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Original Research Article

Diagnosis and Treatment of Peri-implantitis among Dentists in Saudi Arabia

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Abstract
Aim: *The aim of this study was to detect the knowledge and awareness of dentists practicing dental implantology in Saudi Arabia regarding the diagnosis and treatment of peri-implantitis.*
Materials and Methods: *100 dentists practicing dental implantology in Saudi Arabia were randomly selected and asked to answer a systematized questionnaire about the diagnosis and treatment of peri-implantitis that comprised of six parts as the following: The dentist's demographic data, bacteria, implant surface, antimicrobials and antibiotics, diagnosis, management and treatment modalities of peri-implantitis. The sample of the study consisted of dentists who hadn't received any specialty or training degree other than implantology and dentists who had received other specialty degree in addition to implantology. The validity and the reliability of the questionnaire were tested. The data obtained were tabulated, and the statistical parameter was estimated.*
Results: *The majority of the dentists agreed that treated-surface implants have better osseointegration and higher long-term success rate in comparison to smooth-surface implants. Also, roughly half or more than half the dentists used the diagnostic parameters bleeding on probing, probing depth, suppuration, and bone loss ≥2 mm for the detection of peri-implantitis. In addition, the most preferable surgical treatment modality employed by the dentists for implants with peri-implantitis was bone grafting combined with a membrane. Furthermore, the most preferable delayed loading protocol chosen by the dentists for definitive prosthesis installation after implant placement was 4-6 months.*
Conclusion: *There is need for randomized clinical trials on the pathogenesis, etiology, diagnostic parameters, and treatment modalities of peri-implantitis with large sample sizes. Workshops and symposia are recommended.*
Keywords: *Peri-implantitis, Dentists, Bacteria, Implant(s), Chlorhexidine, Antibiotics, Diagnosis, Treatment*

Introduction

Peri-implant diseases present in two forms: peri-implant mucositis and peri-implantitis. The aforementioned peri-implant diseases are identified by an inflammatory reaction in the tissues surrounding an implant.[1,2] Peri-implantmucositis is a reversible disease in which the presence of inflammation is limited to the soft tissues surrounding a dental implant with no signs of loss of supporting bone following initial bone remodeling during healing. Peri-implantitis is characterized by an inflammatory process around an implant, that

includes both soft tissue inflammation and progressive loss of supporting bone beyond biological bone remodeling.[1,2,3]

Materials and Methods

Ethical approval

The study was registered with the research center of Riyadh Elm University (FRP/2018/281) and received ethical approval from the institutional review board of the same institution (RC/IRB/2018/1341).

Selection of the content for analysis and statistical analysis

100 dentists practicing implantodontics in the Kingdom of Saudi Arabia were randomly selected and asked to fill in a systematized questionnaire about the diagnosis and treatment of peri-implantitis. The study was carried out from January 2019 to March 2019. After taking the consent of the dentist on an informed consent statement form for clinical studies, each dentist was provided with a systematized questionnaire about the diagnosis and treatment of peri-implantitis which was adapted based on Togashi et al. 2014[4] and comprised of six parts as the following: The dentist's demographic data, bacteria, implant surface, antimicrobials and antibiotics, diagnosis, management and treatment modalities of peri-implantitis (Figure 1).The sample of the study consisted of dentists who hadn't received any specialty or training degree other than implantology (general dentists, specialists, consultants) and dentists who had received other specialty degree, registered at the Saudi Commission for Health Specialties, in addition to implantology (specialists and consultants).

Validation of the questionnaire

Content validity

The validity of the questionnaire was measured by testing the answers of experienced implantologists against the ideal answers. The experienced respondents were able to answer all questions correctly, suggesting that the questionnaire had valid clear content.

Reliability

Reliability of the questionnaire was tested by distributing sixteen pilot sample questionnaires to dentists practicing implantology. The Cronbach's alpha was found to be 0.802 which is considered good for a new questionnaire according to Nunnally & Bernstein 1994 (pages 264-265).[5]

Statistical analysis

After tabulation of the data obtained, the distribution and frequency of the different variables were described, and the statistical parameter was estimated (confidence intervals for proportions at confidence level 95%). All statistical analyses were performed using the IBM SPSS Statistics 20 data processing software.

Results

The sample of 100 dentists practicing dental implantology in Saudi Arabia consisted mainly of males (80%). Also, the majority of the respondents received their education in implantodontics at universities (68%) and in particular at Saudi universities: Saudi public (36%) and Saudi private (35%).

In addition, the whole sample (100%) consisted of dentists who hadn't received any specialty or training degree other than implantology n=41 (41%) and dentists who had received other specialty degree in addition to implantology n=59 (59%) (Table 1). The dentists who hadn't received any specialty or training degree other than implantology were distributed as the following: general dentists n=33 (33%), specialists n=6 (6%), and consultants n=2 (2%). However, the dentists who had received other specialty degree in addition to implantology consisted of specialists n=35 (35%) and consultants n=24 (24%), and they were distributed as the following: specialists in periodontics n=22 (22%), specialists in maxillofacial surgery=2 (2%), specialists in prosthodontics n=10 (10%), specialists in restorative dentistry n=1 (1%), consultants in periodontics n=12 (12%), consultants in maxillofacial surgery n=5 (5%), consultants in prosthodontics n=5 (5%), and consultants in restorative dentistry n=2 (2%).

