

ORIGINAL ARTICLE

Oral health-related quality of life following peri-implantitis surgery: A prospective study

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Abstract

Aim: The aim of this prospective study was to describe long-term patient-reported outcomes following surgical treatment of peri-implantitis.

Methods: Oral health-related quality of life (OHRQoL) of 43 patients diagnosed with peri-implantitis was recorded using the short form of the Oral Health Impact Profile (OHIP-14), where low scores indicate low impact. A Norwegian version of the OHIP-14 form was filled out 1 week before and 6-, 18- and 36 months after the peri-implant surgery. The mean and median OHIP-14 scores were calculated for its seven domains (i.e., Functional limitation, Physical pain, Psychological discomfort, Physical disability, Psychological disability, Social disability, and Handicap) across four different time points. The dataset was analyzed to find correlations between independent variables and the OHIP-scores.

Results: The OHIP-14 scores were at a low level from baseline to 36 months post-surgery. The mean scores at specific time points were at baseline 7.2 (SD 7.3), 6 months post-surgery 6.0 (SD 6.9), 18 months post-surgery 6.8 (SD 9.7), and 3 years post-surgery 7.0 (SD 9.4). None of these changes were statistically significant. Specific domains of OHRQoL did not significantly differ across different time points (pre- and post-surgery) in males (except for domain "Handicap") or females (except for domain "Functional limitation").

Conclusions: The reported OHIP-14 measures were initially low and stayed low up to 3 years after peri-implant surgery. This may indicate that neither the disease nor the treatment deteriorated or improved the OHRQoL.

KEYWORDS

dental/oral implants, multilinear regression, OHIP, OHRQoL, peri-implant surgery, peri-implantitis

1 | INTRODUCTION

Peri-implantitis is a plaque-associated pathological condition occurring in peri-implant tissues, characterized by tissue inflammation and subsequent progressive loss of the implant supporting bone (Berglundh et al., 2018; Schwarz et al., 2018). The prevalence of

peri-implantitis range between 11.3%–47.1% depending on the diagnostic criteria applied (Derks et al., 2016; Koldsland et al., 2010; Kordbacheh Changi et al., 2019).

The primary goal of peri-implant therapy is to disrupt the biofilm to achieve resolution of the submucosal infection. Although non-surgical treatment is performed, surgical treatment is usually

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deemed necessary. The long-term results still seem unpredictable though, and maintenance/ supportive peri-implant treatment is mandatory and lifelong. The treatment and pocket probing may be painful (Norum et al., 2019; Stanner et al., 2017). Peri-implant diseases are in most cases asymptomatic and not generally perceived by the patients (Romandini, Lima, et al., 2021). However, following surgical treatment pain may be experienced. Peri-implant soft tissue dehiscence (PISTD) in anterior implants is highly prevalent and more than twice as often reported in implants with peri-implantitis than in implants without peri-implantitis (Romandini, Pedrinaci, et al., 2021). Following surgical intervention, an even larger portion of the implant surface might be exposed, and there may be more space between the soft tissue and the suprastructure. A PISTD might influence oral health-related quality of life (OHRQoL) as this may negatively affect the esthetics and phonetics. To the best of our knowledge, this has not been assessed in long-term studies. This may also be influenced by extent and severity of disease. As of today, not many studies have focused on OHRQoL and treatment of peri-implantitis in a long-term perspective.

According to The World Health Organization, oral health is a key indicator of overall health, well-being and quality of life (WHO, 2020). OHRQoL is a multidimensional construct that “includes a subjective evaluation of the individual’s oral health, functional well-being, emotional well-being, expectations and satisfaction with care, and sense of self” (Sischo & Broder, 2011). In the recent decades, significant interest in the effects of periodontal disease on patients’ OHRQoL has evolved and patient-reported outcome measures have become important criteria to assess overall treatment success (Lang & Zitzmann, 2012).

