Prevalence of Peri-Implantitis in Implants with Turned and Rough Surfaces: a Systematic Review

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ABSTRACT

Objectives: Moderately-rough implant surface may improve implant therapy in terms of bone integration, but the increased surface roughness might affect the initiation and development of peri-implantitis. The aim of the present review was to compare the prevalence of peri-implantitis in implants with rough and turned (machined) implant surfaces.
Material and Methods: An electronic literature search was conducted of the MEDLINE and EMBASE databases for articles published between 1 January 1990 and 1 March 2018. Clinical human studies in the English language that had reported on prevalence of peri-implantitis in tuned and rough surface implants were searched. The initial search resulted in 690 articles.
Results: Eight articles with 2992 implants were included in the systematic review. The incidence of peri-implantitis for two implant surfaces varied between studies. A meta-analysis was not feasible due to the heterogeneity among studies. Implant with rough surfaces were more favourable for plaque accumulation during short-term follow-up. On a long-term, turned implants surfaces were associated with more plaque and higher peri-implant bone loss. Peri-implant clinical parameters and survival rate for two implant surfaces was similar.
Conclusions: Within the limitations of the present study, rough implant surface does not seem to increase the incidence of peri-implantitis in comparison to turned implants surface.

Keywords: dental implant; osseointegrated dental implantation; peri-implantitis; systematic review; titanium.

Accepted for publication: 12 March 2019
To cite this article:
Saulacic N, Schaller B.
Prevalence of Peri-Implantitis in Implants with Turned and Rough Surfaces: a Systematic Review
J Oral Maxillofac Res 2019;10(1):e1
URL: http://www.ejomr.org/JOMR/archives/2019/1/e1/v10n1e1.pdf
doi: 10.5037/jomr.2019.10101

INTRODUCTION

Dental implant rehabilitation has become a standard procedure to replace the missing or hopeless teeth. Several longitudinal studies have reported high survival rates on a long-term of the implants over a period up to 10 years [1,2]. Different risk factors have been identified since first implants with turned, minimally rough surface (Sa 0.5 to 1 µm) were placed, including location and length of < 10 mm [3,4]. Many techniques have been developed including titanium plasma spraying, acid etching or grit blasting, with the aim of improving the osseointegration and decrease the possibility of early implant failure [5-7]. The introduction of new, moderately rough implant surface (Sa 1 to 2 µm) enhanced strongest bone response and are currently the most used [8,9]. Despite of these encouraging data, clinicians had to consider several types of complications that may be encountered. Marginal bone loss (MBL) around moderately rough implants was higher as compared to turned surface implant, without being significant [6,10-12].

Plaque-induced peri-implantitis is one of the most common late biological complication in dental implantology [13]. It can be defined as a site-specific condition characterized by an inflammatory reaction that involves the hard and soft tissue, with loss of supporting bone around osseointegrated dental implants [14-16]. Peri-implantitis is often associated with bleeding at the peri-implant margin after the insertion of a periodontal probe into the peri-implant space, increased peri-implant pocket-probing depth, mucosal recession, and/or suppuration [17]. Actually, the differential diagnosis between peri-mucositis and peri-implantitis relay on the supportive bone loss in addition to the inflammatory process around an implant [18]. The incidence of peri-implant mucositis ranged from 30.7 to 50% and for peri-implantitis from 9.6 to 40% of sites [19,20]. Numerous etiological factors play a role for the prevalence and progression of infection; micro and macro design of the implant, the abutment connection, the passivation of the prosthesis and excessive mechanical load were all related with the disease [21]. Furthermore, periodontitis and smoking are considered the two most common patient-related risk factors for biological problems [22-24]. If only one of these could starts a chain reaction leading to lesions, then they generally play the role of worsening factors each for the others [25]. Nevertheless, bacterial adhesion and biofilm formation on the implant surface is often an initial step in peri-implantitis. Moderately-rough implant surface may improve implant therapy, but the increased surface roughness might affect the initiation and development of peri-implantitis [26]. When exposed to the oral environment, implants with rough surface may facilitate the accumulation of plaque [27,28], affecting the equilibrium with the host [29,30]. Consequently, implants with rough implant surface might lose more bone due to the peri-implantitis compared to implants with turned surfaces [6,31,32]. On the other hand, Pongnarisorn et al. [33] found that the development of the inflammation was associated with the presence of plaque, independent on the surface roughness. Quirynen et al. [34] analysed the biofilm from the subgingival area and showed no difference in the microbiota of turned and moderately rough, anodized implant surfaces. Furthermore, other authors found similar clinical outcome for implants with turned and moderately rough surfaces [7,11,35]. The currently available evidence does not provide any firm, specific confirmation that the incidence of peri-implantitis is related to the implant surface roughness [23,36,37].