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Questionnaire
Choose one correct answer
Demographic Data
1.Gender ( ) Male ( ) Female
2.City -------
3.Institution for specialization in implantodontics
( ) University ( ) Academy/Institute
( ) Other clarify----------
4.Institution for specialization in implantodontics
( ) Saudi Public ( ) Saudi Private
( ) Non Saudi Public
( ) Non Saudi Private
5.Clinical Practice Experience in dental Implantology
( ) ≤ 2 years ( ) 3-5 years
( ) 6-10 years ( ) ≥11 years
6.Field of work
( ) General dentist ( ) Specialist
( ) Consultant/ Professor
7. Have you received other specialty degree registered at the Saudi Commission for Health Specialties?
( ) No If ( )Yes, Check
( ) Periodontics ( ) Maxillofacial surgery
( ) Prosthodontics
( ) Other clarify----------
Bacteria
8. Are gram negative anaerobic rods elevated in peri-implantitis sites?
( ) Yes ( ) No ( ) I don't know
9. Which of the following is elevated in peri-implantitis sites?
( ) T. forsythia ( ) Coccoid bacteria
( ) I don't know
10. Are the bacteria associated with periodontitis and peri-implantitis similar?
( ) Yes ( ) No ( ) I don't know
Implant Surface
11. Does the failure rate of peri-implant osseointegration vary according to the design and surface chemistry of the implant?
( ) Yes ( ) No ( ) I don't know
12. Is peri-implantitis induced bone loss greater in rough-surface implants?
( ) Yes ( ) No ( ) I don't know
13. Do treated-surface implants have better osseointegration and higher long-term success rate in comparison to smooth-surface implants?
( ) Yes ( ) No ( ) I don't know
Antimicrobials and Antibiotics
14. Chlorhexidine in different formulations and dosages must be prescribed adjunctively after every mechanical debridement.
( ) Yes ( ) No ( ) I don't know
15. Which of the following is a local antibiotic?
( ) Ornidazole (Tiberal)
( )Tetracycline HCl(Actisite)
( ) I don't know
16. Which of the following is **NOT** common for implant surface decontamination in peri-implantitis?
( ) Citric acid etch
( ) Isopropanol
( ) Hydrogen peroxide
( ) I don't know
Diagnosis
17. What is the threshold of bone level loss around implants in peri-implantitis?
( ) ≥ 2mm ( ) ≥5mm ( ) I don't know
18. What is the threshold of probing depth around implants in peri-implantitis?
( ) ≥2mm ( ) ≥5mm ( ) I don't know
19. What is the clinical consideration for early detection of peri-implantitis?
( ) Bleeding, Probing, Suppuration
( ) Inflammation
( ) Presence of plaque and calculus
( ) Implant mobility
( ) I don't know
Management and Treatment
20. When performed properly, is non-surgical mechanical debridement sufficient to treat peri-implantitis?
( ) Yes ( ) No ( ) I don't know
21. Regarding maintenance by mechanical debridement, which of the following is recommended for effective cleaning of titanium implants?
( ) Periodontal steel curettes
( ) Ultrasonic steel tip
( ) Carbon fiber or plastic curettes
( ) Air powder abrasive unit of bicarbonate
( ) I don't know
22. What surgical treatment modality would you employ with peri-implantitis?
( ) Bone grafting combined with a membrane
( ) Bone grafting, only
( ) Membrane, only
( ) Osteotomy around the implant
( ) I don't know
23. Delayed loading recent protocols recommend that the definitive prosthesis is installed after implant placement:
( ) 3 months ( ) 4-6 months
( ) 6-8 months

Figure 1: Questionnaire answered by the dentists randomly selected for this study

Bacteria

The majority of the dentists agreed that gram negative anaerobic rods are elevated in peri-implantitis sites as shown in Table 2. Also, consultants in periodontics were very well familiar with T. forsythia as an elevated bacteria in peri-implantitis sites 92% (95% CI= 87% to 97%); in addition, 80% (95% CI= 72% to 88%) of consultants in prosthodontics were able to recognize T. forsythia (Table 2). Furthermore, a substantial number of the dentists agreed that the bacteria associated with periodontitis and peri-implantitis are similar as shown in Table 2.

Implant Surface

The majority of the dentists agreed that the failure rate of peri-implant osseointegration varies according to the design and surface chemistry of the implant as shown in Table 3. Also, a substantial number of the dentists agreed that peri-implantitis induced bone loss is greater in rough-surface implants, except specialists in maxillofacial surgery and specialists who hadn't received any specialty degree other than implantology as shown in Table 3. In addition, the majority of the dentists agreed that treated-surface implants have better osseointegration and higher long-term success rate in comparison to

smooth-surface implants as shown in Table 3 (Chart 1).

Antimicrobials and Antibiotics

Half or more than half the consultants in periodontics 66.7% (95% CI= 57% to 76%), prosthodontics 80% (95% CI= 72% to 88%), maxillofacial surgery 60% (95% CI= 50% to 70%), and roughly half the specialists in maxillofacial surgery 50% (95% CI = 40% to 60%) agreed that the adjunctive use of chlorhexidine after every mechanical debridement is unnecessary (Table 4). Also, a substantial number of the dentists were able to recognize tetracycline HCl (Actisite) as local antibiotic as shown in Table 4.

In addition, half or more than half the dentists who had received other specialty degree in addition to implantology, except specialists in periodontics 31.8% (95% CI = 23% to 41%) and restorative dentistry, were able to recognize that isopropanol isn't used for surface decontamination of implants as shown in Table 4.

Table 1: Respondents' Profile (Demographic Data)

Question	Answer	Count	Percentage %
Q1 Gender	Male	80	80 [72-88]
	Female	20	20 [12-28]
Q2 City/Region	Middle Region (Riyadh)	86	86 [79-93]
	Western Region (Jeddah)	2	2 [1-5]
	Eastern Region (Al-Hofuf, Dammam, Dhahran, Al-Ahsa, Khobar)	10	10 [4-16]
	Northern Region (Hail)	1	1 [1-3]
	Southern Region (Abha)	1	1 [1-3]
Q3 Institution for Specialization in Implantodontics	University	68	68 [59-77]
	Academy/Institute	20	20 [12-28]
	Company	11	11 [5-17]
	Hospital	1	1 [1-3]
Q4 Institution for Specialization in Implantodontics	Saudi Public	36	36 [27-45]
	Saudi Private	35	35 [26-44]
	Non Saudi Public	13	13 [6-20]
	Non Saudi Private	16	16 [9-23]
Q5 Clinical Experience in dental Implantology	≤ 2 years	38	38 [28-48]
	3-5 years	25	25 [17-33]
	6-10 years	21	21 [13-29]
	≥11 years	16	16 [9-23]
Q6 Field of Work	General dentist	33	33 [24-42]
	Specialist	41	41 [31-51]
	Consultant/ Professor	26	26 [17-35]
Q7 Other specialty degree registered at the Saudi Commission for Health Specialties in addition to dental implantology	No	41	41 [31-51]
	Yes, Periodontics	34	34 [25-43]
	Yes, Maxillofacial surgery	7	7 [2-12]
	Yes, Prosthodontics	15	15 [8-22]
	Yes, Other (Restorative Dentistry)	3	3 [1-6]

