Cent. Eur. J. Med. • 7(2) • 2012 • 209-215
DOI: 10.2478/s11536-011-0125-y

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Central European Journal of **Medicine**

Oral Health-Related Quality of Life and Dental Implants – preliminary study

Research Article

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Received 20 September 2011; Accepted 2 November 2011

Abstract: Oral health-related quality of life (OHRQoL) is multifaceted and involves many factors. One of them is the use of dental implants. It was the aim of our study to assess whether implant therapy might improve OHRQoL. We consulted patients with at least one Astra Tech implant. Each patient completed oral health questionnaires, which were then statistically evaluated using the Wilcoxon signed-ranks test and Analysis of Covariance from a functional and aesthetic point of view. Differential response on individual scales was assessed using multivariate approach. All twelve marginal Wilcoxon tests showed an overall improvement in OHQoL ($\alpha = 0.05$). On the aesthetic scale, OHRQoL was found to be associated with marital status, aesthetic reasons for undergoing surgery and number of front teeth replaced by implants. On the functional scale, three covariates were statistically significantly and appeared to have affected the levels of OHRQoL. The most significant explanatory effect was observed for the number of front teeth replaced via implantation, followed by the presence of chewing problems. Marital status was also found to have significantly affected the OHRQoL functional scale. Significant implant-related improvements in both scales were observed in patients with at least one implant in the front dental area.

Keywords: *Dentistry • Implant • Quality of life*

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1. Introduction

For some patients, dental care may focus solely on the maintenance of healthy teeth and gums, whereas for others it might also include aesthetic concerns and the impact of facial appearance on their self-esteem and interaction with others [1]. Quality of life (QoL) recognizes the value of an individual's health in a broader psychological and social context. The concept of "oral health-related quality of life" (OHRQoL) captures the aim of this new perspective. [1]. OhRQoL is a multidimensional concept dealing with quality of life related specifically to oral health and diseases [2]. It reflects human experience, which has an impact on personal well-being and satisfaction with life. QoL and OHRQoL are not terms that are easy to define; these are multifaceted concepts, involving clinical measures as well as subjective responses to these measures [1].

There are complexities in the possible relationship between dental patients with missing teeth and a combination of oral malfunction and personal well-being [3]. OHRQoL has been studied for over 15 years, with development and testing of measures intended to assess the functional, social and psychological outcomes of oral disorders being carried out through self-reporting questionnaires [4]. Tooth loss can cause severe stress in adults. Difficulties in accepting tooth loss also affect

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partially dentate patients, as these patients can feel less confident, avoid laughing in public, and engaging in close relationships [3].

Using a prospective randomised controlled trial, Raghoebar et al. compared the outcomes from conventionally produced and implant-supported dentures. As expected, the outcomes after one, five and ten years of follow-up showed that the application of implant-supported dentures has at all times resulted in fewer complaints than that of conventional ones [5]. Osseointegrated dental implants were shown to represent predictable options for treatment, ranging from the replacement of individual teeth to complete arch restorations [6].

A study by Strassburger et al. reviewed the influence of prosthodontic and dental implant treatments on patient satisfaction with OHRQoL, but it concluded that very little is known about other indications than edentulism in implantology. Fully edentulous patients experience negative impacts on OHRQoL due to their condition and benefit significantly from the use of dental implants to support mandibular prostheses. However, support by more than two implants does not appear to further significantly increase patient satisfaction and OHRQoL [7]. In a systematic review, Thomason et al. presented very similar results to Strassburger et al. Most studies compared conventional dentures with implant-supported overdentures [8]. The study by Dierens et al. evaluated patient-centred outcomes of full-arch screw-retained rehabilitation on immediately loaded implants and confirmed significant improvement in general patient satisfaction [9]. In our study we covered replacement of a single tooth, anchor to hold a bridge and complete edentulism for dental implant placement using only one implantological system.

We opted for the Astra Tech Implant System™, which proved to be an efficient, reliable and safe implantological system. The main features of the system are as follows: Conical Seal Design™, MicroThread™, and Connective Contour™. The system is documented from a long-term perspective with regards to prospective clinical studies on partially dentate patients treated with fixed partial bridge [10], totally edentulous patients treated with overdentures [11], or fixed full bridge [12].