Present review aimed to reveal if modern, rough surface implants display more peri-implantitis than older implants with turned surface. Patients' characteristics were considered as possible risk indicators for peri-implantitis, as assessed by clinical and radiographic parameters.

MATERIAL AND METHODS

Protocol and registration

The methods of the analysis and inclusion criteria were specified in advance and documented in a protocol. The review was registered in PROSPERO, an international prospective register of systematic reviews. The protocol can be accessed at:
http://www.crd.york.ac.uk/PROSPERO/displayrecord.asp?ID=CRD42016051996;
registration number: CRD42016051996.

The reporting of this systematic analysis adhered to the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) Statement [38].

Focus question

The following focus question was developed according to the population, intervention, comparison, and outcome (PICO) study design.

PICOS guidelines

- Population: patients exhibiting at least one

osseointegrated solid screw-type implant diagnosed with peri-implantitis. All definitions of peri-implantitis were included.
- Interventions: dental implants with rough surface characteristics;
- Comparative: turned (machined) surface implants;
- Outcome: primary - occurrence of peri-implantitis; secondary - clinical parameters, bleeding on probing (BOP), suppuration (SUP), plaque accumulation and probing pocket depth (PD).

Question

Does the prevalence of peri-implantitis and the infection indicating clinical parameters like BOP, SUP, plaque accumulation, PD, is increased around implants with rough surfaces (Sa > 1 µm) as compared to implants with turned, minimally rough surface?

Information sources

A search was conducted on the National Library of Medicine database (MEDLINE) through its online site (PubMed) and EMBASE databases.

Literature search strategy

The search strategy incorporated the examination of electronic databases, supplemented by hand searches for articles published in English between 1 January 1990, and 1 March 2018. The following keywords were used: "periimplantitis" OR "peri-implantitis" OR "periimplant" OR "peri-implant" AND "prevalence" OR "incidence" OR "surface characteristics" OR "surface roughness" OR "implant surface" OR "turned" OR "machined". Hand search was conducted in the following journals: Clinical Oral Implants Research, Clinical Implant Dentistry and Related Research, European Journal of Oral Implantology, Implant Dentistry, International Journal of Oral & Maxillofacial Implants, International Journal of Periodontics and Restorative Dentistry, Journal of Clinical Periodontology, Journal of Oral Implantology, International Journal of Oral and Maxillofacial Surgery, Journal of Periodontology, and Journal of Prosthetic Dentistry. The references of each relevant study were screened to discover additional relevant publications and to improve the sensitivity of the search.

Inclusion and exclusion criteria

The applied inclusion criteria for the studies were as follows:

- Human prospective and retrospective observational and controlled clinical studies evaluating prevalence of peri-implantitis in patients with osseointegrated rough-surface and turned (machined) surface solid screw-type type implants;
- Implants functioning of at least 1 year;
- At least 10 implants included;
- Studies from which smokers were not excluded;
- All peri-implantitis definitions were accepted;
- Studies reporting on peri-implantitis prevalence and/or plaque accumulation, BOP, SUP and PD.

The following types of articles were excluded as follows:

- *In vitro* and animal studies; studies based on charts or questionnaires;
- Studies of patients with only machined and only rough surface implants, or ceramic implants;
- Studies not focused specifically on the selected topic or that included unclear data;
- Literature reviews, case reports and editorials were not included.

Sequential search strategy

Titles and abstracts from this search were screened by reviewers based on the inclusion criteria. Two independents reviewers screened all selected abstracts for possible inclusion and determined the selection of full-text articles. Any disagreement was resolved through discussion, consulting a third part when consensus could not be reached.

