* (2004) [69], Bratu., *et al* (2009) [66], Goswami (2009) [55]; therefore, the randomization process in such a scheme can be difficult to achieve. The potential for bias is always a concern, which is another limitation of this study.

Another factor to be considered is the effect of single prosthesis, comparing to splinting cases that provide additional forces, consequentially more marginal bone resorption.

May be there is a difference in MBL (Marginal Bone Loss), at early period, meaning before loading lead to crestal bone remodeling, which was not detected by this systematic review literature.

Notice that the articles before 2004 have more variables than the recent ones, which may contribute to the heterogeneity effect (Tables 3-5).

Implants with machined collar would appear to experience similar marginal bone loss at long-term and less complications leading to higher patient oral quality of life. However, some clinicians believe that implants with rough collar, placed subcrestally, produce better levels of patient satisfaction because of the aesthetics results [18,19,60,67,73-76].

Conclusion

After analyzing 18 studies, results failed to provide evidence that either type of implant collar surface leads to superior marginal bone levels in patients over time. While the meta-analysis indicated significantly less marginal bone loss in rough than smooth surface implants at short follow-up intervals, there was also significant heterogeneity among those studies. Studies reporting on follow-up after 3 or more years failed to show an MBL (Marginal Bone Loss), advantage for either surface texture. Further, the magnitude of average differences failed to achieve clinically relevant levels at any follow-up interval.

Long-term research is needed to address the implant neck surface consequences, with special attention to the preservation of bone structure at the implant interface for long-term predictability [20,30,34,35].

Acknowledgment

There were no financial relationships between any of the authors and the manufacturers of products involved in this present study. The authors thank the New York University Dental Research Librarian, Richard C. McGowan. In addition, a special thanks the Eastman Institute of Oral Health University of Rochester for the inspiration during this project; Jack Caton DDS, MS, Sorin Teich DMD, MBA, FACD, Eli Eliav DMD, PhD and Ronald J. Billings, DDS, MSD.

Bibliography

1. Brånemark PI., *et al*. "Intra-osseous anchorage of dental prostheses. I. Experimental studies". *Scand Journal of Plastic Reconstructive Surgery* 3 (1969): 81-100.

2. Buser D., *et al*. "Influence of surface characteristics on bone integration of titanium implants. A histomorphometric study in miniature pigs". *Journal of Biomedical Materials Research* 25 (1991): 889-902.

3. Deporter DA., *et al*. "A histological comparison in the dog of porous-coated vs. threaded dental implants". *Journal of Dental Research* 69 (1990): 1138-1145.

4. Quirynen M., *et al*. "An in vivo study of the influence of the surface roughness of the implant on the microbiology of supra- and subgingival plaque". *Journal of Dental Research* 72.9 (1993):1304-1309.

5. Lin GH., *et al*. "The significance of keratinized mucosa on implant health: a systematic review". *Journal of Periodontology* 84.12 (2013):1755-1767.

6. Albrektsson T and Wennerberg A. "Oral implant surfaces: Part 1 – review focusing on topographic and chemical properties of different surfaces and in vivo responses to them". *International Journal of Prosthodontics* 17 (2004): 536-543.

7. Alberektsson T and Wennerberg A. "Oral Implant Surfaces: Part 2—Review Focusing on Clinical Knowledge of Different Surfaces. Oral Implant Surfaces: Part 2". *The International Journal of Prosthodontics* 17.5 (2004): 544-564.

8. Åstrand P., *et al*. "Nonsubmerged implants in the treatment of the edentulous upper jaw: A prospective clinical and radiographic study of ITI implants— Results after 1 year". *Clinical Implant Dentistry and Related Research* 2 (2000): 166-174.

9. Berglundh T., *et al*. "The soft tissue barrier at implants and teeth". *Clinical Oral Implants Research* 2 (1991): 81-90.

10. Binon PP. "Implants and components: Entering the new millennium". *The International Journal of Oral and Maxillofacial Implants* 15 (2000): 76-94.

11. Norton MR. "Marginal bone levels at single tooth implants with a conical fixture design. The influence of surface macro- and microstructure". *Clinical Oral Implants Research* 9 (1998): 91-99.

12. Oh TJ., *et al*. "The causes of early implant bone loss: myth or science?". *Journal of Periodontology* 73 (2002): 322-333.

