

Treatment difficulty and treatment outcome in orthodontic care

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SUMMARY The influence of perceived treatment difficulty on the outcome of and investment in orthodontic treatment was studied in 19-year-old individuals treated by general practitioners or specialists within the totally subventioned Swedish system for orthodontic care. A total of 313 individuals were evaluated according to treatment outcome and treatment investment. About one-quarter of the treatments evaluated were classified as easy, one-quarter as moderately difficult, and one-half as difficult. The perceived treatment difficulty was on a group basis associated with the pretreatment need. The treatment outcome became less favourable and the treatment investment more expensive the greater the perceived difficulty. More than one-quarter of the treatments provided by general practitioners were classified as difficult compared with three-quarters of those provided by specialists. The outcomes were, in general, more favourable for specialist treatments than for those provided by general practitioners, although the individuals treated by specialists, on the average, were classified as more difficult than those provided by general practitioners. Easy treatments were found to be extremely cost-effective and should be carried out when possible. General practitioners should preferably treat uncomplicated cases, and an increased use of fixed appliances would be desirable in the treatment of moderately difficult treatments. Difficult cases should be treated exclusively by specialists. Cases with little need or benefit of treatment, or a poor prognosis should be given low treatment priority, and patients and parents should in these cases be informed about the small expected benefit and risks involved.

Introduction

To date, no suitable index has been developed to measure treatment complexity (Otuyemi and Jones, 1995). Experienced orthodontic clinicians, however, have a fairly clear perception of whether a case will be easy or difficult to treat and whether it will be stable after treatment. However, on what knowledge do they base their conclusions?

Rowe (1989) studied the assessment of 30 orthodontists in examining the pretreatment records and giving their opinion regarding difficulty of treatment. The study casts were then scored with an objective measure of malocclusion, and it was concluded that treatment difficulty and malocclusion severity were distinct, but related entities, even though some components

of malocclusion were not reliable predictors of perceived treatment difficulty. DeGuzman *et al.* (1995) made an attempt to validate the PAR Index (Richmond *et al.*, 1992) for malocclusion severity and treatment difficulty by using the opinions of a panel of 11 American orthodontists. They found a close association between the orthodontists' perception of severity of dental malocclusion and perceived difficulty of treatment. As treatment difficulty undoubtedly influences the outcome of orthodontic treatment, the process of selection of patients to be treated by a specialist or by a general practitioner is crucial (Bergström *et al.*, 1995).

Treatment difficulty, however, is only one of the many factors influencing the outcome of orthodontic treatment, which can be visualized

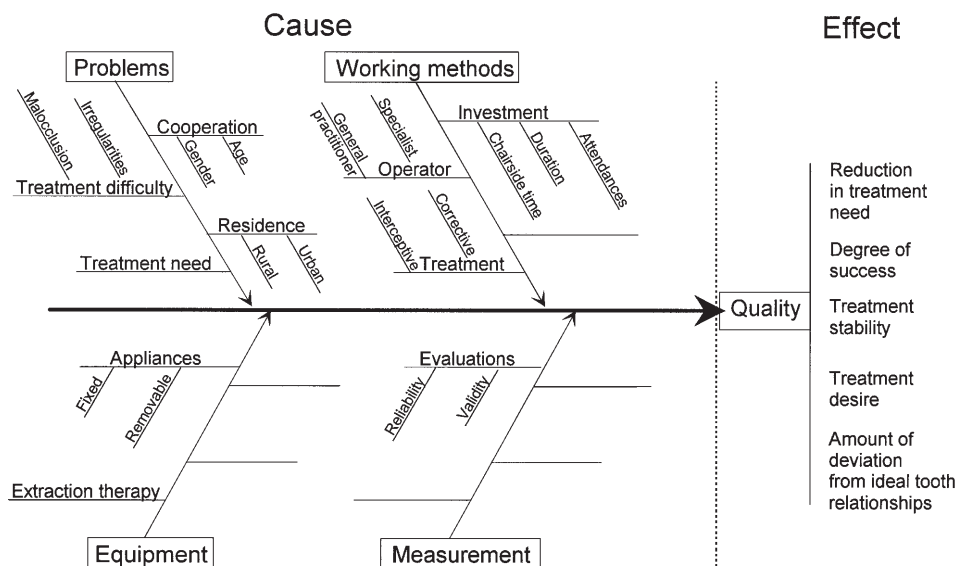


Figure 1 Factors influencing orthodontic treatment.

by a fish-bone diagram, illustrated in Figure 1 (Ishikawa, 1985).

