Does the quality of advanced prosthetic dentistry determine patient satisfaction?

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In a clinical follow-up study 42 patients were selected from an original sample of 335 individuals who had undergone extensive prosthetic treatment. The selection was done in accordance with a treatment satisfaction measure. The selected patients' appliances were classified in accordance with the California Dental Association (CDA) quality assessment system. Altogether, most of the new reconstructions were rated as satisfactory. The removable partial dentures had a somewhat higher share of non-acceptable appliances according to the CDA criteria. There was an association between the CDA categories and patient satisfaction. Using logistic regression analysis and knowing the CDA rating, we could correctly classify 67% of the patients with regard to the satisfaction measure. The satisfaction measure was modified on the basis of an interview, improving the model to 83% correctly classified. It was concluded that the technical quality of the prosthodontic treatment was associated with patient satisfaction. □ *Clinical follow-up study; multivariate analysis; quality control*

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It is important to assess the quality of oral restorative treatment, as this issue is a reappearing factor in several attempts to define satisfaction with dentistry (1–6). Obvious aspects for the dentist are, for example, margin integrity, surface color, anatomic form, and treatment of materials. However, the perspective of the patient does not necessarily coincide with that of the dentist (7).

Various technical details may be salient to the dentist but hardly perceptible or recognized by the patient (8). Yet, in most suggested evaluation instruments, technical competence is regarded as crucial from the patient's perspective. In one study of the relation between perceived technical competence and dental anxiety the authors concluded 'that the largest predictor of anxiety was the patients' perception of the dentist's technical competence' (9). The two parties in the clinical relationship thus do not always base their opinion about the outcome of the treatment on the same premises (10). Social and psychologic factors interact with the patient's perceptions of the reconstructions, modifying, perhaps obfuscating, any direct relationship between the technical quality and the personal satisfaction of the patient (11, 12). Still, dissatisfaction with prosthodontics, although relatively rare, is one of the main areas of complaints and conflicts in dentistry (11, 13). It is therefore important to investigate the possible direct relation between technical quality and patient satisfaction in prosthetic dentistry.

There are, however, few studies in this area. Several reasons for this scarcity of studies can be pointed out. Both the concepts 'technical quality' and 'patient satisfaction' are difficult to operationalize, both in dentistry and in other medical areas (14). It can be argued that treatment success or failure cannot be defined independent of the patient's evaluation (15).

Thus, patient satisfaction tends to be compared with various aspects of patient expectations rather than with 'objective' therapeutic outcome or its technical quality (16, 17). Alternatively, the patient's 'lay' opinion is compared with the therapist's judgement of the patient's functional ability or alleged level of pain (18). Quality assessment of dentists' work can also be regarded as delicate and sensitive by the dentists, even implying legal complications (19, 20). Consequently, there are few reliable and clinically useful evaluation systems. Further, dissatisfaction with oral restorations is comparatively rare, making it difficult to find sufficiently large clinical materials that show some variation in satisfaction.

Here, we use a quality evaluation system developed on behalf of the California Dental Association, the CDA system (21, 22). This system, used by calibrated examiners, has been shown to fulfill high requirements as to accuracy and reproducibility. It is a comprehensive system, encompassing most dental practice areas, but it also contains a special section for the assessment of prosthetic dentistry, which in this study was applied in follow-up of prosthodontic patients (14, 23). In the CDA system used here, implant therapy was not included per se. However, in the application, relevant judgement criteria for constructions were applied also when constructions were supported by osseointegrated fixtures.