The aim of our study was to assess whether the implant therapy might improve quality of life in dental patients regardless of implant location. We employed analysis of covariance to assess the association between independent predictors and the outcome within each QoL scale and to contrast the results with those obtained from an overall analysis. Using the multivariate analysis of variance we identify independent predictors associated with differential QoL response on individual QoL scales.

2. Material and Methods

Patients included in our study had at least one Astra Tech implant placed in their oral cavity, their final prosthetic reconstruction was cemented for more than one months and they responded ro our questionnaire.

The total number of inserted implants was 297. These were inserted in 39% premolars, 26% molars, 14% central and 14% lateral incisors, 8% canines and in the lower jaw: 73% molars, 21% premolars, 3% central incisors, 2% canines and 1% lateral incisors. All treatments and evaluations were carried out in accordance with the Helsinki Declaration. Ethical approval for the study was given by the Faculty Hospital Motol – Ethics Committee of the 2nd Medical School of Charles University, Prague.

Patients who were diagnosed as requiring therapy were asked to consider joining the trial. The objectives of the study were explained to patients, who were given the opportunity to give their informed consent to treatment. Prior to their involvement, patients were given an explanatory letter providing details of the project.

There were many possible reasons for receiving implants, ranging from loss of one tooth, a uni(bi)-lateral edentulous area and missing front or back teeth, up to complete edentulism. 105 patients were given a structured, one-off questionnaire and asked to participate via mail. Before receiving this letter, they were contacted by telephone and informed that they would re ceive a letter from the faculty. Patients were asked to return completed questionnaire by mail within 14 days. Ninety-seven patients filled the entry criteria to participate in the trial (esp. undertaking the final prosthetic treatment, which had to be carried out at least one month after the cementation, and completing the full survey) and were included in our study. The group consisted of 40 men and 57 women, whose mean age was 46.91 years. The questionnaire (see Table 1) was designed according to the GOHAI (Geriatric Oral Health Assessment Index) which has proven to be an excellent tool in the detection of oral disorders (4) and OHIP-14 (Oral Health Impact Profile), which measures impact of oral problems and covers physical, psychosocial and social dimensions (2). A five-point Lickert scale was used with each of the twelve QoL-related questions, identifying the frequency of difficulty experienced by a patient before and after the implantation (score 1 = “always”, score 2 = “frequently”, score 3 = “sometimes”, score 4 = “rarely”, score 5 = “never”). Questions were grouped into two categories: one dealing with dental function (difficulties biting food, difficult grinding/chewing food, difficult taste sensation, limitations on kind and amounts of food, gums and teeth

Table 1. Oral health related quality of life questionnaire. Answers to questions 5-16 according to the five-level Lickert scale: score 1 = "always", score 2 = "frequently", score 3 = "sometimes", score 4 = "rarely", score 5 = "never".

1. Age				
2. Sex	male	female		
3. Marital status	single	married	divorced	widow/widower
4. Level of education	apprentice	high school	college	university
5. Difficulties biting food – without/ with implants.				
6. Difficult grinding/chewing food – without/ with implants.				
7. Difficult taste sensation – without/ with implants.				
8. Unpleasant feeling when eating – without/with implants.				
9. Uncomfortable eating in front of people – without/with implants.				
10. Limited on kind and amounts of food – without/with implants.				
11. Difficult speaking and articulation – without/with implants.				
12. Limited on social contact with other people – without/with implants.				
13. Sensitive teeth and gums to heat/cold – without/with implants.				
14. Unsatisfied with my appearance – without/with implants.				
15. I had troubles at work – without/with implants.				
16. My troubles absolutely worsened quality of my life – without/with implants.				
17. Why I chose dental implant treatment?	my appearance – just for myself	my appearance – for my professional feeling	difficulties when grinding/chewing	

sensitive to heat/cold, unpleasant feeling when eating, subject is uncomfortable eating in the presence of other people); and the other with appearance (difficulty in speaking and articulation, level of social contact with other people, satisfaction with one's appearance, trouble at work due to missing tooth/teeth, subjective impact of dental appearance on one's quality of life). The remaining questions were demographic, and covered the patients' age, gender, marital status and level of education.

The outcome measure of changes observed per item and patient was calculated from the differences in the QoL readings recorded before and after the implants were placed. The significance of a population change in the QoL score recorded per each item was assessed using the Wilcoxon signed-ranks test applied to differences in the QoL scores recorded before and after the implants were placed.

