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The Impact of Diabetes, Smoking, and Periodontitis on Patients' Oral Health related Quality of Life after Treatment with Corticobasal Implants - An Evaluative Study

Aleksandar Bogdanov Lazarov

Private Dental Implant Center, "ALDENTAL-APMP-IPPMP DENTAL" LTD, Sofia, Bulgaria

Abstract

Introduction: Diabetes, smoking, and periodontitis are considered risk factors for the survival of conventional dental implants; however, research about their impact on the oral health-related quality of life (OHRQoL) of patients treated with corticobasal implants is lacking. **Materials and Methods:** Two hundred twenty-seven adult patients completed a postoperative OHRQoL questionnaire. Aspects of their oral health were examined in relation to periodontitis, diabetes, smoking, and against a control group with none of the conditions. A subgroup of 118 patients with pre- and postoperative OHRQoL data were studied for changes in their OHRQoL. The impact of the risk factors on the patients' posttreatment OHRQoL was examined through multiple regression analysis. The paired data were analyzed through Wilcoxon signed-rank test. **Results:** The satisfaction with the treatment was high and robust irrespective of periodontitis, diabetes, smoking, or more than one factors, $P > 0.05$ for all tests. The smokers' satisfaction was significantly higher than the nonsmokers, $P = 0.003$. The majority of the patients experienced a steady reduction in frequency to the full absence of oral health problems ($P < 0.001$ for all tests). The patients with periodontitis reported a significantly higher reduction in limitations related to food choice, $P = 0.026$. Posttreatment complications were few, mainly in the first postoperative year. **Discussion:** Our results provide reassurance to patients with periodontitis, diabetes, and smokers that corticobasal implants are an effective treatment option with the same benefits for their oral health quality of life as for patients without these risk factors.

Keywords: Dental implants, diabetes mellitus, health-related quality of life, periodontal diseases, tobacco smoking

INTRODUCTION

Diabetes, smoking, and periodontitis have been identified as risk factors for the survival of dental implants. While the findings about diabetes as a risk factor for implant survival are ambivalent,^[1-4] the evidence for smoking and periodontitis as risk factors is consistent.^[5-7] Numerous studies have shown their negative impact on patients' oral health-related quality of life (OHRQoL).^[8-12]

However, in the current scientific literature about immediate loading, most of the studies have examined the efficacy of two-piece dental implants^[13,14] with insufficient number of reports about corticobasal implants. Immediate loading corticobasal implantology has provided encouraging results with a high success rate,^[15] notwithstanding pretreatment risk factors, such as bone atrophy, periodontitis,^[16] diabetes, and smoking.^[17] Nonetheless, the impact of diabetes, smoking,

and periodontitis on the OHRQoL of patients treated with corticobasal implants is lacking. The present study aimed to address this need by examining essential aspects of the OHRQoL of a cohort of patients treated with corticobasal implants in relation to advanced periodontitis, controlled diabetes, regular smoking, and against a control group free of these risk factors.

Address for correspondence: Dr. Aleksandar Bogdanov Lazarov,
Private Dental Implant Center, "ALDENTAL-APMP-IPPMP DENTAL" LTD, Sofia
1113, Ul. Lyulyakova Gradina 7, Bulgaria.
E-mail: alex.lazarov@yahoo.co.uk

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Treatment under immediate placement immediate loading protocols

The goal of the treatment with corticobasal implants is to achieve a bilaterally balanced function of the chewing organ, based on stable occlusion, through cortical fixation, immediate splinting, and loading of the implants. The corticobasal implants are designed to be firmly anchored into the second or third cortical. The implant design allows its placement into fresh extraction sockets and in healed bone areas.

