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# What Factors Might Affect the Success of Fixed Appliance Therapy in Adolescent Patients? Part 1

**Abstract:** The success of orthodontic treatment can be judged in a number of ways, two of which are treatment efficiency and occlusal outcome. Treatment efficiency can be measured in terms of length of treatment and number of visits, whilst occlusal outcomes can be both dynamic and static. The factors that affect success can be considered under three headings, namely patient factors, operator factors and appliance factors. This article will consider outcome and the patient factors which might affect treatment success in our adolescent patients, whilst Part 2 will consider operator and appliance factors.

**Clinical Relevance:** The conversational model of consent requires that clinicians disclose all of the appropriate information to patients prior to them making the decision whether to accept or decline treatment.<sup>1</sup> Understanding factors that could affect the outcome with respect to both treatment efficiency and occlusal result will therefore help inform this consent process.

**Ortho Update 2013; 6: 82–85**

There are at least four stakeholders involved with orthodontic treatment namely:

- The patient;
- The parent(s)/carer(s);
- The clinical team;
- The treatment commissioner.

Each stakeholder may have a different understanding of the ideal orthodontic treatment outcome. Common sense suggests that they would all consider an aesthetically pleasing, healthy and functional occlusion, treated in the minimum time, at minimal cost and with minimal risk, to be a successful outcome. This article will attempt to define what we currently understand by the terms

‘treatment efficiency’ and ‘occlusal outcome’ and will focus on factors that have been shown to influence one or both of these measures of success.

## Treatment efficiency

The efficiency of a course of orthodontic treatment can be defined not only in terms of the total duration of treatment, but also by the total number of visits, their length, the cost and quantity of materials used and by the level of training of the person(s) required to perform the treatment tasks. Published evidence appears to focus upon the duration of treatment and number of visits.

## Duration of treatment

This may refer to the time from diagnosis, through active treatment to final debond and beyond into retention, or may just refer to the time when appliances are being worn. As might be expected, an increase in the duration of appliance wear is not only associated with an increased financial cost, both in terms of clinical time and materials, but also with an increased cost to the patient’s oral health. The longer the treatment time with fixed appliances, the greater the chances of root resorption<sup>2</sup> and the greater the likelihood of developing white spot lesions,<sup>3</sup> although this does not necessarily translate into an increased caries prevalence.<sup>4</sup> It would

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therefore seem wise to minimize the duration of active fixed appliance therapy commensurate with achieving the desired occlusal outcome.

**Number of visits**

The burden of frequent orthodontic appointments can be heavy for the clinician, the patient and the patient's family, with associated direct and indirect costs. Direct costs for the family will arise through time off work for the parent/ carer and travel for both scheduled and unscheduled visits. The latter are usually due to appliance breakages, but may also result from patient or parental concerns regarding discomfort or unexpected tooth movements, such as space opening. The direct costs for the orthodontist can be relatively easily measured in terms of material costs and the clinical time. Material costs will include not only those of the appliance, eg adhesives, brackets, tubes, wires, elastomers, but also clinic costs, such as heating and lighting, sterilization processes and protective equipment. Indirect costs to the clinical team arise through the subliminal pressure of the unpredictable emergency visit in an already busy clinic schedule. Minimizing the number of both scheduled and unscheduled appointments therefore improves treatment efficiency and is an important measure of outcome.

**Occlusal outcome**

Occlusal outcome has traditionally been measured using the PAR (Peer Assessment Rating) index, which quantifies how much the teeth deviate from normal alignment and occlusion. The index was developed in order to enable clinicians to evaluate their treatment results, to encourage self-reflection and, hopefully, to improve future occlusal outcomes.

