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Periodontal Treatment, Psychological Factors and Oral Health Related Quality of Life

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CONFLICT OF INTEREST

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ABSTRACT

Aims: To determine changes in OHRQoL and clinical status after periodontal treatment and the factors predicting these changes.

Methods: Cohort of 140 patients with chronic periodontitis receiving non-surgical treatment. Participants self-completed questionnaires: Sense of Coherence, Locus of Control, Self-esteem and Task-specific Self-efficacy before treatment, and Oral Health Impact Profile at treatment, oral hygiene review and end of study. Relationships between OHRQoL, clinical data, individual and environmental characteristics were analysed with structural equation modelling guided by the Wilson and Cleary model.

Results: OHRQoL and the periodontal status improved after treatment. Greater sense of coherence and age, better periodontal status, lower DMFT and being male predicted better OHRQoL after treatment. Better task-specific self-efficacy and self-esteem, but worse plaque score predicted better end periodontal status.

Conclusions: OHRQoL and periodontal status improved after periodontal treatment, and this was predicted by individual demographic and psychological factors. These factors may assist with case selection and as possible points for intervention to improve clinical and subjective outcomes of periodontal treatment.

CLINICAL RELEVANCE

Scientific rationale for the study: The psychological predictors of clinical and OHRQoL outcomes of periodontal treatment are unclear in adults with chronic periodontitis.

Principal findings: Nonsurgical periodontal treatment improved the clinical conditional and OHRQoL after treatment in the psychosocial and pain-dysfunction OHIP-14 dimensions. OHRQoL outcomes were predicted by sense of coherence, individual demographic factors, and the periodontal status, which was also predicted by task-specific self-efficacy, self-esteem and plaque score.

Practical implications: Knowledge of psychological factors may be helpful in developing a strategy for managing patients with chronic periodontitis, and it is suggested that interventions to enhance relevant psychological reserves may improve OHRQoL and clinical outcomes of periodontal treatment.

1 INTRODUCTION

Little is known about which factors may determine the clinical and subjective outcomes of periodontal treatment. It is increasingly acknowledged that periodontal diseases adversely impact on Oral Health Related Quality of Life (OHRQoL) (Ferreira, Dias-Pereira, Branco-de-Almeida, Martins, & Paiva, 2017), and there is evidence from clinical studies, that routine periodontal treatment can improve this (Botelho et al., 2020; Shanbhag, Dahiya, & Croucher, 2012). Sense of coherence, self-efficacy, self-esteem and locus of control are important psychological reserves relevant to the care of people with periodontal diseases.

Sense of coherence is defined as “a global orientation that expresses the extent to which one has a pervasive, enduring through dynamic feeling of confidence that stimuli deriving from one’s internal and external environments in the course of living are structured, predictable and explicable, the resources are available to one to meet the demands posed by these stimuli and these demands are challenges, worthy of investment and engagement” (Antonovsky, 1987). Sense of coherence is related to personal behaviours important in the management of periodontal diseases. There is consistent and experimental evidence that sense of coherence influences OHRQoL (Elyasi et al., 2015; Eriksson & Lindstrom, 2007; Johansson et al., 2010; Nammontri, Robinson, & Baker, 2013). However, no longitudinal studies have investigated sense of coherence in relation to the clinical outcomes of periodontal treatment in adults. Locus of control may also influence oral health behaviours (Padmaja et al., 2018), and thereby, periodontal outcomes, but again, the available data are not sufficiently robust to allow firm conclusions (Borkowska, Watts, & Weinman, 1998; Galgut, Waite, Todd-pokropek, & Barnby, 1987).

High self-efficacy is “the extent or strength of one’s belief in one’s own ability to complete tasks and reach goals” (Ormrod, 2006). Self-efficacy specific to oral health care predicts better oral hygiene and remaining in periodontal treatment, but its impact on OHRQoL remains unclear (Kakudate, Morita, & Kawanami, 2008; Kakudate et al., 2010; Woelber et al., 2015). The few reports on self-esteem in relation to periodontal outcomes in adults, also leave its importance unclear (Dumitrescu & Kawamura, 2010; Musurlieva & Stoykova, 2015; Syrjala, Ylostalo, Niskanen, & Knuuttila, 2004).

