Towards a comprehensive model for the study of compliance in orthodontics

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SUMMARY   The aims of the present study were to explore methods used by Dutch orthodontists in daily practice to estimate and stimulate patient compliance, and to develop a theoretical model of compliance.

A questionnaire, containing 38 items, was distributed among participants at the annual congress of the Dutch Society of Orthodontists in September 2002. The items concerned the need for and the level of patient adherence during orthodontic treatment, modes of estimating and stimulating compliance, and perceived reasons for non-compliance. Based on this pilot study and on an extensive literature search, a model for future research was developed in which concepts related to compliance in orthodontics were systematically organized.

Of the 88 orthodontists who attended the congress, 51 responded (mean age 47 years, 22 per cent females). The respondents considered compliance to be of vital importance for a successful treatment result. Most patients were regarded as moderate compliers. The respondents believed that a lack of awareness of dental problems, a lack of motivation to co-operate, and personal problems were the main reasons for non-compliance. Only indirect methods were used to estimate compliance.

It was concluded that Dutch orthodontists used subjective methods to measure compliance in daily practice, and that a theoretical model was needed to be able to examine compliance in orthodontics in a more systematic way. A multiple assessment of compliance, using a variety of research methods, seems to be the most appropriate way at present to ensure accuracy in measuring levels of patient compliance in orthodontics.

Introduction

In a recent study (Mehra *et al.*, 1998), it was reported that American orthodontists in daily practice use subjective methods to predict and improve patient compliance. According to these orthodontists, the most important predictors of patient compliance are the patients' desire for, or interest in, orthodontic treatment, the frequency of broken appliances, the maintenance of good oral health, the interaction between the orthodontist and the patient, the interpersonal relationships between the patient and the parent, and the patients' perceptions of their malocclusions and facial aesthetics. Also, parent-related factors, such as punctuality in attending appointments, parental desire or interest in orthodontic treatment and the interaction between the orthodontist and the patient's parents were mentioned as predictors of patient compliance (Mehra *et al.*, 1998).

In many studies, methods for recognizing and improving patient compliance have been suggested. For instance, compliance may be assessed by measuring the amount of tooth movement, by asking the patient and parents direct and detailed questions about appliance wear, or by using electronic timing devices (Klages *et al.*, 1992; Cole, 2002). It has also been suggested that patient co-operation during orthodontic treatment may be improved by educating the patient and parents about the importance of compliance, by concentrating on the patient's activities throughout the day and by verbally praising compliant behaviour (Sahm *et al.*, 1990; Rubin, 1995).

Of all 253 registered orthodontists (mean age 47 years, 24 per cent females) working in the Netherlands, the majority (64 per cent) work alone in independent private practice. No studies were found about the methods they used to recognize and encourage patient compliance in daily practice. Do Dutch orthodontists use similar methods as American orthodontists to predict and improve patient compliance? And what can be said about the validity and reliability of these methods?

The aims of the present study were two-fold; first, as stated, current clinical methods used by Dutch orthodontists to predict and improve patient compliance in orthodontic practice were examined and evaluated. Second, an integrative, comprehensive model was developed for future theory-based studies and empirical analysis of the determinants and consequences of compliance in orthodontics.

Materials and method

The majority of orthodontists in the Netherlands are members of the Dutch Society of Orthodontics. They meet twice a year for a congress. During a congress in September 2002, a

questionnaire was distributed with the request that it should be returned by post. In October 2002, a reminder was sent to non-responders. The questionnaire was originally developed in 1993 for a study among Dutch periodontists and hygienists (Berndsen *et al.*, 1993). In the present investigation, the items were slightly reformulated, so that they fitted the sample of orthodontists. The 38 items dealt with the perceived need for patient adherence during orthodontic treatment, modes of estimating and stimulating compliance, and perceived reasons for non-compliance (see the Appendix). The items were open-ended or could be answered on an itemized rating scale (Judd *et al.*, 1991). The responses were categorized and analysed using the Statistical Package for Social Sciences 10.0 (SPSS Inc., Chicago, Illinois, USA).