Table 2: Bacteria

Specialty		Bacteria Responses-Estimated Proportions (95% CI)											
		Q8 Gram Negative Anaerobic Rods				Q9 Kind of Elevated Bacteria				Q10 Bacteria with Periodontitis and Peri-implantitis			
		Yes %	No %	I don't know %	Total%	T.forsythia %	Coccoid %	I don't know %	Total %	Yes %	No %	I don't know %	Total%
Implant* only	GD*	64 [55-73]	0	36 [27-45]	100	36 [27-45]	6 [1-11]	58 [48-68]	100	67 [58-76]	15 [8-22]	18 [10-26]	100
	Specialist	50 [40-60]	17 [24-10]	33 [24-42]	100	33 [24-42]	33 [24-42]	33 [24-42]	100	33 [24-42]	33 [24-42]	33 [24-42]	100
	Consultant	100	0	0	100	50 [40-60]	0	50 [40-60]	100	100	0	0	100
Perio*	Specialist	68 [59-77]	5 [1-9]	27 [18-36]	100	41 [31-51]	18 [10-26]	41 [31-51]	100	59 [49-69]	36 [27-45]	5 [1-9]	100
	Consultant	100	0	0	100	92 [87-97]	0	8 [3-13]	100	83 [76-90]	8 [3-13]	8 [3-13]	100
Surgery*	Specialist	100	0	0	100	50 [40-60]	50 [40-60]	0	100	50 [40-60]	50 [40-60]	0	100
	Consultant	80 [72-88]	20 [12-28]	0	100	60 [50-70]	20 [12-28]	20 [12-28]	100	60 [50-70]	20 [12-28]	20 [12-28]	100
Prostho*	Specialist	60 [50-70]	0	40 [30-50]	100	30 [21-39]	20 [12-28]	50 [40-60]	100	90 [84-96]	0	10 [4-16]	100
	Consultant	100	0	0	100	80 [72-88]	20 [12-28]	0	100	100	0	0	100
Resto*	Specialist	100	0	0	100	100	0	0	100	0	100	0	100
	Consultant	100	0	0	100	100	0	0	100	100	0	0	100

*Implant = Implantology, Perio = Periodontics, Surgery = Maxillofacial Surgery, Prostho = Prosthodontics, Resto = Restorative Dentistry, GD = General Dentist

Diagnosis

Approximately half or more than half the dentists indicated to ≥ 5 mm as the threshold of probing depth around implants in peri-implantitis as shown in Table 5. In addition, around half or more than half the dentists indicated to ≥ 2 mm as the threshold of bone level loss around implants in peri-implantitis, except specialists in periodontics and restorative dentistry, consultants in restorative dentistry, and specialists who hadn't received any specialty degree other than implantology as shown in Table 5. Furthermore, roughly half or more than half the dentists indicated to bleeding on probing, probing depth, suppuration as the diagnostic parameters for early detection of peri-implantitis, except specialists in periodontics and restorative dentistry and specialists who hadn't received any specialty degree other than implantology as shown in Table 6 (Chart 2).

Table 3: Implant Surface

Specialty		Implant Surface Responses-Estimated Proportions (95% CI)											
		Q11 Design & Surface Chemistry				Q12 Rough-Surface Implants				Q13 Treated-Surface Implants			
		Yes %	No %	I don't know %	Total%	Yes %	No %	I don't know %	Total%	Yes %	No %	I don't know %	Total%
Implant* only	GD*	88 [82-94]	6 [1-11]	6 [1-11]	100	45 [35-55]	39 [29-49]	15 [8-22]	100	70 [61-79]	21 [13-29]	9 [3-15]	100
	Specialist	50 [40-60]	17 [10-24]	33 [24-42]	100	33 [24-42]	50 [40-60]	17 [10-24]	100	83 [76-90]	0	17 [10-24]	100
	Consultant	50 [40-60]	50 [40-60]	0	100	50 [40-60]	50 [40-60]	0	100	100	0	0	100
Perio*	Specialist	95 [91-99]	5 [1-9]	0	100	82 [74-90]	18 [10-26]	0	100	91 [85-97]	9 [3-15]	0	100
	Consultant	83 [76-90]	17 [10-24]	0	100	75 [67-83]	25 [17-33]	0	100	92 [87-97]	8 [3-13]	0	100
Surgery*	Specialist	100	0	0	100	0	100	0	100	100	0	0	100
	Consultant	80 [72-88]	20 [12-28]	0	100	80 [72-88]	20 [12-28]	0	100	100	0	0	100
Prostho*	Specialist	90 [84-96]	10 [4-16]	0	100	80 [72-88]	20 [12-28]	0	100	100	0	0	100
	Consultant	80 [72-88]	20 [12-28]	0	100	100	0	0	100	100	0	0	100
Resto*	Specialist	100	0	0	100	100	0	0	100	100	0	0	100
	Consultant	100	0	0	100	100	0	0	100	100	0	0	100

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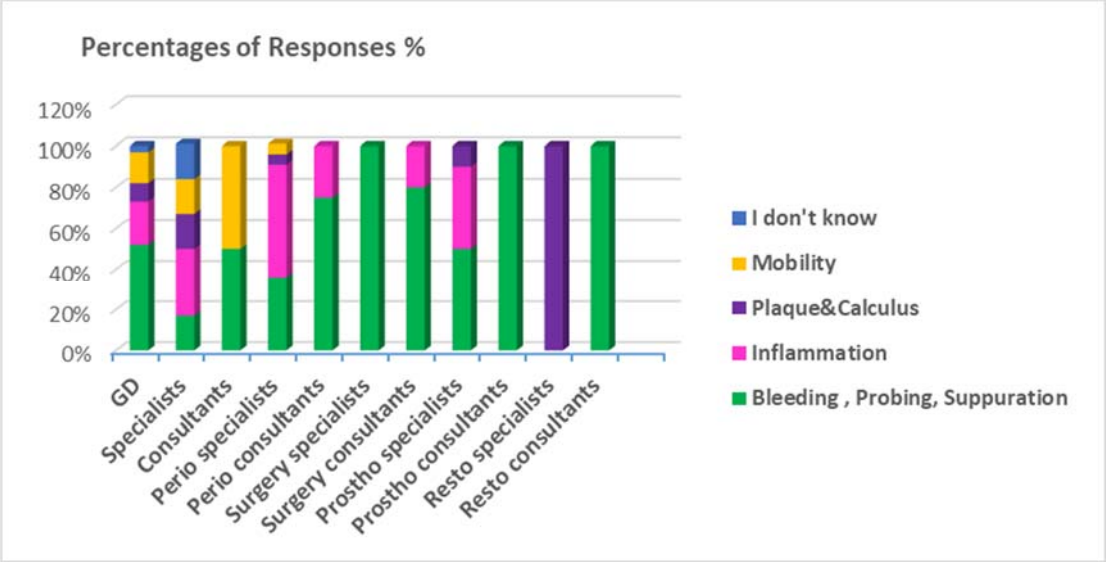