The treatment consists of two major phases: surgical and prosthetic. In the surgical phase, all oral pathology is addressed, and the implants are placed according to the methods described in the consensus papers issued by International Implant Foundation (IIF)^[18] in the same operative session. The prosthetic phase includes full or partial jaw rehabilitation in up to 3 days through a single-piece metal fused to ceramic (MFC) bridge cemented on the implants. As a rule, second molars are not included in the bridge. Anterior contacts are strictly avoided, with a 2 mm overjet and 0 mm overbite. The anterior guidance is “group function.”^[19]

MATERIALS AND METHODS

Study design

The study followed an evaluative design as it aimed to assess the OHRQoL of a cohort of patients treated with corticobasal implants at a single implant center in Sofia, Bulgaria, in the period between December 2015 through March 2021. Authors declare that all subjects have signed a declaration of the agreement their data is to be used for statistical and publication purposes. Authors further declare that the study was noninvasive, all patient's rights were fully protected, and hence no ethical issues are a matter of concern. They add that according to Bulgarian law (where the study was performed) for such types of studies, no clearance from the ethical committee is necessary. The data were generated from the routine intraclinical documentation which patients complete preoperatively and at checkup visits postoperatively. Normally, the patients are asked whether they would grant permission for their data to be used for intraclinical evaluations and research purposes. This is done through a signed consent form in compliance with the ethical principles specified in the World Medical Association Declaration of Helsinki, revised in 2000, Edinburgh.

As part of this documentation process, patients complete a modified version of the *OHIP-20 for Dental Implants Patients* (OHRQoL questionnaire) translated into Bulgarian by a specialist with clinical experience and reviewed by another bilingual clinician. A pilot test helped revise ambiguous questions. The internal consistency of the items, as shown by the Cronbach's alpha test, was $\alpha = 0.858$. The questions concerning patients' satisfaction are measured on a scale of 1–5, with increasing numbers marking higher levels of satisfaction. Oral health issues before and after the treatment are assessed on an ordinal scale (1 = never; 2 = seldom; 3 = sometimes; 4 = frequently; and 5 = always). The patient

documentation, including the OHRQoL questionnaire, is handled by a trained dental assistant who is not engaged in evaluation or research projects.

From the existing data, a total of 227 patients met the inclusion criteria: (1) signed consent form; (2) completed the posttreatment OHRQoL questionnaire with no more than two missed questions. Of them, 118 had also completed the pretreatment OHRQoL questionnaire and these data were used to track changes in the patients' OHRQoL as a result of the treatment. The results are given separately for the two samples.

Statistical analysis

The minimum sample size necessary to detect significant differences between the subsections of patients was established through MedCalc, Version 20.008 (2021).^[20] The calculated cases per risk factor were compatible with the numbers in the actual data [Table 1].

The patients' posttreatment satisfaction level was described through the means and standard deviations. The role of the target risk factors was examined through multiple regression analysis to rule out the effect of covariates. The patients with more than one risk factor were compared versus the control group with no risk factors through an independent samples *t*-test.

The oral health problems before and after the treatment were presented with frequencies and percentages and analyzed through the Wilcoxon signed-rank test. The changes in the frequency of oral health problems were examined for association with the target risk factors through multiple regression analysis with the remaining risk factors as potential covariates.

The Chi-square test and Fisher's exact test were used for categorical data. All statistical tests were two-tailed and the results were interpreted as significant at $P < 0.05$. The data analysis was performed with the statistical software IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY (2020)^[21] and Minitab 19 Statistical Software. State College, PA (2020).^[22]

RESULTS

The 227 patients with after-treatment OHRQoL data were almost equally distributed between genders, with 67.50% ($n=153$) being younger than 60 years. The mean time of the after-treatment data was 12.81 ± 9.77 months, median 10 months. The patients with pre- and after-treatment OHRQoL data were distributed in subsections in similar proportions to the bigger sample [Table 2].