The response rate was satisfactory. Of the 88 orthodontists who visited the congress, 42 responded immediately. Following the reminder, nine more orthodontists replied, bringing the sample size to 51 (response rate 63 per cent) (mean age 47 years, range 33–66 years, females 22 per cent). The data of one subject who visited the meeting as a guest of honour and one orthodontist still in training were excluded. Orthodontists in the sample had worked between 3 and 36 years in an orthodontic practice (mean years of experience = 16.7; 95 per cent confidence interval 14.5–18.9). Forty-one orthodontists (84 per cent) worked in private practice, two at a university (4 per cent), and six both in private and academic practice (12 per cent).

Results

Compliance was perceived by all orthodontists as a vital ingredient of a successful treatment result. Only a small minority stated that orthodontic treatment of a non-compliant patient can be successful, depending on the type of treatment. However, according to these subjects, the minimum contribution of the patient was his or her willingness to visit the orthodontist on a regular basis. Orthodontists considered most patients to be moderate compliers. Non- or poor compliers were seen as exceptions in their patient populations.

All respondents tried to improve compliance by giving compliments and positive feedback. They estimated compliance by questioning the patient and parent(s). Non-verbal language of both the patient and their parents was mentioned as an important indicator of compliance. The amount of eye contact between the patient and the orthodontist, and the patient and the parent was considered to be an indicator of interest and motivation, and thereby, an indirect indicator of compliance. Also, clinical indications, such as periodontal disease, the appearance of the braces and the number of loose brackets, were mentioned as possible indicators of compliance. A minority of respondents actually checked the ability of patients in handling the appliances (for example, by asking patients to fix elastics in their presence).

There were eight response options for the question 'Why do you think patients do not follow your advice completely?'. Respondents could choose more than one option. The frequencies of responses are presented in Table 1. The most important 'other reason' mentioned was puberty. Approximately 24 per cent of respondents reported that patients do not co-operate fully because of their age, because they were having 'ups and downs' as a consequence of puberty, or because they were starting to resist authority.
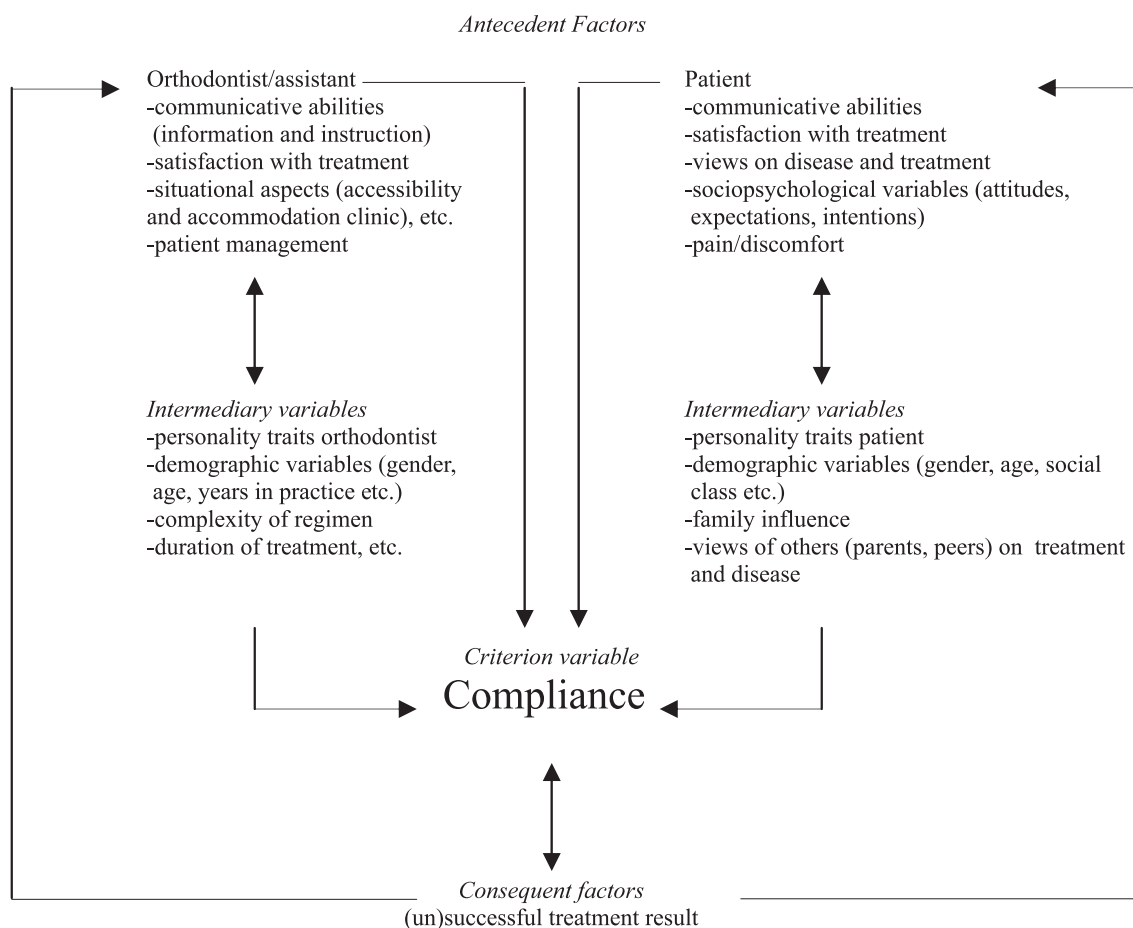
The orthodontists were also asked whether they believed they were able to predict the co-operative behaviour of a patient, after having seen him or her once or twice. Fifty-eight per cent of all respondents answered negatively, 42 per cent positively. According to those who answered positively, verbal and non-verbal communication of the patient and/or his or her parents, oral hygiene, social class, attitude of the patient and parents towards the orthodontist and staff, and knowledge of the patient about his or her own dental situation predicted future compliant behaviour.

