Orthodontic patient co-operation: a review of the clinician’s role in predicting and improving patient compliance

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This systematic narrative review outlines factors associated with patient co-operation during orthodontic treatment. The co-operation of orthodontic patients, related to oral hygiene, appliance wear, diet and appointment attendance, can be highly influential on treatment outcome and the development of a number of potential adverse effects. While each patient is an individual with unique variations, patient age, gender, socio-economic status, parental relationships and psychological factors have been regarded as potential predictors of compliance. The assessment of potential patient co-operation can be difficult. A number of predictive methods have been attempted, including survey-based scales and subjective measurements, although, at present, clinicians lack a reliable quantitative tool for co-operation determination. Through communication, clinicians may alter patient co-operation. However, an individualised, patient-centred approach and the development of a relationship between the orthodontist and the patient remain essential.

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Background

During orthodontic treatment, a number of existing behaviours, for which the patient is ultimately responsible, may need to be modified.1 These include: maintaining an excellent standard of oral hygiene; adequate wear of removable devices (such as elastics, intraoral removable appliances, or headgear) as instructed; a consideration of diet to avoid unnecessary appliance breakages and keeping to scheduled appointment times.2,3 A lack of patient co-operation can compromise even the most well thought-out treatment plans and mechanics.2

Inadequate oral hygiene arguably may cause the greatest adverse effects during orthodontic treatment, as consequences may be irreversible.4 Gingivitis is a manageable oral health condition, which may progress to periodontitis, resulting in irreversible tissue destruction.5 The majority of orthodontic patients develop a level of gingivitis, with a biofilm shift to include a greater concentration of gram-negative bacteria, which flourish in anaerobic environments and may lead to periodontal disease.6-7 Enamel demineralisation occurs over time on a susceptible tooth surface in the presence of fermentable carbohydrates in plaque, and has been reported to occur in up to 50% of orthodontic patients.8 Enamel demineralisation initially presents as incipient white spot lesions, which may progress to cavitations in a process that occurs more rapidly in orthodontic patients compared with the general population.8 While reports emphasise the introduction of novel clinical preventive agents (such as advances in nanotechnology), a focus on patient co-operation and behaviour modification may be sufficient for the prevention of enamel demineralisation in the vast majority of patients.7
Orthodontic treatment duration should be as minimal as possible, while achieving treatment objectives, not only for patient comfort, but to reduce the risk of time-dependent adverse effects. Poor elastic wear by patients has been identified as a factor in determining treatment duration, but is unfortunately difficult to control, or to directly measure. Pain, forgetfulness and laziness were noted as the most common reasons for non-compliance in a study on factors associated with elastic wear. A lack of dietary consideration leading to breakages, as well as poor maintenance of scheduled appointments by a non-compliant patient present obvious practice management and financial issues, and could also lead to an increased treatment phase with an associated risk of reduced patient co-operation and an increase in time-sensitive adverse effects.

The aim of the present systematic narrative review was to explore the body of literature related to orthodontic patient co-operation, with a focus on predicting co-operation levels and the clinician’s role. An electronic database search of articles published in English was conducted using the PubMed database, and applying the MeSH terms of ‘patient compliance’ (encompassing patient adherence and co-operation) and ‘orthodontics’. The lead author selected the papers, including reviews, clinical trials, comparative studies and evaluation studies. Other appropriate sources were identified from bibliographic material within the selected papers. Although numerous included studies were published prior to the turn of the century, and it must be accepted that societal norms and values may have changed over time, those studies still hold valuable information regarding patient co-operation in orthodontic treatment.

Predicting patient co-operation
Many studies have been conducted to identify methods of co-operation assessment, often with conflicting results. A number of patient co-operation factors have been identified (to be discussed below). However, it must be emphasised that every patient is an individual, with variations not only in the presenting malocclusion, but also in character and response. Additionally, with continuing maturation throughout adolescence and orthodontic treatment time, predictive factors may change during the treatment period.