Chart 2: Percentages of Responses to the Clinical Characteristics of Peri-implantitis

Table 4: Antimicrobials and Antibiotics

Specialty		Antimicrobials and Antibiotics Responses-Estimated Proportions (95% CI)												
		Q14 Chlorhexidine				Q15Local Antibiotics				Q16Surface Decontamination				
		Yes %	No %	I don't know %	Total%	Ornidazole %	Tetracycline HCl%	I don't know %	Total%	Citric acid%	Isopropanol %	Hydrogen peroxide %	I don't know %	Total%
Implant* only	GD*	54.5 [45-64]	30.3 [21-39]	15.2 [8-22]	100	15.2 [8-22]	57.6 [48-67]	27.3 [19-36]	100	9.1 [3-15]	39.4 [30-49]	15.2 [8-22]	36.4 [27-46]	100
	Specialist	66.7 [51-70]	16.7 [9-24]	16.7 [9-24]	100	33.3 [24-43]	50 [40-60]	16.7 [9-24]	100	50 [40-60]	16.7 [9-24]	33.3 [24-43]	0	100
	Consultant	100	0	0	100	0	50 [40-60]	50 [40-60]	100	0	50 [40-60]	50 [40-60]	0	100
Perio*	Specialist	59.1 [49-69]	13.6 [7-20]	27.3 [19-36]	100	36.4 [27-46]	40.9 [31-51]	22.7 [14-31]	100	31.8 [23-41]	31.8 [23-41]	18.2 [11-26]	18.2 [11-26]	100
	Consultant	33.3 [24-43]	66.7 [57-76]	0	100	8.3 [3-14]	91.7 [86-97]	0	100	8.3 [3-14]	83.3 [76-91]	8.3 [3-14]	0	100
Surgery*	Specialist	50 [40-60]	50 [40-60]	0	100	0	100	0	100	50 [40-60]	50 [40-60]	0	0	100
	Consultant	40 [30-50]	60 [50-70]	0	100	40 [30-50]	60 [50-70]	0	100	0	80 [72-88]	20 [12-28]	0	100
Prostho*	Specialist	30 [21-39]	40 [30-50]	30 [21-39]	100	30 [21-39]	40 [30-50]	30 [21-39]	100	20 [12-28]	70 [61-79]	0	10 [4-16]	100
	Consultant	20 [12-28]	80 [72-88]	0	100	0	100	0	100	0	80 [72-88]	20 [12-28]	0	100
Resto*	Specialist	0	100	0	100	0	100	0	100	100	0	0	0	100
	Consultant	0	100	0	100	0	100	0	100	0	100	0	0	100

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Management and Treatment

A considerable number of the dentists agreed that non-surgical mechanical debridement is insufficient to treat peri-implantitis as shown in Table 5.

Also, the majority of the dentists chose carbon fiber or plastic curettes as the instruments recommended for effective cleaning of titanium implants, and none of them chose periodontal steel curettes, except few general dentists and specialists who hadn't received any specialty degree other than implantology as shown in Table 7.The most preferable surgical treatment modality employed by the dentists for implants with peri-implantitis was bone grafting combined with a membrane (Table 8); in addition, the most preferable delayed loading protocol chosen by the dentists for definitive prosthesis installation after implant placement was 4-6 months (Table 8).

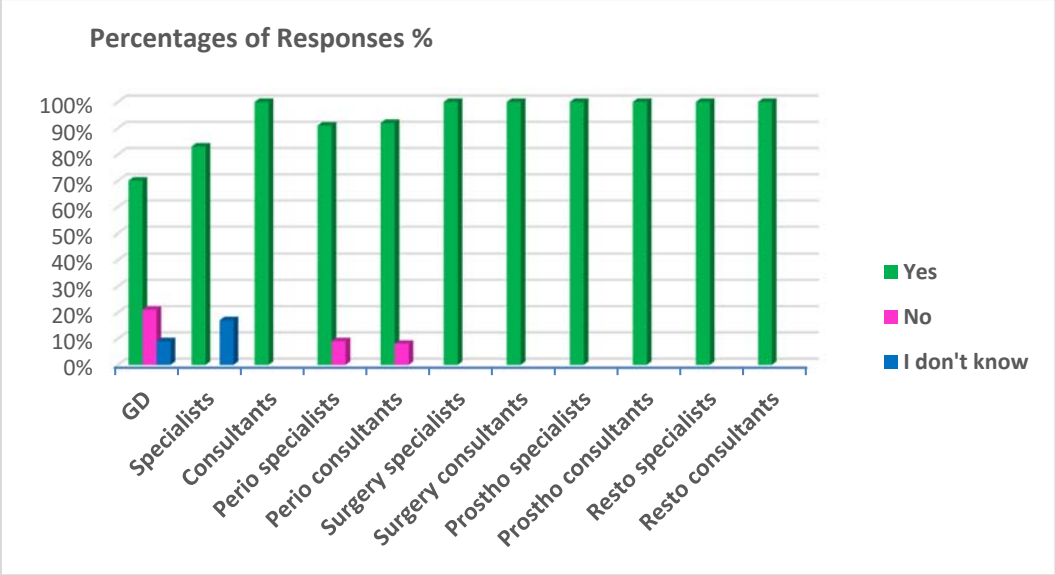

Chart 1: Percentages of Responses to Treated-Surface Implants and Osseointegration