13. Buser D., *et al*. "Clinical experience with one-stage, non-submerged dental implants". *Advances in Dental Research* 13 (1999): 153-161.

14. Buser D., *et al*. "10-year survival and success rates of 511 titanium implants with a sandblasted and acid-etched surface: a retrospective study in 303 partially edentulous patients". *Clinical Implant Dentistry and Related Research* 14.6 (2012): 839-851.

15. Valderrama P., *et al*. "Bone changes around early loaded chemically modified sandblasted and acid-etched surfaced implants with and without a machined collar: A radiographic and resonance frequency analysis in the canine mandible". *The International Journal of Oral and Maxillofacial Implants* 25 (2010): 548-557.

16. Adell R., *et al*. "Long- term follow-up study of osseointegrated implants in the treatment of totally edentulous jaws". *The International Journal of Oral and Maxillofacial Implants* 5 (1990): 347-359.

17. Romanos GE., *et al*. "Long-term results after subcrestal or crestal placement of delayed loaded implants". *Clinical Implant Dentistry and Related Research* 17.1 (2015): 133-141.

18. Wennerberg A., *et al*. "Implant Surfaces and their Biological and Clinical Impact". *Springer* 7.8 (2015): 65-88.

19. Wennerberg A and Albrektsson T. "Effects of titanium surface topography on bone integration: a systematic review". *Clinical Oral Implants Research* 20.4 (2009): 172-184.

20. Albrektsson T and Isidor F. "Consensus report of session IV". In: Lang NP, Karring T (eds). Proceedings of the First European Workshop on Periodontology. London: Quintessence (1994): 365-369.

21. Albrektsson TO., *et al*. "Biological aspects of implant dentistry: osseointegration". *Periodontol 2000* 4 (1994): 58-73.

22. Lee DW., *et al*. "Effect of microthread on the maintenance of marginal bone level: a 3- year prospective study". *Clinical Oral Implants Research* 18 (2007): 465-475.

23. Romanos GE., *et al*. "Immediately loaded platform-switched implants in the anterior mandible with fixed prostheses: a randomized, split-mouth, masked prospective trial". *Clinical Implant Dentistry and Related Research* 16.6 (2014): 884-892.

24. Lazzara RJ and Porter SS. "Platform switching: a new concept in implants dentistry for controlling post restorative crestal bone levels". *International Journal of Periodontics and Restorative Dentistry* 26 (2006): 9-17.

25. Renvert S., *et al*. "How do implant surface characteristics influence peri- implant disease?". *Journal of Clinical Periodontology* 38.1 (2011): 214-222.

26. Bateli M and Att W. "Neck Configurations for Preservation of Marginal Bone Level: A Systematic Review". *The International Journal of Oral and Maxillofacial Implants* 26 (2011): 290-303.

27. Hänggi MP., *et al*. "Crestal bone changes around titanium implants. Part I: A retrospective radiographic evaluation in humans comparing two non-submerged implant designs with different machined collar lengths". *Journal of Periodontology* 76 (2005): 791-802.

28. Hartman GA and Cochran DL. "Initial implant position determines the magnitude of crestal bone remodelling". *Journal of Periodontology* 75.4 (2004): 572-577.

29. Vouros ID., *et al*. "Systematic assessment of clinical outcomes in bone-level and tissue-level endosseous dental implants". *The International Journal of Oral and Maxillofacial Implants* 27.6 (2012):1359-1374.

30. Lindhe J and Meyle J. "Peri-implant diseases: Consensus report of the Sixth European Workshop on Periodontology". *Journal of Clinical Periodontology* 35.8 (2008): 282-285.

31. Lang NP., *et al*. "Clinical and microbiological effects of subgingival restorations with overhanging or clinically perfect margins". *Journal of Clinical Periodontology* 10 (1983): 563-578.

32. Esper LA., *et al*. "The role of keratinized mucosa in peri-implant health". *The Cleft Palate-Craniofacial Journal* 49.2 (2012):167-170.

33. Paiva RBM., *et al*. "Peri-implant tissues health and its association to the gingival phenotype". *Dental Press Implantology* 6.4 (2012):104-113.

34. Albrektsson T and Isidor F. "Consensus report of session IV". In: Lang NP, Karring T (eds). Proceedings of the First European Workshop on Periodontology. London: Quintessence (1994): 365-369.