Improving the periodontal condition may improve self-esteem, but there are no data for this.

Elucidating the role of relevant individual factors in predicting clinical outcomes and OHRQoL, may help in the development of more holistic and patient centred approaches for the management of periodontal diseases. This approach would differ from the traditional methods of treatment that are heavily based on the biomedical model of health as it may assist in case selection and in the identification of points for interventions to support treatment.

The Wilson and Cleary (1995) conceptual model facilitates exploration of relationships between characteristics of the individual and their environment, and the various levels of symptom status, functional status, general health perceptions and OHRQoL (Figure 1). Structural Equation Modelling (SEM) allows simultaneous testing of direct and indirect relationships between possible determinants to elucidate the roles of biological, psychological and social factors in a comprehensive biopsychosocial model of health. The aims of this study were to determine the OHRQoL and clinical changes after periodontal treatment and the factors predicting these changes.

2 METHODS

This report is the first part of a prospective (follow-up) single arm intervention study in patients with chronic periodontitis, to which consecutive patients attending a periodontology clinic were recruited. A minimum sample size of 100 was estimated based on 2 latent and 10 observed variables to detect a minimum effect size of 0.1, with a power of 95% and 0.05 level of significance. The study was approved by East Midlands-Nottingham Research Ethics Committee, the Health Research Authority and sponsored by Sheffield Teaching Hospitals NHS Foundation Trust.

Eligible patients were aged at least 18 years with a diagnosis of chronic periodontitis (Armitage, 1999) with 3 or more sites having periodontal probing depths of ≥ 4 mm and bleeding up to 30 seconds after probing. Patients who had periodontal treatment in the previous 3 months, antibiotics in the previous month, any medical condition or medication that may affect the susceptibility to periodontal disease, who did not have the capacity to consent for themselves or answer self-completed questionnaires, pregnant and lactating females, and non-English speaking participants were excluded.

Gender, smoking habits (current, ever, never), ethnicity, Index of Multiple Deprivation (IMD) (<http://tools.npeu.ox.ac.uk/imd/>), education (ISCED 2011 levels of education) and occupation (Office of National Statistics) were recorded.

All patients underwent a full periodontal examination to record the numbers of natural, decayed, missing and filled teeth, periodontal probing depth (mm) and gingival recession (mm) from which the clinical attachment loss was calculated. The proportion of sites bleeding on probing and plaque scores were also recorded (Wilson & Magnusson, 1996; O'Leary, Naylor & Drake, 1972). The same trained and calibrated examiner (AR) recorded data before treatment, and 3 to 9 months afterwards. The type of tooth brush used (manual/electric), frequency of brushing, type of toothpaste used (fluoride/other additives), interdental brushing, use of tape or floss and the frequency of interdental cleaning, use of mouthwash were recorded at each time point.

Treatment comprised ultrasonic scaling and root surface debridement under local analgesia and instruction in oral hygiene by one of three dental hygienists. Symptoms and oral hygiene were reviewed approximately 1 month after treatment when further advice on plaque control was given.

The intra-examiner reliability of all clinical measurements was assessed for the examiner (AR) on a random sample of patients. Intra-examiner reliability of plaque score measurements was also calculated for each hygienist. Inter-examiner reliability was assessed for plaque scores between each hygienist and the clinical examiner (AR), as these were the only measures recorded by two examiners (Intra-Class Correlation Coefficient).

OHIP-14 questionnaires were completed at treatment, interim oral hygiene review and end of study review time points to measure Oral Health Related Quality of Life (Slade, 1997). Three dimensions of OHRQoL, (psychosocial, pain-discomfort and functional limitation) were determined (Montero et al, 2010). The other questionnaires used were Sense of Coherence (SoC-13) (Antonovsky, 1987), Task Specific Self-efficacy (TSSE) (Woelber et al., 2015), Rosenberg Self-esteem Scale (Rosenberg, 1965) and Multidimensional Health Locus of Control questionnaire C (condition specific) (Wallston, 2005). Data were treated as missing if > 3 items were missing, and substituted with the mean score of non-missing items if <3 items were missing (Tsakos et al., 2009).