The results of this pilot study indicated that Dutch orthodontists used several subjective methods to estimate and improve patient compliance, just like their American colleagues (Mehra *et al.*, 1998). Unfortunately, the validity and reliability of these perceptions on compliance are questionable. Because practising orthodontists may have a limited background in the behavioural basis of compliance, the decisions and behavioural styles of orthodontists are likely to be intuitively based on personal experience. The question is whether orthodontists in the present study based their views concerning compliance on evidence-based research or on private experiences or prejudices.

It is widely recognized that the strength of evidence of scientific studies decreases from experimental studies or clinical trials (in which certain conditions are under the control of the investigator) to studies without controls (such as observational studies), as the susceptibility to bias increases (Glenny and Harrison, 2003). The orthodontic

Table 1 Reasons why patients do not always comply.

	% of total sample
1. Patients did not understand the advice	33
2. Patients had not sufficiently mastered the Dutch language	12
3. Patients were not sufficiently aware of their problematic dental situation	61
4. Patients did not feel like working for their own dental health	51
5. Patients had personal problems besides their dental problem	37
6. My assistants and I lacked time to explain the advice properly	4
7. My assistants and I had not been sufficiently clear	20
8. Other reasons	24

Orthodontist/assistant
-communicative abilities
 (information and instruction)
-satisfaction with treatment
-situational aspects (accessibility
 and accommodation clinic), etc.
-patient management

Patient
-communicative abilities
-satisfaction with treatment
-views on disease and treatment
-sociopsychological variables (attitudes,
 expectations, intentions)
-pain/discomfort

Intermediary variables
-personality traits orthodontist
-demographic variables (gender,
 age, years in practice etc.)
-complexity of regimen
-duration of treatment, etc.

Intermediary variables
-personality traits patient
-demographic variables (gender, age, social
 class etc.)
-family influence
-views of others (parents, peers) on treatment
 and disease

Criterion variable
Compliance

Consequent factors
(un)successful treatment result

Figure 1   Factors that affect and result from compliance.

literature is predominately based upon observational studies, and although it is disappointing that only a few investigations are experimental in design, this may be partly due to the topics considered relevant in orthodontic research. It seems urgent to formulate hypotheses that can be tested experimentally. However, a comprehensive theoretical model in which possible variables related to compliance are systematically organized, so that clear research questions can be formulated, is lacking.

