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A RETROSPECTIVE STUDY TO EVALUATE SOME POTENTIAL RISK INDICATORS ON OSSEOINTEGRATED DENTAL IMPLANTS IN A SAMPLE OF IRAQI PATIENTS

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ABSTRACT : Determining risk indicators for dental implants is an essential strategy for preventing peri-implant diseases and effective diagnosis of dental implant success. To investigate the impact of certain potential factors on the osseointegrated dental implant. Eighty-four individuals were included in our study, 50 cases as a patient's group and 34 participants as a control group. All cases were diagnosed based on certain criteria, 30 (60%) of patients had peri-implantitis, 20 (40%) with severe peri-implantitis, 36(72%) were generalized, and 15 (30%) as localized peri-implantitis cases. The study has indicated that 44.7% of dental implants were in the anterior maxilla, followed by (27.3%) posterior maxilla, (17.4%) posterior mandible, and (10.4%) anterior mandible. Also results were showed that the anterior maxilla was significantly the highest (*P*=0.000) in the incidence of PID than any other implantation sites (PMx, PMa, AMa). The most patients' complaint was 28(56%) altered gingival appearance, followed by 20(40%) pathological mobility, 16(32%) halitosis, 16(32%) pain, 12(28%) bleeding, 8(16%) unpleasant taste. The majority of the implants in both groups were long, regular-width, conical and had a rough surface In the patient group, all risk indicators related to implant design were showed a significantly higher than the control group, except for regular-width and screw type implant, which were significantly lower than control. In conclusion, the study improved that many different potential risk indicators contributed to the development of PIDs.

Key words : Risk indicators, dental implants, peri-implant diseases.

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INTRODUCTION

Peri-implantitis is an infectious disease characterized by inflammatory mucosal lesion with bone loss around the osseo-integrated dental implant. The dental implant is an artificial device usually made of titanium (Ti), inserted into the bone for replacing one or more missing teeth and healthy periodontium is an essential for implant treatment. Regard to peri-implantitis it should be presumably mention risk indicators as no longitudinal possible studies are available, which would identify true risk factors (Lindhe *et al*, 2008). Risk indicators of peri-implantitis are diverse and can summarize as following:

History of periodontitis, many studies have been showed positive relationship between history of periodontitis and current peri-implantitis (Ferreira *et al*, 2018; Schwarz *et al*, 2018). Heitz-Mayfield and Huynh-Ba, were stated that patients with a history of periodontitis are at greater risk for peri-implantitis than non-periodontal patients as the measured odds ratios (OR) run from 3.1 to 4.7(Heitz-Mayfield and Huynh-Ba, 2009).

There is strong evidence of a positive correlation between poor oral hygiene and peri-implantitis. An early prospective study was reported a link between peri-implant bone loss and poor oral hygiene, particularly in smokers (Lindquist *et al*, 1997). Another study was documented the accessibility to oral hygiene correlated significantly with the stability of the peri-implant (Serino and Ström, 2009). A Brazilian study noted that an increased risk of peri-implantitis was in non-smoking individuals suffering from poor metabolic control (Ferreira *et al*, 2006). As well as there is a clear correlation between smoking and peri-implantitis in which adjustment was made for poor oral hygiene. The (OR) range was between 3.6 and 4.6 (Rodriguez-Argueta *et al*, 2011).

Diabetes mellitus is considered as a risk factor for peri-implantitis (Marrone *et al*, 2013). Mucositis is a potential peri-implantitis risk factor (Lang *et al*, 2009). Several studies have emphasized the importance of wider zone keratinized mucosa on long-term peri-implant soft and hard tissue health and stability (Block *et al*, 1996; Schrott *et al*, 2009). However, the presence of a sufficient keratinized mucosa could not ensure absence of peri-implant lesions (Roos Jansåker *et al*, 2006).

Although, limited evidence suggested that alcohol consumption is a risk factor for peri-implantitis (Alissa and Oliver, 2012). However, > 10 g daily consumption of alcohol leaded to significant bone loss around implants (Galindo Moreno *et al*, 2005). Koo *et al* (2004) were stated that Alcohol consumption affects bone metabolism by suppressing osteoblasts proliferation and increasing osteoclastic activity.

