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Acta Clin Croat 2021; 60:367-372
doi: 10.20471/acc.2021.60.03.05

Original Scientific Paper

THE EFFECT OF LOCAL AND SYSTEMIC FACTORS ON DENTAL IMPLANT FAILURE – ANALYSIS OF 670 PATIENTS WITH 1260 IMPLANTS

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SUMMARY – The etiopathogenesis of dental implant failure is multifactorial and may include numerous local and systemic factors, however, studies including both local and systemic factors are still lacking. Therefore, the aim of this study was to evaluate whether periodontal disease, oral hygiene index, i.e. bleeding on probing (BOP), full mouth plaque index (FMPI), smoking, systemic diseases, as well as implant characteristics (length and diameter) affect failure of implant-prosthodontic therapy. Data on 670 patients were retrieved in whom 1260 dental implants had been placed and followed-up for at least five to ten years. Categorical data were analyzed by the χ^2-test, whereas Mann-Whitney test was used for continuous variables (age, BOP and FMPI). The values of $p<0.05$ were considered significant. The effect of local and systemic factors on the success of implant-prosthodontic therapy was assessed by multiple logistic regression analysis. Forty-five (6.7%) patients had systemic diseases, of which diabetes mellitus was most common, followed by atherosclerosis, diabetes and atherosclerosis, diabetes mellitus type 1, lymphoma, and hepatitis C. One-third (33.4%) of the patients were smokers. Periodontal disease was present in 170 patients, while 500 patients were without periodontal disease. Nine implants were lost during the period of five years. There were no differences regarding the type of implant or type of connection to the prosthetic suprastructure. However, most of these patients had a periodontal disease. There were no significant differences in dental implant failure rates between smokers and non-smokers or between patients with and without systemic diseases. Furthermore, the results of this study showed that implant type (straight *vs*. tapered) and type of connection with prosthodontic appliance (cemented or screw retained) did not affect BOP and FMPI. In smokers, significant improvement of BOP and FMPI was noticed. Initially, smokers had a significantly worse BOP (0.0037) when compared to non-smokers; however, there were no differences regarding FMPI (p=0.4218) between the two groups. In patients with periodontal disease, improvement of BOP and FMPI was seen at 5-year follow-up and no significant differences were found when compared to patients without periodontal disease. There were no significant differences in BOP and FMPI between patients with and without diabetes at 5-year follow-up. Atherosclerosis had a significant

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Received May 21, 2019, accepted July 2, 2019

negative effect on BOP, but not on FMPI at 5-year follow-up. It is concluded that periodontal disease had a significant impact on the implant-prosthodontic therapy.

Key words: *Dental implants; Failure; Periodontal indices; Local and systemic factors*

Introduction

Although there are many published papers dealing with the connection between systemic diseases and success of implant therapy, the guidelines on this subject remain an enigma even today. It is well known that intravenous treatment with bisphosphonates, as well as radiation therapy and recent myocardial infarction and cerebrovascular insult make absolute contraindications for implant placement. However, some systemic illnesses still lack clear criteria, and it remains unknown to what extent diseases such as diabetes, cardiovascular, and gastrointestinal disease can affect failure of implant treatment[1]. Clementini *et al.*[2] conclude that the amount of evidence for implant failure in patients with systemic diseases is rather low and there is a need for further research. Local factors that may influence dental implant outcome are the following: smoking, previous periodontal disease, inappropriate oral hygiene, diameter, length and type of implant, localization of implant placement, and prosthodontic construction. Earlier studies revealed that smoking and previous periodontal disease closely correlated with peri-implantitis[3-5]. Renvert *et al.*[6] showed connection between poor oral hygiene, past periodontal disease, and smoking as the most significant risk factors for peri-implantitis. Cho-Yan Lee *et al.*[7] found that in people who had previously suffered from periodontal disease, the occurrence of peri-implantitis was more frequently associated with inappropriate maintenance of oral hygiene in relation to previous data on periodontitis. Recent studies report contradictory results regarding smoking and peri-implantitis. Morales-Vadillo *et al.*[8] and El Pedro *et al.*[9] report strong correlation between smoking and periodontal disease, unlike Jung *et al.*[10] and de Souza *et al.*[11]. With regard to implant characteristics, Topkaya *et al.*[12] noted that implant length and diameter were important for success, a finding which was also confirmed by Bataineh and Al-Dakes[13] and Yesildal *et al.*[14]. Based on their meta-analysis, Atieh *et al.*[15] report that conical dental implants are superior to cylindrical ones, however, without statistical significance.