Assessment of methodologic quality and synthesis of results

The quality of all included studies was assessed during the data extraction process. The quality appraisal involved evaluating the methodologic elements that might influence the outcomes of each study. The Cochrane Collaboration's two-part tool for assessing risk of bias [39] was used to assess bias across the studies and identify papers with intrinsic methodologic and design flaws. Relevant data of interest regarding the previously stated variables were collected and organized into tables.

Statistical analysis

A meta-analysis integrates the quantitative findings from separate but similar studies and provides a numerical estimate of the overall effect of interest. All analyses were performed on studies that reported the clinical and/or radiologic outcomes of different peri-implantitis treatment methods. Thus, each study provided estimates of outcome measures (e.g., odds ratio [OR], relative risk). The goal was to obtain global estimates of these measures and to test whether they differed significantly. Global estimates of a proportion can be obtained by simply pooling together the data from each study. However, a test for significance cannot be applied to such pooled data, as these studies were heterogeneous with respect to study population and treatment protocol. This assumption was tested by the heterogeneity test using the Cochran Q statistics. The random-effects model (the Der Simonian and Liard method [40]) was more appropriate to use since it took into account both the random variation within the studies and the variation among different studies, especially because in some cases the heterogeneity test yielded a lop P value. Later findings indicated the fixed-effects model might be invalid.

RESULTS

Article review and data extraction were performed according to the PRISMA flow diagram (Figure 1).