The Oral Health Impact Profile (OHIP) (D. Locker, 1988) is the most widely used instrument for evaluating the impact of dental treatments on OHRQoL. The oral health model was initially validated as a 49-question scale dealing with seven domains: Functional limitation, Physical pain, Psychological discomfort, Physical disability, Psychological disability, Social disability, and Handicap. An easy-to-use version of the instrument, the OHIP-14, was developed and validated by Slade (1997). The OHIP-14 questionnaire, which is used in the present study, is a shortened, easy-to-use version made up of 14 questions that cover the same seven domains.

Few studies have assessed the impact of peri-implant disease on OHRQoL. A cross-sectional study by Insua et al. (2017) reported that patients generally have a poor understanding and perception of peri-implantitis and its impact. Some studies have shown that

periodontal conditions exert a negative impact on the OHRQoL (Buset et al., 2016; Graziani & Tsakos, 2020; Sharma et al., 2018). The periodontal condition affects the ability to eat, speak, and socialize, as well as interpersonal relationships and daily activities; thus, it may affect OHRQoL (Cunha-Cruz et al., 2007).

The aim of the present study was to describe the long-term patient-reported outcome following surgical treatment of peri-implantitis and secondary aim was to analyze variations in outcome.

2 | MATERIAL AND METHODS

2.1 | Study design

This study was designed as a prospective study assessing the long-term outcome of OHRQoL measures 36-months after peri-implant surgery using the OHIP-14 questionnaire. The study flow chart is presented in Figure 1.

The study was approved by the Norwegian Regional Committee for Research Ethics, REC (2012/2257). All participants were given written information about the trial and signed an informed consent. The peri-implant surgeries were performed at the Department of Periodontology, Faculty of Dentistry, University of Oslo. The surgeons were experienced and board-certified periodontists (Koldslund et al., 2018). The study was registered at [ClinicalTrials.gov](https://www.clinicaltrials.gov) (NCT03421717). The study was funded by the Faculty of Dentistry, University of Oslo.

A power analysis showing a sample size of 48 subjects with effect size 0.15%, at a 5% significance level would provide 80% power to detect a significant difference.

2.2 | Study population

Norwegian adults were recruited consecutively from subjects referred to the Department of Periodontology, Institute of Clinical Dentistry, Faculty of Dentistry, University of Oslo, for treatment of peri-implant disease.

The study population has been described in detail in previous publications (Koldslund & Aass, 2020; Koldslund et al., 2018). Briefly, the subjects included were patients registered with one or more implants with peri-implantitis fulfilling the inclusion criteria and willing to participate in the study. The diagnosis of peri-implantitis used

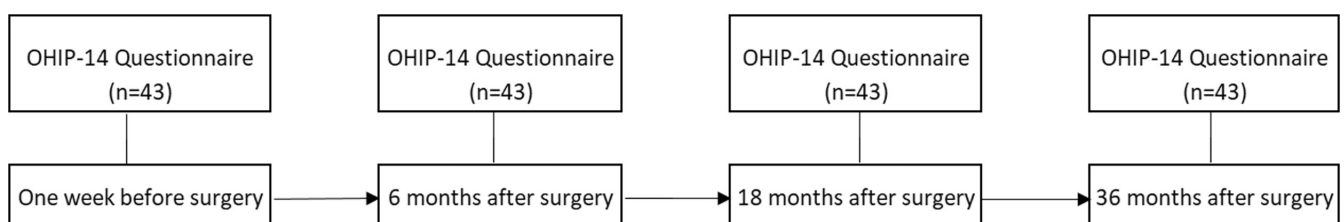


FIGURE 1 Flow chart

was based on the consensus from the VIII European Workshop on Periodontology; changes in the level of crestal bone, the presence of BoP, and/or suppuration; with or without concomitant deepening of pockets (Lang & Berglundh, 2011; Sanz & Chapple, 2012). Hence, only implants with baseline radiographs available to assure progressive bone loss ≥ 2.0 mm (mesial and/or distal site) and BoP/suppuration registered at the same site/ sites were considered for inclusion (Koldsland et al., 2018). The exclusion criteria were acute conditions of gingivitis and periodontitis, medical reasons, and/or insufficient oral hygiene.