Therefore, local factors are the most influential ones and pose a serious threat to the long-term success of implant therapy. In order to elucidate this comprehensive and often puzzling relationship, we performed a follow-up investigation of local factors in patients with various systemic conditions, who were treated with dental implants.

Materials and Methods

Study design and research protocol were accepted and confirmed by the Ethics Committee of the School of Dental Medicine, University of Zagreb. All included patients signed the informed consent form written according to the Helsinki II protocol. All patients were treated at a private practice in Zagreb, Croatia. A total of 670 patients were followed-up for a minimum of five years (60 months) in order to assess the impact of systemic conditions on overall success of implant therapy. A total of 1260 implants were placed between 2008 and 2012. Demographic data are shown in Table 1. Full mouth plaque score and full mouth bleeding

Table 1. Demographic data on study participants

Parameter		n	%
Median age (age range, yrs)	46.5 (19-79)		
Age (yrs)	0-40	229	34.18
	41-60	361	53.88
	61+	80	11.94
Smokers	Yes	224	33.43
	No	446	66.57
Periodontal disease	Yes	170	25.37
	No	500	74.63
Systemic diseases	At least one disease	45	6.72
	Atherosclerosis	8	1.19
	Diabetes mellitus 1	3	0.45
	Diabetes mellitus 2	27	4.03
	Diabetes mellitus 1 + atherosclerosis	5	0.75
	Lymphoma	1	0.1
	Hepatitis C	1	0.15
	None	625	93.28
Total number of patients		670	100.00

score were measured on all present teeth on both vestibular and oral surfaces at baseline and 60 months after placement of the prosthodontic appliance. Systemic conditions were noted at the first interview, and data were updated on recall visits at 5-year follow-up.

Data were analyzed using Medcalc (v. 11.4). Categorical data were analyzed by the χ^2-test. Continuous variables (age, bleeding on probing (BOP), and full mouth plaque index (FMPI)) were not normally distributed, therefore the non-parametric Mann-Whitney test was used. The values of $p<0.05$ were considered significant. The effect of local and systemic factors on the success of implant-prosthodontic therapy was assessed by multiple logistic regression analysis. Loss of implants was a dependent variable, whereas age, smoking, data on previous periodontal disease, type, length and diameter of implants, prosthodontic appliance fixation modality, and systemic diseases were independent variables.

Results

Forty-five (6.7%) patients had systemic diseases, of which diabetes mellitus was most common (n=35), followed by atherosclerosis (n=8), diabetes and atherosclerosis (n=5), diabetes mellitus type 1 (n=3), lymphoma (n=1), and hepatitis C (n=1). One-third (33.4%) of the patients were smokers. Most of the patients were aged 41-60, mean age 53.9 years. All patients were treated during the 2008-2012 period, therefore the data obtained could be retrieved for at least five years. Periodontal disease was present in 170 patients, whereas 500 patients were free from periodontal disease. Of 670 patients, 628 patients had undergone only one procedure. A single implant was placed in 333 patients, while more than one were placed in 337 patients. Nine implants were lost during the period of five years. There were no differences according to the type of implant or type of connection to prosthodontic appliance (Table 2). Patients with periodontal disease had significantly more implant failures when compared to patients without periodontal disease (Table 3). There were no significant differences in dental implant failure between smokers and non-smokers or between patients with and without systemic diseases. Furthermore, the results of this study showed that implant type (straight *vs.* tapered) and type of connection with prosthodontic appliance (cemented or screw retained) did not affect BOP and FMPI. In smokers, significant improvement of BOP and FMPI was noticed. Initially, smokers had a significantly worse BOP (0.0037) when compared to non-smokers; however, there were no differences between the two groups regarding FMPI (p=0.4218). In patients with periodontal disease, improvement of BOP and FMPI was seen at 5-year follow-up and no significant differences were found when compared to patients without periodontal disease. There were no significant differences in BOP and FMPI between pa-