Patient age
Patients commonly present for orthodontic treatment during adolescence, a period in which there may be a psychological shift towards a general resistance to adult authority. This may be due to the development of a more independent identity, and a transition in the relative importance of parental values versus peer group standards. It has been suggested that the orthodontist may act as a surrogate parental figure from which the adolescent patient attempts to gain autonomy. When predictors of orthodontic compliance using the Maryland Parent Attitude Survey and Adjective Check List were investigated in 30 American adolescents aged between 12 and 18 years, it was found that age was the single best predictor, with younger children more compliant during orthodontic treatment, although it was a small study of participants with a limited age range. However, when compliance related to hours of wear of bionator appliances was assessed in German patients aged from nine to 15 years (N = 77), no relationship between age and compliance was identified. The same study identified that increased treatment duration was significantly correlated with reduced compliance, and the conclusion suggested that the relationship between compliance and age is highly complex and non-linear. Additional studies have also identified a lack of correlation between age and co-operation, although there is wide variability between the types of appliances used, and the age range of participants.

The conflicting results of past studies may reflect the confounding effect of psychological maturation, which often occurs during the time of orthodontic treatment. Maturation during adolescence is a development that may lead to a path of self-responsibility and a healthy nature, or to the establishment of health-risking behavioural traits. Both of these patterns are highly relevant to orthodontic compliance, with one being positive and the other potentially negative. Additionally, adolescents may not fully understand the consequences of their current actions on their future dental and general health. Adult orthodontic patients are more mature, recognise their own motivation for seeking treatment, are financially aware, and hence have attracted less attention regarding compliance.
Socio-economic status (SES) and academic achievement

In order to investigate potential relationships between performance on psychological tests and compliance, three questionnaires were delivered to 252 North American patients, aged between 11 and 17 years. One index (The Home Index) provided information on an individual’s home background and socio-economic status (SES). Good compliance was correlated with a Home Index score that indicated better academic abilities, and was hypothesised to be due to the connection between familial factors such as communication and family involvement in the orthodontic process. Interestingly, an association between good compliance and being an only-child has also been described.

Children from low or lower-middle class families have been identified as more compliant than those from other SES groups, although other investigations have not confirmed this association. Participants with a higher SES have been reported to be more co-operative in a number of studies, which may be attributed to the higher aesthetic values in these social groups. The studies are heterogeneous in methodology and samples, and it is unlikely that the results may successfully be extrapolated to generalised external populations. Patients who are rated as co-operative by their orthodontic providers have also been shown to be judged by their schoolteachers as being co-operative. This indicates that the response to orthodontics is likely to be an overall attitude and non-specific to the prescribed treatment. A higher level of health knowledge and awareness before treatment may also be a predictor of better co-operation.

Parental relationship

A familial environment provides the foundations on which individuals build their values, including those related to the self-perception of appearance. These values are significantly correlated between children, siblings and mothers and, to a lesser extent, fathers. Investigations that have assessed the effect of parental relationships on the co-operation of adolescent orthodontic patients have found significant correlations. The relationship between the parent and orthodontic provider, and between the provider and patient is considered predictive of compliance levels. Positive relationships with patients (and their parents) are essential in all fields of dentistry, and communication skills must be emphasised.

Teenage patients in particular may hold negative attitudes towards orthodontic appliances, which parents can aid in addressing. It has been suggested that parental control is related to patient co-operation. Patients who are compliant are more likely to spend time in organised activities with parental supervision, and have more positive social role models compared with non-compliant patients. During treatment, in a sample of 227 North American patients (aged seven to 16 years) and their parents, parental motivation levels were shown to decrease compared to pretreatment, while patient motivation did not change, and was maintained consistently at a level lower than that of the parents. An association between a parent and their child’s desire to receive orthodontic treatment was identified, which, if parental desire for treatment was high, was reflected as beneficial co-operation because more motivated children provided more co-operative responses in promising to maintain oral hygiene and elastic wear. Parental support during orthodontic treatment has also been stressed following findings of a USA-based study of 39 patients (aged 11 to 14 years) whose co-operation levels decreased in the later stages of treatment compared with eight to 10 months following treatment commencement. The investigators found that the only positive predictor of compliance at eight to 10 months into treatment was a positive attitude toward orthodontic treatment by the parent. Orthodontists must make an effort to include parents and encourage parental support during the period of orthodontic treatment.

Conversely, a poor relationship between a patient and their parent has also been associated with poor compliance. A child gaining higher scores in the Adolescent Alienation Index (measuring the level of alienation from society felt by an individual, occurring with a lack of self-esteem, for example) reflects that the individual may not feel supported by their parents, and this is associated with lower orthodontic compliance.