The aim of this investigation was to study the influence of perceived treatment difficulty on the outcome of and investment in orthodontic treatment provided by general practitioners or specialists.

Subjects and methods

From samples of young adults in three Swedish counties (Bergström and Halling, 1996a) a total of 942 individuals (mean age 18.8 years, SD 0.44) were examined clinically and retrospectively in 1987 with reference to malocclusions and orthodontic treatment received during childhood and adolescence (Table 1).

The procedures and routines for examining the individuals have been described earlier (Bergström *et al.*, 1995). All individuals who had undergone orthodontic treatment (350 individuals) were selected and divided into different groups by gender, county, type of orthodontic

treatment provided, and whether the treatment was provided by a general practitioner or by a specialist. The orthodontic competence of the general practitioners was variable. Orthodontic courses of about 15 days had, however, been available in the three counties for more than 10 years. Of the 350 individuals, 37 were omitted due to insufficient documentation. In 32 of the specialist-treated individuals, an additional previous treatment episode performed by a general practitioner could be estimated. Thus, the total number to be estimated was 345 treatments in 313 individuals.

On the basis of the collected material (case notes, pre- and post-treatment study models, and photographs) and during a period of 3 months, the cases were separately estimated according to perceived treatment difficulty and treatment outcome by two orthodontic specialists (KB and LJ), who both had more than 20 years of clinical experience. When the estimated score differed between the two examiners (which occurred in 13 per cent of the judgments) a new estimation was made in consensus.

Table 1 Distribution within each of the three counties of orthodontically-treated or untreated participants.

County	Treated by				Untreated		Total
	general practitioners		specialists				
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	
Stockholm	38	11	57	17	242	72	337
Kronoberg	68	22	60	20	174	58	302
Kopparberg	97	32	30	10	176	58	303
Total	203		147		592		942

Definitions and calculations of variables used in this study (suggested treatment, treatment difficulty, treatment outcome, treatment investment, and other variables)

Suggested treatment. On the basis of pretreatment records, the optimal therapy or the *suggested treatment* was determined.

Perceived treatment difficulty. Defined as the efforts needed to establish proper (normal) tooth relationships, perceived treatment difficulty was estimated on the basis of pretreatment records according to a three-grade ordinal scale.

Easy treatment: in principle, measures of 'once-only character' involving no active treatment, e.g. extraction of temporary or permanent tooth/teeth where spontaneous alignment is expected; appliance for space maintenance.

Moderately difficult treatment: cases where *minor tooth movements* are required, e.g. teeth in crossbite where the tooth inclinations are favourable; crowded, malpositioned teeth; post-normal relations (less than half a cusp-width).

Difficult treatment: severe anomalies where *major tooth movements* are required, e.g. post-normal relations, especially in older patients; increased overbite (6 mm or more); multiple aplasia or large gaps after extraction; impacted teeth.

Even a fourth alternative was required.

No therapy suggested: when little need or benefit of treatment could be expected, or the prognosis was judged to be poor.

Treatment outcome. An overall description consisting of: (i) reduction in treatment need; (ii) degree of success (treatment result); (iii) treatment stability; (iv) treatment desire; and (v) amount of deviation from ideal tooth relationships was defined as treatment outcome:

1. The *treatment need* was analysed according to a modified Indication Index (Bergström *et al.*, 1995) and converted to a global scale (Table 2), using the calculation:

$$\text{Percentage score reduction in treatment need} = 100(\text{SB} - \text{SA})/\text{SB},$$

where SB = mean score before treatment and SA = mean score after treatment.