Table 2. Type of connection between implant and prosthodontic appliance, and type of implant

		n	%
Prosthodontic appliance	Cement	941	74.68
	Screw	319	25.32
Implant type	Cylindrical	513	40.6
	Conical	743	58.97
	Unknown	4	0.32
Total number of implants		1260	100.00

Table 3. Success of implants with regard to periodontal disease and smoking

	Unsuccessful implant		Successful implant		Total		p
	n	%	n	%	n	%	
Periodontal disease							
No	6	0.67	885	99.33	891	100	p=0.001
Yes	11	2.98	358	97.02	369	100	
Smoker							
No	9	1.82	485	98.18	494	100	p=0.3587
Yes	8	1.04	758	98.96	766	100	
Total	17	1.35	1243	98.65	1260	100	

tients with and without diabetes at 5-year follow-up. Atherosclerosis had a significant negative effect on BOP, but not on FMPI at 5-year follow-up.

Discussion

Earlier studies revealed that smoking and previous periodontal disease were closely correlated with peri-implantitis[3-6]. Recent studies report contradictory results regarding smoking and peri-implantitis. Morales-Vadillo *et al.*[8] and El Pedro *et al.*[9] found strong correlation between smoking and periodontal disease, unlike Jung *et al.*[10] and de Souza *et al.*[11], which is also in concordance with our results. Considering implant characteristics, Topkaya *et al.*[12] noted that implant length and diameter were important for success, a finding which was also confirmed by Bataineh and Al-Dakes[13] and Yesildal *et al.*[14]. Based on their meta-analysis, Atieh *et al.*[15] report that conical dental implants are superior to cylindrical dental implants, however, without significance. It was previously assumed that the length and diameter of implants might correlate with the risk of failure of dental implant treatment. Raikar *et al.*[16] found the highest dental implant failure in implants exceeding 11.5 mm in length and with diameters smaller than 3.75 mm, however, we could not confirm this finding as there were no differences in dental implant success according to implant length and diameter. Topkaya *et al.*[12] report that implant length and diameter were important for successful implant-prosthodontic therapy, a finding which we could not confirm. Furthermore, some authors[17] suggest that type of dental implant system might influence the success of this therapy. Atieh *et al.*[15] performed a meta-analysis of 1199 studies and included five studies with overall 336 implants in 303 people. Their analysis revealed that conical dental implants had less marginal bone loss when compared with cylindrical dental implants, a finding which we could not confirm as there were no differences between the implant type and success of treatment. Dalago *et al.*[4] found a 3.6 times higher dental implant failure in patients with cemented restorations when compared with screw-retained restorations. We could not confirm this finding as there were no differences between cemented and screw-retained implants with regard to implant failure, which is also in concordance with the results reported by Gracis *et al.*[18].

Previously, it has been suggested that systemic diseases such as diabetes, cardiovascular diseases, osteoporosis, etc. might lead to increased dental implant failure. However, nowadays, the results are contradictory. Annibali *et al.*[19] did not find an increased risk in diabetes patients. Manor *et al.*[20] in a retrospective study on medically complex patients could not confirm significant differences between the groups regarding implant failures or complications. Diz *et al.*[21] state that the degree of systemic disease control is a more important factor than the mere systemic disease, a finding which was confirmed by El Pedro *et al.*[9], Elsubeihi and Zarb[22], De Souza *et al.*[23], De Araújo Nobre *et al.*[3], and Gomez-de Diego *et al.*[24]. A recent systematic review of the correlation of systemic diseases and implant failure[25] reported a large heterogeneity of results and low evidence strength of published studies. The authors concluded that positive results of implant-prosthodontic therapy in most systemic conditions should be carefully interpreted and that the impact of cardiovascular diseases and osteoporosis (on intravenous bisphosphonates) on this type of therapy should be further investigated[25]. Lopez-Cedrun *et al.*[26] conclude that there are still no known specific risk factors for failure of implant treatment in osteoporosis patients who are on oral bisphosphonate therapy. However, Renvert *et al.*[27] showed that cardiovascular diseases were significantly associated with the occurrence of peri-implantitis. Manor *et al.*[20] and Neves *et al.*[28] found the greatest failure of implant-prosthodontic therapy in patients with cardiovascular diseases. It is interesting to note that the results of our study showed that atherosclerosis had a significant negative effect on BOP, but not on FMPI at 5-year follow-up. It seems that cardiovascular diseases may compromise osseointegration as they decrease the oxygen and nutrient supply to the bone marrow.