The implant position in the arch as a local factor that threatens the long-term survival of the implant. In particular, maxillary posterior region was associated with a higher implant failure. Implant design and surface is another risk factor, an association of short and wide implants with increased implant loss rates was suggested (Alsaadi *et al*, 2008). Some studies have showed a positive relationship between smooth surface and the health of peri-implant tissues (Astrand *et al*, 2004; Esposito, Ardebili and Worthington, 2014), whilst others have found no correlation of the implant surface on marginal bone loss (Wennström *et al*, 2004; Renvert *et al*, 2012).

Residual cement serves as a foreign body in addition to its clear role in stimulating and persistence bacterial infection. Wilson and Thomas were found that excessive dental cement was associated with clinical and /or radiological signs of peri-implantitis in 81% of 39 cases (Wilson Jr, 2009). The last factor is the microorganisms mainly bacteria, since peri-implantitis is a chronic inflammatory disease associated with bacterial challenge, so biofilms are forming along the surface of the implant and developing above the mucous margin, in bad oral hygiene conditions (Ramanauskaite *et al*, 2018). Al-Dahbi *et al* (2020) were isolated more than 20 bacterial spp. (pathogenic and commensal) associated with dental implant.

Aim of the study : Assessment the impact of some risk factors on dental implant.

MATERIALS AND METHODS

Ethical statements for human/animal experiments : Institutional ethics committee approved the study and informed constant were obtained by each participant. Each participant was known about the study follow up before enrolling for the study. I confirm that all experiments were performed following relevant guidelines and regulations. The study proposal was accepted by biology department, college of science of Mustansiriyah University, Baghdad, Iraq.

A total of 84 participants, fifty patients with diseased implants (PID) and 34 with functional implants (≥ 3 years) and heathy periimplant tissue were collected from different private dental clinics, Baghdad, Iraq in 10 months. Full medical history was recorded in a case sheet for each patient, which is designed to include some possible risk indicators for peri-implantitis such as those related to general individual health like diabetes, hypertension, dry mouth and others related to oral health as ulcer, history of periodontitis, absence of keratinized mucosa, edentulism and factors related to patient habits and oral self-care like oral hygiene, dental clinic visit, smoking status, bruxism, clenching as well as other indicators related to the dental implants such as the position of dental implant concerning the arch (AMx, PMx, AMa, PMa) and implant topology including implant design (length, width, geometry) and implant surfaces (rough, smooth).

Inclusion and exclusion criteria

The participants should have at least one dental implant with definitive prostheses for at least one year and the implant of the patient was diagnosed with peri-implantitis, evident in radiographic bone loss ≥3 mm, PPD ≥6 mm and a positive BoP score (Renvert *et al*, 2018). While some patients were excluded if they have had any follow-up visit for plaque control of the prosthesis and/or the implants, patients who had taken any antibiotic or anti-inflammatory therapy in the past 6 months prior to clinical examination and sampling, patients under chemo, radiation therapy, patients with allergy to Metronidazole (MTZ) and/or amoxicillin (AMX), patients got orthodontic intervention and patients, who had poorly controlled diabetes mellitus (HbA1c ≥8.0) (Filho *et al*, 2014).

Statistical analysis

For the purpose of studying the significance level or P-value between the different factors that were included in the study, the percentage, chi-square and Z-test were calculated. The values of $p>0.05$ were considered statically non-significant while $p<0.05$ and <0.01, 0.001 were considered significantly different, highly significantly different, respectively. The statistical analysis was carried out by SPSS (v 20).

RESULTS AND DISCUSSION

Eighty-four individuals were recruited in our study, 50 cases (patient's group) were classified as patients with peri-implant disease (PID) and 34 participants with functional implants (≥ 3 years) and heathy periimplant tissue (as a control group). In the patient's group, the total number of dental implants was 126, fifty-nine (46.8%) of which were diagnosed with Peri-implant diseases (PID).

Regarding to the patients' groups (N=50), all cases were diagnosed based on the criteria previously mentioned, 30 (60%) patients had peri-implantitis, 20 (40%) with severe peri-implantitis, 36(72%) were generalized and 15 (30%) as localized peri-implantitis cases (Table 1).

In 14(28%) of the patients, the development of periimplantitis was occurred earlier, after having functional implants < 4 years, while in 36(72%) patients was diagnosed at a later time after actual disease progression (Table 2).

The main patients' complaint that prompted them to visit the dental clinic is depicted in Table 3.

The results have been indicated that most patients' complaint was 28(56%) altered gingival appearance, followed by 20(40%) pathological mobility, 16(32%) halitosis, 16(32%) pain, 12(28%) bleeding, 8(16%) unpleasant taste.