Results based on after-treatment data from 227 patients

None of the target risk factors had a confounding effect on the remaining two for any of the examined aspects of oral health: diabetes and smoking on the effect of advanced periodontitis ($P > 0.05$ for all tests); periodontitis and smoking on diabetes ($P > 0.05$ for all tests); and periodontitis and diabetes on smoking ($P > 0.05$ for all tests).

Table 1: Sample size calculations for comparison of means

	Advanced periodontitis	Diabetes	Smoking	One/more risk factors
Type I error (alpha)	0.05	0.05	0.05	0.05
Type II error (Beta, 1-power)	0.20	0.20	0.20	0.20
Difference of means	0.50	0.50	0.50	0.50
SD group 1	0.60	0.60	0.60	0.70
SD group 2	0.50	0.50	0.50	0.50
Ratio of sample sizes in groups 1 (with risk factor) and 2 (without risk factor)	131/89	24/197	99/101	161/34
N of cases required in group 1	25	14	20	58
N of cases required in group 2	17	115	21	13
Total sample size required (both groups)	42	129	41	71

SD: Standard deviation

Table 2: Characteristics of the patients

Variables	After treatment data (n=227)	Before and after treatment data (n=118)
Sex		
Men	110 (48.50)	57 (48)
Women	117 (51.50)	61 (52)
Age (years)		
<60	153 (67.50)	81 (69)
>60	74 (32.50)	37 (31)
Time of the after-treatment data (months)		
3-6	61 (28.00)	35 (30)
7-12	90 (40.00)	57 (48)
13-24	47 (21.00)	18 (15)
25-36	15 (7.00)	4 (3)
>6	9 (4.00)	4 (3)
Complexity of the treatment		
Both upper and lower complete jaws	151 (66.50)	82 (69)
One complete and/or partial jaw	76 (33.50)	36 (31)
Reason for tooth loss/extraction		
Advanced periodontitis	131 (58.00)	76 (64)
Decay complications	89 (39.00)	42 (36)
Missing data	7 (3.00)	0
Diabetes		
Yes	24 (11.00)	12 (10)
No	196 (86.00)	106 (90)
Missing data	7 (3.00)	0
Smoking		
Yes	99 (43.50)	53 (45)
No	101 (44.50)	65 (55)
Missing data	27 (12.00)	0
Risk factors		
One to three	161 (71)	97 (82)
No	34 (15)	21 (18)
Missing data	31 (14)	0

The patients with periodontitis did not differ significantly from those without periodontitis: overall satisfaction ($P = 0.925$), implants ($P = 0.329$), dental construction ($P = 0.493$), and articulation and speaking ($P = 0.151$).

Likewise, diabetes did not have a significant effect on the patients' contentment with the treatment: overall satisfaction ($P = 0.542$), implants ($P = 0.967$), dental construction ($P = 0.378$), and articulation and speaking ($P = 0.225$).

The smokers expressed a significantly higher overall satisfaction as compared to the nonsmokers: difference 0.11 (95% confidence interval [CI]: 0.03–0.18), $P = 0.002$. No other significant differences were observed between smokers and nonsmokers: implants ($P = 0.605$), dental construction ($P = 0.398$), and articulation and speaking ($P = 0.278$).

No significant differences existed between the patients with one/more risk factors versus the control group: overall satisfaction ($P = 0.290$), implants ($P = 0.967$), dental constructions ($P = 0.475$), and articulation and speaking ($P = 0.382$) [Table 3].

The patients' level of comfort with the implants and dental constructions was expressed as the mean score of three questions related to pain, swelling, and infections. The ease of mastication was a composite score, including chewing difficulties, food choice, and meal interruptions. The patients' psychological well-being was calculated as the mean of three questions related to nervousness, sleeping difficulties, and self-confidence.