Overall, the level of evidence for absolute and relative contraindications for implant-prosthodontic therapy is low. Of course, in patients who have a greater number of risk factors, such as previous periodontitis, smoking, lack of appropriate oral hygiene, and poor control of systemic diseases, a greater incidence of dental implant-prosthodontic treatment failure might be encountered.

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Sažetak

UTJECAJ LOKALNIH I SISTEMSKIH ČIMBENIKA NA NEUSPJEH DENTALNIH IMPLANTATA – ANALIZA 670 PACIJENATA S 1260 IMPLANTATA

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Etiopatogeneza neuspjeha vezanog uz implantoprotetsku terapiju je multifaktorijalna i može uključivati brojne lokalne i sistemske čimbenike, iako još uvijek nedostaju istraživanja na tu temu. Stoga je cilj ovoga istraživanja bio ustanoviti utječe li prisutnost prijašnje parodontne bolesti, stupanj oralne higijene odnosno krvarenje pri sondiranju (KPS) i plak cijele usne šupljine (PCUŠ), pušenje, sistemske bolesti, kao i same značajke dentalnih implantata (veličina, tip) na neuspjeh implantoprotetske terapije. Analizirani su podaci za 670 pacijenata kojima je ugrađeno 1260 dentalnih implantata i koji su praćeni tijekom najmanje pet godina. U statističkoj obradi primijenjen je program Medcalc. Kategorički podatci obrađivani su χ^2-testom. Kontinuirane varijable (dob, KPS, PCUŠ) nisu bile normalnih distribucija te su stoga analizirane neparametrijskim Mann-Whitneyjevim U testom. Vrijednosti $p<0,05$ smatrane su značajnima. Rezultati ovoga istraživanja su pokazali kako je 9 implantata bilo izgubljeno, pri čemu nije bilo značajne razlike u tipu implantata ili načinu pričvršćenja protetske suprastrukture. Ipak, zanimljivo je da je većina pacijenata imala parodontnu bolest. Nadalje, nije bilo značajne razlike između pušača i nepušača u odnosu na gubitak implantata. Nije bilo značajnih razlika s obzirom na sistemske bolesti ovih bolesnika. Nadalje, rezultati ovoga istraživanja su pokazali kako tip implantata (konični odnosno cilindrični) i vrsta fiksacije protetskog nadomjestka na implantat (cementirani ili vijkom fiksirani) nije imao značajnog utjecaja na KPS ili PCUŠ. Kod pušača koji su ujedno imali i značajno lošije inicijalno stanje KPS (0,0037) od onih koji nisu pušili, u svim slučajevima došlo je do poboljšanja KPS i PCUŠ, no za PCUŠ to nije bilo značajno (p=0,4218). U bolesnika s parodontnom bolesti došlo je do poboljšanja KPS i PCUŠ nakon 60 mjeseci praćenja te nije bilo razlika u odnosu na osobe koje nisu imale bolest parodonta. Također, nije bilo značajnih razlika u KPS ili PCUŠ između osoba s dijabetesom i onih bez dijabetesa nakon petogodišnjeg praćenja. Ateroskleroza je imala značajan negativan utjecaj na KPS, ali ne i na PCUŠ, nakon pet godina praćenja. Može se zaključiti kako je jedino parodontitis imao značajan utjecaj na neuspjeh implantoprotetske terapije.

Ključne riječi: *Dentalni implantati; Neuspjeh; Parodontni indeksi; Lokalni i sistemski čimbenici*