Table 2 Global scale for conversion of Indication Index. According to the number of markings in the different columns the treatment need is expressed as a number between 0 and 10.

Scale	Treatment need		
	Very great	Great	Moderate/ uncertain
0	0	0	0
1	0	0	1–2
2	0	0	≥3
3	0	1	0–2
4	0	1	≥3
5	0	2	0–2
6	0	2	≥3
7	0	≥3	Any
8	1	0–2	Any
9	1	≥3	Any
10	≥2	Any	Any

2. The actual *degree of success (treatment result)* related to the desired result was analysed and classified as poor, acceptable, or good.

Score 0	Poor	The treatment result does not coincide with the treatment goal. The malocclusion persists and only minor changes have occurred.
Score 0.5	Acceptable	The result coincides in part with the treatment goal. The signs of severity of malocclusion have been reduced, e.g. post-normal relations (< half a cusp-width); overbite without gingival impingement; minor crowding or spacing.
Score 1	Good	The treatment result is substantial and coincides with the treatment goal. Minor rotations or slight irregularities of single teeth may, however, be allowed.

Calculation:

degree of success = $100(n_s + 0.5n_a)/n_t$,
 where n_s = number of cases with good result,
 n_a = number of acceptable cases, and n_t = total number of cases.

3. The *treatment stability* was analysed at the age of 19 years and classified as poor, acceptable or good:

Score 0	Poor	Definite relapse observed.
Score 0.5	Acceptable	Signs of relapse observed.
Score 1	Good	No signs of relapse observed.

Calculation: mean scores.

4. The *treatment desire* was defined as the patient's degree of motivation to undergo treatment. The treatment desire after treatment was analysed (regarding further treatment) and classified as:

Great	The patient can, without reservations, accept further treatment.
Moderate	Treatment is accepted, but with certain reservations, such as 'no fixed braces', 'no surgery'.
Little	The patient is embarrassed by his malocclusion but is not willing to consider appliance therapy.
None	The patient has no or is not aware of any malocclusion and/or is not embarrassed by their malocclusion.

Calculation: percentage of individuals with *great or moderate treatment desire*.

5. As a separate process of evaluation all post-treatment study casts were classified into one of three groups according to the *amount of deviation from ideal tooth relationship*:

Score 0	Great deviation from ideal tooth relationships, e.g. pre- or post-normal relations (> half a cusp-width); cross-bite (> two pairs of teeth); great crowding or spacing.
Score 0.5	Moderate deviation from ideal tooth relationships, e.g. increased overbite without gingival impingement; minor crowding or spacing (< 2 mm/quadrant).
Score 1	No or minor deviation from ideal tooth relationships, e.g. minor rotations or slight irregularities of single teeth.

Calculation: mean scores.

Treatment investment. An overall description consisting of (1) chairside time, (2) treatment duration, and (3) number of attendances during active treatment period was defined as treatment investment:

1. *Chairside time* was calculated according to a model (see appendix), where 'time tickets' are assigned to the different aspects of treatment and then summed to determine total chairside time.

2. *Treatment duration* was registered as the length of the active treatment period to the nearest month.
3. *The number of attendances* during the active treatment period was registered.

Other variables. The provider of care (general practitioner or specialist) and the gender, county of residence, and age of the patient at the start of treatment were registered.

Reliability

The reliability was calculated by re-estimation of the records from 50 individuals randomly selected from the original sample. The time lapse between the two estimations was 2 months.

Statistics

In the statistical analysis of the reliability, the gamma statistic G was used (Siegel and Castellan, 1988). The statistical significance of differences between groups was evaluated by the chi-squared test, and differences between means were evaluated by the Mann-Whitney U test or the two-tailed Student's t -test. A probability at the 5 per cent level or less was considered statistically significant.