All four aspects of the patients' oral health-quality of life showed a high level of satisfaction. This trend was maintained between the subsections. The presence of periodontitis was not associated with a significant impact on the patients' comfort ($P = 0.089$), mastication ($P = 0.699$), taste ($P = 0.077$), and psychological well-being ($P = 0.206$). The patients with diabetes did not differ significantly from those without diabetes: comfort ($P = 0.593$), mastication ($P = 0.600$), taste ($P = 0.872$), and psychological well-being ($P = 0.672$). Smoking habits did not reveal a significant influence on the patients' comfort ($P = 0.734$), mastication ($P = 0.297$), taste ($P = 0.510$), and psychological well-being ($P = 0.164$). The patients with one/more risk factors had a significantly lower score for taste versus the control group (difference 0.15, 95% CI: 0.08–0.22), $P = 0.035$. No other significant differences were observed between the two groups:

Table 3: Satisfaction with specific aspects of the treatment with corticobasal implants in the group of 227 patients with after treatment data

	Overall	Implants	Construction	Articulation speech
Total	4.93±0.25 5 (4-5)	4.94±0.23 5 (4-5)	4.88±0.32 5 (4-5)	4.66±0.54 5 (4-5)
Periodontitis				
Yes	4.93±0.25 5 (4-5)	4.92±0.26 5 (4-5)	4.90±0.29 5 (4-5)	4.62±0.56 5 (4-5)
No	4.93±0.25 5 (4-5)	4.96±0.19 5 (4-5)	4.87±0.34 5 (4-5)	4.71±0.50 5 (4-5)
Diabetes				
Yes	4.88±0.33 5 (4-5)	4.90±0.30 5 (4-5)	4.71±0.46 5 (4-5)	4.50±0.73 5 (4-5)
No	4.94±0.24 5 (4-5)	4.94±0.23 5 (4-5)	4.89±0.31 5 (4-5)	4.66±0.53 5 (4-5)
Smoking				
Yes	4.99±0.14** 5 (4-5)	4.95±0.22 5 (4-5)	4.91±0.29 5 (4-5)	4.62±0.56 5 (4-5)
No	4.88±0.33 5 (4-5)	4.93±0.26 5 (4-5)	4.86±0.34 5 (4-5)	4.69±0.52 5 (4-5)
Risk factors				
One to three	4.94±0.23 5 (4-5)	4.94±0.24 5 (4-5)	4.89±0.31 5 (4-5)	4.64±0.56 5 (4-5)
Control	4.88±0.33 5 (4-5)	4.94±0.24 5 (4-5)	4.85±0.36 5 (4-5)	4.70±0.52 5 (4-5)

**Significantly higher than the mean of the opposite category at $P < 0.01$. In each cell of the table, the first line shows the mean±SD. The second line shows the median (minimum–maximum). SD: Standard deviation

comfort ($P = 0.884$), mastication ($P = 0.210$), and psychological well-being ($P = 0.720$) [Table 4].

The composite satisfaction score for the patients with one/more risk factors and the control group showed very similar distributions, with identical median scores and nearly identical means, $P = 0.868$ [Figure 1].

Complications after treatment with corticobasal implants

Forty-four of the 227 patients (19%) reported problems after the treatment [Figure 2]. The highest rate of problems occurred in the first posttreatment year (A). The problems were not significantly associated with the presence of periodontitis ($P = 0.861$), diabetes ($P = 0.402$), smoking ($P = 0.482$), or one/more risk factors ($P = 0.353$) (B). The most common problems included chewing difficulties, discomfort, pain, and aesthetics. The type and number of problems were not associated with the presence or absence of risk factors (C).

Results based on before–after-treatment data from 118 patients

A significant reduction in the frequency of oral health issues was observed in the group with before and after OHRQoL data. The rate of swelling and infections decreased in 92% of the patients ($P < 0.001$), pain was reduced in 96% ($P < 0.001$), and chewing ability improved in 89%, $P < 0.001$. The patients reported completely removed or significantly lessened limitations on food choice imposed by dental problems, $P < 0.001$. The number of patients with persistent or frequent chewing problems was reduced to zero.