One of the most important challenges of peri-implantitis is that symptoms do not appear in the same way for all patients, and usually appear lately at the end of the inflammatory stages (Lang and Lindhe, 2015), this explains why that most cases (72%) were diagnosed as late periimplantitis along with the high rate (40%) of pathological mobility of the implant as a chief patients complaint, such mobility indicates implant-supported bone loss and eventual loss of the implant. Thus, patients are advised to attend regular dental appointments and seek advice from their dentist if they have any concerns about oral health. A patient is more likely to notice bleeding while brushing their teeth. The patient may also notice swelling around the implant, bad breath and/or a bad taste. Pain is believed to be a rare symptom and is generally associated with an acute infection (Prathapachandran and Suresh, 2012).

The present study aimed to evaluate the impact of some selected potential risk indicators on terminal outcome of dental implant therapy, these indicators were divided into main categories, (1) Patient-related risk indicators such as general individual health (diabetes, hypertension, dry mouth), oral health (ulcer, history of periodontitis, Absence of keratinized mucosa, edentulism), patient habits and oral self-care (oral hygiene, dental clinic visit, smoking status, bruxism, clenching) as in Table 4 and (1). Other indicators related to the dental implants such as the position of dental implant concerning the arch (AMx, PMx, AMa, PMa) and implant topology including implant design (length, width, geometry) and implant surfaces (rough, smooth).

Table 1 : Distribution of PID patients according to diagnosis

Type of PIDs	Patients (50) No (%)	*p* value (z-statistic)/X^2
1. Periimplantitis	Y:30(60%)	0.0001
	N:20(40%)	
2. Severe peri-implantitis	Y: 20(40%)	0.0001
	N: 30(60%)	
3. Localized/periimplantitis	Y:15(30%)	0.0001
	N:35(70%)	
4. Generalized/periimplantitis	Y: 36(72%)	0.0001
	N: 14(28%)	

Y: yes, **N:** no

Table 2 : Distribution of PID patients according to disease development.

Disease development	Patients (50) No (%)	*p* value (z-statistic)/X^2
1. Early	14(28%)	0.001
2. Moderate	22(44%)	0.001
3. Late	14(28%)	0.001

Table 3 : Distribution of chief complaint among patient and control groups.

Type of complaint	Patients (50) No. (%)	Control (34) No. (%)	*p* value (z-statistic)
1. Altered gingival appearance	28(56%)	0(0%)	0.0001
2. Bleeding	12(28%)	0(0%)	0.001
3. Halitosis	16(32%)	0(0%)	0.001
4. Migration of teeth	3(6%)	0(0%)	0.08
5. Pathological mobility	20(40%)	0(0%)	0.0001
6. Pain	16(32%)	0(0%)	0.001
7. Unpleasant taste	8(16%)	0(0%)	0.01
8. Hypersensitivity	0(0%)	0(0%)	NS

1. Patient-related risk indicators

a. General individual health

The study showed that there was a significant association between the patient group and type I or type II diabetes compared to the control group ($p = 0.001$), as 3 (6%), (6,12%) of the patients had diabetes type I or type II, respectively.

Regarding the investigation of the effect of blood pressure disturbance on implant failure, 24 (48%) of patient and 18 (52.9%) of healthy participants showed normal pressure. while the patient group showed a significant increase in the number of hypertensive cases compared to the control group ($p = 0.01$). It is worth noting that no one of the two groups suffered from hypotension.

On the other hand, the results indicated that 6(12%) of the patient group suffered from dry mouth syndrome, and showed a significant difference with 0 (0%) the control group ($p = 0.01$)

Both local and systemic risk factors can lead to high failure rates, diabetes is a chronic disease with high blood sugar (hyperglycemia) and various side effects. In a systematic review of 22 clinical studies and 20 publications, Naujokat *et al* (2016) were found that diabetic patients had poor osseointegration, an increased risk of peri-implantitis, and a higher level of implant failure. On the other hand, Altay *et al* (2018) were concluded that diabetes and hypertension are the predominant systemic indicators among patients with peri-transplant disease.

Xerostomia is a common complaint of nearly half of the elderly population and about a fifth of younger adults (Mortazavi *et al*, 2014). Although not considered a disease, it may indicate changes directly related to the salivary glands or indirectly as a result of systemic diseases. Persistently low flow rate of saliva during time may lead to oral health problems (such as candidiasis, tooth decay and mucosal complications, changes in the oral environment that affect the hard and soft tissues of the mouth (Escobar and Aitken-Saavedra, 2018).