In total, 43 study participants (24 females, 19 males) with a diagnosis of progressive peri-implantitis participated. Mean age at time of surgery was 64.9 years (SD 9.0, median 64 years, range 45–86). A Norwegian version of the OHIP-14 form (Dahl et al., 2011; Holst & Dahl, 2008) was filled out 1 week before and 6-, 18- and 36 months after the peri-implant surgery. A total of 116 implants treated for peri-implantitis were included. Medical history was recorded, and all patients got supragingival/mucosal debridement. Factors hampering proper oral hygiene regime was removed. Subjects were only included when less than 20% of sites (implants and teeth) were recorded with plaque.

The patients were grouped according to number of implants treated; 1–2 implants, 3–4 implants, or 5–7 implants. They were also grouped and analyzed according to bone loss at the most severely affected implant.

2.3 | Treatment and questionnaire

Patients fulfilling the inclusion criteria were scheduled for peri-implant surgery. One week prior to surgery, baseline measurements were made at the Institute of Clinical Dentistry at the Department of Periodontology. Suppuration, plaque, pocket probing depths, gingival bleeding, and presence of keratinized mucosa were registered. Before the clinical and radiographic examination at baseline, the participants filled out the OHIP-14 questionnaire. A resective surgical treatment was thereafter performed. The patients were prescribed systemic antibiotics and chlorhexidine mouthwash.

Four and twelve weeks after surgery, oral hygiene instruction was given. No peri-implant probing or submucosal scaling was performed the first 6 months after surgery. Supportive peri-implant monitoring and/or treatment were performed every 3 months after surgery. At intervals 6-, 18-, and 36-months post-surgery the study participants answered the OHIP-14 questionnaire.

2.4 | OHIP-14 questionnaire

Scores were derived from the OHIP-14 questionnaire by summing the responses on each of the individual questions. The OHIP-14 questionnaire is grouped into seven domains: Functional limitation, Physical pain, Psychological discomfort, Physical disability, Psychological disability, Social disability, and Handicap.

Participants were asked to answer the OHIP-14 questions on a five-point Likert scale (Likert, 1932) coded as follows: “never” = 0, “hardly ever” = 1, “occasionally” = 2, “fairly often” = 3 and “very often” = 4. Possible OHIP-14 scores range from 0 (no problems at all) to 56 (all problems experienced very often) (Ng & Leung, 2006) at each time point.

2.5 | Statistical analyses

Statistical analyses were performed using IBM SPSS Statistics version 26 (IBM, USA). The normal distribution of variables was assessed using the Kolmogorov–Smirnov and Shapiro–Wilk test. Descriptive statistics of patient's age at surgery, gender, smoking status, and systemic factors (coronary heart disease, diabetes, rheumatic disease), dental characteristics (number of teeth present, number of implants present, extent of peri-implantitis and severity of peri-implantitis), and seven domains of OHIP-14 was performed. The continuous variables were presented as Mean \pm SD, and categorical variables were presented as frequency with corresponding percentages. Non-parametric Friedman tests was performed to assess significant differences in mean scores of seven dimensions of OHIP-14 across different time points, that is, 1 week pre-surgery, 6-, 18-, and 36-months post-surgery. In addition, mean area under the curve at different time points was computed and compared. Subgroup analyses by gender and smoking was also performed. Results were regarded statistically significant if $p < 0.05$.

TABLE 1 Study population

Variables	Measurements (SD)
Gender	
Male	19
Female	24
Mean age (years; mean SD)	64.9 [8.7]
Age range	45–86
Coronary/heart disease	
Yes	5
No	38
Diabetic disease	
Yes	3
No	40
Rheumatic	
Yes	2
No	41
Current smoker	
Yes	21
No/previous	22
Number of teeth at baseline	9.9 [7.5]
Number of implants at baseline	5.6 [2.9]

3 | RESULTS

Table 1 represents baseline characteristics of the study population. The mean age was 64.9 (8.7) and 60% were females. Nearly 50% were current smokers, and the majority had no heart diseases, diabetes, or rheumatic diseases.

From a total of 2408 values, 131 values were missing (5.4%). Nine out of 43 patients had more than 3 missing values. Missing values were filled in with median values for each patient for each question. This adjustment had minor impact on the overall result.