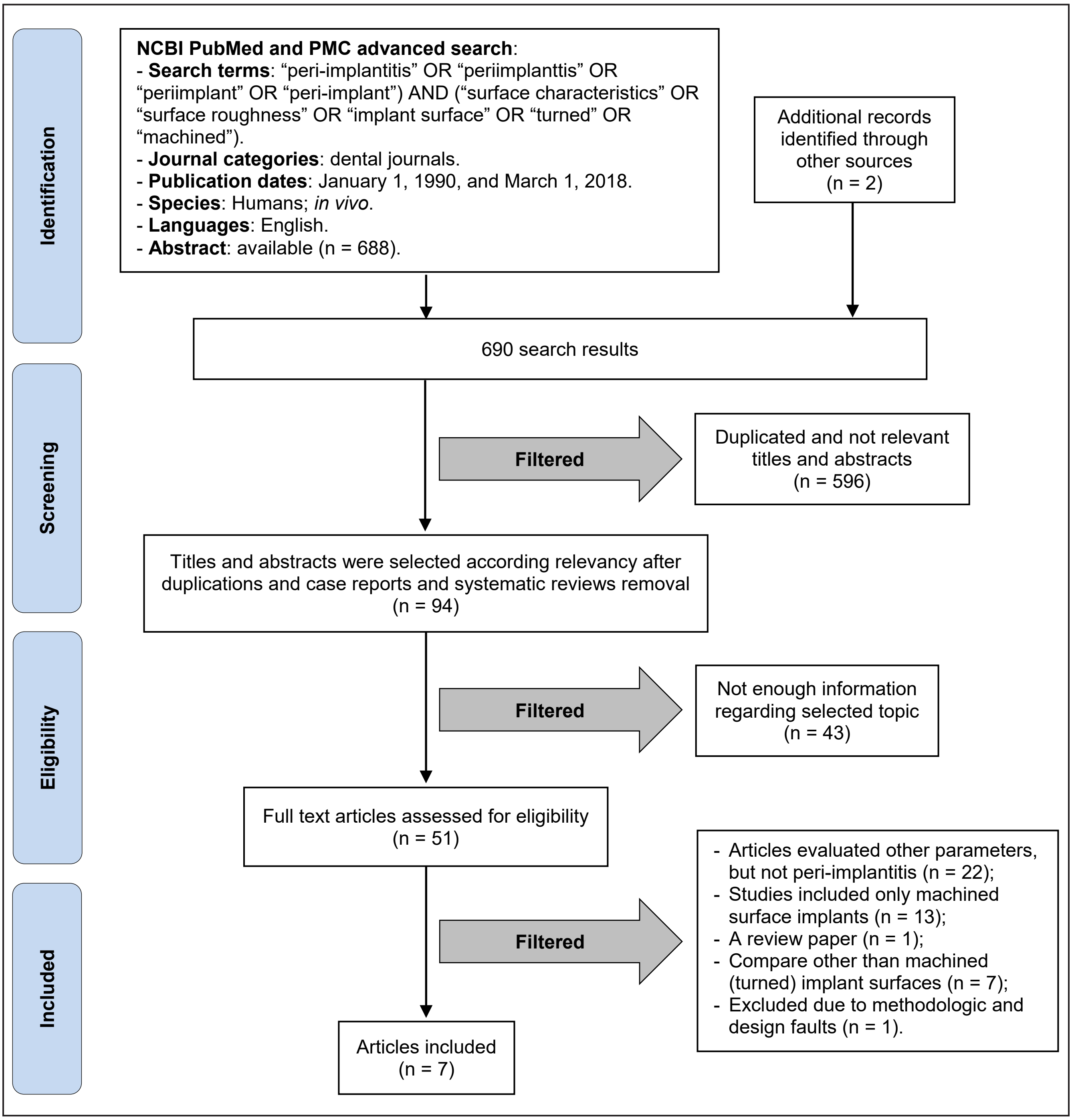

Figure 1. PRISMA flow diagram.

The initial search displayed 688 results from the MEDLINE (NCBI PubMed and PMC) and EMBASE databases and two results from other sources. A total of 690 search results were initially screened. The inclusion and exclusion criteria were applied to 51 full-text articles. Finally, seven articles were included in the review. A total of 2992 implants were included, 1083 having turned and 1909 having rough surface. From 331 implants diagnosed with peri-implantitis, 97 were with turned and 234 with rough surface (Table 1). The reasons for excluding studies after full-text assessment were as follows:

- articles evaluated other parameters, but not prevalence of peri-implantitis (n = 22);
- studies included only machined surface implants (n = 13); a review paper (n = 1);
- compare other than machined (turned) and rough implant surfaces (n = 7);
- methodologic and design faults (n = 1).

Data extraction

Out of the 8 included studies, information on the study type, follow-up period, number of patients and implants, implant type, prevalence of peri-implantitis and definition of the disease were retrieved (Table 1).

Information on the clinical parameters (i.e. BOP, plaque, SUP, PD) around rough and turned (machined) surface implants was extracted and presented in Table 2. Mean values and standard deviations, where available, were retrieved.

Patient related factors, including smoking habits, history of periodontitis, preoperative systemic antibiotics, rheumatologic conditions, diabetes, osteoporosis, immunosuppressive therapy are presented in Table 3.

Study characteristics

Four of the included studies were prospective [41-44], two retrospective [45,46] and one case - control study [47]. Half of the included studies evaluated implants that were in function more than 10 years [43-46]. Turned (minimally rough) implant surface was compared to rough, titanium-plasma sprayed [41-45] and moderately rough, sandblasted surfaces and oxidized [44,45,47] and sandblasted and chemically cleaned surfaces [46]. The definition of peri-implantitis greatly differed among the included studies (Table 1).

Quality assessment

Summarizing the risk of bias for each study, all studies were classified as unclear risk of bias for one or more key domains (Table 4). There was a significant heterogeneity among studies (Q = 14.2447; degrees of freedom [df] = 6; P = 0.0270; OR = 0.697; 95% confidence interval [CI] = 0.546 to 0.888).

Results of individual studies

Clinical parameters

Survival rate of implants was the same in most of the studies [41-44]. Only Polizzi et al. [45] found significantly more implant failures with turned surfaces (P = 0.005). Higher incidence of peri-implatitis was observed on rough surfaces [45], as well as on turned implant surfaces, with (P = 0.015) [47] and without statistical significant difference (P > 0.05) [44]. Vandeweghe et al. [46] observed no difference in incidence of peri-implantitis between two surfaces.