Psychological factors

Psychological aspects of orthodontic co-operation have been investigated following the inconsistencies regarding the predictive values of demographic factors. The hypothesis that orthodontic co-operation may be predicted via psychological testing has existed for a number of decades, with El-Mangoury among
the first to present this theory.\textsuperscript{23} The prediction of co-operation may be used in behaviour modification. It may also be used to predict outcomes and then modify treatment plans to reduce the level of co-operation required for treatment success.

Investigations on the psychology of patient compliance should reflect a current theory of health behaviour.\textsuperscript{10} The Health Belief Model, developed in the 1950s by social psychologists, is a noted theory of orthodontic patient health behaviour, with variables that assess barriers or cues to action, socio-psychological variables, susceptibility and beneficial actions.\textsuperscript{10}

An eponymous psychological test was introduced by El-Mangoury, which included an achievement and affiliation motivation test and an attribution motivation test.\textsuperscript{23} Affiliation motivation is ascribed to those individuals who seek orthodontic treatment in order to improve aesthetics, which is psychologically associated with attempting to improve relationships.\textsuperscript{24} Attribution motivation is the motivation for perceiving causes of internal or external success and failure.\textsuperscript{24} This psychological tool was tested on 70 patients (aged over 14 years), and generated a conclusion that affiliation motivation was most predictive for determining the wear of headgear, elastics, and appointment keeping; while achievement motivation was most predictive for oral hygiene.\textsuperscript{23} This conclusion is a large generalisation (suggesting only a single dimension that affects orthodontic compliance), and has been disputed by others.\textsuperscript{2} Definite conclusions were not reached in successive studies involving regression analyses from questionnaire results.\textsuperscript{2} Only small correlations were created, leading to a conclusion that personality tests were not significant predictors, which contradicts the hypothesis that psychological testing may be of predictive value.\textsuperscript{2}

The health locus of control theory was developed from Rotter’s Internal/External Scale (for obesity).\textsuperscript{25} Individuals with an internal locus of control believe that their actions affect what happens, so these patients adapt faster, with less perceived pain during orthodontic treatment.\textsuperscript{12} In contrast, individuals with an external locus of control feel that they are victims in uncontrollable situations and are less likely to be compliant during treatment.\textsuperscript{12} The relationship between the locus of control theory and compliance with headgear wear has been investigated, but the locus of control was not clearly related to co-operation.\textsuperscript{19} A later report concluded that the health locus of control theory is not suitable as a model with significant effect on orthodontic patient behaviour, as it does not recognise the complete range of personality traits involved.\textsuperscript{16} More recently, locus of control questionnaires were used in a study of 561 Korean patients (mean age 16.4 years).\textsuperscript{26} Despite the large sample size, the results did not support the hypothesis that there is a good correlation between locus of control and compliance, although an accepted limitation of the study was the possible bias introduced by subjective measures of compliance.\textsuperscript{26}

The use of the Millon Adolescent Personality Inventory in evaluating orthodontic compliance was introduced by Southard et al.\textsuperscript{27} This inventory is computer-scored and designed for adolescent populations, with measures of eight personality patterns (including inhibited and confident) and 12 regions of psychosocial concern (such as personal esteem, peer security and scholastic achievement).\textsuperscript{27} The inventory was administered to 100 North American patients (aged 13 to 18 years), and scholastic achievement and peer security were found to be important compliance factors.\textsuperscript{27} The authors cautioned against the use of the tool in a clinical setting, as further assessments were considered advisable to improve co-operation prediction.\textsuperscript{27}

**The assessment of patient co-operation**

Measures of orthodontic co-operation are essential in health research and may be used as a clinical tool to assess effectiveness in behaviour modification techniques and changes in patient compliance over time. Unfortunately, the literature regarding orthodontic patient co-operation displays many inconsistencies in the methods used to evaluate compliance, making it difficult to directly compare studies on the topic. In an attempt to prevent future research from further presenting inconsistent methods, Slakter et al. created the Orthodontic Patient Co-operation Scale involving a Likert-style format, which assessed 10 behaviours.\textsuperscript{28} The study trialled the scale on 44 American patients (in eighth- or ninth-grade), two- and six-months after the initiation of treatment.\textsuperscript{28} The scale was found to possess adequate internal consistency, and compliance measurements were stable over the two time periods; however, these were only four months apart.\textsuperscript{28} The test is time-consuming and lacks information on the motivation for, or the priority of, treatment, but may identify issues with a parental relationship.\textsuperscript{28} The scale
was also used in the 1990s by two other groups, but its use has not been widespread. 22,29