The PAR index is applied to an individual's pre- and post-treatment study casts, with scores assigned to the various occlusal traits that make up the malocclusion before and after treatment. The difference between the two scores has been shown to be a valid and reliable means of judging the outcome of orthodontic treatment.<sup>5</sup> The PAR index is often used in longitudinal studies and is one of three main occlusal indices shown to be published in high-impact scientific literature.<sup>6</sup>

As a means of judging occlusal outcome, however, it does have some limitations. For example, PAR scoring is a record of the static and not the dynamic

occlusion, which raises the question of whether a good static occlusal result implies a good functional occlusion. A significant relationship has been found between the static and the dynamic occlusion of the incisor teeth, suggesting that a good static incisal relationship will be associated with a good functional incisal relationship, but this has not been demonstrated with molar relationships.<sup>7</sup> Since the pre-treatment PAR score includes a heavy weighting for overjet, correction of the incisor overjet to create a good static incisal relationship will lead to a low final PAR score and, hopefully, a good dynamic occlusion, although this requires more study. Moreover, PAR scoring merely records the occlusal result with respect to maxillary and mandibular alignment, overjet, crossbites, centre-lines and interdigitation. It is therefore a representation of the dental bases and does not clearly demonstrate how the orthodontic result might sit aesthetically within the patient's face.

Finally, a low PAR score does not necessarily correlate with other indices, such as the Index of Orthodontic Treatment Need (Figure 1).

Nevertheless, the PAR index is an extremely useful, albeit incomplete, measure of orthodontic outcome.

It is now worth considering the factors that might affect treatment efficiency and occlusal outcome or, in other words, factors that affect our ability to deliver orthodontic care that is 'on target and on time' (Bergstrand, lecture series 2013).

**Factors affecting treatment efficiency and occlusal outcome**

The factors affecting efficiency and outcome can be classified as:

1. Patient factors;
2. Operator factors; or
3. Appliance factors (Figure 2).

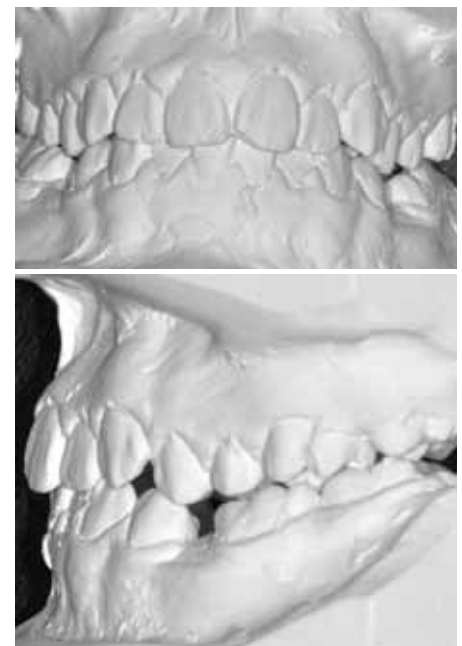
**Patient factors**

**Treatment compliance or adherence**

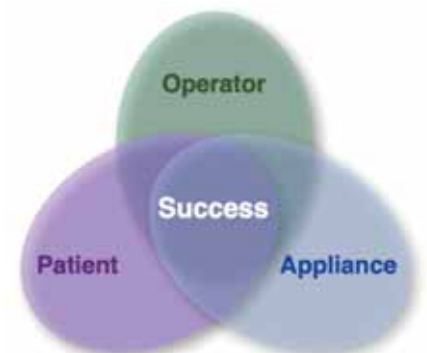
As might be expected, poor treatment compliance usually contributes to an increase in both treatment duration and the total number of visits. The term compliance suggests a level of passivity by the patient, whereas treatment adherence conveys the active participation required by the adolescent to achieve orthodontic success. Ideal treatment adherence includes regular attendance, careful oral hygiene measures and maintaining the integrity

of the fixed appliance. An investigation of the records of 140 consecutively completed fixed appliance cases from five American orthodontic offices reported an average treatment time of 28.6 months.<sup>8</sup> However, there was a range of 23.4 to 33.4 months. Nearly half (46.9%) of the cases with increased treatment duration could be explained by poor patient adherence factors. These included a higher number of missed appointments, a greater number of replacement brackets/bands and poor oral hygiene.