As items appearing in the questionnaire mapped two different scales (different groups of problems – functional and aesthetic) of QoL, scores evaluating the average rate of change in the QoL were also evaluated as outcome measures pertinent to each of the two scales. The Functional Scale (FS) combined responses from seven items in the questionnaire, while the Aesthetic Scale (AS) combined responses from the remaining five.

2.1. Statistical methods

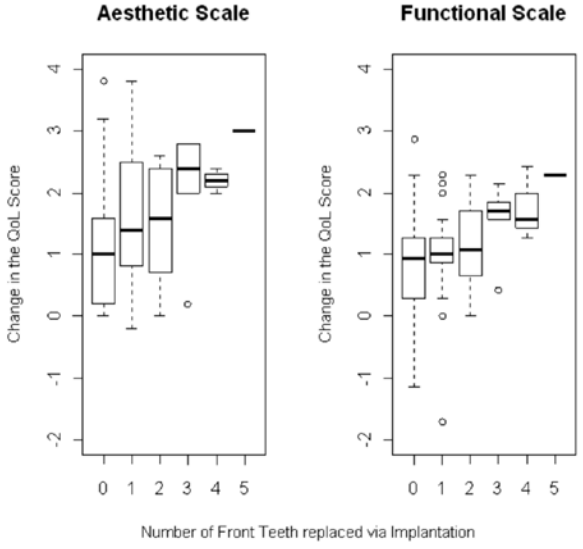
The kind and statistical significance of a change in the overall and scale-specific quality of life scores due to implants were assessed using the Analysis of Covariance (ANCOVA) modelling of pair differences in the QoL scores recorded for each patient. The results from univariate ANCOVAs were complemented with those obtained from the multivariate analysis which helped to identify independent predictors associated with differential QoL response. This analysis aims at identifying possible interactions between independent predictors and the outcome across all domains (scales) of interest. The results obtained here cannot be derived from any or all univariate ANCOVA analyses. All statistical analyses were performed using R software for statistical computing and graphics [16].

3. Results

All twelve marginal Wilcoxon signed-ranks tests supported an overall improvement in QoL due to implants, at a statistical significance level of $\alpha = 0.05$.

An unadjusted association between the number of front teeth replaced by implants and the QoL scores on the AS and FS, respectively, is shown in Figure 1. Both panels of Figure 1 show an approximately linear trend in the QoL scores as a function of the number of front teeth

Figure 1. Change in the QoL scores on the AS and FS, respectively, as a function of the number of front teeth replaced by implantation.



replaced. Analysis of Covariance allowed for studying multiple association of the outcome with several factors of interest.

3.1. ANCOVA modelling results

3.1.1. QoL assessment on the Aesthetic Scale

On the Aesthetic Scale (AS), implant-related change in the QoL scores was found to be associated with marital status, aesthetic motivation for accepting surgery (patients' concern for their personal and/or professional appearance) and the number of front teeth replaced by implants. Table 2 shows the overall statistical significance for each factor independently associated with the outcome on the AS. The number of front teeth replaced by implants appeared to have explained most of the total variance in QoL scores.

Quality of life was positively affected by the number of front teeth replaced by implants ($p = 0.0006$). This covariate had the strongest impact on the QoL scores on the AS. Other factors that affected QoL at the 0.05 statistical significance level were the concern for professional appearance ($p = 0.0028$), concern for personal appearance ($p = 0.0075$) and marital status ($p = 0.0079$).

Table 3 shows the effect, size and statistical significance of every covariate that significantly affected QoL scores on the AS. Intercept, as shown in Table 3, represents a mean difference (d) in the QoL scores due to implants in patients whose model covariates are all set to a baseline. This applies to single patients with no front teeth implants who did not express concern for their personal or professional appearance among the reasons for their implant surgery ($d = 0.2404$, $p = 0.4148$).

Every front tooth replaced by implants contributed towards an increase in QoL score by 0.29 units ($p = 0.0006$). Therefore, for example, the replacement of four front teeth through implants would result in a mean increase of 1.16 units in QoL score. Subjects who listed concern for professional appearance amongst their reasons for opting for implants saw an average increase of 0.59 units ($p = 0.0101$) in their QoL scores, similar to those who listed personal aesthetic concerns ($d = 0.59$, $p = 0.0145$). Subjects listed under marital status "Divorced" showed a further increase of 0.76 units ($p = 0.0122$) in QoL scores. Covariates such as age,

Table 2. Statistical significance of covariate effects on OHRQoL on the AS. Mean values in the show that the number of implants in the frontal area has the greatest impact on improving OHRQoL in the aesthetic scale.