With regard to patient satisfaction, no standardized measure is available, no doubt because the concept is multidimensional and complex. It cannot be captured by any single indicator. A common problem is the low discriminatory power of most measures, especially in contexts in which the professional level of dentistry is high. However, we have previously begun the development of a multidimensional measure of patient satisfaction with

special emphasis on prosthetic dentistry, presently in the process of publication (24). It is an index calculated from seven different dimensions: 1) Patient attitudes towards information and the informativeness of the dentist; 2) The general well-being of the patient; 3) The economy of the treatment; 4) The comfort of the prosthesis; The satisfaction with appearance as to 5) the number of the teeth, 6) the shape of the teeth, and 7) the color of the teeth. The comprehensiveness and multidimensionality of the measure resulted in adequate discriminatory ability. However, much work remains with regard to the validity and reliability of the measure before it can be applied clinically. The present study is a part of that work, in which quality as assessed through the CDA system will be related to satisfaction according to the measure.

The present study had two specific aims: 1) using the prosthetic part of the CDA system, several constructions will be analyzed and evaluated as to margin integrity, anatomic form, and color/surface, and 2) using the multidimensional measure of patient satisfaction as a screening instrument, the technical quality will be correlated with patient satisfaction both bivariately and in logistic regression multivariate models.

This will be done in a selected population of patients who have undergone advanced prosthetic treatment and been followed-up during at least 1 year.

Materials and methods

Study design

In a previous study the dimensions of satisfaction mentioned in the introduction were investigated among 335 patients who had recently received advanced prosthetic dentistry. This amounted to a total investigation of all such patients during April to December 1992 in one Swedish county. The satisfaction study was a questionnaire follow-up conducted during 1994. The following questions were relevant for patient satisfaction. Response alternatives are noted in parentheses.

- Have you gotten used to your new teeth yet? (Yes/No)
- Is it easier to eat/more difficult to eat/or the same as before treatment? (Yes/No)
- Did you receive sufficient information about the treatment and its result before it commenced? (Yes, absolutely sufficient/Sufficient/Insufficient/No, highly insufficient)
- Did you receive sufficient information about how to tend your teeth in the future? (Absolutely sufficient/Sufficient/Insufficient/No, highly insufficient)
- Do you think that (Your teeth are too dark/Your teeth are too light/Your teeth are too long/Your teeth are too short/Your teeth have just about the right length)?

Four items with the response alternatives (Agree absolutely /Agree/Disagree/Disagree absolutely).

- I would have preferred more teeth
- I think the number of teeth is just right
- I think my teeth have the right shape
- I think the position of my teeth is right
- Do you think that your dental treatment will affect your social self-confidence so that you (Feel more secure meeting other people?/Feel less secure meeting other people?/Same as before treatment)
- Do you think that the restoration of your mouth has affected your general health? (In general, I feel better/In general, I feel worse/No change)
- Do you think that the patient charge you pay for the performed treatment is (Far too high/Somewhat too high/Just about right/Somewhat too low/Far too low)?
- If your treatment would have been twice as expensive, would you still have gone through with it? (Yes, absolutely/Yes, maybe/No, maybe not/No, absolutely not)

The dimensionality of the components of the measure was assessed through factor analysis, in which many of the constituent items could be combined into the resulting seven dimensions. This index thus summarized information from 17 variables and was then constructed by summing dichotomies for each of the seven dimensions with satisfaction indicated as 1 and dissatisfaction as 0. It could thus range between 0 and 7 dimensions of satisfaction. The distribution was skewed but had sufficient discriminatory ability—not more than 24% of the patients scored on all seven dimensions.

During the latter part of 1995 a selection of patients were contacted once more and asked to participate in a clinical follow-up. The selected patients had then worn their prostheses during 1 year or more and were screened in accordance with the satisfaction index. Two patient groups were formed: group A contained those patients who indicated satisfaction on three or fewer dimensions and was named 'less satisfied', and group B consisted of those who indicated satisfaction on all seven dimensions and was named 'fully satisfied'.

All patients in group A were contacted (34 persons) but only every second patient in group B (31 persons). This limitation was due to available resources.