Five studies compared accumulation of plaque implants with turned and rough surfaces [41-45]. Turned implants surfaces were in favour of lower plaque accumulation at the prosthesis delivery [41,42], after 1 [41] and 13 years of loading [44]. Nevertheless, more plaque was found on turned from 6 to 10 years [45], at 7 years [44] and from 12 to 15 years following loading [43]. None of these differences was statistically significant.

A study by Moberg et al. [42] found significantly deeper probing PD in the turned surface implant group (P < 0.05), whereas Polizzi et al. [45] found significantly deeper probing pocket depths on palatal/lingual sites on rough surfaces (P = 0.015). Nevertheless, Polizzi et al. [45] detected also no difference on vestibular surfaces (P = 0.373) (Table 2).

The frequency of implants with BOP was higher on turned implant surfaces during first 3 years (P > 0.05) [42] as well as at 7-year (P = 0.01) [44] and 13-year follow-up (P > 0.05) [44]. More BOP was also found on rough implant surfaces (P > 0.05) [43], but depended also on the time-point of observation [41] or a jaw [43]. Suppuration was more frequently detected on rough surfaces from 6 to 10 years follow up (P > 0.05) [44,45] and on turned surfaces at 13 years (P > 0.05) [44].

Two studies reported increased MBL on rough implant surfaces [42,43]. Interestingly, Vandeweghe et al. [46] found increased MBL by rough implant surfaces by multivariate (P = 0.016), but not by univariate analysis. Higher MBL on turned implant surface was found at base-line,

Table 1. Included studies

Study	Year of publication	Study design	Follow-up (years)	Number of implants/number of patients		Prevalence of peri-implantitis		Significance	Peri-implantitis definition
				Turned implants	Rough surface implants	Turned implants	Rough surface implants		
Astrand et al. [41]	2004	Continuity of the study Astrand et al. [41]. Prospective randomized study, split-mouth design	3	73 (Brånemark System®; Nobel Biocare AB, Goteborg, Sweden)/ 28 patients	77 (TPS®; Straumann AG, Waldenburg, Switzerland)/ 28 patients	0 implants	7 implants (9.1%)	The difference statistically significant	Infection including purulent discharge and bone loss
Moberg et al. [42]	2001	Prospective randomized study	3	102 (Brånemark System®;Nobel Biocare AB, Goteborg, Sweden)/ 20 patients	106 (TPS®; Straumann AG, Waldenburg, Switzerland)/ 20 patients	1 implants	3 implants	Not indicated	Peri-implant infection with bone reduction
Ravald et al. [43]	2012	Prospective randomized controlled study	12 - 15	177 (Brånemark System®; Nobel Biocare AB, Goteborg, Sweden)	176 (TPS®; Straumann AG, Waldenburg, Switzerland)	9 implants (5%)	10 implants (6%)	NR	Bone loss ≥ 2 mm and bleeding or pus on probing
Renvert et al. [44]	2012	Prospective clinical trial	13	102/22 patients machine-etched (Brånemark System®; Nobel Biocare AB, Goteborg, Sweden)	132 implants/19 patients (TiOblast™ implants; Astra Tech AB, Mölndal, Sweden)	12 implants (11.5%)	9 implants (7.1%)	No difference in the incidence of peri-implantitis over a period of 13 years as an effect implant surface and design was found.	Peri-implantitis incidence was defined as bone loss ≥ 1 mm after 1 year, and with BOP or suppuration
Polizzi et al. [45]	2013	Retrospective study (both types of implants in the same patient)	10	257 (Brånemark System®; Nobel Biocare AB, Goteborg, Sweden)/ 96 patients	243 moderately rough oxidized surfaced (TiUnite®; Nobel Biocare AB, Goteborg, Sweden)/ 96 patients	1 implant	9 implants	Peri-implantitis diagnosed in 4 patients (4.2%) and 10 implants (2%), 9 being TiUnite® implants and 1 turned (significance not indicated)	Mucosal lesion associated with suppuration and deepened pockets but always accompanied by loss of supporting marginal bone (Lindhe and Meyle [20])
Vandeweghe et al. [46]	2016	Retrospective study	At least 10 years in function (mean 172 [SD 42] months; range 120 to 252)	76 (Southern Implant System®; Southern Implants, Irene, South Africa)/ NR	121 moderately rough surface, obtained by sandblasting and chemical cleaning (Southern Implant System®; Southern Implants, Irene, South Africa)/ NR	NR	NR	Prevalence of peri-implantitis 4.1% in turned and moderately rough implants, with no significant difference between (P = 0.7)	PD > 6 mm in combination with BOP/ suppuration and attachment loss/bone loss of 2.5 mm
de Araújo Nobre and Malo [47]	2014	Case-control study	At least 1 year in function	296 (Brånemark System®; Nobel Biocare AB, Goteborg, Sweden)/ NR	1054 moderately rough oxidized surfaced (TiUnite®; Nobel Biocare AB, Goteborg, Sweden)/ NR	74 (5.5)%	196 (14.5)%	Machined implant surface identified as a risk factor for peri-implant pathology (P = 0.015; OR = 1.46)	Peri-implant pathology was diagnosed through: peri-implant pockets ≥ 5 mm diagnosed through probing of the peri-implant sulcus/pocket using a probe calibrated to 0.25 N, bleeding on probing; bone loss visible to X-ray; and attachment loss equal to or greater than 2 mm