If compliance in orthodontics is to be examined in controlled studies, it is necessary to define clearly which possible variables need to be analysed, and which possible interactions between variables may be expected. In order to generate hypotheses that may be tested in future experimental studies, a preliminary theoretical model of compliance is suggested.

De Groot (1981) presented a general methodological model for psychological research. This model, called a 'nomological network', was used as the basis for the compliance model shown in Figure 1. The nomological network contains a central concept (in the present study: patient compliance), as well as antecedent factors that may affect the central concept (i.e. compliance), intermediate

variables that may influence the causal relationship between antecedent factors and the central concept, and finally consequent factors, that is the causal effects of the central concept. For example, in the presented compliance model, the amount of initial pain and discomfort experienced by orthodontic patients (antecedent factors) has been found to predict the acceptance of orthodontic appliances and treatment in general (Bartsch *et al.*, 1993; Sergl *et al.*, 1998). However, it has also been reported that certain personality traits and/or age (intermediate factors) may influence patients' adaptation to pain and discomfort during orthodontic treatment (Egolf *et al.*, 1990; Brown and Moerenhout, 1991; Jones and Chan, 1992). Therefore, although pain and discomfort can be seen as causal factors for compliance, their influence may be affected by intermediary factors.

The intermediary variables in the nomological network are fixed factors; that is, they cannot be manipulated. The antecedent factors, on the contrary, are variable and can be changed or manipulated. Pain, for instance, can be controlled, but the way one copes with pain and discomfort cannot be manipulated (coping behaviour is considered to be a fixed personality trait). The consequent factor, in this case a (un)successful treatment result, is directly affected

by the central concept or the criterion variable in the model, i.e. patient compliance.

Antecedent factors

In Figure 1, which is based on an extensive study of the literature, it is hypothesized that a number of antecedent factors are directly related to compliance. In previous studies, for example, it has been found that the communicative abilities of orthodontists, the satisfaction of the patient as well as the satisfaction of the orthodontist with the treatment and the medical encounter, the general views of the patient on disease and treatment, and socio-psychological variables are all directly related to compliance (DiMatteo *et al.*, 1993; Sinha *et al.*, 1996; Albrecht and Hoogstraten, 1998; Sergl *et al.*, 2000). Moreover, it can be argued that part of the antecedent factors are also affected by intermediary and consequent factors. So, these antecedent factors are not only a cause for compliance, but are also dependent variables.

Intermediary variables

It is assumed that intermediary variables interact with antecedent factors. For example, although demographic variables (such as age) are not consistently related to compliance (Gross *et al.*, 1988), pre-adolescent children have been judged more receptive and obedient to parental influence than adolescents and post-adolescents (Richter *et al.*, 1998). It has been shown previously that although parents have a stronger influence on patient adherence during the initial stages of treatment, later in treatment patient compliance is largely related to self-motivation (Albino *et al.*, 1991). Thus, the duration of treatment, as well as the age of the patient, may interact with an antecedent factor, such as the view of the patient on disease and treatment.

Consequent factors

Some orthodontists in the pilot study believed that the treatment result may be successful, even when a patient does not comply. However, orthodontic treatment can only start when a patient attends for a first consultation, and, when fixed appliances are used, a second consultation is unavoidable to terminate treatment. Absolute non-compliance is therefore hard to imagine among orthodontic patients. The effect of compliance on the treatment result seems to be related to the specific type of treatment a patient receives, as well as to their oral condition.

Treatment may be defined as unsuccessful when, for instance, the treatment time is longer than expected, teeth and periodontium are damaged, additional teeth are extracted, or a corrected malocclusion relapses after treatment (Southard *et al.*, 1991). These factors may be directly affected by the compliant behaviour of the patient. The consequent factors in turn may affect the antecedent factors as well as the criterion variable.