It should be remembered that treatment duration alone is not necessarily an accurate reflection of treatment adherence, as between 9 and 13% of cases may be debonded early for reasons of poor patient adherence.<sup>9</sup> Similarly, PAR score



**Figure 1.** (a, b) Anterior and lateral views of study models of a malocclusion with a high need for orthodontic treatment (IOTN 5i Dental Health Component) and very low pre-treatment PAR score of 7.



**Figure 2.** Diagram of the factors influencing orthodontic success.

alone is not necessarily a good indicator of compliance, as the early debond cases in the same study still achieved a mean 67% reduction in PAR score. This compared with a mean reduction of 78% within the total sample of 823 consecutively treated patients. Thus a patient with poor adherence may still complete treatment quickly and may even attain a superficially good occlusal outcome with a low final PAR score.

#### Gender

Although some patients certainly seem to break their appliances more frequently than others,<sup>8</sup> the results from studies looking at the relationship between gender and appliance breakage, and therefore one element of patient adherence, are somewhat equivocal. One study has reported bracket survival to be slightly better in females,<sup>10</sup> one has shown it to be better in males<sup>11</sup> and a third found no such correlation between breakage and gender.<sup>12</sup>

In relation to treatment duration, only one study has reported treatment duration to be longer in males, and then only by an average of 1.2 months when treated in a similar manner by the same orthodontist.<sup>13</sup> There was no suggested explanation of this variance within the discussion.

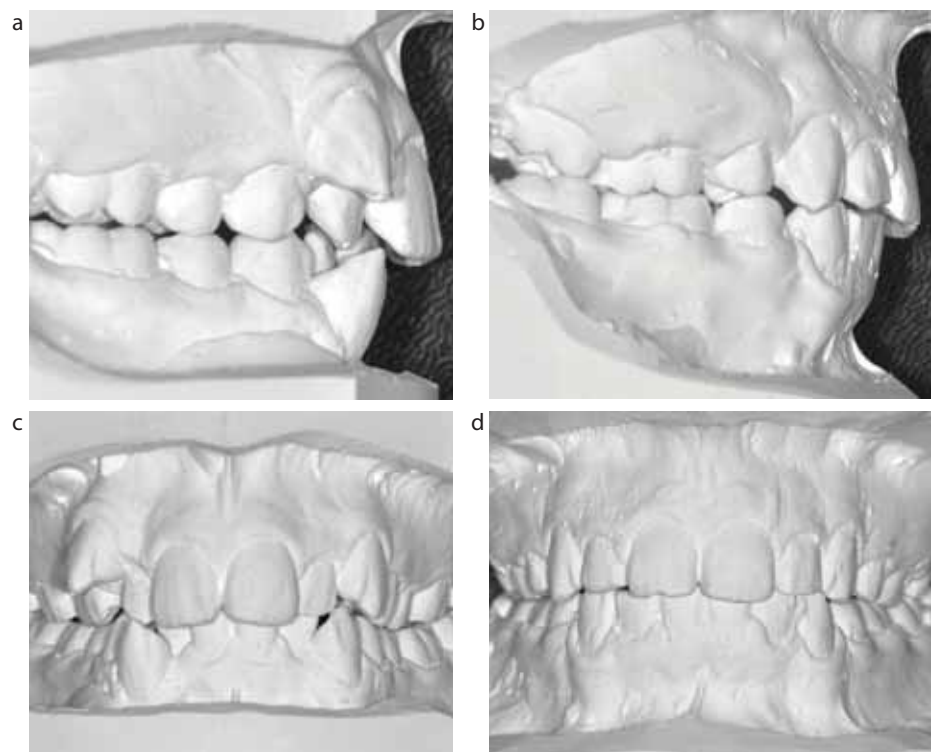
#### Age

There seems to be little evidence to link treatment duration with the age of the patient as long as the permanent dentition is present at the start of treatment. Starting treatment earlier than 9 years of age has been found to be associated with increased treatment duration and with more frequent visits,<sup>14</sup> but there appears to be no significant difference in treatment duration between adolescents starting treatment aged 12 years and those aged 16 years. It therefore appears that the stage of dental development is more significant than chronological age.<sup>15</sup>