35. Albrektsson T., *et al*. "Statements from the Estepona Consensus Meeting on Peri-implantitis, February 2–4, 2012". *Clinical Implant Dentistry and Related Research* 14.6 (2012): 781-782.

36. Cosyn J and Sabzevar MM. "Commentary: Two-Piece Implants with Turned Versus Microtextured Collars". *Journal of Periodontology* 78.9 (2007): 1657-1663.

37. Abu-Hammad O., *et al*. "Effect of dental implant cross-sectional design on cortical bone structure using finite element analysis". *Clinical Implant Dentistry and Related Research* 9 (2007): 217-221.

38. Watzak G., *et al*. "Radiological and clinical follow-up of machined- and anodized-surface implants after mean functional loading for 33 months". *Clinical Oral Implants Research* 17 (2006): 651-657.

39. Pecora GE., *et al*. "Clinical Evaluation of Laser Microtexturing for Soft Tissue and Bone Attachment to Dental Implants". *Implant Dentistry* 18.1 (2009): 57-66.

40. Botos S., *et al*. "The Effects of Laser Microtexturing of the Dental Implant Collar on Crestal Bone Levels and Peri-implant Health". *The International Journal of Oral and Maxillofacial Implants* 26.3 (2011): 492-498.

41. Quirynen M and Bollen CM. "The influence of surface roughness and surface-free energy on supra and subgingival plaque formation in man. A review of the literature". *Journal of Clinical Periodontology* 22.1 (1995):1-14.

42. Misch CE. "Contemporary implant dentistry". *Elsevier Health Sciences* 33 (2007): 735-762.

43. Mombelli A., *et al.* "The epidemiology of peri-implantitis". *Clinical Oral Implants Research* 23.6 (2012): 67-76.

44. Heitz-Mayfield LJ., *et al*. "The therapy of peri-implantitis: A systematic review". *The International Journal of Oral and Maxillofacial Implants* 29 (2014): 325-345.

45. Claudio M., *et al*. "Prevalence and Possible Risk Factors of Peri-implantitis- A Concept Review". *The Journal of Contemporary Dental Practice* 16 (2015): 750-757.

46. Gotfredsen K and Karlsson U. "A prospective 5 years study of fixed partial prostheses supported by implants with machined and TiO2-blasted surface". *Journal of Prosthodontics* 10.1 (2001): 2-7.

47. Hermann JS., *et al*. "Influence of a machined collar on crestal bone changes around titanium implants: a histometric study in the canine mandible". *Journal of Periodontology* 82.9 (2011): 1329-1338.

48. Stein AE., *et al*. "Effects of implant design and surface roughness on crestal bone and soft tissue levels in the esthetic zone". *The International Journal of Oral and Maxillofacial Implants* 24.5 (2009): 910-919.

49. Renvert S., *et al*. "Treatment modalities for peri-implant mucositis and peri-implantitis". *American Journal of Dentistry* 26.6 (2013): 313-318.

50. Calvo Guirado JL., *et al*. "Influence of collar design on peri-implant tissue healing around immediate implants: A pilot study in Foxhound dogs". *Clinical Oral Implants Research* 26.7 (2015): 851-857.

51. Negre B., *et al*. "Peri-implant soft tissues around implants with a modified neck surface. Part 1 Clinical and histometric outcomes: a pilot study in minipigs". *Journal of Clinical Periodontology* 40.4 (2013): 412-420.

52. Alsaadi G., *et al*. "Local and systemic factors on late implant loss". *Clinical Oral Implants Research* 19 (2008): 670-676.

53. Annibali S., *et al*. "Short dental implants: a systematic review". *Journal of Dental Research* 91 (2011): 25-32.

54. Arnhart C., *et al*. "Impact of implant surface topography: a clinical study with a mean functional loading time of 85 months". *Clinical Oral Implants Research* 24.9 (2013): 1049-1054.

55. Goswami MM. "Comparison of Crestal Bone Loss along Two Implant Crest Module Designs". *Medical Journal Armed Forces India* 65 (2009): 319-322.

56. Pecora GE., *et al*. "Clinical Evaluation of Laser Microtexturing for Soft Tissue and Bone Attachment to Dental Implants". *Implant Dentistry* 18.1 (2009): 57-66.

57. Zetterqvist L., *et al*. "A prospective, multicenter, randomized-controlled 5-year study of hybrid and fully etched implants for the incidence of peri-implantitis". *Journal of Periodontology* 81.4 (2010): 493-501.