Table 2 presents the mean and median (interquartile range, IQR) for all seven domains as well as total domains of OHIP-14 questions

TABLE 2 The mean score, median (IQR) and SD for the seven domains

		1 week pre-surgery	6 months post-surgery	18 months post-surgery	36 months post-surgery
<i>Specific domains of OHIP-14</i>					
Functional limitation	Mean (SD)	0.81 (0.98)	0.63 (0.93)	0.84 (1.27)	0.84 (1.09)
	Median (IQR)	0 (0-0)	0 (0-1)	0 (0-1)	0 (0-2)
Physical pain	Mean (SD)	1.47 (1.74)	1.49 (1.67)	1.42 (1.78)	1.30 (1.66)
	Median (IQR)	1 (0-2)	1 (0-3)	1 (0-2)	1 (0-2)
Psychological discomfort	Mean (SD)	1.67 (1.82)	1.51 (1.88)	1.56 (2.05)	1.77 (2.38)
	Median (IQR)	1 (0-4)	1 (0-2)	1 (0-2)	1 (0-4)
Physical disability	Mean (SD)	0.56 (1.12)	0.40 (0.82)	0.56 (1.52)	0.56 (1.26)
	Median (IQR)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)
Psychological disability	Mean (SD)	1.14 (1.61)	0.98 (1.41)	0.98 (1.71)	1.26 (2.00)
	Median (IQR)	0 (0-2)	0 (0-2)	0 (0-2)	0 (0-2)
Social disability	Mean (SD)	0.33 (0.75)	0.26 (0.66)	0.37 (0.95)	0.33 (0.89)
	Median (IQR)	0 (0-2)	0 (0-0)	0 (0-0)	0 (0-0)
Handicap	Mean (SD)	1.23 (1.51)	0.72 (1.37)	1.07 (1.70)	0.91 (1.54)
	Median (IQR)	1 (0-2)	0 (0-1)	0 (0-2)	(0-2)
All domains	Mean (SD)	7.21 (7.33)	5.98 (6.90)	6.80 (9.72)	6.95 (9.43)
	Median (IQR)	7 (1-10)	3 (1-9)	3 (0-10)	3 (0-9)

FIGURE 2 Estimated mean area under the curve for "all domains" of OHIP-14 at different time intervals (AUC1 = 1 week pre-surgery to 6 months post-surgery, AUC2 = 6 months to 18 months, AUC = 18 months to 36 months)

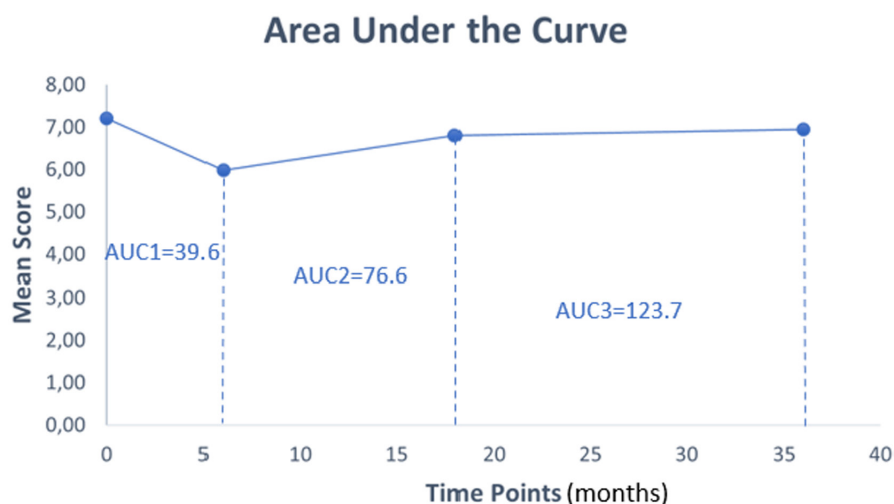


TABLE 3 Distribution of reported outcomes during the observation period according to the Likert scale