Most studies emphasize the importance of presence an adequate area of keratinized tissue around the implant (Smeets *et al*, 2014). Kungsadalpipob *et al* (2020) were noted that there is a significant association between decreased keratinized mucosa and increased plaque buildup, mucosal retraction, interproximal bone loss ≥ 3 mm and periimplantitis.

b. Oral health

Surprisingly, the results indicated that the history of periodontitis was highly increased with PIDs, reaching 39 (78%) of the total patient group compared to 9(26.5%) in control group (p =0.0001).

Whereas, the number of participants who suffered from the absence of keratinized mucosa around the dental implants in the patient group was 21 (42%) patients with highly significant difference from the 0(0%) control group ($p = 0.001$).

Our result on the impact of edentulism (*i.e.* toothlessness) status showed that the majority of periimplantitis cases (40 (80%)) were occurred in dentate patients (*i.e.* partially edentulous) with a significant differences from the control group (22, 64.7%) ($p = 0.001$), while the least were edentulous (i.e. complete edentulous) in one or both jaws.

c. Patient habits and oral self-care

The comparison results indicated that there were significant differences between the two groups (patients and control), only 12 (24%), 8 (16%), 16 (32%), 32 (64%) of the participating patients were regularly visiting the dental clinics, used inter-dental cleaning aids, good oral hygiene and non-smokers, respectively. Eight (16%) and 3 (6%) had bruxism and clenching respectively.

There are a variety of factors by which an implant can lose attachment to the bone and fail once it fuses successfully, including: poor oral hygiene (plaque buildup) or severe biting force resulted from parafunctional activity such as habit of clenching and grinding of teeth (*i.e.* bruxism).

Given that plaque is the main causative factor in the development of biofilms around the implants. Thus, it is considered an indicator of the extent of oral hygiene (Lindquist *et al*, 1997). In addition to the fact that its quantities increase in smokers (Andrews *et al*, 1998), so it is not surprising to find a close relationship between poor oral hygiene (and/or smoking) and bone loss around the implant. Moreover, Ferreira *et al* (2006) have proven that the relationship between PIDs and the degree of plaque is strong and dose dependent.

In fact, Heitz-Mayfield *et al* (2013) have been revealed that patients with poor oral hygiene are up to 14 times more likely to develop peri-implantitis. Interestingly, in a group of 23 patients with 109 implants, Serino and Ström (2009) showed that only 4% of the implants in patients with good oral hygiene - had periimplantitis while 48% in patients with poor oral hygiene. Marcantonio *et al* (2015) have been concluded that 53% of smokers have signs of periimplantitis, and smoking in combination with poor self-care have the highest risk factors for developing periimplantitis.

Occlusal overload (*i.e.* excessive biting forces) either come from parafunctional habits exerted by patients, or from an insufficient number of implants to handle the biting forces, such forces are likely to place non-axial loads on both teeth and implants for long periods (Fu *et al*, 2012). Because implants lack periodontal ligaments, so when placed under an increased load, they cannot withstand excessive pressures. The stress of loading in turn will concentrate on the marginal bone around the implant and thus lead to increased bone loss as this area is remodeled under pressure. Furthermore, occlusal overload may expose the implant surfaces and thus became populated by microorganisms leading to further bone loss. Consequently, the effects of occlusal overload may be amplified in patients with poor oral hygiene (Isidor, 1996).

2. Other factors related to dental implants

a. Implant position in the arch

The number of implants was 31, 9, 18 and 9 in the anterior maxilla (AMx), anterior mandible (AMa), posterior maxilla (PMx) and posterior mandible (PMa), respectively. On the other hand, the total number of dental implants for the control group were 46 healthy peri - implants, distributed over the jaws by 15, 4, 15 and 12 at AMx, AMa, PMx, PMa, respectively (Table 5), which shows the distribution of dental implants in both maxilla and mandible of both (patients, control) group.

As indicated from the Table 5 that 44.7% of dental implants were in the anterior Maxilla, followed by (27.3%) posterior Maxilla, (17.4%) posterior Mandible and (10.4%) anterior Mandible.

The results showed that the anterior maxilla was significantly the highest (*P*=0.000) in the incidence of PIDs than any other implantation sites (PMx, PMa, AMa). Notably, no significant differences ($p > 0.05$) between the three remaining diseased peri implant sites (PMx, PMa, AMa) (Fig. 1).