An independent t-test was used to compare data for participants completing the study and lost to follow-up. The clinical changes after treatment were analysed using

paired t-tests for parametric data or related samples Wilcoxon Signed Rank Test for non-parametric data. The proportion of changes in probing depth $\geq 2\text{mm}$ was also calculated. Changes in oral hygiene habits were tested by Repeated Measures ANOVA. A P -value of <0.05 was taken as statistically significant. SPSS version 24 was used for statistical analysis.

All potential predictors of OHRQoL and periodontal status were considered in SEM to test variables within the Wilson and Cleary Model, to explore the relationship between the baseline predictors (observed variables) and OHRQoL (latent variable) at the end of the study. Predictors of periodontal status (latent variable) at the end of the study were also explored. Confirmatory Factor Analysis (CFA) determined whether observed variables adequately indicated latent variables. A full SEM was developed and a parsimonious model by removing non-significant paths. The difference in Chi-square and degrees of freedom were used to test the difference between models (Werner & Schermelleh-Engel, 2010). The parsimonious model was not statistically different to the full model, and was used to determine the predictors of OHRQoL and periodontal status at the end of the study.

SEM was performed in Amos version 25 using maximum likelihood estimation with 900 bootstrap samples resampled to produce less biased standard errors and 95% CI bootstrap percentiles. Direct, indirect and total effects (β) for paths linking variables were estimated by the software. The statistical significance of indirect effects was used to assess mediation using bias-corrected bootstrap confidence intervals. Model fit was assessed using Chi-squared, root-mean square error of approximation (RMSEA) with 90% CI, standardized root mean square residual (SRMR), goodness of fit index (GFI) and comparative fit index (CFI). Thresholds for a good model fit were Chi-squared/degree of freedom ratio <3.0 , SRMR ≤ 0.08 , RMSEA ≤ 0.06 , GFI and CFI ≥ 0.90 (Hu & Bentler, 1999).

We hypothesized *a priori* that periodontal status and OHRQoL after treatment would be predicted by age, gender, smoking, ethnicity, occupation and education, by psychological factors (sense of coherence, task-specific self-efficacy, self-esteem, locus of control) and the environmental factor Index of Multiple Deprivation.

3 RESULTS

One hundred and sixty adults with chronic periodontitis were recruited. Two were subsequently withdrawn and 18 lost to follow-up (Figure 1). Amongst those completing the study, 2 participants had missing items for sense of coherence, 6 for task-specific self-efficacy, 8 for locus of control, 2 for treatment and end OHRQoL, and 1 for oral hygiene review OHRQoL. One hundred and forty provided complete data, and the characteristics of participants completing and those not completing the study were similar. Nearly all (95%) participants completed treatment in one visit, the remainder needing two. The mean interval from completion of treatment to end of study was 3.6 months (85% of participants).

The mean age of participants completing the study was 50.4 years (range 30-78 years, standard deviation 10 years). Fifty-one (36.4%) were male, 89 (63.6 %) were female. Almost 86% were white British. Most were from high occupational bands, with over 30% educated to degree level, and from the 2 least deprived Index of Multiple Deprivation quintiles.

Participants mainly used electric toothbrushes. A daily antiseptic mouth rinse was used by less than half. Most participants brushed twice daily, and all used a fluoride toothpaste and/or toothpastes with other additives to control hypersensitivity. Oral hygiene habits did not change significantly over the study period, with the exception that electric toothbrush use increased to 80% of participants ($P=0.018$). Daily use of interdental brushes increased and the use of dental floss or tape declined in accordance with the advice given.