Table 5: Diagnosis, Management and Treatment

Specialty		Diagnosis Responses-Estimated Proportions (95% CI)								Management & Treatment Responses-Estimated Proportions (95% CI)			
		Q17 Bone Level Threshold				Q18 Probing Depth Threshold				Q20 Non-Surgical Debridement			
		≥2 mm %	≥5 mm %	I don't know %	Total%	≥ 2 mm %	≥5 mm %	I don't know %	Total %	Yes %	No %	I don't know %	Total%
Implant* only	GD*	58 [48-68]	24 [16-32]	18 [10-26]	100	30 [21-39]	52 [42-62]	18 [10-26]	100	48 [38-58]	33 [24-42]	18 [10-26]	100
	Specialist	33 [24-42]	33 [24-42]	33 [24-42]	100	17 [10-24]	50 [40-60]	33 [24-42]	100	67 [58-76]	17 [10-24]	17 [10-24]	100
	Consultant	100	0	0	100	0	100	0	100	50 [40-60]	50 [40-60]	0	100
Perio*	Specialist	36 [27-45]	59 [49-69]	5 [1-9]	100	14 [7-21]	86 [79-93]	0	100	59 [49-69]	36 [27-45]	5 [1-9]	100
	Consultant	92 [87-97]	8 [3-13]	0	100	8 [3-13]	92 [87-97]	0	100	33 [24-42]	67 [58-76]	0	100
Surgery*	Specialist	50 [40-60]	50 [40-60]	0	100	50 [40-60]	50 [40-60]	0	100	100	0	0	100
	Consultant	80 [72-88]	20 [12-28]	0	100	0	100	0	100	60 [50-70]	40 [30-50]	0	100
Prostho*	Specialist	50 [40-60]	50 [40-60]	0	100	10 [4-16]	90 [84-96]	0	100	60 [50-70]	40 [30-50]	0	100
	Consultant	100	0	0	100	0	100	0	100	0	100	0	100
Resto*	Specialist	0	100	0	100	0	100	0	100	0	100	0	100
	Consultant	0	100	0	100	0	100	0	100	100	0	0	100

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Table 6: Diagnosis

Specialty		Diagnosis Responses-Estimated Proportions (95% Cl) Q19 Early Detection of Peri-implantitis					
		Bleeding, Probing, Suppuration %	Inflammation %	Plaque& Calculus %	Mobility %	I don't know %	Total %
Implant* only	GD*	52 [42-62]	21 [13-29]	9 [3-15]	15 [8-22]	3 [1-6]	100
	Specialist	17 [10-24]	33 [24-42]	17 [10-24]	17 [10-24]	17 [10-24]	100
	Consultant	50 [40-60]	0	0	50 [40-60]	0	100
Perio*	Specialist	36 [27-45]	55 [45-65]	5 [1-9]	5 [1-9]	0	100
	Consultant	75 [67-83]	25 [17-33]	0	0	0	100
Surgery*	Specialist	100	0	0	0	0	100
	Consultant	80 [72-88]	20 [12-28]	0	0	0	100
Prostho*	Specialist	50 [40-60]	40 [30-50]	10 [4-16]	0	0	100
	Consultant	100	0	0	0	0	100
Resto*	Specialist	0	0	100	0	0	100
	Consultant	100	0	0	0	0	100

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Discussion

Bacteria

"Peri-implanitis" has many features in common with chronic adult periodontitis,[6] and bacteria commonly associated with periodontitis are highly prevalent in peri-implantitis.[7] For instance, peri-implantitis has been associated with Gram-negative anaerobic bacteria similar to those found around natural teeth in patients with severe chronic periodontitis.[1] Also, bacteria found in periodontitis, such as Porphyromonas gingivalis, are major pathogens in peri-implantitis.[7,8] Therefore, implants should not be placed in patients with untreated periodontal disease because of the possibility of infection of the implant surfaces from former periodontopathic bacteria.[8] In addition, it has been found that Gram-negative anaerobic rods are significantly elevated in peri-implantitis sites,[6] and T. forsythia is significantly the most elevated microorganism in peri-implantitis of all the following species (T. forsythia, P. gingivalis, T. socranskii, Staph. aureus, Staph. anaerobius, Strep. intermedius, and Strep. mitis).[7] Furthermore, many studies have indicated to Staphyloccous aureus as possible bacteria in the initiation and development of peri-implantitis.[1,6,7,9] On the other hand, healthy periodontal sites and peri-implant sites in patients with successful implants have high percentages of coccoid cells, while motile rods, spirochetes, and fusiform bacteria are infrequent and in low proportions.[6]

Table 7: Management and Treatment

Specialty		Management & Treatment Responses-Estimated Proportions (95% CI)					
		Q21Cleaning of Titanium Implants					
		Periodontal steel curettes %	Ultrasonic steel tip %	Carbon fiber or plastic curettes %	Air powder abrasive unit of bicarbonate %	I don't know %	Total %
Implant*	GD*	9 [3-15]	9 [3-15]	55 [45-65]	12 [6-18]	15 [8-22]	100
	Specialist	17 [10-24]	17 [10-24]	33 [24-42]	17 [10-24]	17 [10-24]	100
	Consultant	0	0	100	0	0	100
Perio*	Specialist	0	9 [3-15]	82 [74-90]	5 [1-9]	5 [1-9]	100
	Consultant	0	8 [3-13]	83 [76-90]	8 [3-13]	0	100
Surgery*	Specialist	0	0	100	0	0	100
	Consultant	0	20 [12-28]	80 [72-88]	0	0	100
Prostho*	Specialist	0	0	90 [84-96]	0	10 [4-16]	100
	Consultant	0	0	100	0	0	100
Resto*	Specialist	0	0	100	0	0	100
	Consultant	0	0	100	0	0	100

*Implant = Implantology, Perio = Periodontics, Surgery = Maxillofacial Surgery, Prostho = Prosthodontics, Resto = Restorative Dentistry, GD = General Dentist

Implant Surface

Success or failure of dental implant treatment is mainly based on the principles of creating and maintaining an interface between the implant and surrounding bone. This can be achieved by osseointegration, which is a direct structural and functional connection between an implant and the bony tissue around it.[10] The osseointegration process is influenced by many factors: anatomical location, implant size and design, surgical procedure, loading effects, biological fluids, age and gender, and surface characteristics (surface roughness in particular); Initial interaction between the implanted material and biological environment is considered to be dominated by the surface properties,[11] and the response of the tissues to the implant is largely controlled by the nature and texture of the surface of the implant.[10]In the same context, previous studies have mentioned that dental implant design and surface chemistry may have an impact on the invasion of oral microorganisms into the fixture-abutment interface.[7] Also, Palmer et al. have indicated that peri-implantitis occurs more commonly at implants with rough surfaces that allow bacterial colonization[8]; in addition, Teughels et al. have concluded that an increase in surface roughness above the R_a threshold of 0.2 mm facilitates biofilm formation on restorative materials, and the biofilm formation is also influenced by the type (chemical composition) of biomaterial or the type of coating. Therefore, transmucosal implant surfaces with a higher surface roughness facilitate biofilm formation.[12] However, Quirynen et al. found that a reduction in surface roughness (less than a roughness of 0.2 μm) had no major effect on the microbiologic composition and had no impact on bacterial adhesion and/or colonization.[13] Therefore, research has come up with three types of methods for surface modifications of implants (mechanical, chemical, and physical); these methods aim to enhance the biomechanical properties of the implant such as stimulation of bone formation in order to improve osseointegration, remove surface contaminants, and improve wear and corrosion resistance.[14] There are various chemical methods of implant surface modifications including chemical treatment with acids or alkali, hydrogen peroxide treatment, sol-gel, chemical

vapor deposition, and anodization. For instance, chemical surface modification of Ti alters surface roughness and composition and enhances wett-ability/surface energy.[14] In addition, physical methods of implant surface modification include plasma spraying, sputtering, and ion deposition. The surface defects gained by the physical modification provide mechanical resistance through bone interlocking.[14]