58. Nickenig HJ., *et al*. "A 5-year prospective radiographic evaluation of marginal bone levels adjacent to parallel-screw cylinder machined-neck implants and rough-surfaced microthreaded implants using digitized panoramic radiographs". *Journal of Cranio-Maxillofacial Surgery* 41.7 (2013): 564-568.

59. Astrand P., *et al*. "Astra Tech and Branemark implant system implants: a prospective 5 -year a comparative study. Results after one year". *Clinical Implant Dentistry and Related Research* 1 (1999): 17-26.

60. Engquist B., *et al*. "Marginal bone reaction to oral implants: a prospective comparative study of Astra Tech and Branemark implant system implants". *Clinical Oral Implants Research* 13 (2002): 30-37.

61. Astrand P., *et al*. "Astra Tech and Branemark System implants. a 5-year prospective study of marginal bone reactions". *Clinical Oral Implants Research* 15 (2004a): 413-420.

62. Piao CM., *et al*. "Marginal bone loss around three different implant systems: radiographic evaluation after 1 year". *Journal of Oral Rehabilitation* 36.10 (2009): 748-754.

63. Lee SY., *et al*. "A 3-year prospective radiographic evaluation of marginal bone level around different implant systems". *Journal of Oral Rehabilitation* 37 (2010): 538-544.

64. Meijer HJ., *et al*. "Mandibular overdentures supported by two Brånemark, IMZ or ITI implants: a ten-year prospective randomized study". *Journal of Clinical Periodontology* 36.9 (2009):799-806.

65. Shin YK., *et al*. "Radiographic Evaluation of Marginal Bone Level Around Implants with Different Neck Designs After 1 Year". *The International Journal of Oral and Maxillofacial Implants* 21.5 (2006): 789-794.

66. Astrand P., *et al*. "Three-year follow-up report of a comparative study of ITI Dental Implants and Brånemark System implants in the treatment of the partially edentulous maxilla". *Clinical Implant Dentistry and Related Research* 6.3 (2004b):130-141.

67. Meijer HJ., *et al*. "Mandibular overdentures supported by two Brånemark, IMZ or ITI implants: a 5-year prospective study". *Clinical Oral Implants Research* 15.4 (2004): 421-427.

68. Wennstrom JL. "Lack of association between width of attached gingiva and development of soft tissue recession: A 5year longitudinal study". *Journal of Clinical Periodontology* 14 (1987): 181-184.

69. Zechner W., *et al*. "Radiographic follow-up of peri-implant bone loss around machine-surfaced and rough surfaced interforaminal implants in the mandible functionally loaded for 3 to 7 years". *The International Journal of Oral and Maxillofacial Implants* 19 (2004): 216-222.

70. Bratu EA., *et al*. "A rough surface implant neck with microthreads reduces the amount of marginal bone loss: a prospective clinical study". *Clinical Oral Implants Research* 20.8 (2009): 827-832.

71. Peñarrocha-Diago MA., *et al*. "Influence of implant neck design and implant-abutment connection type on peri –implant health. Health. Radiological study". *Clinical Oral Implants Research* 24.11 (2013): 1192-1200.

72. Albrektsson T., *et al*. "Statements from the Estepona Consensus Meeting on Peri-implantitis, February 2–4, 2012". *Clinical Implant Dentistry and Related Research* 14.6 (2012): 781-782.

73. Gotfredsen K and Karlsson U. "A prospective 5 years study of fixed partial prostheses supported by implants with machined and TiO2-blasted surface". *Journal of Prosthodontics* 10.1 (2001): 2-7.

74. Misch CE., *et al*. "Scientific rationale for dental implant design". In: Misch CE, editor. Contemporary Implant Dentistry 3rd ed. St. Louis: Mosby (2008): 200-232.

75. Sánchez-Siles M., *et al*. "Incidence of peri-implantitis and oral quality of life in patients rehabilitated with implants with different neck designs: A 10-year retrospective study". *Journal of Cranio-Maxillofacial Surgery* 43 (2001): 2168-2174.

76. Arnhart C., *et al*. "Impact of implant surface topography: a clinical study with a mean functional loading time of 85 months". *Clinical Oral Implants Research* 24.9 (2013): 1049-1054.

Volume 3 Issue 11 November 2019

© All rights are reserved by Klenise Silva Paranhos., *et al.*