TPS = titanium plasma sprayed; BOP = bleeding on probing; PD = probing depth; NR = not reported.

Table 2. Clinical parameters

Study	Plaque		Bleeding on probing		Suppuration		Pocket probing depth	
	Turned	Rough	Turned	Rough	Turned	Rough	Turned	Rough
Astrand et al. [41]	7.9%	9.1%	11.9%	7.5%	Not reported	Not reported	Not reported	Not reported
Moberg et al. [42]	37%	36%	14%	20%	Not reported	Not reported	≤ 3 mm: 96 % 3 to 5 mm: 4 %	≤ 3 mm: 97.5%; 3 to 5 mm: 2.5% (P < 0.05)
Ravald et al. [43]	Maxilla: 28 (31)%; mandible: 44 (40)%	Maxilla: 18 (22)%; mandible: 35 (32)%	Maxilla: 54 (18)%; mandible: 39 (17)%	Maxilla: 45 (12)%; mandible: 36 (16)%	Not reported	Not reported	1 to 3 mm: maxilla 47%, mandible 70%; 4 to 5 mm: maxilla 50%, mandible 26%; ≥ 6 mm: maxilla 3%, mandible 4%	1 to 3 mm: maxilla 49%, mandible 66%; 4 to 5 mm: maxilla 32%, mandible 23%; ≥ 6 mm: maxilla 19%, mandible 11%
Renvert et al. [44]	61.5%	64.3%	89.7%	82.1%	3.8%	1.2%	3.1 (2.2) mm	2.6 (2.3) mm
Polizzi et al. [45]	29 (29.2)%	14 (14.9)%	Not reported	Not reported	1 (1.1)%	4 (4.3)%	Verstibular: 2.51 (0.97) mm; palatal/lingual: 2.59 (0.82) mm	Verstibular: 2.53 (0.82) mm; palatal/lingual: 2.79 (0.97) mm (P = 0.015)
Vandeweghe et al. [46]	Not reported	Not reported	47.2% for all implants	Not reported	Not reported	Not reported	3.64 (0.96) mm (range 1.25 to 7.25 mm) for all implants	
de Araújo Nobre and Malo [47]	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported

Table 3. Patient related factors

Author	Smoking	Periodontitis	Preopearative antibiotics	Rheumatologic condition	Diabetes	Osteoporosis	Immunosuppressive therapy
Astrand et al. [41]	Excluded > 20/day (7 patients < 20/day)	Excluded	Yes	Excluded	Excluded	Excluded	Excluded
Moberg et al. [42]	Excluded	Excluded	Not specified	Excluded	Excluded	Excluded	Excluded
Ravald et al. [43]	8 patients	Apparently excluded	Not specified	9 patients	5 patients	No	8 patients
Renvert et al. [44]	16 patients current and past	Included	Not specified	0 patients	0 patients	3 patients	Asthma 3, bronchitis 1, allergy 2 patients
Polizzi et al. [45]	Included 55.2%; previous 7.3%	1%	Not specified	Excluded	2.1%	1%	1%
Vandeweghe et al. [46]	5 patients	Excluded	Not specified	Excluded	Excluded	Excluded	Excluded
de Araújo Nobre and Malo [47]	Smoker 1.1%; ex-smoker 71.9%	60.5%	Not specified	10.7%	9.7%	0 %	2%