Table 4: Patients' comfort, mastication, taste, and psychological well-being in the group of 227 patients with after treatment data

	Comfort (pain free)	Mastication	Taste	Psychological well-being
Total	4.85±0.29 5 (3.33-5)	4.76±0.29 5 (3.33-5)	4.88±0.39 5 (3-5)	4.93±0.18 5 (3.75-5)
Periodontitis				
Yes	4.82±0.33 5 (3.33-5)	4.77±0.31 5 (3.33-5)	4.83±0.48 5 (3-5)	4.92±0.19 5 (3.75-5)
No	4.89±0.21 5 (4-5)	4.74±0.28 5 (4-5)	4.94±0.43 5 (4-5)	4.94±0.16 5 (4-5)
Diabetes				
Yes	4.88±0.30 5 (4-5)	4.80±0.30 5 (4.33-5)	4.87±0.35 5 (4-5)	4.96±0.09 5 (4.50-5)
No	4.84±0.23 5 (3.33-5)	4.76±0.30 5 (4-5)	4.88±0.39 5 (3-5)	4.93±0.19 5 (3.75-5)
Smoking				
Yes	4.85±0.29 5 (3.33-5)	4.79±0.29 5 (3.33-5)	4.86±0.37 5 (3-5)	4.91±0.23 5 (3.75-5)
No	4.83±0.30 5 (3.33-5)	4.74±0.30 5 (4-5)	4.89±0.40 5 (3.33-5)	4.95±0.12 5 (3.75-5)
Risk factors				
One to three risk factors	4.84±0.31 5 (3.33-5)	4.77±0.30 5 (3.33-5)	4.84±0.45 5 (3-5)	4.93±0.19 5 (3.75-5)
Control	4.85±0.22 5 (4.33-5)	4.70±0.30 4.66 (4-5)	5±0.00* 5 (5-5)	4.94±0.13 5 (4.50-5)

*Significantly higher rating in the control group versus the group with risk factors at $P < 0.05$. In each cell of the table, the first line shows the mean±SD. The second line shows the median (minimum–maximum). SD: Standard deviation

Before the treatment, 31% of the patients did not have problems related to taste and 25% reported rare problems. This explains the lower percentage (65%) of patients with an improvement in taste after the treatment, nevertheless significant, $P < 0.001$.

A positive change was observed in the patients' psychological state caused by dental problems, with 92% overcoming-related issues, $P < 0.001$. Before the treatment, 66% had rare to frequent sleeping problems

due to oral problems; after the treatment 97% had no complaints, $P < 0.001$. Due to dental problems, 60% of the patients experienced rare to persistent negative reflection on their self-confidence before the treatment, and all 60% reported improved self-confidence after the treatment, $P < 0.001$ [Table 5].

The patients with periodontitis showed a significantly higher mean reduction in limitations related to food choice (-2.17 ± 1.27) versus the patients without periodontitis (-1.55 ± 1.50 ; 95% CI: 0.08–1.16), $P = 0.026$. All five cases (4%) with increased food restrictions were patients without periodontitis [Figure 3a]. The level of reduction in the other oral health issues was similar between the two groups: infections and swelling ($P = 0.985$), pain ($P = 0.618$), chewing discomfort ($P = 0.671$), taste ($P = 0.582$), nervousness ($P = 0.173$), sleep disturbance ($P = 0.180$), and self-confidence ($P = 0.541$).

Diabetes and smoking did not show a significant impact on the level of improvement in any of the oral health issues examined in this study ($P < 0.05$ for all comparisons). We did not find a significant difference between the patients with one or more risk factors versus the control group with none of the risk factors ($P > 0.05$ for all comparisons). While not significant, the mean reductions in oral health issues were higher in the group with risk factors [Figure 3b].