Table 8: Management and Treatment

Specialty		Management & Treatment Responses-Estimated Proportions (95% CI)									
		Q22 Surgical Treatment Modality						Q23Delayed Loading			
		Bone grafting with a membrane %	Bone grafting %	Membrane %	Osteotomy %	I don't know %	Total%	3 months %	4-6 months %	6-8 months %	Total%
Implant* Only	GD*	67 [58-76]	12 [6-18]	0	3 [1-6]	18 [10-26]	100	33 [24-42]	67 [58-76]	0	100
	Specialist	67 [58-76]	17 [10-24]	0	0	17 [10-24]	100	17 [10-24]	83 [76-90]	0	100
	Consultant	100	0	0	0	0	100	50 [40-60]	0	50 [40-60]	100
Perio*	Specialist	45 [35-55]	5 [1-9]	23 [15-31]	5 [1-9]	23 [15-31]	100	9 [3-15]	82 [74-90]	9 [3-15]	100
	Consultant	75 [67-83]	0	8 [3-13]	8 [3-13]	8 [3-13]	100	83 [76-90]	17 [10-24]	0	100
Surgery*	Specialist	50 [40-60]	50 [40-60]	0	0	0	100	0	50 [40-60]	50 [40-60]	100
	Consultant	80 [72-88]	0	20 [12-28]	0	0	100	40 [30-50]	60 [50-70]	0	100
Prostho*	Specialist	60 [50-70]	0	10 [4-16]	0	0 [21-39]	100	30 [21-39]	70 [61-79]	0	100
	Consultant	100	0	0	0	0	100	40 [30-50]	60 [50-70]	0	100
Resto*	Specialist	0	0	100	0	0	100	100	0	0	100
	Consultant	100	0	0	0	0	100	100	0	0	100

*Implant = Implantology, Perio = Periodontics, Surgery = Maxillofacial Surgery, Prostho = Prosthodontics, Resto = Restorative Dentistry, GD = General Dentist

Antimicrobials and Antibiotics

The use of chlorhexidine as an adjunct to mechanical debridement to prevent recolonization of bacteria hasn't shown great influence in the resolution of peri-implantitis or peri-implant mucositis. For instance, Porras et al. and Thöne-Mühling et al. have concluded that mechanical debridement with or without the use of chlorhexidine is effective in the treatment of peri-implant mucositis.[15,16] In addition, Heitz-Mayfield et al. found that mechanical debridement in conjunction with oral hygiene alone was effective in reducing peri-implant mucositis, and adjunctive application of chlorhexidine gel did not enhance the results compared with mechanical cleansing alone.[17] Also, Porras et al. agreed with Mombilli et al.[6] that implants with peri-implant mucositis harbored different types of Gram-negative anaerobic rods and found that these pathogens were markedly reduced or eradicated after mechanical debridement with or without the use of chlohexidine at 3 months.[15] In the same context, Revert et al. indicated that adjunctive use of chlorhexidine resulted in limited outcome in the treatment of peri-implant lesions.[18] Literature has reported different kinds of antibiotics used in conjunction with non-surgical and surgical

mechanical debridement for the treatment of both chronic and aggressive periodontitis such as tetracyclines, doxycycline, penicillins (amoxicillin), metronidazole, macrolides (spiramycin, erythromycin, azithromycin), clindamycin and ciprofloxacin. Amoxicillin and metronidazole combination has been the most common combined antibiotic therapy reported[19,20]; all the aforementioned medications have been indicated to as systemic antibiotics applied for the treatment of peri-implantitis in addition to ornidazole (1000 mg daily for ten days), which is a common systemic antibiotic for the treatment of peri-implanititis[21,22,23] beside (amoxicillin + metronidazole).[20,22] Figuero et al. referred to azithromycin (500 mg/day for 4 days) as a systemic antibiotic for the treatment of peri-implant diseases.[24] Although systemic antibiotics are widely used for the treatment of peri-implant diseases, the significance of adjunctive antibiotic therapy in the treatment of peri-implantitis remains controversial,[22] and there is lack of sound scientific basis for the use of systemic antibiotics as part of standard mode of therapy,[2,20,21]so it's not known if the use of systemic antibiotics in surgical therapy of peri-implantitis is required because of limited evidence of their advantages.[2,20] Therefore, there is need for randomized clinical trials to show the effects of systemically administered antibiotics in the treatment of peri-implantitis.[21] On the other hand, local antibiotics are used in conjunction with mechanical debridement, and the additional effects of local antibiotics were noted in all studies but were generally moderate. Although, the current available scientific information on the use of local antibiotics is insufficient,[21] studies agree on their positive effect in the treatment of peri-implantitis. For instance, local antibiotics used for the treatment of peri-implantitis such as minocycline hydrochloride microspheres (Arestin®),[18,21,25,26] 8.5% doxycycline gel (Atridox®),[21,27]and tetracycline HCl fibers (Actisite®)[21,24,28] improved the results of the treatment of peri-implantitis when used adjunctively. The theoretical advantages of locally administered antibiotics in comparison to systemically delivered antibiotics are: the high concentrations that can be achieved, the significantly reduced risk of side and adverse effects, the absence of interaction with other drugs, the reduced risk of the emergence of antibiotic resistant bacteria, the independence from patient compliance due to the professional delivery of the drug.[18,21,25] In addition to chlorhexidine and local antibiotics, citric acid, hydrogen peroxide, chloramine T, and sterile water are used for implant surface decontamination in peri-implantitis sites.[29]