Historically, subjective measures of compliance have been utilised in co-operation literature. El-Mangoury rated compliance by recording headgear/elastic wear, appointment attendance, oral hygiene standards and appliance maintenance. 23 Comparatively, Egolf et al. used subjective clinical assessments of headgear or elastic wear, without including oral hygiene, which had previously been reported as unrelated to appliance wear. 10,23 Several additional studies have employed similar subjective measurements. 17,26 A Clinical Compliance Evaluation form was developed by Richter et al., which, when completed, provided an overall compliance score based on oral hygiene, appliance wear, appointment punctuality and appliance maintenance. 29 Objective measures were made regarding oral hygiene (a modified plaque index), appointment punctuality (by recording how late the patient was), and appliance maintenance (recording breakages or losses) with criteria assigned specific scores. 29 The measurement of appliance wear, however, remained subjective, as it was measured in the percentage of time worn, which was assessed by patient questioning and unspecified clinical examination techniques. 29 Additionally, measures of punctuality or keeping of appointments may not take into account the parental role in organising orthodontic visits.

Clinically, compliance may be measured by direct or indirect means. Direct compliance measurements involve the use of timing devices, while indirect measurements are made by clinical judgements. Built-in timing devices, producing a read-out every three to four weeks, were fitted into bionator appliances for 77 German patients (aged nine to 15 years). 11 The average compliance level was appliance wear for 56.7% of the recommended wear time, while Cole et al. reported a mean compliance rate of 74.5% (with a range of 5.6% to 107.7%) related to 16 American patients (mean age 12 years eight months) wearing headgear fitted with timing devices. 11,30 A discussion of the use of such timing devices may be worthwhile prior to the commencement of treatment as a patient who is aware that the clinician will be able to monitor their appliance use is likely to be more co-operative. Ethical issues may arise in the use of these devices without prior consent.

In a survey of orthodontists that evaluated clinical assessments of compliance, 90% of respondents measured patient co-operation by interviewing the patient or parent, examining the patient and checking the fit of the appliance. 31 Other methods used by orthodontists were looking for signs of use (75% of respondents) and appliance handling by the patient (69%). 31 Only 4% of respondents used Invisalign compliance indicators (a dye that is washed out with use, but lacks a quantitative assessment) or direct wear-time sensors (which have the disadvantage of being more costly than other methods, and some parents may find the idea distasteful as the patient is being ‘watched’). 31 Although the results indicate that clinicians lack a reliable, quantitative tool to assess patient co-operation, the response rate of the clinicians was relatively low. 31 The replication of subjective compliance measures may be predicted to be greater in more experienced clinicians. 31

The clinician’s influence on patient co-operation

Changes in health behaviour may occur by a number of means. Five stages of self-change have been described by Prochaska and DiClemente, which indicate that individuals shift between phases of pre-contemplation, contemplation, preparation, action and maintenance of change. 32 These changes were initially described in respect to smoking cessation, but are equally relevant to changes in dental behaviour. Orthodontic treatment ideally should not commence until individuals are in the action and maintenance phases (of oral hygiene, keeping appointments, following dietary instructions and wear of appliances/elastics), and orthodontists may guide patients into the contemplation or action stages (especially with the aid of parents in the case of a young patient).

As orthodontic patients are often adolescents who are in a psychological transitional period of maturation, orthodontists should educate these individuals. The expectations of treatment, as well as the significances of delaying or rejecting treatment must be discussed in terms of future consequences, with an emphasis on building a personal sense of responsibility by each patient. 12 Secondary to the finding that female patients in the sample were more concerned about aesthetics compared with males, Clemmer and Hayes suggested that orthodontists emphasise aesthetic results to female patients, predicting that males would be more responsive to a focus of the responsibility of
treatment results on their own actions and efforts; however, societal values have changed since this study was conducted.19 The authors also found that individuals with more severe malocclusions did not necessarily rate their malocclusion as being so severe, and advised orthodontists to sensitise these patients to the extent of their own malocclusion, to increase an understanding of the necessity for treatment, although this suggestion may not necessarily adhere to ethical principles.19