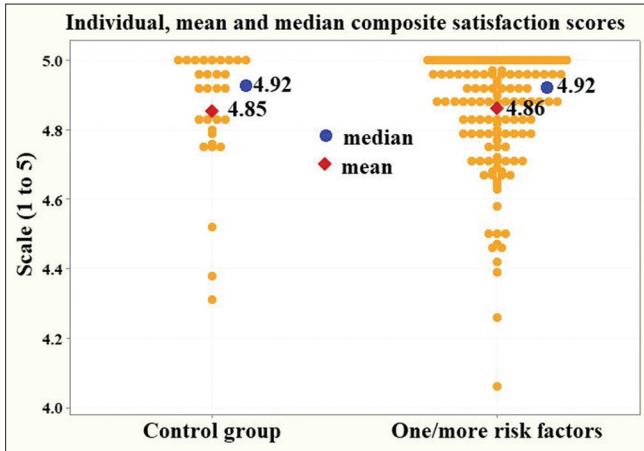


Figure 1: Individual, mean, and median values of the composite satisfaction score for the patients with one/more risk factor and the control group, showing lack of significant difference that can be attributed to the presence of one or more risk factors

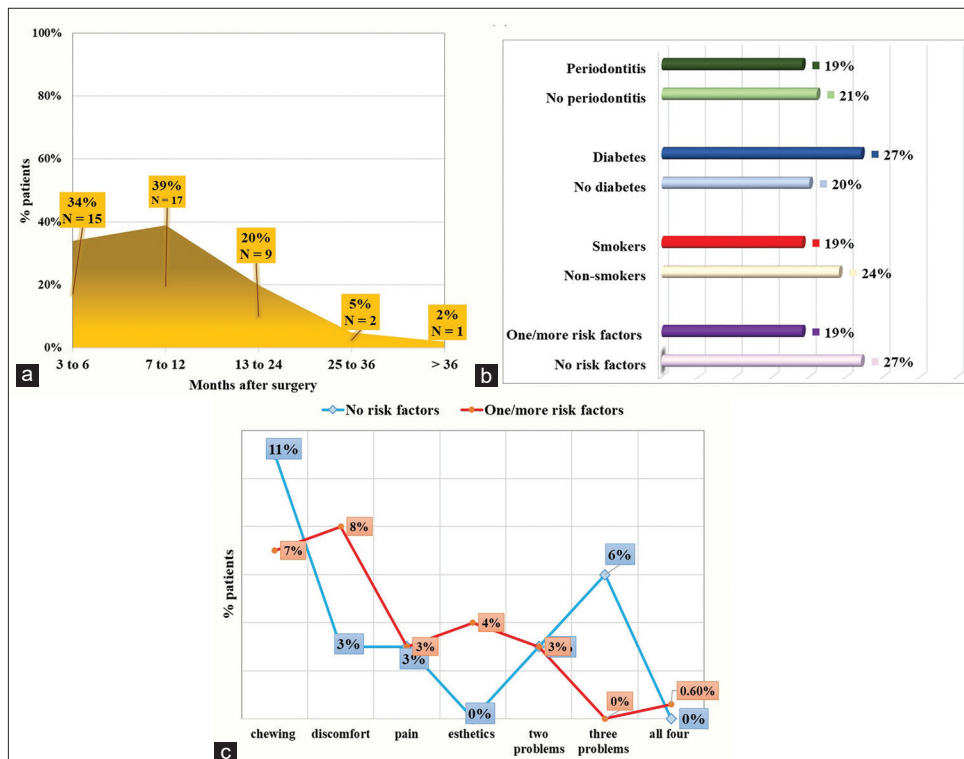


Figure 2: Reported problems after the treatment with immediate placement immediate loading corticobasal implants. The distribution of problems over time is shown on Panel (a). The distribution of problems according to the presence of risk factors is illustrated on Panel (b). The proportion of patients with specific problems in the group with one or more risk factors and the control group (with no risk factors) is shown on Panel (c).