Diagnosis

Several parameters are used to define the extent and severity of peri-implantitis including radiographic bone loss, probing depth, bleeding on probing, and suppuration.[1,2,3,30] Probing depth which has been used to determine peri-implant tissue health is duplicatable and repeatable within 1 mm of accuracy at periodontal sites ≥4 to ≥5 mm[1] or >4 to >5 mm with a difference of 1 mm among studies.[30] In general, the threshold of probing depths for implants in peri-implantitis is ≥5 mm,[8,31,32] and probing can be done with a traditional periodontal probe using light force (0.25N).[1,2] Radiographs confirm marginal bone loss, either as a definitive loss from a defined landmark (e.g. ≥2 mm from implant head) or loss of bone compared to the previous radiographic examination.[8,33] In case previous radiographs are unavailable, the American Academy of Periodontology has adopted the diagnostic parameter of bone loss of the VIII European Workshop on Periodontology: 'In the absence of previous radiographic records, a threshold vertical distance of 2 mm from the expected marginal bone level following remodelling post-implant placement is recommended.'[1,3] Mombilli et al. stated that 'the typical bone defect is crater-like, runs all around the implant, and is strictly demarcated. As perfect osseointegration is maintained apically to the defect, bone destruction can progress without any notable signs of implant mobility. Mobility therefore indicates complete loss of osseointegration and is a sign of total failure'[34]; therefore, the American Academy of Periodontology didn't consider mobility a good diagnostic parameter since a mobile implant is hopeless and should be removed.[1] Also, the consensus report of

the Sixth European Workshop didn't refer to mobility as a diagnostic parameter.[2]

Management and Treatment

Peri-implant mucositis can be successfully treated if detected early and when combined with effective non-surgical mechanical debridement,[1,2] while non-surgical therapy has not been effective for the treatment of peri-implantitis.[1,2,24] Therefore, a standard mode of surgical therapy is recommended for the treatment of peri-implantitis. This therapy should include a clear surgical design, a proven method of decontaminating the implant surface, and an appropriate means of infection control.[3] Debridement includes the removal of soft plaque and calculus by using implant-safe instruments that will not damage the surface such as plastic scalers,[8,15,16] carbon fiber currettes,[17,24] and titanium coated currettes.[17,24,26] Ultrasonic tip can also be used but only with a covering that prevents gouging and disturbance of the surface because titanium implant abutments are easily defected and scratched with traditional metal instruments.[8,16] Steel-tipped instruments are contraindicated on titanium.[8] Standard powdered air-abrasive systems are based on the air-spray of sodium bicarbonate. They are used for polishing and for removing tooth stains, but cannot be used for implant instrumentation because they may damage hard and soft tissue as a result of their high abrasiveness.[24,35] Recently, a powered air abrasive system, based on a low-abrasive amino-acid glycine powder, has been effective in the elimination of the bacterial biofilm from the root surface without damaging hard and soft tissues, and it has been recommended for the debridement of implant surfaces.[24]

Various surgical techniques have been recommended depending on the final objective of the surgical intervention: (I) access for cleaning and decontamination of the implant surface (access flaps), (II) access for cleaning and decontamination plus exposure of the affected surfaces for cleaning (apically repositioned flaps), and (III) access for cleaning plus aiming for bone regeneration and re-osseointegration (regenerative techniques).[24] The use of xenograft plus collagen membrane appeared superior in terms of probing-depth reduction and clinical attachment level gain in comparison to the use of autogenous bone grafting alone or bone substitutes alone.[24] Some dental practitioners attempt to regenerate the lost bone using techniques such as guided bone regeneration. In cases where regenerative techniques have been used and bone fill has occurred, most research has concluded that re-osseointegration is unlikely to occur.[8] Regenerative procedures such as bone graft techniques with or without the use of barrier membranes resulted in various degrees of success. However, it must be insisted that such techniques only attempt to fill the osseous defect and do not redeem the bone loss.[2] So far, research has found no additional beneficial effects on treatment outcome of regenerative procedures, [bone grafts/substitutes, guided bone regeneration (GBR)], in implant sites with bone craters.[2] The original Brånemark protocol recommended leaving implants unloaded and buried beneath the mucosa for approximately six months in the maxilla and three months in the mandible, due to differences in bone quality. However, the original Straumann protocol did not differentiate between upper and lower jaw and advised a three–month healing period for both maxilla and mandible.[36] Palmer et al. mentioned in their textbook published in 2012 that 'Nowadays, the majority of delayed loading protocols recommend a maximum three-month healing period for both jaws.'[8] In the present study, the discrepancies among the dentists' answers concerning delayed loading of definitive prosthesis after implant placement could be justified by the existence of different schools such as Brånemark protocol and Straumann protocol. In addition, in the present study, the discrepancies among the dentists' answers concerning the chosen surgical treatment modality could also be justified by the lack of sound scientific basis in literature that standardizes the mode of surgical therapy. Furthermore, in the present study, there were clear discrepancies among the dentists' answers concerning the adjunctive use of chlorhexidine and the sufficiency of non-surgical mechanical debridement for the resolution of peri-implantitis inflammatory process. Therefore, peri-implantitis should be a matter of concern, and all

dentists practicing implantology should dynamically get involved in all aspects related to peri-implantitis.

Conclusion

There is lack of sound scientific basis for many aspects of peri-implantitis such as systemic antibiotics, regenerative procedures (bone graft techniques with or without the use of barrier membranes), and the mode of surgical therapy. Therefore, there is need for randomized clinical trials with large sample sizes on the pathogenesis, etiology, diagnostic parameters, and treatment modalities of peri-implantitis. Also, workshops and symposia are recommended.