The psychological characteristics of completing participants are presented in Table 1. Cronbach's alpha for total scores, dimensions and sub-scales for multi-dimensional questionnaires (OHIP-14, Task-specific Self-efficacy and Locus of Control) were generally in the range from acceptable to excellent. However, Cronbach's alpha for the Locus of Control chance items was questionable and 'powerful other' items was poor (George and Mallery, 2010).

The inter- and intra-examiner reliability of clinical measurements was excellent for plaque scores, and for intra-examiner reliability of probing depths, bleeding on probing and plaque scores (ICC >0.9), and good for recession (ICC 0.834). The clinical

status of participants before and after periodontal treatment is presented in Table 2, and these did not differ significantly to those not completing the study, other than for DMFT ($P=0.008$). All participants completing the study had mild to severe chronic periodontitis. Before treatment, approximately 30% of sites had ≥ 4 mm periodontal pocketing, of which 18.5% were ≥ 6 mm in depth. Almost half of sites had lost clinical attachment, with over 30% having ≥ 3 mm and 15.8% ≥ 5 mm. Approximately 24% of sites bled on probing and visible plaque was present on 43.9% of tooth surfaces.

Table 3 summarizes OHIP-14 total and dimension scores at study time points. OHIP-14 scores for participants who completed and those lost to follow-up were similar. Cronbach's alpha for the total OHIP-14 scale and psychosocial dimension at all time points was excellent and good for all the pain-discomfort questions. The internal consistency for functional limitation at baseline fell within the unacceptable range, although this increased at subsequent study time points and was acceptable at the end of the study.

Mean total OHIP-14 scores decreased from 13.95 before treatment to 11.96 and 12.01 at interim oral hygiene review and final review time points respectively, indicating an improvement in OHRQoL. Mean psychosocial impact scores decreased between treatment, and review and end of study ($P<0.01$). The pain-discomfort dimension also decreased between treatment and oral hygiene review time points ($P<0.05$) and between treatment and end of study ($P<0.01$). The changes in OHIP-14 scores were not significant for functional limitation. The effect size (change in OHIP scores divided by baseline standard deviation) (Agou, Locker, Streiner, & Tompsond, 2008; Cohen, 1992; Locker, Jokovic, & Clarke, 2004) for changes in total OHIP-14 scores and OHIP dimensions from treatment to end of study were all small: 0.18, 0.17, 0.22 and 0.05 for changes in total OHIP-14, psychosocial impacts, pain-discomfort and functional limitation respectively for the difference between treatment and end of the study.

Probing depths reduced between baseline and end of study, with clinically meaningful reductions ≥ 2 mm accounting for 8.38%. Overall, almost 67% of periodontal sites remained stable with no changes in clinical attachment loss, 20% gained attachment and 13% underwent further clinical attachment loss. Furthermore, there were significant reductions in plaque scores and bleeding on probing after treatment.

Confirmatory factor analysis (CFA) assessed the measurement model for the latent factors of end of study periodontal status and OHRQoL (Figure 2). Index of Multiple Deprivation, qualifications and education did not fit within an acceptable model and were unrelated to the other variables in the model, or periodontal measures in bivariate analysis (not shown).

The full model predicting periodontal status and end of study OHRQoL is shown in Figure 3 and the statistical fit indices for the measurement, full and parsimonious models in Table 4. The fit of measurement and full models met all the fit criteria. The direct and indirect paths for the parsimonious model are summarized in Table 5 and Figure 4.

OHRQoL at the end of the study was predicted by baseline sense of coherence, end periodontal status, end DMFT, age and gender. Thus, people with a better sense of coherence, better periodontal status, fewer decayed missing and filled teeth, who were older and male, had less impact of oral health on their everyday life after treatment. There were also significant indirect effects between self-esteem, task specific self-efficacy, end plaque score and OHRQoL, which were mediated by the periodontal status. The end of study periodontal status was predicted by task specific self-efficacy, end plaque score and self-esteem. Thus, people who were more confident about brushing, interdental cleaning and visiting their dentist, who had better self-esteem, but who had more plaque had better periodontal status at the end of the study.