Results

Reliability

Correlations or degree of agreement (G) were calculated from the two evaluations. For the perceived treatment difficulty the correlation coefficient was 0.86, for the treatment need 0.93, for the treatment result 0.99, for the treatment stability 0.97, and for the amount of deviation from ideal tooth relationships 0.98.

Perceived treatment difficulty, treatment outcome, and treatment investment

Distribution of treatments according to (1) perceived treatment difficulty; (2) treatment

outcome; and (3) treatment investment are shown in Table 3.

1. Twenty-three per cent of the treatments were judged as easy, 27 per cent as moderately difficult, and 47 per cent as difficult. No treatment was advised for 3 per cent of the cases.
2. The pretreatment need score was, on average, 3.2 for easy treatments, 3.8 for moderately difficult treatments, and 4.6 for difficult treatments ($P < 0.05$). The reduction in treatment need was, on average, 77 per cent in easy treatments, 69 per cent in moderately difficult treatments, and 68 per cent in difficult treatments (NS). When no treatment was suggested, the reduction in treatment need was 24 per cent ($P < 0.001$), which means that the malocclusions had, on average, become worse. The treatment success score was, on average, 92 per cent for easy treatments, 77 per cent for moderately difficult treatments, 64 per cent for difficult treatments, and 17 per cent when no treatment was suggested ($P < 0.01$).
3. The average chairside time was estimated to be 100 minutes in easy treatments, 240 in moderately difficult treatments, and 334 in difficult treatments ($P < 0.001$). The duration of active treatment was, on average, 15 months in moderately difficult treatments and 24 months in difficult treatments ($P < 0.001$), and the average number of attendances was 13 in moderately difficult treatments compared with 23 in difficult treatments ($P < 0.001$).

Comparison between general practitioner-treated (GPT) cases and specialist-treated (SPT) cases

Distribution of treatments provided by general practitioners or by specialists according to perceived difficulty of treatment, mean age at start of treatment, and outcome of and investment in treatment are shown in Table 4.

General practitioners provided 61 per cent of the treatments and specialists 39 per cent. Seventy-three per cent of the cases treated by specialists could be classified as difficult in contrast to 29 per cent of those treated by general practitioners ($P < 0.001$). The mean ages of the

Table 3 Distribution of treatments according to perceived difficulty of treatment, and outcome of and investment in treatment. Statistically significant differences between groups are shown.¹

Perceived treatment difficulty	n	%	Treatment outcome					Treatment investment				
			Pretreatment need	Post-treatment need	Reduction in need ² (%)	Degree of success ³ (%)	Stability of active treatment 0–1	Great/moderate desire (%)	Deviations from ideal tooth relationships 0–1	Minutes	Months	Attendances
1. Easy	79	23	3.2	0.5	77	92	–	9	0.60	100	–	–
			***	***		***		*		***		
2. Moderately difficult	94	27	3.8	1.1	69	77	0.86	22	0.60	240	15	13
			*	***		***	***			***	***	***
3. Difficult	160	47	4.6	1.3	68	64	0.66	14	0.51	334	24	23
			***	*	***	***		*				*
No treatment suggested ⁴	12	3	2.1	2.2	–24	17	0.36	25	0.25	255	19	14
Totals	345	100	4.1	1.1	67	72	0.72	16	0.54	263	21	19

¹*** $P < 0.001$; ** $P < 0.01$; * $P < 0.05$.² $100 (SB - SA)/SB = RS$, where SB = score before treatment, SA = score after treatment, and RS = percentage reduction of score.³ $100(n_s + 0.5n_a)/n_t$, where n_s = number of cases with good result, n_a = number of acceptable cases, and n_t = total number of cases.⁴No treatment was suggested in the retrospective assessment. The individuals had, however, been treated.

patients at the start of treatment were 11.1 years (SD 2.17) and 13.5 years (SD 2.41) in the two groups respectively ($P < 0.001$).