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References

1. Rosen P, Clem D, Cochran D, et al. Peri-implant mucositis and peri-implantitis: a current understanding of their diagnoses and clinical implications. *J periodontol*. 2013;84(4):436–443.
2. Lindhe J, Meyle J, Group D of the European Workshop on Periodontology. Peri-implant diseases: consensus report of the sixth European workshop on periodontology. *J Clin Periodontol*. 2008;35(Suppl 8):282-285.
3. Sanz M, Chapple IL, Working Group 4 of the VIII European Workshop on Periodontology. Clinical research on peri-implant diseases: consensus report of Working Group 4. *J Clin Periodontol*. 2012;39(Suppl 12):202–206.
4. Togashi AY, Carmelo RA, Pereira NC. Level of knowledge of dentists about the diagnosis and treatment of peri-implantitis. *Dent Press Implantol*. 2014;8(1):30-38.
5. Nunnally JC, Bernstein IH, eds. *Psychometric Theory*. 3rd. New York: McGraw-Hill; 1994.
6. Mombelli A, Van Oosten MAC, Schürch Jr E, Lang NP. The microbiota associated with successful or failing osseointegrated titanium implants .*Oral Microbiol Immunol*. 1987;2:145-151.
7. Persson GR, Renvert S. Cluster of bacteria associated with peri-implantitis. *Clin Implant Dent Relat Res*. 2014;16(6):783-793.
8. Palmer RM, Howe LC, Palmer PJ, eds. *Implants in Clinical Dentistry*. 2nd ed. London: Informa Healthcare; 2012.
9. Thurnheer T, Belibasakis GN. Incorporation of staphylococci into titanium-grown biofilms: an in vitro “submucosal” biofilm model for peri-implantitis. *Clin Oral Implants Res*. 2016;27(7):890–895.
10. Alla RK, Ginjupalli K, Upadhya N, Shammas M, Ravi RK, Sekhar R. Surface roughness of implants: a review. *Trends Biomater Artif Organs*. 2011;25(3):112-118.
11. Bagno A, Di Bello C. Surface treatments and roughness properties of Ti-based biomaterials. *J Mater Sci Mater Med*. 2004;15(9):935-949.
12. Teughels W, Van Assche N, Sliepen I, Quirynen M. Effect of material characteristics and/or surface topography on biofilm development. *Clin Oral Implants Res*. 2006;17(Suppl 2): 68–81.
13. Quirynen M, Bollen CM, Papaioannou W, Van Eldere J, Van Steenberghe D. The influence of titanium abutment surface roughness on plaque accumulation and gingivitis: short-term observations. *Int J Oral Maxillofac Implants*. 1996;11(2):169-178.
14. Dahiya V, Shukla P, Gupta S. Surface topography of dental implants: a review. *J Dent Implants*. 2014;4(1):66-71.
15. Porras R, Anderson GB, Caffesse R, Narendran S, Trejo PM. Clinical response to 2 different therapeutic regimens to treat peri-implant mucositis. *J Periodontol*. 2002;73(10):1118-1125.
16. Thöne-Mühling M, Swierkot K, Nonnenmacher C, Mutters R, Flores-de-Jacoby L, Mengel R. Comparisonof two full-mouth approaches in the treatment of peri-implant mucositis: a pilot study. *Clin Oral Implants Res.* 2010;21:504–512.
17. Heitz-Mayfield LJA, Salvi GE, Botticelli D, Mombelli A, Faddy M, Lang NP. Anti-infective treatment of peri-implant mucositis: a

randomised controlled clinical trial. *Clin Oral Implants Res*. 2011;22(3):237–241.
18. Renvert S, Lessem J, Dahlén G, Lindahl C, Svensson M. Topical minocycline microspheres versus topical chlorhexidine gel as an adjunct to mechanical debridement of incipient peri-implant infections: a randomized clinical trial. *J Clin Periodontol*.2006;33(5):362-369.
19. Heitz-Mayfield LJA. Systemic antibiotics in periodontal therapy. *Aust Dent J*. 2009;54 (Suppl 1):S96–S101.
20. Heitz-Mayfield LJA, Lang NP. Antimicrobial treatment of peri-implant diseases. *Int J Oral Maxillofac Implants*. 2004;19(Suppl):128–139.
21. Jan van Winkelhoff A. Antibiotics in the treatment of peri-implantitis. *Eur J Oral Implantol*. 2012;5(Suppl):S43–S50.
22. Javed F, AlGhamdi AST, Ahmed A, Mikami T, Ahmed HB, Tenenbaum HC. Clinical efficacy of antibiotics in the treatment of peri-implantitis. *Int Dent J*. 2013;63(4): 169–176.
23. Mombelli A, Lang NP. Antimicrobial treatment of peri-implant infections. *Clin Oral Implants Res.*1992;3(4):162–168.
24. Figuero E, Graziani F,Sanz I, Herrera D, Sanz M. Management of peri-implant mucositis and peri-implantitis. *Periodontol 2000*. 2014;66(1):255–273.
25. Renvert S, Lessem J, Dahlén G, Renvert H, Lindahl C. Mechanical and repeated antimicrobial therapy using a local drug delivery system in the treatment of peri-implantitis: a randomized clinical trial. *J Periodontol*. 2008;79(5):836-844.
26. Schär D, Ramseier CA, Eick S, Arweiler NB, Sculean A, SalviGE. Anti-infective therapy of peri-implantitis with adjunctive local drug delivery or photodynamic therapy: six-month outcomes of a prospective randomized clinical trial.*Clin Oral Implants Res*. 2013;24(1):104–110.
27. Büchter A, Meyer U, Kruse-Lösler B, Joos U, Kleinheinz J.Sustained release of doxycycline for the treatment of peri-implantitis: randomized controlled trial. *Br J Oral Maxillofac Surg*. 2004;42(5):439-444.
28. Schenk G, Flemmig TF, Betz T, Reuther J, Klaiber B. Controlled local delivery of tetracycline HCl in the treatment of priimplant mucosal hyperplasia and mucositis. A controlled case series. *Clin Oral Implants Res*. 1997;8:427-433.
29. Elemek E, Almas K. Peri-implantitis: etiology, diagnosis and treatment: an update. *NY State Dent J*. 2014;80(1):26-32.
30. Lin GH, Kapila Y, Wang HL. Parameters to define peri-implantitis: a review and a proposed multi-domain scale. *J Oral Implantol*. 2017;43(6):491-496.
31. Pjetursson BE, Helbling C, Weber HP, et al. Peri-implantitis susceptibility as it relates to periodontal therapy and supportive care. *Clin Oral Implants Res*. 2012;23(7):888–894.
32. Poli PP, Cicciu M, Beretta M, Maiorana C. Peri-implant mucositis and peri-implantitis: a current understanding of their diagnosis, clinical implications, and a report of treatment using a combined therapy approach. *J Oral Implantol*. 2017;43(1):45-50.
33. Koldsland OC, Scheie AA, Aass AM. Prevalence of peri-implantitis related to severity of the disease with different degrees of bone loss. *J Periodontol*. 2010;81(2):231-238.
34. Mombelli A, Müller N, Cionca N. The epidemiology of peri-implantitis. *Clin Oral Implants Res*. 2012;23(suppl 6):67–76.
35. Kontturi-Närhi V, Markkanen S, Markkanen H. Effects of airpolishing on dental plaque removal and hard tissues as evaluated by scanning electron microscopy. *J Periodontal*. 1990;61(6):334-338.
36. Palmer RM, Smith BJ, Howe LC, Palmer PJ, eds. *Implants in Clinical Dentistry*. London: Martin Dunitz; 2002.