	"Never"	"Hardly ever"	"Occasionally"	"Fairly often"	"Very often"
Likert scale	0	1	2	3	4
Percentage of total	70	16	10	2	1
Number of values	1695	389	235	57	32

TABLE 4 Mean and median changes in OHIP-scores according to gender during the total observation period

		Female (n = 24)				Male (n = 19)				
		1 week pre-surgery	6 months post-surgery	18 months post-surgery	36 months post-surgery	1 week Pre-surgery	6 months Post-surgery	18 months Post-surgery	36 months Post-surgery	p-value
<i>Specific domains of OHIP-14</i>										
Functional limitation		Mean (SD)	0.71 (0.91)	0.58 (0.97)	1.13 (1.54)	0.88 (1.15)	.045*			
		Median (IQR)	0 (0-1)	0 (0-1)	1 (0-1.5)	0 (0-2)				
Physical Pain		Mean (SD)	1.75 (1.85)	1.88 (1.92)	1.79 (2.08)	1.63 (1.88)	.762			
		Median (IQR)	2 (0-2.5)	1.5 (0-3)	1 (0-2.5)	1 (0-2)				
Psychological discomfort		Mean (SD)	2.08 (1.95)	2.29 (2.01)	2.25 (2.33)	2.71 (2.69)	.710			
		Median (IQR)	2 (0-4)	2 (1-4)	1 (0.5-4)	2 (0-4.5)				
Physical disability		Mean (SD)	0.67 (1.30)	0.54 (0.98)	0.71 (1.90)	0.71 (1.52)	.706			
		Median (IQR)	0 (0-1)	0 (0-1)	0 (0-0)	0 (0-0.5)				
Psychological disability		Mean (SD)	1.66 (1.88)	1.50 (1.59)	1.42 (2.08)	1.96 (2.33)	.103			
		Median (IQR)	1 (0-3.5)	1 (0-3)	0 (0-2)	1 (0-2.5)				
Social disability		Mean (SD)	0.33 (0.70)	0.33 (0.64)	0.54 (1.21)	0.38 (1.06)	.772			
		Median (IQR)	0 (0-0)	0 (0-0.5)	0 (0-0.5)	0 (0-0)				
Handicap		Mean (SD)	1.37 (1.66)	0.88 (1.48)	1.42 (1.95)	1.25 (1.79)	.341			
		Median (IQR)	1 (0-2)	0 (0-1.5)	1 (0-2)	0 (0-2)				
All domains		Mean (SD)	8.58 (8.04)	8.00 (7.64)	9.25 (11.57)	9.5 (10.9)	.941			
		Median (IQR)	7 (1-12)	5.5 (2-13.5)	5 (1.5-14.5)	6 (1.5-11.5)				
<i>Specific domains of OHIP-14</i>										
Functional limitation		Mean (SD)	0.95 (1.08)	0.68 (0.89)	0.47 (0.70)	0.79 (1.03)	.126			
		Median (IQR)	1 (0-2)	0 (0-2)	0 (0-1)	0 (0-1)				
Physical pain		Mean (SD)	1.11 (1.56)	1.00 (1.15)	0.95 (1.17)	0.89 (1.29)	.813			
		Median (IQR)	0 (0-2)	1 (0-2)	0 (0-2)	0 (0-2)				
Psychological discomfort		Mean (SD)	1.16 (1.54)	0.53 (1.12)	0.68 (1.20)	0.58 (1.12)	.057			
		Median (IQR)	0 (0-0)	0 (0-0)	0 (0-1)	0 (0-1)				
Physical disability		Mean (SD)	0.42 (0.84)	0.21 (0.54)	0.37 (0.83)	0.37 (0.83)	.930			
		Median (IQR)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)				
Psychological disability		Mean (SD)	0.47 (0.84)	0.32 (0.75)	0.42 (0.83)	0.37 (0.96)	.763			
		Median (IQR)	0 (0-1)	0 (0-0)	0 (0-1)	0 (0-0)				

TABLE 4 (Continued)