To illustrate, Bandura (1977) postulated that individuals will engage or persist in a behaviour to the extent that they believe the behaviour will lead to a desired outcome. When efficacy of behaviour (a successful treatment result) is perceived by a patient, the behaviour may be reinforced. Therefore, a successful treatment outcome may stimulate compliance, while equally the converse is true and compliance may stimulate a successful treatment outcome. Also, when patients perceive an unsuccessful treatment result, they may lose their initial motivation to co-operate, and by behaving less co-operatively, the treatment result may deteriorate.

In the presented model, a (un)successful treatment result is considered to be part of a circular process, and not simply the endpoint of a linear input–output process. In other words, cause and effect constitute a fully connected loop, such that some events in the loop can equally well be called a cause or effect.

Criterion variable

The concept of compliance is the central element in the presented theory, it is therefore vital to analyse the merits and shortcomings of the methods currently available to assess compliance. Compliance may be measured in two ways; either directly or indirectly. The primary reason to use direct measurements is that they are less subject to bias than indirect assessments. The electronic headgear timer, for instance, provides an objective measure of actual headgear usage (Cole, 2002; Bartsch and Witt, 2003). Also, a clinical assessment by orthodontists may be an appropriate and relatively objective method. However, direct measurements are often costly and time-consuming, and physiological measures do not always manifest themselves as the most coherent, consistent measures of adherence (Cummings *et al.*, 1984). Sometimes malocclusions may improve for reasons other than following the prescribed regimen. Furthermore, the cleanliness of headgear tubes and the headgear strap or the ease of placement of appliances can be measured (Cureton *et al.*, 1993). These methods, however, are more complicated, as variables such as 'cleanliness' or 'ease' must first be standardized before they can be used. Moreover, appliance maintenance has been found to have relatively little effect on overall adherence (Richter *et al.*, 1998). Indirect measurements of adherence are more frequently used in current clinical practice, possibly due to the relative ease by which these measures are obtained. However, indirect variables, such as the level of oral hygiene or non-attendance at appointments, are not necessarily valid indicators of compliance (Egolf *et al.*, 1990). Although orthodontists' judgements concerning compliance may not be completely valid and reliable, they seem to be more 'trustworthy' than patients' self-reports. In previous studies, it has been reported that patient and parent judgements about compliance were significantly less reliable than

orthodontists' judgements (Cummings *et al.*, 1984; Sahm *et al.*, 1990). Indeed, for obvious reasons patients do not always tell the truth about their behaviour. Patients and their parents should therefore be asked for detailed yet simple information, as general questions about compliance may result in unreliable answers (Sahm *et al.*, 1990). Because compliance can be measured in so many different ways, it seems that a multiple assessment of compliance, using a variety of research methods, is the most appropriate way at present to ensure accuracy in the measurement of compliance in orthodontics.

Discussion

The sample used in the pilot study is thought to be sufficiently representative of orthodontists in the Netherlands. Despite possible different perceptions at an individual level, it is clear that all respondents considered patient compliance to be a vital ingredient of a successful treatment result. They shared several methods to improve and estimate patient compliance. All orthodontists repeatedly explained to patients why compliance is necessary. They all emphasized the patients' responsibility for a successful treatment outcome and, in addition, all respondents reported that they praised compliant patients verbally. Although direct measurements are less subject to bias than indirect assessments, none of the respondents used direct methods to assess compliance. Indirect measurements of compliance were frequently used. These findings are consistent with the results of other studies (Rubin, 1995; Mehra *et al.*, 1998).

In order to generate hypotheses that may be experimentally tested in future research, so that compliance may be measured in a more valid and reliable way, a theoretical, comprehensive model has been designed. In previous studies, different models have been proposed, for example the Health Belief Model (Becker *et al.*, 1977), the Theory of Reasoned Action (Ajzen and Fishbein, 1980), and the Health Decision Model (Eraker *et al.*, 1984). However, although several components in these models are relevant in the present context, they have been used to explain behaviour in general, and not explicitly compliance in orthodontics. A major problem is that, in orthodontics, compliance cannot be explained primarily on the basis of a patient's attitude and subjective norms, as implied by Ajzen and Fishbein (1980), or on the health beliefs of individuals, as proposed by Becker *et al.* (1977), as most orthodontic patients are children or adolescents, who do not make decisions independently of their parents. Therefore, a new, preliminary model is presented. Of course, the theory proposed may be incomplete or even partly untenable.