The reduction in treatment need was 55 per cent among GPT cases compared with 81 per cent among SPT cases ($P < 0.001$), and the degree of success in the two groups was 67 and 80 per cent respectively ($P < 0.01$). The proportion of individuals with moderate or great desire for further treatment was 22 per cent among GPT cases, and 7 per cent among SPT cases ($P < 0.01$).

The average chairside time was estimated to be 212 minutes in GPT cases compared with 431 in SPT cases ($P < 0.001$). The duration of active treatment was, on average, 18 months in GPT cases and 23 months in SPT cases ($P < 0.01$), and the average number of attendances was 14 in GPT cases compared with 22 in SPT cases ($P < 0.001$).

In 32 of the specialist-treated individuals, an additional previous treatment episode performed by a general practitioner could be estimated. The results there were as follows. The reduction in treatment need was 5 per cent, the degree of success was 40 per cent, and the percentage of individuals with moderate or great desire for further treatment was 90 per cent. The grade of difficulty was in no case changed to a more easy classification. The average chairside time was 225 minutes in Kopparberg County, compared with 143 and 188 minutes in Kronoberg and Stockholm County, respectively ($P < 0.001$).

Comparison between counties

The proportion of treatments perceived to be easy in Stockholm County was 14 per cent, compared with 28 per cent and 23 per cent in Kronoberg and Kopparberg Counties respectively ($P < 0.05$). Cases where no treatment was suggested occurred in 0 per cent in Stockholm County, compared with 2 per cent in Kronoberg County and 7 per cent in Kopparberg County ($P < 0.05$; Table 5).

Discussion

Suggested treatment, i.e. optimal therapy, was determined on the basis of pretreatment records

and with the following question in mind: 'What would you have done if this was your child?' In other words, the judges were trying to find the best possible solution for the patient, with a reasonable expenditure of effort in proportion to the benefit. The goal was not always an ideal occlusion. When the benefit of achieving an ideal occlusion was little or doubtful in comparison with an alternative solution requiring less effort, then the suggested treatment could well be the alternative with less effort.

The three grade scale of perceived treatment difficulty was chosen to obtain an easy way of classification. The treatments were divided into non-active or active treatments, the latter being divided in two groups due to the degree of movement. Easy treatments, i.e. no active tooth movements, are not very time consuming. Even if they are defined as easy, it could, however, be difficult to select which cases are going to respond well to extraction only treatment plans. For the reason of simplicity active tooth movements were divided into two groups only, minor or major tooth movements required.

In examining 'treatment need' a modified Indication Index was used as being the best of three compared indices (Bergström and Halling, 1996b). The Indication Index was found to have the widest base for evaluation and was the only one where even expected normal or abnormal changes could be evaluated.

An easy way of classification was a major reason in the choice of the different outcome measures. A more quantitative registration of deviations in millimetres may give an appearance of objectivity. However, this is no guarantee that the validity will increase. Instead, in this study several different measures were combined to increase the validity.

The model for chairside time is only a rough estimation of time used in different procedures of treatment. In one British study, observer-generated timings were recorded (Kelly and Springate, 1996), but the method proved inefficient because of small sample sizes for the more time-consuming and infrequently performed procedures. Furthermore, several factors associated with this method were likely to result in the quoted value being an underestimation of

Table 4 Distribution of general practitioner-treated cases (GPT) or specialist-treated cases (SPT) according to perceived difficulty of treatment, mean age at start of treatment, and outcome of and investment in treatment (mean values of scores and frequencies). Statistically significant differences (=*) between GPT cases and SPT cases are shown.