Patients feel more in control of their treatment if they are involved in the orthodontic process and are able to link their behaviours with treatment progress.12 At each treatment visit, it is important to emphasise and reinforce the activities that a patient is performing well, specifically in relation to how that affects an outcome. The patient should understand why maintaining good oral hygiene, following dietary advice or wearing an appliance, headgear or elastics is beneficial, rather than believing it is simply what the orthodontist wants. Several studies emphasise the role of the orthodontist-patient relationship in compliance.2,10,12,19,21,26,33 An individualised, patient-centred approach and the development of a relationship between the orthodontist and patient are essential, and may also act to reduce the discomfort perceived during orthodontic treatment.34

The use of rewards has been advised in the encouragement of orthodontic compliance in adolescent patients. It has been suggested to advise parents early in treatment to create ‘contracts’ with their children to receive a weekly privilege (such as going to the movies) in response to acceptable and responsible behaviour.35 While this method does have the benefit of involving parental support, which has been correlated with increased compliance, it may be difficult to employ for children with poor compliance in a non-supportive or busy family, and may be perceived as bribery.

Measured by the Orthodontic Patient Co-operation Scale and a newly developed Clinical Compliance Evaluation form, the effect of rewards on compliance was quantitatively assessed in a USA-based study, although an assessment of inter-examiner reliability was not included.29 After being rated in terms of compliance, 144 patients (age range nine to 17 years) were assigned to one of three groups: a control group, a group that received a graded report card at each visit, and a group that received a graded report card as well as rewards for high scores.29 It was found that those individuals who were already rated as ‘above-average compliers’ did not display any differences in compliance despite receiving rewards, although oral hygiene in the ‘below-average compliers’ group improved with rewards.29 These results indicate that a reward system based on compliance grades may be beneficial for individuals with poor compliance. This study was included in a systematic review of randomised controlled trials of interventions to increase orthodontic compliance.36 From 381 identified papers, only four were eligible for qualitative analysis, with none being suitable for meta-analysis.36 The review emphasises the heterogeneity of the orthodontic co-operation literature, and the need for future well-designed studies.36

The effect of active reminders on oral hygiene compliance in US orthodontic patients (aged 11 to 19 years) was recently investigated in a randomised controlled trial in which weekly reminders (to brush at least three times daily) were sent via text message to the experimental group.37 There were no significant differences between the control and experimental groups at baseline, but the experimental group displayed less bleeding on probing and presence of plaque four appointments after the experiment initiation.37 A randomised controlled trial based in China investigating the effects of regular educational messages via a messaging application found that the intervention was associated with reduced treatment time and increased compliance.38 Many modern practices utilise a text message system to send reminders of appointments, and these results show that a similar technique for oral hygiene or appliance wear may be beneficial, as laziness or forgetfulness have been shown to be a primary reason for a lack of compliance with elastic wear.39 A systematic review assessing compliance with removable appliance wear confirmed that further prospective research investigating the efficacy of interventions to improve compliance is required.39

Conclusion
The importance of co-operation during orthodontic treatment is well understood, with an emphasis placed on preventing prolonged treatment duration via the wear of elastics, headgear and other appliances; and/or preventing reversible and irreversible health issues such as gingivitis and enamel demineralisation. While there has been much interest regarding the topic
of co-operation among orthodontic patients, few strong conclusions have been reached regarding the evaluation and the potential for the modification of patient co-operation. Tests to assess the likelihood that an individual patient will be compliant would aid many clinicians, who may then choose to alter treatment plans to either avoid or include compliant-heavy appliances depending on the test results. The majority of demographic factors have been shown to be inconsistent in predicting patient compliance, and it is likely that factors such as age, gender and SES are far too simplistic to act as a strong tool in such prediction, although may be considered to give an idea of the patient’s individual overall background and environment. Psychological tests have also gained popularity in an attempt to predict compliance. Knowledge of a patient’s performance in the school environment may aid in forecasting compliance levels, but relationships have been found to be a vital aspect in co-operation. Parental relationships, as well as the relationship established between the orthodontist, the patient, and their parents have been shown to be useful predictors of compliance. Compliance may be assessed directly or indirectly, and it is likely that future technological developments will allow more direct monitoring in the future, without being overly invasive for the patient or parents. An essential tool in increasing compliance levels clinically is to nurture a strong relationship with the patient and their parents, treating each patient as the individual they are, to maximise the treatment outcome and satisfaction.

The authors declare that they have no competing interests.

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