The anterior maxilla was traditionally a major aesthetic concern. A myriad of possible causes that make teeth in the anterior maxilla are hopeless including frequent root canal failure, tooth decay and gum disease, vertical root fractures and trauma, all of which can leave the area deficient in the bone and soft tissue support (Al-Sabbagh, 2006).

Several studies have suggested an association between the implant site (anterior/posterior or maxilla/ mandible) and the prevalence of PIDs.In particular, maxillary implanted sites were indicated as statistically significant risk indicators of periimplantitis (Maló and Oliveira, 2014; Konstantinidis *et al*, 2015; Dalago *et al*, 2017).

b. Implant topology

Table 6 indicates that the majority of the implants in both groups were long, regular-width, conical and had a rough surface.

In patient group, all risk indicators related to implant design were showed a significantly higher than the control group, except for regular-width and screw type implant, which were significantly lower than control.

Table 4 : Distribution of participants according to health and habit status.

Participants / General health status	Patients (50) No. (%)	Control (34) No. (%)	*p* value (z-statistic)
Diabetes			
Type I	3(6%)	0(0%)	0.05
Type II	6(12%)	0(0%)	0.01
Blood pressure disturbance			
hypotension	0(0%)	0(0%)	NS
Normal	24(48%)	18(52.9%)	O.05
Hypertension	26(52)	16(47.1)	O.01
Dry mouth	6(12%)	0(0%)	0.01
Oral health status			
Ulcer	3(6%)	0(0%)	0.05
History of periodontitis			
Yes	39(78%)	9(26.5%)	0.0001
No	11(22%)	25(73.5%)	
Absence of keratinized mucosa			
Yes	21(42%)	0(0%)	0.001
No	29(58%)	34(100%)	
Edentulism			
Partial	22(64.7)	40(80%)	0.001
Complete	12(35.3)	10(20%)	
Patient habits and oral self-care			
Oral hygiene			
Good	16(32%)	28(82.3%)	0.001
Moderate	20(40%)	4(11.7%)	
Poor	14(28%)	2(6%)	
Clinic visit			
Regular	7(20.8%)	12(24%)	0.05
Irregular	27(79.2)	38(76%)	0.01
Smoking status			
Nonsmoker	N=32(64%)	28(82.3%)	0.05
Light	L= 5(10%)	2(6%)	
Moderate	M= 10(20%)	3(8.8%)	
Heavy	H=3(3%)	1(2.9%)	
Bruxism	0.01	1(0%)	8(16%)
Clenching	0.001	0	3(6%)

Ongoing research has shown that subtle changes in implant topology can affect success rates. Accordingly, a variety of different implant sizes and shapes have been developed to achieve predictable osseointegration (Gaviria *et al*, 2014).

Table 5 : Distribution of dental implant with jaws among patients and control group.

Implant	Patients (50) No (%)	Control (34) No (%)	*p*-value (z-statistic)/X^2
Number of implants	126	46	
IWOPID	67(53.2%)	46(100%)	0.001
IWPID	59(46.8%)	0(0%)	0.000
P value	0.05	0.000	
Position in the arch			
IWOPID placed at AMx	31(24.5%)	15(32.6%)	0.001
IWPID placed at AMx	31(24.5%)	0(0%)	0.000
P value	NS	0.001	
IWOPID placed at AMa	9(7.1%)	4(8.7%)	0.05
IWPID placed at AMa	5(3.8%)	0(0%)	0.05
P value	0.06(NS)	0.05	
P value within the groups	0.000		
IWOPID placed at PMx	18(14.2%)	15(32.6%)	0.08
IWPID placed at PMx	14(11.1%)	0(0%)	0.000
P value	0.06(NS)	0.001	
IWOPID placed at PMa	9(7.1%)	12(26.1%)	0.08
IWPID placed at PMa	9(7.1%)	0(0%)	0.001
p value	NS	0.001	
p value within the groups	0.01		
Comparative statistical analysis			
p value AMx vs AMa (IWPID)	0.000***		
p value PMx vs PMa (IWPID)	0.06(NS)		
p value AMx vs PMx (IWPID)	0.001**		
p value AMa vs PMa (IWPID)	0.06(NS)		
p value AMx vs PMa (IWPID)	0.000***		
p value AMa vs PMx (IWPID)	0.06(NS)		

IWOPID: implant without PID, **IWPID:** implant with PID, **AMx:** anterior maxilla, **AMa:** anterior mandible, **PMa:** posterior mandible, **PMx:** posterior maxilla.