Male (n = 19)		1 week Pre-surgery	6 months Post-surgery	18 months Post-surgery	36 months Post-surgery	p-value
Social disability	Mean (SD) Median (IQR)	0.32 (0.82) 0 (0–0)	0.16 (0.69) 0 (0–0)	0.16 (0.37) 0 (0–0)	0.26 (0.65) 0 (0–0)	.852
Handicap	Mean (SD) Median (IQR)	1.05 (1.31) 0 (0–2)	0.53 (1.22) 0 (0–1)	0.63 (1.21) 0 (0–1)	0.47 (1.02) 0 (0–0)	.032*
All domains	Mean (SD) Median (IQR)	5.47 (6.08) 5 (1–8)	3.42 (4.91) 2 (1–3)	3.68 (5.58) 1 (0–6)	3.74 (5.92) 1 (0–5)	.115

* = statistically significant

at baseline (1-week pre-surgery), 6-, 18- and 36 months post-surgery. No significant difference was observed across all four time points in relation to the seven domains.

The mean score of the total of seven domains of OHIP-14 were 7.2 (SD 7.3), 6.0 (SD 6.9), 6.8 (SD 9.7), 7.0 (9.4) at baseline (pre-surgery), 6-, 18-, 36-months post-surgery, respectively. No significant difference was observed in relation to total domains. Further, the estimated mean area under the curve in relation to total domain across different time intervals was 39.6 for baseline to 6 months post-surgery, 76.6 for 6 to 18 months post-surgery, and 123.7 for 18 to 36 months post-surgery, respectively (Figure 2).

Between the different time points no statistically significant differences were observed (Table 2).

On the Likert scale 11 patients reported at least once score 3 (“fairly often”) and 8 patients reported at least once score 4 (“very often”) over the 3-year study period. The distribution of the reported answers is presented in Table 3. The OHIP-scores recorded at the different time intervals according to gender and smoking habits are presented in Tables 4 and 5.

Specific domains of OHRQoL do not significantly differ across different time points (pre- and post-surgery) in males (except for domain “Handicap”) and females (except for domain “Functional limitation”).

The variables severity and extent of peri-implantitis did not show any statistical significance in relation to the outcome (data are not shown).

4 | DISCUSSION

Using the OHRQoL instrument OHIP-14, subjects rated the impact of their oral health on their quality of life one week before and 6-, 18-, and 36 weeks after peri-implant surgery. Seventy percent of the total values in the OHIP-14 questionnaire were “0”, implying that these patients “never” experienced problems related to a specific OHRQoL-question. This implied that OHRQoL for most patients, were not influenced by peri-implantitis or the treatment performed. Abrahamsson et al. (2017) reported that most patients initially, when receiving the implants, were satisfied with their implant therapy, but when problems with their implants occurred, the patients became less positive regarding the care obtained and provided. The results illuminated the importance of patient-centered communication in dentistry. Taking the time to listen to what patients have to say and asking questions with focus on emotional issues strengthen the therapeutic alliance, with benefits for treatment outcome and satisfaction with care (Pinto et al., 2012). In the present study, it was essential to spend time explaining to the patients why the peri-implant surgery was necessary and how it should be carried out. Patients were also encouraged to seek advisory support from the performing surgeon if needed.

The domain “Psychological discomfort” had the highest mean scores, indicating that the discomfort of having peri-implantitis may be more important than the other domains. Social disability had the

TABLE 5 Mean and median changes in OHIP-scores according to smoking habits during the total observation period