The selected patients received a letter that explained the purpose of the study, that participation was voluntary, and that the project was approved by the Lund University Ethical Committee, implying confidentiality of all results, including in relation to their regular dentist. The letter also asked for their participation in a free, painless, clinical examination and contained information about time and place for it. Travel costs were to be remunerated.

Participation

Of the 'less satisfied' group, 26 patients (77%) agreed to participate. Of the 'fully satisfied' group, 17 individuals (55%) agreed. The difference was thus rather large but not statistically significant according to a chi-square test for independence ($P = 0.0656$). Using the PRE measure lambda and with participation as the dependent variable, there was no significant improvement in predicting participation from knowing the satisfaction ($\lambda = 0.08$;

Table 1. Percentage distribution of CDA classifications of units

CDA category	Satisfactory		Not acceptable		*n*
	R*	S†	T‡	V§	
New appliances					
Margin integrity	77	19	1	4	347
Anatomic form	44	53	3	0	460
Color/surface	76	23	1	0	460
Old appliances					
Margin integrity	74	23	0	4	115
Anatomic form	40	53	7	0	149
Color/surface	48	44	8	0	149

* Range of excellence.
† Satisfactory.
‡ Replace or correct for prevention.
§ Replace immediately.

$P = 0.30$). Non-participation was due to several reasons. Three patients were deceased, one was ill at the time of the study, five could not be reached, four were unable to come to the examination, and nine refused. Of the refusers, four were 'fully satisfied', and five were 'less satisfied'.

Procedures

At the clinical visit, the patients first received verbal information about the study design and its purposes, followed by an interview with a highly experienced general practitioner (GP). The questions originally used in the mailed questionnaire in 1994 for the satisfaction classification were then posed again. Responses were recorded in a structured and standardized protocol. A repeated measure value of the satisfaction index was calculated. The result was then used for assessing test–retest reliability of the original classification of patients.

The clinical examinations were then performed by two calibrated specialists in prosthodontics (U. Hakestam and T. Karlsson of the present authors), in accordance with the CDA procedures (25). All constructions in the patients' mouths, new as well as old ones, were examined to obtain a complete picture of the patients' restorative status as a whole. In the analyses it is clearly indicated which results refer to the new and which to the old constructions and to the material as a whole.

Patient profiles

The therapy performed was categorized in three groups: group 'Fixed': 31 patients who since 1993 had received fixed prosthetic therapy in one or two jaws; group 'RPD': 9 patients who had received removable partial dentures combined with fixed prosthodontic appliances in either jaw (2 patients had two RPDs, yielding 11 RPDs that were evaluated); group 'Implants': 5 patients with osseointegrated fixtures by the method of Brånemark, one of which belonged both to the 'fixed' and 'implant' groups.

In all, 43 patients were examined, but 1 individual was afterwards excluded from the study due to internal non-response in the questionnaire. Twenty-two patients had an older construction in addition to those performed during the study period. One was an implant construction, and the others were fixed constructions.

The overall mean number of examined units per person was 13.8, and the pontic/abutment ratio for all restorations was 0.3. The total number of examined units (crowns and cantilevers) was 609. For those constructions made during the study period 460 units were examined. Obviously, the CDA category 'margin integrity' could not be assessed on cantilevers, leaving 347 teeth judged for that category. The mean number of new units per person was 10.5, and the pontic/abutment ratio was 0.3.

Statistical methods

In comparing CDA ratings with a patient property such as satisfaction, there is a problem with the level of analysis. This was solved by aggregating the CDA rating results for each patient, so that a patient was classified as having a not acceptable overall CDA rating if *any* such rating occurred in the patient's mouth, including any RPDs. The theoretical rationale for this procedure was the judgement that possible dissatisfaction would not pertain to any particular tooth but rather to the patient's perceptions of the oral status as a whole. This was also the reason for including old appliances in the analysis.