Table 4. Assessment of the risk of bias

Author	Random sequence generation	Allocation concealment	Blinding	Incomplete outcome data	Selective reporting	Other bias
Astrand et al. [41]	+	?	?	+	+	+
Moberg et al. [42]	?	?	?	+	?	+
Ravald et al. [43]	?	-	-	+	+	?
Renvert et al. [44]	?	?	?	+	+	+
Polizzi et al. [45]	?	?	?	+	+	?
Vandeweghe et al. [46]	?	?	?	+	+	+
de Araújo Nobre and Malo [47]	?	?	?	-	-	+

+ = low risk of bias; ? = unclear risk of bias; - = high risk of bias.

1 and 3 years (P > 0.05) [41,44], at 7-year (P = 0.003) [44], from 6 to 10 years (P = 0.006) [45] and at 13-year following loading (P = 0.015) [44]. Cumulative success rate was higher for turned than rough implant surfaces (P > 0.05) [42].

Patient related factors

Three studies included chronic periodontitis patients [44,45,47]. Renvert et al. [44] identify this patient related factor to statistically significantly influence peri-implantitis prevalence (P < 0.001). Furthermore, the likehood of having MBL > 1 mm for patients with history of periodontitis was of 2.1 if having a systemic disease, independent on smoking status [44]. Smoking was reported in most of the studies. Ravald et al. [43] found increased MBL by smokers, whereas Vandeweghe et al. [46] couldn't confirm this relation neighed by univariate (P = 0.408) nor multivariate analysis (P = 0.259).
Four studies involved patients having medical problems taking some kind of medication. Nevertheless, rheumatologic condition [43,47], diabetes [43,45,47] or osteoporosis [44,45] *per se* were not related to the prevalence of peri-implantitis. Three investigations included also patients undergoing immunosuppressive therapy [43-45]. In line with the previously mentioned conditions, immunosuppressive therapy did not show to have a significant influence on peri-implantitis prevalence.

DISCUSSION

The aim of the present review was to assess if rough implant surface may be more prone to peri-implantitis as compared to the implants with older, turned surface [6,31,32]. The clinical parameters were similar for both implant surfaces, whereas implants with turned surfaces demonstrated higher MBL. Studies included in this review varied in the definition and incidence of peri-implantitis.
Turned implants surface seems to be less favourable for plaque accumulation during short-term follow-up

periods, but more favourable during later periods of follow-up. The smoothness of the implant surface is considered crucial determinant for biofilm formation [29,48], with a clinically confirmed threshold roughness (Ra 0.2 µm) [49,50]. Influence of surface roughness on the adhesion of microorganisms may be, however, compensated by the proceeding maturation of the oral biofilm [51] and rapid re-growth by multiplication of the remaining species rather than by recolonization [52]. As observed for plaque accumulation, most of the studies included in the present review revealed no significant difference in other clinical parameters around implants with rough as compared with the minimally rough surfaces. This corroborates previous findings on different transmucosal implant surfaces [33] and abutments [53] that failed to establish different inflammatory cell lesions despite of the various topographies. Nevertheless, a meta-analysis of the included studies was not feasible due to the significant heterogeneity among studies.

With eight different diagnostic criteria, peri-implantitis is still not a clearly defined condition [13]. Although "*itis*" stands for inflammation [18], the diagnosis of peri-implantitis may be quite challenging for the clinician. PD and BOP allows the ability to investigate the clinical conditions, but both parameters are considered weak indicators of ongoing breakdown of the peri-implant tissues [36,54,55]. Steady radiographic marginal bone level can occur in spite of the clinical symptoms of peri-implantitis [43,56]. PD levels of up to 9 mm may coincide with clinical success [57]. Roos-Jansåker et al. [5] found even increased BOP and suppuration around implants with bone gain than with bone loss. Nonetheless, peri-implantitis is considered a late complication and needs some time before it develops [58]. With a plethora of diagnostic criteria, it would be more appropriate to re-define the peri-implantitis by selecting an ongoing MBL truly threatening implant survival [36]. Significantly different MBL reached on a long-term follow-up in the included studies indicates that implants with turned surfaces may be more prone to peri-implantitis. Hence, modern oral implants are generally preferred over the old implant systems due to the stronger bone response [9].