It seems self-evident that the question of why orthodontic patients comply requires more than a single answer or variable. The proposed model may help to examine compliance in orthodontics in a more systematic way. It is recommended that in future studies the subjective methods of assessing compliance are compared with more objective estimates, in order to identify the most effective procedures in estimating compliance.

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Appendix

Questionnaire about patient compliance in orthodontics

Question	Response category
1. According to you, what is a successful treatment result?	Open-ended
2. Can a treatment result be successful when a patient does not co-operate?	Two-point scale
(2b: If answered 'yes', can you explain your answer?	Open-ended)
3. How many of your patients (as a percentage) do not co-operate sufficiently during treatment?	Six-point scale
4. How many of your patients (as a percentage) co-operate moderately during treatment?	Six-point scale
5. How many of your patients (as a percentage) co-operate fully during treatment?	Six-point scale
6. What do you do to motivate a patient to comply during treatment?	Open-ended
7. How do you know that a patient does or does not comply?	Open-ended
8. According to you, why do you think patients do not follow your advice completely?	Eight options
9. After seeing a patient once or twice, can you predict his or her compliant behaviour?	Two-point scale
(9b: If answered 'yes', can you explain your answer?	Open-ended)
10. What do you do when you feel dissatisfied about communication with a patient?	Five options
11. How do you commit your patient to the treatment?	Open-ended
12. How many of your patients (as a percentage) worry seriously about their dental situation?	Six-point scale
13. When a patient has problems in co-operating, do you think he or she will tell you so?	Three-point scale
13b. Please explain your answer	Open-ended
14. What do you do when you think a patient is not complying?	Seven options
15. What do you do when a patient does not attend an appointment?	Open-ended
16. What do you do when you notice fear in a patient?	Open-ended
17. What kind of information about treatment do you give your patients?	Open-ended
18. When giving instruction, do you take into account the knowledge/experience a patient has with orthodontic treatment?	Two-point scale
(18b: If answered 'yes', can you explain how you do that?)	Open-ended
19. When giving instructions, do you take into account the emotional state of the patient?	Two-point scale
(19b: If answered 'yes', can you explain how you do that?)	Open-ended
20. What do you do when you notice a patient does not understand your instructions?	Seven options
21. Do you think your patients feel satisfied about the atmosphere in the clinic and the waiting room?	Three-point scale
22. Do you think your patients feel satisfied about ways to reach the clinic?	Three-point scale
23. How many of your patients (as a percentage) are of an ethnic minority group?	Six-point scale
24. How important is the role of your assistant during the actual treatment of patients?	Three-point scale
24a. How important is your role during the actual treatment of patients?	Three-point scale
25. How important is the role of your assistant in communication with patients?	Three-point scale
25a. How important is your role in communication with patients?	Three-point scale
26. How important is the role of your assistant in the instruction of patients?	Three-point scale
26a. How important is your role in the instruction of patients?	Three-point scale
27. How important is the role of your assistant in stimulating patients to comply?	Three-point scale
27a. How important is your role in stimulating patients to comply?	Three-point scale
28. Who has more contact with patients, you or your assistant?	Three-point scale
29. Are you male or female?	Two-point scale
30. What is your date of birth?	Open-ended
31. How many years have you worked as an orthodontist?	Open-ended
32. In which province of the Netherlands do you work?	Open-ended
33. In what kind of practice do you work?	Three-point scale
34. How many treatment chairs do you have in your practice?	Open-ended
35. How many assistants work with you?	Open-ended
36. Do you think that, during your orthodontic training, you learnt enough about ways of communicating with patients?	Four-point scale
37. Are there questions in this questionnaire which you think are difficult to answer?	Two-point scale
(37b: If answered 'yes', please note which questions you found difficult	Open-ended)
38. Do you think the above questions concern all aspects of compliance?	Two-point scale
(38b: If answered 'no', please explain your answer	Open-ended)