By means of contingency tables, differences were assessed by three different statistical methods: 1) By ordinary probability calculation with chi-square or Fisher's exact test when materials were small. 2) By calculating the reduction of error through Goodman and Kruskal's tau, and 3) By calculation of odds ratios (OR) with 95% confidence intervals (in two-by-two tables). Thus, different interpretations of differences are possible, in terms of independence of samples, in terms of proportional reduction of error, and in terms of chance (26, 27). Judgements of the strength of an association are based on the tau and OR values, since statistical significance

Table 2. Reasons for classification of teeth in new and old appliances as not acceptable. Number of units

Reason (CDA characterization)	New	Old
Margin integrity		
Faulty margins that cannot be properly repaired	2	0
Caries contiguous with margin of restoration	7	3
Fractured restoration	2	0
Mobile restoration	3	1
Anatomic form		
Form likely to result in food retention causing caries or irritations	5	6
Contact is faulty	3	3
Restorations grossly overcontoured	5	2
Restorations grossly undercontoured	2	0
Surface		
Surface grossly irregular not related to anatomy and not subject to correction	5	12

primarily is dependent on the size of the material and indicates the precision and not the strength of an association. For judgement of differences between the satisfaction classifications of the two measurement occasions, Cohen's kappa was used to assess the test–retest reliability of the measure (26). In a multivariate assessment of satisfaction logistic regression analysis was used, including analysis of residual plots and Cook's distances to find outliers and to judge the goodness of fit of the models (28). Logit probabilities were calculated for stereotypic persons.

Results

Quality results

On a tooth level, only including fixed restorations, three variables were evaluated in accordance with the CDA classification: margin integrity, anatomic form, and color/surface. In Table 1 the distributions of those variables are given for both the old and the new appliances.

Table 3. Dichotomized* CDA classification of units in the new appliances in different treatment categories. Percentages, absolute numbers in *P* values calculated with chi-square

	Satisfactory		Not acceptable		
CDA category	%	*n*	%	*n*	*P*
Margin integrity					
Fixed	97	(264)	3	(8)	
Implants	100	(30)	—		
RPDs	87	(39)	13	(6)	0.0023
Anatomic form					
Fixed	97	(361)	3	(10)	
Implants	94	(31)	6	(2)	
RPDs	95	(53)	5	(3)	0.3723
Color/surface					
Fixed	99	(369)	1	(2)	
Implants	100	(33)	—		
RPDs	95	(53)	5	(3)	0.0043

* The dichotomization is performed between the CDA categories R and S, judged as satisfactory, and T and V, judged as not acceptable.

As can be seen in Table 1, the vast majority of the new reconstructions were rated as satisfactory. Of 460 units, only 34 were not acceptable. There were no conspicuous differences between the new and the old appliances. The reasons for classifying teeth as not acceptable are stated in Table 2.

In a subdivision of the quality ratings of the new appliances over the three treatment categories there were significant differences with regard to margin integrity and color/surface between the treatment modalities. Owing to the limited size of the material, the subdivision was performed only on the dichotomized CDA categories. The differences were obviously due to the RPD treatment category, with higher shares of not acceptable appliances (Table 3).

The removable parts of the RPDs were judged. In sum, seven RPDs in the upper jaw and four in the lower jaw were classified. One patient had an RPD in both jaws. The classification of RPDs was done for the CDA categories 'material', 'design', and 'function'. All RPDs were accepted as to 'material'. With regard to 'design', six constructions were classified as satisfactory and five as unsatisfactory. Of the latter, four were rejected owing to inadequate saddle area extensions, and one had caused severe periodontal damage. With regard to 'function', six appliances were considered satisfactory. Of those rejected, there were three RPDs with inadequate retention and two appliances that caused pain or decreased function. All patients with a non-acceptable rating for an RPD also had such a rating on the tooth level CDA classification.