Perceived treatment difficulty	GPT/ SPT	Age at start of treatment	Treatment outcome		Reduction in need ¹ (%)	Degree of success ² (%)	Stability of active treatment 0–1	Great/moderate desire (%)	Deviations from ideal tooth relationships 0–1	Treatment investment		
			Pre-treatment need	Post-treatment need						Minutes	Months	Attendances
	%	<i>n</i>										
1. Easy	21 1	74 5	3.2 3.0	0.5 0.2	77 93	93 80	– –	8 20	0.61 0.50	98 152	– –	– –
2. Moderately difficult	19 8	65 29	3.7 4.0	1.5 0.2*	54 92*	71 91*	0.84 0.91	32 0*	0.57 0.65	230 333*	12 20*	10 18*
3. Difficult	18 29	61 99	4.3 4.8	2.1 0.8*	46 80*	40 78*	0.50 0.72*	25 8*	0.34 0.63*	326 475*	24 24	19 24*
No treatment suggested ³	3 1	9 3	2.3 1.7	2.3 1.7	–38 0	11 33	0.30 0.50	33 0	0.19 0.50	271 205	20 17	15 11
Totals	61 39	209 136	3.7 4.5*	1.4 0.7*	55 81*	67 80	0.69 0.75	22 7*	0.49 0.63*	212 431*	18 23*	14 22*

¹ $100(\text{SB} - \text{SA})/\text{SB}$ = RS, where SB = score before treatment, SA = score after treatment, and RS = percentage reduction of score.

² $100(n_s + 0.5n_g)/n_t$, where n_s = number of cases with good result, n_g = number of acceptable cases, and n_t = total number of cases.

³No treatment was suggested in the retrospective assessment. The individuals had, however, been treated.

Table 5 Distribution of treatments by perceived treatment difficulty and county. *P* values have been calculated for comparison between the counties.

Perceived treatment difficulty	Stockholm County (%)	Kronoberg County (%)	Kopparberg County (%)	Total		<i>P</i> value
				<i>n</i>	(%)	
Easy	14	28	23	79	23	NS
	$P < 0.05$					
Moderately difficult	34	27	23	94	27	NS
Difficult	52	43	47	160	47	NS
No treatment suggested	0	2	7	12	3	$P < 0.05$

actual chairside time. The mean value for specialist treatments with two-arch fixed appliances was found by Kelly and Springate to be 206 minutes, compared with 475 for specialist treatments in difficult cases in this study. In another British study, Jones (1990) used appointment diaries and calculated that 334 minutes were needed to complete two-arch fixed appliance therapy. The actual time spent may vary greatly due to, e.g. the operator or the technique used. The model used in this study may be considered satisfactory for comparison between different groups of treatments and providers.

Estimation of cost in terms of money has not been made in this study, as the treatments were provided in the early eighties, and the cost per hour varied, both between individuals and groups. Considering the fact that the cost of specialist treatment was on average higher than non-specialist treatment, and that the chairside time only includes active treatment, the chairside time may, however, give some indication of the difference in cost between SPT and GPT.

The items treatment need, treatment result, treatment stability, and deviations from ideal tooth relationships are presented in Tables 3 and 4, with mean scores and statistical differences calculated according to the Mann-Whitney *U*-test. The outcome has also been analysed according to the chi-squared test with regard to differences between groups of varying degree of treatment need, treatment result etc. and similar results were found. Mean scores are used to present the results for greater comprehension.

The reliability of the estimations was high. According to the guidelines of Landis and Koch (1977), values in the range found in this study may be interpreted as almost perfect reliability. Malmgren (1980) found that the level of agreement between judgments was higher after joint training. The fact that both the examiners in this study had long clinical experience and a great deal of joint training may explain the high level of agreement between the two estimations.

The validity of the evaluations may be more difficult to determine (Carlos, 1970). To achieve high validity the assessment base should be wide enough to allow considerations important for the case to be taken into account. If an index has a narrow base, essential factors may be disregarded in the assessment. The Indication Index has a wide base for assessment (Bergström and Halling, 1997). To increase the validity of the outcome measures, it was decided to describe the treatment outcome in several ways. The reduction in treatment need presents a good picture of the outcome in finished cases, but the treatment result gives a good evaluation of treatment in the mixed dentition, where partial treatments are often carried out. The treatment goal could be, for example, to correct an incisor in crossbite. After successful completion of treatment, however, further treatment need for other reasons could still exist or could emerge later. In these cases the actual treatment result is a more valid measure. Treatment stability is an important aspect of treatment outcome. The stability was evaluated when the patients were 19 years of