		Current smoker (n = 21)					Non Smoker (n = 22)				
		1 week pre-surgery	6 months post-surgery	18 months post-surgery	36 months post-surgery	p-value	1 week pre-surgery	6 months post-surgery	18 months post-surgery	36 months post-surgery	p-value
<i>Specific domains of OHIP-14</i>											
<i>Functional limitation</i>											
	Mean (SD)	0.81 (0.98)	0.76 (1.09)	1.14 (1.65)	0.95 (1.28)	.3141					
	Median (IQR)	0 (0-2)	0 (0-1)	1 (0-2)	0 (0-2)						
<i>Physical Pain</i>											
	Mean (SD)	1.71 (1.93)	1.76 (1.67)	1.76 (2.21)	1.57 (1.85)	.7316					
	Median (IQR)	1 (0-3)	2 (0-3)	1 (0-2)	1 (0-2)						
<i>Psychological discomfort</i>											
	Mean (SD)	1.81 (1.72)	2.05 (2.09)	2 (2.55)	2.62 (2.80)	.3802					
	Median (IQR)	2 (0-4)	2 (0-4)	1 (0-4)	1 (0-4)						
<i>Physical disability</i>											
	Mean (SD)	0.71 (1.38)	0.52 (1.03)	0.86 (2.03)	0.81 (1.66)	.7254					
	Median (IQR)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)						
<i>Psychological disability</i>											
	Mean (SD)	1.62 (1.88)	1.48 (1.50)	1.52 (2.23)	1.95 (2.43)	.2845					
	Median (IQR)	1 (0-3)	1 (0-3)	0 (0-2)	1 (0-3)						
<i>Social disability</i>											
	Mean (SD)	0.43 (0.75)	0.33 (0.73)	0.62 (1.28)	0.43 (1.12)	.7224					
	Median (IQR)	0 (0-1)	0 (0-1)	0 (0-1)	0 (0-0)						
<i>Handicap</i>											
	Mean (SD)	1.62 (1.68)	0.90 (1.41)	1.42 (2.03)	1.19 (1.86)	.3208					
	Median (IQR)	2 (0-2)	0 (0-2)	0 (0-2)	0 (0-2)						
<i>All domains</i>											
	Mean (SD)	8.71 (7.90)	7.80 (7.50)	9.33 (12.6)	9.52 (11.42)	.6899					
	Median (IQR)	8 (1-10)	5 (1-14)	2 (1-16)	5 (1-12)						
<i>Specific domains of OHIP-14</i>											
<i>Functional limitation</i>											
	Mean (SD)	0.82 (1.01)	0.50 (0.74)	0.54 (0.67)	0.73 (0.88)	.2898					
	Median (IQR)	0.5 (0-1)	0 (0-1)	0 (0-1)	0.5 (0-1)						
<i>Physical pain</i>											
	Mean (SD)	1.22 (1.54)	1.23 (1.66)	1.05 (1.46)	1.09 (1.19)	.8093					
	Median (IQR)	1 (0-2)	0.5 (0-2)	0.5 (0-2)	1 (0-2)						
<i>Psychological discomfort</i>											
	Mean (SD)	1.55 (1.95)	1 (1.54)	1.14 (1.36)	0.95 (1.56)	.1480					
	Median (IQR)	0.5 (0-3)	0 (0-2)	1 (0-2)	0 (0-2)						
<i>Physical disability</i>											
	Mean (SD)	0.41 (0.80)	0.27 (0.55)	0.27 (0.70)	0.32 (0.65)	.6107					
	Median (IQR)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)						
<i>Psychological disability</i>											
	Mean (SD)	0.68 (1.17)	0.50 (1.14)	0.45 (0.74)	0.59 (1.18)	.7361					
	Median (IQR)	0 (0-1)	0 (0-1)	0 (0-1)	0 (0-1)						

TABLE 5 (Continued)

Non Smoker (n = 22)		1 week pre-surgery	6 months post-surgery	18 months post-surgery	36 months post-surgery	p-value
Social disability	Mean (SD)	0.23 (0.75)	0.18 (0.59)	0.14 (0.35)	0.23 (0.61)	.9679
	Median (IQR)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	
Handicap	Mean (SD)	0.86 (1.25)	0.55 (1.34)	0.73 (1.24)	0.64 (1.14)	.4546
	Median (IQR)	0 (0-2)	0 (0-1)	0 (0-1)	0 (0-1)	
All domains	Mean (SD)	5.77 (6.60)	4.23 (5.92)	4.36 (4.96)	4.50 (6.37)	.4160
	Median (IQR)	4 (1-7)	2 (1-5)	3 (0-6)	2.5 (0-7)	

lowest mean scores. This might imply that dental implants are well functioning regardless of a diagnosis of peri-implantitis, and that the disease, even though it gives you discomfort, may not prevent social interaction with others. As reported by Romandini, Lima, et al. (2021), peri-implant diseases are in most cases asymptomatic and not perceived by the patients. This seems to be observed also following peri-implantitis treatment.