4 DISCUSSION

The key finding of this study is that non-surgical periodontal treatment appeared to improve OHRQoL and the periodontal status of participants. Key individual demographic and psychological factors directly predicted OHRQoL and indirectly predicted OHRQoL, being mediated via the periodontal status.

The improvement in OHRQoL after periodontal treatment is in agreement with previous studies (Baiju, Peter, Varghese, & Anju, 2017; Botelho et al., 2020; Goel & Baral, 2017; Mendez, Melchior, Angst, Stadler, Oppermann, & Gomes, 2017; Shanbhag, Dahiya & Croucher, 2012). Changes in the psychosocial and pain-discomfort dimensions are also consistent with previous reports (Goel & Baral, 2017; Makino-Oi et al., 2016; Wong, Ng, Corbet, & Leung, 2012), and add to the evidence

of periodontal diseases negatively impacting on OHRQoL and that treatment improves this.

This study determined the predictors of OHRQoL after treatment. Sense of coherence was the strongest predictor and had a direct psychological effect on patients' everyday life after treatment. Individuals with strong sense of coherence tend to stay well and remain satisfied with their quality of life irrespective of adversity or stressors (Antonovsky, 1987). Consequently, a person who thought their periodontal condition was manageable might have fewer impacts on their everyday life.

A stronger sense of coherence is associated with better OHRQoL (Boman, Wennstrom, Stenman, & Hakeberg, 2012; Savolainen et al., 2005), particularly in relation to psychological discomfort, disability and handicap domains. Sense of coherence has been associated with good oral health behaviours (Elyasi et al., 2015; Eriksson & Lindstrom, 2007), regular dental attendance regular tooth brushing (Ayo-Yusuf, Reddy, & van den Borne, 2008), and a weak sense of coherence with unfavourable behaviours (Savolainen et al., 2005). However, the effect of sense of coherence was not mediated via the periodontal status in our study participants.

The effect of Sense of coherence on OHRQoL after periodontal treatment has not been reported previously. However, this finding is consistent with a study of adolescents (Baker, Mat, & Robinson, 2010). These findings suggest that knowledge of a person's sense of coherence may be important when tailoring interventions for optimal OHRQoL and clinical outcomes. Experimental evidence demonstrated sense of coherence influenced OHRQoL in children, in whom an health promotion intervention to enhance OHRQoL was tested in a RCT (Nammontri, Robinson, & Baker 2013). Accordingly, there is scope to investigate this to help adult patients respond better to periodontal treatment.

Better OHRQoL with greater age may be due to participants adapting, by changing their expectations in response to external events with age (MacEntee, 2007) or lower expectations compared with younger people (Slade & Sanders, 2011; Steele et al., 2004).

The underlying reason for females having worse OHRQoL after treatment is unclear. Some data suggest that females have worse OHRQoL (Brauchle, Noack, & Reich, 2013; Fotedar et al., 2014), or that men report lower impacts amongst participants with periodontitis (Wellapuli & Ekanayake, 2016). However, other studies report no gender difference in participants with periodontitis (Saito et al., 2010; Miao

et al., 2016; Masood, Newton, Bakri, Khalid, & Masood, 2017; Mendez, Melchior, Angst, Stadler, Oppermann & Gomes, 2017; Sonnenschein, Betzler, Kohnen, Krisam, & Kim, 2018; El Sayed et al., 2019).

Unsurprisingly, missing teeth and the status of those remaining predicted OHRQoL. Periodontal treatment will not improve the DMFT, and so this effect persisted in these patients. Generally having better dental status is associated with better OHRQoL (Steele et al., 2004; Ng & Leung, 2006; Fotadar et al., 2014; Masood, Newton, Bakri, Khalid & Masood 2017; He, Wei, Wang, & Ji, 2018; Kato, Abrahamsson, Wide, & Hakeberg, 2018). Cumulatively, these data emphasise the value of appropriate comprehensive care.