Covariate	DF	Mean Sq	F-stat	p-value
Marital Status	2	4.116	5.104	0.0079
Concern regarding Personal Appearance	1	6.029	7.477	0.0075
Concern regarding Professional Appearance	1	7.631	9.463	0.0028
Number of Front Teeth Replaced	1	10.332	12.812	0.0006
Residuals	91	0.806		

Table 3. Mean difference in the AS-specific OHRQoL scores due to implants. Individual changes in the values of scores for different answers of study patients.

Regression Coefficient	Estimate (Std. Error)	p-value
Intercept	0.2404 (0.2924)	0.4148
Status="Married"	0.2249 (0.2247)	0.3194
Status="Divorced"	0.7581 (0.2965)	0.0122
Concern regarding Personal Appearance="YES"	0.5930 (0.2380)	0.0145
Concern regarding Professional Appearance="YES"	0.5882 (0.2240)	0.0101
Number of Front Teeth Replaced	0.2926 (0.0817)	0.0006

Table 4. Statistical significance of covariate effects on OHRQoL on the FS. Three variables have an impact on OHRQoL change in the FS at the significance level of p = 0.05.

Covariate	DF	Mean Sq	F-stat	p-value
Marital Status	2	1.926	3.667	0.0294
Chewing Problems	1	4.905	9.338	0.0029
Number of Front Teeth Replaced	1	6.132	11.674	0.0009
Residuals	92	0.525		

Table 6. Mean difference in the overall QoL scores due to implants. Scale-specific effects may remain hidden in the global approach to the analysis of OHRQoL. Some independent model variables can behave only as a scale-specific.

Regression Coefficient	Estimate(Std. Error)	p-value
Intercept	0.5682 (0.1653)	0.0009
Status="Married"	0.3425 (0.1835)	0.0651
Status="Divorced"	0.5717 (0.2439)	0.0212
Concern regarding Professional Appearance="YES"	0.3237 (0.1844)	0.0825
Number of Front Teeth Replaced	0.2529 (0.0675)	0.0003

gender and education did not appear to have influenced the levels of change in the QoL scores at statistical significance level α = 0.05.

3.1.2. QoL assessment on the Functional Scale

Table 4 shows that on the Functional Scale, three covariates appeared to have influenced QoL at statistical significance level α = 0.05. The most significant explanatory effect was observed with the number of front teeth replaced by implants (p = 0.0009), followed by the presence of chewing problems (p = 0.0029). Marital status was also found to have significantly affected QoL on the FS (p = 0.0294).

Intercept, as shown in Table 5, represents the mean implants-related change in the QoL scores in single patients with no front teeth implants who did not list chewing problems amongst their reasons for opting for implant surgery. Even in this group, the average

Table 5. Mean difference in the FS-specific QoL scores due to implants. Mean difference in the FS of OHRQoL in patients who have all the independent variables of the model set to baseline.

Regression Coefficient	Estimate(Std. Error)	p-value
Intercept	0.3977 (0.1601)	0.0147
Status="Married"	0.2936 (0.1911)	0.1279
Status="Divorced"	0.4163 (0.2345)	0.0792
Chewing Problems="YES"	0.4827 (0.1638)	0.0041
Number of Front Teeth Replaced	0.2239 (0.0655)	0.0009

improvement in the functional QoL appears to be statistically significant (p = 0.0147).

Patients who listed chewing problems as their reason for opting for surgery showed a further increase in the QoL scores (d = 0.48, p = 0.0041). Divorced subjects showed marginally significant increase of 0.42 units (p=0.0792) in the FS-specific QoL scores. Covariates such as age, gender and education did not appear to have influenced the levels of change in the QoL scores at statistical significance level α = 0.05.

3.1.3. QoL assessment on the Overall Scale

The overall QoL score combined all twelve items of the questionnaire into one average value. Comparison of the results shown in Table 6 below with those reported above reveals an instance of 'mixing apples and oranges', where the averaging of inconsistent effects over two different scales resulted in an inevitable distortion. The magnitude and statistical significance of such effects diminished due to averaging. This is why we no longer observe chewing problems or personal concern for one's appearance amongst the significant predictors of implants-related change in the overall QoL scores.