The implant length ranges from 6 to 20 mm. The most common length is between 8-15 mm. while the implant width typically ranges from 3 to 7 mm. Research indicates that shorter (Mijiritsky *et al*, 2013), narrower implant (Lee *et al*, 2005) have lower success rates than long and wider implants, respectively. The reason was attributed to a decrease in stability of shorter / narrower implants due to less contact area between cortical bone and implant surface (Mijiritsky *et al*, 2013).

Table 6 : Distribution of participants according to implant topology.

Participants / Implant topology	Patients (50) NO (%)	Control (34) NO (%)	*p* value (z-statistic)/X^2
Design			
Length			
Short	1(2%)	0(0%)	0.001
Long	49(98%)	34(0%)	
Width			
Narrow	11(22%)	6(14.8%)	0.001
Regular	39(78%)	29(85.2)	
Geometry			
Conical	25(50%)	12(35.3%)	0.01
Screw	9(18%)	15(44.2%)	
Cylindrical	16(32%)	7(20.5%)	
Surface roughness			
Rough surfaces	48(96%)	34(0%)	0.001
Smooth surfaces	2(4%)	0(0%)	

Finally, low PIDs incidence in both regular width and screw type implant can be attributed to the fact that regular width offers more stability to the implant by providing more contact area with cortical bone, Nonetheless, short/ narrow implants are preferred for highly absorbable alveolar bone areas, small spaces, patient's bone quantity. thereby, to achieve optimal stability and to prevent over-instrumentation (Gaviria *et al*, 2014). On the other hand, A screw retained option is probably more desirable due to the ease of removal, examination and maintenance than a cemented one (Gaviria *et al*, 2014). In addition, implant cement is considered the most important iatrogenic risk factor, acting as a nidus for plaque and calculus accumulation and/or as a foreign body in the oral activity that can lead to cementinitis (*i.e.*, inflammation caused by cement) (Smeets *et al*, 2014). Wilson Jr. (2009) found that residual cement was present in 81% of PIDs cases. After removal, the clinical and endoscopic signs of peri-implant disease were absent in 74% of the test implants. Similarly, Korsch *et al* (2014) concluded that removal of cement residues reduces ~60% of the inflammatory responses.

While less use of the smooth type dental implants (4% of patient group) is due to the increasing surface roughness would increase the surface area of the implant, resulting in the formation of a more extensive and complex

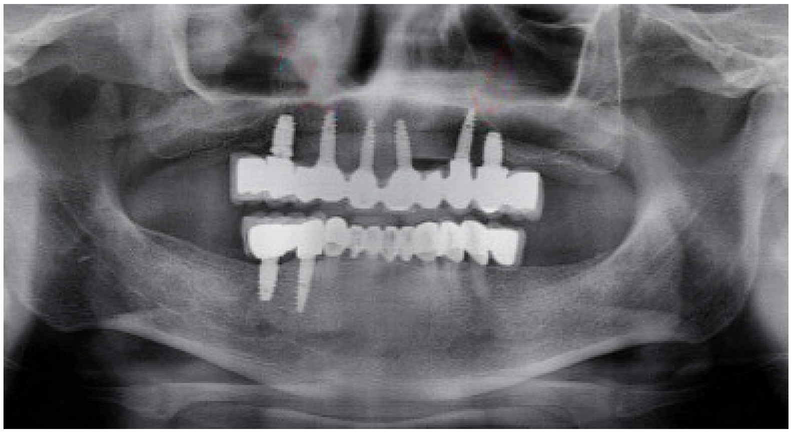

Fig. 1 : An OPG radiograph taken from a 62-year-old patient, revealing six maxillary implants in the anterior and posterior part and two posterior mandibular implants. The left 2nd one that arrow "in the canine area" have a radio-opacity indicates a bone resorption in this area due to peri-implantitis.

fibrin scaffold. Thus, increased adhesion, proliferation, and bone differentiation of mesenchymal stem cells and promotes greater mineralization of the matrix (Ma *et al*, 2017).

CONCLUSION

The study improved that many different potential risk indicators contributed to the development of PIDs but the most important risk factors were: Altered gingival appearance, history of periodontitis, generalized peri-implantitis, moderate oral hygiene, number of diseased dental implants, position in the Arch: Anterior maxilla, long length implant; > 7mm, rough Surface and the presence of systemic disease.

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Ethical statements for human/animal experiments

The study was approved by institutional ethics committee "University of Mustansiriyah" and informed consent was obtained in written by each individual participants. Each participant was known about the study follow up before enrolling for the study.

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