The clinical outcomes are consistent with the many others reporting improvements in periodontal health after non-surgical treatment (Eberhard, Jervoe-Storm, Needleman, Worthington, & Jepsen, 2008; Heitz-Mayfield, Trombelli, Heitz, Needleman, & Moles, 2002; Hung & Douglass, 2002; Lang, Tan, Kraehenmann, & Zwahlen, 2008; Mailoa et al., 2015; Smiley et al., 2015; Tunkel, Heinecke, & Flemmig, 2002). This research has shown the end periodontal status is a direct predictor of OHRQoL and furthermore, has a possible mediating role for task-specific self-efficacy, self-esteem and plaque control improving OHRQoL.

There are few reports specifically on task-specific self-efficacy in relation to periodontal diseases in adults, and fewer still in patients with chronic periodontitis. Self-efficacy has been related to brushing, flossing and dental visiting (Stewart, Strack, & Graves, 1997; Syrjala, Knecht, & Knuuttila, 1999). Our finding that task-specific self-efficacy directly and positively predicted the periodontal status after treatment, highlights the possibility of enhancing task-specific self-efficacy to optimize improvements in the periodontal status, and thereby indirectly OHRQoL.

Better self-esteem directly predicting better periodontal status after treatment is also a new finding. Again, clinicians might anticipate a positive effect of high self-esteem on clinical outcomes and consideration might be given to interventions to enhance it, with an aim of improving clinical outcomes in those with low self-esteem. Whilst there are no adult studies with which to compare these findings, self-esteem is linked with oral hygiene in adolescents, when oral health beliefs and self-esteem may indirectly predict gingival bleeding via tooth brushing and oral hygiene effectiveness (Koga et al., 2019).

Better plaque control directly predicting worse periodontal health at the end of the study is difficult to explain. It may be that although plaque control improved, residual deep periodontal pockets remained after treatment (18% $\geq 6\text{mm}$). An alternative explanation might be that this is a Type 1 error. Nonetheless, a better end plaque score indirectly predicted better OHRQoL, and so taking the body of evidence as supporting the notion that good plaque control is required to maintain periodontal health, it would seem important to support and enhance these measures.

The strengths of this study include being theory driven and of longitudinal design. It is the first to use SEM to analyse OHRQoL and clinical outcomes after periodontal treatment, which enabled simultaneous analysis of a comprehensive array of predictors. The lack of a control group restricts conclusions regarding the effect of treatment. In addition, the homogeneity of the sample did not permit analysis of socioeconomic position as a predictor of OHRQoL. This would require a wider sampling frame, possibly via recruitment of patients in primary care.

5 CONCLUSIONS

Nonsurgical periodontal treatment improved OHRQoL and the clinical condition in patients with chronic periodontitis. Sense of coherence, age, periodontal status, DMFT and gender predicted OHRQoL. Task-specific self-efficacy, self-esteem and plaque score predicted the periodontal status. Interventions to enhance psychological factors may enhance treatment outcomes.

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TABLE AND FIGURE LEDGENDS

Table 1 Psychological characteristics of participants completing the study (N=140)

TABLE 2 Clinical data for participants. Periodontal probing depths (PPD), clinical attachment loss (CAL), tooth mobility index, bleeding on probing, plaque scores and DMFT at baseline and end of study time points.

Table 3 OHIP-14 Scores at study time points.

Table 4 Fit indices for measurement model, full and parsimonious SEM end of study models for periodontal status and OHRQoL.

Table 5 Direct and indirect effects of associations between individual characteristics, end of study periodontal status and OHRQoL.

Figure 1 Measurement model obtained through Confirmatory Factor Analysis including two latent variables and seven items representing end of study periodontal status and OHRQoL.

Figure 2 Full theoretical model of relationships between periodontal status, plaque, DMFT, individual demographic and psychological characteristics, smoking, environmental characteristics and end of study OHRQoL according to the Wilson and Cleary conceptual model (Wilson & Cleary, 1995).

Figure 3 Parsimonious model predictors of the end of study periodontal status and OHRQoL.