Satisfaction measure

The patients were screened to achieve maximum contrast between satisfied and less than satisfied patients. On the basis of the interview a satisfaction index was constructed, using the same variables as in the screening. The procedure was repeated with cut points set for maximum discrimination. The consistency of the satisfaction measures was high (kappa = 0.66). The distribution was different, however, at the second occasion, since especially the less than fully satisfied were spread over

Table 4. Dichotomized CDA classification of teeth in all patients cross-tabulated against the satisfaction measure. Percentages. Odds ratios (OR) with 95% (confidence interval) (CI), Goodman and Kruskal's tau, and *P* values from Fisher's exact test or chi-square

CDA category	Less satisfied	Fully satisfied	*n*
Margin integrity			
Satisfactory	53	47	30
Not acceptable	75	25	12
OR = 0.4			
95% CI = 0.1–1.7			
Tau = 0.04			
P = 0.1732			
Anatomic form			
Satisfactory	53	47	32
Not acceptable	80	20	10
OR = 0.3			
95% CI = 0.1–1.5			
Tau = 0.05			
P = 0.1258			
Color/surface			
Satisfactory	46	54	35
Not acceptable	86	14	7
OR = 0.2			
95% CI = 0.2–1.8			
Tau = 0.06			
P = 0.1294			
Overall CDA rating			
Satisfactory	24	76	21
Not acceptable	57	43	21
OR = 5.0			
95% CI = 1.1–10.0			
Tau = 0.12			
P = 0.0278			

more categories than in the screening measurement. Either they had become more satisfied over time or the measure was not constant in test–retest. The consistency was regarded as satisfactory, however.

Quality and satisfaction

The association between the CDA categories and satisfaction was first analyzed in a contingency table in which the CDA assessment was done so that a patient with any such classification in his or her mouth was classified as not acceptable (Table 4).

Results showed a rather strong association between the overall CDA rating and the satisfaction index. The point estimate of OR was 5.0, indicating a fivefold risk of having any unacceptable CDA rating for those who were dissatisfied. According to the tau measure, error in predicting satisfaction from knowing the CDA rating could be reduced by 12%. Both measures of association were significant. For the three different aspects of the quality judgements there were no separate associations with satisfaction. Restricting the analysis to only the new appliances, the overall association was weakened (tau = 0.05; $P = 0.1465$). However, it was considered that dissatisfaction may be related only to the old appliances but caused a general dissatisfaction affecting also the new appliances. Three such patients were found. They had unacceptable ratings only on their old appliances but had indicated dissatisfaction, even though the questions concerned only their satisfaction with the new appliances. When they were removed from the analysis, the association increased between the CDA rating and the satisfaction index (tau = 0.09; $P = 0.0652$). These three patients had extensive older reconstructions. In the interviews it was a clear impression that they had difficulties distinguishing whether the origin of their oral problems was the new or the old appliances.

Multivariate analysis

The results were further analyzed through construction of logistic regression models with the dichotomized satisfaction measure as dependent variable. Owing to the small size of the material, it was not possible to include variables amounting to full-model specifications; the analysis was therefore limited to keeping the age and gender of the patients constant. The results are given in Table 5.

The model did not quite reach significance as a whole, but the CDA measure was significant despite this. Bivariately, both the model and the CDA rating were significant. Two-thirds of the patients were correctly classified by the model. The model thus means that, for example, a female patient younger than 65 years and with satisfactory CDA rating has a probability of 71% of being satisfied, whereas a male person older than 65 years and with unsatisfactory CDA rating has a probability of 20% of being satisfied. These figures were obtained through calculation of logit values.

Reassessing the satisfaction measure through the interviews and rerunning the model, almost identical results were achieved, except a slight improvement of the correct classification of patients, from 66.7% to 70.7% correctly

Table 5. A logistic regression model with satisfaction as dependent variable and overall CDA rating, age, and gender as independent variables ($n = 42$)

Independent variable	Regression coefficient	Odds ratio	*P* value
Age (older than 65 years)	−0.71	0.49	0.3584
Gender (female)	0.78	2.17	0.2605
CDA rating (satisfactory)	1.5	4.30	0.0383
Intercept	−1.39		0.3570

– 2LL improvement 7.32, 3 df, $P = 0.0623$. 66.7% correctly classified.

classified. The CDA classification reached an OR of 5.93 when using the revised satisfaction index.