#### Presenting malocclusion/PAR score

It might be expected that the initial presenting malocclusion could also affect treatment duration. One study found an increase of 1.3 months associated with an initial Class II molar relationship,<sup>13</sup> compared to Class I or Class III. In the same study, there was also an increase of 1.4 months in treatment duration if there was initially maxillary crowding of 3 mm or more.

Similarly, a patient with a deep overbite might be expected to take



**Figure 3.** (a-d) Anterior and lateral views of pre- and post-treatment study models of a case with a greatly improved PAR score from 46 to 2.

longer to treat than a patient with an average depth overbite. This is because reducing the overbite could prove time-consuming in itself, whilst the lower incisor brackets may be more frequently bitten off as a result of a deep overbite, requiring repeated re-bonding. Indeed, it would seem reasonable to expect that lower arch brackets would undergo more occlusal loading during mastication with resultant breakage than those on maxillary teeth in all but some Class III incisor relationships. However, to date there is no evidence to suggest this.<sup>12,16</sup> Indeed, somewhat surprisingly, one study investigating bonding adhesives found maxillary brackets (12.4%) were five times more likely to fail than mandibular brackets (2.3%).<sup>16</sup> This suggests that other patient factors, such as pen chewing or nail biting, rather than just occlusal contact, might be more important in relation to appliance breakage.

Not surprisingly, in trying to identify potential pre-treatment markers of difficult cases, a higher pre-treatment PAR score correlates well with what orthodontists consider to be the more difficult cases to treat.<sup>17</sup> The case illustrated in Figure 3 had a high pre-treatment PAR score of 46, which was reduced to just 2 at the end of 12 months of functional appliance therapy followed by four first

premolar extractions and 19 months of fixed appliance therapy. This is an example of a case with an initially high PAR and a 'greatly improved' rating of outcome (Figure 3).

In addition, with difficult cases, a mean final PAR score below 10 is seen as an acceptable or good occlusal outcome, whilst for those cases considered as being easy to treat, only a mean final PAR score of 5 or below is considered acceptable. Since the percentage reduction in PAR between these two groups is not significantly different, this suggests that the difficult cases have a greater residual malocclusion and treatment need at the end of treatment than the easy ones. Therefore, in terms of occlusal outcome, a higher initial PAR score could be considered to be a marker of a likely poorer final occlusal outcome.

However, a high initial PAR score will not necessarily prevent the orthodontist from striving to achieve an ideal occlusal result and might account for why increased treatment duration has been associated with a higher pre-treatment PAR score,<sup>18</sup> although this is not a universal finding.<sup>19</sup>

#### Patient discomfort

Pain following the placement of fixed appliances has been reported



**Figure 4.** View of cheek traumatized by the end of the archwire causing patient discomfort.

by 95% of patients,<sup>20</sup> but any possible correlation between pain experience and outcome, in terms of the duration of treatment and occlusal result, does not appear to have been reported. It could be expected that patients who suffer from more pain may be more likely to request early removal of the appliances, leading to a shorter duration of treatment. Patients may also remove components of the appliance if they are causing soreness (Figure 4) and may have an increased number of attendances if they are concerned about trauma from the appliance. Lastly, the orthodontist may be less likely to strive for a higher level of finishing if the appliances are continuing to cause discomfort, so there may be a lower level of improvement in PAR score.

The second part of this article will look at the operator and appliance factors that may influence the efficiency and efficacy of orthodontic treatment within the adolescent.

#### Acknowledgements

Thanks to the patients who have permitted the use of their photographs and also to the friends, family and colleagues who have given their time and expertise to assist in the writing of this paper.

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