age, but if treatment had been performed in late adolescence, the full extent of a possible relapse might not have been apparent. Long-term observations of treated cases after retention often reveal a disturbing degree and frequency of relapse (Sadowsky *et al.*, 1994). Treatment desire is a measure where the patient's views to some extent are registered; however, this measure is fairly rough. An interview when the patient was older would be a good complement. Deviation from ideal tooth relationships is a measure where the treatment need is disregarded. The ideal occlusion is the ultimate goal to be achieved in orthodontic treatment, in spite of the fact that there is little evidence for the validity of this (Shaw *et al.*, 1991). Together these outcome measures give a satisfactory picture of the outcome in orthodontically-treated patients.

Perceived treatment difficulty on a group basis was associated with the pretreatment need: the higher the treatment need the higher the perceived treatment difficulty. This is in line with other studies (Rowe, 1989; DeGuzman *et al.*, 1995).

Treatment outcome became less favourable with increasing difficulty of treatment. The least favourable outcome was in the group when no treatment was suggested, e.g. in cases of little need or benefit of treatment or a poor prognosis. In a study of borderline cases, as many as half of the patients did not appear to benefit from treatment (Richmond, 1992), leading to the conclusion that borderline patients should be given a low treatment priority. Shortcomings in prognosis evaluation were an important reason for treatment failure in a study by Ahlgren (1993). In these cases, patients and parents should be informed about the small expected benefit from orthodontic treatment (Birkeland *et al.*, 1996; Witt and Bartsch, 1996).

Easy treatments, e.g. mostly extraction therapy, resulted in a 92 per cent degree of success and only 9 per cent desired further treatment. The outcome of appliance treatment was, in general, lower. That easy treatments resulted in a high reduction of treatment need and a high degree of success may be explained by the fact that in cases where the results from extraction therapy are not

as good as expected, treatment is often supplemented with appliance therapy. Some of the less successful cases are thereby transferred to another group. Nevertheless, nearly every fourth treatment was successfully carried out by mere extraction therapy. This is in accordance with Persson *et al.* (1989), who found a significant capacity for spontaneous improvement by removal of all first premolars in Class I cases with crowding.

Easy treatments, for example, removal of premolars without appliance therapy, are often not reported in the literature. It seems likely that appliances are applied as a routine soon after tooth extraction. In countries where the orthodontists are salaried employees, easy treatments are more naturally integrated into the dental health care system, to be used in selected cases. These treatments are extremely cost-effective, although the need for follow-up will add some cost and, when the expected result is not achieved, appliances can be applied later. The treatment will seldom become difficult in these cases. However, the majority of cases are not suitable for such extraction only treatment plans, and appliances need to be used from the beginning.

With increasing treatment difficulty the treatment investment increased, both in chairside time, as well as duration of and number of attendances during active treatment. In GPT cases, the investments were smaller than in SPT cases. One explanation may be that difficult GPT cases with poor outcome were discontinued or referred to a specialist. It is unlikely that more chairside time invested in GPT cases would have resulted in a better outcome.

There was a greater percentage of perceived easy treatments in Kronoberg and Kopparberg Counties than in Stockholm County. This may be explained by the different treatment policies in the counties (Bergström and Halling, 1996). Treatment was provided for 42 per cent of the individuals in Kronoberg and Kopparberg Counties, compared with 28 per cent in Stockholm County. Interceptive treatment (e.g. often classified as easy treatment) was used to a great extent in Kronoberg and Kopparberg Counties, but very little in Stockholm County. The differences between counties as to which treatments

were perceived to be difficult and which moderately difficult were not statistically significant.

Originally, the orthodontic care policy in Sweden was to allow the more easy cases to be treated by general practitioners while the specialists treated the difficult cases (Linder-Aronson, 1974). According to our results, 31 per cent of the treatments handled by general practitioners were classified as moderately difficult and nearly the same proportion (29 per cent) as difficult. This distribution does not uphold the original professed intention.