Except plaque accumulation, the triggering mechanism behind bone loss may include foreign body reaction to cement and loading conditions [54]. Furthermore, the progressive MBL may be also triggered by the metal particles and metal ions resulting in an immune-osteolytic reaction [59]. An ongoing MBL related to immunological reaction mechanism result in cellular reactions, generating a shift in the delicate balance between osteoblasts and the osteoclasts [36]. MBL associated with cement rests may be further coupled to the leakage of the Ti around dental implants [60,61]. Immunological problems may be further complicated by problems related to the patient. Still, these conditions seem to play no major impact on the incidence of peri-implantitis in the present review.

A history of periodontitis was identified as a risk factor for the survival and success rate of implants with rough surface [62,63]. Present review seems to confirm the previous findings that placement of implants with rough surface in the patients prone to peri-implantitis was not disadvantageous compared to implants with turned surface [35,64]. In a 10-year retrospective study Aglietta et al. [24] found lower implants survival rate and higher bone loss in periodontally compromised than periodontally healthy tobacco smokers, regardless of the implant system used. While smoking was initially related to the early healing events on implants with turned surface [65,66], later studies confirmed its impact irrespective of the type of implant surface [67,68]. Relation between smoking and the type of implant surface cannot be confirmed rom the present review, as the analysed studies varied in defining the criteria for smokers (i.e. number of cigarettes a day).

According to the present review, it does not seem that the use of minimally instead of moderately rough surfaces would help to prevent peri-implantitis. Nevertheless, this assumption is limited by the quality of included studies. As previously quoted [37], there is still a lack of adequate studies on the impact of implant surface on the development of peri-implantitis. It might be expected that the patients included in the present review were closely monitored by the research teams. The status of oral hygiene might influence the presence of pathogens more than the surface characteristics [28]. Low incidence of peri-implantitis (1.9%) on a long-term was demonstrated for implants with oxidized surfaces when the patients with acceptable hygiene were scheduled for regular professional cleaning [69]. Supportive therapy was found essential for the long-term success of implant placed in periodontitis-susceptible patients [11,70]. Thus, the oral hygiene instructions and the importance of plaque control shall be consequently stressed to patients before and after implant placement [71,72]. Several concepts are presently under investigation aiming to combat the bacterial infection, including functional implant surfaces less prone to bacterial colonisation [73] and a more robust peri-implant functional seal [74].

Limitations

The evidence of this systematic review was limited to randomized, controlled clinical studies. Half of the studies included implants that were in function less than 10 years and evaluated presence of peri-implantitis as a secondary outcome. The definition of peri-implantitis varied significantly in included studies. Implants with rough surface (Sa > 1 µm) were pooled together and compared to implant with turned, minimally rough surface. All studies included in this review revealed an unclear or high risk of bias. The proportion of information from studies with unclear or high risk of bias may be sufficient to affect the interpretation of results.

CONCLUSIONS

The present systematic review revealed that only a few studies provide sufficient data for assessing peri-implantitis prevalence based on the implant surface characteristics (turned vs. rough surface). A meta-analysis was thus not feasible within the frames of the present study. The limited evidence suggests no strong correlation between rough surface implants and incidence of peri-implantitis when compared to turned implant surfaces.

ACKNOWLEDGMENTS AND DISCLOSURE STATEMENTS

The authors report no conflicts of interest related to this study.

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To cite this article:
Saulacic N, Schaller B.
Prevalence of Peri-Implantitis in Implants with Turned and Rough Surfaces: a Systematic Review
J Oral Maxillofac Res 2019;10(1):e1
URL: http://www.ejomr.org/JOMR/archives/2019/1/e1/v10n1e1.pdf
doi: 10.5037/jomr.2019.10101