Table 5: Change in oral health-related issues in 118 patients treated with corticobasal implants under immediate placement immediate loading protocols

Oral health issues	Time	Frequency, n (%)					Wilcoxon	
		Never	Seldom	Sometimes	Frequently	Always	Percentage change	P
Infections and pain								
Infections and/or swelling	Before	2 (2)	23 (19)	41 (35)	35 (30)	17 (14)	-92	<0.001
	After	99 (84)	13 (11)	6 (5)	0	0	=6 +2	
Pain	Before	3 (3)	24 (20)	55 (46)	29 (26)	7 (6)	-96	<0.001
	After	107 (91)	10 (8)	1 (1)	0	0	=4 +0	
Mastication and taste								
Chewing discomfort and/or difficulties	Before	5 (4)	13 (11)	27 (23)	42 (36)	31 (26)	-89	<0.001
	After	75 (64)	33 (28)	10 (8)	0	0	=8 +3	
Influence on food choice	Before	15 (13)	19 (16)	22 (19)	36 (30)	26 (22)	-79	<0.001
	After	82 (70)	26 (22)	6 (5)	4 (3)	0	=17 +4	
Taste	Before	37 (31)	30 (25)	26 (22)	16 (14)	9 (8)	-65	<0.001
	After	102 (87)	11 (9)	4 (3)	1 (1)	0	=29 -+6	
Psychological state								
Nervousness and stress	Before	17 (14)	27 (23)	33 (28)	33 (28)	7 (6)	-83	<0.001
	After	109 (92)	9 (8)	0	0	0	=17 +0	
Sleeping problems	Before	40 (34)	35 (30)	30 (26)	9 (8)	3 (2)	-65	<0.001
	After	115 (97)	3 (3)	0	0	0	=35 +0	
Problems with self-confidence	Before	47 (40)	32 (27)	23 (19.5)	10 (8.5)	6 (5)	-60	<0.001
	After	116 (98)	2 (2)	0	0	0	=40 +0	

Minus (-): Less frequent/improved, Equal (=): No change/sustained, Plus (+): More frequent/worsened

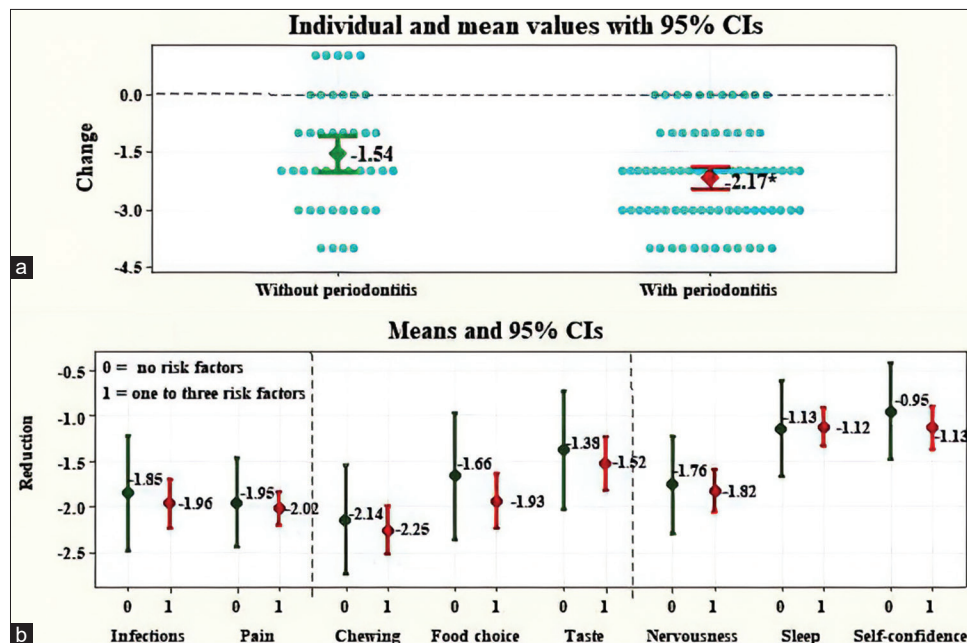


Figure 3: Individual and mean change in the need to choose food due to dental problems showing a higher reduction in the group with periodontitis (Panel a). Mean changes in oral health issues after the treatment in the group with one/more risk factors versus the control group with no risk factors. No significant differences were observed that could be attributed to the presence of risk factors (Panel b)