Using qualitative information from the interview, the satisfaction of the patients could be further reassessed. In all, the examiners judged that six patients could be reclassified as to their registered satisfaction. Of those, five who were classified as satisfied showed a measure of dissatisfaction in the interview, whereas one person revealed herself as actually satisfied with the received treatment. Using these reassessed data in another logistic regression model, the model was improved. There were 83.3% correctly classified patients, and the model was statistically significant ($P = 0.0000$). The CDA rating retained and strengthened its association with satisfaction. Recalculating the logit probability assessments, a young woman with an acceptable CDA rating had a probability of 89% of being satisfied, whereas a man older than 65 and with an unfavorable CDA rating had a probability of 18% of being satisfied.

Discussion

In an authoritative discussion of dental practice, Bader & Shugars state that 'the 'quality' of a service was defined more by its technical perfection than its success in resolving the patient's problems' (29). Insofar as this statement implies some form of contradiction between patient needs and technical excellence, it seems to be refuted by the present results. The main result here is that there is a significant association between technical quality, as assessed through the CDA system, and patient satisfaction. This result strengthens the tenet of Helen Gift, who pointed out that research has shown clear associations between health-related quality of life measures and clinical oral indicators (30).

Furthermore, our result is noteworthy in view of the general experience that disparity of patient–provider judgement of treatment quality increases when patient satisfaction is low (18), a finding, however, that may be explained by the fact that independent evaluation of treatment quality has not been made.

There were few serious complications. In this respect, our results agree with findings from previous follow-up studies of fixed prosthodontic appliances (14, 31).

The patients with removable partial dentures diverged somewhat from the general impression of high technical quality. However, there were few of them in the present material, making it hazardous to draw general conclusions. There could be several reasons for the lower quality of these appliances. The therapy is technically complicated, as it often involves precision attachments, and the dentist frequently collaborates with several different technicians. This collaboration may not always be optimal, as noted by other authors (32). Further, since the Swedish Dental Health Insurance has decreased the cost difference for RPD and FPD therapies, patients have usually chosen the more expensive therapy. An effect could be that dentists usually have less experience with RPD therapy, which is reflected in the lower quality of their work.

The validity of the satisfaction measure may be doubted since it relies on questionnaire data. However, the credibility of the main result is strengthened by the fact that the result was stable through various satisfaction classifications in which complementary information was obtained through interviews. Few patients were reclassified after these qualitative considerations. The result is thus robust and not very sensitive to changes in the satisfaction variable.

Another obvious weakness of the present study is of course the small size of the material, which makes generalization of the findings hazardous. The design of the study was not intended to retain representativity but rather to ensure maximum contrast. The issue of the relation between patient satisfaction and technical quality of the treatment at various levels of these parameters thus remains and should be the subject of future studies.

Further, it remains to be investigated whether patient dissatisfaction is directly caused by their perception of inadequacies of their appliances. An alternative explanation is that the communication was better between the dentists and the patients with good technical quality of their appliances, leading to improved satisfaction. Settling of this issue would require more intricate studies using observations of the patient–provider situation (33). An argument against this possibility could be that we found no variance associated with individual dentists concerning the quality of the therapies.

In conclusion, the present results underline the importance of high technical quality as a cornerstone of prosthetic dentistry, also when quality of life and patient satisfaction are in focus.

Further support for this contention was found in our subjective experience that almost all patients in the study expressed great satisfaction with their treatment in the interview with the general practitioner. They claimed that it had influenced their quality of life in a positive manner. This reinforced our opinion that prosthodontic rehabilitation is an important part of the patient's quality of life.

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