In general, females had higher mean score than males in all 7 domains. This is in accordance with Araujo et al. (2010) who reported the oral health impact to be statistically significantly associated with gender, using the OHIP-14. An impact of gender differences and perception of OHRQoL has also been reported previously (Pattussi et al., 2010; Ulinski et al., 2013).

Current smokers had an overall higher mean score on OHIP-14 than non-smokers. To the best of our knowledge, no studies have assessed the association between smokers and OHRQoL in patients surgically treated for peri-implantitis. Jansson et al. (2014) reported that smoking was statistically significantly related to a decrease in OHRQoL in patients with periodontitis. However, there is a lack of knowledge as to what the association means. Tomar et al. (2011) proposed that cigarette smoking may be either an independent risk factor for reduced OHRQoL or may serve as a marker for an underlying, but unidentified factor.

The extent and severity of peri-implantitis might influence the results. However, due to the low number of participants and the low OHIP-14 scores, this was not calculated in the present study.

The subjects in this study comprised a selected group of patients referred to a specialist clinic in periodontology for treatment of peri-implantitis, and therefore, the results should be interpreted with caution as the results may not be generalized. In addition, the subjects were referred both from general practice and specialist clinics to a university clinic. This may affect the patients psychologically, appreciating that they were well taken care of and given optimal treatment. In this study the patients have not been charged with any fee for the surgical treatment nor for the follow-up. It might be speculated that this might affect their overall satisfaction, feeling that they were not going to be dissatisfied with a cost-free treatment.

The highest mean OHIP-14 score across all time intervals for one patient found in this study was 120. The mean values are low and could indicate that the patients with severe peri-implant disease still perceived their OHRQoL as good. However, this may also reflect that the OHIP-14 did not entirely capture the impact of peri-implantitis in relation to OHRQoL in the present study. The OHIP-14-instrument suffers from certain limitations such as a floor effect, which means that most scores accumulate at the bottom of the scale (David Locker & Allen, 2002). This implies that the OHIP-14 instrument's standard score might not distinguish between study participants. The high prevalence of subjects with zero scores in this study may compromise the ability of OHIP-14 to detect within-subject changes. However, another study discussed alternatives for assessment of OHRQoL (Ohrn & Jonsson, 2012). The Geriatric Oral Health Assessment Index (GOHAI) (Atchison & Dolan, 1990) is an instrument consisting of 12-item questionnaires

and it is considered a gold standard used in measuring the oral health impact of the geriatric patients. Ohrn and Jonsson compared the usefulness of the OHIP-14 and GOHAI questionnaire assessing OHRQoL at the basic examination and after initial dental hygiene treatment. A greater variety in the responses with the GOHAI questionnaire compared to the OHIP-14 was found. Hence, the GOHAI questionnaire may be more useful for patients with periodontal disease. This might also be relevant when scoring OHRQoL of patients treated for peri-implantitis.

5 | CONCLUSIONS

The OHIP-14 measures in the present study were initially low and stayed low up to three years after peri-implant surgery. This indicates that neither the disease nor the treatment seemed to deteriorate the OHRQoL following surgical treatment of peri-implantitis.

AUTHOR CONTRIBUTIONS

Kristin Rustand: Data curation (equal); formal analysis (supporting); investigation (equal); software (equal); visualization (lead); writing – original draft (lead); writing – review and editing (equal). **Anne Merete Aass:** Conceptualization (equal); funding acquisition (lead); methodology (equal); project administration (equal); supervision (equal); validation (equal); writing – review and editing (equal). **Abhijit Sen:** Data curation (equal); formal analysis (lead); software (supporting). **Odd Carsten Koldslund:** Conceptualization (equal); methodology (equal); project administration (equal); supervision (equal); writing – review and editing (equal).

CONFLICT OF INTEREST

I declare that I have no conflicts of interest to disclose for this article.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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