DISCUSSION

Although several studies^[13,14,23,24] have reported on patients' satisfaction with endo-osseous implant-supported prostheses, research about the role of risk factors on OHRQoL is still rare. A positive impact of corticobasal implants on the patients' satisfaction has been found by Awadalkreem *et al.*^[25] Our results corroborate their findings and provide additional evidence about the robust effect of the treatment with corticobasal implants in the presence of periodontitis, diabetes, and smoking. Moreover, the smokers expressed a significantly higher overall satisfaction as compared to the nonsmokers. Given the fact that in conventional dental implantology, smoking is considered a risk factor,^[26,27] the high level of satisfaction reported by the smokers is reassuring, especially considering that all of them described themselves as regular long-term smokers – over 10 cigarettes a day.

Studies on conventional implants have shown a positive impact on the patients' articulation and speech.^[28,29] The special design of the occlusal scheme^[19,30-32] in corticobasal implantology, with no occlusal contacts in the front, necessitates empirical evidence about how this scheme affects the patients' ability to articulate. Our results showed a high level of contentment with the ease and clarity of pronunciation and speaking irrespective of periodontitis, diabetes, and smoking.

Other important aspects of oral health are related to absence of pain, swelling, and infections; mastication ease; taste; and psychological well-being. We observed a consistently high level of satisfaction which was stable over and above the risk factors. The only exception was in relation to taste, where the control group expressed perfect satisfaction versus a slightly lower level by the patients with one to three risk factors.

The data from before and after the treatment revealed a steady reduction in the frequency to the full absence of pain, swelling, and infections in more than 90% of the patients irrespective of the target risk factors. The ability to eat a variety of foods without chewing difficulties is greatly impaired in people suffering from tooth loss and periodontitis.^[33,34] After the treatment, our patients reported completely removed or significantly reduced limitations on food choice notwithstanding the presence of risk factors. Moreover, the patients with periodontitis experienced a significantly higher reduction in food-choice limitations versus those who did not have periodontitis.

A significant positive change was observed in the patients' psychological state after the treatment, with 92% overcoming nervousness and stress related to dental problems. All patients who suffered from low self-esteem before the treatment due to deteriorating dental health reported significant improvements regardless of the presence of risk factors.

Posttreatment problems and complaints occurred mainly in the first postoperative year, subsiding by the end of the 24th month. The finding collaborates previous observations about the decreasing rate to full disappearance of problems after the 12th postoperative month.^[13]

Limitations of the study are that the patients with different risk factors were not balanced in number although they satisfied the minimum required sample size. The conclusions about diabetes are limited to patients with controlled diabetes. Although corticobasal implants have shown high (95.7%) survival rate with no signs of peri-implantitis in a 57-month observation,^[15] our findings need further validation with long-term OHRQoL data, beyond 36 months.

CONCLUSIONS

Our results provide evidence that the treatment with corticobasal implants is an effective method for restoring the patients' main oral functions, self-confidence, and psychological well-being with a low rate of postoperative complaints which minimize after the 12th postoperative month. The treatment is highly beneficial irrespective of the presence of advanced periodontitis, controlled diabetes, regular smoking, or more than one of these factors. The conclusions have direct implications for the clinical practice, providing reassurance to patients with periodontitis, diabetes, and smokers that corticobasal implants are an appropriate treatment option with the same benefits for their oral health quality of life as for patients without these risk factors.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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