3.1.4. Multivariate Analysis of the Quality of Life

Multivariate analysis of covariance performed for the QoL data identified age, marital status, concern for personal look, professional look, chewing problems

Table 7. Multivariate Analysis of Differential Response in the Quality of Life in the Two QoL Scales (Aesthetic & Functional). Age, marital status, and three possible reasons for implantation were associated with different responses, as well as the number of implants in the frontal area.

		Pillai's Test		Num, Denom	
Covariate	DF	Statistic	Approx. F	DF	Pr(>F)
Intercept	1	0.732	110.341	2, 81	<0.0001
Age	1	0.115	5.270	2, 81	0.0071
Marital Status	2	0.182	4.098	4, 164	0.0034
Personal Look	1	0.175	8.583	2, 81	0.0004
Professional Look	1	0.099	4.429	2, 81	0.0150
Chewing Problems	1	0.079	3.460	2, 81	0.0362
nFTR	1	0.122	5.639	2, 81	0.0051
Residuals	83				

and the number of front teeth replaced via implantation (nFTR) as the covariates associated with statistically significant differential response in the two QoL scales. A summary of the results is shown in Table 7. The most significant differential response in the AS and FS was the concern for personal appearance, followed by marital status, number of front teeth replaced by implants, age, concern for professional look and chewing problems.

4. Discussion

It may be expected that some covariates act in a scale-specific way, that is to say, the affect the QoL scores differently on different scales; this underscores the importance of identifying the scales on which the association between predictor and the outcome may possibly change. On the other hand, statistical significance of consistent effects retained in the overall analysis could be expected to increase, as was the case with the number of front teeth replaced by implants.

It is rather obvious that the overall measure of quality of life combined the results from the two domains in no optimal way. Several covariate effects which appeared more pronounced and more significant within a particular scale were reduced when the two scales were combined. This is because different covariates influenced the QoL levels differently on different scales. This finding naturally results in the use of multivariate analysis where the QoL measures observed within the two scales jointly represent bivariate normal outcome. The multivariate analysis will allow us to identify the covariates responsible for differential response in the two domains of interest.

Quality of life is affected by oral health in the majority of population [3]. As a consequence, physical pain and psychological status related to oral condition were most frequently reported to affect adult lives [13]. It is also well known that dental implants should be employed only after the cessation of skeletal growth, that is to say, mostly in adult patients.

A fully edentulous condition has negative impact on OHRQoL [14,15]. Our data helped to reveal other conditions which had a negative impact on QoL scores. It has been concluded by Strassbuger et al. [7] that QoL studies have concentrated on dental implants in edentulous patients, but other indications for implant therapy were not discussed. Functional aspects and OHRQoL in a subject with one indication - tooth agenesis, as studied by Goshima et al. [17] and confirmed that implant-supported single crowns in tooth agenesis led to a significant increase in masticatory function as well as OHRQoL, subjectively as well as clinically.

In our study we cover virtually all indicators (excluding implant-supported overdenture), all of which utilise the same implantology system. We have thus eliminated the effect of a special type of implant and connected prosthetic components with the study results.

Tooth-supported restorations represent a traditional option for tooth replacement [18]. Allen and McMillian have shown that patients who requested implants, but received conventional dentures, reported low satisfaction with the dentures and only a modest improvement in QoL [19]. It is for this reason that we chose only patients with missing teeth who had had these teeth replaced by dental implants.

5. Conclusions

We have demonstrated that dental implant therapy has a positive, statistically significant impact on oral health-related quality of life.. All twelve parameters employed in the assessment of an impact of dental implants on the QoL have consistently supported an improvement in QoL. The use of a scale-specific approach to the analysis of QoL data helped in distinguishing the specific factors which influence outcomes. We have shown that the overall analysis does not offer a satisfactory summary of the data. Scale-specific analyses of covariance rendered more insight into the nature of changes in the QoL in relation to independent predictors. Significant implant-related improvements in the QoL scores were observed on both the aesthetic and functional scale in patients with at least one implant in the front dental sector. The use of multivariate analysis of covariance helped us in identifying predictors associated with differential response on the two scales of interest. This analysis uncovered the interactions between independent predictors and the two scales summarizing the outcome which could not be identified from any or all univariate analyses.

Acknowledgements

The work was supported by grant D-2009-56 and partially through the 1M06014 of MSMT CR project.

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