The mean age of the patients at the start of treatment was lower in GPT cases than in SPT cases. This may be explained by the large proportion of early interceptive care in GPT cases, using extraction therapy or removable appliances, while in SPT cases, the wide use of fixed appliances requires that the late mixed or permanent dentition period must be completed before treatment is started (Tang and Wei, 1990).

In nearly all (95 per cent) difficult or moderately difficult treatments provided by general practitioners, removable or functional appliances were used. Treatment with fixed appliances has been shown by several authors to be more effective than treatment with removable appliances (Pickering and Vig, 1975; Tang and Wei, 1990; Richmond *et al.*, 1993), whereas no differences were found by Ahlgren (1993). The use of fixed appliances has been found to be more important than the orthodontic qualification or the level of experience of the practitioner (Richmond *et al.*, 1994). Thus, it is possible that the outcome measures for GPT cases would have been more favourable if fixed appliances had been used to a greater extent. The majority (86 per cent) of the specialist treatments in this study were carried out with fixed appliances (compared with less than 5 per cent in GPT cases), and statistical comparisons between GPT cases and SPT cases where the same type of appliances were used could therefore not be calculated in this study.

The value of comprehensive early treatment before referral to a specialist seems, in general, to be limited. Selecting patients directly for specialist care without previous appliance treatment may in these cases be a more cost-effective method. Our results indicate that general practitioners, to

a greater extent, should deal with easy instead of difficult treatments, and an increased use of fixed appliances would be desirable in moderately difficult treatments. Difficult treatments should be treated exclusively by specialists.

Conclusions

The perceived treatment difficulty in this study was associated on a group basis with the pretreatment need. About one-quarter of all treatments were classified as easy, one-quarter as moderately difficult, and one-half as difficult. The treatment investment increased and the treatment outcome became less favourable with increasing perceived difficulty of treatment. The outcome was least favourable in the group where no treatment was suggested. Almost every fourth treatment was successfully carried out by mere extraction therapy. The outcome measures were, in general, more favourable for specialist treatments than for those provided by general practitioners, in spite of the fact that the specialist treatments on average were classified as more difficult than those provided by general practitioners.

The following conclusions may thus be drawn:

1. Easy treatments were shown to be extremely cost-effective and should be carried out when possible.
2. General practitioners should preferably deal with uncomplicated cases and an increased use of fixed appliances would be desirable. Difficult malocclusions should be treated exclusively by specialists.
3. Cases with little need or benefit of treatment or a poor prognosis should be given low treatment priority. Patients and parents should, in these cases, be informed about the small benefit expected and the risks involved.

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Appendix

Model for estimating chairside time in minutes, where ‘time tickets’ are assigned to the different aspects of treatment and then summed to determine total chairside time. The model, designed by four orthodontists and one general practitioner, was applied to orthodontically-treated individuals.

Type of treatment procedure	Specialist	General practitioner
Administration		
orthodontic consultation	—	—
letter of referral	5	10
orientation at treatment start—information, discussion	15	15
registration (anamnesis, status, impressions, radiographs, photographs, and therapy planning)	60	—
radiograph or photograph during treatment/session	10	10
impressions for study casts	10	15
Extraction/surgery		
extraction of deciduous tooth	20	20
extraction of permanent tooth	30	30
extraction by surgical means	60	60
grinding of tooth/teeth	10	15
fibrotomy	30	—
fraenectomy, surgical exposure of tooth	60	60
Removable appliances		
delivery	10	20
adjustment	10	15
construction-bite for functional appliance	5	10
grinding of functional appliance	10	30
Fixed appliances		
separation before banding	5	15
application—full band, one jaw	60	—
application of lingual arch, extra-oral traction, or sectional archwire	30	60
simple check	10	15
adjustment	15	15
changing of archwire, simple	15	30
changing of archwire, complicated	30	—
recementing, rebonding	10	20
removal—simple	15	15
removal—complicated	30	—
bonding, fixed retainer	30	—